Determining the Average Width of the Riparian Zone in the Cassels-Rabbit Lakes Area of Temagami, Ontario using Understory Indicator Species

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INTRODUCTION

The nature of riparian, or shoreline ecosystems in eastern Canada is virtually unknown and the minimal protection from logging that they currently receive in Ontario will ultimately lead to their demise in that province. This lack of understanding and protection is somewhat surprising considering that they are typically one of the most productive and biologically diverse ecosystems in the forested landscape (Thomas et al. 1979, Hunter 1990, Gregory et al. 1991, Naiman et al. 1993, Naiman and Decamps 1997). Because of this productivity and diversity, riparian ecosystems are extremely valuable to people by providing many goods and services such as aesthetic beauty, access to water, a source of food such as fish, etc. Unfortunately, however, these ecosystems have been heavily exploited and poorly conserved by humans. More than 80% of North America's original riparian ecosystems have disappeared due to this exploitation (Naiman et al. 1993).

In an attempt to minimize logging impacts to riparian ecosystems and their associated aquatic ecosystems in Ontario, the government's current *Code of Practice for Timber Operations in Riparian Areas* (MNR 1991) specifies that a three meter buffer zone must be left along stream banks. However, our observations in the field indicate that riparian (streambank) ecosystems in central Ontario's forests are often wider than three meters. There is also mounting evidence from studies conducted elsewhere that much wider buffer zones are required to protect the full complement of biodiversity in riparian ecosystems. For example, a study in Vermont found that, to include 90% of the riparian plant species, the stream buffer zone must range from 10 to 30 meters in width (Spackman and Hughes 1995). The same study also showed that to include 90% of the bird species of the riparian ecosystem, the buffer width must vary from 75 to 175 meters. Another study examining six species of *Ambystoma* salamanders that depend on wetlands, primarily in northeastern and northcentral United States, found that to include 95% of the salamander populations, the buffer zone would have to extend 164 meters from the wetland edge into the terrestrial habitat (Semlitsch 1998). According to these studies, buffer zones along streams in central Ontario's forests may have to increase to at least 30 meters in order to protect plant species, and to at least 175 meters in order to protect salamander and bird habitat. In some cases, they may have to be as wide as 400 meters to protect all components of biodiversity (Brinson et al. 1981).

The purpose of this study was to use understory vegetation data to determine the mean width of the riparian zone in the Cassels-Rabbit Lakes area of the Temagami region of Ontario. This work has direct implications for the evaluation of current government guidelines that specify a three-meter protective buffer strip on either side of the stream. The results presented in this report are based only on the understory data. Additional future analyses that include the shrub/sapling data and the overstory data may modify the estimated width of the riparian zone as determined from these understory data.

