

## Development of a Landowner's Riparian Health Index (LORHI): a case study in the Broughtons Creek watershed

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**Abstract:** An index is a readily obtainable measurement that depicts a variable or process which itself is not easily measured. The Landowners' Riparian Health Index (LORHI) is founded on fundamental riparian parameters, is easily evaluated and cost efficient. The LORHI is calculated as the product of the riparian buffer width parameter and the vegetation diversity parameter within the riparian buffer zone. Landowners or tenants can evaluate the riparian buffer on their land by responding to a one-page questionnaire. Using the LORHI, conservation district managers and landowners can identify problematic and unhealthy reaches and concentrate remedial actions in these areas. The Landowners Riparian Health Index was estimated for 22 reaches (44 banks) along the main stem of Broughtons Creek in the Little Saskatchewan River watershed. Results indicate that 50 percent of the channel length has a riparian health problem. Sixty-four percent of the problematic and unhealthy banks are unfenced pasturelands (classified as Unhealthy) that could be upgraded by the fencing out of livestock. Rehabilitation of the vegetal diversity (often, simply the seeding of bare ground) will result in an additional upgrading.

### Introduction

A riparian zone is defined as the aquatic ecosystem and the portions of the adjacent terrestrial ecosystem that directly affect or are affected by the aquatic environment (Gregory and Ashkenas 1990). This includes streams, rivers, and lakes and their adjacent side channels, floodplains and wetlands. The riparian area also includes portions of hill slope that serve as streamside habitats for wildlife (Gregory and Ashkenas 1990).

Consequently, riparian areas are hosts to complex ecological units representing niche specific habitats of various avian, terrestrial and aquatic fauna. The vegetal growth in the riparian zone retards excessive erosion, traps sediment, adsorbs a variety of pollutants and attenuates floods.

There are many riparian classifications, most of which are prepared by and for government agencies. Riparian health classifications are applied to urban riparian zones, agricultural riparian environments or forest riparian areas. Generally, riparian classification systems, guidebooks and field notes are associated with a specific geographical area and are structured towards specific study requirements. For example, the field book "Caring for the Green Zone: Riparian Health Assessment for Small Streams and Small Rivers" (Fitch et al. 2001) has been published for an audience of livestock producers, landowners, and resource managers in southern Alberta. The "Alberta Lotic Wetland Health Assessment For Streams and Small Rivers" is designed to assist land managers in setting management priorities and stratifying riparian sites in Southern Alberta (Lotic Health 2001). Another riparian evaluation, the "Specification Riparian Forest Buffer," is used by the U.S. Forest Service to monitor riparian areas such as in the Willamette National Forest, Oregon. This classification system is concerned with landuse conflicts (Wélsch 1991). Other classifications, such as the "Watershed Restoration Program" (Hogan et al. 1996) and the "Forest Practices Code of British Columbia" address the restoration, protection and maintenance of fish, aquatic and forest resources which have been negatively affected by forest harvesting practices (Oikos and Johnson 1996). However, there are few, if any, riparian health classifications that encourage the agricultural landowner to assess the riparian health of their stream frontage without requiring a minimal level of technical expertise.

### **Objective of the Study:**

The objective of this study was to develop a landowners' riparian classification system that can be used by landowners and watershed managers to evaluate and monitor the health of riparian zones in prairie agricultural watersheds.

### **Riparian Health Assessment**

Fitch et al. (2001) define riparian health as the ability of a reach, the entire stream or a watershed composed of many streams, to perform a number of key ecological functions. A healthy riparian ecosystem is characterized by natural processes such as flooding, erosion and deposition,

vegetation succession, herb ivory and deciduous leaf fall interacting to create a dynamic system of exceptional natural diversity that is sustainable (Tighem 1995). The health of a riparian area can be assessed by the vitality and productivity of the vegetation in the buffer zone, that area adjacent and including the stream channel (Fitch et al. 2001).

## Riparian Buffer Width Assessment

Most riparian classification schemes acknowledge buffer width, corridor width or leave strips as a critical parameter in assessing riparian health (Gregory and Ashkenas 1990, Chilibeck et al. 1993 and Castelle et al. 1994). Buffer width significantly impacts the effectiveness of sediment entrapment, erosion control, and habitat cover (Welsch 1991). Without a buffer, the vegetal diversity in the buffer zone need not be considered.

