Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Summary of Resources and Land Use Issues Related to Riparian Areas in the Lower West Lake Winnipeg Watershed Study Area

Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration
(AAFC-PFRA)
Winnipeg, MB

2005

Canada

MRAC
Manitoba Rural Adaptation Council Inc.
ADVANCING CANADIAN AGRICULTURE AND AGRI-FOOD

Preface

This report is one of a series of watershed summary reports completed for the Agriculture Environmental Sustainable Initiative's Riparian Areas: Planning and Priority Setting project. Due to scale and data accuracy limitations, these reports do not replace the need for site-specific analysis; rather, they serve as a generalized guide for overall planning purposes on a watershed basis. These reports are available in .pdf format on the Manitoba Riparian Health Council's website (www.riparianhealth.ca), or can be obtained by contacting:

Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration
Prairies East Region,
200-303 Main Street
Winnipeg, Mb
R3C 3G7
Tel: (204)983-2243
Fax: (204)983-2178

Citation:
Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration, Prairies East Region. 2004. Summary of Resources and Land Use Issues Related to Riparian Areas in the Lower West Lake Winnipeg Watershed Study Area. Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration, Winnipeg.

Acknowledgements:
Funding for this project was provided by the Manitoba Rural Adaptation Council. The following individuals from AAFC-PFRA contributed significantly to the compilation, interpretation and derivation of the information contained in this report.

Professional expertise was provided by:
P. Michiels, T. Horechko, J. Fitzmaurice, J. Powers, R. Lewis, T. Scott, N. Mischuk, J. Tokarchuk

Technical support was provided by:
C. Wyrzykowski, K. Gottfried, R. Aquino, S. Garrick, S. Solivar, J. Bergthorson, N. Diehl, R. Rosario

Table of Contents

List of Figures **2**

List of Tables **3**

Background **5**

Importance of Riparian Areas **6**

Watershed Overview **7**

Climate and Ecology **11**

Water Resources **14**

Hydrology *14*

Water Quality *14*

Land Cover **15**

Soil Resources **19**

Soil Surface Texture *20*

Soil Drainage *22*

Agricultural Capability *25*

Water Erosion Risk *29*

Agricultural Activities **31**

Watershed Considerations **35**

Soils and Land Cover *35*

Riparian Areas *36*

Farm Management Practices *39*

Agriculture Production Intensity *40*

Summary **46**

Future Steps **47**

References **48**

Glossary **51**

Appendix A **52**

Appendix B **53**

Appendix C **55**

Appendix D **58**

List of Figures

Figure 1.0 Sub-watersheds within the Lower West Lake Winnipeg Watershed study area (water shown at 1:50,000 scale) **8**
Figure 2.0 Digital elevation model of the Lower West Lake Winnipeg Watershed study area (radar image was obtained by the Shuttle Radar Topography Mission, 2000) **9**
Figure 3.0 Rural municipalities in the Lower West Lake Winnipeg Watershed study area **10**
Figure 4.0 Ecoregions and ecodistricts in the Lower West Lake Winnipeg Watershed study area **13**
Figure 5.0 2001 Land cover in the Lower West Lake Winnipeg Watershed study area **17**
Figure 6.0 1994 Land cover in the Lower West Lake Winnipeg Watershed study area **18**
Figure 7.0 Soil surface texture in the Lower West Lake Winnipeg Watershed study area **21**
Figure 8.0 Soil drainage classes for the Lower West Lake Winnipeg Watershed study area **24**
Figure 9.0 Agricultural capability class in the Lower West Lake Winnipeg Watershed study area **28**
Figure 10.0 Water erosion risk in the Lower West Lake Winnipeg Watershed study area **30**
Figure 11.0 Density of shoreline in the West Lake Winnipeg Watershed study area, as determined by the 1:50,000 NTS data sheets **37**
Figure 12.0 Livestock density in the West Lake Winnipeg Watershed study area, as a percentage of the highest value in Manitoba of 0.AU/ha (as reported in the 2001 Census of Agriculture) **42**
Figure 13.0 Level of fertilizer use in the West Lake Winnipeg Watershed study area in 2000, as a percentage of the highest value in Manitoba of $101.23/ha (as reported in the 2001 Census of Agriculture) **44**
Figure 14.0 Level of pesticide use in the West Lake Winnipeg Watershed study area in 2000, as a percentage of the highest value in Manitoba of $81.65/ha (as reported in the 2001 Census of Agriculture) **45**

List of Tables

Table 1.0 Climate data for ecoregions within the Lower West Lake Winnipeg Watershed study area 12
Table 2.0 Land cover (2001) and general trend over a seven-year period (1994 – 2001) in the Lower West Lake Winnipeg Watershed study area 16
Table 3.0 Soil surface texture in the Lower West Lake Winnipeg Watershed study area[1] 20
Table 4.0 Soil drainage classes for the Lower West Lake Winnipeg Watershed study area[1] 23
Table 5.0 Canada Land Inventory (CLI) class descriptions 25
Table 6.0 Canada Land Inventory (CLI) subclass descriptions 26
Table 7.0 Agricultural capability in the Lower West Lake Winnipeg Watershed study area [1] and the major type of limitations within each class. 27
Table 8.0 Water erosion risk classes in the Lower West Lake Winnipeg 29
Watershed study area [1] 29
Table 9.0 Summary of cultivated crops, including crops cut for hay, silage, green feed, etc, grown in the Lower West Lake Winnipeg Watershed study area (2001 Census) 32
Table 10.0 Summary of tillage practices in the Lower West Lake Winnipeg Watershed study area (2001 Census) 32
Table 11.0 Summary of the conservation practices carried out in the Lower West Lake Winnipeg Watershed study area (2001 Census) 33
Table 12.0 Livestock distribution in the Lower West Lake Winnipeg Watershed study area (2001 Census) 34
Table 14.0 Summary of manure application in the West Lake Winnipeg Watershed study area in 2000 (from 2001 Census of Agriculture) 35
Table 15.0 Summary of shoreline density in the West Lake Winnipeg Watershed study area (includes permanent and intermittent streams and waterbodies). 36
Table 16.0 Summary of land cover in a 50 m buffer around all waterbodies and on either side of watercourses in the West Lake Winnipeg Watershed study area (using 2001 satellite imagery and 1:50,000 NTS water layers)[1] 39
Table 17.0 Comparison of livestock density in the West Lake Winnipeg Watershed study area using 2001 Census livestock numbers converted to Animal Units[1] 41
Table 18.0 – Comparison of crop production intensity in the West Lake Winnipeg Watershed study area using dollars spent on pesticides and fertilizers in 2000 (as reported in the 2001 Census of Agriculture) 43

Background

Riparian areas play an important role in surface water quality and their ability to carry out this function can be affected by anthropogenic activities on the landscape. Agriculture is only one component, with other human activities such as industry, recreation and residences contributing to degraded riparian areas. The intent of this report is to be a first step towards addressing the issue of riparian health, with respect to agriculture, in the watershed study area. By providing information on the land resources and the agricultural activities in the study area, a better understanding of the issue can be obtained which will assist towards better planning and priority setting by local decision makers, land use planners and policy decision-makers. While this reports studies the agricultural aspect of the watershed study area, in a true watershed study, all factors of activities of all sectors must be considered.

This project is a component of the Agriculture and Agri-Food Canada – Prairie Farm Rehabilitation Administration (AAFC-PFRA) Agricultural Riparian Areas: Planning and Performance Monitoring project. Funding was provided by the Manitoba Rural Adaptation Council (MRAC), through the Agricultural Environmental Stewardship Initiative (AESI). The purpose of this project is to provide a central source of riparian-related resource information in a format that is easily accessible to land use planners and policy decision-makers. The information provided can assist in strategic planning for riparian areas in Manitoba. Through the identification of potential problem areas, decision makers can make informed land use decisions that target priority areas.

As part of the Agricultural Riparian Areas: Planning and Performance Monitoring project, AAFC-PFRA has collected, analyzed, and displayed riparian-related data using an Internet Map Server (IMS). The IMS web server is designed to be a one-stop source of riparian-related data and information relevant for analysis, land-use planning, and program design. The IMS site is available under the tools menu on the Riparian Health Council website (*www.riparianhealth.ca*).

The Riparian Health Council (RHC) is comprised of government and non-government agencies with an interest in increasing producer involvement and improving the coordination of cooperative efforts among agencies that develop riparian projects with landowners throughout Manitoba. The Council has developed a vision for cooperative programming that enhances riparian areas and surface water quality across agro-Manitoba while also supporting landowner needs. This project will provide information which can assist the RHC in achieving its vision.

The boundaries used in this report are based on the watershed layer produced by a joint venture between Manitoba Conservation and AAFC-PFRA. For reporting purposes, water flow direction data was used to amalgamate individual sub-watershed units into larger sub-watershed and watershed groups (refer to Appendix D). Due to scale and data accuracy limitations, neither this report nor the information and data provided on the RHC website can replace the need for site-specific analysis. However, these information sources can serve as a guide for general watershed planning purposes.

Importance of Riparian Areas

Although riparian areas occupy only a small percentage of the area of a watershed, they represent an extremely important component of the overall landscape. They are the transitional areas between the aquatic and surrounding upland area. These “green zones” are one of the most ecologically diverse ecosystems. A healthy riparian area can perform a number of ecological functions, including trapping sediment, building and maintaining streambanks, storing floodwater and energy, recharging groundwater, filtering and buffering water, reducing and dissipating stream energy, maintaining biodiversity and creating primary productivity. These functions are essential for sustaining a majority of fish and wildlife species, maintaining functioning watersheds, providing good water quality, forage for livestock and supporting people on the landscape. Disturbance and alteration of a riparian area will impact its ability to carry out these ecological functions. Impacted riparian areas will have a reduced capacity to trap and store sediment and nutrients and stabilizing streambanks (important for surface water quality), provide fish and wildlife habitat, etc.

Recognizing that many sectors contribute to the alteration of riparian areas, including agriculture, recreation, urban and residential development, and forestry, this report will focus on the agricultural impacts to riparian areas in an attempt to provide information that can be used by the agricultural industry to begin to address the issue of riparian health.

Watershed Overview

The Lower West Lake Winnipeg Watershed study area is approximately 143,314 ha in size and is comprised of seven sub-watershed units (refer to Figure 1.0). The watershed drains into Lake Winnipeg, whose waters flow into the Nelson River Basin, and on into the Hudson Bay. There are several lakes of varying sizes within this watershed, including Snake Lake, Fish Lake and Dennis Lake. There are also many streams, creeks and drains present, including Willow and Boundary Creeks and the Fish Lake Drain. A few wetlands and prairie potholes are also located within the study area.

Minor changes in elevation occur throughout the watershed, with values ranging from 290 metres above sea level (masl) between Fish and Snake Lakes, down to 215 masl at the northern tip of the watershed (refer to Figure 2.0).

At the time of this report, the Lower West Lake Winnipeg Watershed study area was outside the boundaries of any existing Conservation District. Five Rural Municipalities (RMs) are present within the watershed boundaries, including Bifrost, Armstrong, St. Andrews and the entire RM of Gimli (refer to Figure 3.0). The Camp Morton Provincial Recreation Park is located about eight km north of Gimli, and is popular for its family vacation cabins, picnicking, hiking, and swimming. Larger towns and communities within the watershed include Gimli, Narcisse and Fraserwood. The RM of Gimli experiences an increase in population during the summer season, with an influx of cottagers who utilize the water-based recreational activities of Lake Winnipeg. Agriculture is an important part of the economy within the watershed. There are extensive wooded areas and grasslands present which provide good grazing capabilities for cattle ranching, as well as potential for wildlife habitat and forestry. Tourism and recreation are other important resources for the local economy, for example the spring viewing of the Narcisse snake pits, as well as the many cottagers who recreate on the shorelines of Lake Winnipeg.

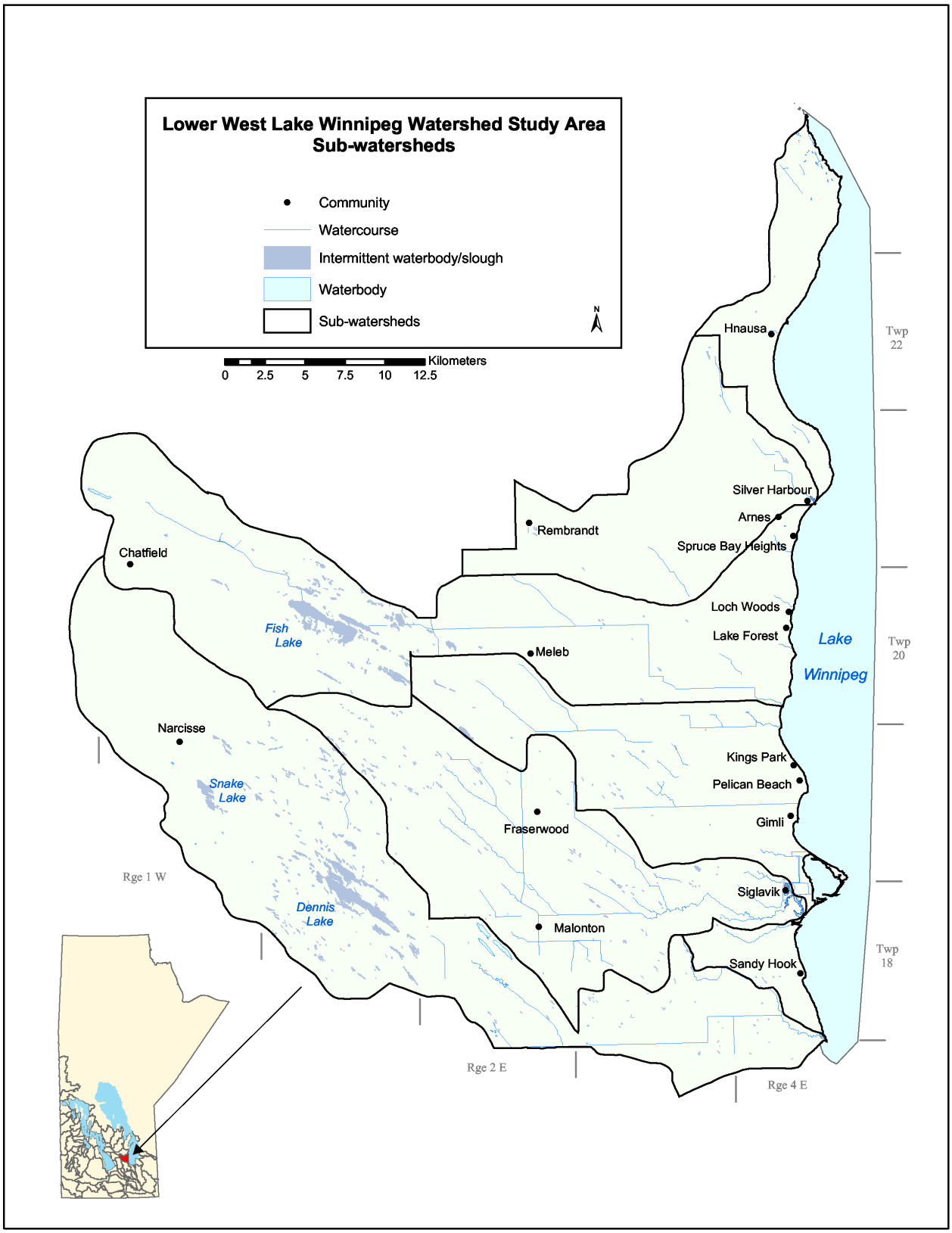


Figure 1.0 Sub-watersheds within the Lower West Lake Winnipeg Watershed study area (water shown at 1:50,000 scale)

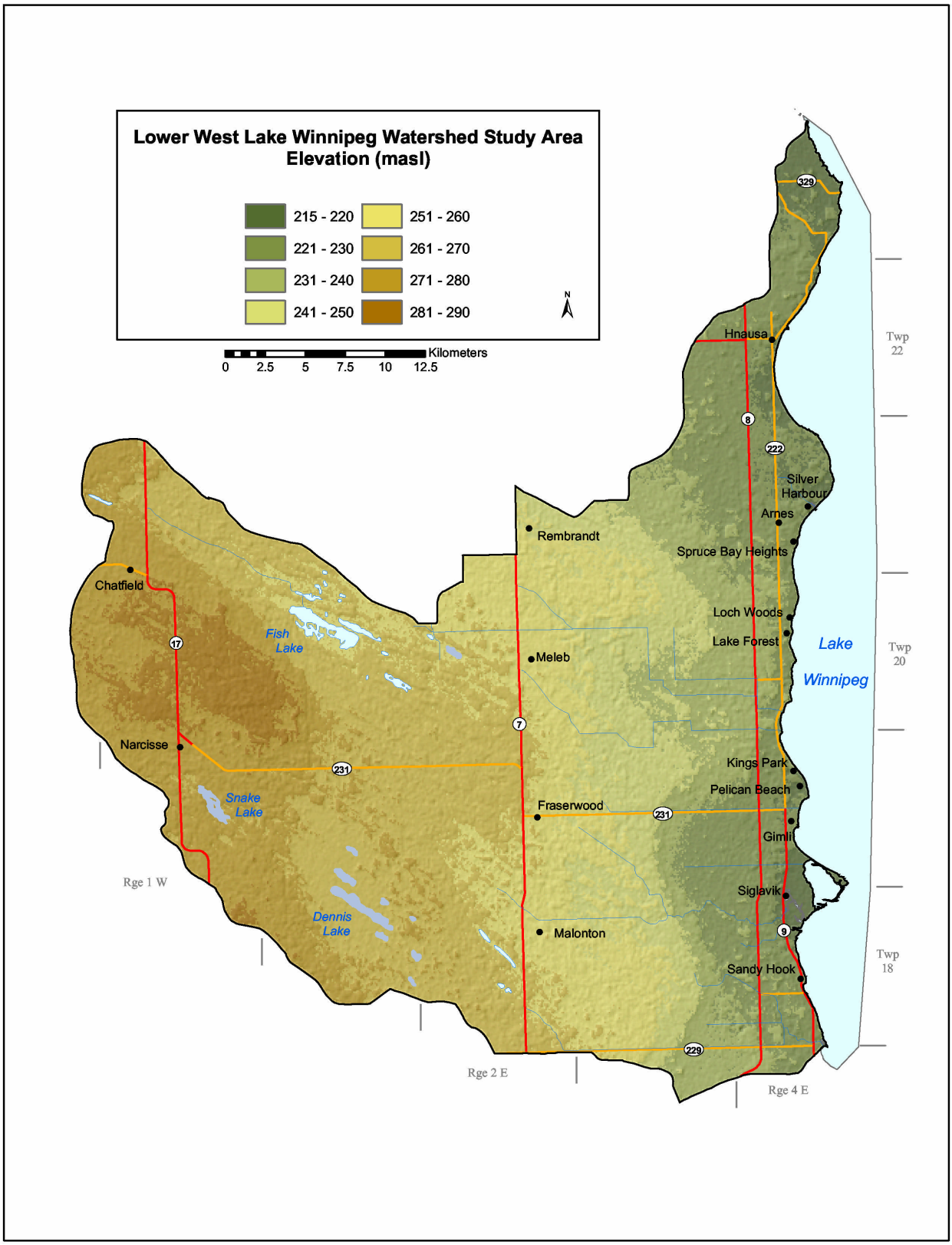


Figure 2.0 Digital elevation model of the Lower West Lake Winnipeg Watershed study area (radar image was obtained by the Shuttle Radar Topography Mission, 2000)

