

Delta Marsh Field Station (University of Manitoba)
Occasional Publication No. 3

**An Annotated Bibliography
on Lake Manitoba
and Adjoining Waters**

by

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L. Gordon Goldsborough

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The cover photo shows the sun setting over Lake Manitoba, 27 July 2004, with bulrushes on the beach by the Delta Marsh Field Station in the foreground. Photo: Heidi den Haan.

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SUMMARY

Keywords: TEXT.

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Introduction

Lake Manitoba located in south-central Manitoba, is the thirteenth largest freshwater lake in North America, spanning approximately 4700 km². The lake is an important resource for Manitoba in terms of fisheries, recreation, hydrology and wildlife. For the past few decades there has been a growing awareness, as a result of few studies on Lake Manitoba and its surrounding waterbodies that the water quality of the lake has been deteriorating for at least the past 30 years. This has increased the need for adequate information on the current and historical biological health of Lake Manitoba and adjoining water bodies, primarily to adequately assess of the impacts of a wide range of human influences and developments on the biological health of the lake and surrounding water bodies. This has resulted in a growing need for a comprehensive bibliography summarizing studies conducted on Lake Manitoba and adjoining water bodies.

In this annotated bibliography the attempted has been to compile all substantive references addressing the current and historical biological health of Lake Manitoba. Selected water bodies that surround Lake Manitoba have also been included in the bibliography including Lake St. Martin, Waterhen Watershed, Pineimuta Lake and Marsh, Dauphin River, Fairford River, the Whitemud Watershed, and Delta Marsh. The lower Assiniboine River, from Brandon to the Assiniboine River Diversion (also known as the Portage Diversion) has also been included, along with the Assiniboine Diversion. In term of biological health, publication dealing with historical and current water quality conditions and water levels, and their effects in the above mentioned water bodies have been included in the bibliography. The effects of water quality and water levels include effects on the physical, chemical and biological features of the ecosystem. Publications containing information on historical regulation of Lake Manitoba and water levels in the lake have also been included.

In total approximately 400 publications are included in this bibliography, spanning a period of over 125 years, with publications as early as 1876 included, continuing up until the beginning of 2002. In the bibliography the content of each publication has been concisely summarized. The summaries given for each publication, focus in material in the documents that pertains to Lake Manitoba and the other water bodies mentioned above. A summary table is also include in this report in Section two, to exemplify specific subject material that is contained in the publications such as various water quality parameters, and information on fisheries, flora, fauna, agriculture,

recreational usage, soils and geology. The location and season of field studies is also given in the table. Locations where publications can be found, if known, are given to aid the reader in locating copies of the publications. A list of the various locations is given along with addresses, contact information, and hours of operation in Section three. Another section (section four) has also been included, which contains a brief list of historical photographs of Lake Manitoba, and select surrounding water bodies.

From this bibliography it is apparent that there is a lack of information on the current and historical health of Lake Manitoba, and the majority of its surrounding water bodies. While the general hydrology of the Lake is relatively well documented, many aspects are inadequately understood, including the physical limnology and water chemistry of the lake. Water quality data is sporadically available on the lake as early as 1926. During the 1960s and 1970s there was a water quality monitoring program carried out at up to sixteen sites in the North and South Basins of the lake. However, the sampling program was reduced to six stations in 1973, with three in each basin, and in 1977 the program was eliminated all together. Furthermore, most of the data that were gathered from the sampling programs are unpublished. Today, only one sampling station exists in the entire lake located approximately 1 km offshore from the south end of the South Basin. The site has been monitoring since 1991. Much of the scientific data gathered on Lake Manitoba has been biological in nature, mostly concerning the lakes fishery. Relatively few published studies exist which have examined the algal or invertebrate composition of the lake. There is clearly an essential need for more scientific data to be gathered on the biological health of Lake Manitoba, as well as its surrounding water bodies.

It should also be noted that due to the expansive amount of publications that have resulted from research studies that have been conducted at Delta Marsh only those that directly relate biological, chemical and influences from Lake Manitoba on the marsh and surrounding area, and influences on the lake from the surrounding watershed are included in this bibliography. The majority of studies conducted in Delta Marsh have also been previously cited in a bibliography compiled by den Haan (unpublished) that is currently in the final stages of completion and will be published later this year. Publications and theses resulting from work at the Delta Marsh can also be found in the Delta Marsh Field Station (University of Manitoba) Annual Reports that can be obtained through the Delta Marsh Field Station (University of Manitoba) (see locations list).

It should also be noted that currently publications are still being added on a daily basis to the Manitoba Conservation and Environment Library, since the closure and the Manitoba Department of Natural Resources Library, and the transfer of its publications to the Manitoba Conservation and Environment Library. Approximately 1,000 publications are being added monthly to the library's catalogue. As a result some publications, other than the ones included in this bibliography could exist on Lake Manitoba and the other surrounding water bodies; however they were not accessible during the compilation of this bibliography, so they may not have been included.

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1. Annotated Bibliography

Anderson, M. G. 1978. Distribution and production of sago pondweed (*Potamogeton pectinatus* L.) on a northern Prairie Marsh. *Ecology* 59: 154-160.

A study examining physical and chemical parameters of the soils and water at 140 sites in Delta Marsh, to determine their influence on the presence and density of sago pondweed (*Potamogeton pectinatus* L.). Vegetation samples were collected from each site and analyzed for dry weight, and observations were made regarding the presence and density of vegetation. Water chemistry analysis parameters included depth, clarity, pH, and alkalinity. Soil analysis parameters included pH, bulk density, organic matter content, and concentrations of total phosphorus, potassium, and nitrate. Results of water and soil chemical analysis at the various sites are discussed in the paper. Observations were also made at each site regarding the extent of wind exposure, and the velocity of winds. Results of the study showed that water depth, soil texture and maximum and directional exposure to wave action were the most important variables affecting the distribution of sago pondweed, and water depth, available potassium and phosphorus in the soil, soil texture and directional exposure were important variables affecting growth at colonized sites.

Location: University of Manitoba, Science and Technology Library, Call No. 574 S729 Jo Ec

Anderson, G. A. and R. E. Jones 1976. Submerged Aquatic Vascular Plants of East Delta Marsh. A wildlife report published as part of the Delta Marsh Management Study. Jointly sponsored by the Province of Manitoba and the Canadian Wildlife Service. Winnipeg, Manitoba. 120 pp.

During the summers of 1973 and 1974 a survey of the submerged aquatic vascular plant communities was conducted in the main water bodies of the east side of Delta Marsh. The survey area was bordered on the west by Delta road and on the east by Sioux Pass, Clandeboye Bay, Waterhen Bay and Mark's Lake. Surveys were completed primarily using aerial photography and ground truthing of vegetation. Approximately 275 photographs of vegetation beds were taken from a plane in August 1973, at an altitude of approximately 170 m, and 305 m. Groundwork identifying species was primarily conducted from an airboat between 22 August and 7 September.

Study sites on the east side of Delta Marsh include Cadham Bay, Simpson Bay, Portage Creek Bay, Lyttle Bay, Home Bay, twenty-two Bay, Twin Lakes, Blackfox Lake Wilson Lake, The Maze, High Point Lake, Horseshoe Pond, Clair Lake, Riley Bay, Bluebill Bay, Johnson Lake, Small Bluebill Bay, Gadwell Bay, Clandeboye Bay, Sioux Pass, Waterhen Bay, and Mark's Lake Complex. For all study sites the general submerged aquatic vascular plants composition is described, along with the growth characteristics of each species present. Also described is the total water surface area of each site, along with the percentage surface area that supports growth of submerged aquatic plants, and the depth characteristics of each site.

Location: Manitoba Conservation and Environment Library, Call No. QK 938 M3 A53 1976

Anonymous. 1944. Post-War Reconstruction Plan No. 2: Lake Manitoba Marshes. Department of Mines and Natural Resources, Games and Fisheries Branch. Winnipeg, MB. 17 pp.

A report describing proposed development plans for Delta and Lake Francis Marshes for hunting and gaming. The plans include the construction of dams at the marshes to control water levels in the marsh to improve waterfowl and muskrat production; one at the narrows of Clandeboye Bay, one at Eaglenest Creek, and on the creek into Cadham Bay. The plans also include the purchase of private land that is essential for the proper control of the marsh area. The digging of deeper channels to increase muskrat habitat and planting of aquatic

plants suitable for muskrat feeding is also called for, along with the construction of building for administration and access road to Simpson's Bay and Waterhen Bay. Cost estimates of the various aspects of the development plan are included.

Location: Manitoba Conservation and Environment Library, Call No. GB 628.15 P67 1944

Anonymous. 1961. Mystery killers in Lake Manitoba. Fishing Bulletin 2: 20-21.

An article discussing "death waves" in Lake Manitoba. Death waves form under the ice in shallow offshore waters in the mid-winter and move toward the center of the lake at speeds of 200 yards to one mile per week. These waves are associated with bad odors and a rusty-red discoloration. According to local fisherman the phenomenon has appeared in the lake for years. These waves were investigated in 1961 by the provincial sanitary control commission and natural resources through field tests and observation, and microscopic examination. Investigations showed that dissolved oxygen concentrations at the bottom of the waves were only 20 percent oxygen saturation, while conditions just under the ice, at the lake bottom, and a half-mile in front of the waves were healthy for fish, at level of 80 to 90 percent oxygen saturation. When these waves are intense, many square miles of the lake can be void of aquatic life. The article concludes that the cause of these death waves is still unknown.

Location: National Library of Canada, Call No. SH224

Anonymous. 1963. Are there signs of Over-Fishing in Lake Manitoba. Fishing Bulletin 3: 26.

An article discussing signs of over-fishing in Lake Manitoba. Biologists have noted that as commercial fishing intensifies the catches contain fewer big and older fish, and that per net catches decline and the rate of growth increases. Comparison of results of investigation in 1938, 1946-47, and 1960-62 show that pickerel growth rates have speeded up by one or two years in the last 15 years, and that sauger now attain market size two to three years earlier than previous. This increase growth rate is typically a sign of decreasing numbers due to over-fishing, leaving more food for survivors.

Location: National Library of Canada, Call No. SH224

Anonymous. 1966. Biological Program Lake Manitoba. The fishing Bulletin 5: 15.

A brief article discussing the planned sampling programs for lakes Winnipeg and Manitoba in 1967. Studies planned included fish tagging to determine fish movement to and from Lake Manitoba to the Waterhen Lake and River, and Lake Winnipegosis. The article mentions that more water than usual is being release downstream from the Fairford Dam in 1966 and 1967, so further studies are planned in Lake St. Martin to monitor any changes in the dissolved oxygen levels of the water, as low dissolved oxygen have been observed in the lake in the late winter months, since the operation of the Fairford Dam in 1961.

Location: National Library of Canada, Call No. SH224

Anonymous. 1973. The fishery for a dozen. Fishing Bulletin 13: 12-15.

A graphical summary of fisheries catches (in million of pounds) over a 12 year period from 1960 to 1972 in Lakes Manitoba, Winnipeg, Winnipegosis, and other northern lakes. Fish species examined include pickerel, sauger, whites, and jacks.

Location: National Library of Canada, Call No. SH224

Anonymous. 1976. Delta Management Report: Muskrat Counts – 1976. 9 pp.

A brief summary report on survey conducted on the muskrat populations in Delta Marsh in the early winter of 1976. The report describes the condition of the marsh in between 1974 to 1976, including water level and vegetation characteristics. Muskrat populations in the marsh were approximately between 9000 and 11 000, in 1976 nearly double the count from the year previous. From the study it appears the muskrat population is coming back to reasonably acceptable levels, from the lowest population numbers in 19 years, which was experienced in 1974. Several possible reasons for the increase in the muskrat population over the three year period are reviewed including water levels, vegetation, muskrat harvest, and disease. The report concludes that habitat continues to improve in the marsh, with high water levels and drier conditions in the latter part of the year, it is anticipated that further improvement will be seen the population of muskrat in 1977. The report includes a table summarizing muskrat populations in the marsh from 1943 to 1976.

Location: Manitoba Conservation and Environment Library, Call No. QL 737 R666 D45
1976

**Ashmore, P. E. 1990. Analysis and Interpretation of Assiniboine River Sediment Data
Environment Canada, Water Resources Branch. Winnipeg, MB.**

A copy could not be obtained. The copy of the publication in the Manitoba Conservation and Environment Library is currently missing.

Location: Manitoba Conservation and Environment Library, Call No. TD 227 M3 A853
1990

**Association for the Restoration of Water Levels Manitoba. 1942. Effects of Declining Water
Levels on Industry in Manitoba: A Report of the Association for the Restoration of
Water Levels in Manitoba. Association for the Restoration of Water Levels in
Manitoba. Winnipeg, MB. 35 pp.**

A report discussing problems related to the considerable decline in the waters levels of lakes and rivers in Manitoba during the drought period from 1930 to the early 1940s. Discussions include the significance of the lake to the economy of Manitoba, the significance of the declining water levels, and proposed solutions to the problem. Some of the major water bodies discussed included Lake Manitoba, Lake Winnipeg, Assiniboine River, Lake Winnipegosis, and the Red River. The drop in water levels of water bodies have adverse effects on fishing, fur, game and hunting, lumber, transportation, and tourist industries of the province. The importance of water bodies in Manitoba to these industries and the various adverse effects that have resulted from declining water level are discussed. According to the report the water level of Lake Manitoba is controlled by the first Fairford Dam structure at a mean elevation of 812.38 feet ASL, which was built during 1934 and 1935. By the September 1939 the elevation of Lake Manitoba was at an elevation of 811.1 and stayed at this elevation until April 30, 1940. Proposed solution to the problem include the construction of dams and control gates on the Lake Winnipegosis and Lake Winnipeg, and further construction on the outlet of Lake Manitoba. Another solution discussed for Lakes Manitoba and Winnipegosis is to bypass part of the Saskatchewan River discharge by opening a channel across Mossy Portage from Cedar Lake to Lake Winnipegosis. It is thought that this would raise water levels in Lake Manitoba to an effective level for a few years.

Location: Manitoba Conservation and Environmental Library, Call No. TD 227 M3 A77

Atton, F. M. 1959. The invasion of Manitoba and Saskatchewan by carp. Transactions of the American Fisheries Society 88: 203-205.

A discussion of the introduction of carp (*Cyprinus carpio*) to Manitoba and Saskatchewan, and their current distribution. Carp were unknown in Manitoba until 1938, and in Saskatchewan the earliest acceptable record of carp was in 1921. The article discusses the spread of carp in Manitoba and Saskatchewan since 1921.

Location: University of Manitoba, Science and Technology Library, Call No. 630 A512 Tr

Attwood, C. H. 1928. Surface Water Supply of Canada: Arctic and Western Hudson Bay Drainage (and Mississippi Drainage in Canada) in Alberta, Saskatchewan, Manitoba and Western Ontario – Climatic Years 1925-26. Canadian Department of the Interior, Ottawa, Ont.

A summary of hydrometric investigations conducted in Alberta, Saskatchewan, Manitoba and parts of Ontario Water bodies in 1926. Water bodies in Manitoba examined include Lakes Manitoba and Winnipegosis, and the Whitemud, Assiniboine, Dauphin, Fairford, Waterhen Rivers. Hydrometric data presented includes daily water levels for lakes and daily discharge information for rivers at select sites. Maximum and minimum water levels and discharges are also given. Information on the mean monthly discharge of the rivers and water levels of the lakes also included from 1913 to 1926 at select sites.

Location: Manitoba Conservation and Environment Library, Call No. TD 200 C2s8 no. 54 1928

Attwood, C. H. 1932. Preliminary Report No. 1 on the Proposed Dauphin River Power Development. Manitoba Department of Mines, and Natural Resources.

The report examines a proposed large hydroelectric power development on the Dauphin River. The development would include diverting the Saskatchewan River from Cedar Lake into Lake Winnipegosis, then to Lake Manitoba and through Lake St. Martin, to Lake Winnipeg. The development would result in the generation of approximately 400, 000 horse-power of hydroelectric energy. The report includes a map of the proposed development area showing the proposed channels, dams, dikes, and control structures. The report and the map also included information on the size, shorelines, and water levels of Lake Manitoba, Lake St. Martin, Lake Pineimuta, and Lake Winnipeg in 1932.

Location: Provincial Archives of Manitoba, Location code: GR 1602 G 1061

Baillie, A. D. 1950. Devonian Stratigraphy of Lake Manitoba - Lake Winnipegosis Area, Manitoba. MSc Thesis, University of Manitoba, Winnipeg, MB. 103 pp.

A study conducted during the summer of 1949 examining the Devonian strata outcropping in the Lake Manitoba and Lake Winnipegosis area of Manitoba. The Devonian strata examined constitute a linear 240-mile long (25 to 45 miles wide) belt of bedrock that extends in a northwest direction from north shore of Lake Manitoba (latitude 50° 20' North) to the west shore of Dawson Bay (latitude 53° 10' North). The study examines and describes all outcrops of Devonian rock exposed on the shores and islands of Lake Manitoba, Lake Winnipegosis, Red Deer Lake and Swan Lake, as well as strata exposed by quarrying and road construction. The Devonian Strata in the area are divided in three formations: Elm Point limestone, Winnipegosan formation, and Manitoba Formation. The Elm Point formation is the oldest known Devonian formation outcropping the area, it consists of at least 43 feet of limestone. The Winnipegosan formation, which overlies the Elm Point limestone, consists of 250 feet of dolostone. The Manitoban formation includes a series of shales, argillaceous and dolomitic limestones, and limestones. Each of the three formations is described in terms of distribution, character, thickness, age, fauna, and underlying strata. The structural geology and economic geology of the formation is also discussed. Photos of various sections of the formations are included.

Location: University of Manitoba, Elizabeth Dafoe Library, 2rd floor, Thesis B15673

Baillie, A. D. 1951a. Devonian geology of Lake Manitoba-Lake Winnipegosis area. Manitoba Department of Mines and Natural Resources, Mines Branch Publication 49-2, 71 pp.

The report presents the same information on the Devonian outcropping in the Lake Manitoba and Lake Winnipeg area as presented in Baillie (1950).

Location: Manitoba Mineral Resources Library

Baillie, A. D. 1951b. Silurian Geology of the Interlake Area of Manitoba. Manitoba Department of Mines and Natural Resources, Mines Branch Publication 50-1. 82 pp.

A study examining the stratigraphy, structure, and economic resources of the Palaeozoic formation in outcroppings in the Interlake Region of Manitoba, between Lakes Manitoba and Winnipeg, and Stonewall and Flin Flon. Fieldwork was conducted during the summer of 1950 and focused on the Silurian geology of the area. Surficial geology was examined along the inland area of Lake Manitoba (east shore), Lake St. Martin, Fairford River, Dauphin River, Pineimuta Lake, Lake Winnipegosis (east), and Lake Winnipeg (west) to name a few of the areas examined. Fossils of fauna present in the outcropping were also examined and are discussed, along with stratigraphy, age and physical characteristics of strata, environmental conditions of deposition, and economic geology.

Location: Manitoba Mineral Resources Library

Bajkov, A. D. 1928. A preliminary report on the fishes of the Hudson Bay Drainage System. Canadian Field Naturalist XLII (April 1928): 96-97.

A list of fish species known to occur in the Hudson Bay Drainage System as of 1928. The Hudson Bay Drainage System includes all water bodies in Manitoba, as well as parts of the Northwest Territories, Alberta, Saskatchewan, North Dakota, Minnesota, the northern part of Ontario and the greater part of Quebec. Lakes Manitoba, Winnipegosis, and Winnipeg are the three largest lakes that are part of the drainage system in Manitoba. Fish species collected for the list were gathered by the author in 1926 and 1927, and reported by other authors for various parts of the drainage system. The list includes 19 families, 50 Genera, and 95 species of fish. The list gives the common and scientific names of each fish species.

Location: University of Manitoba, Science and Technology Library, Call No. 574 C16 Fi Na

Bajkov, A. D. 1930a. Biological conditions of Manitoban Lakes. Contributions to Canadian Biology and Fisheries, being studied from the biological station of Canada, N.S., Volume 5-6, no. 12: 381-422.

From 1926 to 1929 an investigation of biological condition of several Lakes in Manitoba was undertaken, at the request of the Biological Board of Canada. The main reason beside study was to find a means by which to preserve fisheries resources and keep them under healthy conditions, by determining the biological conditions under which fish populations can be kept in balance. Sites examined include Lake Winnipeg, Lake Winnipegosis, Lake Manitoba, Lake St. Martin, Waterhen Lake, Dauphin Lake, Atikameg Lake and Clear Lake. Parameters examined include pH, depth, total and organic suspended solids, minerals and other ions, nitrogen (NO₃), temperature, dissolved oxygen, Secchi disk depth, alkalinity, fauna (plankton and benthic fauna) and dominant commercial fish species present.

Location: University of Manitoba, Elizabeth Dafoe Library, Call No. P 574.05 C16Co N.S. v. 5-6 1929-31

Bajkov, A. D. 1930b. A study of the Whitefish (*Coregonus clupeaformis*) in Manitoban Lakes. Contributions to Canadian Biology and Fisheries, being studied from the biological station of Canada, N.S., Volume 5-6, no. 15: 443-445.

The study examines the diet, competitors, spawning, and habitat, and industry of the Whitefish (*Coregonus clupeaformis*). Stomach content analysis was performed to determine their main diet, which consist of various small mollusks. Study sites included Lake Manitoba, Lake Winnipeg, Lake Winnipegosis, Clear Lake and Waterhen Lake.

Location: University of Manitoba, Elizabeth Dafoe Library, 3rd floor, Call No. P 574.05 C16Co N.S. v. 5-6 1929-31

Bajkov, A. D. 1930c. Fishing industry and fisheries investigation in the Prairie Provinces. Transactions of the American Fisheries Society 60: 215-237.

A discussion of fisheries investigations that have been conducted in various lakes and rivers throughout Manitoba, Saskatchewan and Alberta. Lake Manitoba is among the lakes discussed. The article examines investigations that have been conducted on the status and biology of some of the more valuable commercial fish species, which include whitefish, tullibee, goldeye, sturgeon, sauger, pike, perch, pickerel, yellow perch, suckers, catfish, lake trout, speckled trout and various other fish species that have little or no commercial value.

Location: Fisheries and Oceans Canada, Eric Marshall Aquatic Research Library

Bajkov, A. D. 1931. Investigation on Connection with White Fish *Coregonus clupeaformis*. MSc Thesis, University of Manitoba, Winnipeg, MB. 106 pp.

A study from 1926 to 1929 examining the distribution of white fish (*Coregonus clupeaformis*) and its food sources in various lakes throughout Manitoba, primarily Lake Manitoba, Lake St. Martin, Waterhen Lake, Lake Winnipeg, Lake Winnipegosis, Dauphin Lake, Atikameg and Cormorand Lakes and Clear Lake. In order to examine reasons for the distribution of White fish in these lakes, investigations were undertaken examining the physical, chemical, and biological conditions of the lakes. A physical description of each lake is given which includes area and location, hydrology, geology, and physiography. Water chemistry parameters examined in each lake include pH, total suspended solids, dissolved minerals and other ions, salinity, temperature, optical clarity, dissolved oxygen. Observations were also made of changes in water levels, currents, and wind and wave actions, and the characteristics of the sediments. Composition of plankton and benthos species and seasonal and spatial variations in its distribution in each lake were also examined. The report also includes an overview of the biology of white fish in the lakes examined, which includes food sources, competitors, growth rates, fertility, spawning, and migration. The white fish industry is also discussed.

Location: University of Manitoba, Elizabeth Dafoe Library, Thesis B167

Bajkov, A. D. 1932. The genus *Leucichthys* (Ciscoes or Tullibees) in Manitoban waters. Contribution to Canadian Biology and Fisheries (Series A, General, No. 23) 8(26): 327-333.

A study examining the fish genus *Leucichthys*. The most common species in the region is *Leucichthys Artedi Tullibee*, which is found in Lake Manitoba, Lake Winnipeg, Lake Winnipegosis and other lakes. A key to identify the species is given, including length, number of gill rakers, size and color of fins, and body shape. Also discussed is the species spawning habits. The species spawns at the same time as the whitefish (i.e. beginning of November). The number of eggs a female can produce varies between 15, 000 and 20,000.

Location: University of Manitoba, Elizabeth Dafoe Library, 3rd floor, Call No. 574.05 C16 Co

Bajkov, A. D. 1933. Report on Fisheries Investigations: Investigations in Connection with the Broad Tapeworm (*Diphyllobothrium latum*) in Manitoba Waters. Manitoba Department of Mines and Natural Resources. Winnipeg, MB. 19 pp.

A summary of the life history and distribution of *Diphyllobothrium latum*, a broad tapeworm. The larvae live in the meat of certain freshwater fish, and if the fish is eaten raw, the larvae can infect humans, dogs and other mammals. Over twenty-five thousand specimens of different species of fish both commercial and non-commercial from lakes located in Manitoba were examined for the tapeworm. The plerocercoids of *Diphyllobothrium latum* were only found in the flesh of five commercial fish species from Manitoba: pike, sauger, pickerel, yellow perch, and Ling. The plerocercoids of *Diphyllobothrium latum* are very common in the flesh of pike, perch, sauger and Ling in Lake Manitoba.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MMFB msr baj 1 1933

Bajkov, A. D. 1934. The plankton of Lake Winnipeg Drainage System. International Revue der Gesamten Hydrobiologie und Hydrographie 31: 239-271.

A summary of plankton present in the Lake Winnipeg drainage system, which includes Lakes Manitoba and Winnipegosis. Samples of plankton were gathered from more than two hundred water bodies throughout the Lake Winnipeg drainage area during from 1927 to 1933. The article includes a discussion of the historical origin of biota to the Lake Winnipeg drainage system from other regions. The bottoms of Lake Manitoba is flat, muddy and supports an extremely rich fauna, with insect larvae, mollusks and amphipods being the dominant forms. The bottom fauna of Lake Manitoba, as well as Lakes Winnipeg and Winnipegosis are characterized by the presence of very few species, but tremendous number of individuals. The article also contains a list of the species of planktonic organisms present in the Lake Winnipeg drainage system, which includes Lakes Manitoba and Winnipegosis.

Location: Fisheries and Oceans Canada, Eric Marshall Aquatic Research Library

Batt, B. D. J. 2000. The Delta Marsh. In H.R. Murkin, W.R. Clark, and A.G. van der Valk (eds.). Prairie Wetland Ecology: Contributions of the Marsh Ecology Research Program. Iowa State University Press, Ames. IA. p 17-33.

A discussion of Delta Marsh, including a physical description, the geological history of the marsh and current condition of the marsh. The description includes location, size, geology, soils, water chemistry, climate, vegetation, and fauna. Recent developments in the marsh that are discussed include stabilization of water levels on Lake Manitoba and hence the marsh, the introduction of common carp, and the Assiniboine River Diversion. The regulation of Lake Manitoba since 1961 has reduced the magnitude of water level fluctuations on the lake

and the marsh from 2.2 m prior to regulation to 0.6 m post regulation. Thus, the natural wet/dry cycles in the marsh have been dampened, and as a result species diversity and productivity has decreased. Carp are known to root up aquatic macrophytes, increasing water turbidity in marsh, and compete with other fish species. The Assiniboine River Diversion has results in the introduction of new fish species into Lake Manitoba and Delta Marsh.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 P73 2000

Bayfield Laboratory for Marine Science and Surveys, Canadian Hydrographic Service, and the Canadian Department of Fisheries and Oceans. 1982. Lake Manitoba Project Annual Progress Report 1982. Marinav Report no. 1366, Report NO. 82-5.

A hydrographic echo sounding survey of all navigable waters of Lake Manitoba from the Waterhen River to Delta Beach was conducted in 1982 to develop detailed depth maps and navigation charts for Lake Manitoba. Water levels were recorded at three permanent water level gauge locations: Steep Rock, Crane River, and The Narrows. Bottom sediment grab samples were also collected and shore lines examined for material composition.

Location: Fisheries and Oceans Canada, Eric Marshall Aquatic Research Library, Call No. VK 597.M36 B39 1982

Bayfield Laboratory for Marine Science and Surveys, Canadian Hydrographic Service, and the Canadian Department of Fisheries and Oceans. 1983. Lake Manitoba Project Annual Progress Report 1983. Marine Report no. 1393/TR, Report NO. 83-4.

The second year of a hydrographic echo sounding survey of all navigable waters of Lake Manitoba from Waterhen River in the north to Delta Beach in the south, conducted in 1983. The purpose of the survey was to determine the depth of navigable waters in the lake to develop detailed depth maps and navigation charts for Lake Manitoba. Bottom sediment grab samples were also collected and shore lines examined for material composition.

Location: Fisheries and Oceans Canada, Eric Marshall Aquatic Research Library, Call No. VK 597.M36 B39 1983

Beck, A. E. 1980. 1978 Mercury Levels in Fish and Sediment of the Assiniboine, Red and Winnipeg Rivers. Manitoba Department of Mines, Natural Resources and Environment and the Department of Consumer and Corporate Affairs and Environment, Environmental Management Division, Environmental Control Branch, Water Pollution Control. Winnipeg, MB. 39 pp.

A summary of a biomonitoring program conducted in the Assiniboine, Red and Winnipeg rivers in 1978 to investigate mercury concentrations in fish and sediments. Sample sites in the Assiniboine River were located near the city of Brandon and Portage la Prairie. A total of 22 different fish species were caught for sampling, and sediments samples were collected by grab sampling method at five locations at each sample site in the river. In terms of the Assiniboine River, the study found mean mercury levels in the flesh of sauger, walleye and northern pike exceeded the Government guideline level for human consumption of 0.5 µg/g. Several figures, tables, and graphs are included in the report illustrating the sample locations and results.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MCCA Ecb 80-mer

Beck, A. E. 1981. 1979 Mercury Levels in Fish of the Assiniboine, Red and Winnipeg Rivers. Manitoba Department of Mines, Natural Resources and Environment and the Department of Consumer and Corporate Affairs and Environment, Environmental Management Division, Environmental Control Branch, Water Pollution Control. Winnipeg, MB. 30 pp.

A summary of the results from the second year, 1979, of a biomonitoring program started in 1978 to investigate the concentration of mercury in the muscle tissues of fish from the Assiniboine, Red and Winnipeg rivers. Sample sites in the Assiniboine River were located near the city of Brandon and Portage la Prairie. A total of 22 different fish species were caught for analysis during September and October of 1979. In terms of the Assiniboine River, the study found mean mercury levels in the flesh of sauger, walleye, and common sucker exceeded the Government guideline level for human consumption of 0.5 µg/g. Some of the important fish species sampled including walleye, sauger, and northern pike exhibited individual mercury concentrations in excess of 2.5 µg/g. Overall, mean mercury concentrations in 1979 generally showed little statistically significant variation from levels found in 1978. Figures, tables, and graphs are included in the report showing the sampling locations and results.

Location: Manitoba Conservation and Environment Library, Call No. CA2 ME wss 81-nin

Beck, A. E. 1982. 1980 Mercury Levels in Fish of the Assiniboine, Red and Winnipeg Rivers. Manitoba Department of Mines, Natural Resources and Environment and the Department of Consumer and Corporate Affairs and Environment, Environmental Management Division, Environmental Control Branch, Water Pollution Control. Winnipeg, MB. 37 pp.

A summary of the results from the third year, 1980, of a biomonitoring program started in 1978 to investigate the concentration of mercury in the muscle tissues of fish from the Assiniboine, Red and Winnipeg rivers. Sample sites in the Assiniboine River were located near the city of Brandon and Portage la Prairie, and sampling was conducted in September and October of 1980. In terms of the Assiniboine River, mean mercury levels in excess of the Government guideline level for human consumption of 0.5 µg/g were found only in walleye, and overall the mean mercury concentrations in 1980 generally showed little statistically significant variation from those in the two previous years. Figures, tables, and graphs are included in the report showing the sampling locations and results.

Location: Manitoba Conservation and Environment Library, Call No. CA2 ME wss 82-nin

Beck, A. E. 1984. 1981-1982 Mercury Levels in Fish of the Assiniboine, Red and Winnipeg Rivers. Environmental Management Division, Water Standards and Studies Report 84-3. Winnipeg, MB. 82 pp.

A summary of the results from the fourth and fifth years, 1981 to 1982, of a biomonitoring program started in 1978 to investigate the concentration of mercury in the muscle tissues of fish from the Assiniboine, Red and Winnipeg rivers. Sampling was conducted in September and October of both years at three major sites in the Assiniboine River: Lake of the Prairies, the city of Brandon and Portage la Prairie. In terms of the Assiniboine River, mean mercury concentrations were found to be in excess of the Government guidelines were human consumption (0.5 µg/g) in walleye, northern pike, and sauger fish species. Overall, mean mercury levels in the muscle tissue of most fish species sampled during 1981 and 1982 showed little statistically significant change from those of the three previous years. Figures, tables, and graphs are included in the report illustrating the sampling locations and results.

Location: Manitoba Conservation and Environment Library, Call No. CA2 ME wss 84-3

Bernard, D. J. 1970. Depth distribution of the emerald shiner, *Notropis atherinoides*, and the spottail shiner, *Notropis nudsonius* in Lake Manitoba. University of Manitoba Field Station (Delta Marsh) 1969 Annual Report 4: 13-16.

A study examining the effectiveness of various types of fish net to catch emerald shiner, *Notropis atherinoides*, and the spottail shiner, *Notropis nudsonius*. Testing was conducted in Lake Manitoba, in front of the Delta Marsh Field Station (University of Manitoba) during the summer of 1969. In the sample area spottail shiners were generally associated with the bottom of the water column, whereas emerald shiners were dispersed throughout the water column, especially during the day, and at night they were most abundant in the mid-water column and at the surface. It was found that gill nets were best for sampling the adults of both species, and the fry were caught best with tow-nets.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Bernard, D. J. 1971. Depth distribution of the emerald shiner, *Notropis atherinoides*, and the spottail shiner, *Notropis nudsonius* in Lake Manitoba. University of Manitoba Field Station (Delta Marsh) 1970 Annual Report 5: 7-11.

A study examining the spatial and temporal distribution of emerald shiners and spottail shiners in Lake Manitoba in the summer of 1970. Temporal and spatial segregation of the two fish species appears to occur in the early stages of the species up to and during their juvenile phase, whereas the adults of both species appear to occur sympatrically near inshore habitat.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Bernard, D. J. 1972. Ecological Divergence Between Emerald and Spottail Shiners (*Notropis*) in Lake Manitoba. MSc Thesis, University of Manitoba, Winnipeg, Manitoba. 97 pp.

A study of the ecological divergence between emerald and spotted shiners (*Notropis*) that has allowed for their coexistence in Lake Manitoba. The relative abundance, vertical and horizontal distribution, age distribution, and diet of both species were examined at several sites along the south end of Lake Manitoba, near the University of Manitoba Field Station, Delta Marsh. The study also includes some general water chemistry data on Lake Manitoba.

Location: University of Manitoba, Elizabeth Dafoe Library, 2nd floor, Thesis B4563

Berry, D. J. 1957. Whitemud River Basin Investigation: Gladstone Area. Canada Department of Agriculture, Prairie Farm Rehabilitation Administration, Engineering Branch. Winnipeg, MB.

