Agricultural Pollution in Lake Winnipeg: Problems and Potential?

GRADES **OVERVIEW & OBJECTIVES** Students will investigate the extent of agricultural **9**th pollution in Lake Winnipeg by examining maps and data. Students will then discuss the effects of TIME agricultural pollution and possible solutions to determine if farmers are good stewards of the land. 1 class Students will be able to ... **REQUIRED MATERIALS** Identify water flow patterns Determine pollution sources into Lake Winnipeg Lake Winnipeg Watershed Maps - 1 per Analyze and explain the extent of agricultural student or project map for class ✓ Handouts: "Agricultural Pollution in Lake pollution into Lake Winnipeg Winnipeg "; "Agricultural Pollution in Lake Describe possible solutions to determine if Winnipeg (ANSWERS)"; Resource Maps & farmers are good stewards of the land Data (10 included) **MINNESOTA SOCIAL STUDIES STANDARDS & BENCHMARKS**

Standard 1. People use geographic representations and geospatial technologies to acquire, process and report information within a spatial context.

9.3.1.1.2 Apply geographic information from a variety of print and electronic sources to interpret the past and present and plan for the future; provide rationale for using specific technologies for each application. **Standard 3.** Places have physical characteristics (such as climate, topography and vegetation) and human characteristics (such as culture, population, political and economic systems).

9.3.2.3.1 Make inferences and draw conclusions about the physical and human characteristics of places based on a comparison of maps and other geographic representations and geospatial technologies. Standard 9. The environment influences human actions; and humans both adapt to and change, the environment.

9.3.4.9.1 Analyze the interconnectedness of the environment and human activities (including the use of technology), and the impact of one upon the other.

SUGGESTED PROCEDURE

The teacher will hand out a Lake Winnipeg Watershed map to each student or allow all students access to information on the map. Students will be getting information from a variety of resources such as maps and graphs as well as charts explaining the pollution sources into Lake Winnipeg. The 10 resource handouts will also be provided, either printed or shown on the screen in front of the room. Discuss what is occurring in each of the resources.

The teacher will provide the handout, "Agricultural Pollution in Lake Winnipeg". When students have completed the handout, "Agricultural Pollution in Lake Winnipeg", split the class into either Farmers or Environmentalists. Have students come up with reasons why and how to solve the problem of agricultural pollution using their individual viewpoints of either a farmer or an environmentalist. Basic arguments for each include:

Farmers:

Increased fertilizers means increased yield, which means more money. •

• Decreased fertilizer use means economic strain forces farmers to lose money.

Environmentalists:

- Increased fertilizers mean more pollution for Lake Winnipeg and less water use for recreation.
- Decreased fertilizer usage means a healthier ecosystem around and in Lake Winnipeg.

Discuss if this needs to be a dichotomy or whether or not farmers can and are good stewards of the land.

Assessment

- "Agricultural Pollution in Lake Winnipeg" handout
- Class discussion

Website Resources

"Crops" at The Canadian Encyclopedia http://www.thecanadianencyclopedia.ca/en/article/crops/

"State of Lake Winnipeg: 1999 to 2007" at Government of Manitoba https://www.gov.mb.ca/waterstewardship/water_quality/state_lk_winnipeg_report/pdf/state_of_lake_winnipeg_rpt_technical_low_resolution.pdf

- Resource #2: Manure
- Resource #3: Number of Cattle
- Resource #4: Agricultural Land
- Resource #5: Fertilized Area
- Resource #6: Land Cover and Percent of Coverage
- Resource #7: Ecological Regions
- Resource #8: Mean Monthly Discharge into Lake Winnipeg
- Resource #9: Total Phosphorus Concentrations
- Resource #10: Total Nitrogen Concentrations