Most riparian classifications define buffer width as the minimum distance measured normal (at right angles) to the stream from the water edge to the observed area of disturbed vegetation on either the right or left bank. Consequently, buffer width becomes a minimum value dependent upon the left or right bank conditions and riparian health parameters located on the opposite bank are ignored. Buffer width will differ according to type of vegetation, slope, landuse, soil and hydrologic conditions.

Castelle et al. (1994) and O'Laughlin and Belt (1995) found that buffer width varied from 3 to 200 m, depending on the effectiveness for different functions. Peterjohn and Correll (1984) found that nitrogen and phosphorous nutrient concentrations in surface runoff in agricultural areas were reduced by 75 percent when passing through a 19 m agricultural-forest buffer. Welsch (1991) determined a minimum buffer width in a forested environment by assessing the soil hydrologic groups, slope distance from the bank to the disturbed vegetation and soil capability class. Welsch (1991) recommends a minimum buffer width of 75 ft. (23 m) for the forested environment. The Department of Fisheries and Oceans (DFO 1996) suggest that the riparian buffer width be a minimum of 15 m on both sides of the stream to protect fish and fish habitat and the Canadian Wildlife Service guideline (Environment Canada 2000), indicates that streams should have a 30 m wide naturally vegetated buffer on both sides. Both the Department of Fisheries and the Environment Canada buffer width recommendations are incorporated in the Landowners' Riparian Health Index.

## **Vegetal Diversity Assessment**

The diversity and distribution of vegetation in the riparian buffer is recognized as a significant parameter to the health of the riparian zone (Tighem 1996). The variety of species of trees, shrubs, and grasses is an indication of vegetal diversification. Percentage cover is indicative of abundance. Environment Canada (2000) recommends that a healthy riparian zone have a total buffer width of 60 m and that 75% of the stream length be naturally vegetated.

## **The Landowners' Riparian Health Index**

An index is a readily obtainable measurement that depicts a variable or process which itself is not easily measured. The Landowners' Riparian Health Index (LORHI) is founded on fundamental riparian parameters, is easily evaluated and cost efficient. The LORHI is calculated as the product of the riparian buffer width parameter and the vegetal diversity parameter within the riparian buffer zone. The evaluation process can be initiated in the coffee shop or over the phone and ultimately gather information that is useful to the landowner, watershed manager and other researchers. Consequently the LORHI is a subjective evaluation of riparian health based on informal observation of two fundamental riparian parameters.

### **Operational Definition of Riparian Buffer Width:**

The operational definition of buffer width for the LORHI considers both the left and right banks of the stream. Consequently each sample reach will have a left and a right bank buffer width value. Buffer width (metres or feet) is measured or estimated normal to the stream, from the water's edge to an observed area of vegetation disturbance (i.e. the edge of the field or pasture). The minimum width is assigned a score according to the length (distance) measured. The optimum buffer width is greater than 30 metres or 100 feet (Environment Canada standard), which receives a ranked score of 5 out of 5. Other buffer widths are grouped as: 15 m to 29 m (the DFO recommendation for a healthy fishery), 10 m to 14 m (an intermediate width less than the DFO recommendation), 3 m to 9 m (a narrow buffer), and less than 3 m (effectively, no riparian buffer). The associated ranked scoring is 4, 3, 2, and 1 respectively.

### **Operational Definition of Vegetal Diversity in the Buffer Zone:**

The operational definition of vegetal diversity in the riparian buffer considers grasses and emergent aquatic vegetation, trees and shrubs. The

resulting parameter is the sum of the estimated frequency of trees, frequency of shrubs, and percentage of bare ground in the riparian buffer.

Grasses and emergent aquatic vegetation trap sediment and acquire nutrients, control erosion and provide faunal habitat. Rather than estimate percentage grass cover, the LOHRI assesses percentage bare ground present in a 20 m (65 feet) length of reach. Four subjective groupings are possible: no bare ground; the occasional small spot of bare ground (up to 5%); a few patches of bare ground (6%-20%); prominent large patches of unvegetated ground (over 20%). The associated ranked scores are 4, 3, 2 and 1, respectively.

In evaluating tree and shrub diversity the actual species and percentage cover is not as important as the number of individual trees or shrubs. Therefore, identifying species and percentage cover is not required. The landowner need only identify individual trees and shrubs present in a 20 m (65 foot) length of the buffer width. Both the left and right bank is evaluated. Trees taller than the observer (greater than 1.78 m / 5' 10") within a 20 m (65 foot) length of riparian buffer are counted and placed into the following groups: zero trees; 1 or 2 trees (the occasional tree); 3 to 10 trees (some trees); and more than 10 trees (a wooded riparian buffer). These groups are given ranked scores of 1, 2, 3 and 4 respectively.