METHODS

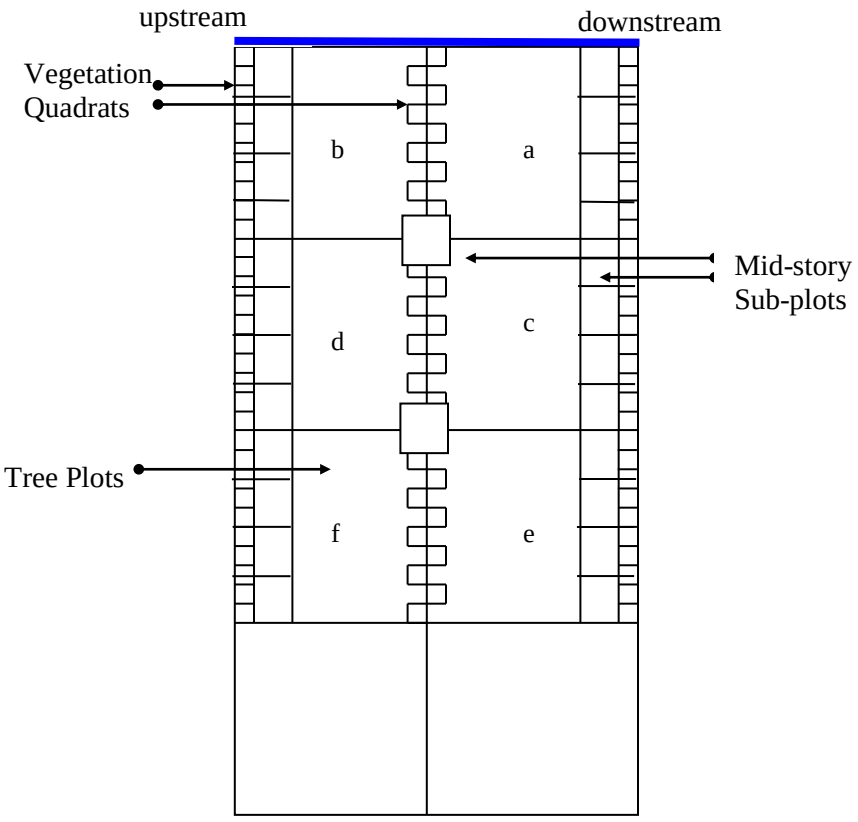
Where possible, we sampled riparian areas in stands where we had previously sampled the uplands. For the most part, we sampled only in pristine, older stands, however, a few stands with minor historical logging were also sampled. In those few stands with historical logging, transects were located only in the unlogged portion of the stand at least 50 m from the stumps. Sampling was restricted to lower order streams – primarily first and second order and occasionally third order. We sampled riparian zones that were located within each forest type found within the study area. These forest types were defined by the dominant tree species shown on Forest Resource Inventory (FRI) maps. We call these "FRI dominance types" and they include stands dominated by black spruce, jack pine, poplar, red pine, white birch, white cedar, and white pine. Sampling was carried out within a rectangular transect that was 30 m long and 20 m wide with the long side running perpendicular to the stream and the short side running along the streambank at the water's edge (see Figure 1). Where it was obvious that the plant community in the riparian zone was unique relative to the adjacent upland area and extended beyond the 30 m mark, two additional 10 x 10 m plots and associated mid-story and understory samples were added at the upland end of the transect until it appeared that the transect had reached the upland area. Transects were located in order to sample the variety of slope conditions (steep, moderate, and gentle) that typify the riparian zone within each FRI dominance type.

Nested within each 30 x 20 m transect, a 2 x 3 matrix of six 10 x 10 m plots was set up (Figure 1). On the inside of each 30 m transect side, 12 contiguous 2.5 x 2.5 m subplots were established and two more of these subplots were located in the center of the two overlapping 20 x 20 m plots. Finally, (1) on the inside of each 30 m transect side, 30 contiguous 1 x 1 m quadrats were sampled, and (2) 30 1 x 1 m quadrats running down the 30 m transect center line and alternating from one side to the other were sampled. The numerous contiguous plots, subplots, and quadrats will allow for assessment of detailed changes in plant species composition and biomass along the habitat gradient between the stream edge and the upland area. In addition, this sampling scheme will allow for duplication of the sampling design used for the upland sampling by removing certain subplots and quadrats, and by combining plots into larger 20 x 20 m plots. Each transect was permanently marked.

If vegetation subplots or quadrats within plot a and/or plot b (see Figure 1) contained an abundance of water or rock due to stream meandering, then additional subplots and/or quadrats were added onto the upland end of the transect to replace those that were missing. If a portion of the vegetation along the streambank fell outside of the plots, subplots, or quadrats due to stream meandering, then additional samples were added at the stream end of the transect. The following activities occurred once each 30 x 20 m transect was established.