A summary of investigations into several proposals concerning the possibility of reducing the flood problem on the Whitemud River near the town of Gladstone, Manitoba. The area adjacent to the town of Gladstone containing agricultural land that is subject to periodic flooding from the Whitemud River during high water years. The study was carried out from May 1956 to May 1957 to investigate the feasibility of two possible diversion schemes: one to run east of Gladstone from the Whitemud River to Lake Manitoba, and the other to by-pass the town by a diversion south of Gladstone. The report includes a description of the topography, hydrology, geology, and soils of the Whitemud River drainage basin. The history of flooding in the area is also discussed, along a short discussion of existing flood control structures and previous studies. The report recommends a flood control scheme whereby one half the flood flows of the Whitemud River are diverted via a diversion channel south of Gladstone through the Dead Lake area. Figures area included illustrating the Whitemud River Watershed, flood control project plans, and the area flooded by the 1956 flood.

Location: Manitoba Conservation and Environment Library, Call No. CA 1 PFRA ER 4

Big Grass Marsh Wildlife Study Committee 1978. Wildlife Report Lower Whitemud River and Big Grass Marsh Flood Control Study. Department of Mines, Resources and Environmental Management, Water Resources Division. Winnipeg, MB. 34 pp.

A comprehensive management plan for Big Grass Marsh to improve wildlife production in the marsh, including fish, muskrat, and waterfowl. The report examines the main users of the marsh including waterfowl, muskrats, and fish, and reasons for declines in their populations over the past few years in Big Grass including: unstable water regimes, generally low water levels, and the encroachment of agriculture. The decline in the Lake Manitoba fishery is also partially attributed to decline in and reduced access to marsh fish habitat around Lake Manitoba, including Big Grass Marsh. The report examines the proposed development and management for the marsh for increased wildlife production, which involves two major components: a ditch on the west of the marsh between the Whitemud River and Big Grass River, and the division of the marsh into 6 cells. Cells for the rearing of Walleye would also be incorporated into the development plan. The proposed water level management plan for the marsh will encourage the establishment of emergent macrophyte species to benefit both waterfowl and muskrat populations. The water level management plan will included scheduled periodic flooding and drawdowns to promote plant diversity. Several benefits of the management plan are discussed. Figures of the proposed development scheme are included.

Location: Manitoba Conservation and Environment Library, Call No. HD 319 M3 W55
1978

Bisset, E. D. R. 1927. Freshwater Fish of Manitoba. Canadian Field Naturalist 41: 127-128.

A list of freshwater fish species that were found in various water bodies throughout Manitoba, as of 1927.

Location: University of Manitoba, Science and Technology Library, Call No. 574 C16 Fi Na

Bodnaruk, R. D. 1976. Delta Marsh Project: Center Unit Engineering Study. Water Resources Division, Dept of Mines, Resources and Environmental Management. Winnipeg, MB.

A study investigating proposed engineering measures for the development of Center Unit of Delta Marsh for improved waterfowl habitat. Since 1961 water levels on Lake Manitoba have been regulated via the Fairford Dam between a range of 801.87 to 812.87 feet ASL. Since regulation the range of fluctuation of water levels in the lake and adjoining marsh has been reduced from 2.2 m pre-regulation to 0.6 m post-regulation. The

stabilization of water levels has reduced vegetation diversity and productivity in Delta Marsh, reducing its attractiveness to waterfowl. The proposed development project will manipulate water levels in the marsh to return it to its natural productivity and improve it as habitat for waterfowl. The report discusses various options for manipulating water levels in the Center Unit of the marsh via diversions or pumps, storage of water by drying, and regulated releases of water by control structures. For the project field surveys and geological investigations were conducted in the marsh from 1974 to 1976. The report also contains cost estimates for the various options proposed, and general comments on the effectiveness of the proposed methods and the impacts of regulation. Several figures are included illustrating the various marsh regulation schemes, and dyke profiles and soils logs from the marsh.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MMWR 76/20

Bond, H. 1996. Management strategies for the rehabilitation of the west unit of Delta Marsh. MNRM Practicum, Natural Resources Institute, University of Manitoba, Winnipeg, MB. 121 pp.

Due to the stabilized water levels on Lake Manitoba, the plant diversity in Delta Marsh has decreased and the abundance of cattail (*Typha* spp.) has increased, resulting in a shift in the species composition and abundance of waterfowl populations that use the marsh. This study identifies causes of habitat deterioration for waterfowl in the west unit of Delta Marsh (water level stabilization, periodic flooding from the Assiniboine River Diversion, and the activity of common carp), and investigates the feasibility of rehabilitating the west unit of Delta Marsh (from Deep Creek on the west to the east side of Forster's Bay) to conditions more attractive to water staging and resting, and recommends management strategies from a biological, social, engineering, and financial standpoint. The study includes a description of Delta Marsh (geology, geography, soils, and climate) and the historical changes that have occurred in the marsh over the past 40 years (water level regimes, vegetation structure, waterfowl, fish and wildlife usage, and general conditions of the marsh) are examined. The study includes a discussion of the importance of water level drawdown and flooding in marshes for plant species diversity. The discussion of management strategies for Delta Marsh includes past management strategies of the marsh (Bossenmaier 1968, Jones 1978, Ould 1980, and Ducks Unlimited, Canada 1981), and potential options for management of the marsh including techniques with water control (drawdown and flooding), and techniques without water control (controlled burns, cutting, disking, and basin deepening). Of the management techniques, drawdown and cutting vegetation were chosen and considered to be the most biologically appropriate methods to improve vegetation diversity and habitat for waterfowl. From these two methods three options are considered and examined for the management of the marsh: 1) drawdown of the entire west unit of the marsh, 2) drawdown at Forster's Bay, and 3) cutting vegetation to break up closed areas of vegetation. An evaluation of the benefits and cost of these three management strategies showed the drawdown at Forster's Bay option has the greatest benefit/cost ratio. The paper also includes a summary of mean monthly water levels in Lake Manitoba at Steep Rock, from 1950 to 1996, and daily water levels in 1995 and 1996.

Location: University of Manitoba, Elizabeth Dafoe Library, Call No. Dafoe Practicum B6092

Bossenmaier, E. F. (editor). 1968. The Delta Marsh Its Values, Problems, and Potentialities. Report of the Technical Committee for Development of the Delta Marsh Manitoba, and the Department of Mines and Natural Resources, Winnipeg, Manitoba. 75 pp.

A comprehensive report on Delta Marsh, topics discussed include: a general description of marsh, the benefits of the marsh, several longstanding problems with the marsh, a proposal to control water levels in the marsh, recommendations for the management and development of the marsh. The general description of the marsh includes information on the geology, soils, vegetation, and climate. Also discussed is the past use of water control structures in Delta Marsh for the stabilization of water levels, to facilitate access and increase wildlife production and harvest. Such control structures have included: dams on the mouths of House Creek, Deep Creek, and Cram Creek; the culvert under Delta Road, near the Village of Delta; the gated culvert at the Delta Channel, connecting the marsh to Lake Manitoba; and the Clandeboye Dam with carp exclusion screens.

Benefits of the marsh discussed include: hunting for waterfowl; trapping for muskrat; waterfowl, deer, and fish usage; research; education; and various other recreational uses. Problems with the marsh examined include: conflicts between waterfowl and agriculture, flooding and salinity problems on agricultural lands, Lake Manitoba water levels control effects on marsh habitat and wildlife, nuisance vegetation, effects of carp on the marsh and poor muskrat populations.

The proposal to control water levels in the marsh would sub-divide the marsh into a number of sections, each capable of independent water level manipulation, and the report recommends that the operating water level in the east portion of the marsh, between the Portage Diversion and Clandeboye Bay, should be raised one foot, by raising Clandeboye Dame to an elevation of 813 feet, and diverting waters from the Portage Diversion into the marsh.

A summary of results from water sampling conducted at 13 sites in Lake Manitoba in 1966 and 1967 (Cober 1968) is also presented in the report in a table format. Parameters include pH, total hardness, total dissolved solids, conductivity, alkalinity, and dissolved ions. Water levels in Lake Manitoba from 1914 to 1967 are also presented graphically.

Location: Manitoba Conservation and Environment Library, Call No. SK 471 M3D4 1968

Boychuk, R. W. and W. F. Cowan. 1976. Investigation of Waterfowl use and Productivity on Pineimuta Lake and Lake St. Martin. Canadian Wildlife Service, Winnipeg, MB. 122 pp.

The report examines the effects of fluctuating water levels, resulting from the regulation of Lake Manitoba, on waterfowl productivity on lakes Pineimuta and St. Martin. The report includes a physical description of lakes St. Martin and Pineimuta, including topography, area, climate, soils, vegetation, waterfowl usage, historical water levels and land use. For the report daily water levels on lakes St. Martin, Pineimuta, and Manitoba from 1950 to 1975 were examined; littoral vegetative community transects were established; and breeding pair counts, netting searches and broad counts were completed. The authors of the report found that water level fluctuations pose a definite threat to waterfowl populations, and that lakes Pineimuta and St. Martin have been seriously altered by the regulation of Lake Manitoba via the Fairford Dam. Water level fluctuations during wet years have become a serious threat to water production in lakes St. Martin and Pineimuta. The report gives several recommendations including methods to improve waterfowl productivity on the two lakes, which include a management scheme for the operation of the Fairford Dam, improved drainage routes, isolation of Pineimuta Lake and management of the uplands. The authors also recommend the Canadian Wildlife Service should maintain and continue to assess the effects of water level fluctuation on the established waterfowl and vegetation transects on Pineimuta Lake and Lake St. Martin. The report includes several graphs, figures and tables illustrating the study areas, water levels, vegetation structure and distribution, and waterfowl species composition and distribution.

Location: Manitoba Conservation and Environment Library, Call No. QL 685.5 M3 1976 MWECW

Boyd, J. 1972. References and Abstracts, Lake Manitoba Fisheries Investigations. Manitoba Department of Mines, Resources, and Environmental Management, Research Branch, MS Report No. 72-18. 25 pp.

A bibliography of published reports and manuscripts investigating the fishery of Lake Manitoba, material is included up to the beginning of 1969. References and abstracts are given. The types of reports discussed in the bibliography include studies of various fish species present in Manitoba lakes, estimates of fish population numbers and productivity in Lake Manitoba, the biological and water quality conditions of lakes in Manitoba, the fishing industry in Manitoban lakes, aquatic plant surveys and development studies concerning Delta Marsh on the south shore of Lake Manitoba.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library, Call No. Delta Gov Docs MAN MREM 56

Brown, D. 1970. Phytoplankton Succession in Cadham Bay Delta Marsh, Manitoba. University of Manitoba Field Station (Delta Marsh) 1969 Annual Report 4: 17-20.

An examination of phytoplankton populations in the Cadham Bay of Delta Marsh from May to September 1969. Water samples were collected and analyzed for phytoplankton species composition, and phosphorus (total), carbon and nitrogen (nitrate and ammonia) concentrations. The study examines the seasonal and depth distribution of various species of phytoplankton including Cyanophyta (blue-green algae), Chlorophyta (green algae) and Chrysophyta (diatoms). The study also examines phytoplankton nutrient limitations in the bay. Phosphorus and nitrogen did not become limiting in the bay. It was postulated that light was the limiting factor in algal growth.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Burchill, C. A. 1989. Would Lake Manitoba have stabilized naturally? The University of Manitoba Field Station (Delta Marsh) 1988 Annual Report 23: 32-33.

A short article suggesting that Lake Manitoba has stabilized *naturally*, since the construction of the Fairford Dam in 1961. The author compares water levels on Lake to those of Lake Winnipegosis pre and post 1961. Before the dam water levels on both lakes were quite variable and highly correlated, and after the dam the correlation between the two drops. The author uses water levels on Lake Winnipegosis to approximate what water levels on Lake Manitoba would have been if the Fairford dam had not been built. Since the dam, water levels on Lake Winnipeg has been fairly stable and as such the author predicts that water levels on Lake Manitoba would have stabilized naturally since 1961 if the dam was not built.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Burrows, F. G. A. 1970. Wind and Set-up on Lake Manitoba. MSc Thesis, University of Manitoba, Winnipeg, MB. 147 pp.

An investigation of factors involved in determining wind set-up on Lake Manitoba, and the resulting amount of water flow through the Narrows of the lake. Field studies were conducted in the fall of 1966 during which wind, currents, and water levels were recorded at the Narrows. A physical description of Lake Manitoba is given which includes morphology, geology, land use and hydrology. According to the author water level fluctuation in Lake Manitoba are of three types: long-term, caused by alternating high and low water periods; seasonal, caused by snowmelt in the spring; and short-term, caused by wind-set up. Long-term and seasonal fluctuations on Lake Manitoba are now controlled due to the Fairford Dam. From the field observations equations were developed and are presented for wind setup and basin flow at the Narrows of Lake Manitoba for winds from the north and the south, under conditions when the Narrows is open or completely blocked. Graphs illustrating wind velocities, water levels, and wind setup at the Narrows are included.

Location: University of Manitoba, Elizabeth Dafoe Library, Thesis B9454

Butler, G. E. 1949. The lakes and lake fisheries of Manitoba. Transactions of the American Fisheries Society 79: 18-29.

The article describes the commercial fishery in the province of Manitoba. Some of the larger water bodies discussed including Lake Manitoba, Lake Winnipeg, Lake Winnipegosis, and Dauphin Lake. The area (1817 mi²) and average depth (20 feet) of Lake Manitoba are also given in the report. The report discusses how commercial fishing has existed on Lake Manitoba for the previous 50 years and the annual production is approximately 5 million pounds with only winter fishing permitted. The lake is a heavy producer of high quality yellow pikeperch. According to the author Lake Manitoba has a larger annual production in pounds per acre (5.01) than any other large lake in Manitoba. The author speculates this high productivity is related to the fact that Lake Manitoba is richer in nitrogen than Lakes Winnipegosis and Cedar Lake.

Location: University of Manitoba, Science and Technology Library, Call No. 630 A512 Tr

Butler, G. E. 1953. Prairie Commercial Fishing. Winnipeg, MB. 9 pp.

An overview of the history of commercial fishing in the Manitoba from 1881 to 1953. Major water bodies discussed include Lake Manitoba, Lake Winnipegosis, and Lake Winnipeg. As early as 1886 summer fishing was carried out on the southern portion of Lake Manitoba, and since 1889 there has been a winter fishery on the lake. The report discusses early method of fishing on the lakes, boating, and early production statistics and handling methods. The author comments that at the time of the report fishing was an important industry and Winnipeg was known as the largest freshwater fish-handling centre in North America.

Location: Manitoba Conservation and Environment Library, Call No. SH 224 M3 W56 B88 1953

Campbell, K. 1976. Fisheries studies on Lake Manitoba: Fishing Bulletin 16:15-17.

A review of some of the major fisheries studies that were conducted in Lake Manitoba during the period from 1973 to 1976. The article also contains some information on Lake Manitoba, which include: Lake Manitoba was one of the first lakes in Manitoba to support a commercial fishery as far back as 1880; and Lake Manitoba plays an important role in the economy of Manitoba, employing more than 375 people and producing some 2 600 000 pounds of marketed fish in 1975. Some of the fisheries projects that have been conducted on Lake Manitoba include a pickerel and sauger tagging project, and a pickerel-rearing project in Nina Lake and Bluff Harbour. The tagging project appeared to show that the narrows acted as a barrier to fish movement from the north basin to the south basin of the lake. Future planned research projects include an experiment fishing program to further examine the age, maturity, and size of fisheries in various location in Lake Manitoba. The 1975/1976 winter season fishery in Lake Manitoba is also briefly summarized. Fish catches were good in the south basin, whereas they were poor in the north basin, overall catches were up from the previous year.

Location: National Library of Canada, Call No. SH224

Canada Department of Energy, Mines, and Resources. 1947. Surface Water Supply of Canada: Arctic and Western Hudson Bay Drainage and Mississippi Drainage in Canada, Climatic Years 1941-42 to 1944-45. Canada Department of Energy, Mines, and Resources, Forests and Scientific Services Branch. Ottawa, ON. Kings Printer.

A summary of Hydrometric surveys conducted in the provinces of Alberta, British Columbia, Saskatchewan, Manitoba, and Ontario from 1941 to 1945. Sites in Manitoba include those in the Nelson River Drainage Basin. A few of the specific sites include: Lake Manitoba, the Whitemud River, the Assiniboine River, and Lake Winnipegosis. The publication contains water flow and water level data. Daily water elevations and daily discharges (maximum, minimum, mean, and total) are given in table format.

Location: Manitoba Conservation and Environment Library, Call No. TD 200 C2S8 1947

Canada Department of Energy, Mines, and Resources. 1954 to 1966. Surface Water Quality Data for Arctic and Western Hudson Bay Drainage and Mississippi Drainage in Canada: Water Years 1963-64. Canada Department of Energy, Mines, and Resources, Water Resources Branch. Ottawa, ON. Queen's Printer.

A summary of Hydrometric surveys conducted in the provinces of Alberta, British Columbia, Saskatchewan, Manitoba, and Ontario in 1964. Sites in Manitoba include those in the Nelson River Drainage Basin. A few of the specific sites include: Lake Manitoba, the Whitemud River, the Assiniboine River, Waterhen Lake and River, Lake Winnipegosis, the Fairford River, Lake St. Martin and Dauphin Lake and River. The book contains water flow and water level data mainly for the 1964 water year. Daily water elevations and daily discharges (maximum, minimum, mean, and total) are given in table format.

Location: Manitoba Conservation and Environment Library, Call No. TD 200 C2S8 no. 145 1966

Canada Department of Energy, Mines, and Resources. 1966 to 1971. Surface Water Data Manitoba 1965 to 1968. Canada Department of Energy, Mines, and Resources, Inland Waters Branch, Water Survey of Canada. Ottawa, ON. Queen's Printer.

A summary of hydrometric surveys conducted in Manitoba from 1965 to 1968. Some of the water bodies examined in Manitoba included Lake Manitoba, Lake St. Martin, Lake Winnipegosis, The Waterhen River and Lake, the Assiniboine River, Whitemud River, and Fairford River. Information on lakes includes daily water levels, historical maximum and minimum water levels, and the historical period of record. Information on rivers includes drainage area; period of record; historical mean, minimum, and maximum discharge, and daily discharge. There are four volumes of hydrometric surveys conducted in Manitoba from 1965 to 1968; results from each year are in a separate report. Surface water data for the years 1969 to 1990 are published by the Inland Water Directorate (Inland Waters Directorate 1968-1991).

Location: Manitoba Conservation and Environment Library, Call No. CA1 WS swd M 1965 to 1968

Canada Department of Energy, Mines, and Resources. 1969 to 1972. Sediment Data for Selected Canadian Rivers 1966 to 1968. Canada Department of Energy, Mines, and Resources, Inland Waters Branch, Water Survey of Canada. Ottawa, ON. Queen's Printer.

A summary of sediment surveys conducted from 1966 to 1968 in rivers throughout Canada. The Assiniboine River is among the rivers located in Manitoba examined in the report. Data presented includes streamflow; instantaneous suspended sediment concentrations; daily mean suspended sediment concentrations; daily suspended sediment loads, dissolved solids concentrations; load summary; particle-size distribution of suspended sediments in percent sand, silt, clay; bed load and bed material; and water temperature. Descriptive information about sampling locations is given and includes location, latitude and longitude, drainage area and whether the flow is natural or regulated (the year that regulation began is given), type of gauge and the total suspended sediment load in tones for the period of record is also included. Historical sediment data collect on the rivers from 1956 to 1968 is also given for some of the rivers, and includes maximum, minimum and total suspended sediment load. There are three volumes of publications; the results of each year of monitoring from 1966 to 1968 are in a separate report. Surveys in years after 1968 (1969 to 1990) were published by the Inland Water Directorate (Inland Water Directorate 1974 to 1992).

Location: Manitoba Conservation and Environment Library, Call No. TD 200 C2S8 no. 145
1966

Canada Department of Northern Affairs and Natural Resources. 1954 to 1966. Surface Water Supply For the Arctic and Western Hudson Bay Drainage and Mississippi Drainage in Canada: Water Years, 1949-50 to 1962-63. Canada Department of Energy, Mines, and Resources, Water Resources Branch. Ottawa, ON. Queen's Printer. 10 Volumes.

A summary of Hydrometric surveys conducted in the provinces of Alberta, British Columbia, Saskatchewan, Manitoba, and Ontario from 1949 to 1963. Sites in Manitoba include those in the Nelson River Drainage Basin. A few of the specific sites include: Lake Manitoba, the Whitemud River, the Assiniboine River, Waterhen Lake and River, Lake Winnipegosis, the Fairford River, Lake St. Martin and Dauphin Lake and River. The book contains water flow and water level data. Daily water elevations and daily discharges (maximum, minimum, mean, and total) are given in table format. The water record years are separated into 10 volumes (Water Resources Papers No. 109, 113, 117, 121, 125, 132, 135, 138, 141).

Location: Manitoba Conservation and Environment Library, Call No. TD 200 C2S8

Canada Department of Resources and Development. 1951. Surface Water Supply of Canada: Arctic and Western Hudson Bay Drainage and Mississippi Drainage in Canada: Climatic Years 1945-46 and 1946-47. Canada Department of Resources and Development, Engineering and Water Resources Branch. Ottawa, ON. Queen's Printer.

A summary of Hydrometric surveys conducted in the provinces of Alberta, British Columbia, Saskatchewan, Manitoba, and Ontario from 1945 to 1947. Sites in Manitoba include those in the Nelson River Drainage Basin. A few of the specific sites include: Lake Manitoba, the Whitemud River, the Assiniboine River, and Lake Winnipegosis. The book contains water flow and water level data. Daily water elevations and daily discharges (maximum, minimum, mean, and total) are given in table format.

Location: Manitoba Conservation and Environment Library, Call No. TD 200 C2S8 no. 101

Canada Department of Resources and Development. 1953. Surface Water Supply of Canada: Arctic and Western Hudson Bay Drainage and Mississippi Drainage in Canada: Climatic Years 1947-48 to 1948-49. Canada Department of Resources and Development, Engineering and Water Resources Branch. Ottawa, ON. Queen's Printer.

A summary of Hydrometric surveys conducted in the provinces of Alberta, British Columbia, Saskatchewan, Manitoba, and Ontario from 1947 to 1949. Sites in Manitoba include those in the Nelson River Drainage Basin. A few of the specific sites include: Lake Manitoba, the Whitemud River, the Assiniboine River, and Lake Winnipegosis. The book contains water flow and water level data. Daily water elevations and daily discharges (maximum, minimum, mean, and total) are given in table format.

Location: Manitoba Conservation and Environment Library, Call No. TD 200 C2S8 no. 105

Canadian Geological Survey. 1876. Report on the Country Between the Upper Assiniboine River and Lake Winnipegosis, Manitoba, By Joseph William Spencer, 1875. In Geological Survey of Canada for 1874-75. Ottawa, Queens Printer. p 57-70.

The report describes various landforms and water bodies in Manitoba, between the Assiniboine River and Lake Winnipegosis. The report includes a brief physical description of Lake Manitoba, and the Waterhen River.

Location: Manitoba Legislative Library, Call No. Geological Survey of Canada for 1874-75

Cherry, J. A. 1972. Geochemical processes in shallow groundwater flow systems in five areas in southern Manitoba, Canada. In J. E. Gill (editor) Proclamations of the 24th International Geological Congress. Montreal, Quebec. Section 11: p 208-221.

A study of the hydrochemistry of groundwater and overburden and shallow bedrock of the Holocene and Pleistocene periods, in five areas located in southern Manitoba. The Delta Marsh area was among the sample sites, along with the Shoal Lake Basin area, Deloraine area, Wilson Creek area, and Whiteshell Nuclear Research Establishment area. Electrical conductivity, total dissolved solids, pH, temperature, and concentrations of major cations and anions of ground water samples were measured in the field at the time of groundwater sample collection. The main hydrogeological features and groundwater water chemistry of the Delta Marsh area is discussed. Results of the study indicate that the dissolution of dolomite and calcite and the dissolution of soluble sulphate and chloride minerals could result in major-ion chemistry of the Delta Marsh area, along with the other study sites. In the Delta area large increases in SO_4^{2-} , Na^+ , Ca^{2+} , and Mg^{2+} occur as the groundwater flows through deposits of Pleistocene clay and silt.

Location: University of Manitoba, Science and Technology Library, Call No. QE 1.I6 1972 V. II

Cherry, J. A., B. T Beswick, W. E. Clister, and M. Lutchman. 1971. Flow patterns and hydrochemistry of two groundwater regimes in the Lake Agassiz Basin, Southern Manitoba. The Geological Association of Canada, Special Paper 9: 321-332.

A study conducted from 1968 and 1971 examining the interrelation between stratigraphy, major-ion distributions and groundwater flow patterns in two shallow groundwater areas of the glacial Lake Agassiz basin in southern Manitoba. Study sites were located on the agricultural plain and marshlands of the Delta area between the south shore of Lake Manitoba and the Assiniboine River, and near the Whiteshell Nuclear Research Establishment, on the Winnipeg River, which empties into the south basin of Lake Winnipeg. Field investigations included geological test drilling, ground water well installations and mathematical modeling of the ground water flows. Results of the study show that the ground water flow in the area between the Assiniboine River and Lake Manitoba occurs in Pleistocene deposits and Mesozoic and Paleozoic carbonates, and area is poorly drained by surface channels. Major-ion distributions are found to be distinctly correlated with the stratigraphy and flow patterns of the area. Salinity was found to be low in ground water recharge areas and high in ground water discharge areas. The article further discusses the processes that lead to the chemical evolution of major mineral and ions in the ground water of the Delta area.

Location: Delta Waterfowl Research Station, David Winton Bell Memorial Library

Cherry, J. A. and M. Lutchman. 1972. Flow patterns and hydrochemistry of a shallow groundwater regime in the Delta Marsh area, Manitoba. University of Manitoba Field Station (Delta Marsh) 1969 Annual Report 4: 13-16.

The study examines the relationship between the stratigraphy, flow patterns of groundwater, and hydrochemistry in the area between the Assiniboine River and Lake Manitoba, referred to as the Delta area. Data for the study was obtained from May to October 1969. The study gives an overview of the hydrology and hydro-chemistry of the west end of the marsh. Overall, shallow groundwater flow pattern in the area appear to be from the south and discharge toward the lake and marsh. A large portion of the shallow groundwater discharge is brackish to saline. Concentration of major ions (Na^+ , Mg^{2+} , and SO_4^{2-}) increase progressive with distance along the groundwater flow gradient.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Christie, L. A. 1990. Environmental Degradation of the Assiniboine and Red Rivers. Science and Technology Division, Research Branch, Library of Parliament. Ottawa, Ont.

A copy of this publication could not be obtained. The copy of this publication located at Manitoba Conservation and Environment Library was missing from circulation when this bibliography was compiled.

Location: Manitoba Conservation and Environment Library, Call No. TD 424.4 P73 C34 1990

Clarke, A. H. 1973. The Freshwater Molluscs of the Canadian Interior Basin. Malacologia 13: 1-509.

An extensive summary of freshwater Molluscs present in the Interior Basin of Canada, extending from the western boundary of the Atlantic Coastal Plain to the Rocky Mountains, and from the Arctic Ocean to the northern boundaries of the drainage basins of the St. Lawrence, Mississippi and Missouri Rivers. The paper provides keys, illustrations, descriptions for the identification of 103 Mollusc species and subspecies that are found in this region, along with their regional geographical distribution and suggested limiting factors for their distribution. The taxonomy, morphology, zoogeography, biology, ecology, and interspecific relationships between the different species and subspecies are also discussed. A summary of previous work conducted in the region is also given, along with a description of the Interior Basin of Canada, which includes topography, geology, Pleistocene history, existing connections between drainage areas, vegetation, and climate. Fieldwork for the study began in 1959, and was conducted annually until 1969. One hundred and three sampling stations were located in Manitoba. Lake Manitoba was among the sample sites, along with some of the adjoining water bodies including Lake Winnipegosis, Assiniboine River, Fairford River and Dauphin River.

Location: University of Manitoba, Science and Technology Library, Call No. 590 M29

Clark, W. R. and D. W. Kroeker. 1993. Population dynamics of muskrat in experimental marshes at Delta Marsh, Manitoba. Canadian Journal of Zoology 71: 1620-1628.

A Study examining muskrat population dynamics in relation to water levels and vegetation succession in Delta Marsh. Studies were conducted during the summers of 1985 to 1989 in an experimental wetlands complex (MERP) in Delta Marsh. All MERP cells were flooded to 1m above normal for 2 years to kill emergent vegetation and then one year of drawdown (cells 3 and 7), or two years (all other cells). In 1985, cells were re-flooded at maintained at one of three water levels normal (long-term average elevation); medium (30 cm above normal); and high (60 cm above normal). Populations were examined for the effect of water levels on population size, survival and recruitment. Results of the study show that muskrat populations increased rapidly during the first two years of re-flooding from 1985 to 1986. However populations decreased from 1987 to 1988 due to impacts of higher water levels on the relative amount of open water and emergent vegetation. Winter survival declined in 1987, and recruitment had declined significantly by May 1988. The most influential demographic factor that caused declines in densities was winter survival, which was consistently low in all treatment cells once flooding reduced the emergent vegetation.

Location: University of Manitoba, Science and Technology Library, Call No. 590 C16 Jo Zo

Clay, R. T. 1987. Final Completed Project Evaluation Report for the Interlake Biome of Manitoba. Ducks Unlimited Canada, Biological Services Group. Winnipeg, MB. 53 pp.

A two-year study, from 1984 to 1985, evaluating waterfowl habitat, and duck populations and productivity in five marshes in the Interlake Region of Manitoba. The five marshes examined included Harrell Enis, Vestfold, Spruce Lake, Big Swan Lake and Lindal's. A description of the soils, geology, and surrounding land use of the marshes is given. The report discusses results of the habitat and waterfowl assessments undertaken. The most notable changes that occurred during the study were reductions in dabblers ducks and increases in diver ducks. The densities of breeding pairs ranged from 0.53 to 1.65 pairs/ha and broods ranged from 0.07 to 0.49 broods/ha in 1984 and 1985. Overall, it was also observed that emergent vegetation in the marshes generally was stunted and sparse, and stands poorly developed.

Location: Ducks Unlimited Canada, Institute for Wetlands and Waterfowl Research Library, Call No. CLA

Cober, J. M. E. 1967a. Dirty water and little fishes. Fishing Bulletin 7: 5-7.

A very brief overview of studies conducted by the Department of Mines and Natural Resources from March to October 1966 in Lake Manitoba, the south basin of Lake Winnipeg, Grass River and Winnipeg River. In Lake Manitoba the salinity of the lake was examined at 13 sampling locations, which were sampled once a month. From comparison to 1928 records (Bajkov 1930a) it appears that the salinity of the lake has increased over the past 40 years.

Location: National Library of Canada, Call No. SH224

Cober, J. M. E. 1967b. The Results of Oxygen Tests on Lake St. Martin, During the Winter of 1966/67. Manitoba Department of Mines and Natural Resources, Fisheries Branch.

During December of 1966 and February of 1967, 16 sites in Lake St. Martin were sampled for oxygen levels in surface and bottom waters, alkalinity, carbon dioxide concentrations, pH, total solids, total hardness, depth and ice thickness. The results of the sampling included dissolved oxygen levels much lower in February than December, and below the limit considered tolerable for fish; a strong hydrogen sulfide odor at several stations; and relatively high values for total solids, total hardness. A brief description of Lake St. Martin is also given including geology, hydrology, area and depth characteristics. To alleviate low dissolved oxygen conditions in Lake St. Martin the report recommends water levels in the lake should be raised several feet by the means of a control structure on the Dauphin River.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MMFB msr cob 2 1967

Cober, J. M. E. 1968. Interim report on Lake Manitoba water quality analysis, 1966 and 1967. Manitoba Department of Mines, Resources, and Environmental Management, Research Branch, MS Report No. 72-18, 25 pp.

From September 1966 to September 1967, monthly water sampling was conducted at 13 sites throughout the north and south basins of Lake Manitoba. The sampling was conducted to determine background seasonal trend in the water quality condition of the lake before the construction of a causeway and bridge at the Narrows. Parameters examined included: alkalinity, total hardness, specific conductance, total dissolved solids, and concentrations of calcium, magnesium, sodium, bicarbonate, carbonate, chloride and sulfide. The report includes a description of Lake Manitoba with information on recreation, topography, geology, soils, climate, vegetation, morphology and morphometry. In general results of the study indicated that seasonal variations in all parameters were observed, with maximum values occurring in January and February, and gradually decreasing to minimum values in April and June. The results of the water sampling were also compared to water sampling done by Bajkov in 1930

(Bajkov 1930a), and both chloride and sulfate values were found to be three times greater than those recorded by Bajkov in 1930 at similar sampling locations.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library, Call No. Delta Gov Docs MAN MREM 56

Cober, J. M. E. 1973. Pesticide Residues in Manitoba Fish. Manitoba Department of Mines, Resources and Environmental Management, Research Branch. MS Report No. 73-31, 26 pp.

During the winters of 1965/66 and 1966/67, samples of various tissues were obtained from fish taken from 16 lakes, reservoirs, and rivers in Manitoba for pesticide analysis. Lake St. Martin was among the sampling site, and the fish species sampled included sucker, pike, and burbot. A brief history of various pesticides, their usage, and effects on different fish species is given in the report. During the 1965/66 sampling period, only the pesticides D.D.T., Dieldrin and heptachlor epoxide were detected in some of the water bodies tested. In Lake St. Martin Dieldrin was not detected in any samples, while D.D.T. and heptachlor epoxide were detected in two of the nine samples taken, one from a sucker viscera tissue sample and the other from a burbot sample. The D.D.T levels found in the burbot sample from Lake St. Martin (0.073 ppm) were the highest levels found among the sample sites. Similarly, the highest heptachlor epoxide concentration detected among the sample sites (0.021 ppm) was found in the same burbot viscera sample from Lake St. Martin.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MMR mr 73-31 1973

Collins, K. M. and P. N. Boothroyd. 1977. Big Grass Marsh Wildlife Study. Canadian Wildlife Service, Ducks Unlimited Canada and the Province of Manitoba. 159 pp.

A summary of present and historical data on the wildlife resources of Big Grass marsh, as a basis for a management plan for the development of the marsh. The report includes description of the history of the marsh, the present conditions, and the proposed wildlife management plan for the marsh. A general description of the marsh is given which includes location and area, physiography and soils, climate. The report discusses conditions in the marsh prior to 1938 in terms of waterfowl production, migratory bird use, muskrat production, fish production, vegetation and land use. The marsh was partially drained in 1909 in an attempt reduce flooding problems for the land could be used for farming, and changes in the marsh are examined since it was drained (i.e. waterfowl production, migratory bird use, muskrat production, fish production, vegetation and land use). In 1938, Big Grass Marsh became the first wetland development project of Ducks Unlimited (Canada), and through the management and restoration of the marsh wildlife production levels return increased to pristine marsh levels. However, local agriculture continues to hinder wildlife production in the marsh. A complete list of bird species found in the marsh is given.

During the summer of 1977 the authors of the study visited the marsh to obtain data on current conditions. During survey of the marsh they obtained water quality and sediment samples various stations throughout the marsh, they also conducted waterfowl breeding, staging, and brood surveys. Observations were also made regarding the present land use, vegetation, and populations of muskrat, white-tailed deer, fish and invertebrates. Results of the survey are presented in the report. Overall, waterfowl production in the marsh was poor in 1977 due in part to extreme drought conditions and more chronic factors such as an unstable water regime in the marsh and encroachment of agricultural activities. The muskrat populations in 1977 were restricted due to a severe winterkill in the winter of 1976-77. Fisheries data indicated that certain fish species migrate into the marsh in the spring to spawn, and the return of these fish to Lake Manitoba was impeded in 1977 by the north dam.