Shrubs and shrub elements (clusters) shorter than the observer (less than 1.78 m / 5' 10") are evaluated and grouped into the following categories: zero shrubs; 1 or 2 shrubs or clusters of shrubs (the occasional bush); 3 to 10 shrubs (some shrubs); and more than 10 shrubs or clusters of shrubs (a bushy riparian buffer). The respective ranked scores are 1, 2, 3 and 4.

The vegetal diversity score is the sum of the bare ground cover score, the trees score and the shrubs score. The maximum vegetal diversity score is 12 (4+4+4); the minimum value is 3 (1+1+1).

### **Calculation and the Evaluation of the LORHI:**

The LORHI is defined as the product of the buffer width score and the vegetation diversity score. The highest possible score is 60 and the lowest is 3. Figure 1 summarizes the possible LORHI values and indicates five states of riparian health. The classification system is rationalized by the following.

An ideal riparian zone (index values of 41-60) must have the Environment Canada recommended buffer width of greater than 30 m (100 feet) and a minimum vegetal diversity score of 9. That is no bare ground, and some trees and shrubs. If the riparian zone displays ideal vegetal diversity (scores of 11 or 12), the Department of Fisheries 15-29

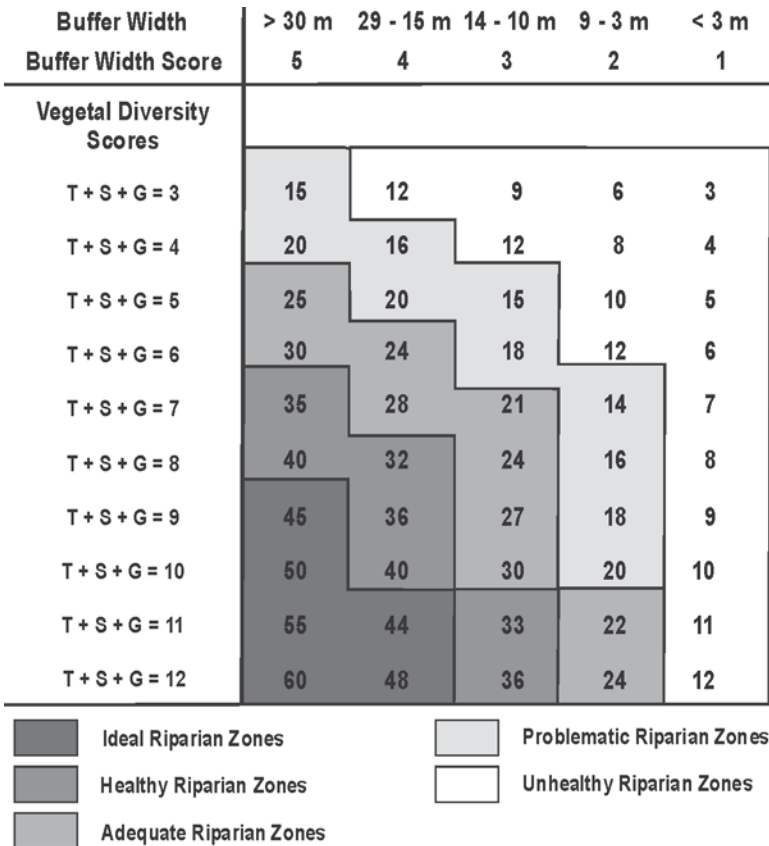


Figure 1: Categorized Landowners' Riparian Health Index values.

m buffer width can result in an ideal riparian zone classification (Figure 1).

The healthy riparian zone (index values of 31-40) will have a buffer width of at least 15 m (Department of Fisheries recommendation) and a vegetal diversity score of 8-10, indicating that at least two of the three vegetation categories score a 3 or better. If the buffer width exceeds 30 m (100 feet) a vegetal diversity score of 7 can result in a healthy riparian zone. If the vegetal diversity is ideal (scores of 11 or 12) a narrower riparian buffer (10-14 m) can also result in a healthy classification (Figure 1).