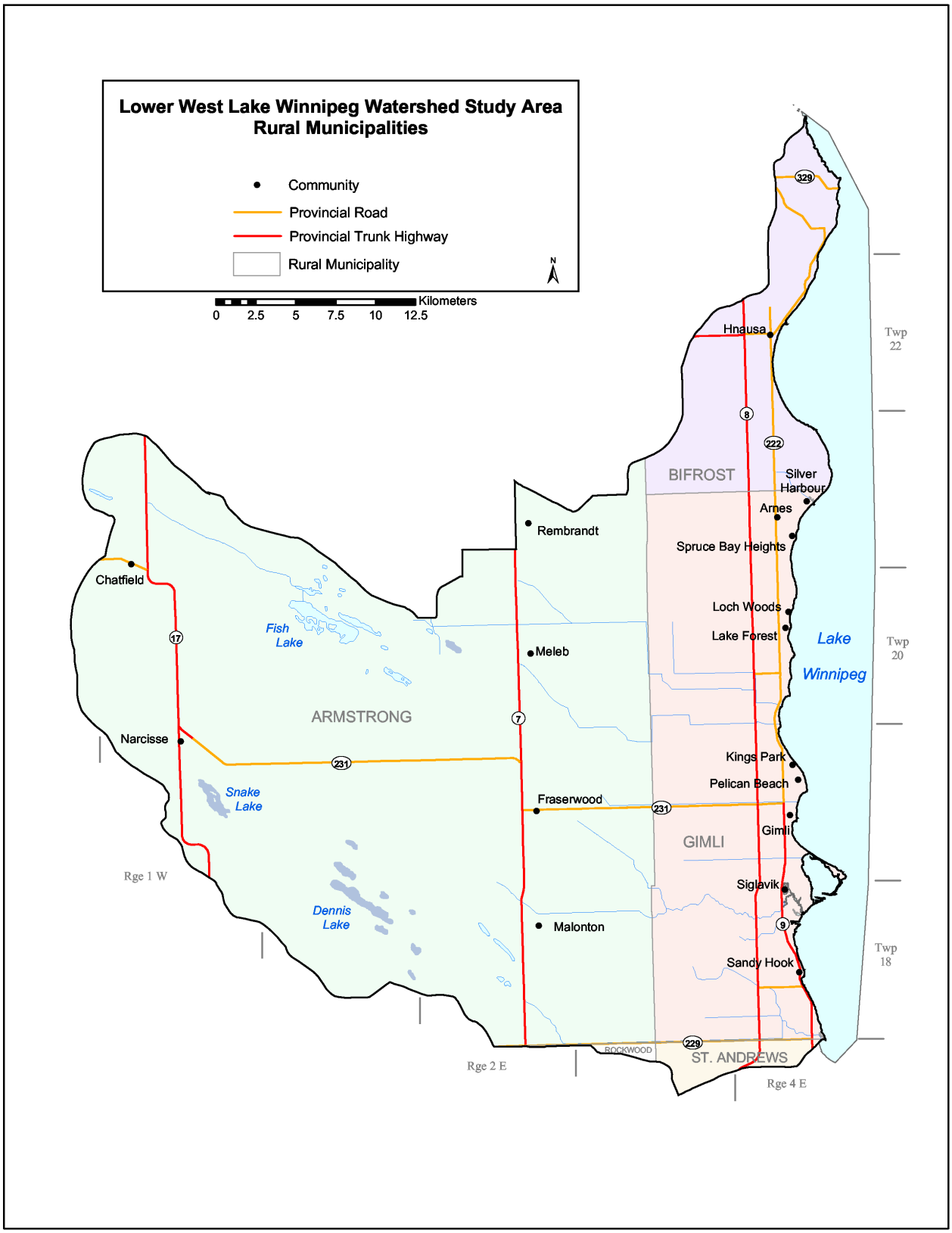


Figure 3.0 Rural municipalities in the Lower West Lake Winnipeg Watershed study area

Climate and Ecology

The Canadian Ecological Land Classification System divides Canada's natural landscapes into terrestrial ecozones, which are further sub-divided into ecoregions and ecodistricts. The classification system was developed by integrating surface vegetation cover, underlying geology, physiography, soils, and climate data (Smith et al. 1998).

Ecozones, the most generalized level in Environment Canada's ecological land classification system, are defined by Smith et al. (1998) as "areas of the earth's surface representative of very generalized ecological units that consist of a distinctive assemblage of physical and biological characteristics". Ecoregions are broad, integrated map units characterized by a unique combination of landscape physiography and ecoclimate. Ecodistricts are integrated map units characterized by relatively homogeneous physical landscape and climatic conditions and they contain Soil Landscapes of Canada polygons nested within them (Smith et al. 1998).

Based on the Terrestrial Ecozones of Canada (Smith et al. 1998), most of the Lower West Lake Winnipeg Watershed study area falls within the Boreal Plains Ecozone, and contains the Mid-Boreal Lowlands Ecoregion (which further contains the Grindstone Ecodistrict) and the Interlake Plains Ecoregion (which further contains the Ashern and Gimli Ecodistricts) (refer to Table 1.0, Figure 4.0). There is a small section in the south which falls within the Prairie Ecozone, and contains the Lake Manitoba Plain Ecoregion (and further contains the Winnipeg Ecodistrict).

The vegetation of the area varies based on moisture and other ecoregion characteristics. The forest stands of this watershed area are dominated by trembling aspen, along with associated species of balsam poplar and white spruce (Smith et al. 1998). In the Ashern Ecodistrict, along with being interspersed with other species, white spruce forms its own pure stands. The distribution of white spruce is greatly affected by forest fires. The Ashern Ecodistrict has had land cleared for agriculture; however some has been converted back to shrub vegetation. Black spruce and some tamarack form the vegetative cover in bogs of this district in association with swamp birch and mosses; while willows, sedge, tamarack, mosses, herbs and forbs are found in the peat lands. In the Gimli Ecodistrict the riverbanks are dominated by Manitoba maple, green ash, elm and cottonwood; while marshes support reeds, cattails and sedges. Poorly drained depressions of the watershed contain willows, sedges and meadow grass vegetation.

Despite weather similarities within the watershed, localized temperature and precipitation conditions exist. Based on climate data for the ecoregions within the Lower West Lake Winnipeg Watershed study area, mean annual precipitation ranges from 510 to 580 mm, while mean annual temperature ranges from 0.9 to 2.4 °C (refer to Table 1.0). The average number of growing season days ranges from 171 to 183 and the average number of growing degree days ranges between 1470 and 1470. Mean annual moisture deficit ranges between 50 and 200 mm (Ecoregions Working Group 1989). These parameters provide an indication of moisture and heat energy available for crop and vegetation growth and generally are sufficient for good growth of a range of crops adapted to the prairies.

Table 1.0 Climate data for ecoregions within the Lower West Lake Winnipeg Watershed study area

Ecozone	Ecoregion	Mean Annual Air Temp (°C)	Mean Growing Season (days)	Mean Growing Degree days	Mean Annual Precipitation (mm)	Mean Annual Moisture Deficit (mm)
Boreal Plains	***Interlake Plain***	1.2-1.6	175-176	1500-1540	510-545	100
	Mid-Boreal Lowland	0.9	171	1470	580	50
Prairies	***Lake Manitoba Plain***	2.4	183	1720	515	200

Note: Climate data is based on eco-climatic data (Ecoregions Working Group, 1989)

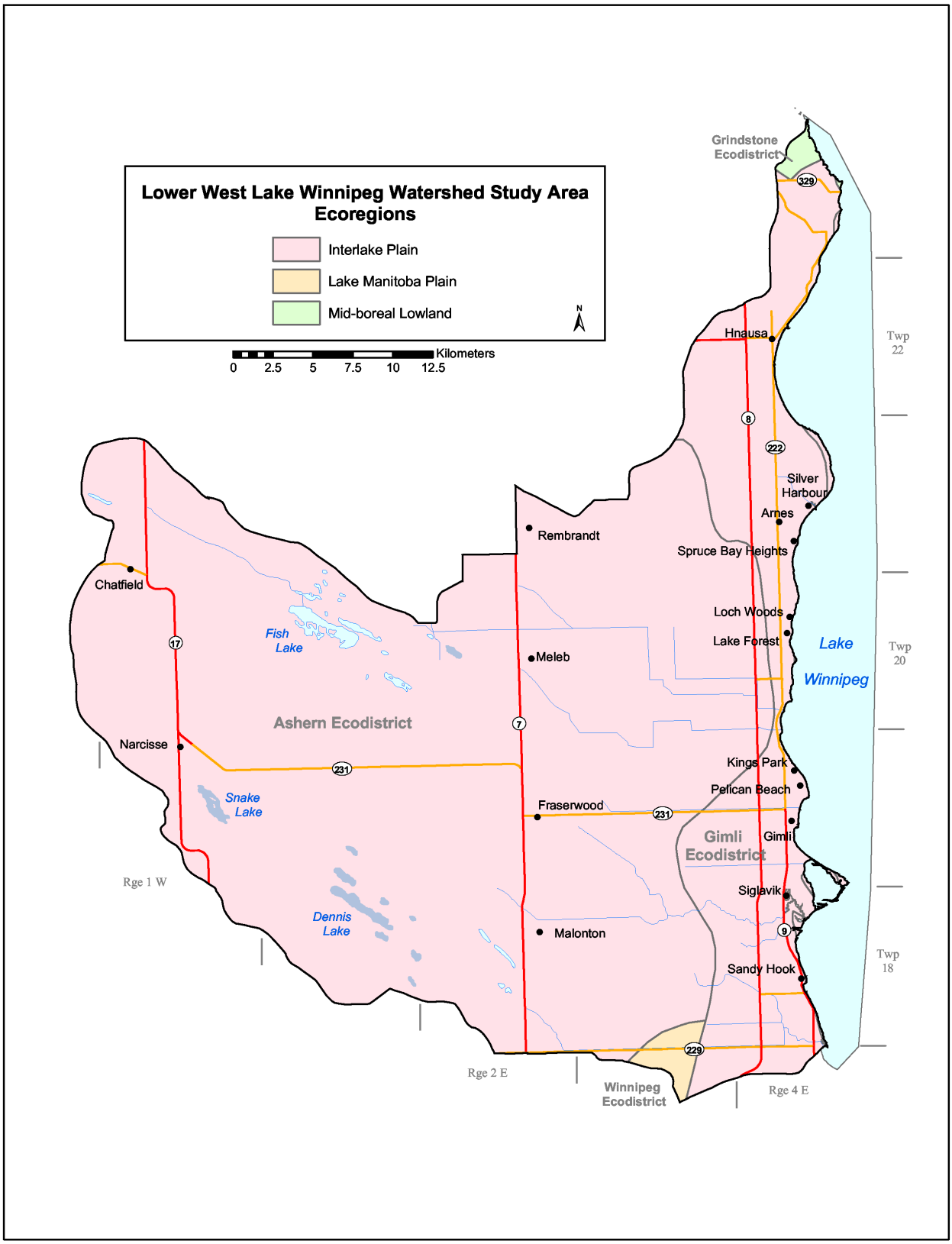


Figure 4.0 Ecoregions and ecodistricts in the Lower West Lake Winnipeg Watershed study area

Water Resources

Hydrology

The Lower West Lake Winnipeg Watershed study area is part of the larger Nelson River Basin. Water within this study area drains into Lake Winnipeg, which is also fed by other watersheds, including the Brokenhead River Watershed, Winnipeg River Watershed, and the major Red River and Assiniboine River Watersheds. The land in the Lower West Lake Winnipeg Watershed study area is drained by various lakes, creeks, streams and drains, which move the water in an easterly direction to eventually empty into the southern basin of Lake Winnipeg. Based on the 1:50,000 National Topographic Series (NTS) data sheets, the watershed contains approximately 589 km of river and stream shoreline (both sides of the waterways are included in that calculation), and 547 km of waterbody shoreline. Most of the waterbody shoreline surrounds intermittent waterbodies (wetlands and sloughs).

Water Quality

Nutrient loading is an important concern with many large and small streams throughout Manitoba. As a result, Manitoba Conservation has developed a long-term nutrient management strategy for surface waters in Manitoba. A comprehensive trend analysis using existing water quality data has been done to detect temporal trends in nutrient concentrations in the streams and rivers in Manitoba (Jones and Armstrong 2001). With the large number of lakes, creeks and drains present in the watershed, as well as the contributions to Lake Winnipeg from other watersheds, there is much potential for impacts on the area's water quality. Future monitoring should be considered.

Land Cover

The land cover classification of the watershed has been interpreted from LANDSAT satellite imagery (which has a 30 metre resolution), using computerized classification techniques. Individual spectral signatures were classified and grouped into the seven land cover classes: annual crop land, forage, grassland, trees, wetlands, water, urban and transportation (refer to Appendix A for land cover class descriptions). Figure 5.0 provides a general representation of the 2001 land cover within the watershed (note: the watershed was analyzed using imagery taken August 2, 2001).

Land use in the watershed is primarily trees and grassland cover. Based on 2001 land cover data, approximately 36% (51,794 ha) of land within the watershed was classified as trees and roughly another 32% (45,142 ha) as grassland (refer to Table 2.0, Figure 5.0). Annual crop land covered about 16% (22,703 ha) of the land in this watershed, and is found in greater proportions within 20 km of the Lake Winnipeg shoreline. Wetland and marsh area is also seen on about 9% of land, mainly in the Fish and Denis Lake areas.

Land cover information is also available from 1994 satellite imagery taken October 26, 1994 for (refer to Figure 6.0). Comparison between the two datasets can result in the emergence of general trends in land cover of the seven-year period, though this will be a rough estimate due to factors such as time/season of satellite image capture, climatic variability and classification requirements.

Over the seven-year period, there has been a decrease in grassland cover (roughly 10,198 ha), while many other land covers have considerably increased (refer to Table 2.0). There has been a substantial increase in forage cover, (195%), while crop land and trees also increased, by 29% and 7%, respectively, likely converted from grassland. Wetland classification showed a slight decrease despite the fact that records from Environment Canada indicate that total precipitation in 2001 at Narcisse was slightly less than that from 1994 (by approximately 50 mm). Wetland and open water classifications may be slightly over estimated due to the fact that the 1994 image classification concentrated specifically on annual cropland to aid in delivery of the Western Grains Transportation Payment Program. Greater attention was paid to all classification categories on the 2001 image classification.

Due to the small size, and tightly integrated nature of wetlands with other land cover categories such as grasslands and shrubs, they can be very difficult to quantify using course resolution imagery. A Prairie Habitat Joint Venture Habitat Monitoring Program coordinated by the Canadian Wildlife Service provides a detailed evaluation of wetland habitat trends in targeted areas of the prairies. Preliminary analysis indicated that in the targeted areas in Manitoba, there has been a net change of -3.0% in wetland areas from 1985 to circa 2000.

Table 2.0 Land cover (2001) and general trend over a seven-year period (1994 – 2001) in the Lower West Lake Winnipeg Watershed study area

Class	Area[1] (ha)	Percent of Study Area	Change in Area (ha)	Percent Change Since 1994[2]
Annual Crop Land	22,703	15.8	5,043	28.6
Trees	51,794	36.1	3,533	7.3
Water	2,595	1.8	20	0.8
Grassland	45,142	31.5	-10,198	-18.4
Wetlands	12,514	8.7	-986[3]	-7.3[3]
Forages	3,771	2.6	2,496	196
Urban/Transportation	4,791	3.3	91	1.9
Total	143,310	100	--	--

1. Area totals are approximate due to the nature of the image analysis procedure
2. Negative changes indicate area has decreased since 1994, positive indicates an increase
3. Due to seasonal changes in wetland size, date of imagery will affect change calculations.