The report also includes a discussion of a proposed wildlife management plan for Big Grass Marsh. The plan includes a summary of the major factors that are limiting wildlife resources in the marsh including rapid and erratic water level fluctuations in the marsh, poor or nonexistent waterfowl nesting cover and the impediment of

fish movement back into Lake Manitoba by the north dam. The report discusses how the management plan will deal with all three of these problems. Recommendations include management of water levels in the marsh, compartmentalization of the marsh to control water levels, modify water control structures so that they don't impede fish movement, and maintaining a large area of undisturbed upland nesting cover for waterfowl. Maps are included illustrating the study area.

Location: Manitoba Conservation and Environment Library, Call No. QH 541.5.M3 C65

Cook, D. and J. C. Mackenzie. 1979. Lake St. Martin Whitefish Study. Manitoba Department of Mines, Natural Resources and Environment, Regional Services Division, MS Report No. 79-12. 40 pp.

During the fall of 1976, an experimental netting program was conducted in the Dauphin River and Lake St. Martin to determine the location of a proposed Lake St. Martin – Dauphin River regulatory boundary, to prevent commercial fisherman from blocking the whitefish return to Lake Winnipeg through the Dauphin River. Other objectives of the program were to determine the date whitefish live the north end of Lake St. Martin, and if pickerel pockets exist in the area of the regulatory boundary. Results from experiment fishing on Lake St. Martin in the fall of 1973 and 1974, are also included in the report for comparison. The study showed that fish come into Lake St. Martin to spawn from Lake Winnipeg, and then return to Lake Winnipeg after spawning. The length of time whitefish stay in Lake St. Martin could not be determined, but fishermen in the area say it depends on water depth, and whitefish remain in the lake longer when water levels are high. No pickerel pockets were found where the Dauphin River and Lake St. Martin converge.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MRRB mrs 79-12 1979

Cowan, W. 1973a. Preliminary Investigation of the Impact of Lake Manitoba Water Regulation Patterns on Wildlife and Wildlife Habitat. An Interim Report to the Manitoba Department of Mines, Resources, and Environmental Management Wildlife Program. Canadian Wildlife Service. 17 pp.

A 1973 preliminary assessment of the general distribution and needs of marsh habitat, waterfowl, muskrat and other vertebrates in and around Lake Manitoba, Lake St. Martin and Pineimuta Marsh, and the effects of Lake Manitoba regulation patterns on wildlife and wildlife habitat in these areas. The report is based almost entirely on a literature review, interviews, and a field study, and recommends further field and laboratory research. The report summarizes historical water levels in Lake Manitoba before regulation in 1961 by the Fairford Dam, and examines the possible effects of two Lake Manitoba water level regulation regimes on lakes Manitoba and St. Martin, and Pineimuta Marsh; the present water level regime with target lake level of 812.17 feet FSL and lowering this mean annual lake level by six inches to 811.67 feet FSL. The effects of these two water level regimes are assessed on marsh vegetation characteristics and acreage (Delta Marsh and Marshy Point), and waterfowl, muskrat and mink populations in and around lakes Manitoba and St. Martin, and Pineimuta Marsh. The report includes background information on the locations and acreage of waterfowl habitat bordering Lake Manitoba, Lake St. Martin, and Pineimuta Marsh, 585000, 19062, and 80317 acres respectively, and populations of waterfowl, mink, and muskrat present in these areas. Based on available information, the authors make a preliminary recommendation that Lake Manitoba should continue to be regulated under the present rules with the target level of 812 FSL minimum, but stress that further research is needed, at least two years, to further clarify the effects of any new lake regimes on wildlife and their habitat in Lake Manitoba, Lake St. Martin, and Pineimuta Marsh, to predict and make a final assessment on the lake control regimes most suitable for wildlife.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Cowan, W. 1973b. Submission to the Manitoba Water Commission Public Hearing RE: Changed Regulation of Lake Manitoba on Behalf of Canadian Wildlife Service. In Cowan, W. Preliminary Investigation of the Impact of Lake Manitoba Water Regulation Patterns on Wildlife and Wildlife Habitat. An Interim Report to the Manitoba Department of Mines, Resources, and Environmental Management Wildlife Program. Canadian Wildlife Service. 5 pp.

A submission to the Manitoba Water Commission Public Hearing regarding the effects of the proposed lowering of the regulation level of Lake Manitoba by six inches, from 812.17 to 811.67 feet FSL, on physical process in Lake Manitoba and peripheral water bodies, such as wind set-up in Lake Manitoba, inter-basin transport of water, flushing action in marshes bordering the lake, shoreline and beach processes, and flows and water levels in Lake St. Martin and Pineimuta Lake. Specific physical effects discussed included: an increase in wind set-up in the lake by approximately five per cent; a two to three per cent reduction in the volume of inter-basin exchange between the north and south basins of Lake Manitoba; a reduction in marsh area surrounding the lake, and a change in their storage characteristics and response to wind set-up, resulting in the marshes becoming more isolated from the lake (six marshes were studied: Skunk Bay, Bluff Harbor, Nina Lake, Moosehorn Lake, Davis Point, and Johnson Lake); a reduction in shoreline wave action; and similar high rates and frequencies of water level changes in Lakes Pineimuta and St. Martin, as those seen under the present regulation level of Lake Manitoba.

Location: Manitoba Conservation and Environment Library, Call No. TC 426.5 M3 P74 1973

Cowan, W. 1973c. Brief to the Manitoba Water Commission: Effects of Regulating Lake Manitoba. In Cowan, W. Preliminary Investigation of the Impact of Lake Manitoba Water Regulation Patterns on Wildlife and Wildlife Habitat. An Interim Report to the Manitoba Department of Mines, Resources, and Environmental Management Wildlife Program. Canadian Wildlife Service. 4 pp.

A brief summary of preliminary studies conducted in some of the marshes that border Lake Manitoba. The report discusses the proposed reduction in the regulation level of Lake Manitoba from 812.17 to 811.67 feet FSL, and how it would be detrimental to waterfowl, decrease marsh habitat, and affect other wildlife species in these peripheral marshes. Recommendations include: the regulation Lake Manitoba should continue under the present conditions, until the relationship of water level patterns to marsh shoreline processes and resultant changes in vegetation can be better understood; wildlife studies should be undertaken to identify affected populations, and a water regulation method more suitable to wildlife can be determined, as the present controls are harmful to waterfowl and muskrat populations; a feasibility study should be conducted on controlling water levels in Lake St. Martin and Pineimuta Lake through ancillary structures; and should the regulation of Lake Manitoba change, it should be done gradually over a number of years.

Location: Manitoba Conservation and Environment Library, Call No. TC 426.5 M3 P74 1973

Cowan, W. F. 1975. Impacts on waterfowl breeding success of flooding in Pineimuta Lake due to regulation of water levels in Lake Manitoba, including suggestions for management. Environment Canada, Canadian Wildlife Service Report. Edmonton, AB. 32 pp.

A study examining the effects of Lake Manitoba water level regulation on waterfowl breeding in Pineimuta Lake, including suggestions for management schemes to alleviate the negative effects. According to the author Lake Pineimuta is a high quality breeding habitat for waterfowl, however since the regulation of water levels on Lake Manitoba via the Fairford Dam in 1961, downstream extreme water level fluctuations have increased in

magnitude and frequency. For instance, in the spring and summer extreme water levels have caused increased spring and summer flooding downstream in Lake Pineimuta and Lake St. Martin, resulting in low waterfowl productivity on Lake Pineimuta in recent years. The report contains data collected during 1974 on breeding waterfowl populations, brood counts, vegetation condition, water levels, river flow and basin contour measurements to study the effects of extreme water level fluctuations on the marsh habitat and waterfowl productivity. Water level fluctuations in Lake Pineimuta during 1974, and in other years prior to after the construction of the Fairford Dam are examined, and the effects of the extreme water level fluctuations on marsh habitat and waterfowl of the lake are determined and discussed. Maps of the study area are included showing survey locations, along with graphs illustrating water levels in Lake Pineimuta, and flows of the Fairford River. A physical description of Pineimuta Lake is also given, which includes location and area, hydrology, soils, geology, climate, vegetation, and dominant waterfowl species usage. The report concludes that the capability of Lake Pineimuta to provide as habitat for waterfowl and other wildlife is dependent on water levels in the lake, which are influenced to a great degree by the regulation of Lake Manitoba via the Fairford Dam. Since the operation of the Fairford Dam, resulting extreme water level fluctuations in Lake Pineimuta have reduced the quality of marsh habitat and waterfowl productivity. Recommendations of the report to improve waterfowl productivity in the lake include the isolation of the Pineimuta Lake from the Fairford River, and the control of water levels in Pineimuta Lake via control structures and a water level management plan. Other recommendations also include a review of the regulation rules for Lake Manitoba to determine a better way of controlling summer floods and winter water levels, and possible changes to the flow capacity of the Fairford Dam to improve flow capacity.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Cowan, W. 2000. Impacts of Artificial Control of Water Levels on Natural Resources on the Lake Manitoba Basin. Report to the Lake Manitoba Basin Initiative. 43 pp.

A report examining the effects the stabilization of water levels in Lake Manitoba have had on the lake and the surrounding watershed. The report also addresses concerns related to the operation of the Assiniboine Diversion and its impacts on both lake levels and water quality; the effects runoff from agricultural lands, and sewage treatment on the shore of the lake and adjoining streams and rivers; and the effects of the introduction of common carp to the lake. The report calls for action to address these concerns and that various interest groups determine an interim water level regime that allow for some annual and seasonal fluctuation in lake water levels to reduce negative effects that have resulted in the lake, and the surrounding drainage basin from the stabilization of the lake.

The report includes a summary of the history of water level manipulation on Lake Manitoba since 1961, and the various negative effects that have resulted. Some of the effects listed include deteriorating water quality, degradation of surrounding marshes, loss and destruction of wildlife habitat, flooding and salinity problems in surrounding agricultural lands, erosion of beaches, reductions in commercial fisheries, introduction of exotic fish species, and effects on recreation and tourism. The report includes a brief physical description of Lake Manitoba that describes area, hydrology, historical water levels, and fish and wildlife usage.

General conclusion of the report include that there is a common agreement among people concerned with Lake Manitoba, that the lake and water bodies in the surrounding watershed are in a state of decline, with deteriorating shorelines, beaches, marshes, and water quality. There is a common vision that the levels of the lake should be allowed to fluctuate on a more seasonal and annual basis than currently allowed under the rules of operation for the Fairford Dam. The government also needs to act to resolve other negative effects caused by the Assiniboine River Diversion, and runoff from agricultural land and sewage outflows. The report also stresses that more information need to be gathered on trends in water quality, fish and wildlife populations, hay production, soil salinity, silt loading and pollution from adjoining river and streams, and activities of carp that impact lakeside marshes.

Location: Delta Waterfowl Research Station, David Winton Bell Memorial Library

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Cowan, W. and M. Matheson. 1973. A Preliminary Investigation of Lake Manitoba as a Wildlife Resource. In Cowan, W. Preliminary Investigation of the Impact of Lake Manitoba Water Regulation Patterns on Wildlife and Wildlife Habitat. An Interim Report to the Manitoba Department of Mines, Resources, and Environmental Management Wildlife Program. Canadian Wildlife Service. 32 pp.

An interim assessment of the waterfowl requirements for Lake Manitoba, Lake St. Martin, and Pineimuta Marsh under Lake regulation. The report briefly discusses the importance of these water bodies for wildlife habitat. Also included are a discussion of historical water levels in Lake Manitoba before and after the lake regulation by the Fairford Dam in 1961, and the acreage and location of marsh habitat around Lake Manitoba, Lake St. Martin and Pineimuta Marsh. The report concludes that a correct assessment of Lake Manitoba capabilities for wildlife is not possible due to a lack of information on the dynamics of the water bodies, waterfowl populations, and an accurate assessment of the lake regimes most beneficial to waterfowl and waterfowl habitat, and the author recommends a minimum of five years of research is necessary before an exact assessment can be finalized.

Location: Manitoba Conservation and Environment Library, Call No. TC 426.5 M3 P74 1973

Cowan, W., P. Winslow and R. Johns. 1973. Preliminary Investigation of the Ecological Effects of the Proposed Lowering of Lake Manitoba level. In Cowan, W. Preliminary Investigation of the Impact of Lake Manitoba Water Regulation Patterns on Wildlife and Wildlife Habitat. An Interim Report to the Manitoba Department of Mines, Resources, and Environmental Management Wildlife Program. Canadian Wildlife Service. 6 pp.

A study examining the possible physical effects the proposed regulation of Lake Manitoba at a new target level of 811.67 feet FSL (six inches below the current regulation level of 812.17) would have on Lake Manitoba and its bordering marshes, contracted by the Canadian Wildlife Service in regards to the recommendations of the preceding report to the Manitoba Water Commission (Cowan 1973a). The report gives general statements concerning the nature and extent of the possible effects the new regulation level would have on wetland habitat, wildlife species, and recreation and economic of Lake Manitoba. Some of the specific effects examined included: decreases in shoreline length and area; decreases in submersed macrophytes of marshes bordering Lake Manitoba; reduction in available cover for waterfowl; increases in the probability of botulism disease in waterfowl; and declines in the muskrat and waterfowl population. The author conclude that the proposed control of Lake Manitoba a lower target level of 811.67 feet FSL would be unsuitable for the welfare of wildlife on and around the lake, and associated recreational and economic values would decline. Recommendations included that Lake Manitoba should remain under the present regulation level, until studies can be conducted to identify and inventory wildlife and habitat effected by the current regulation status, and water regulation more suitable for wildlife can be determined, as the present regulation are deleterious to waterfowl and muskrat populations.

Location: Manitoba Conservation and Environment Library, Call No. TC 426.5 M3 P74 1973

Cram, H. R. 1926. Historical Summary of The Lake Manitoba Level Control Project and Related Problems. Canada Department of the Interior, Dominion Water Power and Reclamation Service. Ottawa, Ont. 13 pp.

A report summarizing studies conducted examining the various means of controlling water levels on Lake Manitoba from 1913 to 1926. Some of the surveys discussed in the report include those examining the power generation possibilities of the Fairford and Dauphin Rivers; construction of canal next to the Fairford River to increase the water outlet capacity of Lake Manitoba, in order to lower the lake; and power generation potential of the Waterhen River, at Meadow Portage. An overview of each survey is given in chronological order, along with excerpts of information contained in the report regarding physical and environmental features of the survey sites. A map is included showing the area of the flood in 1914 around Lake Manitoba.

Location: Manitoba Conservation and Environment Library, Storage Box WSC #10

Crowe, J. M. E. 1969. Lake St. Martin Water Quality tests in 1968. Manitoba Department of Mines and Natural Resources, Fisheries Branch, MS Report No. 68-14. 13 pp.

A summary report of water sampling conducted during February of 1968, at 20 sites in Lake St. Martin. Parameters examined included water depth, ice thickness, dissolved oxygen, pH, carbon dioxide, and alkalinity. Results from similar water quality monitoring studies conducted in 1962, 1963, 1964, 1966-1967, and 1968 in Lake St. Martin are also summarized, and dissolved oxygen concentrations from the 1966-1967 study are compared to the results of the 1968 study. These water quality studies on Lake Manitoba were prompted due to declines in water quality and commercial fishing success, reproductive failure of the whitefish and pickerel and decreased recreational use. The report recommends that higher discharge rates, of at least 100 c.f.s, through the Fairford Dam could to improve the water quality of the lake, and a control structure on the Dauphin River is the only feasible way to maintain St. Martin at a level of 800 feet. Also included in the report is a brief description of Lake St. Martin including its location, area, water depth, the major source of inflow water (Lake Manitoba via the Fairford River), and the main outlet (the Dauphin River to Lake Winnipeg).

Location: Manitoba Conservation and Environment Library, Call No. CA2 MMFB msr 68-14

Crowe, J. M. E. 1972a. Insecticides in Manitoba waters, sediment and fish, 1970. Manitoba Department of Mines, Natural Resources, and Environmental Management, Research Branch, MS Report No. 72-10. 33 pp.

During the summer of 1970, water, sediment, and fish samples were collected from 32 water bodies (lakes, rivers, reservoirs, and ponds) in southern Manitoba for insecticide analysis. The study sites were chosen to represent seven geological areas, various land uses, and insecticide intensities, to examine the geological variation of insecticide concentrations and correlate insecticide levels with land use. Lake St. Martin and Lake Manitoba were among the sample sites. The pesticides examined included Aldrin; Heptachlor epoxide; DEE; Dieldrin; o,p DDT; DDD and p,p DDT.

The survey indicated that in general insecticide levels were low in most fish species examined, and that the fish were the best indicators of the presence of insecticides. The majority of insecticide concentrations fell between 0.1 to 0.10 ppm. In the fish samples low levels (below accepted levels) of Aldrin, DEE, DDD, and p,p DDT were found in pickerel, pike, sucker, and/or tulibee from Lake Manitoba, and low levels (below acceptable levels) of Aldrin, Heptachlor epoxide, DDE, p,p DDT were found in pike from Lake St. Martin. None of the insecticides tested were found in the water or sediment samples from Lake Manitoba and Lake St. Martin.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MMR mr 72-10 1972

Crowe, J. M. E. 1972b. Lake Manitoba Water Quality, 1966 to 1969. Manitoba Department of Mines, Resources, and Environmental Management, Research Branch, MS Report No. 72-15, 21 pp.

In September of 1966, a water quality monitoring program was initiated in Lake Manitoba. The monitoring program was initiated to determine if a causeway and bridge at the Narrows of Lake Manitoba could restrict water flow in and out of the south basin of the lake, decreasing water quality by increasing the concentration of certain chemical components. Another reason for the survey was to determine if there was a difference in the water chemistry of the north and south basins, and if there were and seasonal variations in water chemistry. In September 1966, thirteen sampling sites were established in Lake Manitoba, the majority in the south basin. All thirteen of the sample sites were sampled monthly until February 1967, when the number of stations was reduced to seven. The seven remaining stations were sampled monthly until July 1969. Since 1966 chemical parameters examined included pH, magnesium, sodium, calcium, total hardness, alkalinity, bicarbonate, chloride, sulphate, specific conductance, and total dissolved solids, with phosphate added in December 1967, and boron in July 1968.

The study determined that the construction of the bridge at the Narrows in 1967 did not have any immediate adverse effects on water quality in the south basin. The author also compared the water chemistry results of the study to those found by of Bajkov (1930a) in similar sites in Lake Manitoba, and conclude that concentrations of chloride, magnesium, and sulphate have increased since 1930, and the lake is more eutrophic than previously recorded. The study also found a definite difference in the chemical composition of the north and south basin, and maximum concentrations of all chemical parameters examined where most frequently the highest during March and lowest during April.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library, Call No. Delta Gov Docs MAN MREM 53

Crowe, J. M. E. 1974a. The effect of the operation of the Portage Diversion on the south basin of Lake Manitoba. Manitoba Department of Mines, Resources, and Environmental Management, Research Branch, MS Report No. 74-20, 22 pp.

On April 25, and May 15 and 21, 1974 water samples collected north of the outlet of the Portage Diversion in Lake Manitoba, for analysis of suspended sediment content, particle size distribution, to assess the influence of the Portage Diversion on sediment loads and distribution into Lake Manitoba. Suspended solid concentrations were found to range from 530 to 690 mg/L on April 25, and decreased to a range of 25 to 60 mg/L on the two sampling days in May. From the study the total sediment load from the Portage Division in into Lake Manitoba, in 1974 during its 61-day operation period, was estimated to be approximately 813 909 tons, with 40 609 tons/day entering in April, 9600 tons/day in May, and 3662 tons/day in June. Settling of heavier particles occurred within one mile of the diversion outlet, whereas smaller particles, less than 2.48 μm , remained in suspension in the lake up to 2 $\frac{3}{4}$ miles from the outlet of the Portage Diversion, and probably remain in suspension for long periods of time due to wind and wave resuspension. The report recommends further studies examining and monitoring the sediment load of the Diversion and its dispersal in Lake Manitoba, and sediment core sampling around the outlet of the Diversion, at least one mile into the lake. The report includes figures illustrating the location of sampling sites in Lake Manitoba, and tables showing the usage and discharge of the Portage Diversion from 1970 to 1974, and the percent composition and particle size of suspended materials in the Assiniboine River, Portage Diversion, and south portion of Lake Manitoba.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Crowe, J. M. E. 1974b. Lake Manitoba – the Third Great Lake. Manitoba Department of Mines, Resources and Environment Management, Research Branch. Information Series No 5. 15 pp.

A description of Lake Manitoba, which includes information on location, surface area (4,680 km²), geology, depth, bottom sediment characteristics, hydrology, fisheries, water chemistry, and benthos organisms. Potential causes for the changes in the bottom sediment of the lake from a hard bottom to soft mud in certain areas are examined including farm drainage systems and the Portage Diversion. The major rivers that empty into the lake are also mentioned including the Waterhen River, Fairford River and Whitemud River. The results of the 1973 study undertaken by the Department of Mines, Resources and Environmental Management to examine water quality conditions in the lake at twenty-nine sampling sites are also discussed. Water quality parameters examined included temperature profiles, dissolved oxygen, pH, water clarity, concentrations of dissolved ions and total suspended solids. Sediment samples were also taken for analysis of percent silt, sand and clay; qualities of organic matter; and the presence, composition, and density of benthos organisms. Various pictures and graphs are included. Results of this study were compared to a study conducted on the lake in 1928 (Bajkov 1930a) to examine trends in the various parameters over the last 40 years. Results show that concentration of calcium, magnesium, chloride, sulphate, and total solids have increased in the lake since 1930. Predictions of future increases in the concentration of these elements are also estimated up to 2010. From the examination of the benthos it appears Lake Manitoba is the most productive and rich lake in Manitoba. The future of Lake Manitoba for fisheries production is also briefly examined based on the water quality results.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MNRE is 5

Curry, B. B. 1997. Paleochemistry of Lake Agassiz and Manitoba based on ostracodes. Canadian Journal of Earth Science 34: 699-708.

A study examining the post-glacial hydrochemical history of Lake Manitoba based on the analysis of ostracodes in a 14.5 m sediment core taken from the center of the south basin of Lake Manitoba. The paper discusses changes in water chemistry of Lake Manitoba during the post-glacial period, and the current water chemistry and hydrology of Lake Manitoba. Results from the study show that the salinity of Lake Manitoba has increased three orders of a magnitude over the last 11 000 years. Water in Lake Agassiz and early Lake Manitoba was fresh (TDS < 100 mg/L), cold (mean temperature 5°C) and deep (> 7 m). During the post-glacial period the water chemistry of Lake Manitoba has changed rapidly. Over the course of the Holocene Lake Manitoba has increased in salinity, except for the period from 4500 to 2000 B.P. when the Assiniboine River flowed into the south end of Lake Manitoba and diluted the waters. Early water composition in the Lake from 8000 to 1300 years B.P. was primarily controlled by groundwater flow, whereas since 1300 years B.P. lake water composition has been controlled by precipitation and overland flow. Water depths in the lake since 1300 years B.P. have been the greatest they have been since the earliest days of Lake Manitoba.

Location: University of Manitoba, Science and Technology Library, Call No. 550 C16 Ea

De Geus, P. M. J. 1987. Vegetation Changes in the Delta Marsh, Manitoba Between 1948-80. MSc Thesis, University of Manitoba, Winnipeg, Manitoba. 97 pp.

A study examining the vegetation changes in Delta Marsh before and after the water level regulation of Lake Manitoba in 1961, which reduced the water level of Lake Manitoba from a range more than 2.2 m to 0.6 m. The study examines vegetation in the marsh during the period from 1948 to 1980, through the examination of aerial photographs (taken in 1948, 1954, 1964, 1972, and 1980) and ground truthing. A general description of Delta Marsh is given which includes location, size, climate, geology, soils, hydrology and vegetation composition. The paper includes a discussion on the importance of drawdown and flooding in the diversity and succession of aquatic macrophytes. The influence of Lake Manitoba on the water levels and vegetation dynamics in the marsh are discussed, as well as the effects of the stabilization of water levels on Lake Manitoba since 1961, on the marsh.

The study found that before the regulation of Lake Manitoba the marsh shorelines were dominated by *Phragmites*, and after regulation there was a change in dominance to *Typha*, probably the hybrid *T. glauca*. The study suggests that with continued stable water levels *Typha* will continue to expand in its range and dominance, and with without occasional flooding and drawdown this expansion may cause vegetation infilling of the marsh. The paper also contains graphs illustrating the mean monthly water levels in Lake Manitoba from 1948 to 1980, and several graphs illustrating relationships between water levels and vegetation composition of the marsh and changes from 1948 to 1980.

Location: University of Manitoba, Elizabeth Dafoe Library, 3rd floor, Thesis D3625

den Haan, H. E. (unpublished). Delta Marsh: A Bibliography of Studies Conducted from 1918 Through to the Present. No pagination.

A bibliography summarizing publications that have resulted from chemical, biological, and physical studies at Delta Marsh from the period from 1918 and 2001. Some studies conducted in Lake Manitoba are also included in the bibliography.

Location: in preparation

Delisle, D. 1977. Lake Manitoba Regulation Research 1976/77. Manitoba Department of Agriculture.

A copy of the report could not be obtained for examination. The copy located at the Manitoba Conservation and Environment Library was missing during the compilation of this bibliography.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 Mar 215

Denmark, D. E. 1931. Report of Dauphin River Power Supply: Reconnaissance of Power Site Between Lake St. Martin and Sturgeon Bay, Lake Winnipeg, and Partial Subdivision of Township 33, Range 5, West of the Principal Meridian. Manitoba Department of Mines and Natural Resources. Winnipeg, MB.

A report on a reconnaissance survey of the Dauphin Power Site between Lake St. Martin and Sturgeon Bay, Lake Winnipeg, during July to October 1931. The report gives a general description of Lake St. Martin, and the land between Lake St. Martin and Lake Winnipeg. According to the report Lake St. Martin varies in depth from one to six feet, and it has a boulder bottom and low swampy shores. Almost the entire land area between the Lake St. Martin and Lake Winnipeg is covered by swamp and marsh, and the forest cover is mostly black spruces and tamarack.

Location: Provincial Archives of Manitoba, Call No. GR 1605 G830

Derksen, A. J. 1970. Report on Mercury Contamination in Fish from Waters of the Hudson Bay Drainage System Connected With Manitoba. Manitoba Department of Mines and Natural Resources. Winnipeg, MB.

A summary of mercury analysis conducted in various water bodies of the Hudson Bay Drainage System in Manitoba during the period from 1969 to 1970. Some of the water bodies in south Manitoba sampled included Lake Manitoba, Assiniboine River, Lake Winnipegosis, Lake St. Martin, Waterhen Lake, Lake Winnipeg, Saskatchewan River, Red River and Winnipeg River. Fish species sampled included pike, sauger, walleye, perch, suckers, carp, and whitefish. Samples from the Assiniboine River showed contamination of fish with mercury. A sample of a sauger taken from the Assiniboine River near Portage la Prairie had mercury levels of 1.69 ppm. The range of levels for the Assiniboine River was 0.29 to 1.69 ppm for all fish species examined. Mercury in the river may be coming from the Clor-Alkali plant at Brandon. One pike sampled from Lake

Manitoba also showed high levels of mercury concentrations (0.94 ppm), while levels in other fish species in the lake were low (range of 0.03 to 0.19). Samples of several fish species taken from Lake St. Martin showed levels in the range of 0.07 to 0.23 ppm, and samples from Waterhen Lake were in the range of 0.15 to 0.33 ppm, and samples of several fish species from Lake Winnipegosis range from 0.02 to 0.22 ppm.

Location: Manitoba Conservation and Environment Library, Call No. QH 545 A2M4 D4R4 1970

Derksen, A. J. 1971. Summary Report on Mercury Contamination in Fish from Manitoba Waters. Manitoba Department of Mines and Natural Resources. Winnipeg, MB.

A report on mercury contamination in fish from the major drainage river systems in Manitoba: the Saskatchewan, Churchill, Nelson, Hayes, Winnipeg, Red and Assiniboine Rivers. Fish with mercury contamination levels of 0.5 ppm or more cannot be sold or marketed. The Assiniboine River is among the sites examined, and samples were taken from the river during 1970. Results showed abnormal amounts of mercury in the river. Most samples of pike contained concentration of mercury less than 0.5 ppm, most samples of walleye and sauger contained concentrations above 0.5 ppm. The highest levels of mercury found in fish from the river were found in sauger caught near Portage la Prairie that contained concentrations around 1.69 ppm. Overall along the stretch of the river mercury concentrations in all fish species sampled ranged from 0.16 to 1.69 ppm. Sucker caught upstream of Brandon appeared to not contain mercury, whereas samples below Brandon did. Other lakes sampled included Lakes Manitoba, Winnipegosis, St. Martin and Waterhen. Mercury levels in Lake Manitoba ranged from 0.03 to 0.94 ppm, and those from Waterhen Lake, Lake Winnipegosis, and Lake St. Martin ranged from 0.15 to 0.20 ppm, 0.02 to 0.07 ppm, and 0.07 to 0.23 ppm, respectively. The highest mercury levels in Lake Manitoba were found in a northern pike (0.94 ppm), which was quite a bit higher than the next highest concentration found in fish of 0.19 ppm. See Derksen (1973, 1978a, and 1978b, and 1979) for other reports on mercury contamination in various water bodies throughout Manitoba.

Location: Manitoba Conservation and Environment Library, Call No. QH 545 A2M4 D4S9 1971

Derksen, A. J. 1973. Mercury Monitoring of fishes and water from the Assiniboine Drainage System in Manitoba, 1970-1972. Manitoba Department of Mines, Resources and Environmental Management, Research Branch MS Report no. 73-31. Winnipeg, MB. 49 pp.

A report on fishing sampling conducted in 1970, 1971 and 1972 in the Assiniboine, Minnedosa and Souris rivers for analysis of mercury contamination. Analysis of axial muscle from the fish sampled revealed high levels of mercury. The highest mercury level (1.69 ppm) in 1970 was found in a sauger caught in the Assiniboine River near Portage la Prairie, and similarly in 1971 and 1972 the highest levels (1.33 and 1.71 ppm) were recorded from a sauger in the Treesbank area. Concentrations exceeding 1.00 ppm were also observed in northern pike, walleye, rock bass, and white sucker. Mercury levels in crayfish from the Assiniboine River were also examined and levels ranged from 0.14 to 0.25 ppm, with a mean of 0.20 ppm. Mercury analysis was also conducted on water samples from the Assiniboine River from 1970 to 1972, and results indicated that concentrations were highest in the spring. These elevated spring levels appear to be related to high spring water levels in the river and resultant high suspended sediment loads. Average concentrations in the water were less than 0.3 ppb. Mercury levels observed in pike from the Assiniboine River and Souris River were similar to concentrations found in Pike from the Assiniboine Diversion. This suggests the diversion may be transporting mercury-contaminated water from the Assiniboine River into Lake Manitoba. The author recommends further studies examining of the potential effects of the Assiniboine Diversion on Lake Manitoba, and more mercury monitoring in Lake Manitoba. See Derksen (1971, 1978a, 1978b, and 1979) for other reports on mercury contamination in various water bodies throughout Manitoba.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MMR MR 73-32
1973

Derksen, A. J. 1978a. A Report on Preliminary Studies into Mercury Contamination in Red-Assiniboine River Basin in Manitoba, 1970. Manitoba Department of Renewable Resources and Transportation Services. Research MS Report No. 78-11. 77 pp.

During 1970, samples of water, soils, industrial and sewage effluent, fish, aquatic invertebrates and wildlife from the Red River and Assiniboine rivers, and other water bodies in the Red-Assiniboine River Drainage Basin were examined for mercury contamination. Seventy-nine water samples were collected at 18 locations along the Assiniboine River, and 21 of these samples exceeded the lower limit of detection for mercury (0.0005 ppm). Mercury levels in water samples taken from sites near Portage la Prairie and above the Assiniboine River Diversion Dam were both below the lower level of detection. Elevated levels, equal to or above 0.5 ppm were found in walleye, sauger, and sucker fish species from Assiniboine River from the Shellmouth Dam downstream to Portage la Prairie. One possible source of mercury contaminated along the Assiniboine River noted in the study is the Chlor-alkali plant in Portage la Prairie. See Derksen (1971, 1973, 1978b, and 1979) for other reports on mercury contamination in various water bodies throughout Manitoba.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MRRB mrs 78-11 1978

Derksen, A. J. 1978b. A Report on the Preliminary testing of mercury contamination in fisheries from the Hudson Bay Drainage System Connected with Manitoba. Manitoba Department of Renewable Resources and Transportation Service. Research MS Report 78-70. Winnipeg, MB. 40 pp.

A preliminary report on tests conducted on fish from the Hudson Bay drainage system from December to August 1970 for mercury contamination. Some of the water bodies examined include the Assiniboine River, Lake Manitoba, Lake St. Martin, Waterhen Lake and Lake Winnipegosis. Results from the Assiniboine River showed mercury level in the river ranging from 0.16 to 1.69 ppm. The highest concentration (1.69 ppm) was measured in a sauger from the river near Portage la Prairie. Concentrations in Lake Manitoba ranged from 0.03 ppm to 0.94 ppm. Levels in lakes St Martin, Waterhen, and Winnipeg ranged from 0.07 to 0.23 ppm, 0.15 to 0.33 ppm, 0.02 to 0.33 ppm, respectively. Other major water bodies examined in southern Manitoba include Lake Winnipeg, Saskatchewan River, Winnipeg River and Red River. See Derksen (1971, 1973, 1978b, and 1979) for other reports on mercury contamination in various water bodies throughout Manitoba.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MNA ms 78-70
1978

Derksen, A. J. 1978c. A Review of Possible Natural Sources of Mercury Contamination in Manitoba Waters. Manitoba Department of Renewable Resources and Transportation Service. Research MS Report 78-71. Winnipeg, MB. 71 pp.

An investigation of mercury contamination in fish from water bodies throughout Manitoba, and possible natural and anthropogenic sources for the contamination. Mercury levels were examined in the Lake Manitoba, along with some of its adjoining water bodies such as Lake St. Martin, Waterhen Lake and Lake Winnipegosis. Results of mercury testing conducted in these water bodies from 1970 to 1974 are presented in tabular form. Concentrations of mercury between 0.50 and 1.00 ppm are common on the Assiniboine River, and some fish have been caught with concentrations great than 1.00 ppm. Possible sources of mercury contamination to the Assiniboine River include the cities of Brandon and Portage la Prairie, the surrounding agricultural lands, and naturally occurring geology around the river. Possible sources of Mercury to lakes Manitoba, St. Martin and Waterhen include the movement of contaminated fish from the Assiniboine River and Lake Winnipeg, and

possibly from shale deposits in the area. There seems to be a striking correlation between major fault zones in the Precambrian area and areas in which a relatively large amount of mercury contamination occurs in lakes. Other major water bodies in southern Manitoba examined in the report include the Saskatchewan River, Winnipeg River, Lake Winnipeg and Red River. See Derksen (1971, 1973, 1978a, 1978b, and 1979) for other reports on mercury contamination in various water bodies throughout Manitoba.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MNA ms 78-70 1978

Derksen, A. J. 1978d. Utilization of the Big Grass Marsh area by fish populations and proposal for fisheries enhancement. Manitoba Department of Mines, Natural Resources and Environment, Fisheries Management Branch, MS Report 78-77, Winnipeg, MB.