The adequate riparian classification (index values of 21-30) combines a variety of buffer widths from 3-30 m (10-100 feet) with compensating

vegetal diversity scores (Figure 1). That is, ideal vegetal diversity (11 or 12) with the narrower buffer widths and the moderate vegetal diversity (scores of 5 to 7) with significantly wider buffers.

Problematic riparian zones (index values of 13-20) display a poor combination of buffer width and vegetal diversity. For example, moderate vegetal diversity and narrow buffers or a wider buffer zone and poor vegetal diversity (Figure 1).

Riparian buffer widths less than 3 m (10 feet) represent unhealthy riparian environments regardless of vegetal diversity (Figure 1). Buffer widths less than 10 m (32 feet) with poor vegetal diversity (scores of 3 or 6) are classified as unhealthy as is the slightly wider buffer of 10-14 m (32-45 feet) combined with a vegetal diversity score of 3 or 4 (virtually no vegetation). The unhealthy riparian zone generally has an index value of 12 or less.

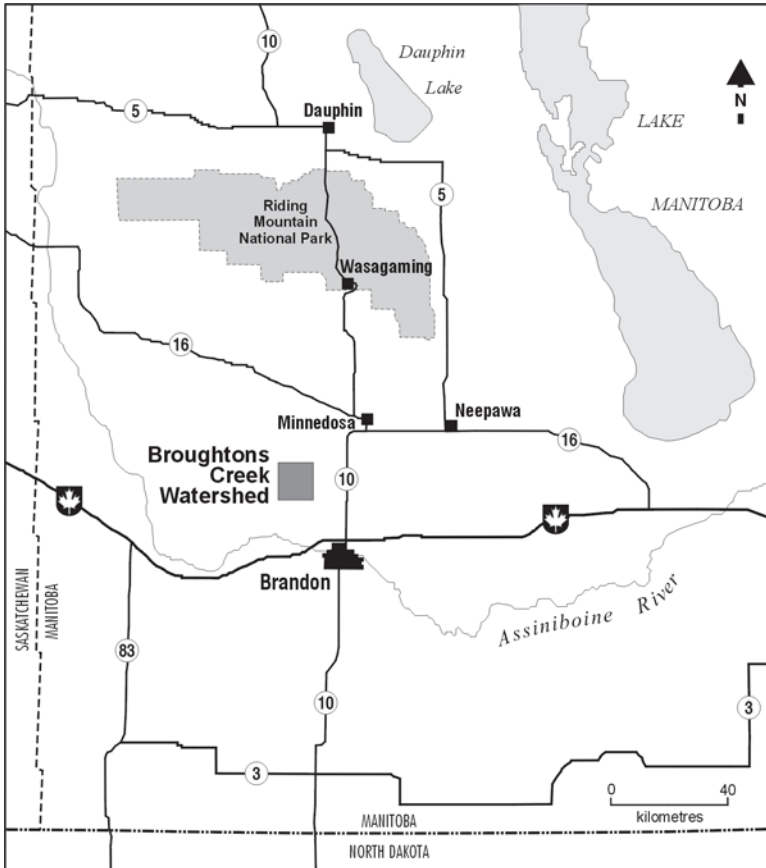
## Case Study: Broughtons Creek Watershed

### Study Area:

Broughtons Creek watershed is located in south-western Manitoba on the Assiniboine River Plain in the rural municipality of Blanshard (NTS 62/K1 and 62/K8) (Figure 2). Specifically, parts of Township 13, Ranges 20 and 21, and parts of Townships 14 and 15, Ranges 21 and 22. The town of Cardale is centrally located in the watershed (Figure 3).

Broughtons Creek watershed covers an area of approximately 265 km<sup>2</sup> (102.6 mi.<sup>2</sup>) (Figure 3). The drainage basin can be classified according to the Horton/Strahler system as a third order basin. The Shreve number (determined from the blue line data on the 1:50,000 topographic map) is calculated to be 27, indicating that Broughtons Creek has 27 tributaries, 14 source catchments and 13 interfluves.

