The New Commons: How Citizen Science can Support Naturally Managed Areas

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Executive Summary

Background

The Vancouver Parks Board has recently released a Request for Proposals (RFP) for the development of an ecological health assessment methodology of Naturally Managed Areas (NMA) in Vancouver Parks. This report has been constructed by a team of Simon Fraser University Environmental Science Capstone students with varied environmental education backgrounds. Creating an efficient, valuable tool to assess and continue monitoring the health of Vancouver Park is crucial to ensuring that green spaces can both be enjoyed by humans and foster urban biological diversity. Our report has been specifically constructed using Vanier Park as a template park, but the methodology is applicable to any similar forested area, or can be modified to accommodate different NMAs.

Our study site, the NMA at Vanier Park, is a small square forested subsection in Vanier park which occupies approximately one hectare of the total park area. The forest is shown as the green NMA area in Fig. 1. The forest is located in the South East section of the park (Fig. 1), and is enclosed by Whyte Avenue on the North West side of the park, a gravel parking lot and bicycle pump track on the North East side of the park, the Burrard Street Bridge and a vacant gravel lot on the South East side of the park, and The Vancouver Academy of Music Parking lot on the South West side of the park.

Fig 1. Vanier Park & Study Area NMA. Created using QGIS. Data retrieved from Vancouver Open Data portal & ESRI satellite imagery.

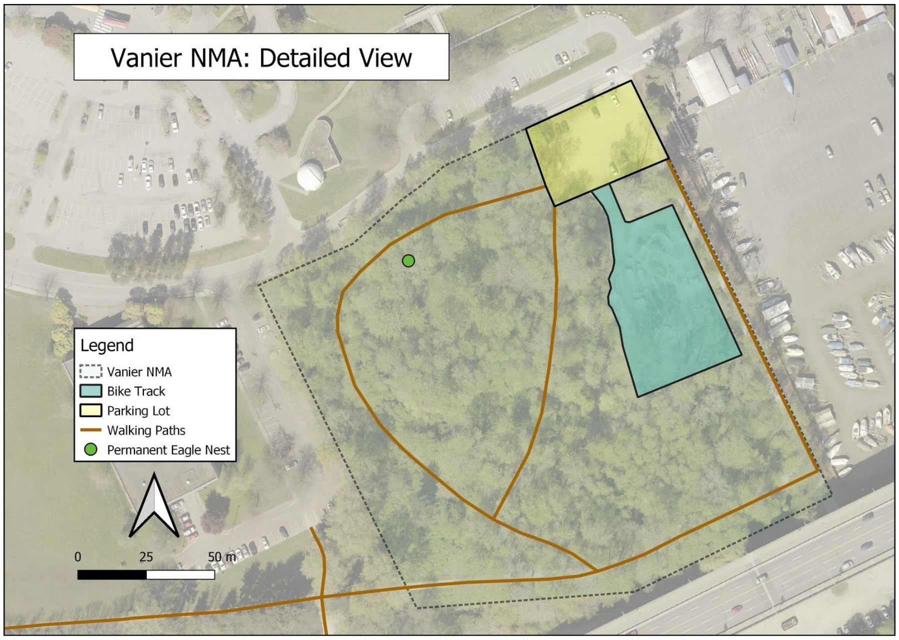

Fig 2. Vanier Park NMA Detailed View. Created using QGIS. Data retrieved from Vancouver open Data Portal & ESRI satellite imagery.

Vanier Park's NMA study area consists of two short-lived tree species - the Red Alder and Black Cottonwood - as well as low-lying invasive vegetation such as English ivy, Japanese Knotweed, and Himalayan Blackberry. In addition to this, there are two main walking paths through the forest (City of Vancouver, 2019; Fig. 2). Contained within the center portion of the wooded area are two small ephemeral bodies of water which exhibit both pond and bog features. The area is also home to an occupied natural Bald Eagle's nest (Fig. 2), a permanent artificial Eagle nesting post, multiple smaller nests, and a duck population. Some work has already been conducted in the area to remove invasive species and add longer living native species such as Douglas Fir, Western Red Cedar, Grand Fir, Sitka Spruce, Vine Maple, Red Elderberry, Salmonberry, Huckleberry, Sword Fern, and Salal (City of Vancouver, 2019).

Vanier Park's NMA displays signs of vandalism and contains a large amount of litter. Furthermore, significant invasive species presence, along with inadequate drainage, imply a low ecological health. There are areas of attempted restoration, but it appears that drainage and habitat fragmentation has negated some of the intended benefits. Additionally, many of the trail pathways are muddy and difficult to traverse. These observations and descriptions can be seen in the images in Appendix 2.

