



Land management practices and their effect on stream health on small farms and ranches

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Farm Adaptation Innovator Program Research Factsheet



Purpose

Streams and creeks flowing through agricultural landscapes are often heavily modified and detrimentally influenced by farming/ranching activities such as forage crop production and livestock grazing. Riparian rehabilitation and the establishment of buffer zones along stream margins may mitigate these impacts. The purpose of this study was to determine whether a single landowner could improve the state of the aquatic ecosystem on their land independent of the actions of adjacent neighbours. The study was aligned with the Beneficial Management Practices (BMP) Program, which provides government funding to individuals and groups of landowners intending to improve agricultural land by establishing riparian buffer zones, field drainage systems, and nutrient management schemes.

Geographic Applicability	Results apply to Alderson Creek and similarly small agricultural watersheds in the southern interior of BC
Commodity Relevance	Small landholdings in forage or pasture operated by individual farmers.
Timeline	June, 2015 to December, 2018

Study Objectives

- Monitor and assess the biophysical conditions in Alderson Creek within each of the properties participating in a Group Environmental Farm Plan
- Document the range of natural fluctuations in water quality parameters by collecting and analysing a data set of baseline conditions, prior to implementation of BMPs
- Perform statistical analyses to determine whether land management practices and their influence on stream health can be differentiated from natural ecosystem variation.

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Methods

- Three years of field monitoring (2015-2017) from April to December during the snow-free period.
- Water quality parameters were measured during bi-monthly visits using hand-held probes (pH, turbidity, conductivity, nitrogen) or monitored continuously (temperature) using loggers at multiple locations along the creek
- Macro-invertebrates and vegetation densities were assessed at five stations along the creek at monthly intervals
- Cross-section surveys at 34 locations were taken with engineer's level and rod, with geo-referenced benchmark pins
- Statistical tests were performed on the data to quantify the degree of temporal and spatial variability and to assess the effect of land management practices

Key Finding 1

- Alderson Creek was subdivided into five (5) adjacent segments or sub-reaches based on property boundaries, each of which had different land management practices (e.g. grazing, forage crop production, wetland)
- Each sub-reach had multiple monitoring stations for water quality measurements
- **Discriminant analysis indicates that each of the reaches has slightly different biophysical characteristics**
- Figure 1 shows that the uppermost sub-reach, R5 (cattle grazing; no riparian fencing) is distinctly different from the lowermost sub-reach, R1 (fallow land not in production)
- **The implication is that land management practices can affect water quality at the scale of a small farm**