The drainage basin extends from its headwaters located near the Blanshard/Strathclair municipal boundary, approximately 30 km (18.75 mi.) southeast to the Broughtons Creek outlet in Airplane Bay, Lake Wahtopanah (Rivers Reservoir) (Figure 3). The basin length, measured along a medial line extending from the mouth of Broughtons Creek northwest through the town of Cardale to a point located on the watershed divide approximately 2.6 km (1.0 mile) south of the southern extent of the rural municipality of Strathclair, is estimated to be 30 km (18.75 mi.). The drainage basin is approximately 15.75 km (9.8 mi.) wide in the headwater region near the Blanshard/Strathclair municipal boundary and 11.2 km (7.0 mi.) wide at the mid-point along the basin length medial line (6.0 km (2.3 mi.) southeast of Cardale. The maximum elevation along the



**Figure 2:** General location of Broughtons Creek Watershed.

watershed divide is estimated to be slightly greater than 600 m (1968 ft) and water levels on Lake Wahtopanah average 470 m (1541 ft.) a.s.l. Consequently, the relative relief for the watershed is calculated to be 135 m or 472 ft. The basin slope, defined as the ratio of basin relative relief to basin length, is calculated to be 0.0045, that is 4.5 m per kilometre (25 ft. per mi).

Broughtons Creek is an intermittent tributary stream of the Little Saskatchewan River that discharges into Lake Wahtopanah, a reservoir in the Little Saskatchewan River. The main stem of Broughtons Creek traverses a hummocky till plain with an average relief less than 3 m (10 feet). The area is predominately agricultural. Prairie sloughs appear to



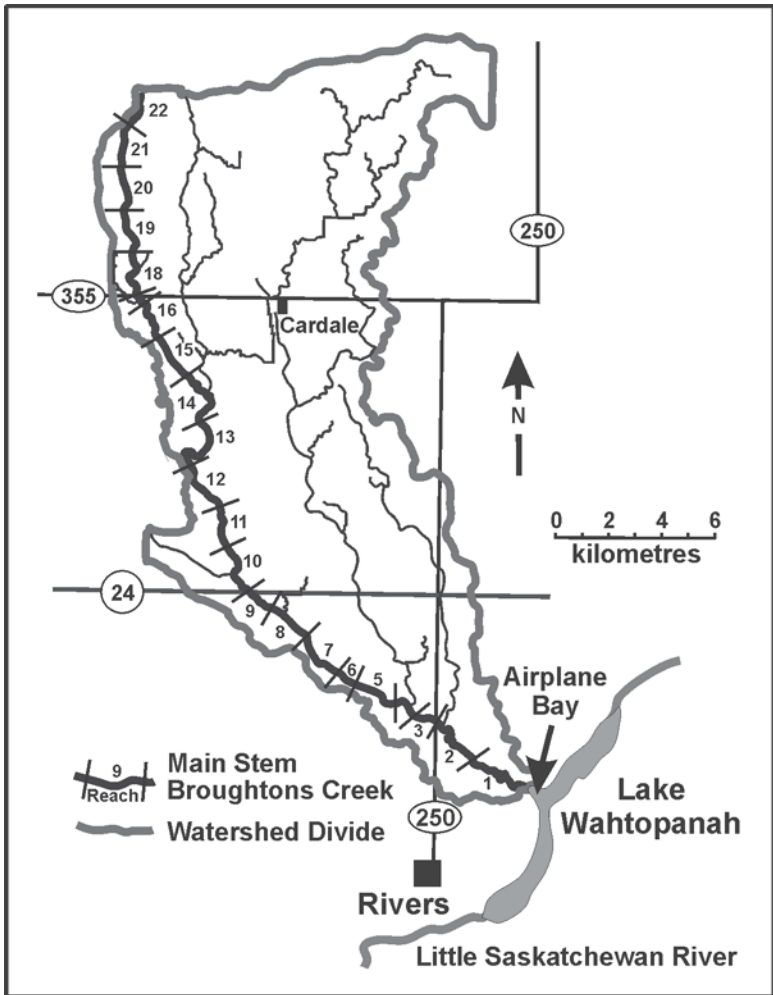


Figure 3: Broughtons Creek Watershed.

be relatively large, elongated, often oriented northwest to southeast, and shallow. There is a preponderance of permanent water bodies.

Broughtons Creek is located in the Aspen Parkland ecoregion. Trees and shrubs surround water depressions and grass is dominant on the slopes and hillsides. Trees in the Broughtons Creek watershed are limited to a few species, mainly Trembling Aspen (*Populus tremuloides*) and Black Poplar (*Populus balsamifera*). The most predominant shrubs are Peach-

leaved Willow (*Salix amygdaloides*), Snowberry (*Symphoricarpos occidentalis*), Wild Rose (*Rosa spp.*), and Chokecherry (*Prunus virginiana*).