Objectives

1. Develop a methodology for determining the ecological health of Naturally Managed Areas (NMA) in Vancouver
2. Apply our methodology for determining ecological health to the NMA in Vanier Park

Methodology

Based on personal academic knowledge and thorough research, we have chosen seven criteria to represent ecological health within the Vanier Park NMA:

1. Soil pH
2. Soil Drainage (Fall-Winter/Spring-Summer)
3. Freshwater Turbidity (Visibility)
4. Percentage of Invasive Plant Species Cover
5. Littering Instances
6. Vandalism Instances
7. Percentage of Continuous Habitat (Unfragmented)

All criteria have been compiled into a one-page printable scorecard, where each category can be scored from Very Poor (1) to Excellent (5) based on the descriptive rubric included in the methodology section below. After a scorecard has been completed, all seven scores are averaged to determine an overall ecological health score between 1 and 5. The resulting average score is then rounded to the nearest number and labelled with one of the following five qualitative categories: Very Poor (1), Poor (2), Acceptable (3), Good (4), Excellent (5). The scoring criteria chosen are not comprehensive in determining ecological health, but they provide a simple and widely applicable assessment for the NMAs of concern for Vancouver Parks Board. Our intention with the proposed methodology is to create an accessible, inclusive, and efficient means for the Vancouver Parks Board to assess basic ecological health within parks. Scoring criteria have been chosen to allow a meaningful assessment to be conducted while minimizing the required equipment, training, and labour hours. This approach allows key community stakeholders to fully understand, and possibly conduct, the ecological assessments necessary for a maintained balance between ecology and recreation. For these reasons, scientific language has also been minimized in both the scorecard and the scorecard rationale.

Results

On Thursday, February 20th, 2020, our team performed an analysis of the ecological health of Vanier Park's NMA using our original methodology. The completed scorecard can be seen below. Once averaged, the determined score was 2, which indicated poor ecological health. This score was representative of our initial conclusion from our visit on Sunday, January 26th, 2020. Due to the similarity between our initial observations and our calculated value from the scorecard, we feel confident that this methodology provides a reliable and accurate overview of the ecological health of NMA's that fit within the context and scope of the RFP.

SCORECARD	VERY POOR (1)	POOR (2)	ACCEPTABLE (3)	GOOD (4)	EXCELLENT (5)	Measured Value (e.g. pH=5.8)	Score (1-5)
SOIL							
pH	<3 or >9	3 - 3.5 or 7 - 9	5 - 7	3.5 - 5		6.2	3
Fall/Winter Overall Drainage	Always Flooded	Flooded Often	Minor Flooding Occasionally	Water Levels Close to Water Table	Water Level at Water Table	Constant seasonal flooding	1
Spring/Summer Overall Drainage	Extremely Dry	Mostly Dry	Large Dry Sections	Small Dry Sections	Water Level Close to Water Table	N/A	N/A
WATER							
pH	<4 or >9.5	4 - 6 or 8.5 - 9	6 - 7 or 7.5 - 8.5	7 - 7.5		N/A	N/A
Dissolved Oxygen	0% - 25%	25% - 55%	55% - 75%	75% - 90%	90% - 110%	N/A	N/A
Temperature (° C)	>25	20 - 25	14 - 20	9 - 13	5 - 8	N/A	N/A
Stream Turbidity (Visibility)	10cm - 0cm or No Visability	23cm - 11cm or Minimal Visibility	23cm - 31cm or Some Visibility	31cm - 99cm or Mostly Clear	100cm - 160cm or Complete Clear	N/A	N/A
BIODIVERSITY							
Invasive Plant Species Percentage	>90% Invasive	90% - 50% invasive	49% - 26% invasive	25% - 10% Invasive	<10% Invasive		2
HUMAN IMPACT							
Littering		Garbage Frequent in Natural Areas and Paths	Some Garbage in Natural Areas and Paths	Minimal Garbage in Natural Areas and Paths		Variety of garbage throughout entire area	2
Ecological Vandalism Instances	Frequent Damage: >15/ha	Common Damage: 10-15/ha	Some Damage: 5-9/ha	Minimal Damage: 1-4/ha	No Damage		3
Habitat Disruption	<10 % Continuous Habitat	10% - 35% Continuous Habitat	36% - 65% Continuous Habitat	66% - 90% Continuous Habitat	>90% Continuous Habitat		2
NOTES:					FINAL SCORE:	Average Score:	2.17
						Rating (e.g. Acceptable)	POOR

Recommendations

From our analysis, we identified several possible improvements which could be made. Developing a stewardship program that tasks volunteers with removing litter and addressing vandalism would be a relatively low effort solution which would offer quickly visible improvement to the NMA. We believe that once the NMA has been cleaned up, visitors would be more likely to refrain from littering or vandalism. To support this goal, signs could be placed throughout the park which aim to educate the public on the ecological restoration efforts being performed. In addition to engaging the public on efforts underway, these signs could also discuss how the average visitor to the park can support these efforts by being respectful of the area by not littering, vandalizing the area, or venturing from the main trail. Furthermore, to reduce habitat disruption, the main trails should be emphasized visually while the non-essential trails should be, temporarily, blocked off while they are restored. Additionally, the removal of invasive species has already been highlighted as an intended course of action for Vanier Park's NMA by the City of Vancouver (2019). We agree that this is the best course of action to repopulate the area with native species and further believe that this could also fall under the responsibility of the same stewardship program discussed above.