Agricultural Pollution in Lake Winnipeg

- 1. Find the following rivers: Identify which direction each river flows. How can you tell which way the river flows?
 - A. Red River
 - B. Winnipeg River
 - C. Saskatchewan River
 - D. Dauphin River
 - Where does Lake Winnipeg drain?
- 2. What languages are printed on the map? Why is this the case?
- 3. Explain why the Winnipeg River deposits the most amount of water into Lake Winnipeg even though it is one of the shortest rivers emptying into the lake.
- 4. Using the resources in this activity. What is the dominant type of agriculture used within the Lake Winnipeg watershed?
- 5. Explain the physical landscape differences between land east of Lake Winnipeg and land to the west of Lake Winnipeg.
- 6. Lake Winnipeg has been designated as one of the most polluted lakes in the world. What factors are causing this designation?
- 7. Why do farmers use phosphorus and nitrogen for their crops? How does this affect the areas of Lake Winnipeg?
- 8. Which area of the map is bringing in the most phosphorus and nitrogen into the lake? Why is this the case? Which resource was necessary to find this information?
- 9. The Lake Winnipeg watershed is divided between two different countries. How does this complicate the problem of cleaning up the watershed area?
- 10. How can the rivers be cleaned up yet not harm agricultural interests in the area dependent upon the fertilizers and cattle for their livelihoods?

Agricultural Pollution in Lake Winnipeg (ANSWERS)

- 1. Find the following rivers: Identify which direction each river flows. How can you tell which way the river flows?
 - E. Red River **Flows north**
 - F. Winnipeg River **Flows west**
 - G. Saskatchewan River Flows east
 - H. Dauphin River Flows east
 - Where does Lake Winnipeg drain? To the north into Hudson Bay
- What languages are printed on the map? Why is this the case?
 French and English. Canada has two official languages and all government documents are printed in both languages.
- Explain why the Winnipeg River deposits the most amount of water into Lake Winnipeg even though it is one of the shortest rivers emptying into the lake.
 More water flows from the Winnipeg River because the lakes and precipitation is greater to the east of the lake than it is to the west of the lake.
- Using the resources in this activity. What is the dominant type of agriculture used within the Lake Winnipeg watershed?
 Cattle ranching and wheat farming
- Explain the physical landscape differences between land east of Lake Winnipeg and land to the west of Lake Winnipeg.
 The landscape to the east of the lake is dotted with lakes and swamps and forested areas whereas the area to the west of Lake Winnipeg is primarily prairie with lower amounts of precipitation.
- Lake Winnipeg has been designated as one of the most polluted lakes in the world. What factors are causing this designation?
 The agricultural runoff from fertilizer used to grow wheat and the manure and waste runoff from cattle goes into the rivers, which is affecting Lake Winnipeg downstream because the rivers empty into the lake.
- 7. Why do farmers use phosphorus and nitrogen for their crops? How does this affect the areas of Lake Winnipeg?

Farmers use phosphorus and nitrogen to aid plant growth for crops. The use of these products in fertilizer means a greater crop yield and more money for the farmer. The agricultural runoff from using these products means a polluted lake. Increased nitrogen levels in the lake mean more plant growth, especially algae, limiting the oxygen levels in the lake.

- Which area of the map is bringing in the most phosphorus and nitrogen into the lake? Why is this the case? Which resource was necessary to find this information?
 The Red River, compared to the other rivers, is bringing in the most amounts of phosphorus and nitrogen into Lake Winnipeg. Resources #9 and #10 show the Red River bringing in large amounts of each product into the lake.
- 9. The Lake Winnipeg watershed is divided between two different countries. How does this complicate the problem of cleaning up the watershed area?

Two separate governments (Canada and the United States) must agree on a plan. This is in addition to the local and regional governments of the areas (i.e. Manitoba, North Dakota, etc.)

10. How can the rivers be cleaned up yet not harm agricultural interests in the area dependent upon the crops and cattle for their livelihoods?Answers will vary depending upon viewpoints.

Resource #1: Crops



Source: The Canadian Encyclopedia: <u>http://www.thecanadianencyclopedia.ca/en/article/crops/</u>

Resource #2: Manure



Source: State of Lake Winnipeg Report. Province of Manitoba.

Resource #3: Number of Cattle



Source: State of Lake Winnipeg Report. Province of Manitoba.

Resource #4: Agricultural Land



Source: State of Lake Winnipeg Report. Province of Manitoba.

Resource #5: Fertilized Area



Source: State of Lake Winnipeg Report. Province of Manitoba.