The main tributary of Broughtons Creek was selected for evaluation of the LORHI (Figure 3). The stream channel is approximately 40 km in length, located in the sidehill position and entrenched 3-6 m below the local plain. The valley is flat-bottomed, U shaped in cross-section and 60-200 m wide. Significant deposits of sand and gravels cover the floor of the stream valley. Channel width ranged from 30 m in pooling areas to 0 m in areas of significant infiltration where the stream dif fuses through continuous vegetation.

### **Determination of LORHI:**

The main stem of Broughtons Creek was divided into twenty-two reaches (Figure 3), defined and identified by section, township and range (Canada Land Survey). Reach 22 (26-15-22) included the headwater tributary, and Reach 1 (1-13-20) was located at the mouth of Broughtons Creek. Small grains or oil seed crops were found along 14 reaches (64% of the channel length). Five reaches flow through pastures (23%), natural vegetation was found along 2 reaches (9%), and there was 1 reach flowing through a hay field (2% of the channel length) (Table 1).

The riparian health of both the left and right bank of each reach was assessed. Buffer widths were recorded as the minimum measured distance in the observed reach (Table 1). The narrowest buffer width, other than those adjacent to pastures, was 5 meters (16.5 ft) and maximum buffer widths were recorded to be 75 m (246 ft).

Figure 4 is a plot of the LOHRI calculated for 22 reaches of the main stem of Broughtons Creek from the mouth to the headwaters. Both the left and right banks were evaluated. The plot indicates that the riparian buffers for 14 banks out of the 44 were classified as unhealthy and 8 were considered problematic. That is approximately 50 percent of the channel length has a riparian health problem. All of the pastures were classified as Unhealthy (LORHI < 12) due to unfenced livestock. Consequently, the buffer width was considered less than 3 m and scored a value of 1. The vegetal diversity scores in the pastures averaged 7.2 indicating that there is potential for reestablishment once the riparian buffer is fenced. Rehabilitation of the vegetal diversity, often simply the seeding of bare ground would result in a upgrading to Adequate.

The riparian buffer for 10 banks was classified as Adequate, 9 were considered Healthy, and 3 Ideal. In terms of channel length that is 23%, 20% and 7%, respectfully. It is estimated that the seeding of bare ground

Table 1: Parameters and Calculation of LORHI, Broughtons Creek Main Stem.

LOCATION		LANDUSE		BUFFER WIDTH				VEGETAL DIVERSITY				LORHI					
Reach	SecTp/Rg	Left Bank	Right Bank	Left Bank Width (m)	Right Bank Width (m)	Score	Width (m)	Left Bank Trees	Left Bank Shrubs	Left Bank Ground	Total Score	Right Bank Trees	Right Bank Shrubs	Right Bank Ground	Total Score	Left Bank	Right Bank
BC1	5-13-20	NAT	NAT	45	75	5	120	4	4	4	12	4	4	4	12	60	60
BC2	6-13-20	UFP	UFP	0	0	1	0	1	1	4	6	1	2	4	7	6	7
BC3	12-13-21	FOD	NAT	6	15	2	21	1	3	4	8	2	3	4	9	16	27
BC4	14-13-21	UFP	UFP	0	0	1	0	1	2	3	6	1	2	3	6	6	6
BC5	15-13-21	NAT	SG	12	34	3	46	3	4	4	11	1	2	3	6	33	30
BC6	16-13-21	NAT	NAT	46	55	5	101	2	2	2	6	1	2	3	6	30	30
BC7	21-13-21	UFP	NAT	0	0	1	0	3	2	4	9	2	2	4	8	9	8
BC8	20-13-21	NAT	SG	30	40	5	70	1	2	4	7	1	1	4	6	35	30
BC9	30-13-21	NAT	NAT	0	0	1	0	4	4	4	12	4	4	4	12	12	12
BC10	6-14-21	UFP	UFP	0	0	1	0	2	2	2	6	3	3	2	8	6	8
BC11	1-14-22	NAT	SG	9	14	2	23	4	2	4	10	4	3	4	11	20	33
BC12	13-14-22	NAT	SG	6	5	2	11	1	3	4	8	4	2	4	10	16	20
BC13	24-14-22	NAT	SG	14	24	3	38	4	2	4	10	4	2	4	10	30	40
BC14	25-14-22	NAT	NAT	20	12	4	32	1	2	4	7	3	2	4	9	28	27
BC15	26-14-22	NAT	SG	20	23	4	43	1	3	4	8	1	3	4	8	32	32
BC16	35-14-22	NAT	SG	14	12	3	26	1	1	4	6	4	3	4	11	18	33
BC17	34-14-22	NAT	SG	37	18	5	55	4	4	4	12	4	4	4	12	60	36
BC18	2-15-22	NAT	SG	5	8	2	13	4	4	4	12	1	3	4	8	24	16
BC19	11-15-22	NAT	SG	17	12	3	29	4	3	4	11	2	3	4	9	33	27
BC20	14-15-22	FOD	FOD	0	0	1	0	1	1	2	4	1	1	2	4	4	4
BC21	23-15-22	UFP	UFP	0	0	1	0	2	2	3	7	1	2	3	6	7	6
BC22	26-15-22	FOD	NAT	11	15	3	26	1	1	4	6	1	1	4	6	18	18