The adjustments in the previous section are fairly immediate fixes which could be implemented quickly. Unfortunately, topics such as turbidity, drainage, and soil pH lack immediate fixes and would, instead, require persistent effort over a longer period of time. Turbidity and drainage are interrelated as standing water bodies are the result of flooding. Because of this, improving the drainage of the area to eliminate seasonal flooding would improve both drainage and turbidity. Implementing a more effective drainage system into the NMA would likely resolve these issues. There are a number of currently integrated pipes meant to direct excess surface water into sinks. These sinks, however, occur at various points in the NMA. If flooding can not be entirely eliminated, we would propose developing a manmade pond in the centre of the NMA which excess water could be directed too. This could be used to create an aquatic habitat which could be home to select aquatic species. Additionally, this would create a riparian area in the park which would provide a reliable indicator for ecosystem health. The final category to improve is soil pH. This is a difficult trait to remedy on the scale of an NMA, admittedly. One potential method for increasing soil acidity is to treat soil in the NMA with ammonium (Weil & Brady, 2016).

The implementation of these recommendations would enhance the quality of care the public has towards NMA's. By investing municipal resources into restoring NMA's, and by working to develop citizen science stewardship programs which enable residents to become active participants in the preservation of NMA's, we believe that the image of NMA's can be transformed into a modern version of the commons: green spaces which fall under the City's jurisdiction but are cared for, and appreciated, by all.

Report Authors

Jordan Gray - Client Point of Contact & Cartographer

Jordan is in the Environmental Earth System's concentration of the Environmental Science program at SFU. He has further experience with GIS, as he is pursuing his certification, and has experience from hydrogeology courses. He will be responsible for communicating with clients, creating maps, interpreting GIS data, and designing the poster.

Matt Koyanagi - Team Logistics and Photographer

Matt is in the Water Science concentration of the Environmental Science program at SFU. Matt has experience utilizing the citizen science approaches discussed in our report from his time teaching elementary school students. Beyond this, he is familiar with the processes involved in vegetation growth through a combination of soil science courses and his home gardening endeavours. Similarly to Jordan, Matt also has experience from hydrogeology courses. Matt will be responsible for scheduling team meetings, communication relevant information to all team members, and taking photos of the study site.

Liam Cormack - Editor

Liam is in the Environmental Earth System's concentration of the Environmental Science program at SFU. Liam has experience with report writing and editing through his job as an editor. Beyond this, he has experience in soil science courses as well as a familiarity with experimental design. He will be responsible for creating and editing written deliverables as well as ensure the proper integration of research, photos, and field studies.

Luc Couture - Researcher

Luc is in the Environmental Earth System's concentration of the Environmental Science program at SFU. Luc is familiar with the practices involved in the institutional governance of natural resources through his coursework at SFU. He has taken several REM courses which provided him with a solid foundation in the management of natural areas. He will be in charge of leading the research process, providing Liam with essential research to integrate, and handling the breakdown of activities performed in our field analysis.

Pritpal Dhillion - Researcher

Pritpal is in the Environmental Earth System's concentration of the Environmental Science program at SFU. He has experience from a coop semester where he was employed as a geologist. He will be responsible for assisting Luc in his research.

(Left to right) Luc Couture, Jordan Gray, and Matt Koyanagi

(Left to right) Liam Cormack, Luc Couture, and Pritpal Dhillion

Table of Contents

1 - Introduction

In this report, we propose an original methodology in response to an RFP from the Vancouver Parks Board. Our methodology takes a unique, citizen science approach to ecosystem assessments. We developed a scorecard so that is accessible to both technical experts as well as laymen so that anyone could perform ecosystem assessments. To explore the validity of our proposed methodology, we implemented our assessment tool within Vanier Park's NMA. Vanier Park's NMA is a small, square forested area approximately one hectare in area. While our assessment tool was made with universality in mind, it was developed with Vanier Park's NMA in mind. Because of this, certain features which may be typical indicators of ecosystem health - such as, for example, the health of a riparian area - are not prominent in our tool. We do believe, however, that despite having a specific template NMA in mind, our scorecard could be used by anyone at any of Vancouver's NMA's to reliably quantify its ecosystem health.

2 - Literature Review

In response to the request for proposals (RFP) from the Vancouver Parks Board, we have developed a new methodology to facilitate holistic ecosystem assessments of Vancouver's naturally managed areas. One key feature of our methodology is its accessibility to the general public. Given the emphasis placed on engaging the public in Vancouver's available literature, we aimed to create an ecosystem assessment tool which could be used by individuals with and without a technical background (City of Vancouver, 2019; City of Vancouver, 2015). With this goal in mind, we created a single page ecosystem assessment scorecard which could be taken to any one of Vancouver's naturally managed areas and used to acquire a generic understanding of the state of the ecosystem. A companion guide has been created to explain how to use the scorecard and what processes ought to be applied when assessing each variable. To ensure our methodology could be applied by as many people as possible, we opted to use non-technical terminology throughout the document (Bonney et al., 2014; Turbé et al., 2019). By empowering the public with the knowledge and tools to understand and perform ecosystem assessments, more stakeholders are brought to the table to advocate for supporting restoration efforts of Vancouver's naturally managed areas (Owen & Parker, 2018). Further, engaging citizen scientists in official projects can facilitate greater connections between the Government and its constituents (Vohland, Weißpflug, & Pettibone, 2019). In this literature review, we explore the benefits of citizen science and highlight compromises that must be made to support citizen scientists. After this introductory discussion, we examine selected variables, and relevant considerations, included in our scorecard to quantify ecosystem health of the entire NMA. We conclude by reconciling any conceptual gaps between what a citizen scientist could reasonably do and what we determined ought to be done in an ecological assessment. The goal of this literature review is to demonstrate that ecological assessments and environmental stewardship do not have to be cryptic, elitist topics left to a minority group of informed stakeholders. Rather, we argue that by presenting the material in general terms, and increasing the number of stakeholders, efforts toward ecosystem preservation and restoration can be enhanced through the greater collaborative efforts of actors with various experience.