The 1978 study examines the importance of Big Grass Marsh and the Whitemud River to fish populations in southern portion of Lake Manitoba. Various development projects for Big Grass Marsh are also discussed including the feasibility of developing Big Grass Marsh as a storage basin for spring flood water from the Whitemud Watershed, and various proposals for developing Big Grass Marsh for wildlife purposes (i.e. waterfowl, muskrat and fish populations). The report includes a physical description of the Whitemud River and Big Grass Marsh, which includes area, location, geology, soils and land use. The report also describes the condition of the commercial fishery on Lake Manitoba since 1915, examining possible reasons for fluctuations in various fish species over the years.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MRRB msr 78-77 1978

Derksen, A. J. 1979. A Summary of mercury contamination in fishes from Manitoba waters to March, 1971. Manitoba. Department of Mines, Natural Resources and Environment, Research Report No. 79-55. Winnipeg, MB. 43 pp.

A study summarizing mercury analysis conducted on fish from water bodies in Manitoba, between December 1969 and March 1971. Lake Manitoba was among the water bodies examined, along with some of its adjoining water bodies including the Assiniboine River, Lake St. Martin, Waterhen Lake and Lake Winnipegosis. Abnormal elevated levels of mercury were found in the Assiniboine River. The highest concentration of mercury found in the river was in a sauger caught near Portage la Prairie (1.69 ppm). Concentrations in Lake Manitoba ranged from 0.03 ppm to 0.94 ppm. Levels in Lakes St Martin, Waterhen, and Winnipeg ranged from 0.07 to 0.23 ppm, 0.15 to 0.33 ppm, 0.02 to 0.33 ppm, respectively. Some of the other major drainage systems examined in the report include the Saskatchewan, Churchill, Nelson, Hayes, Winnipeg, Red River, and their adjoining water bodies. See Derksen (1971, 1973, 1978a, 1978b, and 1978c) for earlier reports on mercury contamination in various water bodies throughout Manitoba.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MRRB msr 79-55 1979

Derksen, A. J. 1988. An evaluation of the Fairford Dam fishway, May-June, 1987, with observation on fish movement and sport fishing in the Fairford River. Manitoba Natural Resources. Fisheries Manuscript Report No. 88-6. Winnipeg, MB. 55 pp.

An evaluation of the Fairford Dam fishway, conducted in 1987. The Fairford Dam, located at the outlet of Lake Manitoba, was completed in 1961 and was constructed to maintain water levels in Lake Manitoba between 247.19 m and 247.80 m. When the Fairford Dam was constructed a fishway was incorporated into Bay 9, consisting of two concrete weirs; however there was no evidence to indicate if the fishway was effective in passing fish upstream from the Fairford River to Lake Manitoba. As early as 1963, commercial fisherman on Lake Manitoba and Winnipegosis expressed concern that fish are leaving the lakes via the Fairford River and

could not return because of the Fairford Dam. Construction of a new Denil-type fishway and flume on the Dam was completed in the 1983/84 winter season. Previous preliminary assessments of the new fishway were conducted between April 19 and May 30, and October 3 to 25, 1984, and from April 15 to 21, 1985. These assessments were sporadic, but indicated suckers and walleye did use the fishway. The current assessment took place during May 6 to 28 and June 2 to 12, 1987. The objective of the assessment was to determine which fish species use the fishway, and determine the extent to which fish species are successful in using the fishway (i.e. the size range of fish that can use the fishway). The study found that the fishway was effective in passing most species and sizes of fish found in the Fairford River, from the river to Lake Manitoba. However high and low flows in the Fairford River, below the dam, may result in fewer fish using the fishway. The majority (93%) of fish species that used the fishway were white sucker, walleye, and sauger. The largest fish to pass through the fishway were carp; some fish exceeded 750 mm in length and 10 kg in weight.

The author also points out that there are number of question this study was not able to answer, including the use of the fishway during spring spawning periods and the fall, the influence of varying flow pattern in the Fairford River on fish movement downstream of the dam, and the significance of the fishway to all fish stocks in the area. The report strongly recommends further assessment of the Fairford fishway.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MNR ms 88-6

Dillon, M. M. Ltd., Consulting Engineers. 1966. Engineering Feasibility Study for Delta Marsh Development Project covering Delta, Clandeboye Bay and Lake Francis Areas, Lake Manitoba. Province of Manitoba, Department of Agriculture and Conservation, Water Control and Conservation Branch. 71 pp.

An engineering study conducted in 1966, to determine the feasibility of developing Delta Marsh for waterfowl management purposes. The report evaluated natural and artificial ways of manipulating water in Delta Marsh to better manage waterfowl and wildlife populations by controlling water level fluctuation in the marsh, diminishing the danger of extreme highs and lows. Possible available water supply sources, control structures, roadways, dykes, channel, surface drainage facilities, and land requirements, were examined to determine the most economically and biologically feasible methods of managing water levels in the marsh. For the report the marsh, designated the Delta Waterfowl Control area, was divided into three areas, each having different drainage, topography, geology and other natural features: the West Marsh District, the East Marsh District, and the Lake Francis District.

For the report all available information on the marsh was reviewed, and a site reconnaissance was carried out between September and October 1965, to view topographic features and water control structures, and collect soil samples at select sites throughout the marsh. Also included in the report is a discussion of background information regarding the marsh including, wildlife production and harvests, soils conditions, topography, hydrology, the connection and influence of Lake Manitoba water levels on the marsh, and land use surrounding the marsh.

The report concluded that average annual surface runoff into the marsh and wind setup from Lake Manitoba were not dependable and sufficient sources to provide necessary water requirements for the proposed management of the marsh. The Portage Diversion, which was under construction at the time of the study, was found to be the most dependable and economically feasible water source for the development. The proposed development would consist of subdividing the marsh into a number of different cells, each having independent water level manipulation. This would be accomplished primarily with earth dikes, canals, drainage ditches and several water control structures.

Location: Manitoba Conservation and Environment Library, Call No. TC 426.5 M3L3 D4 1966

Doan, K. H. 1961. Experimental Fishing at Dauphin River, Lake Winnipeg, September, 1961. Department of Mines and Natural Resources, Fisheries Branch. 5 pp.

A brief report discussing experimental fishing conducted on the Dauphin River in September 1961. The experimental fishing study including recording trap-net catches, weighing fish caught, observation of catches of an otter trawler, and tagging of pickerel. Trap-net catches included pickerel, whitefish, sauger, pike, maria, suckers, perch, tullibee, and sheepshead. A total of 62 pickerel were tagged from those caught in the trap-nets near Clark's Harbour, and 433 pickerel from those caught near Hay Point. The only recaptures were seven pickerel at Hay Point, which were recaptured two days after they were tagged at Hay Point.

Location: Manitoba Conservation and Environment Library, Call No. GT 5904.5 C2 D63 1961

Doan, K. H. and R. R. Andrews 1964a. Experimental Trawling in Lake Manitoba in October 1964. Manitoba Department of Mines and Natural Resources, Fisheries Branch. 14 pp.

During October of 1964, experiment trawling with an otter trawl was conducted in the south basin of Lake Manitoba to evaluate trawling as a new method of predicting the fish stocks in Lake Manitoba. Other methods previous used to predict fish stocks are also discussed, including gill nets with several different mesh sizes. The report concludes that trawling with an otter trawl offers greater mobility and speed in fish sampling at several locations compared with sampling with gill nets, and recommends a more extensive program for trawling should be developed in order to further define its value for commercial gill net fish catch prediction.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MMFB msr doa 3 1964.

Doan, K. H. 1964b. Background material for a consideration of the carp problem in Delta Marsh, Manitoba. Manitoba Fisheries Branch, Winnipeg, MB.

A brief report examining the presence of carp in Delta Marsh, and their potential effects on the marsh as of 1964. The purpose of the report was to determine if carp propose a threat the biological heath of Delta Marsh and Lake Manitoba, and as a result the feasibility of possible measures to control the presence of carp in the marsh and the lake. A chronological list of reports published by the Manitoba Fisheries Branch, which contains information on carp in Manitoba during the period 1938 to 1963, is given. Several features of carp are discussed including habitat, spawning, food, growth, and measures for the control of carp. A brief description of the historical and current usage of the marsh by fish from Lake Manitoba is also given. Some of the effects of carp on the marsh discussed include increased water turbidity, reduced light penetration in the water, and reduced aquatic vegetation growth. The report also includes excerpts from a few studies that had been previously conducted in other water bodies examining the effects of carp on water quality, vegetation, wildlife, waterfowl, and other fish species. General conclusions of the report are that the benefits of controlling of carp in Delta Marsh are not great enough to outweigh the costs, and that as of the date of the report the damage of carp to the fishery of the marsh and Lake Manitoba is entirely conjectural, and as a results future studies are needed.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Doan, K. H. 1971. An Estimate of the Effects of a six-inch Reduction in the Operating Range of the Water Level of Lake Manitoba upon Fisheries Resources. 4 pp.

A brief report examining the effects of lowering the target range of Lake Manitoba water levels by six inches on the fisheries resources of the Lake. The report gives brief an overview of the commercial, sport and domestic fisheries in Lake Manitoba. The effects of lowering the target water level range of lake includes reduced

spawning, rearing, and foraging marsh habitat for fish species; aggravation of winter kills; and a reduced opportunity for fisherman in shallow rocky shore areas. The increased infilling and siltation of the lake bottom from silt-rich runoff from agricultural lands changing the lake bottom from a 'hard' bottom to 'soft' bottom is also discussed, along with fish 'death waves' of low oxygen and red algae. A quantitative estimate of the economic monetary implications of lowering the water level of the lake is also given, which is estimated at annual average loss of \$33 000 in fish production from Lake Manitoba.

Location: Manitoba Conservation and Environment Library, Call No. SF 84.64 C2 W43 1971

Dominion Ecological Engineering Ltd. 1991. The Red-Assiniboine River Basin initiative planning workshop report: workshop held April 22-24, Winnipeg, MB. Environment Canada, Winnipeg, MB.

A draft summary of the deliberation of the Red-Assiniboine Basin Planning Workshop sponsored by Environment Canada and held from April 22-24, 1991 in Winnipeg, Manitoba. The workshop was set-up to examine the water use and soil conservation in the Red-Assiniboine River basin, and examine the potential of developing an ecosystem approach to water management. The objectives of the workshop were to identify water issues or problems, threats to aquatic resources, management question that need to be answered and hypothesis that need to be tested, and water resources opportunities in the basin, development of a preliminary proposal for projects in the basin and draft a conceptual study model. The report contains: background information for the workshop and the proposed Red-Assiniboine River Basin Management Study; the finding of working groups on issues related to hydrology, land and water use, water quality, communications, and policy; and the results and recommendations of the workshop.

Location: Manitoba Conservation and Environment Library, Call No. TD 227 M3 R43 1991

Ducks Unlimited Canada. 1969. Brief to the Manitoba Water Resources Commission Concerning the Maintenance of Water Levels of Lake Manitoba, Presented at Portage la Prairie June 2, 1969. Ducks Unlimited Canada, Winnipeg, MB. 13 pp.

A brief by Ducks Unlimited Canada to the Manitoba Water Commission concerning the possible effects of changes in the regulation of water levels in Lake Manitoba on marsh areas surrounding the lake. The report concludes that a waterfowl range of 812.0 to 814 feet ASL would be better for waterfowl, but a range of 811.0 to 813.0 feet ASL would be a reasonable compromise. However, the lowering of Lake Manitoba to a mean long-term elevation of 811.6 will significantly reduce the area of marshes for waterfowl. Various other uses of Lake Manitoba and the surrounding watershed including agricultural, fisheries, and recreation are also briefly discussed, including and how various lake regulation levels would affect these uses. Some of the best waterfowl marshes that surround Lake Manitoba are listed along with their area. Effects of lowering water levels on the marsh habitat include increases in growth of emergent vegetation and reductions in open water areas, which would cause the reduction of waterfowl habitat and waterfowl hunting around the lake, and result in economic implications for the area.

Location: Ducks Unlimited Canada, Institute for Wetlands and Waterfowl Research Library, Call No. DUC (Library no. 1293)

Ducks Unlimited Canada. 1973. Brief to the Manitoba Water Commission Concerning the Regulation of Lake Manitoba. Ducks Unlimited Canada, Winnipeg, MB. 13pp.

A brief to the Manitoba Water Commission from Ducks Unlimited concerning the effects of lowering of the regulation target water level for Lake Manitoba on marsh habitat around the lake. Lowering the target water level six inches from 812.17 to 811.67 feet ASL would cause deterioration in the size and quality of marsh habitat present around the lake, and have negative implications on waterfowl and muskrat populations, fisheries, and recreation in and around these marshes. The report concludes that there is no justification for lowering the target level of the lake.

Location: Ducks Unlimited Canada, Institute for Wetlands and Waterfowl Research Library, Call No. DUC (Library no. 1286)

Ducks Unlimited Canada. 1978. Pineimuta Marsh Brief to Manitoba Water Commission. Presented by Ducks Unlimited Canada at Gypsumville April 1978. Ducks Unlimited Canada. Winnipeg, MB. 12 pp.

A brief presented to the Manitoba Water Commission by Ducks Unlimited at public meeting held in Gypsumville, Manitoba in April 1978, concerning the effects of Lake Manitoba water level regulation on waterfowl and muskrat productivity in Pineimuta Marsh. A general description of Pineimuta Marsh is given, which includes location, area, topography, soils, geology and dominant emergent vegetation. The report discusses the value of the marsh as habitat for muskrat and waterfowl, and overall productivity of muskrat and waterfowl in the marsh. From surveys conducted in 1974 and 1975, it appears that frequent and severe water level fluctuations in the marsh are severely limiting the areas potential to produce waterfowl and muskrat populations. The water levels fluctuations are severe due to the regulation of water levels in Lake Manitoba via the Fairford Dam. The severe water level fluctuations can and have flooded the marsh during critical nesting and brood rearing seasonings for waterfowl. In the case muskrat flooding has also occurred during May and June when young are born and remain in the dens, which become flooded and the young drowned. Extreme water level fluctuations also occur in the fall, flooding muskrat from their homes. To improve waterfowl and muskrat production in the marsh the report recommendations better operating regimes for the Fairford Dam (less extreme water level changes), and the isolation of the marsh from the Fairford River with dykes and control structures to regulated the flow the waters from the river into the marsh, thereby reducing the effects of the rivers water level fluctuations on the marsh. A hydrograph of water levels on Pineimuta Lake from 1921 to 1973 is included.

Location: Ducks Unlimited Canada, Institute for Wetlands and Waterfowl Research Library, Call No. DUC (Library no. 1775)

Ducks Unlimited Canada. 1981. Delta Marsh Development Proposal. Ducks Unlimited Canada, Winnipeg, MB. 86 pp.

A report examining the development of Delta Marsh, located on the south shore of Lake Manitoba, to restore the deteriorating marsh for wildlife management. The marsh is divided into five units for the development proposal: West Marsh, School Bay Unit, East Unit, Sioux Pass, and Lake Francis. The report examines the effects Lake Manitoba water level stabilization has had on the marsh by reducing the cyclic variation of water levels need in the marsh for a health productive system. Generally, the development proposal will stimulate and restore natural wet/dry cycles in the marsh, through periodic drawdowns in the marsh once every 7 to 10 years, and periodic high water levels. A physical description of Delta Marsh is also given which includes geology, soils, size, water levels, vegetation, and waterfowl, fish and wildlife usage. Negative effects on wildlife production in the marsh are discussed and include primarily stable water levels, agricultural encroachment, and carp introduction. Benefits of the development project include restoring the productivity and diversity of the marsh, increased waterfowl and muskrat populations, the enhancement of the Lake Manitoba fishery, and benefits to agriculture surrounding the marsh. Figures are included illustrating the location of the marsh and the layout of the development plan, and hydrographs of historical Lake Manitoba water levels.

Location: Ducks Unlimited Canada, Institute for Wetlands and Waterfowl Research Library, Call No. DUC (Library no. 1108)

Ducks Unlimited Canada. 1986. Manitoba Major Marsh Status. Ducks Unlimited Canada, Manitoba Office, Winnipeg, MB.

A summary of existing information on thirteen of Manitoba's most important waterfowl marshes. Some of the marshes discussed in the report that are located in the Lake Manitoba watershed include: Turtle River Marsh, Prime Lake, Pineimuta Lake, Big Grass Marsh, Big Point, and Delta Marsh. The report includes physical and biological aspects of the marshes, and historical aspects related to human impacts and development proposals. Physical features discussed include: location, biome type, size, hydrology, soils and inlet and outlets. Historical information includes uses of the marshes, and previous and proposed developments. Biological information includes waterfowl species and other wildlife usage, and vegetation characteristics.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Dunn, C. E. 1915. Report on Lowering Lake Manitoba, Season 1914. Water Resources Branch, Ottawa, Ont. 31 pp.

The 1914 report examining various methods for lowering the water level of Lake Manitoba. The report includes a discussion of previous surveys that were conducted at the head of the Fairford River in 1880, 1894 and 1897. Plans following the survey in 1897 called for the construction of a canal 200 feet wide and 1300 feet long on the south side of the Fairford River, between the lake and the river, to widen the outlet from the lake. Construction of this canal was completed in 1904, however it was unsuccessful in providing flood relief. Further surveys were made from 1913 to 1914 examining further enlargement of the outlet or a new outlet (via the Assiniboine River, Dog Lake to Lake St. Lake and the Fairford River).

The report also examines the feasibility two schemes developed by the Department of public works in 1914 to lower Lake Manitoba; the construction of canal 120 feet wide or 300 feet wide along the north side of the Fairford River. The smaller channel would be expected to lower the lake by about one foot, and the larger one would lower the lake by about two feet. The report includes figures illustrating the proposed canals near the Fairford River. A discussion of interests opposed to and in favor of the lowering of Lake Manitoba are also discussed. Interests opposed to the lowering of Lake Manitoba include navigation, power development, fisheries, and recreation and summer resorts, whereas agriculture is for the lowering of the lake. Measurement of water levels and discharge velocities on the Fairford River from 1912 to 1914 are included.

Location: National Library of Canada, Call No. RG 89 V 565 File 605 (Report No. 605)

Location: Manitoba Conservation and Environment Library, Call No. Storage box WSC #10

Edwards, G. A. and W. N. Howard. 1980. Little Waterhen River fish movement and walleye tagging study, 1971-72. Manitoba Department of Natural Resources. MS Report No. 80-8. 53 pp.

A summary of a fish tagging study conducted on the Little Waterhen River from June 1971 to June 1972. The dominant species caught included suckers (*Catostomus* sp.), burbot (*Lota lota*), walleye (*Stizostedion vitreum*) and northern pike (*Esox lucius*). The report discusses the movement of each species observed. Seasonal fish movements during the study were predominately downstream, and most fish movements were associated with spawning activity. However, ice breakups prevented trapping during the prime fish-spawning period of April 11 to May 4, 1972, so these results could be bias by missed upstream runs.

During the study 5,349 walleye were caught, 1,394 moving upstream and 3,955 downstream. Of these 1,327 were tagged from upstream traps and 3,653 from downstream traps. A total of 4,980 fish were tagged. Of the walleye tagged, 1,808 (36%) were recovered during 1971 and 1976. Over 95 percent (1,487) of the walleye that were recaptured were caught close to the original tagging site in Waterhen Lake and the Waterhen River, and 189 were recaptured on Lake Manitoba, and 132 on Lake Winnipegosis. The Waterhen Rivers system appears to be a prime spawning area for Lake Manitoba walleye, whereas few walleye from Lake Winnipegosis spawn in the Waterhen River. Far more of the walleye that were tagged were recaptured in Lake Manitoba than Lake Winnipegosis.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MRRB mrs 80-8

Hobbs, E. E. and Associates Ltd. 1992. The Destructive Impacts of Lake Manitoba Regulation on the Fairford Saulteaux Volume 1: “It Has Cost Us Our Lives” Years of Government Indifference and Neglect. E.E. Hobbs and Associates Ltd. Winnipeg, MB. 56 pp.

A report examining the effects of regulation of water levels in Lake Manitoba via the Fairford Dam, since 1961, on the Fairford Indian Reserve and other communities, as well as natural resources and biota downstream of the dam. The regulation of Lake Manitoba has resulted in extreme water level fluctuations downstream of the dam, resulting in extreme drought conditions during most low water years, and extreme flooding during most high water years. The report discusses how these extreme water fluctuations and other related effects of the Fairford have effects the Native communities and natural resources downstream of the Fairford including effects on agricultural and recreational lands; the fisheries of Lake St. Martin, Fairford River, and Dauphin River; flooding and damaged to waterfowl and muskrat marsh habitat; and deterioration in water quality. Prior to the construction of the Fairford Dam the community of Fairford was self-supporting with excellent agriculture, trapping, hunting, and fishing in the area. The extreme water level fluctuations downstream of the dam have caused damage and losses to agriculture, trapping, fishing and domestic food harvesting. The report includes an overview of the history of Lake Manitoba regulation from 1890 to 1992, along with a time line of downstream effects resulting of the regulation of the lake. Graphs are included illustrating mean monthly flows and levels in the Fairford River and Lake St. Martin, prior to and following the regulation of Lake Manitoba.

There are also four volumes (two to five) of appendixes to the report. Volume two contain key documents and correspondence showing the role of the governments of Manitoba and Canada in the construction and operation of the Fairford Dam, and its impacts on the land, resources and life of the Fairford Saulteaux. Volume three lists all the correspondence, memoranda and notes gathered during the research examining the effect of the Fairford Dam on the Fairford Saulteaux. Volume four contains notes and interviews conducted with the people of Fairford Saulteaux, and current and past government officials. Volume five contains technical background information used in the assessment of damages that resulted from construction and operation of the Fairford Dam, including maps; population statistics; hydrological information for Lake Manitoba, Lake St. Martin, Lake Pineimuta, and Fairford River; and information on agriculture, fishing, trapping, and domestic foods (i.e. waterfowl) in and around Lake St. Martin.

Location: Hobbs and Associates Ltd.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library, Volume 1 only

Eilers, R. G. 1990. Soil Salinity – Manitoba. Canada – Manitoba Soil Inventory, Land Resources Research Centre, Research Branch, Agriculture Canada. Contribution Number 87-15. 9pp.

A map showing the salinity of soils throughout Manitoba in 1988. A booklet is including examining the features of the map.

Location: University of Manitoba, Science and Technology Library, Call No. S 133 A346 no. 5261B

Elkins, W. A, H. G. Anderson, E. L. Doeling, R. W. Sharp, L. K. Sowls and W. F. Newman. 1948. Report on the Fish and Wildlife Resources in Relation to the Manitoba Central Basin Project. Department of Mines and Natural Resources, Wildlife Management Institute, U.S. Fish and Wildlife Service. 144 pp.

A report discussing the proposed diversion of water from the Saskatchewan River into Cedar Lakes via lakes Winnipegosis, Waterhen, Manitoba and St. Martin. The water stored in these lakes would then enter Lake Winnipeg via a hydroelectric development on the mouth of the Dauphin River. The report examines the possible impacts of the project on the wildlife and fish resources of the region. Field studies for the report were conducted during May and August 1947. A general description of the Central Lake Region (extends northwest about 275 miles from Delta Marsh on the south shore of Lake Manitoba to the Pas on the Saskatchewan River) is given including topography, geology, soils, climate, hydrology and vegetation. A description of the major water bodies in the study area is also given including location and area, topography, drainage, shoreline characteristics, water levels, discharge in the case of the rivers, and basic water quality conditions. The water bodies discussed included the lower Saskatchewan River, Cedar Lake, Lake Winnipegosis, Waterhen Lake, Lake Manitoba and Lake St. Martin. The report discusses the proposed hydroelectric development in terms of the various dams and control structures that would be constructed on the water bodies in the study area, and their proposed operation.

The commercial and sport fisheries on lakes Cedar, Winnipegosis, Waterhen, Manitoba, and St. Martin, are examined and discussed in terms of commercial and sport catches, species composition, and value of the fishery. The effects of the proposed project on the fishery of each lake is examined in terms of effects on spawning, rearing and feeding areas; fish movement (spawning, migrations and emigrational movement); and the physical and chemical change to the water quality. The report also discusses waterfowl habitat and water usage of the major lakes in the study area, along with habitat and usage of fur animals (muskrat, mink, red squirrel, red fox, skunk, coyote, wolf, bobcat, badger, lynx, beaver and jack rabbit), big game (white-tailed deer, mule deer, moose, elk, woodland caribou, barren-ground caribou and black bear), and upland game (grouse, prairie chicken, dove, hare and jack rabbit). The effects of the proposed project on these wildlife species are examined.

In conclusion the study found that that the proposed project would not have a propound effects on overall fish and wildlife resources, but it would have profound local effects. Areas affected include the lower Saskatchewan Delta, parts of Cedar Lake, certain marshes connected to Lakes Manitoba, Lake Winnipegosis, Waterhen Lake, Lake St. Martin, Pineimuta Lake, Flying Post Rapid, and the Dauphin River. Recommendations of the report include, consideration of fish movement in the design of control structures; further studies into the importance of surrounding marshes for waterfowl and furbearers, and determination of important spawning area and runs; and the water level of Waterhen Lake should be kept at 830 to 831 feet ASL. A map of the study area is included, along with hydrographs of water levels on Lakes Manitoba and Winnipegosis from 1913 to 1947. Various photographs are included illustrating the types shorelines around the water bodies in the study area; fish, waterfowl and muskrat habitat; and the Fairford Dam and River.

Location: Manitoba Conservation and Environment Library, Call No. QL 85 R471948

Evans, J. 1974. Vegetation Mapping and Analysis in Delta Marsh. University of Manitoba Field Station (Delta Marsh) 1973 Annual Report 8: 17-23.

A study examining the vegetation of Delta Marsh, to assess changes in the vegetation on a seasonal and long-term basis. During the summer of 1973 vegetation changes were analyzed in the marsh along transects, and soils samples were collected and analyzed for pH, organic content, and moisture content. Preliminary results of the study show that the total percentage marsh, open water, and woodland have remained stable since 1965. The area of farmland around the marsh has expanded due to drier soil conditions in the meadow area of the marsh. Continued analysis of the data will allow for interpretation of changes in individual plant species and open water areas. The paper further discusses variations in soil conditions throughout the marsh and variation in species composition of plant communities in the marsh.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Falkner, N. W. 1972. Fishery Resources of the Whitemud Watershed area. Whitemud River Watershed Resource Study Phase I: Fish Input. Manitoba Department of Mines, Resources and Environmental Management. Winnipeg, MB. 23 pp.

A study describing the present status and potential of the fishery resources of the Whitemud Watershed, as part of the Whitemud River Watershed Resources Study Phase I. The Sport and commercial fishery of the Whitemud Watershed are discussed, focusing on Big Grass Marsh, Big Grass River, Irwin Lake, Jackson Lake, McLung Creek, Neepawa (Stoney) Creek, Pine Creek, Squirrel Creek, Willow Bend, and the Whitemud River. Lists of sport fish species present in each water body are given along with comments if the water body has been stocked with fish, and when angling is conducted, and annual catches. A map of the study area is included. Other volumes of the Whitemud River Watershed Resources Study Phase I include: interrelationships of vegetation, wildlife, and settlement (Brian 1971), land use (Hodgson 1972), wildlife (Goulden *et al.* 1972) agriculture (Jenkins 1972), and outdoor recreation (Searth 1972).

Location: Manitoba Conservation and Environment Library, Call No. SH 328 F35 1972

Fedoruk, A. N. 1971. Checklist of and Key to the Freshwater Fishes of Manitoba. Manitoba Department of Mines, Resource and Environmental Management. Winnipeg, MB. 130 pp.

A key for identifying freshwater fish found in water bodies throughout Manitoba. A brief description of each family of fishes present in Manitoba is given.

Location: Manitoba Conservation and Environment Library, Call No. QL 626.5 M3F4 1969

Fenton, M. M. 1970a. A preliminary report on the Pleistocene geology of the Portage la Prairie to Lake Manitoba area. University of Manitoba Field Station (Delta Marsh) 1969 Annual Report 4: 32-40.

A discussion of the preliminary results of a study examining the Quaternary stratigraphy and surficial geology of an area from the Assiniboine to the south shore of Lake Manitoba. Data for the study were collected from May to September 1969. Surficial geology was examined by the means of shallow drill holes and air photos, and subsurface geology was examined through deep drill holes from 10 to 275 feet deep. The surficial geology consists of six units: glacial till, lacustrine deposits, deltaic deposits, alluvial deposits, beach deposits, and

marsh deposits. Each type of sediment unit is described by texture, color, limnology and vegetative composition, and how and when they were deposited. See (Fenton 1970b) for the full results of the study.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Fenton, M. M. 1970b. The Pleistocene Stratigraphy and Surficial Geology of the Assiniboine Diversion to Lake Manitoba Area, Manitoba. MSc Thesis, University of Manitoba, Winnipeg, MB. 121 pp.

A study examining the Quaternary stratigraphy and surficial geology of an area from the Assiniboine to the south shore of Lake Manitoba. Field work was conducted during the summer of 1969, during which surficial deposits were determined by surficial examination and subsurface data were gathered by drilled holes 105 to 275 feet deep. The study includes a description of the geology of the area including stratigraphy and topography. The history and origin of the stratified units in the cores during the post-glacial period are discussed. Overall the area contains 80 to 275 feet of sediment deposited over south sloping Paleozoic and Jurassic bedrock. The major stratigraphic units are three tills, stratified units above and below each of them and a fluvial unit overlaying the uppermost stratified unit. The tills are carbonate rich clay loams and loams and the stratified and fluvial unit are mainly silts. After the drainage of Lake Agassiz the Assiniboine River flowed north into Lake Manitoba until approximately 2 400 yr B.P., when the river changed course and flowed east into the Red River. Photographs and maps of the study area are included illustrating the surficial geology. Logs of the soil cores are also included.

Location: University of Manitoba, Elizabeth Dafoe Library, 2nd floor, Thesis F3674

Feschuk, P. 1970. Feasibility Study and Cost Estimate of the Lake Manitoba-Garrison Reservoir Diversion. MSc Thesis, University of Manitoba, Winnipeg, MB. 40 p.

A cost and engineering feasibility study examining the Garrison Diversion, diverting and pumping water from Lake Manitoba to the Garrison Reservoir on the Missouri River in North Dakota. The study examines the various reaches of the diversion scheme, which include: Lake Manitoba-Assiniboine River Section, the Assiniboine River Section, the Souris River Section, and the Velva-Garrison Reservoir Section. The study also discusses the pumping and power aspects of the project, and cost involved. A number of possible effects of the diversion are also listed including: effects on groundwater, ecology of the area, and the quality of water diverted to the Garrison Reservoir. Appendixes of the report include information on the hydraulics and hydrology of the Assiniboine and Souris Rivers, dams, reservoir damages, canals, Velva tunnels, pipelines, pumping stations, power, and unit costs. Figures illustrating the layout of the proposed diversion scheme are included.

Location: University of Manitoba, Elizabeth Dafoe Library, 2nd floor, Thesis F41

Filmon, G. A. 1967. An Investigation of the Diversion of Northern Manitoba Waters into Lake Manitoba. MSc Thesis, University of Manitoba, Winnipeg, MB. 69 p.

A investigation into the feasibility of the diversion of water from several sources into Lake Manitoba, mainly the diversion of the Churchill River into the Saskatchewan River via the Sturgeon-Weir River, and the diversion of waters from Lake Winnipeg into Cedar Lake, then the diversion of these waters, along the Saskatchewan River into to Lake Manitoba via lake Winnipegosis. Other diversion schemes are also briefly discussed in the paper including a pumping diversion from Lake Athabasca, and the diversion of the South Seal River into the Churchill River. The purpose of the various diversions schemes are mainly to provide water for

irrigation, industrial consumption, and domestic consumption, since the waters from Lake Manitoba do not meet domestic consumption standards, and are poor for irrigation and industrial purposes due to high dissolved sodium, high total dissolved solids, high total hardness, and turbidity. Through an analysis of the water sources from the Churchill River, Saskatchewan River, and Lake Winnipeg, which indicates the waters from these water bodies are within the standard for irrigation and industrial uses, it is proposed that the various diversion schemes could provide water for these purposes.

The various engineering requirements, layouts, structures, costs, values, and effects of each diversion scheme are discussed and examined. The paper includes a description of the hydrology, topography, and geology of the diversion study sites. Photographs of the various water bodies included in the diversion schemes are included, along with various figures illustrating current and proposed inflow and outflows from the various lakes, and the location and layout of the various diversions schemes.

Location: University of Manitoba, Elizabeth Dafoe Library, 2nd floor, Thesis F487

Framingham, C. F., J. A. MacMillian and D. J. Sandall. 1970. The Interlake Fact. Canada-Manitoba Interlake FRED Agreement. Hignell Printing Ltd., Winnipeg, MB. 700 pp.

A detailed economic study of the resource base, use, and performance in the Interlake Region of Manitoba. Each rural municipality in the Interlake Region is examined independently. Resources bases discussed include population distribution, net migration, geology and mineral deposits, relief, land use classification, wildlife distribution, wildlife wetlands classification, and wildlife uplands classification.

Location: Manitoba Conservation and Environment Library, Call No. HC 114 I5F7 1970

Fraser, W. R., L. A. Hopkins, R. E. Smith, A. LeSann and G. F Mills. 1985. Soils of the Waterhen Area. Canada-Manitoba Soil Survey. Agriculture Canada; Manitoba Department of Agriculture; and the Department of Soil Science, University of Manitoba. Winnipeg, MB. 136 pp.

A description of the soils of the Waterhen area including their distribution, characteristics, capabilities for agriculture and forest crop production and their engineering properties for construction, recreational and community development. Soils maps for the area are included. A general description of the area is also given, which includes geology, relief and drainage, climate, and vegetation.

Location: Manitoba Conservation and Environment Library, Call No. CA1 CMSS sr23 1985

Galay, V. J. 1964. Portage Diversion Outlet Structure Model Studies. Report No. 1, Wind Conditions, Wind Setup, and Wave Characteristics over the South Portion of Lake Manitoba. Manitoba Department of Agriculture and Conservation, Water Control and Conservation Branch. 12 pp.

A background report for the proposed Portage Diversion, examining wind and wave characteristics in the south basin of Lake Manitoba from 1950 to 1964, during the months of April and May. The report examines and discusses wind frequency, direction, velocity, wind set-up, and wave characteristics such as wave height and period. The report includes graphs of the wind and wave characteristics of Lake Manitoba. The report examines these wind and wave characteristics to determine their effects on the proposed Portage Diversion and its resultant performance.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MMWR P609 no.1

Galay, V. J. 1965. Portage Diversion Outlet Structure Model Studies. Report No. 2, Results of Hydraulic Model Studies. Manitoba Department of Agriculture and Conservation, Water Control and Conservation Branch. 18 pp.

A report presenting results of hydraulic model tests performed on a model of the outlet structure of the Portage Diversion. A description of the proposed diversion is discussed in the report, including its location, size, and discharge capacity. Model tests examined flow characteristics of the Diversion, and the effects of Lake Manitoba wind and wave characteristics on the outlet structure. The report also discusses the effects of the diversion on souring in Lake Manitoba at the outlet structure, and silting and sand movement along the south shoreline of Lake Manitoba. The report concludes that the location of the outlet structure will not result in large quantities of sand being moved eastward along the shoreline. The report does mention though that the diversion may introduce some suspended silt and clay from the channel and Assiniboine River to the south end of Lake Manitoba, near the outlet structure. To minimize this silt and clay deposition in Lake Manitoba the author mentions measures will be taken, however there is no further explanation of what the measures may include, the report simply states they will be dealt with in a separate phase of the design.

Photographs of the models are included in the report, along with maps showing the location and layout of the Portage Diversion and outlet structure, and several graphs illustrating water surface profiles, discharge rates, souring and erosion rates at different lake levels, and wave characteristics of the proposed diversion.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MMWR P609 c.1

Galay, V. J. 1974. Assiniboine River Degradation Investigation. Department of Mines, Resources and Environmental Management, Water Resources Branch. Winnipeg, MB.