Landuse - SG - small grains OS - oil seeds UFP - unfenced pasture FP - fenced pasture

FOD - fodder FAL - fallow NAT - natural vegetation

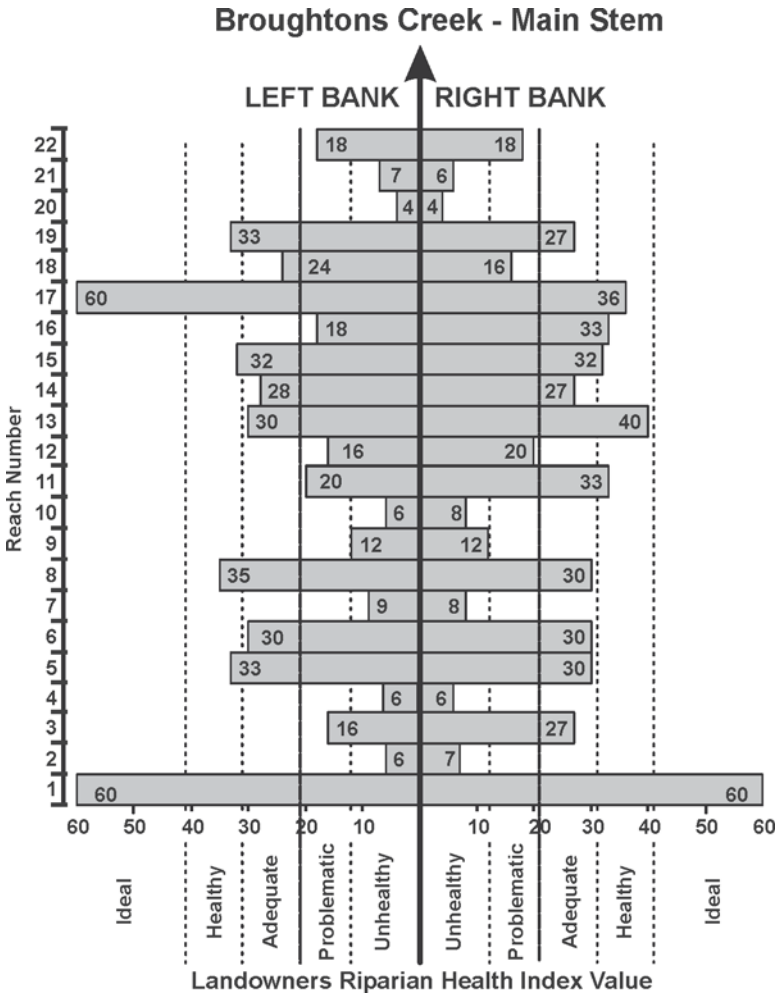


Figure 4: Landowners' Riparian Health Index, Broughtons Creek - Main Stem.

would result in an upgrading of three of the Adequate banks (33%) to a classification of Healthy.

## Conclusions

An index is a readily obtainable measurement that depicts a variable or process which itself is not easily measured. The Landowners' Riparian