- 10 x 10 m plots: overstory trees (10+ cm dbh) and snags (10+ cm dbh; >2 m high) were identified to species and measured for dbh. In addition, snags were assessed for decay class (1=least; 5=most) and for woodpecker activity (presence/absence including pileated activity).
- 2.5 x 2.5 m subplots: percent cover of all mid-story vegetation (>5 m high and <10 cm dbh) were determined by species.
- 1 x 1 m quadrats: all vascular plants, mosses and liverworts as a group, and lichens as a group were identified to species and assessed for percent cover.
- Habitat data and site conditions were described and recorded for each transect including slope position, %slope, aspect, %exposed bedrock, topography, bedrock features, evidence of fire, animal evidence, gaps in the canopy, and wetlands.
- Plant taxonomy was based on Chambers et al. (1996) and Newmaster et al. (1997).

Figure 1. Riparian Sampling Design Including the Transect, Plots, Sub-plots, and Quadrats



The analysis for this study utilised only the understory vegetation data. The first step was to summarise the raw data into mean %cover values for each plant species at each distance from the streambank (1 to 30 m). Using the summarised data it was then possible to identify those species that showed a significant correlation (Pearson product-moment) between their abundance and distance from the streambank. Then, using those species with significant correlations, a backwards stepwise multiple regression (using Statistica) was used to identify the set of species that best predicted distance from the streambank. Once the regression model was identified, it was used to predict the average width of the riparian zone in the Cassels-Rabbit Lakes area of Temagami.

RESULTS

A total of 122 plant taxa (species and species groups) were found in the 37 transects that were sampled in the riparian zone of 16 streams in the Cassels-Rabbit Lakes area (Table 1). The abundance of 56 plant species was significantly correlated with distance from the streambank (30 meters), however, due to constraints of the multiple regression analysis (related to inversion of the correlation matrix) only the 28 (N-2) plant species that were most highly correlated with distance from the streambank were used to develop the prediction model (Table 1). The analysis selected four species (independent variables) for the model including Joe-Pye weed (*Eupatorium maculatum*) and northern beech fern (*Phegopteris connectilis*), which were called the riparian indicator species, and wolf's claw club-moss (*Lycopodium clavatum*) and bracken fern (*Pteridium aquilinum*), which were called the upland indicator species. Both Joe-Pye weed and northern beech fern decreased in

abundance with distance away from the streambank (Figs. 2 and 3), whereas wolf's claw club-moss and bracken fern increased in abundance with distance away from the streambank (Figs. 4 and 5). The abundance of these four species was used to predict distance from the streambank (treated here as the dependent variable). The regression analysis produced an F-value of 106.37 (p= .0000) and an adjusted R^2 of .94, meaning that 94% of the joint variation in the abundance of the four selected species as it relates to the distance from the stream can be explained by our data, leaving only 6% of the variation unexplained. By plugging 0 abundance values into the prediction model for each of the four species, it was then possible to estimate at what point along the 30 meter transect the riparian indicator species would disappear and the upland indicator species would appear. This point was predicted at 16.5 meters from the streambank and thus, is considered to be the average width of the riparian zone.

Table 1. List of Plant Species in the Riparian Zone of the Cassels-Rabbit Lakes Area and their Correlation with Distance from the Streambank (species in bold face represent the most significant correlations and were used to generate the regression model; * means that the correlation was significant but too low to be included in the regression model)

SPECIES NAME	CORRELATION COEFFICIENT
Abies balsamea (basam fir)	.09
Acer pensylvanicum (striped maple)	-.35
Acer rubra (red maple)	.07
Acer saccharum (sugar maple)	-.19
Acer spicatum (mountain maple)*	-.37
Acetaea rubra (baneberry)	-.29
Adiantum pedatum (maiden hair fern)	-.32
Alnus incana (speckled alder)*	-.43
Alnus viridis (green alder)	.31
Amelanchier spp. (serviceberry)	-.21
Anemone candensis (Canada anemone)	-.26
Aralia nudicaulis (wild sarsaparilla)	.29
Aralia racemosa (spikenard)	.00
Aster macrophyllus (large-leaved aster)	**.74**
Athyrium filix-femina (lady fern)	**-.74**
Betula alleghaniensis (yellow birch)	**-.77**
Betula papyrifera (white birch)*	-.45
Botrychium virginianum (rattlesnake fern)*	-.43
Chimaphila umbettula (princes pine)	.00
Cicuta maculata (Cicuta maculata (water hemlock)	-.27
Circaea alpina (drawf enchanter's nightshade)	**-.69**
Clintonia borealis (blue bead lily)	**.64**
Coptis trifolia (goldthread)	**.57**
Cornus canadensis (bunchberry)	**.81**
Cornus rugosa (round-leaved dogwood)	-.08
Cornus stolonifera (red osier dogwood)	.16
Coryllus cornuta (beaked hazelnut)	-.03
Cypripedium acuale (pink lady's slipper)	-.16
Cystopteris bulbifera (bulbet fern)	**-.58**
Diervilla lonicera (nothern bush honeysuckle)*	.39
Dirca palustris (leatherwood)	.12