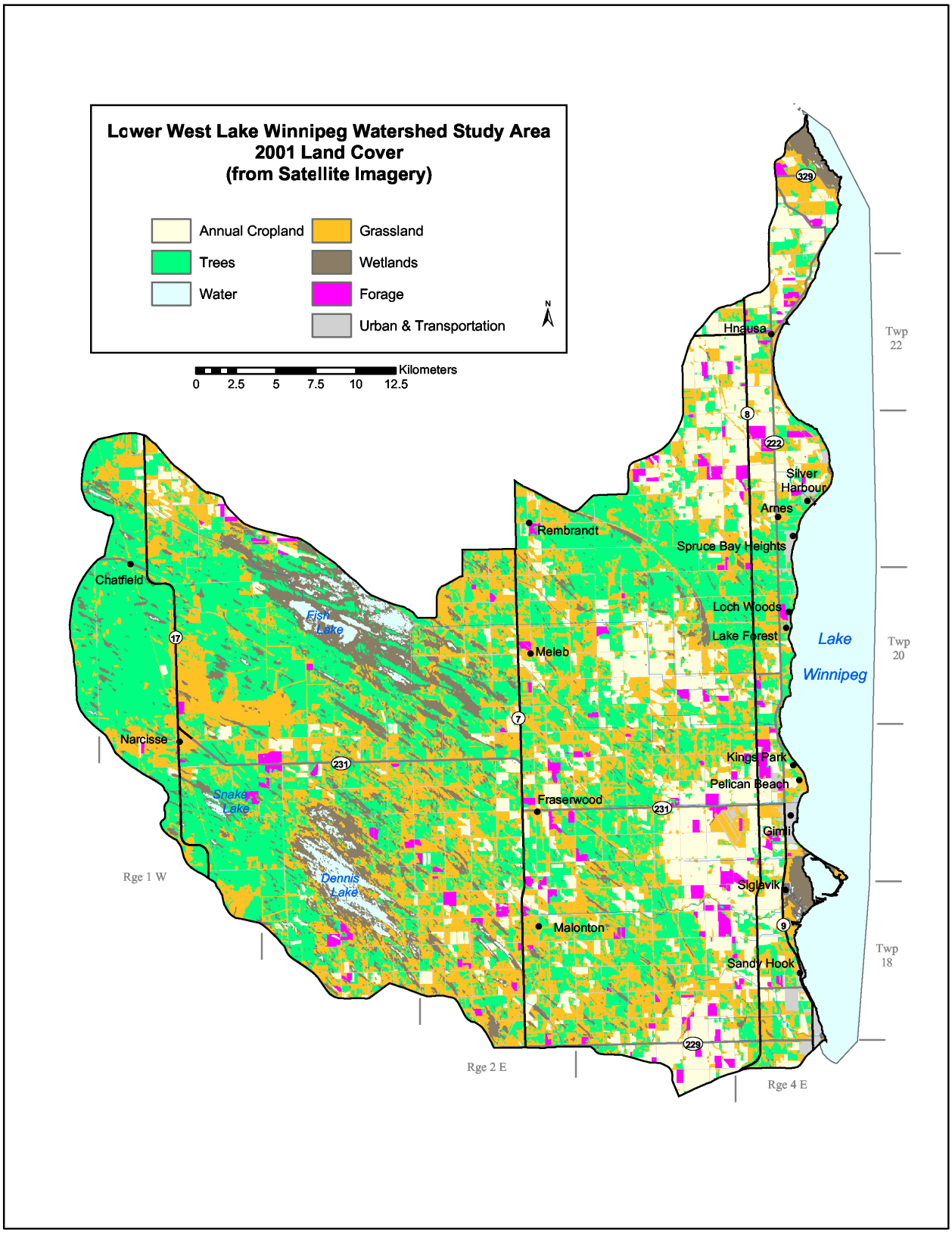


Figure 5.0 2001 Land cover in the Lower West Lake Winnipeg Watershed study area

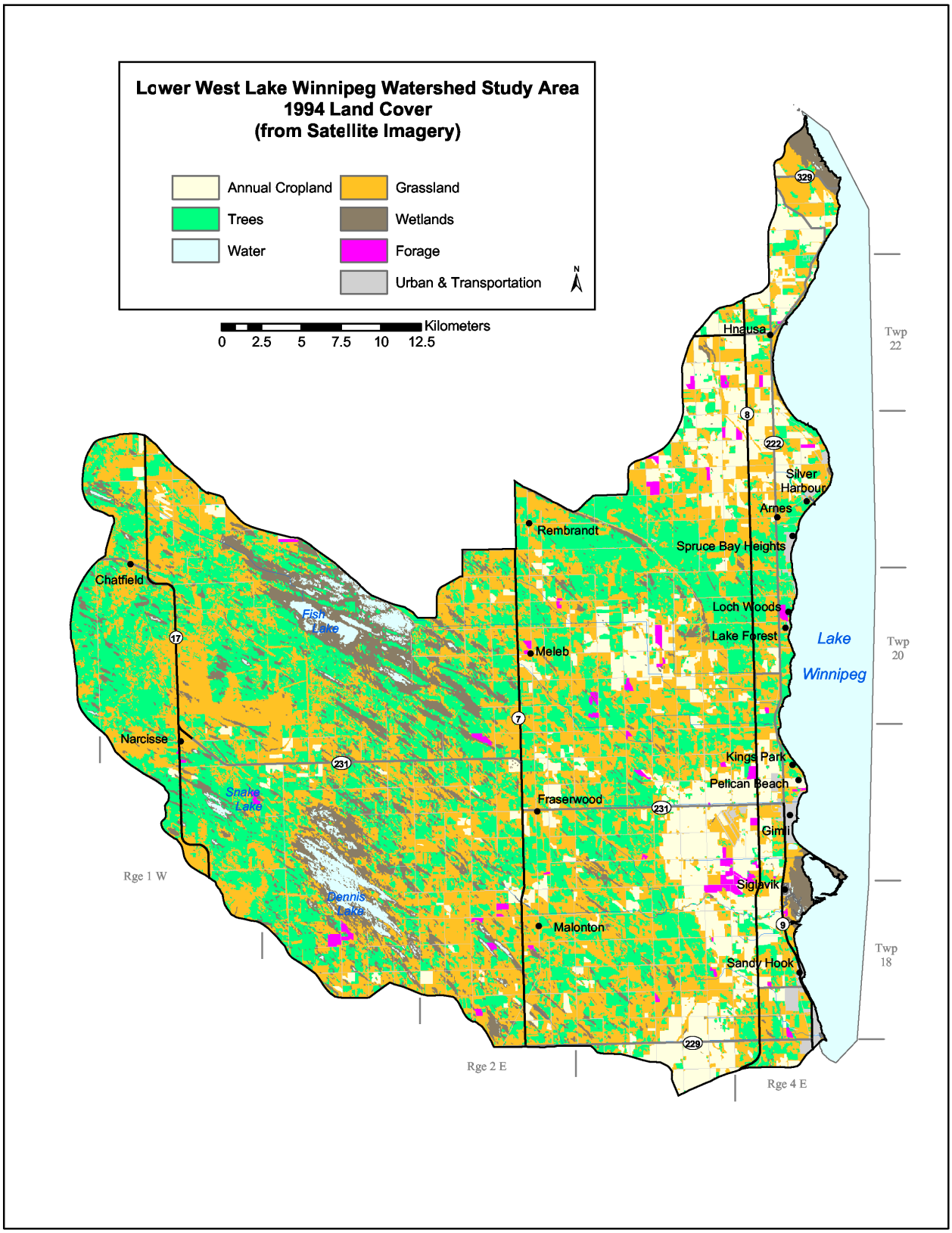


Figure 6.0 1994 Land cover in the Lower West Lake Winnipeg Watershed study area

Soil Resources

Soils data is a critical component of land-use planning. Soil characteristics can be used to determine agricultural capability and to predict risks of erosion, leaching, and run-off. This type of information is important for determining suitable land uses, identifying sensitive areas, and targeting land-use improvement efforts. In terms of riparian health, analysis of soil characteristics can help to identify soils at high risk for erosion and run-off that could contribute to riparian degradation.

Soils data is available for all areas within the watershed. The soils data used in this report were mapped at a detailed scale of 1:20,000 for the Matlock-Gimli areas and around the community of Fraserwood. The remaining area was surveyed at a reconnaissance scale of 1:100,000. Soils information provided in this report is based on the characteristics of the dominant soil series within the soils polygon. A more detailed and complete description of the type, distribution and textural variability of soils in the watershed can be found in the published soil surveys for the area.

The majority of the soils in this watershed were deposited during the last glaciation at time of glacial Lake Agassiz. The western part of the watershed consists of extremely calcareous, very stony, waterworked, loamy glacial till; while the area adjacent to Lake Winnipeg is composed of shallow lacustrine sediments, underlain by loamy, stony, glacial till. These lacustrine sediments move up into the northern shorelines of this watershed.

The soils within the watershed vary, depending on deposition and available moisture. Dark Grey Chernozems are the dominant soil type of this watershed, found on wel-l to imperfectly-drained deposits. Brunisolic soils occur along with the Dark Grey Chernozems on the extremely calcareous glacial till regions in the area adjacent to Lake Winnipeg. Thin Brunisolic soils are common in the well- to imperfectly-drained sites in the west as well. Humic Gleysols occur throughout the watershed, in poorly-drained sites, some areas containing peaty surface layers. There are also poorly-drained organic soils, developed on peat, found in depressions in the western part of the study area.

Soil Surface Texture

Soil surface texture strongly influences the soil's ability to retain moisture, its general level of fertility, and the ease or difficulty of cultivation. For example, water moves easily through coarse-textured (sandy) soils, so little moisture is retained and these soils dry out more quickly than fine-textured (clayey) soils. Sandy soils are often characterized by a loose or single-grained structure which is very susceptible to wind erosion. On the other hand, clay soils have a high proportion of very small pore spaces which hold moisture tightly. Clay soils are usually fertile because they are able to retain plant nutrients better than sandy soils. However, they transmit water very slowly and are therefore susceptible to excess moisture conditions.

The predominant soil surface texture within the watershed is fine loamy (53%) (refer to Table 3.0, Figure 7.0). Clays are also common, covering 15% of the watershed, mainly in areas adjacent to Lake Winnipeg. Organic soils are found throughout the watershed, making up 26% of the area, with an increased presence in the Snake and Denis Lake regions.

Table 3.0 Soil surface texture in the Lower West Lake Winnipeg Watershed study area[1]

Class	Area (ha)	Percent of Study Area
Clayey	21,959	15.3
Fine Loamy	75,390	52.7
Coarse Loamy	1,793	1.3
Sand	5,598	3.9
Coarse Sand	51	0.04
Organic	37,479	26
Rock	99	0.1
Water	582	0.4
Unclassified	176	0.1
Total	143,127	100

1. Soil surface texture is based on the dominant soils series for each soil polygon

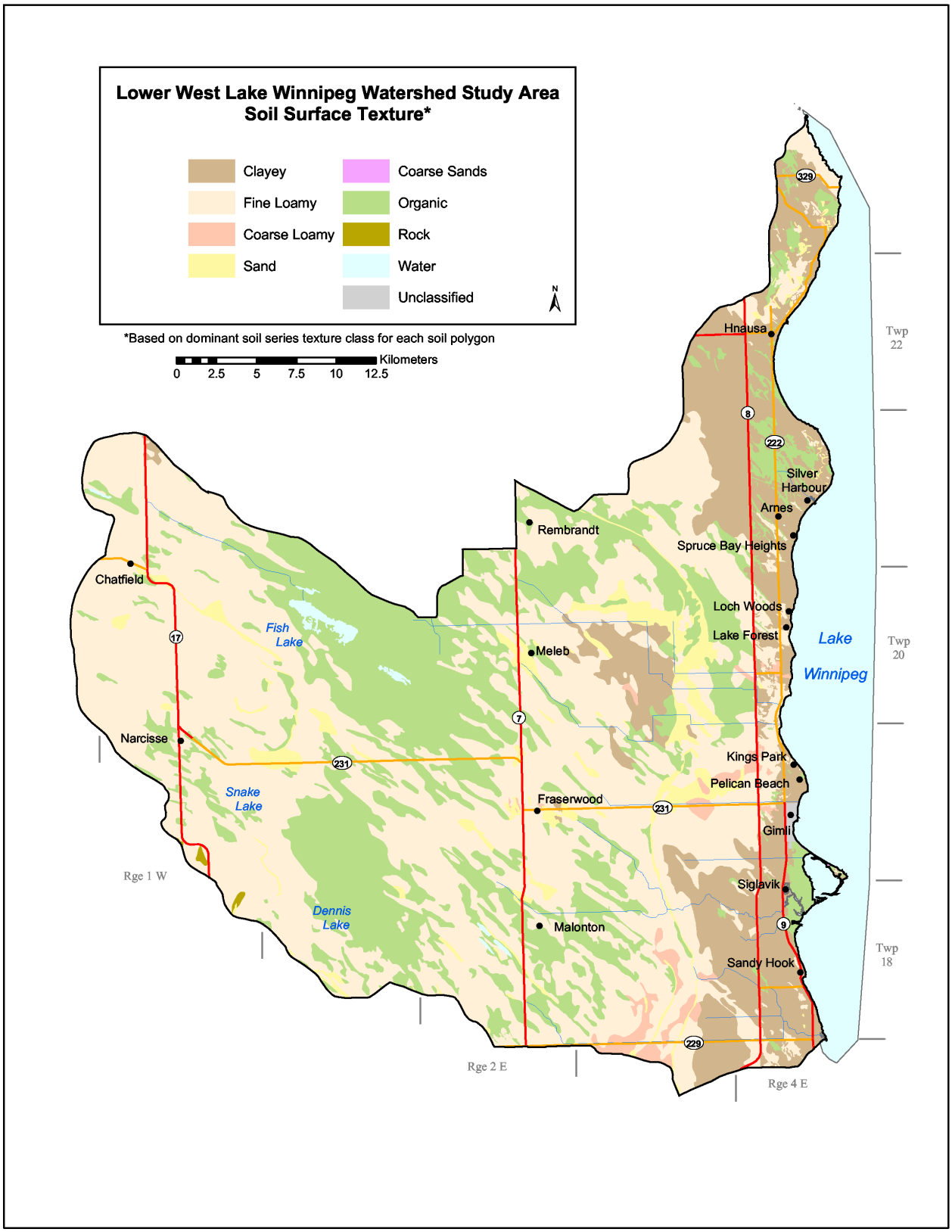


Figure 7.0 Soil surface texture in the Lower West Lake Winnipeg Watershed study area

Soil Drainage

Soil drainage is described on the basis of actual moisture content in excess of field capacity and the length of the saturation period within the plant root zone. Excessive water content in the soil limits the free movement of oxygen and decreases the efficiency of nutrient uptake. Delays in spring tillage and planting are more frequent in depressional or imperfectly- to poorly-drained areas of a field. Surface drainage improvements and tile drainage are management practices that can be used to manage excess moisture conditions in soils. Agriculture and Agri-Food Canada's Land Resource Unit has divided soil drainage into five classes:

1) *Very Poor* - Water is removed from the soil so slowly that the water table remains at or on the soil surface for the greater part of the time the soil is not frozen. Excess water is present in the soil throughout most of the year.

2) *Poor* - Water is removed so slowly in relation to supply that the soil remains wet for a large part of the time the soil is not frozen. Excess water is available within the soil for a large part of the time.

3) *Imperfect* - Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly down the profile if precipitation is the major source.

4) *Well* - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying materials or laterally as subsurface flow.

5) *Rapid* - Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep slopes during heavy rainfall.

Drainage classification is based on the dominant soil series within each individual soil polygon.

According to the drainage classes defined above, over 50% of the soils within the watershed are considered to be imperfectly drained (refer to Table 4.0, Figure 8.0). Scattered areas of poorly and very poorly-drained soils (27%) also occur within the watershed, mainly in areas of organic texture. Well to rapid drainage is found on 11% of the soils. There are also areas of improved drainage found on 7% of the soils, located closer to the lake shoreline. Improved drainage indicates areas where networks of surface drains enhance the surface runoff and reduce the duration of surface ponding, which is especially helpful for agricultural land.

Table 4.0 Soil drainage classes for the Lower West Lake Winnipeg Watershed study area[1]

Class	Area (ha)	Percent of Study Area
Rapid	2,269	1.6
Well	13,204	9.2
Imperfect	76,474	53.4
Poor	3,359	2.3
Poor (Improved)	10,498	7.3
Very Poor	35,980	25.1
Water	582	0.4
Marsh	485	0.3
Rock	98.7	0.1
Unclassified	176	0.1
Total	143,127	100

1. Area has been assigned to the dominant drainage class for each soil polygon

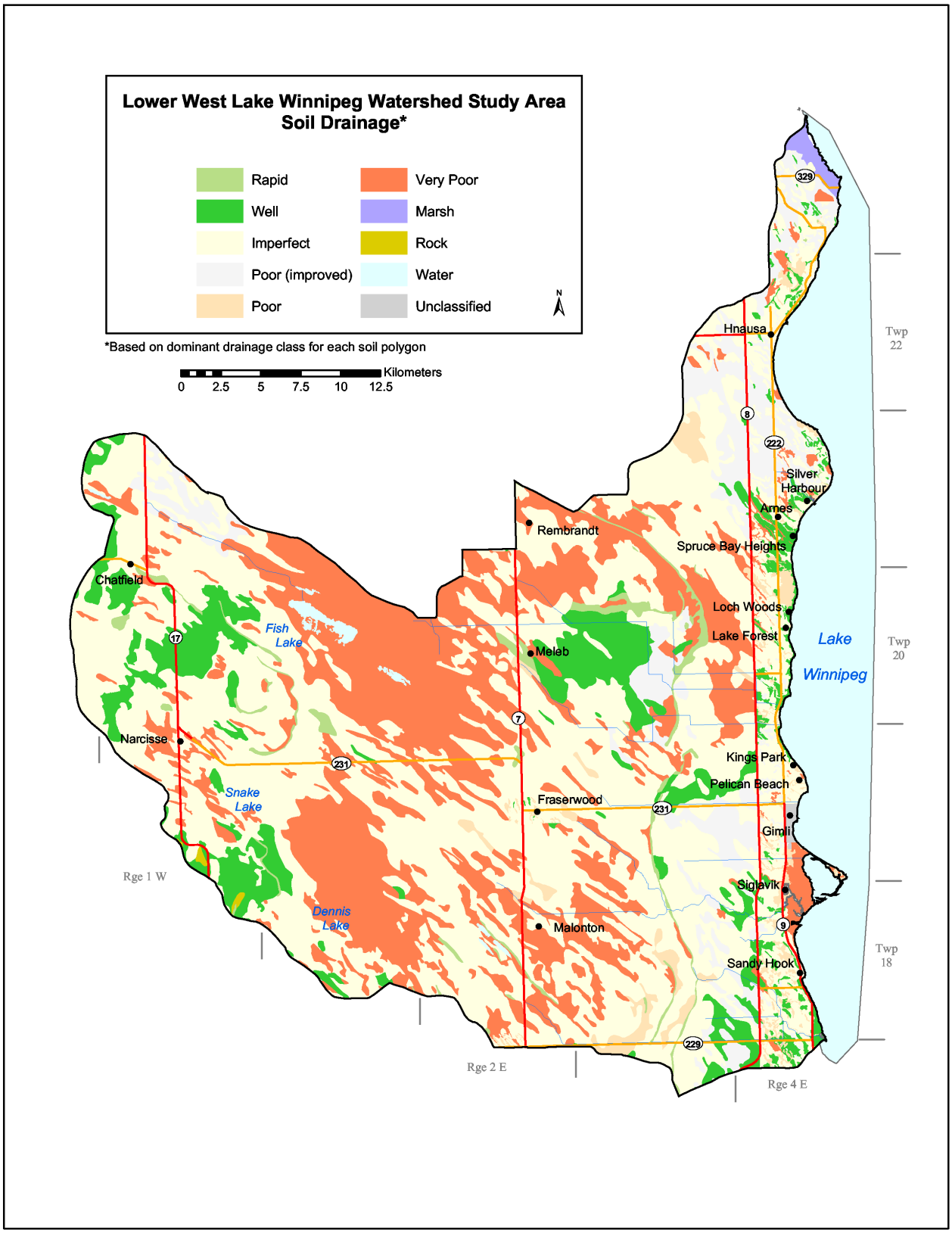


Figure 8.0 Soil drainage classes for the Lower West Lake Winnipeg Watershed study area

Agricultural Capability

The Canada Land Inventory System (CLI) was used to classify land based on agricultural capability. The CLI is a comprehensive survey of land capability and use designed to provide a basis for making rational land-use planning decisions. Under the CLI, lands are classified according to physical capability for agricultural use. The system uses seven classes to rate agricultural capability, with Class 1 lands having the highest capability to support agriculture, and Class 7 the lowest. Table 6.0 provides a description of each class. Subclass descriptors are also used to identify specific limiting factors within each class (Table 7.0). The classes indicate the degree of limitation for mechanized agriculture imposed by the soil. The subclasses indicate the type of limitations that individually, or in combination with others, affect agricultural land use. The CLI classification assumes good land management and is independent of location, accessibility, ownership, distance from cities or roads, and the present use of the land (Natural Resources Canada 2000).