2.1 - Citizen Science

Citizen science is a field that allows for people with minimal scientific background to take part in research projects (Bonney et al., 2014). Bonney et al. (2014) further discuss a case in Jamaica where citizen science volunteers helped collect water data in areas that could not be recorded by automation. This case is a great example of how citizen science can be used in an environment where the normal scientific means were not readily available. This is related to our methodology as it focuses on the concept that environmental scientists are not always going to be available to perform an ecological health assessment of a naturally managed area (NMA).

Robinson et al. (2018) describe citizen science as a field that is fast growing and informed by 10 principles. We focus on the principles that are most closely related to our methodology in this literature review. Robinson et al. (2018) state that citizens have important roles in projects with an actual scientific outcome where both scientists and the participants benefit. Our methodology plans on applying this concept by enabling citizens to perform the environmental health assessment which in turn helps the scientific outcome of restoration. The scientists who may not have access to go out to the field and perform the health assessment benefit from the data collection and the citizens have an enhanced ecological understanding of their local environment (Turbé et al., 2019). Using citizen science as an educational tool for environmental awareness also achieves some of the goals described by the City of Vancouver in the Biodiversity Strategy (2016) and Bird Diversity Strategy (2015) to increase awareness of the general public.

The next principle discussed by Robinson et al. (2018) is in regards to the knowledge and data being made publicly available. The generalized data citizen scientists are capable of collecting can be used to support a wide variety of research projects or policy assessments (Turbé et al., 2019). The dissemination of general citizen science data can help account for knowledge gaps in a cost-effective way (Turbé et al., 2019; Vohland et al., 2019). Making citizen science data publicly available acknowledges the citizens who put in their own efforts to the project, allows for others to be inspired to take part as a citizen scientist in another project, and allows researchers access to generalize data on environmental topics which can be used to support their research with little to no adjustments (Robinson et al., 2018; Turbé et al., 2019). This is relevant to our methodology because our goal is to not only allow for the participants to gain an understanding of ecosystem health and assessment techniques, but also to generate an attachment to the area so that their participation in citizen science in assessing the health is not limited to a one-time only deal.

To ensure these principles are practical to our methodology we have a goal of simplifying the citizen science aspect by creating a scorecard with adequate information described in a way that is digestible for anyone, regardless of scientific background. This step is important because scientific jargon has been shown to have a negative effect on comprehension (Shulman et al., 2020). Ensuring that the material found in our health assessment is digestible by the general public works mutualistically with the concept of citizen science: Using citizen science would be meaningless if the participants were turned away from partaking due to a lack of comprehension. Shulman et al. (2020) describes this process as "communication accommodation", and it is the process of minimizing the usage of technical terms to maximize comprehension. Our goal is to use this in the methodology to increase the viability of citizen science environmental health assessments.

Both Robinson et al. (2018) and Bonney et al. (2014) have information relevant to our methodology and utilize the same guiding principles of citizen science. Unfortunately, the main gap that both articles have is the lack of practical use of this concept. Citizen science is a relatively new underutilized concept and so the articles consist of plenty of conceptual information but lack consistent practical information. Bullock et al. (2020) is a valuable study that tests a key point about our methodology.

2.2 - Ecological Assessment: Variables and Considerations

Our scorecard relies on eleven variables in four categories: Soil (soil pH, soil drainage in the fall / winter, soil drainage in the spring / summer); Water (surface water pH, surface water dissolved oxygen content, surface water temperature, flowing surface water turbidity); Biodiversity (ratio of native to invasive species); and Direct human impacts (presence of litter, ecological vandalism, and habitat disruption). Each of the eleven variables were chosen due to their significance toward the ecological health of natural areas within parks.

2.2.1 - Soil

In the soil category, soil pH and drainage (fall/winter and spring/summer) are included as indicators of healthy soils. Soil pH controls what organisms can survive within the soil as well as nutrient availability for plants (Weil & Brady, 2016). For a temperate rainforest region like the greater Vancouver area, a soil pH near 4 is ideal (Schmidt, 2019; Carpenter et al., 2014; Weil & Brady, 2016). Drainage is the result of how much water is present in the area and how permeable the soil is. If an area is flooded, nutrients and seeds could be washed away. This also indicates soil compaction to some extent through the associated impermeability. Due to the variety of seasonal weather in Vancouver, drainage was separated into two subcategories fall/winter and spring/summer. This means that drainage in spring/summer can tell us if the soil is too dry or too permeable. These two indicators will provide a rough idea of soil health in a naturally managed area and can be estimated using a simple gardening pH meter, and qualitative observation.