Drosera rotundifolia (round-leaved sundew)	-.22
Dryopteris carthusiana fancy (fancy wood fern)	-.32
Dryopteris carthusiana toothed (toothed wood fern)	-.34
Dryopteris marginalis (marginal wood fern)*	-.51
Epigaea repens (trailing arbutus)	-.01
Epilobium angustifolium (fireweed)*	-.36
Equisetum scirpoides (drawf scouring rush)	-.20
Equisetum sylvaticum (woodland horsetail)*	-.50
Eupatorium maculatum (Joe-Pye weed)	**-.66**
Fragaria vesca (woodland strawberry)	-.29
Fraxinus nigra (black ash)	**-.83**
Galium asprellum (rough bedstraw)*	-.40
Galium triflorum (fragrant bedstraw)*	-.55
Gaultheria hispidula (creeping snowberry)*	.37
Gaultheria procumbens (wintergreen)	**.60**
Goodyera repens (rattlelsnake plantain)	.20
Gymnocarpium dryopteris (oak fern)*	-.51
Huperzia lucidula (shining clubmoss)	.06
Hypericum virginicum (marsh St. Johnswort)	**-.62**
Impatiens capensis (spotted touch-me-not)*	-.55
Kalmia angustifolia (sheep laurel)*	.45
Lactuca spp. (wild lettuce)	.25
Larix laricina (tamarack)	.00
Lichen spp.	-.01
Linnaea borealis (twinflower)	.25
Lonicera canadensis (Canada fly honeysuckle)	-.35
Lycopodium annotinum (stiff clubmoss)*	.43
Lycopodium clavatan (wolfs claw club-moss)	**.59**
Lycopodium dendroideum (ground pine)	**.72**
Lycopus americanus (water horehound)	**-.60**
Maianthemum canadense (Canada mayflower)*	.54
Matteuccia struthiopteris (ostrich fern)*	-.55
Medeola virginiana (cucumber root)*	.55
Mentha arvensis (wild mint)*	-.47
Mitchella repens (partridge berry)	.26
Mitella nuda (naked mitrewort)	**-.62**
Monotropa hypopitys (pinesap)	.14
Monotropa uniflora (indian root)	.10
Moss/Liverwort spp.*	.49
Myrica gale (sweet gale)	-.32
Nemopanthus mucronatus (mountain holly)	.13
Onoclea sensiblis (sensitive fern)	**-.71**
Osmorhiza claytoni (sweet cicely)	.04
Osmunda claytoniana (interrupted fern)	-.05
Osmunda regalis (royal fern)*	-.48
Oxalis montana (wood sorrel)*	-.49
Phegopteris connectilis (northern beech fern)	**-.85**
Picea glauca (white spruce)	-.19
Picea mariana (black spruce)*	.50
Pinus bankisiana (jackpine)*	.37
Pinus resinosa (red pine)	-.01