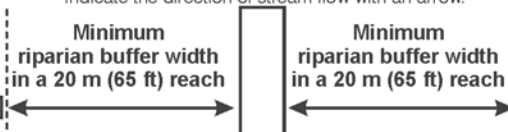
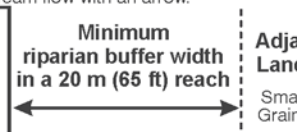
Landowner		Location (Sec. / Twp. / Rg.)
In the box below, Indicate the direction of stream flow with an arrow.		
<b>Adjacent Landuse</b> Small Grains <input type="checkbox"/> Oil Seeds <input type="checkbox"/> Fodder <input type="checkbox"/> Unfenced Pasture <input type="checkbox"/> Fenced Pasture <input type="checkbox"/> Natural <input type="checkbox"/> Other Specify <input type="checkbox"/>	<b>Minimum riparian buffer width in a 20 m (65 ft) reach</b>  metres <input type="text"/> feet <input type="text"/>	<b>Adjacent Landuse</b> Small Grains <input type="checkbox"/> Oil Seeds <input type="checkbox"/> Fodder <input type="checkbox"/> Unfenced Pasture <input type="checkbox"/> Fenced Pasture <input type="checkbox"/> Natural <input type="checkbox"/> Other Specify <input type="checkbox"/>
<b>Vegetal Diversity In a 20 m (65 ft) reach</b> No observable bare ground <input type="checkbox"/> Occasional spots of bare ground <input type="checkbox"/> A few patches of bare ground <input type="checkbox"/> Large patches of bare ground <input type="checkbox"/>	<b>Minimum riparian buffer width in a 20 m (65 ft) reach</b>  metres <input type="text"/> feet <input type="text"/>	<b>Vegetal Diversity In a 20 m (65 ft) reach</b> No observable bare ground <input type="checkbox"/> Occasional spots of bare ground <input type="checkbox"/> A few patches of bare ground <input type="checkbox"/> Large patches of bare ground <input type="checkbox"/>
How many trees (taller than 2 m or 6 ft) are in the riparian buffer? zero <input type="checkbox"/> 1 or 2 <input type="checkbox"/> 3 to 10 <input type="checkbox"/> more than 10 <input type="checkbox"/>	<b>Vegetal Diversity In a 20 m (65 ft) reach</b> No observable bare ground <input type="checkbox"/> Occasional spots of bare ground <input type="checkbox"/> A few patches of bare ground <input type="checkbox"/> Large patches of bare ground <input type="checkbox"/>	How many trees (taller than 2 m or 6 ft) are in the riparian buffer? zero <input type="checkbox"/> 1 or 2 <input type="checkbox"/> 3 to 10 <input type="checkbox"/> more than 10 <input type="checkbox"/>
How many shrubs or cluster of shrubs (shorter than 2m or 6 ft) are in the riparian buffer? zero <input type="checkbox"/> 1 or 2 <input type="checkbox"/> 3 to 10 <input type="checkbox"/> more than 10 <input type="checkbox"/>	<b>Vegetal Diversity In a 20 m (65 ft) reach</b> No observable bare ground <input type="checkbox"/> Occasional spots of bare ground <input type="checkbox"/> A few patches of bare ground <input type="checkbox"/> Large patches of bare ground <input type="checkbox"/>	How many shrubs or cluster of shrubs (shorter than 2m or 6 ft) are in the riparian buffer? zero <input type="checkbox"/> 1 or 2 <input type="checkbox"/> 3 to 10 <input type="checkbox"/> more than 10 <input type="checkbox"/>

Figure 5: Landowners' Riparian Health Assessment sheet.

Health Index (LORHI) is founded on the principle that examining the vitality and productivity of the vegetation in a buffer zone can assess the health of a riparian area. Landowners or tenants can evaluate the riparian buffer on their land by responding to a one-page questionnaire (Figure 5). Due to the subjective nature of the riparian health index and the fact that most farmers have an intimate understanding of their land, respondents can complete the questionnaire in the field, over coffee or the telephone in just a few minutes. The LORHI can be easily calculated and classified into five health categories: Ideal, Healthy, Adequate, Problematic and Unhealthy. Problematic and Unhealthy classifications are generally associated with narrow buffer widths and poor vegetal diversity. Using

the LOHRI, conservation district managers and landowners can identify problematic and unhealthy reaches and concentrate remedial actions in those areas.

The LORHI for the main stem of Broughtons Creek indicates that 50 percent of the channel length has a riparian health problem. Sixty-four percent of the problematic and unhealthy banks are unfenced pasturelands (classified as Unhealthy) that could be upgraded by fencing livestock. Rehabilitation of the vegetal diversity (often, simply the seeding of bare ground) will result in an additional upgrading.

The LORHI is an effective tool for assessing riparian health in small agricultural watersheds. It helps identify problematic and unhealthy reaches that require remedial actions. The LORHI will aid in allocating time and dollars into riparian areas that are in need of rehabilitation.

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