Table 5.0 Canada Land Inventory (CLI) class descriptions

Class #	Description
1	Soils in this class have no significant limitations in use for crops.
2	Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices.
3	Soils in this class have moderate limitations that restrict the range of crops or require special conservation practices.
4	Soils in this class have severe limitations that restrict the range of crops or require special conservation practices or both.
5	Soils in this class have very severe limitations that restrict their capability to produce perennial forage crops, and improvement practices are feasible.
6	Soils in this class are capable only of producing perennial forage crops, and improvement practices are not feasible.
7	Soils in this class have no capability for arable culture or permanent pasture
O	Organic soils

Source: Natural Resources Canada 2000.

Table 6.0 Canada Land Inventory (CLI) subclass descriptions

Subclass	Description
C	Adverse climate
D	Undesirable soil structure and/or low permeability
E	Erosion
F	Low fertility
I	Inundation by streams or lakes
M	Moisture limitations
N	Salinity
P	Stoniness
R	Consolidated bedrock
T	Topography
W	Excess water
X	This subclass is comprised of soils having a limitation resulting from the cumulative effect of two or more adverse characteristics

Source: Natural Resources Canada 2000

Figure 9.0 illustrates the classes of agricultural land found within the watershed. At this generalized map scale, subclass limitations could not be displayed. As Table 7.0 indicates, only 22% of the land within the watershed is productive agricultural land (Classes 1, 2 and 3) and is found within 15 km of the Lake Winnipeg shoreline (refer to Figure 9.0). Another 46% of the land in this watershed is rated as Class 4 land and another 17% is Class 6 land. These soils, along with the organic soils present, are found throughout the remaining watershed area. As indicated in Table 7.0, excess water is the main limitation of agricultural capability in the Class 2 and 3 lands, with some undesirable soil structure limitations. Class 4 soils are greatly affected by undesirable soil structure, while the limitations of Classes 5 and 6 are related to water, mainly an excess.

Table 7.0 Agricultural capability in the Lower West Lake Winnipeg Watershed study area [1] and the major type of limitations within each class.

Class	Subclass	Area (ha)	Percent of Study Area
Class 1		**119**	**0.1**
Class 2		**17,362**	**12.1**
	2D	*3,404*	*2.4*
	2MP	*1,102*	*0.8*
	2W	*10,775*	*7.5*
	2WP	*794*	*0.6*
Class 3		**13,616**	**9.5**
	3D	*2,493*	*1.7*
	3M	*510*	*0.4*
	3W	*10,406*	*7.3*
Class 4		**65,988**	**46.1**
	4DP	*65,889*	*46.0*
Class 5		**8,500**	**5.9**
	5M	*3,413*	*2.4*
	5P	*1,805*	*1.3*
	5W	*3,282*	*2.3*
Class 6	*6W*	**23,550**	**16.5**
Class 7		**635**	**0.4**
Organic		**12,600**	**8.8**
Water		**582**	**0.4**
Unclassified		**176**	**0.1**
Total		**143,127**	**100**

1. Agricultural capability is based on the dominant soil series and slope gradient within each soil polygon

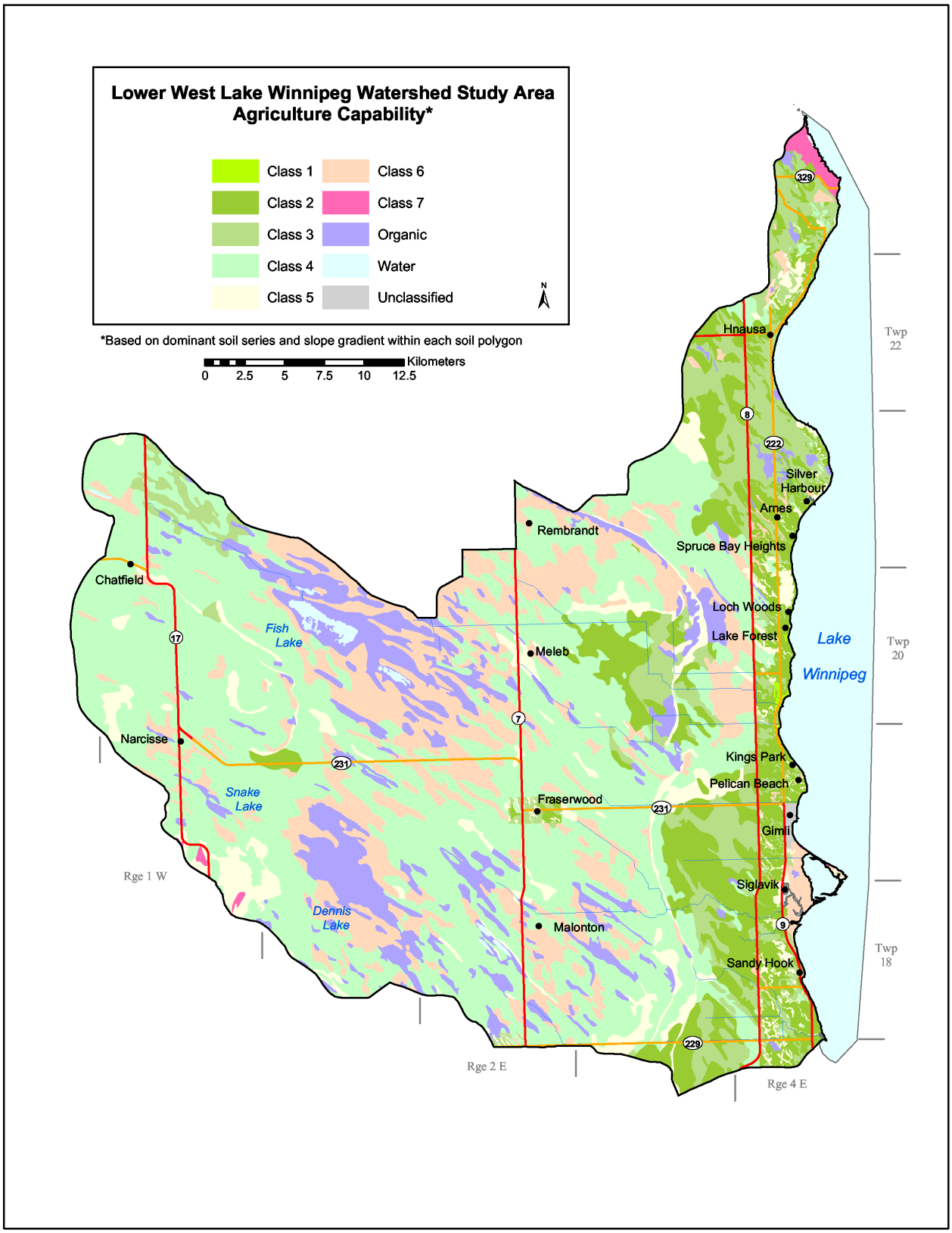


Figure 9.0 Agricultural capability class in the Lower West Lake Winnipeg Watershed study area

Water Erosion Risk

The risk of water erosion was estimated using the Universal Soil Loss Equation (USLE) developed by Wischmeier and Smith (1965). The USLE predicted soil loss (tonnes/hectare/year) was calculated for each soil component in each soil map polygon. Water erosion risk factors used in the calculation include mean annual rainfall, slope length, slope gradient, vegetation cover, management practices, and soil erodibility (Eilers et al. 2002). Erosion risk classes were assigned based on the weighted average soil loss for each map polygon. The five classes of soil erosion risk (ranging from negligible to severe) are based on a bare, unprotected soil condition. However cropping and residue management practices can significantly reduce this risk depending on crop rotation, soil type, and landscape features. Basing the soil erosion risk on the bare soil case helps to identify areas dominated by sensitive, erosive soils which may otherwise be masked if a land use or surface vegetation cover factor was considered (Eilers et al. 2002).

According to the interpreted water erosion risk classification for soils, water erosion is not a concern within this watershed, with 95% of the watershed falling under the low to negligible risk category (refer to Table 8.0, Figure 10.0). Another 4% of the watershed is of moderate concern, found mainly along the Lake Winnipeg shoreline.

Table 8.0 Water erosion risk classes in the Lower West Lake Winnipeg Watershed study area [1]

Risk (tonnes/ha/yr)	Area (ha)	Percent of Study Area
Negligible (<6)	122,762	85.8
Low (6-11)	13,233	9.2
Moderate (11-22)	6,148	4.3
High (22-33)	226	0.2
Water	582	0.4
Unclassified	176	0.1
Total	143,127	100

1. Water erosion risk is based on the weighted average USLE predicted soil loss within each soil polygon, assuming a bare unprotected soil

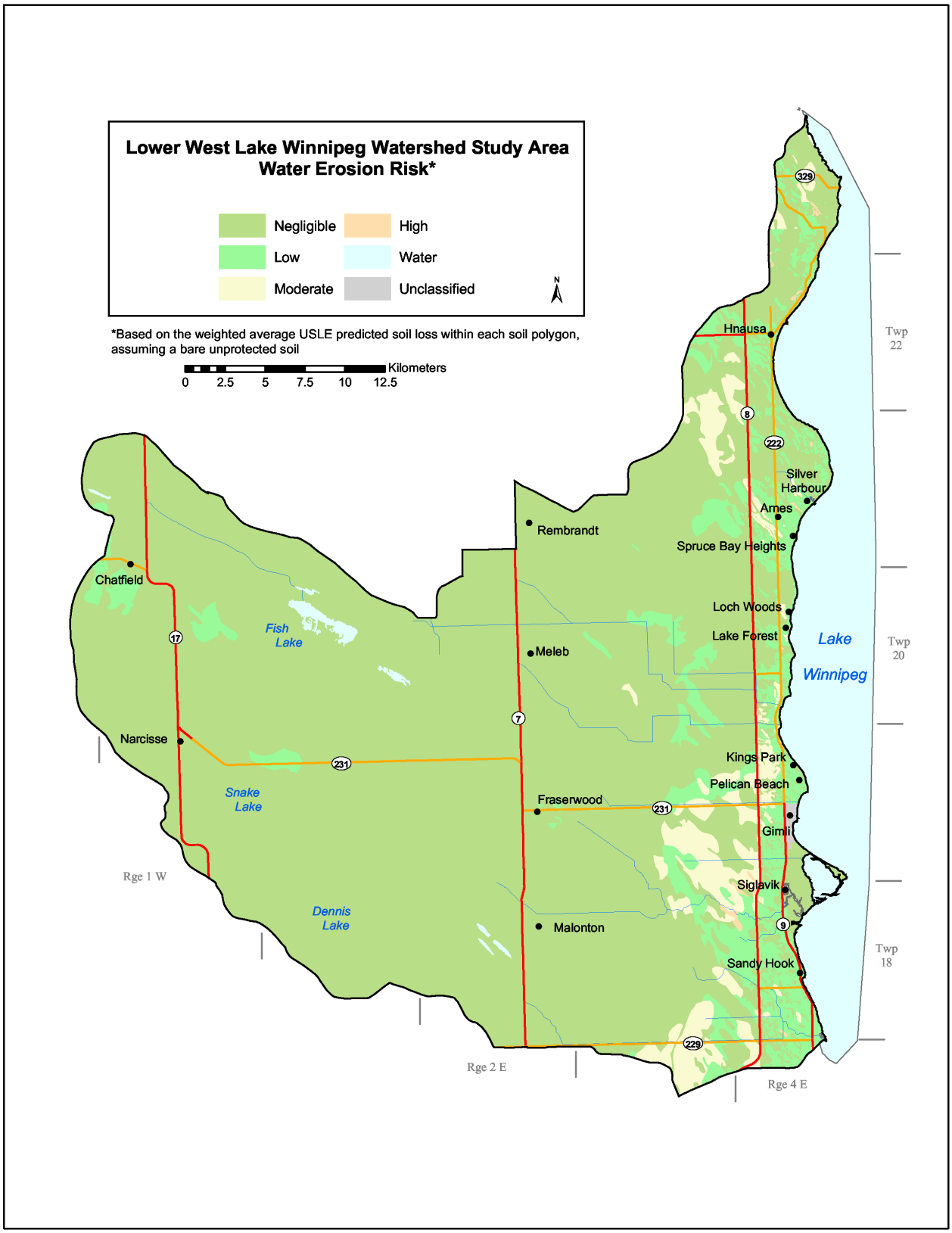


Figure 10.0 Water erosion risk in the Lower West Lake Winnipeg Watershed study area

Agricultural Activities

Riparian areas can be impacted by anthropogenic activities occurring within a watershed. Land use and management practices within riparian zones and on upland areas affect the health of riparian areas. Although agriculture is only one component, with other human activities such as industry, recreation and residences contributing to degraded riparian areas, this report focuses on the impacts of agriculture. By knowing the extent and type of agricultural activities within the watershed, more effective decision-making and project planning can be put into place.

Agriculture data for the watershed was obtained from the 2001 Census of Agriculture using the farm headquarters reporting method, which links census data to the land location of the farm headquarters. In the 2001 Census, the farm headquarters was defined as "the operator's residence if he/she lives on land that is part of the agricultural operation; the location of the main building or main gate of the agricultural operation; or if many parcels of land without buildings are in separate locations, the parcel with the largest land area or share of gross agricultural receipts is considered the farm headquarters" (Statistics Canada 2002). It should be noted that in cases where the farm headquarters location is different from that of the actual farmed land or the location of livestock, inaccuracies in data will be introduced. For example, the reported farm headquarters could fall within one watershed, whereas a proportion of the land/livestock associated with that operation could fall within another. Despite the inaccuracies, the Census of Agriculture provides the most comprehensive source of available agricultural data (see Appendix B for more information and definitions).

The *Statistics Act* requires that all census information be kept confidential. As a result, any data that could disclose information concerning a particular agricultural operation or individual is suppressed in the data tables reported by Statistics Canada. For example, if there are only one or two dairy operations within a watershed, the number of farms reporting dairy will be given, however the total number of dairy cows reported within that watershed will be suppressed. In instances where a geographic area has very few agricultural operations, data are not released separately but are merged with data from one or more geographically adjacent areas (Statistics Canada 2002).

According to the 2001 Census, there were a total of 262 farms utilizing 57% (81,283 ha) of the land in the Lower West Lake Winnipeg Watershed study area. For the purpose of this report, farmland includes all land that is owned, rented, leased (including government land) or crop-shared by agricultural operations. Of this land, 18,198 ha (22%) is leased government land. Of the farmland, 12,519 ha (15%) were prepared for seeding in the fall of 2000 or spring 2001.

Land use and management practices of upland areas are important considerations in watershed planning. Crop type (permanent vs. annual, high residue vs. low residue), tillage practices, nutrient management, and conservation practices on the upland landscape are all activities that can affect water quality within the watershed.

Table 9.0 summarizes the major crops grown in the watershed, including crops cut for hay, silage, green feed, etc. According to the 2001 Census data, forages were the most popular field crop, covering 22% of the farm land. This supports the fact that cattle production and ranching is important in many areas of this watershed. Cultivated crops covered 14% of the farmland.

Table 9.0 Summary of cultivated crops, including crops cut for hay, silage, green feed, etc, grown in the Lower West Lake Winnipeg Watershed study area (2001 Census)

Crop Type	Hectares[1]	Percent of Farm Land[1]	Percent of Study Area[1]
Cereals (wheat, barley, oats)	9,052	11.1	6.3
Forages (alfalfa, alfalfa mixtures, corn for silage[2], tame hay and other fodder crops, forage for seed[2])	17,487	21.5	12.2
Oilseeds (canola, flaxseed[3])	2,007	2.5	1.4

1 - Numbers do not include suppressed data
2 - Data is suppressed for 1 farm reporting
3 - Data is suppressed for 4 farms reporting

Tillage practices on upland fields can affect the amount of erosion and runoff occurring. As the amount of tillage on a field increases, the chance of runoff (containing sediment and nutrients) entering waterways also increases. Table 11.0 provides a breakdown of tillage practices within the watershed. According to the 2001 Census of Agriculture, only 79% of the land prepared for seeding in 2001 was tilled to incorporate most of the crop residue, whereas 21% of the fields had little or no tillage for seedbed preparation, retaining most of the residue on the surface of the fields.

Table 10.0 Summary of tillage practices in the Lower West Lake Winnipeg Watershed study area (2001 Census)

Tillage Practices	Hectares[1]	Percent of Seeded Area[1]	Percent of Study Area[1]
Tillage incorporating most crop residue	9,900	79.1	6.9
Tillage retaining most crop residue on surface[2]	2,265	18.1	1.6
No till or zero till[2]	354	2.8	0.2
Total seeding area prepared	12,519	100	8.7

1 - Numbers do not include suppressed data
2 - Data suppressed for >5 farms reporting

In addition to minimum or no tillage, other conservation practices also reduce water erosion, thereby decreasing the amount of contaminated runoff entering waterways. Other conservation practices reported within the watershed included crop rotation (alternating low residue crops with high residue crops to maintain a good residue cover), permanent grass cover, winter cover crops, contour cultivation, strip cropping, grassed

waterways and shelterbelts or windbreaks. Table 12.0 provides a breakdown of the percentage of farms using these conservation practices within the watershed.

Table 11.0 Summary of the conservation practices carried out in the Lower West Lake Winnipeg Watershed study area (2001 Census)

Conservation Practices	Percentage of Farms Using Conservation Practice
Crop rotation	35.9
Permanent grass cover	44.3
Winter cover crops	0
Contour cultivation	1.5
Strip cropping	0.8
Grassed waterways	1.5
Windbreaks or shelterbelts	8.8

A number of farms within the watershed reported having livestock. As a result, manure production and the utilization of riparian areas by grazing animals are two areas where appropriate management practices should be implemented to reduce nutrient loading into rivers and streams and maintain healthy riparian areas. Table 13.0 provides a breakdown of the livestock distribution within the watershed. Over 65% of the farms within the watershed have cattle, the majority of which are beef cows. There are also 15 farms reporting pigs and 16 farms reporting chickens/hens.

Total Animal Units (AU) produced in the watershed (based on annual nitrogen production) has been calculated using Manitoba's Animal Unit coefficients and by making several assumptions (refer to Appendix C). As represented in Table 13.0, beef cattle made the largest contribution to the total AU produced in the study area (78%). Because of the level of suppressed data in some livestock categories, AU calculations will be underestimated.