Pinus strobus (white pine)	-.23
Plantanthera hyperborea (northern green orchid)	-.19
Plantanthera orbiculata (round-leaved orchid)	.27
Poaceae spp. (grass)	**-.71**
Polygonatum canaliculatum (true solomon's seal)*	-.41
Polygonum cilinode (black fringed bindweed)	-.19
Polypodium virginianum (rock fern)	.00
Populus balsamifera (balsam poplar)	-.22
Populus spp.*	.50
Potentilla palustris (marsh cinquefoil)	-.30
Prunus pensylvanica (pin cherry)	.09
Prunus virginiana (choke cherry)	**-.67**
Pteridium aquilinum (bracken fern)	**.82**
Pyrola spp.	-.04
Quercus rubra (red oak)	-.26
Ribes glandulosum (skunk currant)	.08
Ribes lacustre (black swamp currant)*	.39
Ribes triste (swamp red currant)	-.22
Rubus idaeus (wild red raspberry)*	-.50
Rubus pubescens (drawf trailing raspberry)	**-.61**
Salix spp. (willow)	**.68**
Sambucus canadensis (Canada eldeberry)	.04
Sanicula marilandica (black snake root)	-.20
Scutellaria galericulata (marsh scullcap)	**-.56**
Sedge spp.	**.68**
Smilacina racemosa (false solomon’s seal)	-.19
Solidango canadensis (Canada goldenrod)	-.25
Sorbus americana (American American mountain ash)	-.19
Spiraea alba (meadow-sweet)*	-.50
Streptopus roseus (rose twisted stalk)	.19
Taxus canadensis (Canada yew)	**-.59**
Thalictrum polygamum (tall meadow rue)	**-.64**
Thuja occidentalis (eastern white cedar)	.27
Tiarella cordifolia (foam flower)*	-.43
Trientalis borealis (starflower)*	.38
Trillium cernuum (nodding trillium)	.08
Vaccinium angustifolium (low sweet blueberry)	**.81**
Vaccinium myrtilloides (velvet leaf blueberry)	.33
Viburnum cassinoides (wild raisin)	-.03
Viola spp.	**-.70**

Figure 2. Abundance of Joe-Pye Weed in the Cassels-Rabbit Lakes Riparian Zone

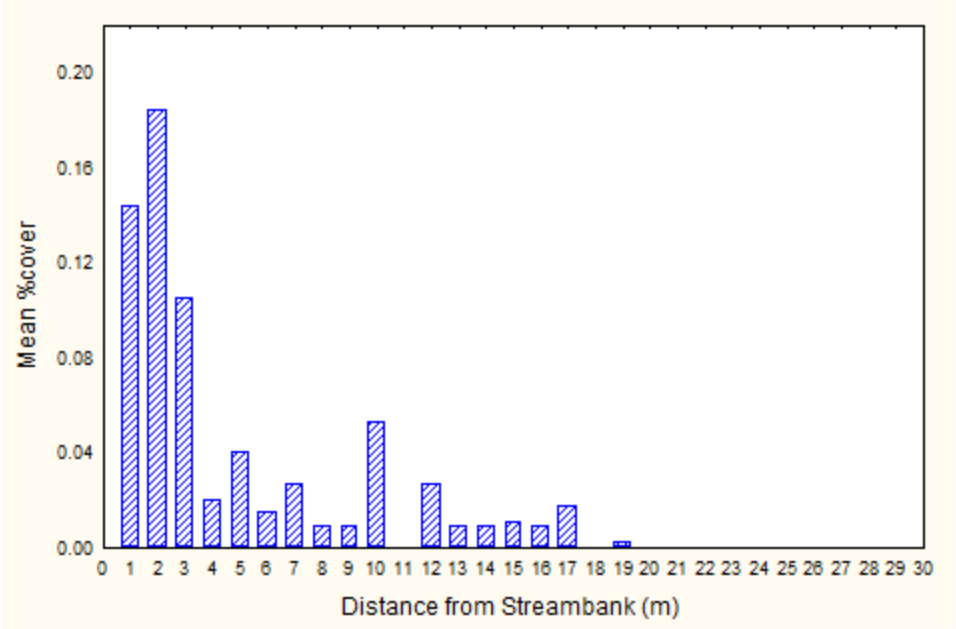


Figure 3. Abundance of Northern Beech Fern in the Cassels-Rabbit Lakes Riparian Zone