An investigation of possible degradation in the Assiniboine River below the Portage Diversion and the Shellmouth Dam. Surveys were conducted in the winters of 1971 and 1972, and May of 1972. The changes to the bed below the Portage Diversion did not indicate a rapid degradation process. Water surface and lowest bed level profiles did not indicate noticeable lowering of the bed level below the Portage Diversion. Bed-material samples collected from below the Portage Diversion show a coarsening of the surface bed-material, indicating some armoring of the river-bed and a reduced rate of degradation. Bore holes taken below the diversions showed sand to a depth of four to six feet below the riverbed, and stiff clay below the sand. Overall, results of the field studies indicated that degradation of the riverbed below the diversion has not progressed significantly. Several figures and graphs are included illustrating locations of sampling sites, a longitudinal profile of the river, properties of the bed material, cross sections of the river at several locations, and results of sieve analysis bed material samples and bore holes taken in the river at several locations.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MMWR 74/27

Galay, V. J. 1980. Lake Manitoba. Conditions of marsh outlet channels and sedimentation. Prepared for Ducks Unlimited Winnipeg. Northwest Hydraulic Consultants Ltd., North Vancouver, B.C.

A report examining siltation problems in five sites throughout Delta Marsh, located on the south shore of Lake Manitoba. Sites examined included Cram Creek, Delta Channel, Clandeboye Bay, Lake Francis, and east drain (an outlet for runoff on the east side of the Portage Diversion). The location of each site is discussed along with causes for siltation problems at each site, and proposed methods to reduce siltation at the sites. The report also assesses the stability of the existing barrier beach that separates Delta Marsh from Lake Manitoba, and discusses some of the major coastal processes that have led to the development of the beach, focusing on the location of four predominant headlands that appear to control the location of the barrier beach. Several aerial and ground photographs of the marsh taken in the summer of 1980 are included along with maps showing the various sites.

Location: Ducks Unlimited Canada, Institute for Wetlands and Waterfowl Research Library, Call No. GAL (Library no. 1662)

Garrod, R. C. 1980. A Preliminary Survey of Some Factors Related to the Distribution of *Potamogeton perfoliatus* L. ssp. *richardsonii* (Benn.) Hulten in Delta Marsh, Manitoba. BSc Thesis, University of Manitoba. Winnipeg, MB. 94 pp.

A study examining various environmental factors that may affect the distribution of *Potamogeton perfoliatus* L. ssp. *richardsonii* (Benn.) Hulten in Delta Marsh. A general physical description of Delta Marsh is given, which includes location and area, topography, geology, soils, hydrology, and vegetation. The regulation of water levels in the marsh, resulting from the regulation of water levels on Lake Manitoba since 1961 is also discussed briefly. Field studies examining vegetation in areas of the marsh were conducted in August 1979. During the field studies observation were made on the abundance and density of *P. perfoliatus* and other aquatic vegetation in studies area, along with water depth. Water samples were also collected from study sites and analyzed for pH, conductivity, and optical clarity, as well sediment samples were collected and analyzed for pH, texture, percentage organic matter, conductivity, and extractable nitrate, phosphate, potassium, and sulphate values. Results of water and sediment analysis are discussed in the report. Overall results of the study show that *P. perfoliatus* is more competitive against other macrophyte species in areas of the marsh where there is a higher exposure to water turbulence, and soil with a coarser texture and less organic matter.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Gauer, E. 1945. Report on Preliminary Survey of Delta Marsh Fur Rehabilitation Block, 1944. Manitoba Department of Mines and Natural Resources. 12 pp.

The report discusses a survey conducted from June 8 to October 24, 1944 to obtain data for the planning and development of the Delta Marsh area for increased and more consistent muskrat and duck populations for hunting purposes. The report proposes a dam between Clandeboye Bay and Lake Manitoba to raise water levels in the marsh to increase muskrat and duck populations, and the possibility of dams on other channels including Eagle Nest Creek. The report includes a description of the drainage area of the marsh and surrounding grazing and haylands, and discusses how the main attraction to Delta Marsh is the fall duck shoot. The report also mentions that any development controlling water levels in the marsh must recognize drainage area of the surrounding agricultural lands and the pronounced annual variation in water levels of Lake Manitoba. Also included is a map of Delta Marsh from Lake Francis on the east to Delta Station on the west, in March 1944.

Location: Provincial Archives of Manitoba, Call no: GR 1602 G 1061

Gauer, E. 1946. Report on Preliminary Survey and Proposed Development of Delta Marsh Fur Rehabilitation Block, 1945. Manitoba Department of Mines and Natural Resources. 6 pp.

A supplementary report to the 1945 report and survey on the development of Delta Marsh for hunting purposes (Gauer 1945). The report discusses the completion of the surveys at Delta Marsh, and phases of the proposed development that have been completed to date, and those that are planned for the future to raise muskrat and duck production levels for hunting purposes. One the completed developments includes a control dam between Clandeboye Bay and Lake Manitoba, which is reported to be in good condition and the water levels in the marsh were 0.15 feet higher than the lake on August 15, 1945.

Location: Provincial Archives of Manitoba, Location code: GR 1602 G 83

Gee, J. H. 1976. Biology of black bullhead (*Ictalurus melas*) in Delta Marsh. University Field Station (Delta Marsh) 1975 Annual Report 10: 19-20.

The article discusses the introduction of non-native catfish into Lake Manitoba and Delta Marsh via the Assiniboine Diversion. Catfish were released into the marsh and lake when the west dyke of the diversion broke during exceptionally high water levels in the spring of 1974. There were no previous records of catfish being caught in the lake or marsh prior to this time despite intensive fishing effects. The most abundant species of catfish introduced to the marsh was the black bullhead (*Ictalurus melas*). Other introduced catfish species that have been found in the lake include channel catfish (*Ictalurus punctatus*) and brown bullhead (*Ictalurus nebulosus*), and tadpole maddox (*Noturus gyrinus*) was found in Delta Marsh. In summer of 1974 the biology of the black bullhead was studied in the marsh. During the study season the spawning of the black bullhead was quite successful. Food of the black bullhead fry consisted of Cladocera, ostracods, amphipods, and trichoptera larvae. Sampling data indicates that adult black bullheads spawn in the marsh during the spring, fry and adults remain in the marsh over the summer, and then in the fall both fry and adult leave the marsh in the autumn and spend the winter in the lake.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Gilliland, J. A. 1965. Geological and Ground Water Investigation for the Portage Diversion. Manitoba Department of Mines, Resources and Environmental Management. Winnipeg, MB. 65 pp.

A study conducted in 1963, to determine the geological and ground water conditions present in the area of the proposed Portage Diversion (as known as the Assiniboine Diversion), diverting waters from the Assiniboine River into Lake Manitoba. The area investigated was a north-south strip 20 miles long and 9 miles wide, extending from just south of the Assiniboine River, near Portage La Prairie, north to Lake Manitoba. Aerial photographs were used to conduct a photogeological survey of the area. An inventory of 280 farms and houses in the study area was also carried out. A well drilling program was also conducted to determine ground water chemistry and flow conditions in the study area. Analysis of ground water chemistry included pH, alkalinity, and total hardness, suspended and dissolved solids, nitrate, and various minerals and ions. Water samples were also collected from the Assiniboine and Lake Manitoba, and analyzed for similar water chemistry parameters. The soil cores from the drilled well holes were also recovered and examined for soil mechanics investigations. Automatic water level recorders were also installed in two locations along the length of proposed Diversion channel, to provide continuous records of water levels during the study. An outline of the geology and soil stratigraphy of the study area are given in the report.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MMWR 65/25

Girman, G. 1974. The Effect of 2,4-Dichlorophenoxyacetic Acid Upon Mixed Phytoplankton Population in Southern Lake Manitoba and Delta Marsh. University of Manitoba Field Station (Delta Marsh) 1973 Annual Report 8: 25-37.

A study examining the effects of pesticides and herbicides on phytoplankton populations in Delta Marsh and southern Lake Manitoba, undertaken in the summer of 1973. The herbicides examined include 2,4-D, 2,4,5-T and pesticides D.D.T., abate and malathion. Lake Manitoba and Delta Marsh receive drainage containing agricultural pesticides and herbicides from farmland via surface runoff and inflows from tributaries such as the Assiniboine Diversion, Blind Channel, Deep Creek, and the Whitemud River. The paper discusses the effects of the herbicides and pesticides on the phytoplankton populations, and variation in the uptake of the pesticides under light and dark conditions.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Goldsborough, L. G. 1983a. Effects of Two Herbicides on Periphytic Algal Productivity. University of Manitoba Field Station (Delta Marsh) 1982 Annual Report 17: 30-33.

A study examining the effects of the triazine herbicides, simazine and terbutryn on periphytic algal biomass and productivity. Studies were conducted in Delta Marsh during the summer of 1982. The effects of various concentrations of the two herbicides were examined in experimental enclosures placed in the Blind Channel of Delta Marsh. All levels of terbutryn (0.01, 0.1, 1.0 mg/L) resulted in significantly less chlorophyll *a* accumulations, an indicator of algal biomass. Higher levels of simazine (1.0 and 5.0 mg/L) caused significant decreases in the chlorophyll *a* accumulations. There was a decrease in the periphytic photosynthetic rate at all levels of terbutryn, and the two higher concentrations of simazine. There was a close relationship between chlorophyll levels and photosynthetic rates at all treatment levels of the herbicides. All treatment except for the one given the highest concentration of terbutryn experienced recovery after being flood with fresh water for a 30 hour period, both in term of chlorophyll *a* and photosynthetic rate. See Goldsborough (1984a) for further results on the study.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Goldsborough, L. G. 1983b. Dissolved Silicon Dynamics in a Marsh Channel. University of Manitoba Field Station (Delta Marsh) 1982 Annual Report 17: 38-43.

An examination of dissolved silicon dynamics in the water of a recently dredged channel stretching from Blind Channel to the canoe dock of the University Field Station. Levels of silicon in the channel were four time higher than the adjacent marsh, and higher than concentrations in Lake Manitoba. Samples sites were established in 1982 along the dredged channel and in the adjacent Blind Channel. Sampling was conducted from June to July, along with dissolved oxygen measurements. Silicon concentrations were constantly higher at sites in the channel closest to the canoe dock, and decreased through the channel into Blind Channel, where concentration were the lowest. Silicon levels increased during high water periods. It was hypothesized that the dredging of the channel exposed previously buried organic deposited to oxygenated waters producing high levels of dissolved silicon in the water.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Goldsborough, L. G. 1984a. Assessment of Some Effects of Simazine on the Structure and Metabolism of Periphyton. University of Manitoba Field Station (Delta Marsh) 1982 Annual Report 17: 32-41.

A study examining the effects of the herbicide simazine on periphyton pigment concentrations, photosynthetic rate, community composition, and sensitivity to herbicide. Studies were conducted during the summer of 1983 in experimental enclosures placed in the Blind Channel of Delta Marsh. Results of the study showed that physiological and phytosociological processes in periphyton may be altered by simazine. The author recommends further studies before any conclusions can be drawn. See Goldsborough (1982a) for earlier studies.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Goldsborough, L. G. 1984b. Ontogeny of a small marsh pond. University Field Station (Delta Marsh) 1983 Annual Report 18: 44-51.

A study conducted in 1983 in the Crescent Pond of Delta Marsh to examine changes in vegetation coverage and pond area of the pond over the past 36 years. The study was based on comparison of pond bathymetry and aerial photographs taken over the 36 year period. Results showed that since 1973 *Typha glauca* had become dominant in high densities around the pond, except for a few isolated populations of *Scirpus lacustris* and *Phragmites australis*. It appears from aerial photographs that the open water area of crescent pond is decreasing exponentially. The author points out that water levels on Lake Manitoba have been regulated since 1961, and that highly fluctuating water levels in the lake and marsh were dampened by the stabilization of the lake, and that this may be connected with the steady decline in the size of Crescent Pond.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Goldsborough, L. G. 1988. Ontogeny of a small marsh pond. University Field Station (Delta Marsh) 1987 Annual Report 22: 37-39.

Summary of a study conducted in 1983 in the Crescent Pond of Delta Marsh to examine changes in vegetation coverage and area of the pond over the past 36 years. The study was based on comparison of pond bathymetry and aerial photographs taken over the 36 year period. Results showed that since 1973 *Typha glauca* had become dominant in high densities around the pond, except for a few isolated populations of *Scirpus lacustris* and *Phragmites australis*. It appears from aerial photographs that the open water area of crescent pond is decreasing exponentially. The author points out that water levels on Lake Manitoba have been regulated since 1961, and the highly fluctuating water levels of the lake and marsh were dampened by the stabilization of the lake, and this may be connected with the steady decline in the size of Crescent Pond.

Since then recent evidence drawn from further field observations and an additional aerial photograph taken in 1987 have further supported the earlier conclusion. During visits to the pond since 1983, it was observed that there had been extensive growth of *Typha* stands in previous peripheral open water areas, and this was backup by the aerial photographs taken in 1987. From a linear model it was estimated that the pond will be covered by vegetation with no open water by 2017. It was noted that if water level regulation continues on Lake Manitoba,

the progressive infilling of the marsh will continue, not only in Crescent Pond but also in other area of the marsh.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Goldsborough, L. G. 1992. Weather and Water Quality Data. The University of Manitoba, University Field Station (Delta Marsh), 1991 Annual Report 26: 13-29.

A summary of meteorological and water quality data collected at the University of Manitoba Field Station at Delta Marsh during 1991. Meteorological data recorded at the field station includes daily photosynthetically available radiation ($E/m^2/d$), daily sunshine, daily air temperature, daily water depth, cumulative wind speed and direction, and daily precipitation. Water depth data recorded in Delta Marsh near the canoe dock of the field station is also presented. Water samples were collected monthly in Lake Manitoba, approximately 1 km offshore from the field station. Water quality data presented includes temperature, depth, clarity, coliforms, alkalinity, pH, dissolved oxygen, conductivity, and concentrations of various nutrients, dissolved ions and minerals, and metals.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Goldsborough, L. G. 1993. Weather and Water Quality Data. The University of Manitoba, University Field Station (Delta Marsh), 1992 Annual Report 27: 11-28.

A summary of meteorological and water quality data collected at the University of Manitoba Field Station at Delta Marsh during 1992. Meteorological data recorded at the field station includes daily photosynthetically available radiation ($E/m^2/d$), daily sunshine, daily air temperature, daily water depth, cumulative wind speed and direction, and daily precipitation. Water depths were recorded in Delta Marsh at the canoe dock of the field station and Blind Channel, and in Lake Manitoba at Westbourne, and are presented in the report. Water samples were collected monthly in Lake Manitoba, approximately 1 km offshore from the field station. Water quality data presented includes temperature, depth, clarity, coliforms, alkalinity, pH, dissolved oxygen, conductivity, and concentrations of various nutrients, dissolved ions and minerals, metals, and various pesticides.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Goldsborough, L. G. 1994. Weather and Water Quality Data. The University of Manitoba, University Field Station (Delta Marsh), 1993 Annual Report 28: 11-25.

A summary of meteorological and water quality data collected at the University of Manitoba Field Station at Delta Marsh during 1993. Meteorological data recorded at the field station includes daily photosynthetically available radiation ($E/m^2/d$), daily sunshine, daily air temperature, daily water depth, and daily precipitation. Water depths were recorded in Delta Marsh (Blind Channel) and in Lake Manitoba (Steepprock and

Westbourne), and data are presented. Water samples were collected monthly in Lake Manitoba, approximately 1 km offshore from the field station. Water quality parameters examined and presented include temperature, depth, clarity, coliforms, alkalinity, pH, dissolved oxygen, conductivity, and concentrations of various nutrients, dissolved ions and minerals, metals, and various pesticides.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Goldsborough, L. G. 1995. Weather and Water Quality Data. The University of Manitoba, University Field Station (Delta Marsh), 1994 Annual Report 29: 11-19.

A summary of meteorological and water quality data collected at the University of Manitoba Field Station at Delta Marsh during 1994. Meteorological data recorded at the field station includes daily photosynthetically available radiation ($E/m^2/d$), daily sunshine, daily air temperature, daily mean wind direction, and daily precipitation. Water samples were collected monthly in Lake Manitoba, approximately 1 km offshore from the field station. Water quality parameters examined and presented include temperature, depth, clarity, coliforms, alkalinity, pH, dissolved oxygen, conductivity, and concentrations of various nutrients, dissolved ions and minerals, metals, and various pesticides. Water samples were also collected at six sites in Delta Marsh on July 15, August 13 and September 13, 1994. Water quality parameters examined in the marsh included temperature, depth, pH, water clarity, conductivity, hardness, alkalinity, chlorophyll *a*, and concentrations of nutrients, various minerals and dissolved ions.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Goldsborough, L. G. 1996. Weather and Water Quality Data. The University of Manitoba, University Field Station (Delta Marsh), 1995 Annual Report 30: 9-12.

A summary of meteorological and water quality data collected at the University of Manitoba Field Station at Delta Marsh during 1995. Meteorological data recorded at the field station includes daily photosynthetically available radiation ($E/m^2/d$), daily sunshine, daily air temperature, and daily precipitation. Water samples were collected monthly in Lake Manitoba, approximately 1 km offshore from the field station. Water quality parameters examined and presented include depth, clarity, coliforms, alkalinity, pH, dissolved oxygen, conductivity, and concentrations of various nutrients and other dissolved ions and minerals.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Goldsborough, L. G. 1997. Weather and Water Quality Data. The University of Manitoba, University Field Station (Delta Marsh), 1996 Annual Report 31: 13-16.

A summary of meteorological and water quality data collected at the University of Manitoba Field Station at Delta Marsh during 1996. Meteorological data recorded at the field station includes daily photosynthetically available radiation ($E/m^2/d$), daily sunshine, daily air temperature, and daily precipitation. Water samples were collected monthly in Lake Manitoba, approximately 1 km offshore from the field station. Water quality parameters examined and presented include temperature, depth, clarity, coliforms, alkalinity, pH, dissolved oxygen, conductivity, and concentrations of various nutrients, dissolved ions and minerals, and metals.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Goldsborough, L. G. 1998. Weather and Water Quality Data. The University of Manitoba, University Field Station (Delta Marsh), 1997 Annual Report 32: 16-19.

A summary of meteorological and water quality data collected at the University of Manitoba Field Station at Delta Marsh during 1997. Meteorological data recorded at the field station includes daily photosynthetically available radiation ($E/m^2/d$), daily sunshine, daily air temperature, and daily precipitation. Water samples were collected monthly in Lake Manitoba, approximately 1 km offshore from the field station. Water quality parameters examined and presented include temperature, depth, clarity, coliforms, alkalinity, pH, dissolved oxygen, conductivity, and concentrations of various nutrients, dissolved ions and minerals, and metals.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Goodyear, M. A. 1997. Further studies on the seasonal distribution and abundance of fish in Delta Marsh. University Field Station (Delta Marsh), 1996 Annual Report 31: 1-4.

The article examines the temporal and spatial distribution of fish in Delta Marsh during the summers of 1995 and 1996. Four sites in Delta Marsh were monitored for the study: three sites in Blind Channel and one site in Crescent Pond. The predominant fish species recorded during the study was fathead minnows. Other species caught included yellow perch, nine-spined and five-spined sticklebacks and bullhead. Spottailed shiners, emerald shiners, juvenile carp and juvenile white sucker were rarely caught during the summer. No darters, trout-perch, logperch, pike, or mudminnow, which were observed in 1983 (Schneider 1983), were caught in during the study period. Fish catches peaked in spring, followed by low catches number in the mid-summer, and a smaller peak in the fall. Fish abundance of various species in the marsh were found to be influenced by water levels and temperatures fluctuations. It was hypothesized that catches of carp and white sucker populations were low in the marsh due to severe spring flooding, cool spring temperatures, and persistent high summer water levels. Which may have delayed spawning in the marsh until late June, and the young-of-the-year carp and sucker may have not been big enough by the end of the sampling period to be caught in the traps.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Goulden, H. D. 1962. Wildlife study of proposed Assiniboine River diversion from Portage la Prairie to Lake Manitoba. Manitoba Department of Mines and Natural Resources. 11 pp.

A summary of a biological study conducted between May and September of 1962 along the proposed route for the Assiniboine River Diversion into Lake Manitoba near Delta Marsh. The purpose of the study was to determine potential effects of the diversion on plant and animal life, mostly aquatic vegetation and waterfowl in Delta Marsh, and to develop recommendations to reduce potential adverse effects, and provide new benefits to wildlife in the marsh. Five alternative routes for the north end of diversion channel as it passes through Delta Marsh, which was considered an important and sensitive area for wildlife production, are examined. The history of flooding along the Assiniboine River, the purpose and operation of the proposed diversion, and the location five different channel routes through the marsh are discussed. Recommendation of the study include that channel route number four with the highest terrain would have the least detrimental effect on wildlife in the marsh. The use of waters from the diversion to raise water levels in the marsh for waterfowl management purposes also discussed. Figures are included illustrating the locations the five diversion channel routes through Delta Marsh. See Goulden (1964) for an Addendum to this report.

Location: Manitoba Conservation and Environment Library, Call No. TC 409 G68 1962

Goulden, H. D. 1964. Addendum to the Report Entitled “Wildlife study of proposed Assiniboine River diversion from Portage la Prairie to Lake Manitoba”, Dated November, 1962, by Herbert D. Goulden. Manitoba Department of Mines and Natural Resources, Game Branch. 2 pp.

An addendum to the biological study conducted between May and September of 1962 along the proposed route for the Assiniboine River Diversion into Lake Manitoba near Delta Marsh. The purpose of the study was to determine effects of the diversion on plant and animal life, mostly aquatic vegetation and waterfowl in Delta Marsh, and to develop recommendations to reduce potential adverse effects and provide new benefits to wildlife in the marsh. Five alternative routes for the north end of diversion channel as it passes through Delta Marsh, which was considered an important and sensitive area for wildlife production, are examined. In the addendum a sixth alternative route is described for the diversion channel just prior to its entry into Lake Manitoba. A map illustrating all six of the proposed routes is included. The sixth route is now the preferred route of the diversion channel in terms of it having the most minimal adverse effects to wildlife of Delta Marsh. The report also briefly discusses the specifics of the proposed diversion route including the controlled out structure, and flow regimes.

Location: Delta Waterfowl Research Station, David Winton Bell Memorial Library

Goulden, H. D., D. A. Davis, I. J. Milliken, L. M. Nelson, A. B. Ransom and W. H. Scott. 1972. Whitemud River Watershed Resource Study Phase I: Wildlife Section. Manitoba Department of Mines, Resources and Environmental Management. Winnipeg, MB. 245 pp.

A report describing results of wildlife studies conducted during Phase I of the Whitemud River Watershed Resource Study. The purpose of the wildlife study was to describe existing and potential wildlife resources of the watershed and to examine habitat loss and other wildlife management problems. A general description of study area is given which includes physiography and soils, vegetation and climate. The wildlife study report is broken up into five separate sections: wildlife habitat inventory, wetlands inventory, land capacity for wild ungulates and waterfowl, kinds and number of wildlife, and wildlife management problem. The wildlife habitat inventory includes a description the present wildlife habitat in the study area, along with the conditions prior to

settlement. Soils in the area are classified and vegetation species lists are given. The wetlands inventory included over 107 wetland in the study area, covering approximately 36 000 acres. Available information on vegetation, water quality, soils, and drainage status of each wetland is given. There are approximately 20 kinds of fish, 6 amphibians, 7 reptiles, 250 birds and 50 mammals. List of birds species recorded during the study period are given, along with list of amphibians, reptiles and mammals. Maps of the study are included which illustrate vegetation, wetlands, and waterfowl areas, in the study area.

Other volumes of the Whitemud River Watershed Resources Study Phase I include: Fish (Falkner 1992), Land use (Hodgson 1972), Interrelationships of vegetation, Wildlife, and settlement (Ransom 1971), Agriculture (Jenkins 1972), and Outdoor recreation (Searth 1972).

Location: Manitoba Conservation and Environment Library, Call No. S 934 C2 G68 1972

Gow, D. B. 1914. Report on the Water Power Possibilities of the Fairford and Dauphin Rivers. Department of the Interior Canada, Water Power Branch, Manitoba Hydrographic Survey. 26 pp.

A report on investigations into the power generation possibilities of the Fairford River and Dauphin River conducted during the summer of 1913. The report discusses details of surveys conducted on the Fairford and Dauphin Rivers during the summer of 1913, examining the characteristics of the two river systems and their potential for power generation. Characteristics examined include the height of river banks; nature of soils; high and low water marks; water storage capacity; water discharge volumes; rainfall, temperature and evaporation; settlements in the area; and possibilities of river navigation. A general description of the two river systems and their surrounding watersheds is also given, which includes the drainage area of the river system, discharge volumes, topography, geology, soils and general vegetation. Some of the characteristics of other water bodies in the drainage system are also discussed briefly including Lake Manitoba, Lake Winnipegosis, Lake St. Martin, Waterhen River and Whitemud River.

Location: National Library of Canada, Call No. RG 89 v.545 File 150

Grant, H. C. 1938. The Commercial Fishing Industry of Manitoba. The Economic Survey Board, Province of Manitoba. Winnipeg, MB. 67 pp.

A survey examining the natural and extent of fisheries resources and the fishing industry in Manitoba up to 1938. The report includes a discussion of the historical development of the industry in Manitoba since 1882, water bodies in the province where commercial fishing occurs, organization of the industry, the demand for freshwater fish, the production of fish in Manitoba, regulations, trends in production and marketing, and major trends in the industry and suggestions toward their solution. Lake Manitoba is among the lakes in the province examined in regards to their fishing industry.

Location: Manitoba Conservation and Environment Library, Call No. SH 224 M3 G73 1938

Green, R. H. 1972. Distribution and Morphological Variation of *Lampsilis radiata* (Pelecypoda, Unionidae) in some Central Canadian Lakes: A Multivariate Statistical Approach. Journal of the Fisheries Research Board of Canada. 29: 1565-1570.

A study examining the distribution and morphological variation of the bivalve mollusk, *Lampsilis radiata* in central Canadian lakes in relation to environmental factors. A total of 382 samples were collected from 37 lakes in Saskatchewan, Manitoba, and northwestern Ontario. The samples collected contained 22 species of bivalve molluscs. Some of the sampling sites in Manitoba included lakes Manitoba, St. Martin, and Winnipeg. Environmental parameters examined included pH, alkalinity, calcium, total hardness, depth, sodium chloride, and sediment mean particle size and percent organic matter. The author examines the influence of these environmental variables on the distribution and morphological variation of *L. radiata* using multivariate

statistical methods. The most important environmental variables appeared to be pH, alkalinity, and sodium chloride concentrations.

Location: Fisheries and Oceans Canada, Eric Marshall Aquatic Research Library

Green, D. J. and A. E. Beck. 1995. Mercury and Other Metal Residues in Fish From the Assiniboine River, Manitoba, Canada, 1978-1992. Manitoba Environment, Report No. 95-07. Winnipeg, MB. 160 pp.

A summary report regarding biomonitoring program conducted by Manitoba Conservation (previously Manitoba Environment) from 1978 to 1992, to determine the extent of trace metal concentrations in the Assiniboine River. Samples of fish muscle tissue were collected from the river at three main sample sites: Lake of the Prairies, near the city of Brandon, and Portage la Prairie, Manitoba. The report also includes a general description of the Assiniboine River and surrounding watershed including location, topography, geology, soils, vegetation, and climate. The report includes various figures illustrating the sample sites, and tables and graphs displaying the results and illustrating trends in the data.

The results of the study revealed that annual concentrations of mercury in predatory species such as walleye, sauger, and northern pike in the Assiniboine River exceeded the federal guideline limit of 0.5 µg/g, and these elevated levels usually occurred in larger sized walleye, sauger, and northern pike. Mercury concentration for other species such as yellow perch, common sucker, brown bullhead, goldeye, Lake trout, and carp were usually less than 0.5 µg/g. Concentrations of other metal in the fish tissues, such as arsenic, zinc, copper, cadmium, nickel, chromium, and selenium were found to be in the range of normal background concentrations and were determined to not to be a threat to human health.

Location: Manitoba Conservation and Environment Library, Call No. CA2 ME r 95-07

Green, D. J. and A. J. Derksen. 1984. The Past, Present and Projected Demands on Manitoba's Freshwater Resources. Manitoba Department of Natural Resources, Fisheries Branch, MS Report No. 84-4. 171 pp.

A 1984 report on freshwater fish resources in Manitoba, with an analysis of past trends in exploitation, predominantly by commercial and recreational fisherman, in order to predict future demands and trends in freshwater fish resources, up until 2000. The major water bodies discussed in the report include Lake Manitoba, Lake Winnipeg and Lake Winnipegosis. The report identifies various ways fish resources are used, past and present trends in the fishery, estimates of total available fish stocks, and estimates of future harvests demands in Manitoba with remarks and recommendations. Also presented is a history of fishing in Manitoba, back as far as the early stages of European settlement in Manitoba. The authors predicts, at the time of publication, that if current trends in the fishery demands continued through to 2000, demands would outstrip stocks of the prime fish species: lake whitefish, walleye, sauger, northern pike and lake trout.

Also included in the report is a brief discussion of Lake Manitoba water chemistry conditions, including total dissolved solids concentration in the lake; the main inflow channels of the lake, including Lake Winnipegosis which contributes over 70 percent of gauged inflows to the lake; and the effects of the Portage Diversion on the lake, such as increased sediment and nutrients loads in the south basin.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MRRB mrs 84-4

Grose, R. E. (editor). 1954. Industrial Resources of Manitoba. Department of Industry and Commerce. Winnipeg, MB. 256 pp.

A overview of the natural resources, water supplies, transportation and other economic factors in Manitoba prior to and during 1954. The report contains information on agriculture, mining, forests, fur, fish, water resources, recreational resources, populations, and other important industries and aspects of Manitoba. An overview of the geology, climate, soils, land use and natural resources of the Manitoba is given. Lake Manitoba is among the various water bodies examined in the report for its fishery, fur production, water resources and recreational resources.

Location: Manitoba Conservation and Environment Library, Call No. HC 114 M3D3 I5 1954

Grosshans, R. E. 2000. The Vegetation Composition of Delta Marsh, Manitoba, Canada (1997): 36 Years of Stabilized Water Levels. Institute for Wetlands and Waterfowl Research, Ducks Unlimited Canada. 40 pp.

A study examining the effects of 36 years of water stabilization on Lake Manitoba since 1961, on the vegetation dynamics of Delta Marsh. Before the Fairford was constructed to stabilize water levels on the lake, water levels in the lake and marsh fluctuated within a range of 1.7 m. Since the stabilization of the lake water level fluctuations in the lake and marsh have been reduced to a range of less than 0.6 m. Water level stabilization on Lake Manitoba has reduced the magnitude and length of extreme high and low water level fluctuations, and as a result this has reduced vegetation complexity, biodiversity, and productivity in the marsh. The stabilized water levels have eliminated the natural wet-dry marsh cycle preventing marsh regeneration, and allowing dominance of certain emergent macrophytes such as *Typha spp.*, *Phragmites australis*, and *Scholocloa festucacea*. Lack of vegetation reestablishment has also caused shoreline erosion and the lack of gently sloping transition zones from the marsh to uplands. The marsh is no longer diverse, dynamic and productive, and as a result it is unattractive to wildlife with its dense, monodominant vegetation. A physical description of Delta Marsh is given along with the role of historical water level variations in the marshes, current and historical accounts and lists of the vegetation composition in the marsh, and changes in its use by waterfowl and muskrat since water level stabilization. Other human influences on the marsh are also briefly touched on including agriculture. A vegetative map of Delta Marsh in 1997 is included. The report concludes that something must be done to restore Delta Marsh for the enhancement of both wildlife and mankind.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Grosshans, R. E. and N. C. Kenkel. 1998. Dynamics of emergent vegetation along natural gradients of water depth and salinity in a prairie marsh: delayed influences of competition. University of Manitoba Field Station (Delta Marsh) 1997 Annual Report 32: 83-93.

A study examining the vegetation dynamics of Delta Marsh following long-term stabilization of water levels on Lake Manitoba in 1961. The study was conducted in the Marsh Ecology Research Complex (MERP) at Delta Marsh, focusing on the response of vegetation to gradients in water depth, salinity, and competition at varying wet-dry cycles. Since 1961, water levels on Lake Manitoba have been regulated at a mean level of 247.5 m asl. The stabilization of water levels has disrupted to natural wet/dry cycle in adjoining marshes and has prevented marsh regeneration, resulting in a dense monodominant macrophyte composition and low diversity. The study examined cells in the MERP complex that had been influenced by stabilized water levels for 36 years, and other cells that have undergone varying water level regimes, to compare vegetation dynamics, composition, and structure under stabilized water levels and under water level regimes that have varying wet/dry periods.

From the study water depth appears to be the primary determinant of plant zonation patterns in the marsh, during natural disturbance regimes and periods of water level stabilization. Soil salinity is another secondary environmental factor influencing the distribution of species along the water depth gradient, and salinity is influenced in part by water depth. Stabilized water levels have also increased competition among species, as cattail-whitetop transition area has disappeared, and Giant Reed Grass in the absence of water level fluctuations has spread.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Gummer, W. D. 1979. Pesticide monitoring in the prairies of western Canada. Water Quality Interpretive Report No. 4. Inland Waters Directorate, Western and Northern Region, Water Quality Branch, Regina, SK, 14 pp.

An overview of pesticide monitoring conducted by the Water Quality Branch of the Department of Environment in Manitoba, from 1971 to 1977. The report includes a discussion of environmental concerns related to pesticides, sources and pathways, toxicological properties. Various Organochlorine, Chlorophenoxy acid, Organophosphorus, and Carbamates pesticides were investigated during the survey which was conducted in water bodies across Manitoba. The Assiniboine River was among the sample sites. Concentrations of the various pesticides found in the water bodies are presented in the report along with a discussion of the results.

Location: University of Manitoba, Elizabeth Dafoe Library, Call No. GovDocs Can1 En912.8 W28 no.4

Hammell, G. 1975. An Investigation into Development of Wildlife Resources at Pineimuta Marsh. Department of Mines and Natural Resources. Winnipeg, MB. 40 pp.

A study examining remedial measures for Pineimuta Marsh regarding the effects of the Fairford Dam on the wildlife populations in the marsh. The regulation of Lake Manitoba via the Fairford Dam began in 1961, and the dam has caused irregular and unpredictable flooding in the marsh. Prior to the operation of the dam in 1961, populations of furbearers and waterfowl were high in the marsh. The study examines four schemes for alleviating the problems at the marsh, involving such changes as better control of water releases from the Fairford Dam with possible channel improvement to the Fairford River, and the construction of a diversion and dikes around the marsh. The report includes a description of Pineimuta Marsh, which includes location, size, waterfowl and bird usage, wildlife usage, vegetation, and surrounding land uses. The report gives an overview of the effects the Fairford has had on the marsh including, extreme unnatural short-term changes in water levels in the spring and summer (unnatural lower water conditions during low water year, and increased extreme flooding during high water years), and depressed furbearer and waterfowl populations. The rapid and extreme spring and summer flooding also destroys waterfowl nests. The report includes graphs of water levels in the marsh before and after regulations, and figures illustrating the marsh and the various improvement schemes.

Location: Manitoba Conservation and Environment Library, Call No. S 621 H36 1975

Hanson, D. G. and L. Drennan. 1980. Portage Reservoir Sedimentation Study 1971. Inland Waters Directorate, Water Survey of Canada. Winnipeg, MB. 10 pp.