Table 12.0 Livestock distribution in the Lower West Lake Winnipeg Watershed study area (2001 Census)

Livestock	Total Number of Farms[1]	Number of Animals[2]	AU Coefficient[3]	Total AU[2]
Total cattle and calves	175	17,758	--	
Total dairy cows	11(2)	329	2	658
Total beef cows	159	7,208	1.25	9,010
Total heifers & steers for slaughter and feeding (1 yr and older)	--	1,125	0.631	710
Total pigs	15(1)	21,207	--	
Total sows	14(1)	2,178	0.313	682
Total nursing and weaner pigs	9(2)	9,168	--	
Total grower and finisher pigs	7(4)	4,657	0.143	666
Boars	10(6)	9	0.2	2
Total hens and chickens	16(5)	1,385	--	
Broilers and Roasters	6(6)	0	0.005	0
Layers (19 weeks and older)	12(12)	0	0.0083	0
Pullets (under 19 weeks)	2(2)	0	0.0033	0
Turkeys	1(1)	0	0.014	0
Total sheep and lambs	6(3)	246	--	
Ewes	6(4)	167	0.2	33
Lambs	3(3)	0		0
Total horses and ponies	50	374	1	374
Bison	3	371	0.8875	329
Elk	0	0	0.52	0
Goats	7(4)	124	0.143	18
				12,482

1 - Numbers in parentheses indicate the number of farms for which data is suppressed for that livestock category
2 - Numbers do not include suppressed data
3 - Refer to Appendix C for the definition of Animal Unit and assumptions used to derive Animal Unit coefficients

Manure is a valuable source of nutrients for crop production. With the prevalence of livestock production in the study area, manure management becomes important. Table 14.0 provides a summary of the method of manure application on the land in the watershed. Solid manure was the most common manure type applied to the land and was broadcasted on 1,042 ha in 2000. Liquid manure was applied using two different methods in the study area with 11 farms spreading it on the surface and 8 farms injecting it. In order to achieve efficient use of the nutrients while ensuring no adverse effects to riparian areas and water quality, management practices should include incorporation of manure as soon as possible after field application, determination of application rates based on crop nutrient requirements, and timing of field applications to nutrient utilization by crops.

Table 14.0 Summary of manure application in the West Lake Winnipeg Watershed study area in 2000 (from 2001 Census of Agriculture)

Method of Manure Application	Number of Farms Reporting[1]	Area (ha) [2]
Solid Spreader	58 (7)	1042
Liquid Spreader (on surface)	11 (1)	464
Liquid Spreader (injected)	8 (4)	287

1. Numbers in parentheses indicate the number of farms for which data is suppressed in that category
2. Numbers do not include suppressed data

Watershed Considerations

The West Lake Winnipeg Watershed study area is made up of numerous, creeks, drains, shallow lakes, and sloughs. It also borders on the southern basin of Lake Winnipeg. This large amount of riparian area must be properly managed to protect surface water both within the watershed and downstream. Land management decisions in upland areas will also influence riparian health.

Soils and Land Cover

The characteristics of the soil and landscape affect the land use. The majority of the soils within the watershed are rated as Class 4, 5 or 6 (69% of the watershed). Only 22% of the study area has Class 2 and 3 soils and is located mainly in the eastern part of the study area, adjacent to Lake Winnipeg. Excess water is the main limiting factor to production on these soils. The majority of the watershed (95%) has a low to negligible risk of water erosion.

To overcome the excess water limitations in some areas of the watershed, a network of drainage systems has been established. These drains are effective at moving water off fields quickly and decreasing the amounts of standing water on fields, allowing for agricultural operations to take place. However, these advantages to agricultural production also cause some concern. The drains move water off fields quicker than normal, loading the river channel to high water levels in response to heavy precipitation events. This could place the river into a flood or near-flood stage, thereby increasing the risk for water erosion. In addition, man-made drains seldom have riparian areas around them, unlike most natural watercourses. With small or non-existent riparian zones, there is increased risk of nutrient and sediment loading into watercourses. Riparian areas and permanent vegetation on adjacent lands are able to trap and store sediment and nutrients found in field runoff, reducing the risk of contamination of surface water.

Land cover provides a glimpse into agricultural practices in the watershed. In 2001 the dominant land covers were trees and grassland, making up 68% of the watershed. Annual crop land made up only 16% of the land cover. The most notable change in land cover since 1994 is the increase in forage cover. Although forages made up a small part of the watershed (3%) in 2001, the area had increased almost three times since

1994. Forage fields were likely converted from grassland, since this category experienced a decrease in area over the seven year period. The increase in forages reflects the expansion of the livestock industry in Manitoba over the last several years.

Riparian Areas

In order to provide an indication of the amount of riparian areas present in the study area, a shoreline density was calculated using the length of shoreline around watercourses and waterbodies. This shoreline density can provide a glimpse into how much upland is in contact with surface waterbodies and watercourses (riparian areas). A higher shoreline density could mean there is a greater potential for interaction between upland activities and surface water. For this analysis, length of shoreline of both permanent and intermittent waterbodies and watercourses was determined from the 1:50,000 NTS datasheets (note that densities will be underestimated since numerous small wetlands and potholes as well as some small constructed water courses (first, second and third order drains) are not captured by the NTS sheets). Table 15.0 provides a summary of the length and density of shoreline in the West Lake Winnipeg Watershed study area. In the West Lake Winnipeg Watershed study area, the Willow Creek sub-watershed (#263) has the highest concentration of riparian areas with 11.4 m of shoreline/ha. Sub-watershed #265 has very little shoreline, with a density of less than 3 m of shoreline/ha. Watercourses (creeks, streams and drains) make up the majority of shoreline in the sub-watersheds #263, 265 and 303 (refer to Figure 12.0). A higher shoreline density will indicate a greater concentration of riparian areas. Since riparian areas provide a buffer between upland areas and surface water, management practices (including riparian pasture management, buffer strips, and grassed waterways) become important to maintain this vegetated buffer area surrounding waterbodies and watercourses.

Table 15.0 Summary of shoreline density in the West Lake Winnipeg Watershed study area (includes permanent and intermittent streams and waterbodies).

Sub-watershed ID	Length of Shoreline[1] (m)	Percent Watercourse Shoreline	Percent Waterbody Shoreline	Shoreline Density[2] (m/ha)
262	356,446	29.1	70.9	9.0
263	292,808	73.4	26.6	11.4
265	37,808	74.8	25.2	2.5
303	192,961	65.2	34.8	10.9
304	256,197	45.3	54.7	7.7

1. Length of shoreline is determined from the 1:50,000 NTS data sheets and will be underestimated due the fact that many small wetlands and potholes as well as some small constructed water courses (first, second and third order drains) are not captured in the data sheets

2. Area is calculated as the entire area of the sub-watershed (minus area of waterbodies from the 1:50,000 NTS data sheets)

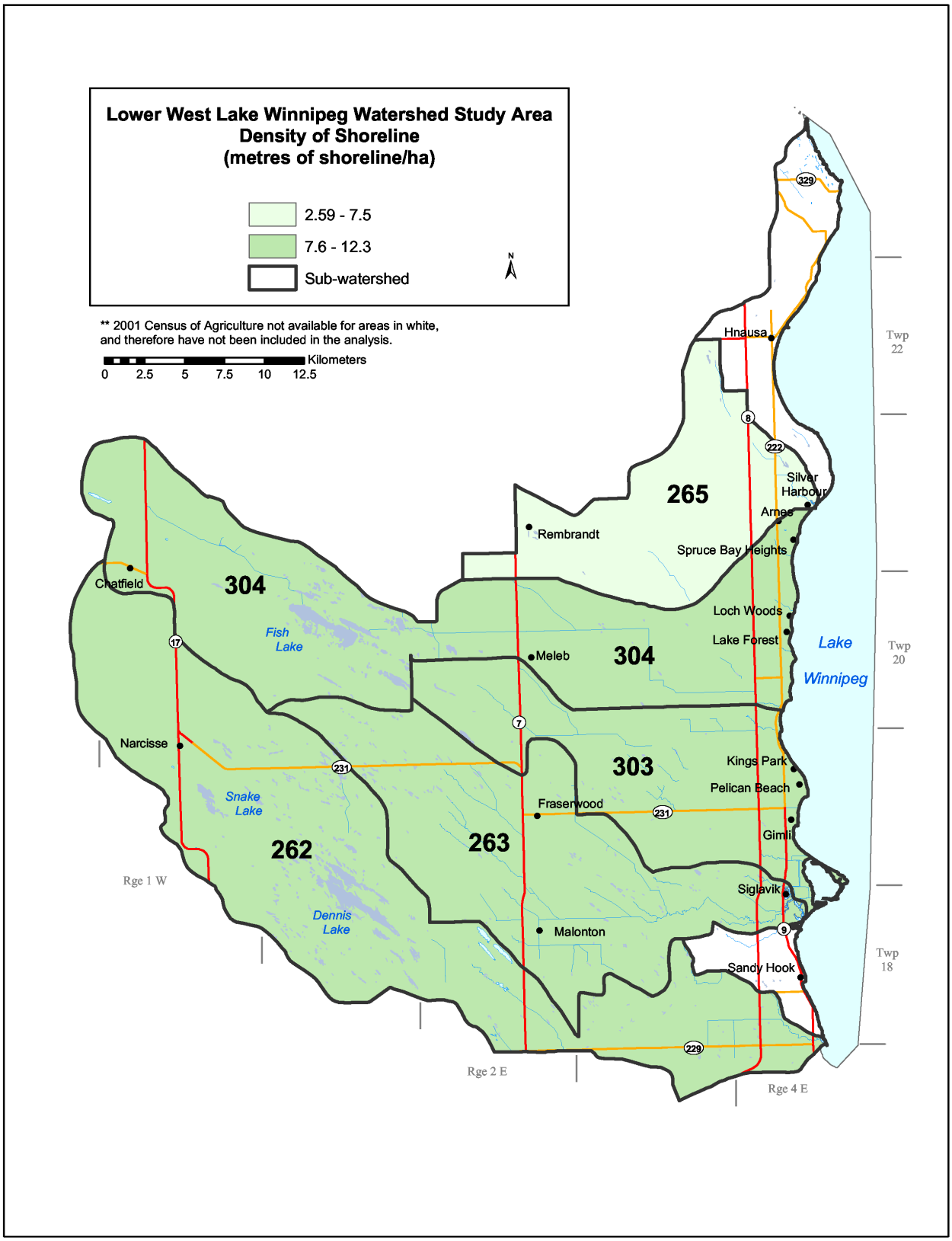


Figure 11.0 Density of shoreline in the West Lake Winnipeg Watershed study area, as determined by the 1:50,000 NTS data sheets

Riparian areas play a very important role in reducing the impact of agriculture on surface water quality. Riparian areas reduce the amount of contaminants, nutrients, and pathogens reaching surface waters by trapping and filtering sediments and by absorbing excess nutrients. The health of a riparian area determines the extent to which the riparian area can perform its functions. Riparian health is generally determined by on-site assessment and evaluation, however this was not feasible for this project. Instead, land cover in a 50 m buffer around waterbodies and water courses (both permanent and intermittent) within the study area was analyzed, since these areas will have a greater likelihood of influencing water quality. Although this method cannot determine management practices occurring in the riparian areas (ie. livestock use of riparian areas, nutrient and pesticide management practices, etc), percentage of trees and annual crops within the buffered area could give an indication of possible health of riparian areas as well as potential agricultural impacts to water quality. Trees are an important part of the riparian area. Tree roots help to stabilize banks and hold the soil in place while canopy cover provides protection from rain drops. Their sparse presence could be an indication of declining riparian health. Another indicator of potential decline in riparian health is the presence of annual crop land in the buffer area. Annual crop land can potentially impact water quality by allowing contaminated runoff to enter surface water.

Table 16.0 provides a summary of the 2001 land cover in a 50 m buffer area around all water courses and waterbodies in the West Lake Winnipeg Watershed study area from the 1:50,000 NTS data sheets). Approximately 5% of the study area is located within 50 m of a watercourse or waterbody (including intermittent streams and wetlands). In this buffered area, only 15% was treed while about 11% was in annual crops. Grassland and wetlands predominated.

Potential impacts of crop production to riparian areas may be greater in areas where annual crop land is predominant within a 50 m area from a watercourse or waterbody. In this study area, annual crop land only makes up a small part of the buffer area (refer to Table 16.0). Impacts will be reduced slightly due to the fact that 21% of the crop land was prepared using minimum or zero tillage. The highest proportion of annual crop land in the 50 m buffer area is found in Sub-watershed #265 which also has the lowest shoreline density (refer to Table 15.0).

The presence of trees within the 50 m buffer may give an indication of the potential for a riparian area to be healthy. The highest proportion of treed areas in the 50 m buffer area is found in Sub-watershed #265 which also has the lowest shoreline density (Table 16.0). In the remaining sub-watersheds treed areas make up less than 20% of the buffer area. Absence of trees can be a result of several factors; trees have been removed due to overgrazing, cultivation or straightening of creeks, or hydrological conditions have changed.

Table 16.0 Summary of land cover in a 50 m buffer around all waterbodies and on either side of watercourses in the West Lake Winnipeg Watershed study area (using 2001 satellite imagery and 1:50,000 NTS water layers)[1].

Sub-watershed ID	Buffered area (percent of sub-watershed)	Percent of Buffered Area						
		annual crop land	trees	water	grassland	wetland	forages	roads, urban
262	4.5	8.2	16.6	14.0	26.4	28.4	1.1	5.3
263	6.1	14.9	19.2	2.3	42.5	8.9	2.8	9.4
265	1.3	28.1	21.9	1.6	31.7	3.2	7.1	6.4
303	6.9	11.6	12.6	8.0	30.5	25.3	2.6	9.4
304	3.8	8.1	9.6	13.5	20.1	42.3	0.3	6.0
Total	4.6	11.2	15.2	9.3	30.2	24.9	1.9	7.4

1. Due to the nature of clipping raster data (land cover layer) with vector data (1:50,000 NTS water layer) and the various scales of the data, areas are estimate.

Farm Management Practices

The 2001 Census of Agriculture had 262 farm headquarters reporting within the study area (note that census data is attached to farm headquarter and reports on activities on farmland associated with that farm, therefore whether or not the land is located within the watershed cannot be differentiated). In 2001, agriculture in the watershed consisted mainly of livestock and grain production with about 57% of the land utilized by farmers. This includes land that is owned, rented, leased (including government land) or crop-shared. Land management practices will have an effect on the health of the riparian areas. Upland management practices such as crop selection and rotation, tillage practices, nutrient management and grassed waterways can have impacts on riparian areas. According to the census data, only 15% of the farmland was prepared for the 2001 growing season, of which 21% was prepared using minimum or zero tillage, resulting in a reduction of the risk of soil erosion. In addition, the majority of the farmers practice crop rotation which, along with minimum and zero tillage, will assist in providing extra soil protection by carrying residues over from one year to the next. In 2001, the majority of the seeded area was sown to cereals compared to oilseed crops. Grassed waterways are another effective practice and, when located along natural drainage paths in fields, can help to reduce water erosion and filter out sediments from runoff before it enters the watercourse or waterbody. In the West Lake Winnipeg Watershed study area, 2% of the farms reported using grassed waterways. Efforts should continue to promote reduced tillage, crop rotation, grassed waterways and other practices which will help reduce soil erosion.

Livestock grazing management is important to the health of riparian areas. Although grazing livestock in the watershed include cattle, sheep and horses, beef production is predominant with approximately 61% of the farms having cow/calf operations. Pastures and forages are necessary for summer grazing and winter feed, and land cover trends show an increase in area dedicated to forages to meet the demand for feed. In order to maximize forage productivity and promote healthy riparian vegetation, ranchers must

ensure that they avoid grazing riparian areas during vulnerable times, such as when streambanks and shorelines are saturated and are more vulnerable to trampling. Ranchers should also ensure that they allow the vegetation a proper rest period after grazing during the growing season. Vegetation requires adequate rest in order to rebuild roots (energy supply), and restore vigour. During grazing periods, ranchers should utilize management tools to distribute livestock evenly over the grazing area. This not only reduces streambank damage due to trampling and overuse, but it also helps to distribute manure evenly across the grazing area. Manure is a valuable source of nutrients for plants, and when evenly distributed can be fully utilized with minimal risk of contamination to nearby waterbodies.

In contrast to grazing systems, confined livestock operations often result in an accumulation of manure that will require mechanical removal and subsequent land application. In the West Lake Winnipeg Watershed study area, there were 11 dairy operations, 15 hog operations and 16 poultry operations in 2001. The majority of these will have confined livestock facilities with associated manure storage facilities. Accumulated manure is a valuable source of plant nutrients and organic matter, which can be used to improve soil quality and crop production. Although riparian areas can trap nutrients found in runoff from fields and reduce the risk of contamination of water sources, manure management practices should include manure incorporation as soon as possible after application to the field and maintenance of buffer zones around riparian areas to minimize the risk of contaminated runoff entering water sources. Other manure management practices include soil and manure testing to assist in applying nutrients to crop requirements.

Agriculture Production Intensity

Riparian areas can be affected by all aspects of activities within a watershed, including agriculture, urban areas, recreation activities, etc. For this report, an attempt was made to determine the level of agriculture production intensity within each sub-watershed to determine which areas of the watershed may have a greater potential to impact riparian health. The level of livestock and crop production was determined on a per hectare basis. Because information is not available to indicate at what point the livestock density or crop production intensity becomes critical with respect to potential impacts on riparian health, the values calculated were compared to the highest value calculated in a sub-watershed in all of Manitoba.

Livestock density was calculated for each sub-watershed. Densities of different types of livestock were standardized by calculating Animal Units per hectare (AU/ha). In Manitoba, an Animal Unit (AU) is defined as the number of livestock required to excrete 73 kg (160 lbs) of nitrogen in a 12-month period. Refer to Appendix C for assumptions used to derive AU coefficients. Suppression of livestock numbers in the census data will affect total AU to varying degrees, depending on the amount of suppression (refer to Table 13.0). Area used in the calculation consisted of hay and crop land, summerfallow, tame pasture and native land used for pasture (as reported in the 2001 Census of Agriculture). In Manitoba, the sub-watershed in which the City of Steinbach is located (in the Seine River Watershed Study Area, refer to Appendix D), had the highest livestock density (0.98 AU/ha). All other livestock densities were compared to this one.