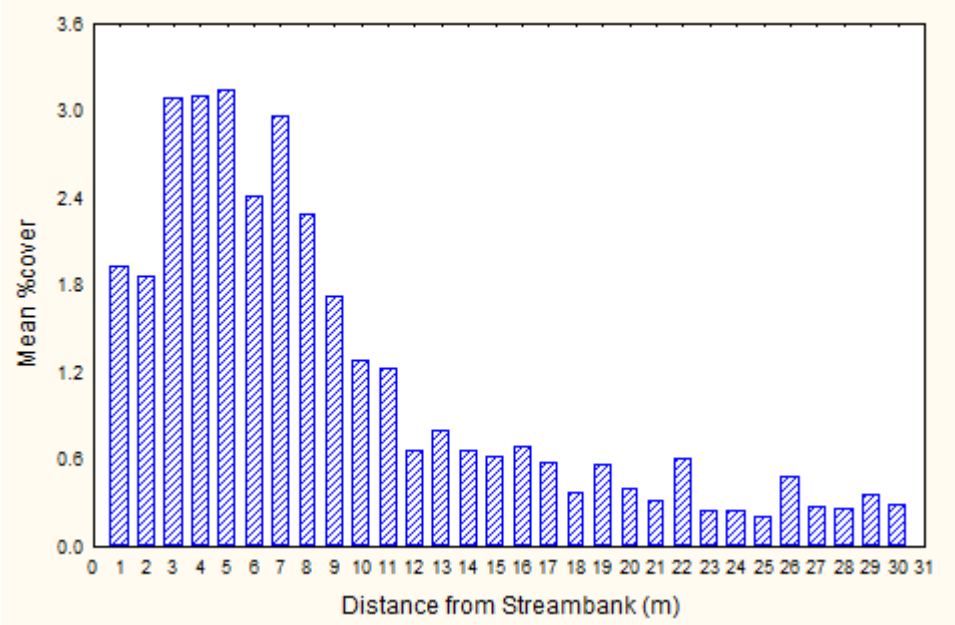


Figure 4. Abundance of Wolf's Claw Club-Moss in the Cassels-Rabbit Lakes Riparian Zone