Results of sediment surveys conducted in the Assiniboine River Reservoir near Portage La Prairie, to determine the rate of capacity of loss due to sedimentation in the reservoir. The reservoir is located at the head of the dam that controls flows into the Assiniboine Diversion. During the survey suspended sediment samples and bed material samples were collected from select sites. Depth sounds were also taken to determine depth profiles of

reservoir. The report includes a discussion of the history of flood control measures on the Assiniboine River, along with a description of the Assiniboine Reservoir. The reservoirs capacity due to sedimentation and erosion could not be determined at the time of the report, and further surveys are planned to determine deposition in the reservoir over time. See (Inland Waters Directorate and Manitoba Department of Natural Resources 1982) for results of the later studies. Figures are included illustrating sample sites, water levels in the reservoir (1971), and water depth profiles of various ranges in the reservoir.

Location: Manitoba Conservation and Environment Library, Call No. TD 396 M3 H36 1980

Harden, N. 1982. Lake Pineimuta Marsh Improvements: Engineering Feasibility Study. Ducks Unlimited, Winnipeg. Draft Report. 8 pp.

A study evaluating six methods for stabilizing water levels in Pineimuta Lake during the waterfowl nesting season from May 15 to June 30. The report discusses the effects that the regulation of Lake Manitoba via the Fairford Dam since 1961, has had on Pineimuta Lake, mainly an increase in the frequency of extreme and erratic high and low water levels, which has resulted in detrimental effects on waterfowl production. A brief description of the marsh is included in the report. The six concepts for stabilizing water levels include various different methods for isolating the marsh from the Fairford River involving dykes, channels, and control structures. Another auxiliary method examined would involve changing the operation criteria of the Fairford Dam, by reducing discharge through the dam during the waterfowl-nesting season (May 15 to June 30). The report recommends two ways this could be achieved: by not allowing increased discharge through the Fairford Dam in spring, allowing Lake Manitoba to rise above the level of existing regulations, or increasing the discharge through the Fairford Dam prior to May 15. The author points out that the second method would be more attractive to people concerned with high water levels around Lake Manitoba, and that in wet years the Fairford Dam would have operated at a high discharge rate, and waterfowl production would be lost in these years. The report includes figures illustrating the various methods for stabilizing water levels in the marsh.

Location: Ducks Unlimited Canada, Institute for Wetlands and Waterfowl Research Library, Call No. HAR

Harkness, W. J. K. 1980. Report on the Sturgeon Situation in Manitoba. Manitoba Department of Natural Resources, MS Report No. 80-3. 18 pp.

A 1936 report on the status of the sturgeon (*Acipenser fulvescens*) in Manitoba, for the purpose of formulating fishery regulations to control commercial fishing of the species. The report includes a historical analysis of the sturgeon in Manitoba, habitats and spawning of the sturgeon, and hatchery practices. The report lists three lines of action that could be taken for the establishment of fishery policies regarding the sturgeon: 1) a general open commercial season for sturgeon in which licenses are granted to a number of fisherman, and fisherman would concentrate their efforts on limited areas where sturgeon congregate, however, this eventually result in the depletion of sturgeon if it is pursued for any length of time; 2) A continuous closed system, in which the sturgeon are allowed to build up stocks for a period of 20 to 50 years, and then moderate, but strictly controlled commercial fishing would be allowed; and 3) A controlled sturgeon fishery, in which fishing is not intense at any one length of time, and a annual catch restriction is put in place to limit catches to a biological sustainable level. The report recommends that under the present condition the waters of Manitoba will not sustain a sturgeon fishery over 10,000 pounds a year. If the province hopes to retain a sturgeon fishery, the only possible way is to limit the catches to 10,000 pounds a year or less, and to permit sturgeon fishing in any one area only once every eight or ten years.

The report stresses that additional information is still needed regarding local conditions, which have a direct bearing on the sturgeon fishery, including water inhabited by sturgeon, and the fishing methods for proper analysis of the situation and for the purpose of proposing a plan for a practical and sustainable sturgeon fishery. The report also cautions that the waters in which the sturgeon are living, feeding and spawning should be carefully guarded and protected from pollution and modification.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MRRB mrs 80-3

Hayden, W. and W. Pollard. 1974. Tests tell a story. Fishing Bulletin 14: 20 10-12.

An brief overview of biological work that was conducted in Lake Manitoba during the summer of 1974 by Manitoba Fisheries. Work conducted included sauger and pickerel tagging studies, experimental fish sampling with different mesh size nets, and fish nurseries and stocking.

Location: National Library of Canada, Call No. SH224

Hinks, D. 1936. Aquatic Plant Survey 1936. Department of Mines and Natural Resources, Game and Fisheries Branch. Winnipeg, MB. 32 pp.

A summary of a survey of important marshes in Manitoba conducted during the summer of 1936. The objective of the survey was to determine vegetation present, and its relative abundance and value as food for waterfowl, and to investigate the factors influencing growth (i.e. water levels, water chemistry (clarity and pH), and type of bottom sediments, etc.). Marshes examined included Netley-Libau Marsh, Delta Marsh, St. Ambroise, Shoal Lake, and Rock Lake. Delta Marsh was examined between August 9 and August 30, 1936. The area was characterized in general as much poorer growth than in Netley-Libau Marsh both in number of plant species present and abundance. The author noted that the marsh has excellent cover of aquatic vegetation, and a great abundance of aquatic animals was also apparent. Observed aquatic fauna included freshwater shrimp, larvae of dragon and damselflies, two-winged flies, adult snails, back swimmers, diving beetles, small shellfish, and crayfish. The overall pH range of the marsh was 7.6 to 8.4. Vegetation present throughout the marsh included Reed Grass, Widgeon Grass, soft-stemmed bulrush, cattail, Bladderwort, broadleaved Arrowhead, Sago Pondweed, Redhead Grass, Water Milfoil, Coontail, Lesser Duckweed and Ivyleaved Duckweed.

Location: Manitoba Conservation and Environment Library, Call No. QK 102 H56 1936

Hinks, D. 1938. Lake Manitoba Investigation: Winter 1937-38. Department of Mines and Natural Resource, Fisheries Branch. Winnipeg, MB. 15 pp.

A summary of an investigation into the Manitoba fishery conducted in the winter of 1937 to 1938 to obtain information on growth rates and ages, and maturity of important commercial fish species, and to obtain information on the effects of small meshed nets (3/8" and 3/4") on fish, especially pickerel. The study found that 3/8" and 3/4" mesh nets definitely damaged pickerel. The author also noted that pickerel populations in the lake showed signs of depletion, and to ensure the welfare of the species nets below 4/4" should be banned. The report also mentions concerns of fisherman related to "Death Waves" on Lake Manitoba. Toward the end of the winter poisonous current of water appear to move under the ice in the lake and kill fish that are caught by them. Although the exact cause of the waves has not been determined, the author points out that the underlying cause of the waves is winter stagnation and oxygen depletion.

Location: Manitoba Conservation and Environment Library, Call No. SH 344 M36 H56 1978

Hinks, D. 1943. The Fisheries of Manitoba. The Department of Mines and Natural Resources, Winnipeg, MB. 102 pp.

A summary of fisheries species present throughout various water bodies in Manitoba. The book includes a key to the identification of the various different families of fishes present in Manitoba. Each family of fish present in Manitoba is described in terms of its common physical characteristics, distribution, food and growth, breeding, and their commercial value. Drawing of the various families of fishes are also included. Some of the fish families mentioned in the text that are present in Lake Manitoba include sturgeon (*Acipenseridae*), whitefish and tulibeas (*Coregonidae*), suckers (*Catostomidae*), minnows, shiners and carp (*Cyprinidae*),

catfishes (*Ameiuridae*), pikes (*Esocidae*), trout (*Percopsidae*), perches (*Percidae*), bass (*Centrarchidae*), drums (*Sciaenidae*), and sticklebacks (*Gasterosteidae*). A brief description of reasons for the distribution and abundance of different fish species is also given, which includes geology, topography, physical and chemical factors (temperature and dissolved oxygen), and biological factors (food, breeding, predators and parasites). See (Hinks 1957), for supplementary information that was added to this book in 1957.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Hinks, D. 1957. The Fishes of Manitoba. The Department of Mines and Natural Resources, Winnipeg, MB. 117 p.

A reprint of "The Fisheries of Manitoba" (Hinks 1943) containing supplementary information by J. J. Keleher and B. Kooyman. The supplement contains changes that have occurred in the scientific and common names of some fisheries in the 14 years since the first publication, and biology of many fishes has been further clarified, and another eight fish species not mentioned in the original publication are now also found in Lake Manitoba and are included in the supplement.

Location: University of Manitoba, Elizabeth Dafoe Library, Call No. Gov Docs Can6 Man1 M5.7 F58 1943

Hochbaum, P. W. 1967. Contemporary Drainage with true prairie of the Glacial Lake Agassiz basin. In W.J. Mayer-Oakes, Life Land and Water. University of Manitoba Press. Winnipeg, MB. p 197-204.

A discussion of the remnant lakes of Glacial Lake Agassiz in southern Manitoba, southeastern Saskatchewan, northwestern Minnesota and northeastern North Dakota. The largest remnant waters of Glacial Lake Agassiz are the great lakes of Manitoba: Lake Manitoba, Lake Winnipeg, and Lake Winnipegosis. The paper briefly discusses the recent drainage characteristics of these three lakes, and their associated lake, rivers, marshes, and beaches. In terms of hydrology inflow and outflows Lake Manitoba is nearly a closed basin, and evaporation can often be greater than inflow. The hydrology and geology prairie potholes are also discussed. The marshes of Lake Manitoba and Lake Winnipeg are among the biggest and most known in the world for their migratory birds and waterfowl populations. The formation of Delta Marsh is briefly discussed. The paper also examines the influence of humans on the drainage characteristics of these lakes and their associated water bodies, including the drainage of marshes and the stabilization of water levels of Lake Manitoba and its associated effects on adjoining marshes. The creation of drainage ditches from the land to Lake Manitoba is also examined for their role in carrying loads of suspended sediments to the lake and associated changes to the bottom sediments of the lake. According to fisherman and cottages the bottom sediments of the southern proportion of the lake were once hard and sandy and they are now soft and muddy. The abundance of sauger and carp at the south end of the lake is apparently reflective of the now muddy bottoms. The author also urges for more studies on the waters entering the south end of the lake and their influence on the water quality of the lake, such as the Portage Diversion, which divests the silt rich spring waters of the Assiniboine River, and ditches and rivers that carry runoff from the surrounding agricultural lands.

Location: University of Manitoba, Elizabeth Dafoe Library, Call No. QE 697 .C68 1966

Hochbaum, P. W. 1971. The Delta Marsh. Department of Mines, Resources, and Environmental Management. 52 pp.

A brief description of Delta Marsh, and its role as a valuable waterfowl habitat. The seasonal sequence in the arrival, nesting, mating, young rearing, and departure of various waterfowl species at the marsh is also discussed, and a complete list of waterfowl that visit the marsh seasonally is presented.

Location: Manitoba Conservation and Environment Library, Call No. QL 114 H634 1971

Hochbaum, H. A. 1981. The Canvasback on a Prairie Marsh. Wildlife Management Institute and the University of Nebraska Press. Reprinted, original publication date 1944. 207 pp.

The book opens with a discussion of the changes that have occurred in Delta Marsh since 1938, including the Assiniboine Diversion, the regulation of water levels in Lake Manitoba and hence the marsh, effects of encroaching agricultural, the spread of the hybrid *Typha glauca*, and increased recreational use of the barrier beach. The preface also discusses the decline of the Canvasback over the past 50 years. The book itself examines biology of the Canvasback in regards to courtship, nesting season, brood season, post breeding season, and the autumn and shooting season. The book includes a description of Delta Marsh, which includes location and area, topography, vegetation, and wildlife and waterfowl usage. The book also discusses changes in the water levels of Lake Manitoba and hence the marsh from 1942 to 1958, and resultant changes in the vegetation of the marsh. Photographs of the marsh and Canvasbacks are included.

Location: Manitoba Conservation and Environment Library, Call No. QL 696 A52 H685 1981

Location: University of Manitoba, Science and Technology Library, Call No. QL 696 A5 H6

Hochbaum, H. A. and P. Ward. 1964. The Delta Marsh: Problems Associated with its Management Planning a Course for Future Action. Delta Waterfowl Research Station, unpublished report. 42 pp.

A report discussing the past and present status of Delta Marsh in 1964. Discussions include the past and present status of waterfowl, muskrat and other furbearers, and fish populations and productivity in the marsh. Several factors known or thought to be related to the diminish of fish and wildlife populations in the marsh are examined including effects of natural water levels, partial closure of Delta Channel, the regulation of water levels on Lake Manitoba, waterfowl hunting pressure, waterfowl sicknesses, muskrat diseases, carp introduction, sedimentation, and various conflicts of interests among uses of the marsh and surrounding lands including encroachment of surrounding agricultural lands, and effects of the proposed Assiniboine Diversion on the marsh (work on the diversion had not yet commenced at the time of the report). The economic and cultural values of the marsh and its resources to Manitoba are also discussed including aesthetics, tourism, habitat, waterfowl hunting, fur resources, haying and grazing. The report also discusses various plans for the management of the marsh for greater waterfowl, muskrat, and fish production. The report stress that need for further research to examine the water chemistry, limnology, fish, and vegetation of the marsh. The report also stresses that the Assiniboine River Diversion could have severe negative effects on Delta Marsh, and further studies need to be conducted examining possible effects of the diversion in the marsh.

Location: Delta Waterfowl Research Station, David Winton Bell Memorial Library

Hodgson, J. A. 1972. Whitemud River Watershed Resource Study Phase I: Land Use. Manitoba Department of Mines, Resources and Environmental Management. Winnipeg, MB. 14 pp.

A report describing the general land use pattern in the Whitemud Watershed. The report is part of the Whitemud River Watershed Resource Study Phase I. The Land use classification of the in the study area is broken up into: urban, horticulture, cropland, pasture and forage crops, native grassland, woodland, swamps and marshes, sand flats, rock and unvegetated surfaces, and water. Maps illustrating the various land uses in the study area are included. According to the report approximately two-thirds of the area is under cultivation or pastureland. The remaining area consists mainly of woodlands (21%) or native grassland (10%).

Other volumes of the Whitemud River Watershed Resources Study Phase I include: Fish (Falkner 1992), Wildlife (Goulden 1972), Interrelationships of vegetation, wildlife, and settlement (Ransom 1971), Agriculture (Jenkins 1972), and Outdoor recreation (Searth 1972).

Location: Manitoba Conservation and Environment Library, Call No. HD 319 M3 H63 1972

Hooper, D. and S. Toni. 1973. Selected Potential for Recreational Development Sites on Lake Manitoba. 64 pp.

A study conducted in May and June 1973, examining the beach recreational potential of various sites along the shore of Lake Manitoba, in light of the proposed changes to the regulation of water levels on Lake Manitoba, by lowering the target water level of the lake by six-inches. The report includes a physical description of Lake Manitoba and the surrounding shoreline. A total of 32 sites were evaluated for their potential for beach recreational use around one of five section of the lake; south basin, north basin east side, north basin west side, Peonan Point, and Reed Island. Sites were evaluated based on their beach composition, beach width, slope of exposed beach, offshore slope (water depth), developable backshore width, soils, and vegetation. The study found that with a few exceptions there was very low potential for further development of beach areas on Lake Manitoba. The best site on the lake occurred at Big Sandy Point on the west side of the south basin.

Location: Manitoba Conservation and Environment Library, Call No. GV 182.3 H66 1973

Huggins, R. C. 1977. Lower Whitemud River and Big Grass Marsh Flood Control Study: Phase I. Winnipeg, Man. Manitoba Department of Mines, Resources and Environmental Management, Water Resources Branch, Planning Branch, Winnipeg, MB.

The report summarizes engineering feasibility studies conducted on several flood control schemes to protect farms and communities along the lower Whitemud River and adjacent Big Grass Marsh. The report includes a brief physical description of the Whitemud Watershed, and a discussion of the historical nature of flooding and resultant damage in the watershed. Nine flood control schemes are reviewed and evaluated in the report, which propose to use various measures such as dams, reservoirs, and diversions in different locations in the watershed to control flooding. Overall the report concluded that none of the proposals had economically favorable benefit-cost ratios, based solely on benefits of spring flood damage reduction. The only scheme that was determined to provide the most effective flood protection in the overall watershed was a combination of a Diversion on Gopher Creek, flood storage in Big Grass Marsh, and regulated release from the marsh, and it was recommended that this scheme warranted further consideration in view of other types of long term benefits it might provide. Based on this, the report recommended that the Government undertake a second phase of study examining the effects, costs, benefits, and implications of this project, and consider modification to the design to take into consideration all the economic and environmental aspects affecting and affected by the project. The report includes several figures illustrating the watershed, and the various flood control schemes.

Phase II of this report (Schellenberg 1979), completed in 1979, is a multi-resource study examining the direct flood control benefits of select projects and other benefits that might accrue to agriculture, wildlife and recreation.

Location: Manitoba Conservation and Environment Library, Call No. TC 530 M3 H84 1979.

Hughes, C. 1983. A Report on the Trophic Status of Lake Manitoba. Basic Trophic Assessment Sub-program, Water Standards and Studies Section, Environmental Management Service Branch, Environmental Management Division. Water Standards and Studies Report No. 83-21. 9 pp.

During ice-free periods from 1980 to 1982, chlorophyll *a* and Secchi dish depth data were gathered from Lake Manitoba, near Twin Lakes Beach. Resultant chlorophyll *a* values indicated moderately high algal populations, and Secchi depths indicated poor water clarity probably the result of increased turbidity due to wind wave action along the beach where samples were collected. Trophic state indices for chlorophyll *a* indicated that the water in Lake Manitoba near Twin Lakes beach is mesotrophic.

Location: Manitoba Conservation and Environment Library, Call No. CA2 ME wss 83-21

Hughes, C. 1998. Water Quality Assessment, 1996 and 1997, Whitemud River Watershed, Manitoba, Canada. Water Quality Management Section, Manitoba Environment Report No. 98-04. 13 pp.

A study of the water quality conditions in the Whitemud River Watershed conducted between April and September of 1996 and 1997. The study was undertaken by the Whitemud Conservation District and the Water Quality Management Section of Manitoba Environment (now Manitoba Conservation). Sites sampled in 1996 and 1997 include the Whitemud River, Boggy Creek, Stoney Creek the Brookdale Drain, Big Grass Marsh drain, and Pine Creek. Parameters examined included pH, temperature, specific conductance, total suspended and dissolved solids, turbidity, bacteria, dissolved oxygen, Secchi depth, chlorophyll *a* and various forms of nitrogen and phosphorus. Concentrations of various parameters were compared at upstream and downstream sites. Results indicated decreases in ammonia-ammonium nitrogen concentrations downstream, high phosphorus concentration throughout the watershed, low chlorophyll *a* levels, and high fecal coliform counts at the Stoney Creek site. Tables and graphs illustrating trends in the results are included.

Location: Manitoba Conservation and Environment Library, Call No. ME r 98-04 c.2 MEW Main

Hughes, C. 1999. Water Quality Assessment of the Whitemud River Watershed, 1996 Through 1998, Manitoba, Canada. Water Quality Management Section, Manitoba Environment Report No. 99-06. 10 pp.

During the summers of 1996 through to 1998, a joint water quality study of the Whitemud River and its tributaries was carried out between the Whitemud Watershed Conservation District and Manitoba Environment's Water Quality Management Section, to gain a better understanding of the water quality conditions in the river, and the causes of water quality change along the river. A total of 11 sites were established for routine summer monitoring, with sampling taking place at seven sites in 1996, ten sites in 1997, and 11 sites in 1998. Streams in the Whitemud Drainage basin sampled in 1996 through 1998 included the Whitemud River, boggy Creek, the Brookdale Drain, the Big Grass Marsh Drain, and Pine Creek. In 1997 and 1998, monitoring was also undertaken on Stony and Spring Creeks and at an extra site on the Whitemud River. In 1998 an additional site was include in the Whitemud River and a one-time sample was collected from a tributary of Spring Creek near the town of Eden.

Water was analyzed in the field for temperature and Secchi disk depth, and water samples were collected for laboratory analysis of pH, specific conductance, total dissolved solids, total suspended solids, turbidity, fecal coliform bacteria, total and dissolved phosphorus, total Kjeldahl nitrogen, ammonia-ammonium nitrogen, total dissolved oxygen, and chlorophyll *a*.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 ME r 99-06

Location: Winnipeg Centennial Library, Call No. 363.7392 HUG

Inland Water Directorate. 1971 to 1991. Surface Water Data Manitoba 1969 to 1990. Inland Water Directorate, Water Resources Branch, Canada.

A summary of hydrometric surveys conducted in Manitoba from 1966 to 1990. Some of the water bodies examined in Manitoba included Lake Manitoba, Lake St. Martin, Lake Winnipegosis, Waterhen River and Lake, Assiniboine River, Whitemud River, and Fairford River. Information on lakes includes daily water levels for 1969 to 1990, historical maximum and minimum water levels, and the historical period of record. Information on rivers includes drainage area; period of record; historical mean, minimum, and maximum discharge, and daily discharge for 1966 to 1990. There are 23 volumes of hydrometric surveys conducted in Manitoba from 1966 to 1990; results from each year are in a separate report. Surveys in the years prior to 1969 (1965 to 1968) are published by the Canada Department of Energy, Mines and Resources (Canada Department of Energy, Mines and Resources 1965 to 1968).

Location: Manitoba Conservation and Environment Library, Call No. CA1 WS swd M1968 to M1990

Inland Water Directorate. 1972 to 1991. Historical Stream Flow summary, Manitoba 1970 to 1990. Inland Water Directorate, Water Resources Branch, Water Survey of Canada. Ottawa, Canada. 161 p.

A summary of historical stream flow data collected by the water survey of Canada from select rivers in Manitoba from 1970 to 1990. Some of the rivers examined in Manitoba include the Assiniboine River, Whitemud River, Fairford River, Big Grass River, Dauphin River, and Waterhen River. Information given includes monthly and annual discharges at select sites along the rivers (latitude and long of sample location is given); drainage area; whether the flow is natural or regulated (the year regulation began is given); and maximum, minimum, and total discharge for each year of record. There are nine volumes of surveys conducted in Manitoba from 1973 to 1990; results from every second or third year (1970, 1973, 1975, 1979, 1982, 1984, 1986, 1988, and 1990) are in a separate report.

Location: Manitoba Conservation and Environment Library, Call No. CA1 WS hss M 1970 to 1990

Location: University of Manitoba, Science and Technology Library, Call No. GB 1230 .M33 A34 1970 to 1990

Inland Waters Directorate. 1973. Inventory of Canadian Freshwater Lakes. Inland Water Directorate, Water Resources Branch, Canada. 34 pp.

An inventory of freshwater lakes in Canada includes location and size. Various maps are included showing the lakes and their surrounding watershed.

Location: University of Manitoba, Science and Technology Library, Call No. GB 1629 c35

Inland Waters Directorate. 1974 to 1992. Sediment Data Canadian Rivers 1969 to 1990.
Inland Waters Directorate, Water Resources Branch, Water Survey of Canada,
Ottawa, Canada.

A summary of sediment surveys conducted from 1969 to 1990 in rivers throughout Canada. The Assiniboine River is among the rivers located in Manitoba examined in the report. Data presented includes streamflow; instantaneous suspended sediment concentrations; daily mean suspended sediment concentrations; daily suspended sediment loads, dissolved solids concentrations; load summary; particle-size distribution of suspended sediments in percent sand, silt, clay; bed load and bed material; and water temperature. Description information about sampling locations is given and includes location, latitude and longitude, drainage area and whether the flow is natural or regulated (the year that regulation began is given), type of gauge and the total suspended sediment load in tones for the period of record is also included. Historical sediment data collect on the rivers from 1969 to 1980 is also given for some of the rivers, and includes maximum, minimum, and total suspended sediment load. There are several volumes of publications, the results of each year of monitoring from 1969 to 1990 is in a separate report. Surveys in years prior to 1969 (1966 to 1968) were published by the Canada Department of Energy, Mines and Resources (Canada Department of Energy, Mines and Resources 1969 to 1972).

Location: Manitoba Conservation and Environment Library, Call No. CA1 WS sdcr 1969 to 1990

Inland Waters Directorate. 1978. Water Quality data Manitoba 1961-1976. Environment
Canada, Water survey of Canada. Ottawa, Canada.

A summary of water quality data in table format collected during the period from January 1961 to December 1976 in Manitoba, by the Water Quality Branch laboratories as part of the National Water Quality Monitoring Program by Environment Canada. A few of the water bodies examined in the report include the Assiniboine River, Fairford River, Dauphin River, Waterhen River, and Whitemud River. A map of Manitoba illustrating the sampling locations is included in the report. An extensive and detailed list of water quality parameters are assessed in the report including pH, temperature, specific conductance, alkalinity, dissolved oxygen, total hardness, coliforms (total and fecal), turbidity, color, suspended and dissolved solids (organic and inorganic), various forms of nitrogen and phosphorus, and numerous pesticides, metals, and other dissolved minerals and ions. The data from this report are also stored on the Environment Canada NAQUADAT computerized storage and retrieval system.

Location: University of Manitoba, Elizabeth Dafoe Library, Call No. Gov Docs Can1 En912.8 Q92 M26 1961-1976.

Inland Waters Directorate. 1980 to 1991. Historical Water Levels Summary 1979 to 1990.
Inland waters Directorate, Water Resources Branch, Water Survey of Canada. Ottawa,
Canada.

A summary of hydrometric surveys conducted in various lakes throughout Manitoba from 1979 to 1990. Information given includes monthly and annual mean water levels, drainage area, and whether flow is natural or regulated (the year regulations began is given). Some of the lakes examined in the report included Lake Manitoba, Lake St. Martin, and Waterhen Lake. There are five volumes of surveys conducted in Manitoba from 1979 to 1990; results from every second or third year (1979, 1982, 1985, 1987 and 1990) are in a separate report.

Location: Manitoba Conservation and Environment Library, Call No. GB 1230 M278 L657 1979 to 1990

Location: University of Manitoba, Science and Technology Library, Call No. GB 707. H588
1987

Inland Waters Directorate. 1980. Detailed surface water quality data Manitoba 1974-1976. Environment Canada, Water survey of Canada. Ottawa, Canada.

A summary of water quality data in table format collected during the period from January 1974 to 1976 in Manitoba, by the Water Quality Branch laboratories as part of the National Water Quality Monitoring Program by Environment Canada. This report is the first in a series of reports from the Inland Water Directorate examining detailed surface water quality in Manitoba. A few of the water bodies examined in the report include the Assiniboine River, Fairford River, Dauphin River, Waterhen River, and Whitemud River. A map of Manitoba illustrating the sampling locations is included in the report. An extensive and detailed list of water quality parameters are assessed in the report including pH, dissolved oxygen, temperature, specific conductance, alkalinity, total hardness, coliforms (total and fecal), turbidity, color, suspended and dissolved solids (organic and inorganic), various forms of nitrogen and phosphorus, and numerous pesticides, metals, and other dissolved minerals and ions. The data from this report are also stored on the Environment Canada NAQUADAT computerized storage and retrieval system.

Location: University of Manitoba, Elizabeth Dafoe Library, Call No. Gov Docs Can1
En912.8 Q92 M26 1974-1976

Inland Water Directorate. 1982a. Detailed surface water quality data Manitoba 1977-1979. Environment Canada, Water survey of Canada. Ottawa, Canada.

A summary of chemical and biological water quality data in tabular format collected during the period from 1977 to 1979 in Manitoba, by the Water Quality Branch laboratories as part of the National Water Quality Monitoring Program by Environment Canada. This report is the second of a series of reports examining detailed surface water quality in Manitoba. A few of the water bodies examined in the report include the Assiniboine River, Dauphin River, and Waterhen River. A map of Manitoba illustrating the sampling locations is included in the report. An extensive and detailed list of water quality parameters are assessed in the report including pH, temperature, dissolved oxygen, specific conductance, alkalinity, total hardness, coliforms (total and fecal), turbidity, color, suspended and dissolved solids (organic and inorganic), various forms of nitrogen and phosphorus, and numerous pesticides, metals, and other dissolved minerals and ions. The data from this report are also stored on the Environment Canada NAQUADAT computerized storage and retrieval system.

Location: University of Manitoba, Elizabeth Dafoe Library, Call No. Gov Docs Can1
En912.8 Q92 M26 1977-1979

Inland Waters Directorate and Manitoba Department of Natural Resources. 1982b. Portage Reservoir Sedimentation Study 1982. Inland Waters Directorate, water Resources Branch, Water Survey of Canada; and Manitoba Department of Natural Resources, Water Resources Branch, Water Control Works Section. Winnipeg, MB. 19 pp.

A study examining sedimentation in the Portage Reservoir conducted between 1970 and 1980 to determine patterns of erosion and sedimentation in the length of the reservoir and relationships between erosion and deposition and the magnitude of river flow. The Portage Reservoir is located at the head of the dam that controls flow through the Assiniboine River Diversion. The rate of sedimentation in the reservoir was determined from topographic surveys and suspended sediment surveys conducted from 1970 to 1980 in the reservoir and stretches of the Assiniboine River upstream and downstream of the reservoir. The rate of sedimentation was found to be less than one percent of the reservoir capacity per year. The study found that sediment deposition occurs in the reservoir predominantly in years with flow peaks less than 40 000 cfs, and erosion predominates in years with higher flood peaks. Figures are included showing sample sites, water levels

of the Assiniboine River, profiles of various ranges the Assiniboine River, and siltation erosion and deposition in the reservoir from 1971 to 1977.

Location: Manitoba Conservation and Environment Library, Call No. TD 396 M3 N38 1982

Inland Waters Directorate. 1988. Miscellaneous Sediment Data Canada 1966-1983. Inland Waters Directorate, Water Resources Branch, Water Survey of Canada, Ottawa, Canada.

A summary of sediment surveys conducted from 1966 to 1983 in select rivers in Canada. Rivers examined in Manitoba included the Assiniboine River and Whitemud River. Data presented includes streamflow; instantaneous suspended sediment concentrations; daily mean suspended sediment concentrations; daily suspended sediment loads, dissolved solids concentrations; load summary; particle-size distribution of suspended sediments in percent sand, silt, clay; bed load and bed material; and water temperature. Description information about sampling locations are also given and includes location, latitude and longitude, drainage area and whether the flow is natural or regulated (the year that regulation began is given), type of gauge and the total suspended sediment load in tones for the period of record is also included.

Location: Manitoba Conservation and Environment Library, Call No. CA1 WS msd c 1966-83

International Garrison Diversion Study Board. 1976a. Report to the International Joint Commission – 1976. International Joint Commission, Ottawa, Ont.

A report on the possible effects of the Garrison Diversion on the quantity and quality of waters in Manitoba and the introduction of foreign Biota. The Garrison Diversion would involve the transfer of water from the Missouri River into the drainage basin of the James, Souris, and Red Rivers. Water bodies of concern that have the potential to be effected by the Garrison Diversion include the Souris River, Assiniboine River, Red River, Lake Manitoba, and Lake Winnipeg. A general description of the study area, which includes the Souris, Assiniboine and Red River Basins and Lakes Manitoba and Winnipeg, is given in the report. The description includes physical features such as geography, physiography, climate, and social features such as population and economy. The report includes a background description of the Garrison Diversion, along with the public concerns related to the possible effects of the project. The current state of water quality and biology in the study areas is also given. The potential impacts of the Garrison Diversion on water quality and quantity of water bodies in the study are discussed, with the major concerns including increases in suspended solids, dissolved salts and heavy metals and other changes in water quality. Several tables and graphs are included that illustrate current conditions and projected conditions after the Garrison Diversion. Other concerns include possible affects on fish and wildlife in Manitoba, and the transfer of foreign biota, and fish parasites and disease.

Location: Manitoba Conservation and Environment Library, Call No. TC 425 M56N9 I5R4 1976 v.1

International Garrison Diversion Study Board. 1976b. Report to the International Joint Commission – 1976: Appendix A. Water Quality Report. International Joint Commission, Ottawa, Ont.

Appendixes of the International Garrison Diversion Study Board Report on the Garrison Diversion (International Garrison Diversion Study Board 1976a), containing the Water Quality Committees report on the current and predicted future (after Garrison Diversion) water quality conditions in the Red River, Souris River, Assiniboine River, and lakes Manitoba and Winnipeg. The current water quality conditions in these water bodies are summarized, and presented in various tables and graphs. Water quality data present was gathered from NAQUADAT (the Canadian national computer data storage and retrieval system). Present water quality conditions in Lake Manitoba were determined from data available from 1966 to 1975, and similarly conditions

in the Assiniboine River were determined from data available from 1960 to 1975. Water quality parameters examined include temperature, pH, total dissolved solids, dissolved oxygen, bicarbonate, silica, discharge, various form of nitrogen and phosphorus, and various metals, pesticides, and other dissolved mineral and ions. The future predicted water quality conditions, after the Garrison Diversion, are discussed and examined thoroughly. The location, morphometry, drainage area, and water budgets of the water bodies are also discussed.

Location: Manitoba Conservation and Environment Library, Call No. TC 425 M56N9 15R4 v.2

International Garrison Diversion Study Board. 1976c. Report to the International Joint Commission – 1976: Appendix B. Water Quality Report. International Joint Commission, Ottawa, Ont.

Appendixes of the International Garrison Diversion Study Board Report on the Garrison Diversion (International Garrison Diversion Study Board 1976a), containing information on stream flows and flooded areas required to determine the effects of the Garrison Diversion on the Souris, Assiniboine, and Red rivers, and lakes Winnipeg and Manitoba. The report describes historic flows and the effects on the Garrison Diversion on these flows and flooded areas. Flow characteristics of the five major water bodies are discussed, and are presented in graphic and tabular form. General descriptions of the study area area also given, which includes geography, climate, population and economy.

Location: Manitoba Conservation and Environment Library, Call No. TC 425 M56N9 15R4 v.3

International Garrison Diversion Study Board. 1976d. Report to the International Joint Commission – 1976: Appendix C. Biology Report. International Joint Commission, Ottawa, Ont.

Appendixes of the International Garrison Diversion Study Board Report on the Garrison Diversion (International Garrison Diversion Study Board 1976a), containing the Biology Committees report on the potential impacts of the Garrison Diversion on living resources (wildlife, fish, aquatic invertebrates, humans and other animals, plants, and eutrophication of lakes and streams) in Manitoba through changes in water quality and quantity and introduction of exotic species. The report includes information on marshes, waterfowl, amphibians and reptiles, birds, mammals, fish, aquatic invertebrates, plants, lake eutrophication, human and animal diseases in Manitoba, and the effects of the Garrison diversion on these resources. The Report also contains species lists for birds, mammals, fish, parasites, aquatic invertebrates, macrophytes, amphibian and reptiles in Manitoba.

Location: Manitoba Conservation and Environment Library, Call No. TC 425 M56N9 15R4 v.4

Jenkins, G. C. 1972. The Agricultural Capability, Degree and Extent of Soil Erosion and Soil Productivity of the Whitemud River Watershed. Whitemud River Watershed Resource Study Phase I: An Inventory of the Agricultural Capability, Productivity and Eroded State of Soils. Manitoba Department of Mines, Resources and Environmental Management. Winnipeg, MB. 77 pp.

A report describing the extent and severity of soils erosion, the capacity of the soil for agriculture, the productivity rating of the soil for annual crops, forage, and grazing the in the Whitemud Watershed. The report is part of the Whitemud River Watershed Resource Study Phase I. Studies were conducted in the summer of 1971. The report includes a general description of the study area, which includes topography, drainage,

geology, soils, vegetation, and climate. The report includes a discussion of land use and soil erosion problems in the watershed. Approximately 56 percent of the study area is under cultivation and 10 percent is forage. Trees and shrubs cover 21.4 percent of the area, native grasses 10 percent, and marsh and open water occupy 1.5 percent. Maps are included showing soil capability for agriculture, soil classification and erosion, and land use classification.