Table 17.0 and Figure 13.0 illustrate the different livestock densities within the sub-watersheds of the West Lake Winnipeg Watershed study area. Beef cattle produced the majority of AU in all sub-watersheds. Although Sub-watershed #262 produced the most AU in the study area, Sub-watershed #304 had the greatest livestock density of 0.28 AU/ha. This is still only 29% of the province's highest value. The remaining areas have livestock densities less than 20% of the province's highest value. Livestock production at any density requires attention to manure management, nutrient management and riparian pasture management. Any area with a higher livestock density will have a greater potential to impact riparian areas.

Table 17.0 Comparison of livestock density in the West Lake Winnipeg Watershed study area using 2001 Census livestock numbers converted to Animal Units[1]

Sub-watershed ID	Area[2] (ha)	Livestock Density	
		AU/ha[1]	As a percentage of 0.981 AU/ha[3]
262	24,383	0.14	14.6
263	17,241	0.19	19.7
265	7,779	0.15	14.8
303	10,417	0.17	17.2
304	9,889	0.28	28.5

1. Refer to Appendix C for assumptions used in calculating Animal Units. Some suppression of data occurs (see Table 13.0)
2. Area is calculated as the amount of land planted to annual and hay crops, summerfallow, tame pasture and native land used for pasture, as reported in the 2001 Census of Agriculture
3. Value is calculated as a percentage of the highest AU/ha value determined in Manitoba (using 2001 Census of Agriculture data)

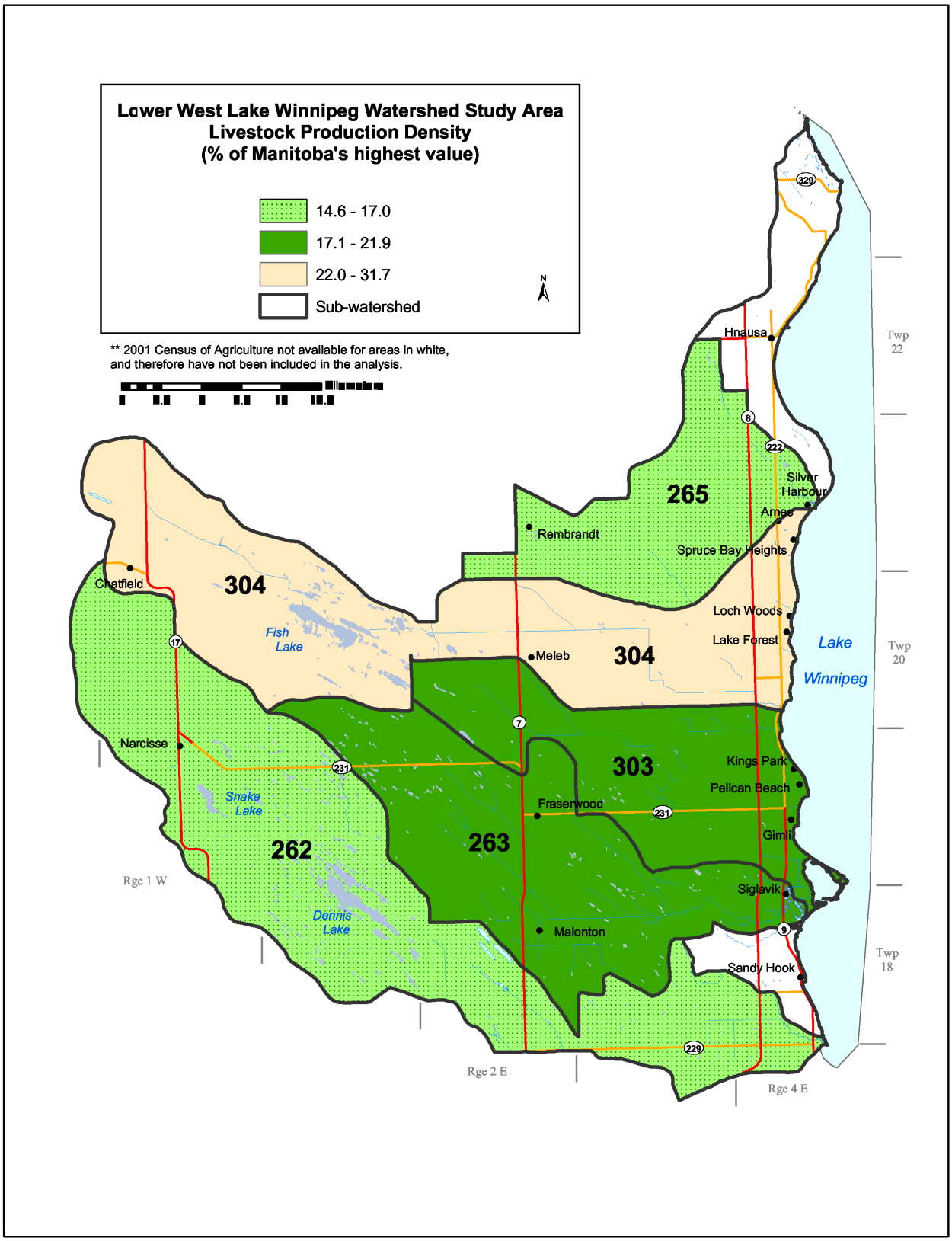


Figure 12.0 Livestock density in the West Lake Winnipeg Watershed study area, as a percentage of the highest value in Manitoba of 0.AU/ha (as reported in the 2001 Census of Agriculture)

The potential for crop production to impact riparian health is present in all the sub-watersheds but may be greater in those with higher fertilizer and pesticide crop inputs. Run-off containing nutrients from manure and commercial fertilizers, pesticides, and pathogens can affect riparian vegetation and biodiversity. The value of commercial crop inputs can be used as an indication of crop production intensity. Crop production intensity within a watershed was determined as dollars spent on fertilizers and pesticides (herbicides, insecticides and fungicides) per hectare in the year 2000, as reported by farms in the 2001 Census. Land area was calculated as the number of hectares used for crop and hay production and summerfallow (as reported by farms within the study area). These numbers ($ fertilizer/ha, $ pesticides/ha) were then compared to the highest respective value calculated in all the sub-watersheds with census data in Manitoba. Fertilizer dollars spent per hectare were compared with the highest value of $101.23/ha, found in the sub-watershed containing the community of Bagot (in the Whitemud River Watershed Study Area). Pesticide dollars were compared with the highest value of $81.65/ha, found in the sub-watershed containing the communities of Poplar Point and High Bluff, north of the Assiniboine River (in the Lower Assiniboine River Watershed Area, refer to Appendix D).

Table 18.0 and Figures 14.0 and 15.0 illustrate the different levels of fertilizer and pesticide use in 2000 within the sub-watersheds of the West Lake Winnipeg Watershed study area. Both fertilizer and pesticide inputs were highest in Sub-watershed #303, though fertilizer input levels were only 57% of the province's highest value and pesticide input levels were only 38%. Though areas with higher crop production intensities may have a greater potential to impact riparian areas and water quality, best management practices with regards to pesticide and fertilizer use are important in all areas.

Table 18.0 – Comparison of crop production intensity in the West Lake Winnipeg Watershed study area using dollars spent on pesticides and fertilizers in 2000 (as reported in the 2001 Census of Agriculture)

Sub-watershed ID	Area[1] (ha)	Fertilizer[2] (as a percentage of $101.23/ha)	Pesticides[2] (as a percentage of $81.65/ha)
262	6,425	33.2	20.7
263	7,927	31.9	14.1
265	4,565	40.9	27.1
303	7,125	56.7	38.1
304	5,170	21.8	9.1

1. Area is calculated as the land planted to annual and hay crops, and summerfallow, as reported in the 2001 Census of Agriculture
2. Value is calculated as a percentage of the highest fertilizer (or pesticide) dollars/ha value determined in Manitoba (using 2001 Census of Agriculture data)

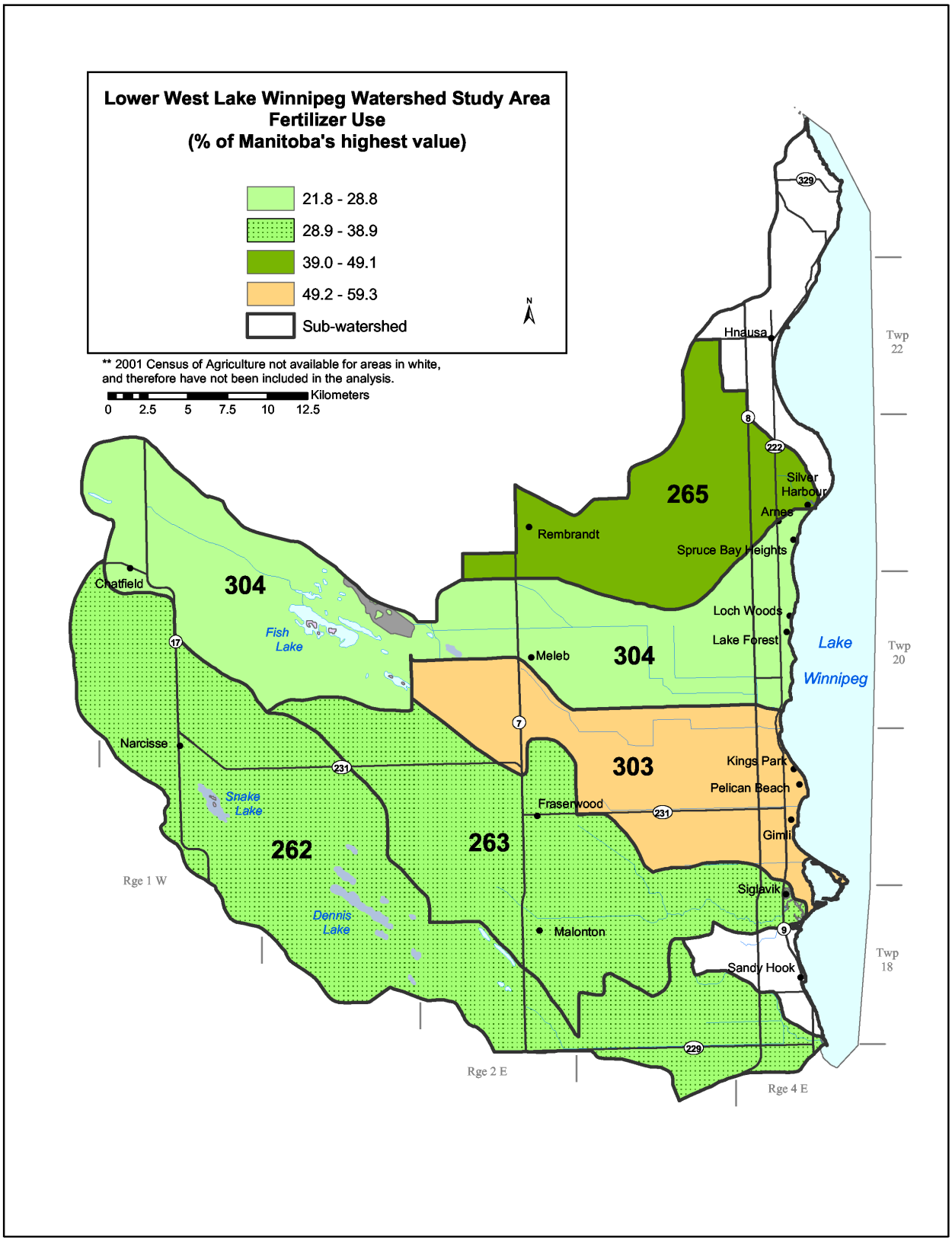


Figure 13.0 Level of fertilizer use in the West Lake Winnipeg Watershed study area in 2000, as a percentage of the highest value in Manitoba of $101.23/ha (as reported in the 2001 Census of Agriculture)

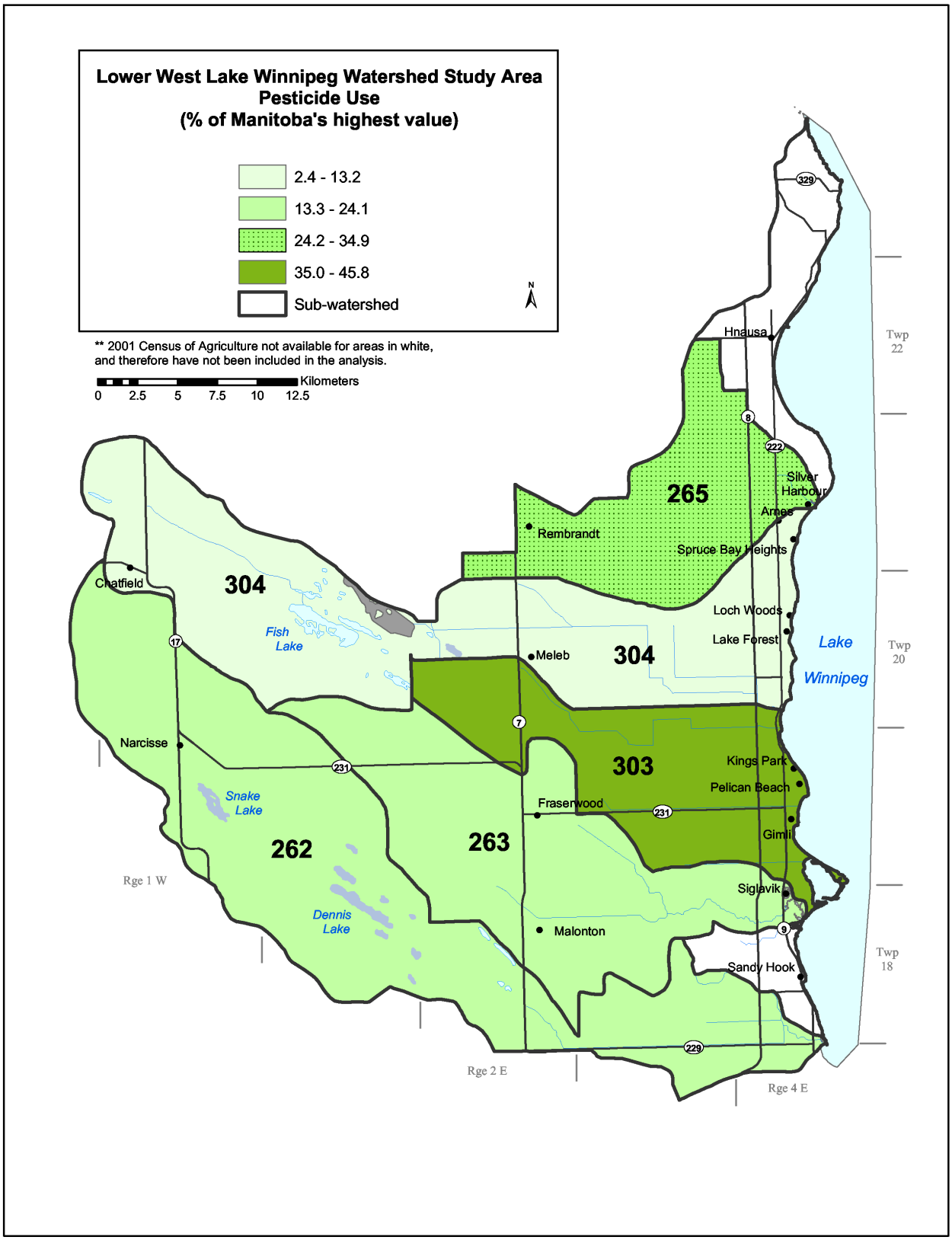


Figure 14.0 Level of pesticide use in the West Lake Winnipeg Watershed study area in 2000, as a percentage of the highest value in Manitoba of $81.65/ha (as reported in the 2001 Census of Agriculture)

Summary

Although riparian areas are affected by all activities in a watershed, this report concentrates on the potential impacts from agricultural activities. The West Lake Winnipeg Watershed study area contains a variety of soils and landscapes and, as a result, supports a diverse agricultural landscape. Appropriate management of agricultural activities is very important to protect riparian areas in the watershed.

Less than a quarter of the West Lake Winnipeg Watershed study area is productive agricultural land and is mainly located along the western side of Lake Winnipeg. The majority of the land cover in 2001 consisted of grassland and wetlands and annual crop land made up only 16% of the study area. Although forages made up a very small part of the land cover, there had been a three fold increase in forage hectares since 1994, reflecting the expansion of the livestock industry. Beef cattle made up the majority of the livestock, representing almost 78% of the Animal Units produced in the study area. Hogs and dairy operations were also present, though to a much smaller extent. Efforts should continue on education and awareness of the importance of nutrient management, manure management, residue management and crop rotation.

By looking at land cover in an area within a 50 metre distance from all waterbodies and watercourses, an attempt was made to determine areas which might have the potential for healthier riparian areas and areas which may be impacted by agricultural activities. Overall, only 11% of the buffered area was annually cropped and a slightly greater area was treed. With annual crop land in close proximity to surface water, there may be greater opportunity for contaminated runoff or chemical drift to affect riparian areas and water quality. Trees are an important part of the riparian area and their presence can indicate a certain level of riparian health. More detailed on-site analysis will be required to determine actual riparian health.

Calculation of shoreline densities provides information on areas where riparian areas are more concentrated. In the West Lake Winnipeg Watershed study area, rivers and creeks, including intermittent streams make up the majority of shoreline, although an area with a large amount of wetland shoreline is found in the western part. The sub-watersheds of Willow Creek and the Town of Gimli have the highest shoreline densities. A higher shoreline density will indicate a greater concentration of riparian areas. Since riparian areas provide a buffer between upland areas and surface water, efforts should continue to promote management practices which maintain or improve riparian health.

An attempt was made to determine an overall level of agricultural intensity with respect to livestock production and crop production. Because thresholds are not known, determinations of high, medium and low were not made. Instead, values were compared to the highest value calculated in Manitoba. In the West Lake Winnipeg Watershed study area, livestock densities tend to be higher in the central portions of the study area, with the highest value found in the Fish Lake Drain sub-watershed. This is still only 28% the highest livestock density in Manitoba. Crop production intensity was generally found to be less than half of the province's highest values. Areas with higher levels of livestock density or crop production intensity, or both, should be targeted for

programs which promote the use of management practices that improve riparian health and reduce impacts to water quality.

This report has been presented to provide a central source of riparian-related information to assist in strategic planning for riparian areas in Manitoba. Riparian areas play an important role in surface water quality and their ability to carry out this function can be affected by anthropogenic activities on the landscape. Agriculture is only one component, with other human activities such as industry, recreation and residences contributing to degraded riparian areas. The intent of this report is to be a first step towards addressing the issue of riparian health, with respect to agriculture, in the watershed study area. By providing information on the land resources and the agricultural activities in the study area, a better understanding of the issue can be obtained which will assist towards better planning and priority setting by local decision makers, land use planners and policy decision-makers. While this reports studies the agricultural aspect of the watershed study area, in a true watershed study, all factors of activities of all sectors must be considered. Due to scale and accuracy limitations, this report does not replace the need for site specific analysis; rather, it serves as a guide for general planning purposes in the West Lake Winnipeg Watershed study area.