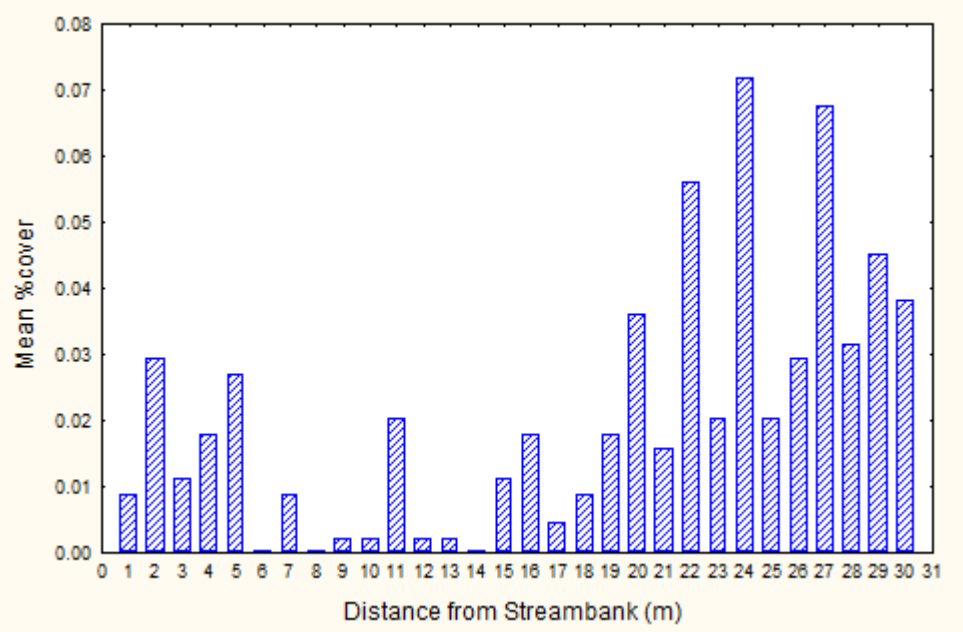
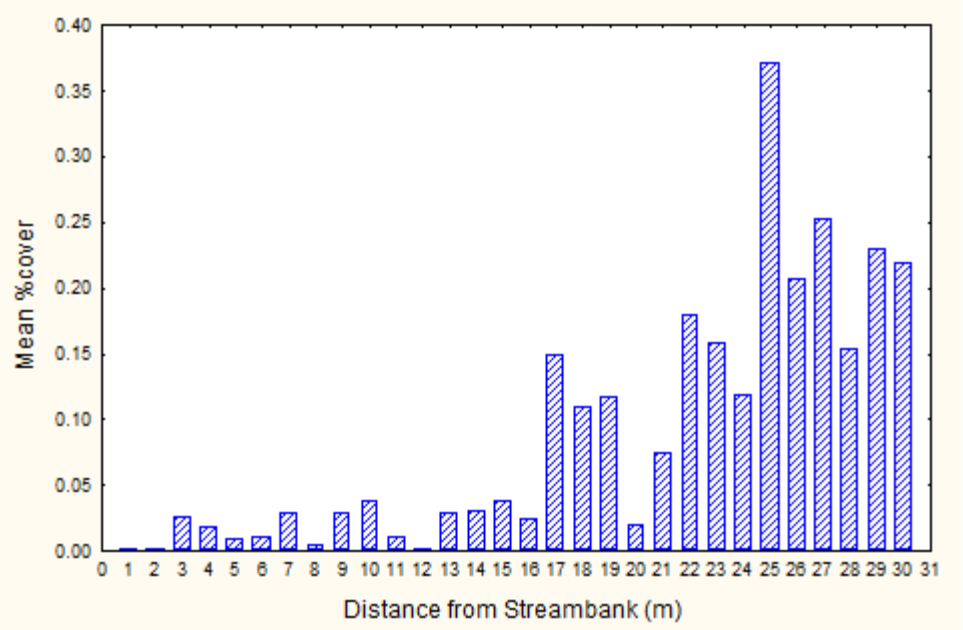


Figure 5. Abundance of Bracken Fern in the Cassels-Rabbit Lakes Riparian Zone



DISCUSSION

The results of this study indicate that the average width of the riparian zone is 16.5 meters on one side of the stream or 33 meters including both sides of the stream and excluding the width of the stream itself. The Ontario Ministry of Natural Resources (OMNR) requires only a six-meter buffer along streams (three meters on each side). This required buffer represents only about 18% of the average riparian zone width in the Cassels-Rabbit Lakes area. Thus, on average and based on these results, the OMNR encourages logging in 82% of the typical riparian zone in the Temagami region of Ontario. Because of this, it is highly likely that logging activities in riparian zones have eliminated, fragmented, and degraded riparian habitats in the Temagami region and other regions of central Ontario. These impacts will continue until the protective buffer zone along streams is widened to reflect the unique features of the zone.

Analysis of additional data collected in the summer of 1999 will enable us to further characterize the nature of the riparian zone in Temagami and to further address issues of riparian zone conservation. These additional analyses are required:

- to incorporate the influence of the shrub/sapling data set,
- to incorporate the influence of the overstory data set,
- to determine the influence of streambank slope on the width of the riparian zone, and
- to characterize variation in riparian width between and within the FRI dominance types that include stands dominated by black spruce, jack pine, poplar, red pine, white birch, white cedar, and white pine.

Assessing the influence of streambank slope and characterizing variation in riparian width will also be pursued during future field seasons.

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