Other volumes of the Whitemud River Watershed Resources Study Phase I include: Fish (Falkner 1992), Wildlife (Goulden 1972), Interrelationships of vegetation, wildlife, and settlement (Ransom 1971), Land use (Hodgson 1972), and Outdoor recreation (Searth 1972).

Location: Manitoba Conservation and Environment Library, Call No. HD 319 M3 H63 1972

Jenkins, G. C. 1974. Whitemud River Watershed Resources Study. Manitoba Department of Mines, Resources and Environmental Management, Winnipeg, MB.

A report on the magnitude and types of resources in the Whitemud River Watershed, and their changes over the past 100 years and problems associated with these resources. Also included is a physical description of the watershed including location and size, surface characteristics, subsurface characteristics, drainage, climate, vegetation, and land use. Several figures and graphs are included that illustrate these physical characteristics of the watershed. The report includes detailed description of the resources of the watershed including land use, recreation, wildlife habitat, and people, along with their associated problems. The general surface and groundwater quality of the watershed are also examined in terms of its range from poor to good, along with water related problems, including water pollution, flooding, and a decline in fish resources. The short-term and long-term capacity of various resources in the watershed also examined including agriculture, wildlife, recreation, and forestry.

Location: Manitoba Conservation and Environment Library, Call No. TC 426.5 M3W5

Jones, R. E. 1978. Delta Marsh Plan. Delta Marsh Technical Advisory Committee and the Project Directorate. Winnipeg, Manitoba. MSc Thesis, University of Manitoba, Winnipeg, Manitoba. 66 pp.

The report discusses the deteriorating state of Delta Marsh resulting from the stabilization of water level on Lake Manitoba since 1961, and examines ways that the marsh can be rehabilitated to a more healthy and productive state to increase waterfowl staging, fish and wildlife production in the marsh. The report proposes to restore natural water level fluctuations in the marsh, allowing periodic periods of drawdown and flooding in the marsh. The plan divides the marsh into five management units: West unit (between Lynch's Point and the Portage Diversion), School Bay unit (between the Portage Diversion and Delta road 240), East unit (between Delta road 240 and Cattle Creek dyke), Sioux Pass unit (Sioux Pass Lake), and Lake Francis unit (between St. Ambrose Ridge to St. Laurent). The physical characteristics of each unit of the marsh are given along with plans for managing water levels in each unit with dykes and control structures. Water requirement and sources for the management of water levels are examined; sources of water discussed include rainfall, surface runoff, Lake Manitoba and the Assiniboine River Diversion. The report also discusses how the marsh will be managed for the enhancement of fisheries, waterfowl and furbearers (muskrat) production and populations. The report also includes a discussion of various other problems that are affecting the marsh including runoff and encroachment from surrounding agricultural land, soil salinity problems, damage from carp, and a reduction in fish access to the marsh.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Jones, G. and N. Armstrong. 2001. Long-term Trends in Total Nitrogen and Total Phosphorus Concentrations in Manitoba Streams. Manitoba Conservation Report No. 2001-07. Manitoba Conservation. Winnipeg, MB. 154 pp.

A report examining water quality data collected from 1970 to 1999 to determine temporal trends in the nutrient concentrations of nitrogen and phosphorus in 33 rivers through Manitoba. Some of the rivers examined in the report include the Assiniboine River, Whitemud River, Waterhen River, and Dauphin River. An overview of the problems associated with increased nutrient concentrations in waterways is given. Water quality data was collected on the rivers mentioned above as far back as 1970 in some cases, up until 1999. The report gives a brief description of each river including location, drainage area, and surrounding land uses. Trends in total nitrogen and total phosphorus are examined and discussed for each river.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MC r 2001-07

Katopodis, C. and R. J. Bowering. 1975. East Delta Marsh Hydrologic Study. Manitoba Department of Mines, Resources, and Environmental Management, Water Resources Branch, Planning Branch. Winnipeg, MB. 12 pp.

A hydrological study of Delta Marsh, examining the proposed removal of a fixed crest dam on Clandeboye Bay and flap gates on Delta Channel, which were both installed in the 1940s to increase water levels in the marsh. The study also examines replacing these structures with gated control structures. The study was conducted because it was felt that the stability of water levels brought on by these structures was detrimental to the marsh. The report includes a brief physical description of the marsh, and a discussion of historical development of the marsh to maximize waterfowl and forbears productivity, including structures that have been constructed in the marsh to control water levels. The historical water levels of Lake Manitoba and the regulation of lake since 1934 via a dam on the Fairford River, which was upgraded in 1961 to the present Fairford Dam is also discussed, with reference to its effects on stabilizing water levels in Lake Manitoba. The majority of the report focuses on the two alternative means of modifying the control structures in the marsh, and their possible effects on the marsh. The report concludes that if the control structures are removed short-term water level fluctuations in the marsh could be severe, and waterfowl nests could be destroyed. On the other hand, if gated structures are installed, water levels in the marsh could be controlled. However, building the gated structures could carry a high cost, and they would have to be monitored and operated properly. Nevertheless, if the productivity of the marsh is to be improved, some costs must be expected.

Various tables, graphs, and figures are included in the report which show wind setup on Lake Manitoba; water levels in Lake Manitoba (1921 to 1972); evaporation, runoff, and precipitation rates for Delta Marsh (1921-1972); water levels for Delta Marsh (1921 to 1972); and water levels in the marsh with water control structures removed and new structures.

Location: Delta Waterfowl Research Station, David Winton Bell Memorial Library

Keleher, J. J. 1952. Interim Report on Ciscoes, *Leucichthys*, Collected from Lakes Manitoba, Dauphin and Winnipegosis. Fisheries Research Board of Canada. MS Research Report 92. Winnipeg, MB. 15 pp.

An examination of cisco, *Leucichthys* species present in lakes Manitoba, Dauphin and Winnipegosis. A total of 704 ciscoes were obtained from Lake Manitoba near Delta, Langruth, Wapaa, Guynemer and Meadow Portage. The fish collected were examined for taxonomy, various measurements, and the presence of the *Triaenophorus crassus*. Lake Manitoba ciscoes collected from the southern and lower northern area of the lake had few parasites, but those caught near Meadow Portage had higher rates of infection.

Location: Manitoba Conservation and Environment Library, Call No. SH 175 K45 1952 no.92

Kenkel, N. C. 1987. Vegetation structure and dynamics of the barrier-beach ridge at Delta, Lake Manitoba. University Field Station (Delta Marsh) 1986 Annual Report 21: 61-83.

A study examining the structure and dynamics of forest vegetation along the barrier beach ridge that separates Delta Marsh from Lake Manitoba. The study investigates the size class, spatial distribution, spatial patterns, and dynamics of the vegetation on the forest ridge since Lake Manitoba was stabilized in 1961. A physical description of the barrier beach is given which includes climate, location, vegetation, soils, and quaternary and recent history. Results from the study indicate that stabilization of water levels in Lake Manitoba have had a profound influence on the structure and dynamics of the forested barrier beach. The forest has expanded approximately 50 m into the Lake Basin since the stabilization. Less flood tolerant species have also been favored by stabilization, and they have been able to colonize areas from which they were previously excluded.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Kenkel, N. C. 1993. Ecohydrological changes and vegetation dynamics in the Delta Marsh: preliminary discussion. University Field Station (Delta Marsh) 1982 Annual Report 27: 57-60.

A study examining the effects of the water level stabilization of Lake Manitoba via the Fairford Dam in 1961, on the vegetation dynamics of Delta Marsh. Water level stabilization can be detrimental to long-term viability and productivity of the marsh as it effects natural wet/dry cycles in marshes by reducing the magnitude of drawdowns and flooding phases in the marsh thereby preventing natural marsh rejuvenation, and keeping the marsh in a 'lake marsh' phase of lowered productivity, species richness and habitat diversity. Prior to 1961 marsh water levels fluctuated over 2 m, however since the dam fluctuations have been less than 50 cm. The study examines the growth, species composition and encroachment of woody vegetation along the shore of Lake Manitoba. Results indicate that the stabilization of Lake Manitoba has led to the expansion of woody vegetation into areas previously dominated by marsh vegetation. Water level stabilization has also led to the increased abundance and encroachment of *Typha* sp. in the marsh in areas formerly dominated by *P. australis*, and in previously open water areas, thereby reducing open water area. Future research is planned to quantify the spatial and demographic patterns of woody species along the south shore of Lake Manitoba to examine vegetation colonization along lakes following artificial stabilization of water levels.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Kenkel, N. C. 1996. Environmental persistence and the structure/composition of north prairie marshes. University Field Station (Delta Marsh) 1995 Annual Report 30: 93- 98.

An examination of effect of Lake Manitoba water level stabilization on the dynamics of vegetation composition at Delta Marsh. Vegetative composition prior to (1924-1960) and following (1992-1996) water level regulation is compared and contrasted by using fractal-based time series analysis to examine Lake Manitoba water levels prior to and after regulation. Fluctuations in water levels play a key role in the marsh vegetation dynamics by promoting and maintaining high levels of species richness and habitat diversity. Since 1961, water levels in Lake Manitoba have been regulated by the Fairford Dam, and this has largely reduced the magnitude of water level fluctuations on the Lake and Delta Marsh, as before regulation water levels varied over 1.7 m, and since regulation fluctuations have been less than 0.5 m. This has in part disrupted the natural wet/dry cycle of water

level fluctuations in the marsh and preventing marsh rejuvenation and lowering productivity and species diversity. Results of the statistical analysis indicate that in fact regulation has stabilized lake level. Water level fluctuations have become less persistent in Lake Manitoba since regulation, reducing or even eliminating the probability of *prolonged* flooding or drawdown events in Delta Marsh. The reduction in magnitude and persistence of water level fluctuations have strongly influenced the vegetation composition, structure, and productivity of the marsh. Delta marsh, like other marshes is disturbance driven and require periodic and prolonged food-drawdown events to maintain its diversity. Water level stabilization has dampened this natural disturbance regime and favored strongly competitive plants that persist under stable conditions, over those that require prolonged, higher magnitude water dry/wet cycles characterized by the marsh prior to regulation.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Kennedy W. A. 1948. Recent increases in growth rates in two species of Lake MB fish. Canadian Fisheries Culturist 3: 18-19.

In the winters of 1945 to 1946 and 1946 to 1947 the Fisheries Research Board of Canada in cooperation with the Manitoba Department of Mines and Natural Resources conducted a survey of the Lake Manitoba Fishery. The survey found that the average growth rate of sauger, *Stizostedion canadense*, and of dore, *Stizostedion vitreum*, had increased of the last few years since 1937. An explanation for the increase in growth rate of sauger was attribute to changes in commercial fishery since 1930. Prior to 1930 sauger were virtually unknown to commercial fisherman of the lake, during the 1930s they began to increase in numbers in catches. During this time water levels on the lake were quite low, and it was believed sauger increased in numbers as a result. Also, once the mesh size of nets was legally increased to 3¼ inches in the winter of 1940-41, catches peaked, and thereafter they decreased. The increase in growth rate was therefore attributed to a decrease in overall number due to exploitation. The increase in the growth rate of dole was attributed to the decrease in sauger population numbers, as they are likely competitors.

Location: University of Manitoba, Elizabeth Dafoe Library, 3rd floor, Call No. 639.2072 C161

Kennedy, W. A. 1949a. The determination of optimum size of mesh for gill nets in Lake Manitoba. Transactions of The American Fisheries Society 79: 167-179.

The study examines the optimum size mesh size for use in Lake Manitoba for the winter fishery. Studies were conducted in during the winters of 1945 to 1946 and 1946 to 1947. A list of the major commercial fishes present in Lake Manitoba is given, which includes pikeperch, sauger, and perch. Tullibee are also taken, but are of little value. Whitefish, suckers, and pike are of minor importance and several other species including goldeye are occasionally caught. Burbot is caught but has no commercial value. The history of the fishery on Lake Manitoba is discussed from 1888 to 1948. From examination of mortality, growth rates, and spawning habits of perchpike and sauger it was determined that a mesh size between 3 inches and 3¾ inches would be the best.

Location: University of Manitoba, Science and Technology Library, Call No. 630 A512 Tr

Kennedy, W. A. 1949b. Relationship of length, weight, and sexual maturity to age in three species of Lake Manitoba fish. Bulletin Fisheries Research Board of Canada. 5pp.

During the winter of 1945 to 1946 and 1946 to 1947 a large number of fish were taken from Lake Manitoba for examination, with gill nets ranging from 1½ to 5¼ inch mesh. Fish were examined for length, weight, state of maturity, and sex. The most important commercial fish species examined in the study included pikeperch (*Stizostedion vitreum*), sauger (*Stizostedion canadense*), and perch (*Perca flavescens*).

Location: University of Manitoba, Science and Technology Library, Call No. SH 223 A344 no. 185

Kiers, A. and B. J. Hann. 1996. Seasonal abundance of fish in Delta Marsh. University Field Station (Delta Marsh) 1995 Annual Report 30: 85.

A study examining the spatial and temporal distribution of fish species at four sites in the Blind Channel of Delta Marsh, from May to August 1995. Water temperature, turbidity, and dissolved oxygen were measured at sample sites, to examine the influence of these environmental variable on fish populations in the marsh. Results of the study showed that the Blind Channel is used by several species of fish (fathead minnows, five-spined and nine-spined sticklebacks, yellow perch, spot-tailed shiners, white sucker, carp, brown and black bullheads and Iowa darter) for spawning, rearing and foraging. The seasonal usage of the marsh by fish appear to peak in late spring-early summer, with a period of low fish populations in the mid-summer, and a smaller peak in the fall.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Klassen, R. W. 1967. Surficial Geology of the Waterhen-Grand Rapids Area, Manitoba 63B, 63G. Department of Energy, Mines and Resources. Geological Survey of Canada Paper 66-36. Ottawa, Ont. 6pp.

A brief paper on the surficial geology of the Waterhen and Grand Rapids areas in the Interlake Region of Manitoba. A description of physiography and bedrock, surficial deposits, and glacial history of the area is given.

Location: Manitoba Conservation and Environment Library, Call No. TN 27 M3 K55 1967

Kohuska, A. 1970. Lake Manitoba to Pembina Triangle Diversion Assiniboine River Pump Station Preliminary Soil Mechanics Report. Prepared for the Saskatchewan-Nelson Basin Project. Manitoba Department of Mines and Natural Resources, Water Control and Conservation Branch, Planning Division. Winnipeg, MB. 15 pp.

A report on the soil mechanics of the area surrounding the proposed Assiniboine River Pump Station, which was proposed to divert water from the Lake Manitoba to the Pembina Triangle. The project involved pumping water from Lake Manitoba into the impoundment behind the diversion works by the means of the Portage Diversion, then into the proposed Hood Dam Reservoir. The proposed pump station was to be located in Section 19, Township 9, Range 8 west. Boreholes 300 feet in depth were drilled during July 1969 to examine the soils, and geology of the study area. The topography of the area is also briefly described. The report includes recommendations for the pump station, intake structures, and Discharge pipes and structure.

Location: Manitoba Conservation and Environment Library, Call No. TA 710.4 C22 M3 L35 1970

Krindle, D. 1971. Seasonal abundance of fish in Delta Marsh. University Field Station (Delta Marsh) 1970 Annual Report 5: 20.

A preliminary study examining the effect of the operation of the Assiniboine Diversion on the south end of Lake Manitoba in 1970. In 1970 the Diversion was in operation from April 17 to May 8. Four stations were set up in Lake Manitoba: 1) 125 m north of Cram Creek, 2) 400 m west and 125 m north of the Diversion, 3) 125 m north of the Diversion, and 3) 5 125 north and 400 m west of the diversion. Phytoplankton counts and species composition, zooplankton species composition, water chemistry, and biological oxygen demand (BOD) were sampled at weekly intervals. Results of the study showed no significant difference in zooplankton composition and water chemistry between the sample sites. From the study it appears the Diversion doesn't have a large impact on zooplankton, phytoplankton, and water chemistry of Lake Manitoba. The author suggests a more comprehensive study examines the effects of the Assiniboine River Diversion on Lake Manitoba.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Kruszynski, G. 1984. Short Term Colonization by Periphytic Diatoms in the Blind Channel, Delta Marsh: A Preliminary Report. University of Manitoba Field Station (Delta Marsh) 1983 Annual Report 17: 83-89.

A study examining the initial colonization of artificial substrata with periphytic communities, conducted in the Blind Channel of Delta Marsh between May and August 1983. Preliminary results of the study showed that during early May the substrata was colonized with an abundant diatom community, over 80 taxa. *Cyclotella*, *Fragilaria*, *Navicula* and *Nitzschia* were the dominant genera. A change in cell density occurred in the second week of sampling, and the dominance shifted to *Fragilaria vaucheriae*, *F. virescens*, and *Nitzschia acicularis*. Colonization rates increased from the first week of sampling to the second from 96 to 284 cells/mm/wk. Overall colonization rates then declined in the third week.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Kruszynski, G. M. 1989. Investigations into the Existence of Associations Within benthic Diatom Communities. MSc Thesis, University of Manitoba. Winnipeg, MB. 97 pp.

A study examining associations between haptobenthic and herpobenthic diatom communities and their surrounding environment using multivariate statistical analysis. Several associations were shown to exist between epiphytic, epipellic, epilithic, epipsammic, and periphytic diatom communities. These benthic algal associations were found to be closely related to the limnological status of the water bodies examined along with nutrient status, pH, general habitat and season. Field studies were also conducted in Delta Marsh to determine if seasonal diatom associations were present in the benthic community of the marsh. Distinct seasonal associations in periphytic diatom were found to exist in the marsh. Variations in the composition of the periphytic diatom community during various seasons (spring, summer and fall) throughout the study are described and examined.

Location: University of Manitoba, Elizabeth Dafoe Library, Thesis K9465.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Kuiper, E. 1958. Benefit Cost Analysis, Lake Manitoba Regulation. Manitoba Department of Public Works, Winnipeg, Manitoba. 22 pp.

A cost analysis report examining costs associated with the regulation of Lake Manitoba in the late 1950s. The report discusses the control of Lake Manitoba by means of a new control dam and channel enlargement on the Fairford River at the outlet of Lake Manitoba. The channel enlargement and dam will reduce to natural water level range of Lake Manitoba from 810.3 – 815.8 feet ASL to an artificial range of 811.0 to 813.0 feet ASL. The report also briefly touches upon other related projects including the development of power of the Dauphin and Nelson Rivers, the Assiniboine River Diversion, and the water supply channel from Lake Manitoba to the Assiniboine River. The possible effects of Lake Manitoba Regulation on Lake Winnipeg are also examined. The benefits of Lake Manitoba regulation are determined based on frequency and magnitude of damage caused by extreme water level fluctuations on the lake. Reduced flooding to agricultural land is the primary benefit of regulation examined in the report. Historical overviews of extreme water levels in the lake are given based on records as far back as 1882. Overall, the report found that the regulation of Lake Manitoba would be economically feasible since the benefit/cost ratio of the project was found to be 1.8.

Location: Manitoba Legislative Library, Call No. TC M31

Kuiper, E. 1961. Benefit cost analysis, Assiniboine River flood control water conservation. Department of Agriculture and Conservation, Water Control and Conservation Branch, Winnipeg, MB. 28 pp.

Benefit-cost analysis of flood control projects on the Assiniboine River: the Shell mouth Dam and Portage Diversion. The study was carried out from August to December 1960, and evaluated the effectiveness of the proposed flood control projects based on examining flood hydrographs of the river with and without the various combinations of flood control projects in place. For each combination, the resultant flood stages and damage reduction along the Assiniboine River were determined. The study found that the most feasible plan for preventing food threats and ensuring a adequate water supply for demands along the river was a combination of the Shellmouth Dam at a cost of \$7 500 000, and the 25 000 cfs Portage Diversion at the High Bluff site, at a cost of \$9 100 000. The benefit-cost ratio of the project was found to be 2.7.

Location: University of Manitoba, Science and Technology Library, Call No. HD 1696 C34 A88

Lakes Winnipeg and Manitoba Board 1958a. Report on Measures for the Control of the Waters of Lakes Winnipeg and Manitoba, Province of Manitoba. Province of Manitoba, Winnipeg, MB. 58 pp.

A report from the Lakes Winnipeg and Manitoba Board regarding the regulation of Lakes Manitoba and Winnipeg for flood control; the regulation of Nelson River for power development; the regulation of the lower Saskatchewan River for the reclamation of the Saskatchewan Delta for agricultural development, and hydro-electric development; and the regulation of the lower Assiniboine River for flood diversion, and water supply. The main purpose of the report was to determine the best way(s) to regulate Lakes Manitoba and Winnipeg to reduce the incidence of extreme high and low water levels, and to regulate the flow of the Nelson River for power development. The report includes a general description of the study areas. The report discusses the problems associated with extremely high and low water levels in the lakes, including loss of agricultural lands, erosion of the shoreline, inconveniences to cottage owners and boaters, and detrimental effects on fish and waterfowl.

The report proposes two ways of controlling water levels in Lake Manitoba: using Lake Winnipegosis as a regulating reservoir, or the construction of a control structure at the outlet of Lake Manitoba, on the Fairford River. The second method, a control structure on the Fairford River, was determined to be more economically feasible at regulating Lake Manitoba between the proposed range of 811.0 and 813.2 feet FSL. Discussion of the regulation of the Assiniboine River included two projects: the diversion of Assiniboine River flood waters into Lake Manitoba during high flow periods, and the diversion of Lake Manitoba waters into the Assiniboine River through a supply channel to increase river flow through greater Winnipeg during dry periods. The report determined both projects would have no appreciable detrimental effects on Lake Manitoba, and recommended the construction of both projects: the Assiniboine River Diversion into Lake Manitoba, and the water supply channel from Lake Manitoba into the Assiniboine River.

The report includes diagrams of the proposed water level regulations schemes; hydrographs of recorded water levels on Lakes Manitoba and Winnipeg from 1914 to 1957, and simulations of water levels under regulation for the same time period; and diagrams of the proposed Fairford Control Structure. The appendixes of the report are included in separate supplementary volumes, appendix one to two (Lake Winnipeg and Manitoba Board, 1958b) and appendix three to eight (Lake Winnipeg and Manitoba Board, 1958c).

Location: Manitoba Conservation and Environment Library, Call No. TC 426.5 M3W4 L3 1958

Lakes Winnipeg and Manitoba Board 1958b. Report on Measures for the Control of the Waters of Lakes Winnipeg and Manitoba, Province of Manitoba: Supplementary Volume I. Province of Manitoba, Winnipeg, MB. 68pp.

A supplementary volume (I) of the Report of the Measures for the Control of the Waters of Lakes Winnipeg and Manitoba, Province of Manitoba, by the Lakes Winnipeg and Manitoba Board, containing appendixes one and two. Appendix one includes a geographical and historical development description of Lakes Manitoba and Winnipeg and their surrounding drainage basins: a geographical description including geology, drainage area, topography, soils, shoreline, vegetation, and climate; and the historical development summary includes information on historical settlements, land use, mining, fishing, trapping, waterfowl hunting, navigation, hydroelectric power, and summer resorts. Includes a summary of available hydrological information on the water levels in Lakes Manitoba and Winnipeg, from studies conducted by the Water Resources Branch of Canada since 1914, and earlier information from explorers and settlers as far back as 1826 are also included, with information on the effects of extreme water level fluctuations (extreme high and low water levels) in lakes Manitoba and Winnipeg. There is also a section summarizing letters, and oral or written presentation submitted by interested municipalities and organizations to the board regarding their concerns about the effects of the regulation of Lakes Winnipeg and Manitoba, and problems they have experienced resulting from extreme fluctuating high and low water levels. Several figures, tables, and diagrams are also included, illustrating such information on the Nelson River Drainage Basin, historical water level (1914 to 1957), land use, populations, and extent of Glacial Lake Agassiz.

Appendix two includes a summary of hydrological studies related to the regulation of lakes Manitoba and Winnipeg. The hydrological studies include water balance, and wind setup and flood frequency analysis. To determine water balances, all available information on stream flows, lake stages, precipitation, and wind setup for Lakes Winnipeg and Manitoba was reviewed as far back as 1913. This information is summarized and included in table format. Several figures and graphs are also included that illustrate the drainage area of Lakes Manitoba Winnipeg and Winnipegosis, lake levels, major outflows and inflows, precipitation, and frequency of wind set up.

Location: Manitoba Conservation and Environment Library, Call No. TC 426.5 M3W4 L3 v.1

Lakes Winnipeg and Manitoba Board 1958c. Report on Measures for the Control of the Waters of Lakes Winnipeg and Manitoba, Province of Manitoba: Supplementary Volume II. Province of Manitoba, Winnipeg, MB.

A supplementary volume (II) of the Report of the Measures for the Control of the Waters of Lakes Winnipeg and Manitoba, Province of Manitoba, by the Lakes Winnipeg and Manitoba Board, containing appendixes three through eight. Appendix three contains a summary of all available background information on the Nelson River and its potential for power development, and proposed power development sites, with figures. Appendix 3 is a summary of information relevant to the regulation of Lake Winnipeg for flood control and measures by which the flooding of land bordering Lake Winnipeg might be alleviated. Remedial measures recommended included the purchase of affected lands, and the construction of dikes. Appendix four contains information on the regulation of Lake Manitoba for flood control and other ways to alleviate flooding to lands bordering the lake, such as the purchase of land subject to flooding, and the construction of dikes. The Nelson River power development, Dauphin River power development, Assiniboine Diversion, and a water supply channel from Lake Manitoba to the Assiniboine River are also discussed, along with the design of Fairford control structure for the regulation of Lake Manitoba, and its effects of on lakes Manitoba, Pineimuta, St. Martin, and Winnipeg. Several figures graphs are included illustrating the land surrounding Lake Manitoba that is subject to flooding; historical water levels and computed water levels with water level regulation, and/or the Assiniboine Diversion and water supply channel; dyking schemes; and the Fairford Dam structure and channel improvements. Appendix six includes a summary of information relevant to the regulation of the lower Saskatchewan River for power development and the reclamation of the Saskatchewan River Delta for agricultural development. Appendix seven summarizes background information and possible effects related to the regulation of the Assiniboine River, via the Assiniboine River Diversion into Lake Manitoba, and the water supply channel from Lake Manitoba into the Assiniboine River. Preliminary designs, cost estimates, and the possible effects (i.e. sediment transport) of the diversion and supply channel on Lake Manitoba are also included with figures. Appendix eight discusses the economic feasibility of regulating lakes Winnipeg and Manitoba for the power development of the Nelson River. Potential markets for the generated power are also examined. Figures and graphs are included illustrating proposed power sites in the Nelson River, Lake Winnipeg levels and outflows, power benefits of regulation, and effects of the proposed regulation range on the dependable outflow from lakes Winnipeg and Manitoba.

Location: Manitoba Conservation and Environment Library, Call No. TC 426.5 M3W4 L3 v.2

Location: University of Manitoba, Elizabeth Dafoe Library, Call No. Gov Docs Can1 N4.6 L25

Landreth, L. M. 1972. A Survey and Mapping of Vegetation Among the South Shore of Lake Manitoba. University of Manitoba Field Station (Delta Marsh) 1971 Annual Report 6: 33-34.

A study examining the emergent and aquatic vegetation composition along the south lakeshore of Lake Manitoba in the summer of 1971. Study sites were located near Delta Marsh, along a 3 km stretch extending from the Assiniboine Diversion outlet to Cram Creek. The nature of the bottom sediment was also recorded in terms of texture and compactness. The survey showed that four emergent species were dominant *Scirpus americanus* and *S. validus*, *Phragmites communis*, and to a lesser extent *Typha latifolia*. Only two submerged species were recorded: *Potamogeton pectinatus* and *P. Richardsonii*. Along the study transect cover by emergents averaged 60 percent and aquatics 75 percent. However, in the east cover by both emergents and aquatics was below the mean of 60 percent, but cover increased to the west toward Cram Creek where complete cover (100%) was observed for several transects. Information from this survey will provide base line information for further studies examining the influence of Lake Manitoba water level stabilization, and changes in that regulation regime, on the vegetation along the shore of Lake Manitoba.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Lapointe, G. D. 1986. Fish movement and predation on macroinvertebrates in a lakeshore marsh. MSc Thesis, University of Minnesota, St. Paul, MN. 88 pp.

A study examining general trend in the movement of fish between Lake Manitoba and Delta Marsh, at Cram Creek, conducted between May and August of 1983. Fish species that were observed moving between the marsh and the lake included common white sucker, northern pike, yellow perch, carp, bullhead, burbot, lake herring, quillback, sauger and walleye. The seasonal marsh usage by the various fish species is also discussed. Graphs are included illustrating the number of species caught entering and leaving the marsh, first and last dates of capture of mature females in the marsh, and minimum and maximum daily water temperatures in the creek. The study also investigates the effects of waterfowl habitat management in Delta Marsh on fish populations. Effects discussed included a reduction in marsh open water area during drawdown, and control structures would impede fish movement into and out of marshes during spawning and foraging. Several recommendations are given to minimize the impacts of waterfowl management on fish species that utilize this marsh habitats including the opening of control structures during critical period of fish movement between the marshes and the lake.

The study also examines the effects of fish predation on macroinvertebrates in Delta Marsh. Studies were conducted in the Forster's Bay of Delta Marsh in the summers of 1982 and 1983. Water column invertebrates appeared to be impacted by fish predation to a greater degree than benthic invertebrates. Fish predation also reduced macroinvertebrate abundance and biomass and affected community structure; and these effects varied with habitat heterogeneity, time, invertebrate species, and season.

Location: Ducks Unlimited Canada, Institute for Wetlands and Waterfowl Research Library

Last, W. M. 1978. A Summary of Lake Manitoba geolimnology and proposed sediment research. The University of Manitoba Field Station (Delta Marsh) 1977 Annual Report 12: 26-34.

A brief review of available limnogeological information on Lake Manitoba, and a proposal for research examining the stratigraphy of the sediments in the lake to determine the post-glacial history of the lake. Information discussed includes a description of Lake Manitoba including geology, morphological, physical and chemical limnology, and biota. A table illustrating water chemistry in the lake in 1930, 1965, 1971, 1974 and 1975 is included, and contains such parameters as hardness, alkalinity, specific conductance, total dissolved solids, pH, and concentrations of nutrients and dissolved ions. Proposed research examining the sediment record of the lake to document and quantify changes in the lake during the post-glacial period is discussed. See (Last 1980) for the results of the post-glacial history research.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Last, W. M. 1980. Sedimentology and Post-glacial History of Lake Manitoba. PhD Thesis, University of Manitoba, Winnipeg, Manitoba. 165 pp.

A study examining the present and past sedimentary and geolimnology of the south basin of Lake Manitoba. The study identifies and interprets major spatial and temporal variations in the sediments of the south basin, and reconstructs and describes the postglacial history of the lake, since approximately 13 500 years B.P., including changes in basin size, water levels, sedimentation rates, productivity, water and sediment chemistry, and fluvial inputs (i.e. the Assiniboine River from 45 000 to 2000 years B.P.). Sediment cores were taken from 50 sites in the south basin of the lake, and two inland sites (town of Oakland and the Cadham Bay of Delta Marsh) from January to March 1978, and 1979. Sediments were analyzed for moisture content, organic matter, texture, density, porosity, grain size, mineralogy, major and trace elements, E_h , pH, and radiocarbon age. During the collection of the sediment cores, additional field data was gathered at select sites including water samples at various depths, water temperature profiles, and bathymetric data.

A detailed physical, chemical, and morphological description of Lake Manitoba is given which includes physiography, climate, geology, soils, size and shape, bathymetry, hydrology (inflow, outflows, water levels and groundwater), limnology, water chemistry (present and historical), and biota (fish, invertebrates, algae). All water quality monitoring conducted in the lake from 1928 to 1980, is summarized and discussed in the study, in order to examine spatial and temporal changes in the water chemistry of the lake since 1928, and hypothesize possible reasons for these changes. The post-glacial sediments of the south basin of lake are described in detail in terms of physical, chemical, and mineralogical properties. The report includes several figures illustrating sampling locations, morphology of the south basin, water chemistry trends, sediment properties, and the post-glacial history of the south basin.

Location: University of Manitoba, Elizabeth Dafoe Library, 2nd floor, Thesis L332 Se

Last W. M. 1982. Holocene carbonate sedimentation in Lake Manitoba, Canada. Sedimentology 29: 691-704.

An examination of the historical and current carbonate mineral component of sediment in the south basin of Lake Manitoba. The study includes a brief physical description of the lake, which includes location, morphological characteristics, geology, and hydrology. Sediment core samples along with water samples were collected from 50 sites in the south basin of Lake Manitoba during the winters of 1978 and 1979. Sediment samples were analyzed for bulk mineralogy, carbonate mineralogy, grain size, organic content, and geochemistry. Water chemistry parameters included pH, temperature, specific conductance, and concentration of various dissolved ions. The study found seasonal and spatial differences exist in the concentration of major ion in the lake, as concentrations are generally the highest during the winter, and concentrations are generally higher in the south basin compared to the north basin of the lake. The historical distribution and occurrence of four genetic types of carbonate minerals are examined in the sediments of in Lake Manitoba: low magnesian calcite, high magnesian calcite, dolomite, and aragonite. The study found that the carbonate mineral composition of modern offshore bottom sediments in the south basin of the lake consists mainly of high magnesian calcite and dolomite with small amounts of low magnesian calcite and aragonite. General conclusion included that magnesian calcite is being precipitated in the south basin of Lake Manitoba and is most likely triggered and controlled by high primary organic productivity in the lake. Various graphs and figures are included showing sampling locations, water chemistry, and sediment mineralogy and textural composition.

Location: University of Manitoba, Science and Technology Library, Call No. 550 S448

Last, W. M. 1984. Modern sedimentology and hydrology of Lake Manitoba, Canada. Environmental Geology 5: 177-190.

A discussion of the modern properties of Lake Manitoba including: morphology, water chemistry, hydrology, biota (benthic fauna and fisheries), and sedimentology. Information on hydrology includes water inflow and outflow sources to the lake, water level fluctuations, and water circulation in the lake. Spatial and temporal variations in the water chemistry in the south and north basins of the lake are examined; with parameters including alkalinity, total hardness, total dissolved solids, and concentration of major ions. Descriptions of the surficial sediments include physical characteristics (grain size, color, moisture content, and organic content), mineralogy, and chemical characteristics (pH, E_h , organic carbon, and concentrations of various ions and metal). Other discussions also include relic sand areas in the south basin from when the Assiniboine River flowed into the lake, modern sedimentary processes (detrital, endogenic and authigenic), sedimentation rates, and interrelationship between physical, chemical, and mineralogical parameters in the surficial sediments. The article includes several figures and graphs illustrating morphological and hydrological characteristics; bathymetry; chemical composition of lake waters and inflow and outflows; historical variations in major ions concentration in waters; mineralogical, textural, and chemical properties of sediments; and sedimentation rates.

Location: University of Manitoba, Science and Technology Library, Call No. 550 E614 Ge

Last, W. M. and J. T. Teller 1979. The Lake Manitoba Stratigraphic Record: A Preliminary Study. The University of Manitoba Field Station (Delta Marsh) 1978 Annual Report 13: 43-49.