2.2.2 - Water

For this section both ponds and streams are considered. The indicators chosen are pH, dissolved oxygen, temperature, and stream turbidity (Fisheries and Oceans & Environment Canada, 1995). pH is important as it sets the limits for what can survive in the water. At various points fish can no longer reproduce and die. Dissolved oxygen is important as it indicates how much oxygen is in the water. Oxygen is used by any non-primary producer in aquatic habitats. Temperature is important since fish can survive warm or cold waters but disease can only survive warmer water. These diseases can affect a range of organisms. Stream turbidity is the last indicator but is very important for streams. If the turbidity is low this means the amount of material suspended is high and at dangerous levels. At this level it can clog gills, block out sunlight, cover benthic organisms, and cover fish eggs. All of these indicators are easily measured with inexpensive equipment and the majority can be applied to both streams and ponds. Turbidity is only a useful indicator for flowing water, therefore it will only be used to assess the health of streams (Fisheries and Oceans & Environment Canada, 1995).

2.2.3 - Biodiversity

Biodiversity is limited in this project to an invasive to native plant species ratio. This criterion is important as it can inform how much of an area is stressed due to invasive species. If invasive species compose a large portion of the natural area, native plants will be stressed through competition for nutrients and space (The Vancouver Board of Parks and Recreation, 2018). This indicator can be measured by recording the coverage ratio of invasive organisms to native organisms.

2.2.4 - Direct Human Impacts

The last category includes three categories: ecological vandalism, littering, and habitat disruption (fragmentation). Human impacts are very important as they are the leading reason for habitat decline (Referowska-Chodak, 2019). For urban areas these three impacts are the more frequent and are therefore used to indicate how humans are impacting habitat health. The littering variable reveals the density of litter instances over the entire park area. This indicator is important as it can lead to soil and water contamination which directly degrades ecosystem health. Ecological vandalism is the second indicator which can indicate to what degree human action is harming the area and organisms. Vandalism includes trampling, cutting plants and/or trees, and burning plants and/or trees. The last indicator is habitat degradation or fragmentation. This indicator is very important as it shows how much of a habitat is continuous and isolated from human impacts (Referowska-Chodak, 2019).

It is worth noting that this is not a comprehensive list of all possible indicators but simply a set that can be used to assess the health of an NMA regardless of educational or socio-economic background. We believe that together all four categories can adequately represent the ecological health of a naturally managed area.

2.3 - Conclusion

Ultimately, the intent with our methodology is not to assess ecological health in a comprehensive way, but rather to have a tool available for efficient and informative check-ins throughout Vancouver. Bridging the gap between community stakeholders and local government is a desired virtue outlined in Vancouver’s city planning literature, which in this case requires communicating scientific knowledge (City of Vancouver, 2015; City of Vancouver, 2019; Vohland et al., 2019). For this reason, technical tools and language have been minimized since these can limit comprehension. The criteria used offer broad and accessible insight, which can be further narrowed if a low score is determined for a particular category (e.g. if winter drainage is found to be poor, this can be investigated further). Our scorecard can be completed by volunteers, stewardship groups, or park board employees with minimal training and equipment costing less than $100 unless a dissolved oxygen meter is included. This results in the ability to inform ecological decisions without large investment, while simultaneously fostering community involvement and education. Ecological assessments must be conducted often for useful data (DiCicco, 2014). It is essential for periodic assessments to be low cost, therefore giving communities or citizen scientists assessment tools will facilitate inexpensive and frequent updates on NMA status. Scientific research supports that the chosen criteria are crucial indicators of ecological health within Vancouver's NMAs. Our single page scorecard has proven to be effective and efficient in the scoring of Vanier Park's NMA, and identifies useful information to address ecological issues.

3 - Methodology

In the sciences, various technical terms are used to communicate details concisely. As members of the scientific community, it is easy to get caught up in the use of scientific terminology and mistake these terms as commonplace when in reality this is not the case. Environmental science is no exception. Unfortunately, the usage of this language can turn away those without a firm grasp on the terminology (Shulman et al., 2020). This leads to a large barrier and, more importantly, an immense knowledge gap between the general public and the people who have spent years studying the field.

Official plans published by the City of Vancouver, such as The Biodiversity Strategy (2016) and the Vancouver Bird Strategy (2015), highlight public awareness and education as important focal points for ecological preservation as well as restoration. Our group plans on reconciling the knowledge gap by encouraging public awareness through our scorecard. Firstly, the scorecard is a tool to provide a meaningful assessment of general ecological health for the Vancouver Parks Board. Secondly, the criteria and scores on the card are meant to be accessible and inclusive through the use of plain language to foster public engagement. This allows communication of expert knowledge to a general audience in accessible terms which are understandable with minimal field experience. We hope that granting the general public access to this tool will help reduce aversion to environmental science and ecological assessment, and perhaps welcome individuals into the field who may have felt alienated by complex language.