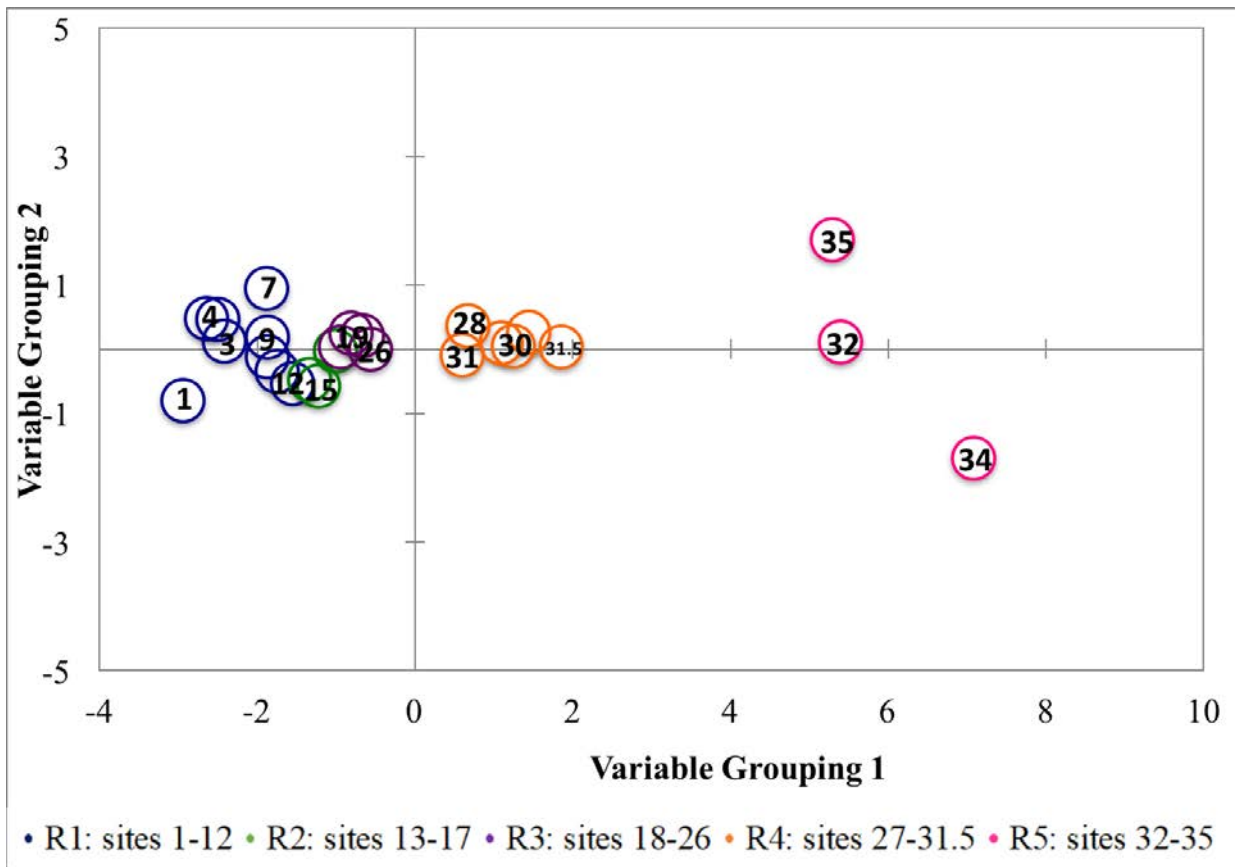


Figure 1. Results from discriminant analysis using turbidity, temperature, pH, and conductivity data from 35 sampling stations over a three-year period. Each sampling station is represented by a circle with a number, and the colours indicate in which of the five sub-reaches of Alderson Creek they appear in. Clusters of like-coloured circles indicate that these stations have similar water quality characteristics. Variable Groupings are weighted combinations of the four standardized water quality parameters used in the analysis.

Key Finding 2

- Macro-invertebrate populations appear to be sensitive to water quality in creeks, which is seemingly influenced by land management practices.
 - Figure 2 shows that R5 (with cattle having free access to the creek) had no invertebrates whereas R4 (with a riparian buffer zone of mature trees and no cattle) had consistently high counts as did R1 (fallow land).
 - R3 also had livestock grazing, but was continuously connected to R2 and R4, whereas R5 was poorly connected to R4 via a culvert beneath a major public road.

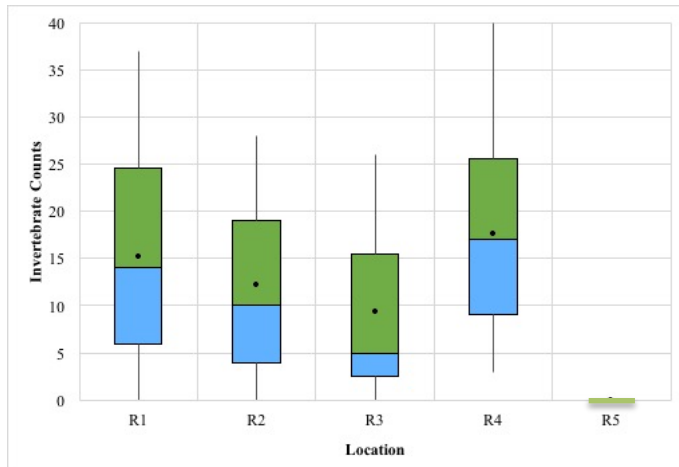


Figure 2. Macro-invertebrate counts in each sub-reach for 2015 - 2017. Small sampling baskets were placed in the creek at representative locations in each reach and sampled monthly. Whisker ends indicate max. and min. values; box top and bottom indicate the range that contains approx. 50% of all the values; solid dot indicates mean; solid line separating green and blue indicates median. Note that only one macro-invertebrates was ever found in R5.