Future Steps

Agriculture is a significant land use found within many watersheds across the southern portions of Manitoba. The way in which individual producers manage their land can have positive and negative impacts on the environment. The understanding of the relationship between management choices available to agricultural producers in Manitoba and the type and extent of their impact on riparian and water quality issues is not well understood. It is crucial that a better understanding of these relationships be developed. This, in combination with more information about the agricultural activities within a watershed, will provide a solid foundation of science and information upon which programs, policies and beneficial management practices can be developed and evaluated.

However, agriculture is only one component of the anthropogenic activities that occur within any given watershed. Other human activities, such as industry, residences and recreation can also significantly contribute to degraded riparian areas and reduced water quality within a watershed. As with agriculture, the relationship between these activities and the type and extent of their impact is typically not well known. If issues related to riparian areas and water quality within watersheds are to be understood there needs to be significant work done to collect information on these other activities and relate them to watershed issues. This will require all sectors, public and private, to jointly focus on these issues and work together to reaching their resolution.

References

Bourne, A., N. Armstrong, G. Jones. 2002. A preliminary estimate of total nitrogen and total phosphorus loading to streams in Manitoba, Canada. Manitoba Conservation Report No. 2002-04. 49 pp.

Canada Land Inventory. 1965. Soil Capability Classification for Agriculture. ARDA, Dept. of Forestry, Canada, Ottawa.

Digital Elevation Model – radar image obtained from Shuttle Radar Topography Mission, an international project spearheaded by the National Geospatial-Intelligence Agency (NGA) and the National Aeronautics and Space Administration, http://www.jpl.nasa.gov/srtm/ ; Cited 26 November, 2003.

Ecoregions Working Group. 1989. Ecoclimatic Regions of Canada, First Approximation. Ecoregions Working Group of the Canada Committee on Ecological Land Classification. Ecological Land Classification Series, No. 23, Sustainable Development Branch, Environment Canada, Ottawa, Canada. 119p. and mapped at 1:7,500,000 scale.

Eilers, R.G., G.W. Lelyk, P.Cyr, and W.R.Fraser. 2002. Status of Agricultural Soil Resources of Manitoba; Summary of Applications and Interpretations of RMSID, (Rural Municipality Soil Information Data Base). Land Resource Group - Manitoba, Semiarid Prairie Agricultural Research Centre, Research Branch, Agriculture and Agri-Food Canada.

Geomatics and Remote Sensing, Manitoba Conservation. 2001. Land Use/Land Cover Descriptions.

Jones, G., N. Armstrong. 2001. Long-term trends in total nitrogen and total phosphorus concentrations in Manitoba streams. Manitoba Conservation Report No. 2001-07. 154 pp.

Land Resource Unit, 1999. Soils and Terrain. An Introduction to the Land Resource. Rural Municipality of Gimli. Information Bulletin 99-16, Brandon Research Centre, Research Branch, Agriculture and Agri-Food Canada.

Land Resource Unit, 1999. Soils and Terrain. An Introduction to the Land Resource. Rural Municipality of Armstrong. Information Bulletin 99-15, Brandon Research Centre, Research Branch, Agriculture and Agri-Food Canada.

Lewis, R., C. Wyrzykowski, M. Wisener. 2004. Watershed-based Census of Agriculture in Canada (as reprocessed by farm headquarters to the Manitoba Gross watershed delineations, Version 5, in the Province of Manitoba with variable totals from the 2001 Census). [electronic format]. Based on: Statistics Canada, 2001 Census of Agriculture custom tabulation, Winnipeg, Manitoba

Manitoba Agriculture and Food. 2000. Farm Practices Guidelines for Poultry Producers in Manitoba. Province of Manitoba

Manitoba Conservation. 2003. 2001-2002 Annual Report. Available from http://www.gov.mb.ca/conservation/annual-report/conservation/2002-report.pdf

Manitoba Conservation 2000. Development of a nutrient management strategy for surface waters in southern Manitoba, Winnipeg, Manitoba. Information Bulletin 2000-02E. http://www.gov.mb.ca/natres/watres/nutrmgt.pdf

Michalyna, W., and G. Podolsky. 1980. Soils of the Matlock-Gimli- Riverton study area. Report D23. Canada-Manitoba Soil Survey. Winnipeg.

Mills, G.F., H. Velduis and R.G. Eilers. 1990. Physiographic Subdivisions of Manitoba, Map and Extended Legend. Manitoba Society of Soil Science: 33rd Annual Meeting, Winnipeg, Manitoba.

Natural Resources Canada. Geogratis CLI Home Page. http://geogratis.cgdi.gc.ca/CLI/frames.html; INTERNET; Cited 14 July 2003. Updated January 2000.

Podolsky, G. 1986. Soils of the Towns of Fraserwood, Inwood, Komarno and a strip of the Lake Manitoba Shoreline. Report D57. Canada-Manitoba Soil Survey. Winnipeg.

Pratt, L.E., W.A. Ehrlich, F.P. LeClaire, and J.A. Barr. 1961 Report of Detailed-Reconnaissance Soil Survey of Fisher and Teulon Map Sheet Areas. Soils Report No. 12. Manitoba Soil Survey. Winnipeg. 80 pp and 2 maps.

Smith, R.E., G.F. Veldhuis, G.F. Mills, R.G. Eilers, W.R. Fraser, G.W. Lelyk. 1998. Terrestrial Ecozones, Ecoregions, and Ecodistricts, An Ecological Stratification of Manitoba's Natural Landscapes. Technical Bulletin 98-9E. Land Resource Unit, Brandon Research Centre, Research Branch, Agriculture and Agri-Food Canada, Winnipeg, Manitoba.

Soil Classification Working Group. 1998. The Canadian System of Soil Classification, 3rd Edition. Research Branch, Agriculture and Agri-Food Canada.

Statistics Canada. 2002. Census of Agriculture. Available from http://www.statcan.ca/english/freepub/95F0301XIE/about.htm; INTERNET; Cited 27 May 2003.

Watmough, M.D., D. Ingstrup, D. Duncan, and H. Schinke. 2002. Prairie Habitat Joint Venture Habitat Monitoring Program Phase I: Recent habitat trends in NAWMP targeted landscapes. Technical Report Series No. 391. Canadian Wildlife Service, Edmonton, Canada

Wischmeier, W.H. and D.D Smith. 1965. Predicting Rainfall-erosion Loss from Crop land East of the Rocky Mountains. U.S. Department of Agriculture, Agriculture Handbook No. 282, U.S. Government Printing Office, Washington, D.C.

Glossary

Animal Unit - the number of livestock required to excrete 73 kg (160 lbs) of nitrogen in a 12-month period in Manitoba

Erosion – The wearing away of the land surface by detachment and transportation of soil and rock material through the action of moving water, wind or other geological processes.

Field Capacity – The amount of water remaining in a soil after free water has been allowed to drain away after the root zone had been previously saturated

Glacial till – Unstratified glacial deposits consisting of clay, sand, gravel and boulders intermingled in any proportion.

Lacustrine – Mineral deposits that either have settled from suspension in bodies of standing fresh water or have accumulated at their margins through wave action. The sediments generally consist of either stratified are varved (layered annual deposits) fine sand, silt and clay deposited on the lake bed; or moderately well sorted and stratified sand and coarser materials that are beach and other near-shore sediments transported and deposited by wave action.

Mean Annual Growing Degree Days - accumulation of days that the daily average temperature [average of maximum and minimum temperature] is greater than 5 C multiplied by the number of 5 C the daily average exceeds 5 C for each day).

Moisture Deficit – Precipitation [P] – Potential Evapotranspiration [PE] = Moisture Deficit accumulated over the growing season by August 13 or September 30.

Permeability – The ease with which water and air pass through the soil to all parts of the profile.

Appendix A

Classification Scheme: Land Cover Mapping of Manitoba	
1. Annual crop land:	Land that is normally cultivated on an annual basis.
2. Forage:	Perennial forages, generally alfalfa or clover with blends of tame grasses.
3. Grassland:	Areas of native or tame grasses, may contain scattered stands of trees
4. Trees:	Lands that are primarily in tree cover
5. Wetlands:	Areas that are wet, often with sedges, cattails, and rushes
6. Water	Open water – lakes, rivers, streams, ponds, and lagoons
7. Urban and Transportation:	Towns, roads, railways, quarries

Appendix B

The Census of Agriculture is conducted concurrently with the Census of Population by Statistics Canada, every five years. The 2001 Census of Agriculture is the most recent Census to date. The Census of Agriculture collects information from operations that meet the definition of a census farm.

In 1996 and 2001, a census farm was defined as "an agricultural operation that produces at least one of the following products intended for sale: crops (hay, field crops, tree fruits or nuts, berries or grapes, vegetables, seed); livestock (cattle, pigs, sheep, horses, game animals, other livestock); poultry (hens, chickens, turkeys, chicks, game birds, other poultry); animal products (milk or cream, eggs, wool, furs, meat); or other agricultural products (Christmas trees, greenhouse or nursery products, mushrooms, sod, honey, maple syrup products)" (Statistics Canada 2002).

The *Statistics Act* requires that all census information be kept confidential. As a result, any data that could disclose information concerning a particular agricultural operation or individual is suppressed in the data tables reported by Statistics Canada. Suppressed data are, however, included in the aggregate subtotals and totals within each data table. In instances where a geographic area has very few agricultural operations, data are not released separately, but are merged with data from one or more geographically adjacent areas (Statistics Canada 2002).

2001 Census of Agriculture Terms and Definitions (*Source: Statistics Canada 2002)*

Agricultural operation: a farm, ranch or other agricultural operation producing agricultural products for sale. Other agricultural operations include, for example: feedlots, greenhouses, mushroom houses, nurseries, Christmas tree farms, fur farms, hobby farms, game farms, beekeeping, sod, fruit and berry, maple syrup and poultry hatchery operations. Sales in the past 12 months are not necessary but there **must** be the intent of sales.

Summerfallow land: a term used to describe land on which no crop will be grown in order to conserve moisture but which will be sprayed or cultivated for weed control.

Tame or seeded pasture: grazeable land that has been improved from its natural state by seeding, draining, irrigating, fertilizing or weed control.

Natural land for pasture: grazeable land that has not been recently improved.

Tillage: the practice of working the soil for the purpose of bringing about the more favourable conditions for plant growth. Clean-till (conventional tillage) incorporates most of the crop residue into the soil, while minimum-till (conservation tillage) retains most of the crop residue on the surface. No-till includes direct seeding into stubble or sod.

Crop rotation: a practice where crops are alternated each year, or in a multi-year cycle, for soil conservation or disease control purposes.

Permanent grass cover: a practice where a field or land is kept in grass cover indefinitely to keep the soil from being eroded away.

Winter cover crops: crops such as oats or fall rye seeded in the fall to protect the soil from water and wind erosion during the winter and from heavy rains and runoff in the spring.

Green manure crops for plough down: the practice of incorporating young green plants into the soil for fertility purposes. These plants are usually grown with the single purpose of being used as a soil improver. Common examples are buckwheat and red clover.

Contour cultivation: the practice of cultivating the field across the slope to reduce soil erosion from rapid water runoff.

Grassed waterways: either natural or constructed, to control soil erosion. The waterway is permanently grassed and consists of a shallow channel, which is designed to slow down runoff water. The grass stabilizes the soil and prevents it from being washed away. They are usually shaped to allow easy crossings by farm machinery.

Strip-cropping: (or strip farming, field strip-cropping or wind strip-cropping) a method of controlling soil erosion by dividing the farm into narrow fields having different crops, with or without fallow. For example, the narrow fields may be alternately cropped–uncropped (e.g., wheat–fallow–wheat–fallow) or they may be strips of different crops (cereals, corn, soybeans). The widths of the cropped strips are usually multiples of a tillage implement or spray boom, etc.

Windbreaks or shelterbelts: trees, either planted or naturally present. This practice is used more predominantly in western Canada where farmland is more susceptible to wind action and where trapping snow for moisture is important.

Appendix C

Summary of Animal Unit coefficients used in Manitoba as compared to those used for calculations in this report[1]. Assumptions are given in the following Table.

Livestock	Animal Units produced by one animal (MAFRI)	Animal Unit coefficient used in report
Dairy		
Milking Cows (including associated livestock)	2.000	2.000
Beef		
Beef Cows, incl. associated livestock	1.250	1.250
Backgrounder	0.500	\
Summer pasture	0.625	} 0.631
Feedlot	0.769	/
Hogs		
Sows, farrow-to-finish	1.250	--
Sows, farrow-to-weanling	0.313	0.313
Sows, farrow-to-nursery	0.250	--
Weanlings	0.033	--
Grower/finishers	0.143	0.143
Boars (artificial insemination operations)	0.200	0.200
Chickens		
Broilers	0.0050	0.0050
Roasters	0.0100	--
Layers	0.0083	0.0083
Pullets	0.0033	0.0033
Turkeys		
Broilers	0.010	\
Heavy Toms	0.020	} 0.014
Heavy Hens	0.010	/
Horses (PMU)		
Mares, including associated livestock	1.333	1.00
Sheep		
Ewes, including associated livestock	0.200	0.200
Feeder Lambs	0.063	--
Goats	0.143	0.143
Bison		
Cow	1.00	\
Bull	1.00	} 0.8875
Calf	0.25	/
Elk		
Cow	0.53	\
Bull	0.77	} 0.520
Calf	0.05	/

1. An Animal Unit is defined as the number of livestock required to excrete 73 kg (160 lbs) of nitrogen in a 12-month period (as defined in the Farm Practices Guidelines for Poultry Producers in Manitoba)

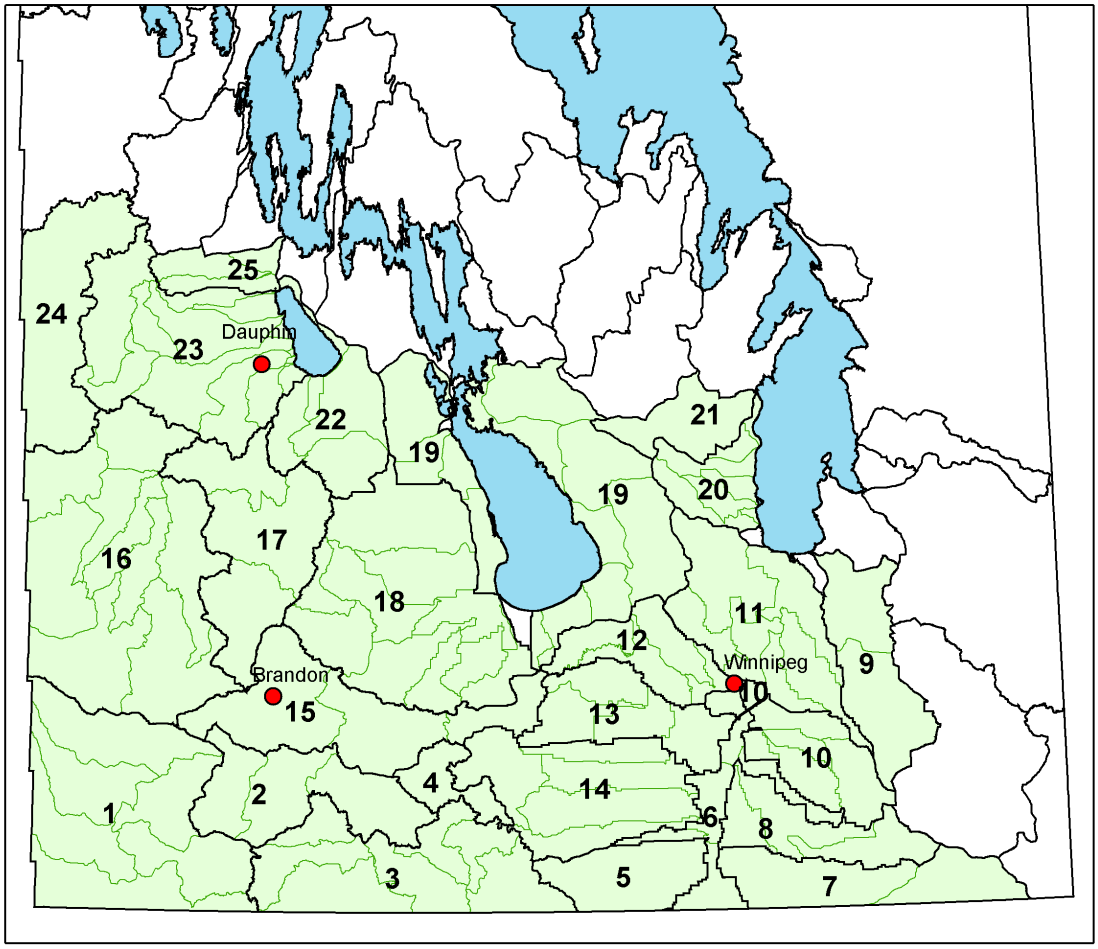
Summary of assumptions made in calculating Animal Units[1] from 2001 Agricultural Census Data.

Livestock	Manitoba Animal Unit Category	Census Category	Assumptions Used for Animal Unit Calculations with census data
Dairy	Milking cows (including associated livestock)	Dairy cows	Assumed categories are equal.
Beef	Beef cows	Beef cows	Assumed number of beef cows reported in 2001 Census equal cow/calf pairs
	Backgrounder Summer pasture Feedlot cattle	Heifers and steers for slaughter or feeding 1 yr and older (combined categories)	Assumed steers and heifers reported in these census categories are split into the three categories (communication with MAFRI). Animal unit coefficient determined using this ratio.
Pigs	Sows, farrow–to-weanling	Sows	Assumed there are no farrow-to-finish operations and no weanling operations in Manitoba – only farrow-to-weanling and grower/finisher operations.
	Grower/finishers	Grower and finisher pigs	
	Boars (artificial insemination operations)	Boars	Assumed all boars reported in the 2001Census are from artificial inseminations.
Chickens	Broilers	Broilers and roasters	Assumed all birds reported in the census category are broilers (communication with MAFRI).
	Layers	Laying hens (19 weeks and older)	Assumed categories are equal.
	Pullets	Pullets (under 19 weeks)	Assumed categories are equal.
	Broiler breeding hens	Laying hens in hatcheries	Assumed all laying hens in hatchery supply flocks reported in Manitoba are broiler breeder hens.
Turkeys	Broiler, Heavy Toms, Heavy Hens	Turkeys	Assumed “turkeys” represents 20% boilers, 40% heavy toms, 40% heavy hens (communication with MAFRI). Animal unit coefficient is determined using this ratio.
Sheep	Ewes, including associated livestock	Ewes	Assumed ewe/lamb pairs (communication with MAFRI).
	Feeder lambs	Lambs	Assumed no feeder lambs in province since numbers are very small and cannot be determined from census data (communication with MAFRI).
Horses	Horses	Total horses and ponies	Assumed each animal produces 1 Animal Unit – PMU farms not identified in Census (communication with MAFRI).