Shulman and colleagues (2020) describe the process of translating technical scientific knowledge in general terms as “communication accommodation”, and it is often undervalued and under-used. The authors state that people without a scientific background can more easily digest information when it is communicated in a less technical manner. To maximize inclusivity and help raise ecological literacy of the general public, the scorecard uses terminology that any individual, regardless of scientific background or education level, can understand. This way it will be possible for anyone, such as volunteers or students, to assess the ecological health of a naturally managed area despite not having access to an environmental specialist.

We will be using our scorecard to assess the ecological health of Vanier Park, and plan to take the terminology used in the scorecard into an elementary school setting to survey the students in the class about their understanding of the terms. This ensures that the scorecard is both effective in practice and also properly communicates the adequate information to assess the ecological health of a naturally managed area. The scorecard and its contents can be found below. The indicators were selected with the goal in mind of assessing health with minimal cost and the ability to be completed by Vancouver Parks Board or citizen scientists.

3.1 - Indicators

Indicator category	Indicator
Soil	Soil pH Drainage (Fall/Winter & Spring/Summer)
Water	Water pH Dissolved Oxygen Temperature (˚ C) Stream Turbidity (Visibility)
Biodiversity	Invasive Plant Species Percentage
Human Impact	Littering Ecological Vandalism Instances Habitat Disruption

3.1.1 - Soil pH

To measure soil pH two accessible tools can be used. First a probe can be inserted into moist soil for 60 seconds then the participant records the data. Second, pH can be recorded by using a simple powder and reagent kit. Using this kit, a spoonful of soil is combined with the powder and then a drop of reagent. The mixture will turn a certain colour corresponding to the pH of the soil. Multiple data points should be collected in different areas of the NMA to get a good average pH. Once pH is measured it can be noted in the designated scorecard row.

3.1.2 - Overall Drainage

To measure soil drainage different values are expected based on the time of year. The participant should walk around the NMA recording if the soil appears to be overly dry or flooded. Once the drainage is rated it can be noted in the designated scorecard row.

3.1.3 - Water pH

There are plenty of different cost effective tools to measure pH on the market and even tools that contain pH, temperature and TDS within one tool (VIVOSUN). This tool can be picked up and placed in the water and then the participant conducting the assessment can enter the reading into the designated scorecard row.

3.1.4 - Dissolved Oxygen

Measuring dissolved oxygen can be done using a DO kit by Hach (1469-00). To measure DO simply insert the probe into the water and record the measurement into the designated scorecard row. Most DO kits are on the more expensive side and might not be within a budget of a stewardship program. For this sake, our scorecard has been designed so that if this indicator is not measured the remaining indicators can still accurately represent water health in the NMA.

3.1.5 - Water Temperature

Temperature can be measured using a variety of tools such as a combo measurement tool like the VIVOSUN pH, TDS and Temperature probe. With this tool simply insert the probe into the water and set the tool to measure temperature. Wait until the device displays the reading and record the value in the designated scorecard row.

3.1.6 - Turbidity

Turbidity can be measured with various devices; the easiest and most accessible is with a meter stick or measuring tape. The participant can measure turbidity by inserting the tape measure into three water bodies or three sections of the water body. The participant should insert the measuring tape until the bottom is no longer visible then the distance can be recorded into the designated scorecard row. In some instances the body may be shallow, for these circumstances descriptive conditions can be used to more accurately rate the turbidity.

3.1.7 - Invasive to Native Species Ratio

To assess the invasive species ratio, the study area should be surveyed. The survey consists of identifying which plant species are invasive and estimating the relative percentage of area dominated by invasive species. The surveyor should be familiar with which plant species are native and invasive and be able to identify them. Information for region specific invasive species can be found online. In addition to possessing this knowledge or identification key, surveyors must walk enough of the area to give a reasonable estimate of the ratio between these plant types.

3.1.8 - Littering

To measure littering, the park needs to be surveyed for the frequency and locations of litter. This information can then be recorded in the designated scorecard row.

3.1.9 - Ecological Vandalism

Vandalism should be measured by first noting the various types that are observed. After surveying the NMA, observations should be reviewed and recorded in the designated scorecard row.

3.1.10 - Habitat Disruption

Assessing habitat disruption can be done by finding the largest continuous area. Once identified, walking around the remainder of the park and estimating what percentage of total area was included in the continuous area. To support estimations, satellite imagery or GIS could be used to conduct a simple raster grid analysis to determine the percentage of continuous habitat. Once the percentage is determined enter it into the designated scorecard row.

3.2 - Scorecard Procedure

To get a full understanding of the ecological health, this ecological assessment scorecard should be performed at least once during summer months and winter months. In order to use the scorecard below, simply go down the table in whatever order the participant wishes. For each indicator, the recorded or observed value should be entered on the right-hand side in the ‘measured condition/observation’ column. Once the observations are recorded the participant will need to add a value from 1-5 based on the scorecard into the far right ‘score’ column. Lastly to get the final rating, the participant will add up the score column and divide the total by the amount of indicators used. This average score will then be given the rating attributed to the score (e.g. poor or acceptable) which represents the overall health of the NMA.