Resource #6: Land Cover and Percent of Coverage



Source: State of Lake Winnipeg Report. Province of Manitoba.

Resource #7: Ecological Regions



Source: State of Lake Winnipeg Report. Province of Manitoba.



Resource #8: Mean Monthly Discharge into Lake Winnipeg

Figure 4.4: Mean monthly discharge into Lake Winnipeg as proportion of total tributary discharges from 1999 to 2007. (Data Source: Water Survey of Canada, G. McCullough)

Source: State of Lake Winnipeg Report. Province of Manitoba. https://www.gov.mb.ca/waterstewardship/water_quality/state_lk_winnipeg_report/pdf/state_of_lake_winnipeg_rpt_technical_high_resolution.pdf

Resource #9: Total Phosphorus Concentrations

Table 7.2: Annual average total phosphorous loads to Lake Winnipeg from major tributaries and atmospheric deposition and outflow from the Nelson River.

	Phosphorus (tonnes per year)													
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Red River	2,661	4,165	4,418	8,176	4,266	5,425	2,782	7,344	3,082	2,050	6,800	9,917	7,044	7,188
Winnipeg River	779	855	1,051	1,089	553	1,047	1,093	1,380	1.313	503	1,607	1,410	968	1.032
Saskatchewan River	289	271	362	578	397	424	353	98	202	199	309	668	569	566
Dauphin River	19	53	78	188	123	157	73	154	12	2	20	111	113	72
East Side Rivers	135	152	154	188	116	184	182	233	248	113	235	256	160	219
Brokenhead River	15	6	10	14	13	5	16	20	14	7	43	72	23	62
Fisher River	2	4	8	17	41	10	33	72	6	3	108	36	33	25
Icelandic River	2	8	22	27	47	10	46	63	9	6	46	72	40	26
Atmospheric Deposition	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Total	4,401	6,013	6,604	10,777	6,055	7,762	5,077	9,864	5,384	3,384	9,667	13,043	9,451	9,691
Outflow from Nelson River	1,536	1,754	2,055	1,987	2,249	1,813	1,989	2,840	3,864	2,195	2,574	8,119	4,795	4,634

Source: State of Lake Winnipeg Report. Province of Manitoba.

Resource #10: Total Nitrogen Concentrations

Table 7.5: Annual average total nitrogen loads (tonnes per year) to Lake Winnipeg from major tributaries and atmospheric deposition.

Nitrogen (tonnes per year)														
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Red River	22,121	36,370	34,558	37,871	35,303	33,681	24,459	37,755	12,849	11,157	34,155	42,840	42,996	34,554
Winnipeg River	19,291	21,119	25,770	24,700	12,939	21,861	23,446	30,949	26,647	13,345	27,735	31,303	17,512	18,996
Saskatchewan River	6,938	7,016	9,467	13,760	8,870	9,592	7,678	3,037	5,167	5,440	7,026	16,211	16,012	13,841
Dauphin River	1,144	3,637	5,102	5,102	3,539	4,349	2,308	4,287	835	602	1,652	6,825	10,804	7,296
East Side Rivers	3,079	3,488	3,545	3,794	2,306	3,520	3,701	4,864	4,292	2,188	4,104	4,686	3,115	3,427
Brokenhead River	251	111	173	197	192	81	346	507	390	117	398	793	369	548
Fisher River	21	50	91	198	471	121	375	828	66	39	1,242	418	385	286
Icelandic River	19	70	185	234	397	87	391	535	75	49	389	615	344	221
Atmospheric Deposition	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500
Nitrogen Fixation	9,300	9,300	9,300	9,300	9,300	9,300	9,300	9,300	9,300	9,300	9,300	9,300	9,300	9,300
Total	71,664	90,662	97,691	104,656	82,818	92,093	81,505	101,562	69,121	51,737	95,501	122,481	110,336	97,969
Outflow from Nelson River	26,077	32,793	45,385	54,494	36,059	30,320	41,886	50,403	23,588	32,024	39,655	65,336	53,165	50,822

Source: State of Lake Winnipeg Report. Province of Manitoba.