Key Finding 3

- Natural fluctuations in water quality on small streams can be large (Figure 3). The range between the max. daytime temp. and min. night-time temp. is about 6-10 °C, which indicates very rapid response to air temperature and sunlight.
- Although the average daily temperature is consistently below 21°C, which is considered a critical threshold for fish survival, the warmest periods of the day are typically above that threshold, suggesting poor habitat quality during the summer.

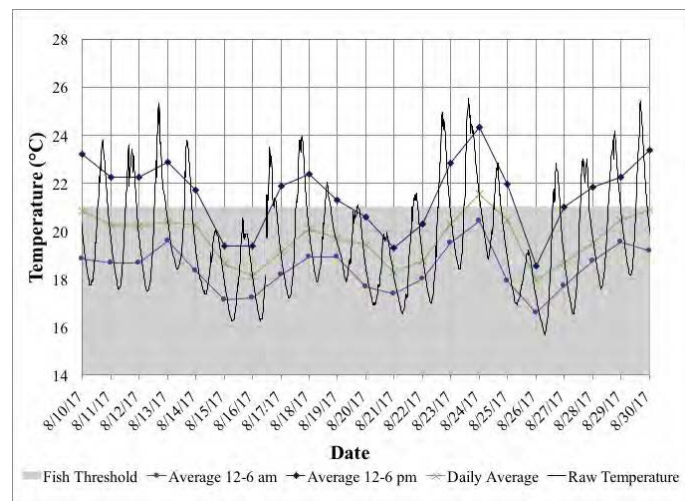


Figure 3. Temperature trends for a 3-week period at a station located in R5. Black line shows 10-min measurements throughout the day. Green line shows the daily average. Blue and purple lines show 6-hr averages for 12-6 pm and 12-6 am, respectively. Shaded region indicates temperatures generally acceptable for salmonids.

Definitions

Discriminant Analysis – a statistical method for establishing the degree to which there are clusters or groupings within a data set

Riparian Zone – in reference to a river or creek including the channel, banks, and adjacent zones

Macro-invertebrates – a general term that refers to animals without spines, but in this study includes aquatic lifecycle of insects such as stoneflies, mayflies, and caddisflies

Turbidity – the clarity or cloudiness of water, usually because of suspended sediment and organics

Sub-reach – a section or segment of the creek that has relatively uniform characteristics

Rehabilitation – a process of relative improvement in the existing condition toward a more desirable condition (the term 'restoration' is commonly used but not preferred because it implies that there is agreement as to what the restored state should be based on historical ideals)

Implications for Climate Change Adaptation on Small Farms

- Small creeks typically show great variability in space and time, which means that long-term trends in average conditions aren't immediately evident, even to those living alongside the creek—only the extreme events are readily apparent and held in memory
- Long-term studies (over tens of years) are essential if one wishes to demonstrate that the implementation of a management practice has yielded a desirable result. This is especially true for climate change adaptation strategies because the anticipated impact of climate change is to increase the severity of droughts, floods, and other extreme events even though the average conditions may not trend very far from the historical norm
- Perhaps the best method of determining the positive benefits of riparian rehabilitation is to conduct vegetation and macro-invertebrate assays rather than measure water quality parameters. The flora and fauna respond quickly to water quality and to altered sediment and flow conditions in the creek (as well as shading from trees)
- Riparian rehabilitation projects would seem to offer one mechanism for adapting to climate change on small farms because there appears to be a correlation between land management and ecosystem health

Limitations

The study focused on a very small agricultural watershed in the North Okanagan, and the exact results may not be applicable to other watersheds with different soils, underlying sediments, weather conditions, and vegetation patterns. Nevertheless, the general conclusions about the importance of land management practices are expected to apply in other agricultural landscapes with small farms or ranches.



Alderson Creek in spring (left) and late summer (right) showing how flow is choked by growth of water cress and other aquatic plants because of absence of a wide riparian buffer zone with trees that provide shade and nutrient uptake

Future Work

Continued monitoring of this and other projects that have implemented beneficial management practices leading to environmental improvements so as to demonstrate the positive impacts.

Develop information programs that inform small landowners about best-management practices that can be used as climate change adaptation strategies.

For more information:

regarding agricultural adaptation in BC see:
<http://www.bcagclimateaction.ca/>

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