Livestock	Manitoba Animal Unit Category	Census Category	Assumptions Used for Animal Unit Calculations with census data
Bison	Bison	Bison	Assumed adults represent 85% and calves represent 15% of bison population in Manitoba (communication with MAFRI). Animal unit coefficient is determined using this ratio.
Elk	Elk	Elk	Number of calves and sex of animals not identified in Census – assumed 45% cows, 35% bulls and 20% calves (communication with MAFRI). Animal unit coefficient is determined using this ratio.
Goats	Goats	Goats	Number of kids and sex of animals not identified in Census – assumed 7 goats make up one Animal Unit, irregardless of age and sex.

1. One Animal Unit is defined as the number of livestock required to excrete 73 kg (160 lbs) of nitrogen in a 12-month period (as defined in the Farm Practices Guidelines for Poultry Producers in Manitoba)

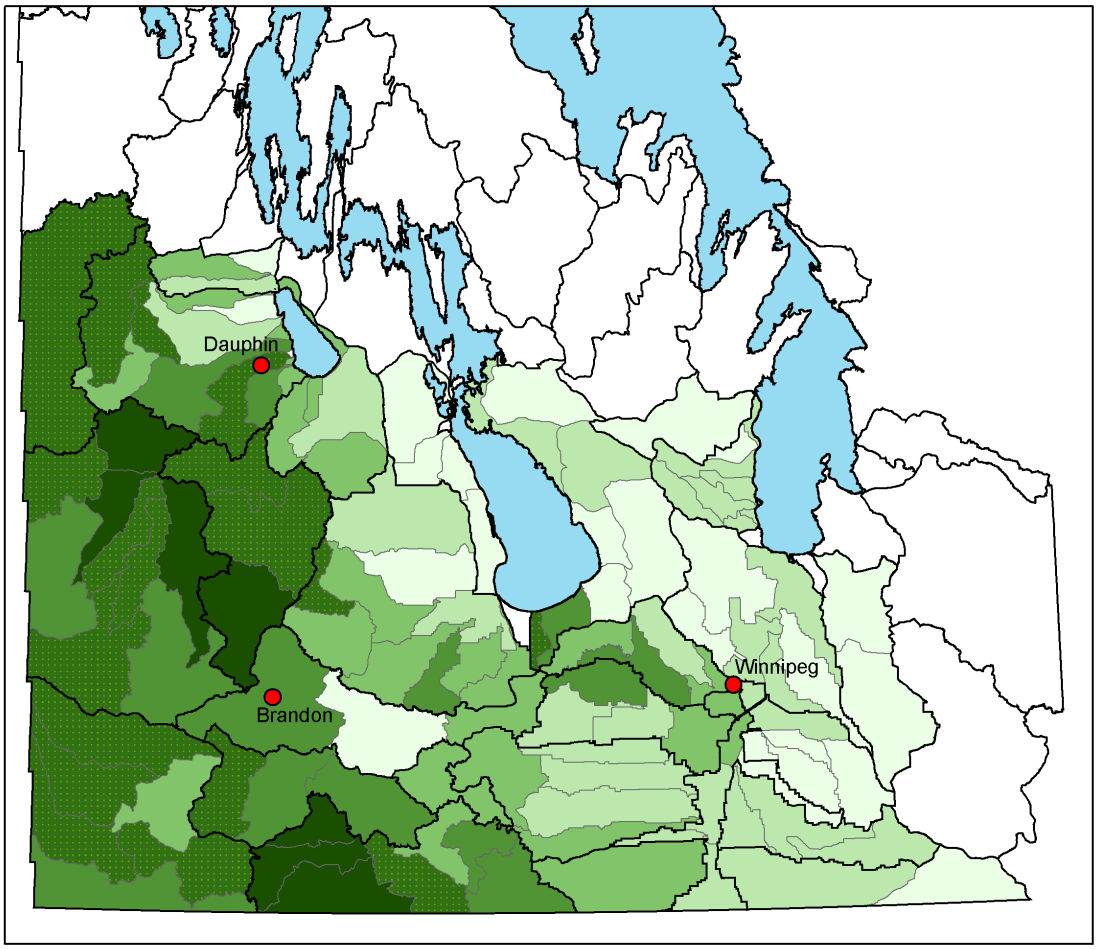
Appendix D



Watershed Study Area Summary Reports in Manitoba (black outline) and the sub-watershed areas (green outlines) used for the custom tabulation of the 2001 Census data.

Watershed Study Areas Sub-watershed areas

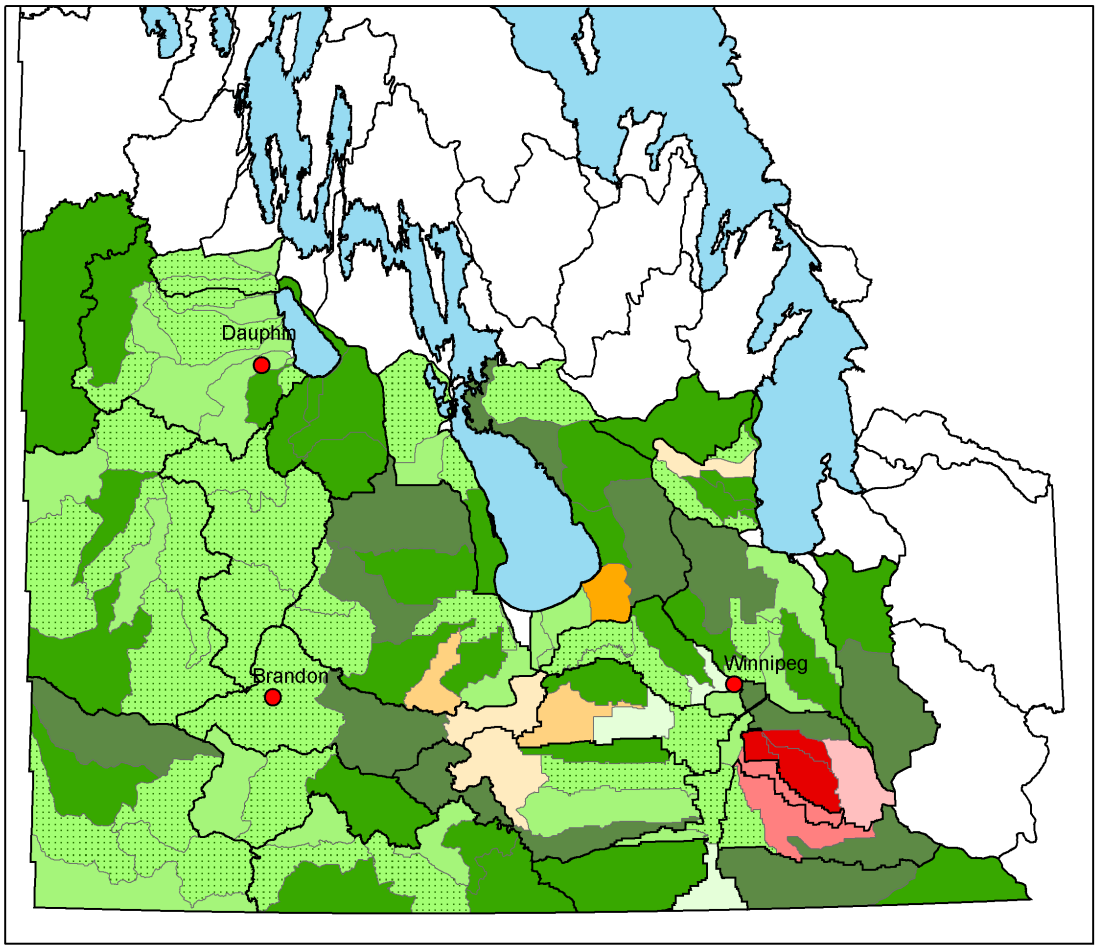
ID	Report	ID	Report
1	Upper Souris River Watershed Study Area	14	Boyne-Morris River Watershed Study Area
2	Lower Souris River Watershed Study Area	15	Middle Assiniboine River Watershed Study Area
3	Pembina River Watershed Study Area	16	Upper Assiniboine River Watershed Study Area
4	Cypress River Watershed Study Area	17	Little Saskatchewan River Watershed Study Area
5	Plum River Watershed Study Area	18	Whitemud River Watershed Study Area
6	Upper Red River Watershed Study Area	19	Lake Mantitoba Watershed Study Area
7	Roseau River Watershed Study Area	20	Lower West Lake Winnipeg Watershed Study Area
8	Rat-Marsh River Watershed Study Area	21	Icelandic River Watershed Study Area
9	Brokenhead River Watershed Study Area	22	South Dauphin Lake Watershed Study Area
10	Seine River Watershed Study Area	23	West Dauphin Lake Watershed Study Area
11	Lower Red River Watershed Study Area	24	Shell River Watershed Study Area
12	Lower Assiniboine River Watershed Study Area	25	Mossy River Watershed Study Area
13	La Salle River Watershed Study Area		



Comparison of Shoreline Densities in Manitoba
calculated as metres of shoreline/ha in each sub-watershed*

2.6 - 7.5	17.3 - 22.1
7.6 - 12.3	22.2 - 27.0
12.4 - 17.2	27.1 - 31.8

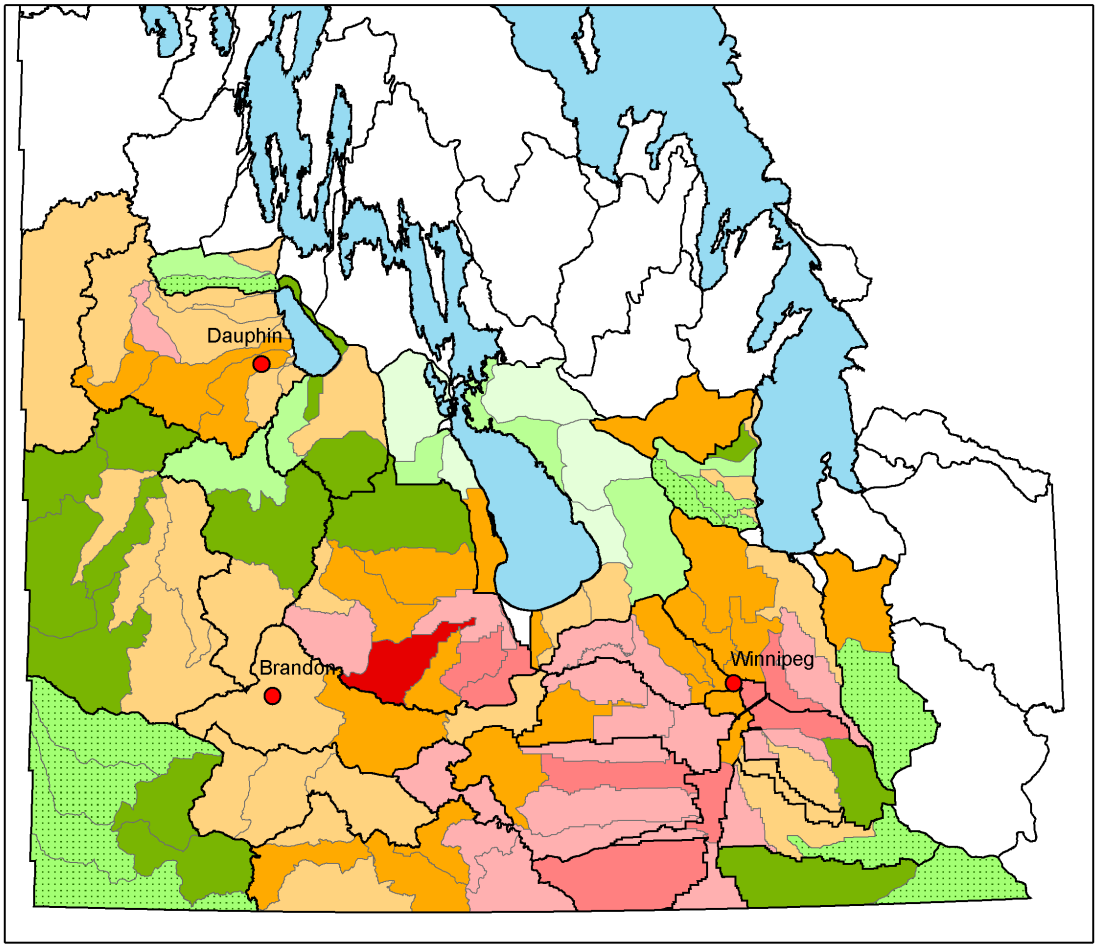
* Length of shoreline of both permanent and intermittent waterbodies and watercourses was determined from the 1:50,000 NTS datasheets (note that densities will be slightly underestimated since numerous small wetlands and potholes as well as some small constructed water courses (first, second and third order drains) are not captured by the NTS sheets).



Comparison of livestock production densities in Manitoba as a percentage of the highest value calculated in a sub-watershed using 2001 Census livestock numbers converted to Animal Units*

2.4% - 7.3%	17.1% - 21.9%	31.8% - 36.6%	75.7% - 80.5%
7.4% - 12.2%	22.0% - 26.8%	41.4% - 46.3%	95.1% - 100%
12.3% - 17.0%	26.9% - 31.7%	70.7% - 75.6%	

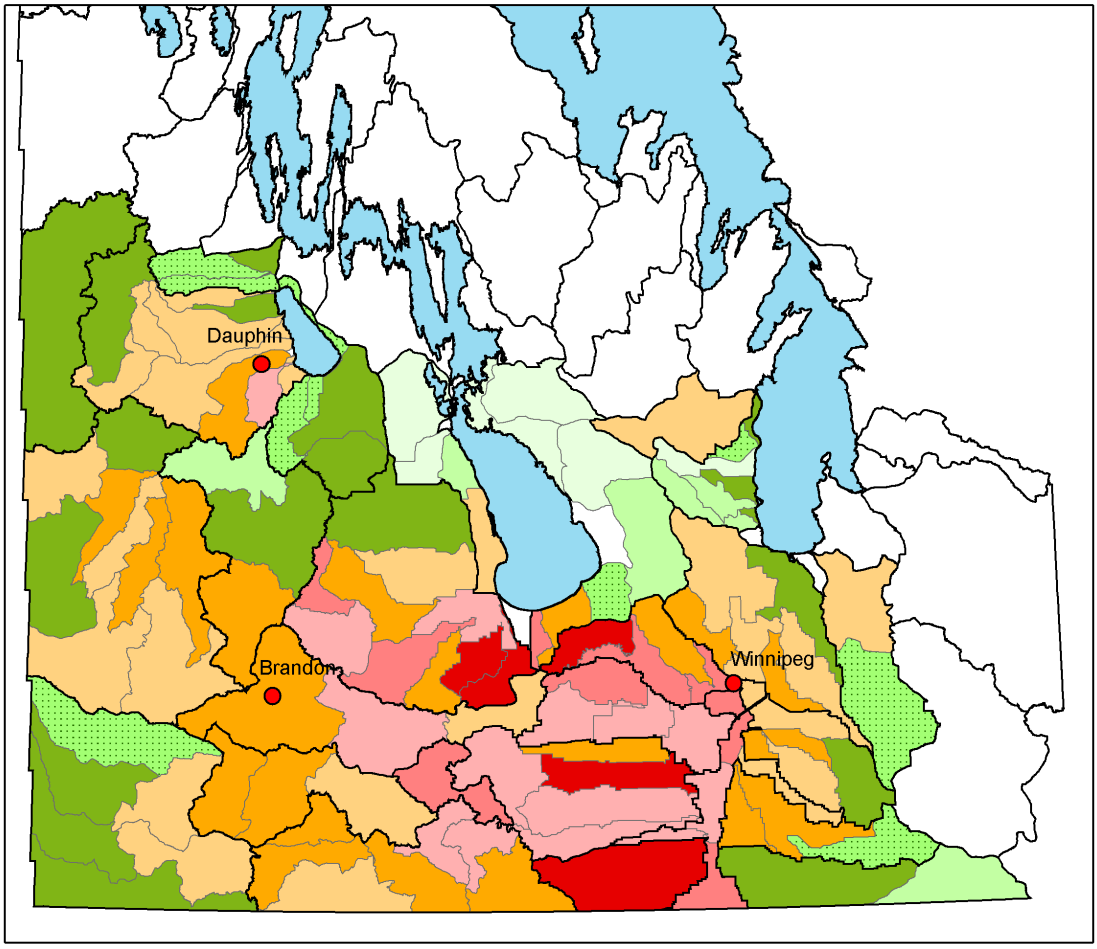
* Densities of different types of livestock were standardized by calculating Animal Units per hectare (AU/ha). In Manitoba, an Animal Unit is defined as the number of livestock required to excrete 73 kg (160 lbs) of nitrogen in a 12-month period (refer to Appendix C for assumptions used to derive AU coeffiecients). Suppression of livestock numbers in the census data will affect total AU to varying degrees, depending on the amount of suppression. Area used in calculation consisted of hay and crop land, summerfallow, tame pasture and native land used for pasture (as reported in the 2001 Census of Agriculture).



Comparison of commercial fertilizer use in sub-watersheds in Manitoba, calculated as a percentage of the highest value in a sub-watershed (as reported in the 2001 Census of Agriculture).*

8.4% - 18.6%	39.0% - 49.1%	69.6% - 79.6%
18.7% - 28.8%	49.2% - 59.3%	79.7% - 89.8%
28.9% - 38.9%	59.4% - 69.5%	89.9% - 100%

* Level of fertilizer use is calculated as dollars spent on fertilizers per hectare in the year 2000, as reported by farms in the 2001 Census of Agriculture. Land area was calculated as the number of hectares used for crop and hay production and summerfallow (as reported by farms for the 2001 Census).



Comparison of pesticide use in sub-watersheds in Manitoba, calculated as a percentage of the highest value in a sub-watershed (as reported in the 2001 Census of Agriculture).*

2.4% - 13.2%	35.0% - 45.8%	67.6% - 78.3%
13.3% - 24.1%	45.9% - 56.6%	78.4% - 89.2%
24.2% - 34.9%	56.7% - 67.5%	89.3% - 100%

* Level of pesticide use (herbicides, insecticides and fungicides) is calculated as dollars spent on fertilizers per hectare in the year 2000, as reported by farms in the 2001 Census of Agriculture. Land area was calculated as the number of hectares used for crop and hay production and summerfallow (as reported by farms for the 2001 Census).