3.3 - Ecological Assessment Scorecard

SCORECARD	VERY POOR (1)	POOR (2)	ACCEPTABLE (3)	GOOD (4)	EXCELLENT (5)	Measured Value (e.g. pH=5.8)	Score (1-5)
SOIL							
pH	<3 or >9	3 - 3.5 or 7 - 9	5 - 7	3.5 - 5			
Fall/Winter Overall Drainage	Always Flooded	Flooded Often	Minor Flooding Occasionally	Water Levels Close to Water Table	Water Level at Water Table		
Spring/Summer Overall Drainage	Extremely Dry	Mostly Dry	Large Dry Sections	Small Dry Sections	Water Level Close to Water Table		
WATER							
pH	<4 or >9.5	4 - 6 or 8.5 - 9	6 - 7 or 7.5 - 8.5	7 - 7.5			
Dissolved Oxygen	0% - 25%	25% - 55%	55% - 75%	75% - 90%	90% - 110%		
Temperature (˚ C)	>25	20 - 25	14 - 20	9 - 13	5 - 8		
Stream Turbidity (Visibility)	10cm - 0cm or No Visability	23cm - 11cm or Minimal Visibility	23cm - 31cm or Some Visibility	31cm - 99cm or Mostly Clear	100cm - 160cm or Complete Clear		
BIODIVERSITY							
Invasive Plant Species Percentage	>90% Invasive	90% - 50% invasive	49% - 26% invasive	25% - 10% Invasive	<10% Invasive		
HUMAN IMPACT							
Littering		Garbage Frequent in Natural Areas and Paths	Some Garbage in Natural Areas and Paths	Minimal Garbage in Natural Areas and Paths			
Ecological Vandalism Instances	Frequent Damage: >15/ha	Common Damage: 10-15/ha	Some Damage: 5-9/ha	Minimal Damage: 1-4/ha	No Damage		
Habitat Disruption	<10 % Continuous Habitat	10% - 35% Continuous Habitat	36% - 65% Continuous Habitat	66% - 90% Continuous Habitat	>90% Continuous Habitat		
NOTES:					FINAL SCORE:	Average Score:	
						Rating (e.g. Acceptable)	

Fig 3. Blank scorecard to be used in NMA assessments. This scorecard is the improved version which includes new criteria for each rating and specific indicator. We found this to be necessary through our testing of the initial scorecard which revealed issues regarding clarity and scope. To address these issues more indicators were added to the water category and the human impact category was clarified.

4 - Results

4.1 - Team Assessment of Site

On Thursday, February 20th, 2020, our team performed an analysis of Vanier Park's NMA using our developed methodology. The completed table can be seen below. Once averaged, the determined score was 2, which indicated poor ecological health. This score was representative of our initial conclusion from our visit on Sunday, January 26th, 2020. Due to the similarity between our initial observations and our calculated value from the scorecard, we feel this methodology provides a reliable overview of the ecological health of NMA's that fit the context and scope of the RFP.

4.2 - Completed Scorecard for Vanier Park

SCORECARD	VERY POOR (1)	POOR (2)	ACCEPTABLE (3)	GOOD (4)	EXCELLENT (5)	Measured Value (e.g. pH=5.8)	Score (1-5)
SOIL							
pH	<3 or >9	3 - 3.5 or 7 - 9	5 - 7	3.5 - 5		6.2	3
Fall/Winter Overall Drainage	Always Flooded	Flooded Often	Minor Flooding Occasionally	Water Levels Close to Water Table	Water Level at Water Table	Constant seasonal flooding	1
Spring/Summer Overall Drainage	Extremely Dry	Mostly Dry	Large Dry Sections	Small Dry Sections	Water Level Close to Water Table	N/A	N/A
WATER							
pH	<4 or >9.5	4 - 6 or 8.5 - 9	6 - 7 or 7.5 - 8.5	7 - 7.5		N/A	N/A
Dissolved Oxygen	0% - 25%	25% - 55%	55% - 75%	75% - 90%	90% - 110%	N/A	N/A
Temperature (°C)	>25	20 - 25	14 - 20	9 - 13	5 - 8	N/A	N/A
Stream Turbidity (Visibility)	10cm - 0cm or No Visability	23cm - 11cm or Minimal Visibility	23cm - 31cm or Some Visibility	31cm - 99cm or Mostly Clear	100cm - 160cm or Complete Clear	N/A	N/A
BIODIVERSITY							
Invasive Plant Species Percentage	>90% Invasive	90% - 50% invasive	49% - 26% invasive	25% - 10% Invasive	<10% Invasive		2
HUMAN IMPACT							
Littering		Garbage Frequent in Natural Areas and Paths	Some Garbage in Natural Areas and Paths	Minimal Garbage in Natural Areas and Paths		Variety of garbage throughout entire area	2
Ecological Vandalism Instances	Frequent Damage: >15/ha	Common Damage: 10-15/ha	Some Damage: 5-9/ha	Minimal Damage: 1-4/ha	No Damage		3
Habitat Disruption	<10 % Continuous Habitat	10% - 35% Continuous Habitat	36% - 65% Continuous Habitat	66% - 90% Continuous Habitat	>90% Continuous Habitat		2
NOTES:					FINAL SCORE:	Average Score:	2.17
						Rating (e.g. Acceptable)	POOR

5 - Recommendations

From our analysis, we identified several possible improvements which could be made. Developing a stewardship program that tasks volunteers with removing litter and addressing vandalism would be a relatively low effort solution which would offer quickly visible improvement to the NMA. We believe that once the NMA has been cleaned up, visitors would be more likely to refrain from littering or vandalism. To support this goal, signs could be placed throughout the park which aim to educate the public on the ecological restoration efforts being performed. In addition to engaging the public on efforts underway, these signs could also discuss how the average visitor to the park can support these efforts by being respectful of the area by not littering, vandalizing the area, or venturing from the main trail. Furthermore, to reduce habitat disruption, the main trails should be emphasized visually while the non-essential trails should be, temporarily, blocked off while they are restored. Additionally, the removal of invasive species has already been highlighted as an intended course of action for Vanier Park's NMA by the City of Vancouver (2019). We agree that this is the best course of action to repopulate the area with native species and further believe that this could also fall under the responsibility of the same stewardship program discussed above.

The adjustments in the previous section are fairly immediate fixes which could be implemented quickly. Unfortunately, topics such as turbidity, drainage, and soil pH lack immediate fixes and would, instead, require persistent effort over a longer period of time. Turbidity and drainage are interrelated as standing water bodies are the result of flooding. Because of this, improving the drainage of the area to eliminate seasonal flooding would improve both drainage and turbidity. Implementing a more effective drainage system into the NMA would likely resolve these issues. There are a number of currently integrated pipes meant to direct excess surface water into sinks. These sinks, however, occur at various points in the NMA. If flooding can not be entirely eliminated, we would propose developing a manmade pond in the centre of the NMA which excess water could be directed too. This could be used to create an aquatic habitat which could be home to select aquatic species. Additionally, this would create a riparian area in the park which would provide a reliable indicator for ecosystem health. The final category to improve is soil pH. This is a difficult trait to remedy on the scale of an NMA, admittedly. One potential method for increasing soil acidity is to treat soil in the NMA with ammonium (Weil & Brady, 2016).

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CityStudio is an innovation hub where city staff, students, faculty and community work together to design experimental projects that make Vancouver more sustainable, liveable and joyful. It works in collaboration with the City of Vancouver and six post-secondary institutions (SFU, UBC, BCIT, Langara, ECUAD and NEC).

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Appendix

In this section, we have included photos of the study site documenting the features discussed in the proposal. All photos were taken by Matt on our initial visit to the site on January 26th, 2020.

Image 1. Shows Vanier Park forest area being overrun with invasive plant species.

Image 2. Shows vandalism to the trunk of a tree

Image 3. Shows some of the litter that can be found at Vanier Park.

Image 4. Shows a bird’s nest found in the trees.

Image 5. Shows more litter by the creek in the Park.

Image 6. Shows the eagle’s nest that was installed in the park

Image 7. Shows trees being planted in a now flooded area.

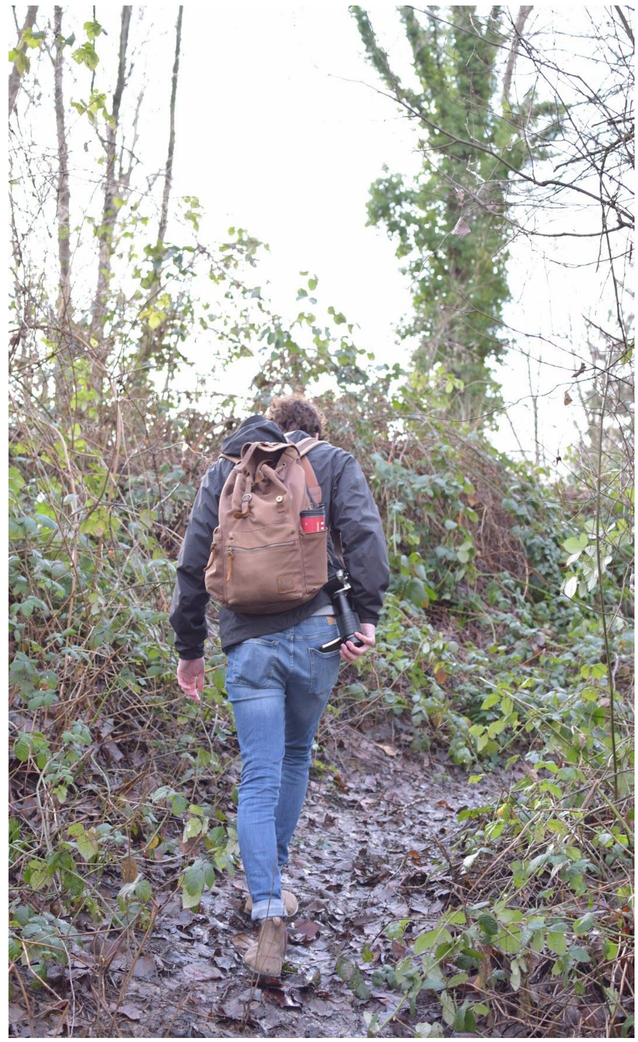

Image 8. Shows the narrow, poorly maintained walkways in the forest.