A discussion of the preliminary results of a coring program initiated in the winter of 1977 to investigate the post-glacial stratigraphy of Lake Manitoba. Sediment core were collect from 50 sites in the south basin of Lake Manitoba. Preliminary results showed that in general the sediments of the lake become more clay-rich and less silty with depth in record. The article discusses the preliminary interpretations of post-glacial history of Lake Manitoba. Generally, the first period of lacustrine sediment started approximately 13-14 000 year B.P., and water conditions were deep. Approximately 10 500 to 11 000 years B.P. the lake level dropped, and the next 2,000 years was characterized by fluctuating water levels with periodic periods when the lake was completely dry. After 8500 years B.P. waters levels rose again and were stable for 4000 years. At 5500 to 4500 years B.P. a combination of drier weather of the diversion of the Assiniboine River from the Lake, lowered water levels in the lake and dried the lake completely until 4500 B.P., when water levels increased and the lake became shallow. Since then water levels and sedimentation have been fairly stable in the lake.

Location: University of Manitoba, Science and Technology Library, Call No. 550 E614 GE

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Last, W. M. and J. T. Teller 1983. Holocene Climate and Hydrology of the Lake Manitoba Basin. Geological Association of Canada Special Paper 26: 333-353.

An examination of Lake Manitoba which includes modern characteristics, major trends and variations in the historical sediment record of Lake Manitoba post Lake Agassiz, important stratigraphic features in respect to paleohydrology and paleoclimate of the lake, and the Holocene or postglacial history of the lake. The article includes a modern physical description of Lake Manitoba including location, area, geology, morphology, hydrology, and general water chemistry and sediment characteristics. To examine the postglacial history of the lake, 51 sediment cores were taken from the south basin of the lake from January to March 1978 and 1979, and analyzed for trends in various physical, chemical, mineralogical, and biological parameters. Some of the more important stratigraphic features of the bottom sediments of Lake Manitoba, which are discussed in the article include distinct marker zones from pedogenesis related to period of extremely low water levels or no water present in the basin; carbonate mineral fluctuations in the sediments; variations in the abundance of pyrite in the

sediment; the alluvial sand area in the southern portion of the lake beneath the fine-grained modern mud, which was created by the Assiniboine River when it flowed into lake; and variations in pollen stratigraphy in the sediments illustrating variations in the climate of the region during the post-glacial period. The article concludes with a general summary of the postglacial history of Lake Manitoba, from approximately 11 000 B.P. to present. Figures are given showing sediment core sampling locations, the lake during various post-glacial phases, and variations in mineral parameters of the sediments.

Location: University of Manitoba, Elizabeth Dafoe Library, Call No. QE 697 G564 1983

Last, W. M., J. T. Teller and R. M. Forester 1994. Paleohydrology and paleochemistry of Lake Manitoba, Canada: The isotope and ostracode records. Journal of paleolimnology 12: 269-282.

A discussion of the results of stable isotope stratigraphy and reconnaissance ostracode paleoecology of a 13.5 m long sediment core taken from the south basin of Lake Manitoba in February, 1978. The paper includes a description of Lake Manitoba, which includes morphology, climate, hydrology, and geology. A List of major ostracode species present in Lake Manitoba during the Agassiz phase is given. From analysis of stable isotope ratios of calcium carbonate, and the distribution of ostracodes present in the sediment core, the paleolimnology and history of Lake Manitoba is recreated and discussed from approximately 12 000 years B.P. to present.

Location: University of Manitoba, Science and Technology Library, Call No. 560 J826 Pal

Logan, E. M. 1982. The recreational feasibility of a nature touring route between Lake Manitoba and Lake Winnipegosis. University of Manitoba Master's of Natural Resources Management, University of Manitoba, Winnipeg, MB. 106 pp.

A study examining the feasibility of a land based nature study route between Lake Winnipegosis and Lake Manitoba and along the north shore of Lake Manitoba, to provide for the growth and demand of naturalist based activities. The study includes a physical description of the study sites including Lake Manitoba, Lake Winnipegosis and the Waterhen watershed. The study examines the existing recreational attributes of the existing road network that would be suitable for a nature touring route, and includes a inventory of natural resources present in the area: landscape features, vegetation cover, fishing, wildlife and waterfowl populations and habitat, climate, water resources, and other significant features, as well human social and cultural resources in the study area are examined. The study also touches on potential impacts that could result from users of the nature route. Development opportunities are also defined and recommends are given for possible alternatives courses of action regarding the development of the proposed nature route.

Location: University of Manitoba, Elizabeth Dafoe Library, Call No. Practicum L82

Long, J. A. 1973. Frequency of Discharge Measurement Study Waterhen River Below Waterhen Lake 05LH005. Water Survey of Canada, Inland Waters Directorate, Department of the Environment. Winnipeg, MB. 8 pp.

A examined of water discharge measurements from the Waterhen River below Waterhen Lake. Water levels and discharge on the river were measured as early as 1913. The report contains flow and water level information from 1958 to 1973. Water levels on lakes Manitoba and Waterhen are also included. The main purpose of the report was to determine the minimum number of discharge measurements required annually to maintain accuracy standards for daily discharge calculations of the Waterhen River.

Location: Manitoba Conservation and Environment Library, Call No. GB 1207 M4 L66 1973

Löve, D. and A. Löve. 1954. Vegetation of a prairie marsh. Bulletin of the Torrey Botanical Club 81: 16-34.

The study examines the vegetation of Delta Marsh, on the south shore of Lake Manitoba. The study includes a brief physical description of Delta Marsh. The study describes the vegetation present and transitions in vegetation throughout the marsh and along the barrier beach ridge that separates the marsh from Lake Manitoba. Soils properties and characteristics are also describes for the barrier beach and the marsh.

Location: Ducks Unlimited Canada, Institute for Wetland and Waterfowl Research Library

Lubinsky, I. 1975. Fauna of Freshwater Molluscs of the Delta Marsh, Manitoba, and its Zoogeographic Features. University of Manitoba Field Station (Delta Marsh) 1974 Annual Report 9: 55-64.

A study examining the distribution of freshwater molluscs in Delta Marsh in relation to the aquatic environment, from May to October 1967. During the study 25 species of molluscs were observed: eight *Lymnaeidae* spp., three *Physidae* spp., eleven *Planorbidae* spp., one *Valvatidae* spp., one *Hydrobiidae* spp., one *Sphaeriidae* spp. The fauna of the marsh consisted mostly of gastropods and only one species of Pelecypods. The paper discusses the seasonal and spatial distribution of freshwater molluscs present through different area of the marsh, along with historical distribution and changes in the molluscs present in the marsh.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Lutchman, M. 1970. Hydrogeology and Hydrochemistry of the Portage la Prairie-Delta Area, Manitoba. Unpublished Report of the Department of Geology, University of Manitoba. Winnipeg, MB.

A copy of this publication could not be found for examination at any public or government library in Winnipeg, Manitoba.

Location: unknown

Lysack, W. 1997. The winter commercial Fishery of Lake Manitoba 1997. MS Report no 97-03. 100 pp.

A summary of the commercial fishery on Lake Manitoba since 1931. The report discusses various technological improvements in fishing equipment and transportation, along with regulation changes to minimum mesh sizes and zones that have caused declines in Lake Manitoba commercially important fish stocks since the in the 1950s. Changes in the catch yields of various commercially important species since 1931 are examined, along with temporal trends in fish mortality rates and growth characteristics. Commercially important species examined in the report include walleye, sauger, pike and perch. The report includes a brief description of Lake Manitoba. Various graphs and tables are includes illustrating the trends in the data.

Location: University of Manitoba, Science and Technology Library, Call No. QH 106.2 M3 M35 no. 97-03

Macaulay, A.J. 1973. Taxonomic and Ecological Relationships of *Scirpus Acutus* Muhl. and *S. validus* Vahl (Cyperaceae) in Southern Manitoba. PhD Thesis, University of Manitoba. Winnipeg, MB. 213 pp.

A study conducted during the summers of 1970 and 1972 examining the taxonomic and ecological relationships between *Scirpus acutus* Muhl. and *S. validus* Vahl in southern Manitoba. The distribution and habitat requirements of *S. acutus* and *S. validus* are discussed in terms of the responses of the two species to a number of environmental parameters including, temperature, light, water depth, water level fluctuations, alkalinity, pH, total dissolved solids, and concentrations of calcium, magnesium, and sulfate, nitrogen and phosphorus. The implications of the finding of the report are also discussed in reference to the management of marsh for waterfowl and muskrat populations. Study sites included Delta, Langruth, Minnedosa, The Pas, and Netley Marshes. A description of southern Manitoba is given which includes geology, topography, soils, climate, hydrology and vegetation. Some of the distinct features of each of the study areas are also described.

Location: University of Manitoba, Elizabeth Dafoe Library, Thesis M1287.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

MacDonald, D. 1981. Lake Manitoba 1980 Fish Stock Assessment Program. No pagination.

Results of studies conducted in the winter of 1980, and spring and summer of 1981 to examine the fish stocks in Lake Manitoba. The objectives of the studies were to estimate fish survival and mortality rates, describe maturity regimes, describe growth rates, and determine age composition of fish stocks in the lake. Studies conducted to evaluate the fish stocks included experimental netting with gill nets of varying mesh sizes at several sites in Lake Manitoba, and the examination of the walleye and sauger caught for weight, sex, maturity, and collection and examination of fish scales. Walleye and sauger caught commercially from the lake were also examined similarly to those caught in experimental nests.

Results of the studies include statistical analysis of sauger and walleye catches in the north and south basins for total numbers caught in each basin, mean length and weight relationships, instantaneous mortality and survival rates, maturity rates, age-specific frequency, sex ratios, and age classes. Various tables and graphs are included illustrating the results. White and Redhorse sucker catches are also briefly examined in terms of differences in the percentage catch in the north and south basin. Other fish species caught during the study included perch, pike, white fish, cisco, carp, burbot, and channel catfish. These species were not examined statistically but the total numbers caught in the north and south basins are presented in table format. See MacDonald (1982) for the second year of the study.

Location: Delta Waterfowl Research Station, David Winton Bell Memorial Library

MacDonald, D. 1982. Lake Manitoba 1981 Fish Stock Assessment Program. No pagination.

Results of studies conducted in the winter of 1981, and spring and summer of 1982 to examine the fish stocks in Lake Manitoba. This was the second year of fish stock assessment studies conducted in Lake Manitoba; see MacDonald (1981) for results of the first study, conducted from 1980 to 1981. The objectives of the study were to estimate fish survival and mortality rates, describe maturity regimes, describe growth rates, and determine age composition of fish stocks in the lake. Studies conducted to evaluate the fish stocks were the same as those conducted in the previous study; experimental netting with gill nets of varying mesh sizes at several sites in Lake Manitoba, with examination of the walleye and sauger caught for weight, sex, maturity, and collection and examination of fish scales. Walleye and sauger caught commercially from the lake were also examined similarly to those caught in experimental nests.

Results of the study were analyzed statistically in the same manner as the previous study, sauger and walleye catches in the north and south basins were examined statically for total number caught in each basin, mean

length and weight relationships, instantaneous mortality and survival rates, maturity rates, age-specific frequency, sex ratios, and age classes. White and Redhorse sucker catches are also briefly examined in terms of differences in the percentage catch in the north and south basin. Other fish species caught during the study included perch, pike, white fish, cisco, carp, burbot and goldeye. These species were not examined statistically but the total numbers caught in the north and south basins are presented in table format.

Location: Delta Waterfowl Research Station, David Winton Bell Memorial Library

MacKay, G. A. 1965. A brief summary of the hydrology of Lakes Winnipegosis and Manitoba. Paper presented at the annual meeting of the Canadian branch of Royal Meteorological Society, on January 15, 1965. 12 p.

A description of the hydrology of Lakes Manitoba and Winnipegosis. Both lakes are part of the Dauphin River drainage basin, the characteristics of the basin and both lakes are discussed in the report includes inflows, runoff, drainage areas, evaporation, droughts, and water levels of both lakes over the past 50 years, along with topography, geology, and climate of the areas. The report indicates that evaporation losses from Lake Manitoba area much larger than runoff from the drainage area. The maximum range of water levels on both lakes over the past 50 years has been about six feet, and the Fairford Dam on the Fairford River has reduced this range to about two feet. A map of the Dauphin River Watershed is included.

Location: Delta Waterfowl Research Station, David Winton Bell Memorial Library

Manitoba Department of Agriculture and Immigration. 1958. Whitemud Watershed. Department of Agriculture and Immigration, Soils and Crops Branch. Queens Printer. 11 pp.

A brief description of the Whitemud Watershed including location and area, topography, drainage, history of settlement, history of drainage, population, and agricultural statistics.

Location: Manitoba Conservation and Environment Library, Call No. GB 992 C2 M35 1958

Manitoba Department of Agriculture. 1976. Lake Manitoba Regulation Research 1976/77. In cooperation with the Departments of Mines, Resources and Environmental Management. Province of Manitoba, Winnipeg, Manitoba.

A summary of cost analysis research conducted during 1976 and 1977 to examine costs associated with flooding problems along the shores of Lake Manitoba. Areas examined included the value of producers feed lost due to high lake levels, cost/impact strategies to lessen the high water conditions, a cost estimate of draining the south pool of Lake Manitoba, and a cost estimate of dyking shore lines. Cost/impact strategies to alleviate the high water conditions included lowering the target level of the lake from 812.17 feet to 811.67 feet, using Lake Winnipegosis for water storage to control Lake Manitoba levels, and increasing the outflow capacity of Lake Manitoba through a additional channel beside the Fairford River.

Location: Manitoba Legislative Library, Call No. GovDoc Man SpR 1976 Box 166 #5

Manitoba Department of Health and Public Welfare. 1957. Sanitary Survey of the Assiniboine River, 1953-1956. Winnipeg: Manitoba Dept. of Health and Public Welfare, Section of Environmental Sanitation. 23 pp.

A pollution survey of the Assiniboine River conducted from 1953 to 1956. The report included a general description of the Assiniboine River, which included geology, drainage area, tributaries, climate, topography and hydrology. The report also briefly describes the historical and economic importance of the river including,

water supply usage, waste disposal, fishing, transportation, and possible municipal and industrial sources of pollution to the river. Water samples were collected from the Assiniboine River, between Virden and the City of Winnipeg and analyzed for water temperature, dissolved oxygen, biological oxygen demand (BOD), coliforms, and chloride concentrations. A map illustrating the sampling points along the river is included in the report. Several graphs are included illustrating trends in the bacteriological and chemical parameters analyzed. Mean monthly discharge of the Assiniboine River near Brandon and Headingley from 1911 to 1955 is also included.

Location: University of Manitoba, Elizabeth Dafoe Library, Call No. Gov Docs Can6 Man1 H2.7 Sa65 1957

Manitoba Department of Mines, Resources and Environmental Management, Planning Branch. 1977. The Whitemud Watershed Resource Scheme. Department of Mines, Resources and Environmental Management, Planning Branch. Winnipeg, MB. 70 pp.

A document examining the resources of the Whitemud Watershed, to aid in the conservation and management of the land, water and related resources in the watershed. Resources examined in the report included agriculture, water, wildlife and wildlife habitat, and interrelationships between the resources. Each resource is examined and conservation strategies are recommended for a variety of problems associated with the various resources.

Location: Manitoba Conservation and Environment Library, Call No. GB 992 C2 W85 1977

Manitoba Environment and Workplace Safety and Health. 1943-1993. Laboratory Analysis Files 1943-1993. The W.M. Ward Technical Service Laboratory. Winnipeg, MB.

Analyst's logbooks showing results of chemical analyses performed on environment samples submitted by Manitoba Environment and Workplace Safety and Health to the W.M. Ward Technical Service Laboratory between 1943 and 1993. The logbooks also contain some background information about some of the samples. Results of chemical analyses performed on water samples collected by Manitoba Environment in various water bodies through Manitoba are included. Chemical analysis included a broad range of parameters. Some of the water bodies examined included the Assiniboine River, Lake Manitoba, and Whitemud River.

Location: Provincial Archives of Manitoba, Call No. See Government Record Files - EW 0060

Manitoba Rural Development, Conservation District Authority. 1990. Whitemud Watershed Conservation District; Management Plan. Manitoba Rural Development, Conservation Districts Authority, Neepawa, Man. 43 pp.

A management plan for the conservation of natural and man-made resources in the Whitemud Watershed Conservation District. A variety of management plans are discussed in the report including strategies for the enhancement and conservation of various resources including waters, soils, fisheries, wildlife, heritage resources, recreation and tourism in the watershed. Water management plans include erosion control, maintenance and restoration of drainage systems, greater landowner responsibility, water conservation incentives, control of spring flooding, restricting land clearing, maintaining and enhancing surface and groundwater quality, and completing the Big Grass Marsh Project. Soil management plans include improving shelterbelts, incentives for better farm practices, and more conservation positive Government programs. Fisheries management strategies include dam modifications, protecting and enhancing fish habitat, and rearing and stocking programs, and wildlife strategies include preserving special wildlands, retaining and enhancing wetlands, encouragement of wildlife and habitat enhancement projects. Heritage resource enhancement plans involved protecting natural and cultural landscapes and encouraging local awareness and recreation, and tourism strategies included conservation recreation programs, and hunter information and control systems.

Location: Manitoba Conservation and Environment Library, Call No. HD 319 M3 W458
1990

Manitoba Water Commission. 1971. Comments of the Lakes Winnipeg and Manitoba Board on Lake Manitoba Regulation (Excerpts from the Report on Measures for the Control of the Water of Lakes Winnipeg and Manitoba, June 1958). Manitoba Water Commission. Winnipeg, MB.

Excerpts from “the Report on Measures for the Control of the Water of Lakes Winnipeg and Manitoba, June 1958” (Lakes Winnipeg and Manitoba Board 1958a, 1958b and 1958c). The excerpts focus on the portions of the report that examine the regulation of Lakes Manitoba for flood control between the water levels of 811 and 813 feet ASL. This target range would lower the natural stage of the lake by approximately three feet. The main purpose for the lowering of the lake is to reduce agricultural losses due to flooding of the land the surrounds the lake during extremely high lake levels. The report describes remedial measures that include control of Lake levels, along with the purchase of flood prone reservation land, and dyking. The report proposes two ways of controlling water levels in Lake Manitoba: using Lake Winnipegosis as a regulating reservoir, or to construction of a control structure at the outlet of Lake Manitoba, on the Fairford River. The second method, a control structure on the Fairford River, was determined to be more economically feasible at regulating Lake Manitoba between the proposed range of 811.0 and 813.2 feet FSL.

The report includes a general description of Lake Manitoba, which includes the present and historical geology, surrounding lakes and rivers, hydrology, topography, soils, shoreline, vegetation, climate, history of settlement, surrounding land use, fisheries, trapping, waterfowl usage, and navigation. Observations of historical water levels on Lake Manitoba since 1876 are examined, and problems associated with extremely high and low water levels in the lake are discussed including loss of agricultural lands, erosion of the shorelines, inconveniences to cottage owners and boaters, and detrimental effects on fish, muskrat, and waterfowl. Written and oral briefs submitted to the committee from communities bordering the lake are also included, illustrating the concerns of communities regarding water levels on Lake Manitoba, and their opinion of how lake Manitoba should be regulated. Possible effects of the proposed Fairford Dam on lakes Pineimuta, St. Martin and Winnipeg are also discussed briefly.

Location: Manitoba Conservation and Environment Library, Call No. GB 1399.5 C2 C66
1971

Manitoba Water Commission. 1973a. Lake Manitoba Regulation, Volume I. Manitoba Water Commission, Province of Manitoba, Winnipeg. 46 pp.

As a result of continued conflicts regarding the regulation of Lake Manitoba, in 1968 the Manitoba Water Commission was given the task of determining and recommending the most acceptable and practical range of water levels that Lake Manitoba water levels could be regulated between, and whether or not it's feasible and desirable to maintain lake levels at different water levels during different seasons. To accomplish these tasks the Manitoba Water Commission held public hearing in 1969 in Dolly Bay and Portage la Prairie, Manitoba (Manitoba Water Commission, the. 1973b), to determine the publics views regarding how water levels in Lake Manitoba should be regulated. The Manitoba Water Commission also reviewed available information on Lake Manitoba, the surrounding watershed, and other related water bodies that were affected by the regulation of Lake Manitoba, including the Dauphin River, Lake St. Martin, Pineimuta Lake, and Lake Winnipegosis. The report includes background information on Lake Manitoba and the Dauphin River drainage basin, including: location and physical features, climate, hydrology, vegetation, soils, land use, economy. Hydrographs of water levels in Lakes Manitoba, St. Martin, and Pineimuta, from 1921 to 1969 are also included in the appendix of the report. Effects of Lake Manitoba regulations examined in the report include effects on: agricultural lands around lakes Manitoba, Pineimuta and St. Martin; wildlife and wetland habitat around lakes Manitoba, St. Martin, and Pineimuta; fisheries resources of lakes Manitoba and St. Martin, and the Dauphin River; and recreation and tourism.

The Manitoba Water Commission concluded that it was not economically feasible to regulating Lake Manitoba to reduce the frequency and occurrence of high levels on Lake Manitoba to reduce flooding to farmer's lands, though the construction of control facilities to regulate outflows form Lake Winnipegosis. In terms of recreational, wildlife and fisheries resources, the commission determined that the value of each of these resources would be reduced if Lake Manitoba were regulated at a target level of 811.67 feet, rather than the present 812.17 feet. The Manitoba Water Commissions final recommendations included: that Lake Manitoba should continue to be regulated at a target level of 812.17 feet throughout the year; outflows from Lake Manitoba through the Fairford Dam should be at least 50 cfs year round; and additional long-term studies should be undertaken to obtain a better understanding of the sensitivity and dynamics of various resources with water levels variations on Lake Manitoba including agricultural, wildlife, and fisheries resources associated with lakes Manitoba, St. Martin, and Pineimuta, and the Dauphin River.

Location: Manitoba Conservation and Environment Library, Call No. MAN WAT COM LMR v.1. 1973

Location: Manitoba Legislative Library, Call No. Gov Docs Man WC

Manitoba Water Commission. 1973b. Lake Manitoba Regulation, Volume II. Manitoba Water Commission, Province of Manitoba, Winnipeg. 133 pp.

Transcripts of the Manitoba Water Commission public hearings held in Dolly Bay and Portage la Prairie, Manitoba, during 1969, regarding the regulation of Lake Manitoba. The public hearings were held to determine the public opinion on the most acceptable and practical range within Lake Manitoba water levels could be regulated, and whether or not it's desirable to maintain water levels in Lake Manitoba at certain different levels during different seasons. The public hearings were part of the Water Commission report (Manitoba Water Commission, the. 1973b), examining the various effects of Lake Manitoba water level regulation on wildlife, agricultural, fisheries, and recreation in Lake Manitoba and the surrounding watershed, in order to determine and recommend the most acceptable way water levels in Lake Manitoba should be regulated.

Location: Manitoba Conservation and Environment Library, Call No. TC 426.5 M# 1973 v.2

Location: Manitoba Legislative Library, Call No. Gov Docs Man WC

Manitoba Water Commission. 1978. Lake St. Martin and Pineimuta Lake Regulation. Report to Department of Mines, Resources, and environmental management, Manitoba Water Resources Branch.

A study by the Manitoba Water Commission examining the effects of the erratic and extreme ranges in water levels on lakes Pineimuta and St. Martin, resulting from the water level regulation of Lake Manitoba, on agricultural, wildlife, fisheries, and recreational resources associated with the lakes. A brief description of both lakes is included in the report discussing their location, size, tributaries, vegetation, waterfowl, fisheries, and other terrestrial wildlife. The report includes background information on the historical regulation of Lake Manitoba, and its effects on the agriculture, recreation, fisheries, waterfowl, wildlife resources of lakes St. Martin and Pineimuta. Nine schemes for improve the water levels regimes downstream of the Fairford Dam, in Lake St. Martin and Pineimuta, are discussed and evaluated in the report, including dams and dykes, Dauphin River canalization, lower Fairford channel improvements, a diversion to Lake St. Martin, and control structures. Figures illustrating the nine different schemes are included in the report. Recommendations of the report included: no construction of water control structures downstream of the Fairford Dam occur until a time when additional benefits resulting from them can be determined; further examination of the operational methods for the Fairford Dam to determine if any changes can be made to prevent large and sudden change in water level downstream of the dam during critical periods associated with resources of the lakes; and the need for further studies examining the compartmentization of Pineimuta Lake to optimize waterfowl productivity in the lake.

Location: Manitoba Conservation and Environment Library, Call No. MAN WAT COM
LSM 1978

Manitoba Water Commission. 1980. Review of the Red River Floodway, Portage Diversion, and Shellmouth Reservoir. Manitoba Water Commission. Winnipeg, MB.

A review of the Red River Floodway, Portage Diversion, and Shellmouth Reservoir to determine how effective they have been in reducing flood damage. In the case of the Portage Diversion, the report examines if the Diversion has caused flooding of agricultural lands downstream, or if these conditions existed before the Diversion was in operation. According to the report the flooding of agricultural lands in the area of Deep Creek, near Delta Marsh, is a natural occurrence, and the Portage Diversion actually lessens the problem in magnitude. The report also contains transcripts of public hearing held in Brandon and Winnipeg, Manitoba in 1980 concerning the effectiveness of the structures.

Location: Manitoba Conservation and Environment Library, Call No. TC 426.5 .M3R4

Martin, R. T. 1965. Preliminary Soil Mechanics Report on the Lake Manitoba Supply Canal, Part A: Delta Marsh Inlet Area. Planning Division, Water Control & conservation branch, Department of Agriculture and Conservation. 10 pp.

A report on the proposed Lake Manitoba supply channel that would divert waters from Lake Manitoba, on the east side of Delta Marsh, into the Assiniboine River near Sawyer's Creek to dilute pollution inputs from the Red River into the city of Winnipeg. The report discusses the location, and four inlet routes of the proposed channel, focusing on the soils present along the inlet route of the channels. The drilling program was conducted from December 1964 to January 1965. The soil-testing program consisted of moisture content, organic content, and grain size classification. The water table was also measured at each site. Results include a description of soil characteristics along each inlet channel. Figures showing the location of the four proposed inlet channel from Lake Manitoba in Delta Marsh are included.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Mazerolle, M. and W. F. Cowan. 1975. Waterfowl productivity on Lake Pineimuta, summer 1974. Canadian Wildlife Service, Habitat Assessment Report. Winnipeg, MB. 21 pp.

During the summer of 1974 surveys were conducted on Lake Pineimuta and the surrounding marshes to investigate the productivity of waterfowl, identify major marsh vegetation, obtain shoreline and basin contour information on Pineimuta Lake and Marsh and the Fairford Dam, and observations of other birds, wildlife, and fish were also recorded during the surveys. The control of water levels on Lake Manitoba via the Fairford Dam, since 1961 has resulted in extreme water level fluctuations downstream of the Fairford Dam in Lake Pineimuta. The purpose of the study was to determine the effects of these extreme water levels on waterfowl production in Lake Pineimuta, and to predict optimum water regimes for nesting waterfowl and determine a feasible way of controlling water levels in Lake Pineimuta to achieve optimum water regimes. During the surveys in 1974, from April 12 to June 6, extreme spring water levels fluctuations and flooding occurred on Lake Pineimuta causing the destruction of many waterfowl nests during the breeding and rearing season, resulting in low nesting success. Results of the survey showed that water levels on Lake Pineimuta are closely dependent on flow on the Fairford River, and since the operation of the Fairford Dam in 1961, water levels in Fairford River and Pineimuta Lake have fluctuated with a greater magnitude and frequency. Conclusions of the study included that if summer water levels were controlled on the Lake Pineimuta to reduce the instance of extreme water level fluctuations and create a water level regime on the lake similar to that of the natural conditions prior to the operation of the Fairford Dam, waterfowl productivity would increase.

A physical description of the study area is given which includes area and location, hydrology, climate, geology, topography, soils, and vegetation. Figures illustrating survey locations are included, along with graphs of water levels on Pineimuta Lake before and after the operation of the Fairford Dam.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Merendino, M. T., L. M. Smith, H. R. Murkin and R. L. Pederson. 1990. The response of prairie wetland vegetation to seasonality of drawdown. Wildlife Society Bulletin 18: 245-251.

A study examining the effects of water drawdown date on the recruitment of macrophyte species from the seedbanks in Delta Marsh. Studies were conducted during the summer of 1988. The effects of four drawdown dates were evaluated; May 15 (late spring), June 15 (early summer), July 15 (mid-summer), and August 15 (late summer). Seedbank soil was collected on August 14 1987, from four sites dominated by cattail (*Typha* spp.), hardstem bulrush (*Scirpus lacustris*), purple loosestrife (*Lythrum salicaria*), and whitetop (*Scolochloa festucacea*). Results indicated that early drawdown dates (May and June) resulted in greater shoot density of emergent species than late drawdown dates (July and August). Drawdown periods are important for reestablishment of diverse stands of emergent vegetation in open water areas, and resultant vegetation can provide cover, nesting, and food material for waterfowl.

Location: University of Manitoba, Science and Technology Library, Call No. 590 W6467 So Bu

Merendino, M. T. and L. M. Smith. 1991. Influence of drawdown data and reflood depth on wetlands vegetation establishment. Wildlife Society Bulletin. 19: 143-150.

A study examining the effect of water drawdown date on the vegetation density in marshes in year following varying reflood conditions. Studies were conducted in Delta Marsh during the summers of 1988 and 1989. The effects of four different drawdown dates were examined (May 15, June 15, July 15, and August 15) in the 1988, and these varying drawdown dates were subjected to four different reflood depths in the 1989 (0, 15, 30 and 50 cm). Results of the study showed that early season drawdown (May and June) allow perennial plants enough time to develop rhizomes capable of producing shoots under the flood conditions in the following year. Of the drawdown dates examined, May drawdowns were also most beneficial to breeding waterfowl. May drawdown maximized cover growth and seed production of desirable species (alkali bulrush and hardstem bulrush) and minimized the growth of undesirable species (cattail and purple loosestrife). Drawdown periods and subsequent reflooding are a critical part of the natural wetland wet/dry cycle, and are important for reestablishment of diverse stands of emergent vegetation in open water areas.

Location: University of Manitoba, Science and Technology Library, Call No. 590 W6467 So Bu

McArthur, P. (no date). State of Lake Manitoba. In Manitoba History Scrap Book M1, 1884-1994, p 72.

An article discussing the proposed lowering the Lake Manitoba by two feet to reduce flooding problems in the surrounding uplands. The author of the article recorded the rise and fall the Lake Manitoba for 12 years, and he contends the lake is one foot lower than last August (date not given). He is opposed to the lowering of Lake Manitoba, and feels it would be an injustice to fisheries, timber industries and quarries on the lake. According to him no flood like the one that occurred in 1882, has occurred on the lake for the previous 80 years. He feels the present complaints of flooding are from those who have not used the lake in extremely dry seasons. If the lake were lowered two feet it would be too low for navigation of steamers.

Location: Manitoba Legislative Library, Call No. M1 1884 -1902.

McCrimmon, H. R. 1968. Carp in Canada. Fisheries Research Board of Canada, Bulletin 165, Ottawa, ON. 94 pp.

An overview of introduction of carp, *Cyprinus carpio* Linnaeus, into Canada, along with the biology of carp, distribution, the commercial and sport fishery, marketing, effects on native biota, and controls methods. Carp was first introduced to Manitoba in 1885, but the establishment of the species was not permanent, and carp weren't really known in Manitoba until 1938, when the first recorded appearance of the species occurred in the Red River at Lockport. The presence of carp in the Assiniboine River was first recorded in 1948, at Virden. Carp were first present in Lake Manitoba by 1948. Effects of carp include uprooting and destruction of macrophyte vegetation, increased water turbidity, and resultant effects on waterfowl, fish, invertebrates, and other wildlife.

Location: Fisheries and Oceans Canada, Eric Marshall Aquatic Research Library, Cat. No. Fs 94-165 (library no. 1085)

McDonald, M. and L. G. Goldsborough. 1997. Soil composition and elevation along the forested dune ridge at the University Field Station. University of Manitoba Field Station (Delta Marsh) 1996 Annual Report 31: 67- 75.

In 1993 transects were established along the beach ridge that separates Delta Marsh from Lake Manitoba, to determine tree distribution, soil disturbance, herbaceous cover, in order to develop a long-term monitoring program to examine potential erosion of the beach ridge. In the summer of 1996, the ridge was visited again to collect additional information at each transect including elevation, depth of organic soil horizon, and soil texture. Variation in the beach ridge morphology have occurred historically due to wind and wave forces from Lake Manitoba, and more recently from cottage development and the regulation of Lake Manitoba via the Fairford Dam since 1961. Results of the visit revealed that the topography of the ridge is highly irregular. Soils horizons varied from 1 to 30 cm, soils were generally circumneutral, soils near the shore were more alkaline, and organic matter content was highest on the marshes end of the transects and decreased toward the lake.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

McKay, M. C. 1971. Whitemud River Watershed Resources Study Phase I Prospectus. Manitoba. Department of Mines, Resources and Environmental Management, Resources Planning Branch. Winnipeg, MB. 95 pp.

As result of numerous requests for aid in solving problems in the Whitemud Watershed the Whitemud River Watershed Resource Study was initiated in the spring of 1970. Some of the various problems in the watershed include soil erosion and gullyng, flooding, drainage, and water shortages. The report is a general summary of the study program for phase I of the project, which will include an examination and description of the natural resources (agriculture, fish, forests, recreation, water and wildlife) and cultural resources (historical, present land use and socio-economic) in the watershed. An overview of the time-line of work and costs related to phase I of the project are also given.

The results of the study examining the natural resources of the area are published in separate volumes: Fish (Falkner), Interrelationships of vegetation, wildlife, and settlement (Brian 1971), Land use (Hodgson 1972), Wildlife (Goulden *et al.* 1972) Agriculture (Jenkins 1972), and Outdoor recreation (Searth 1972).

Location: Manitoba Conservation and Environment Library, Call No. GB 992 C2 M36 1971

McKinney, G. 1992. If you change this river. Manitoba Against the Assiniboine Diversion, Winnipeg, MB.

A video examining the Assiniboine South-Hespler area study of the proposed diversion of water from the Assiniboine via the Pembina River System to the Morton and Winkler areas for irrigation, municipal and industrial needs, and its effects on habitat, water quality and communities along the Assiniboine River. The effects of previous dam placed on the river for irrigation and storage purposes are also examined including the Stephenfield Dam built in 1963.

Location: Manitoba Conservation and Environment Library, Call No. AV VHS 118

McLachlan, E. B. 1978. West Park, Delta, Manitoba - Design in a Fragile Ecosystem. Master of Landscape Architecture, University of Manitoba, Winnipeg, MB. 62 pp.

A thesis examining the redesign of West Park at Delta, Manitoba, a recreational facility on the south shore of Lake Manitoba, to reduce the negative effects of the facility on the ecology of beach ridge. West Park has been used intensively for several years and exemplifies ecological problems associated with recreational developments on beach ridges such as clearing of native vegetative cover, and the exposure of sand to wind and subsequent erosion. A physical description of Lake Manitoba is given which includes morphology, water levels, climate, and the historical use of the beach ridge at Delta since 1900. The design of the facility includes reforestation of the beach ridge adjacent to the beach, access to the beach by a fenced pathway and boardwalk, restriction of parking to the south end of the site, camping sites separated by planted trees, and the development of marsh and beach ridge interpretive trails to educate the public on their importance. Figures are included illustrating the current layout of the facility and the new proposed layout.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library, Call No. Delta Gov Docs Man MISC 2

McLeod, J. A. 1954. A Brief Report on an Investigation of Possible Muskrat Habitats in the Lake Winnipegosis Area. Manitoba Department of Mines and Natural Resources, Game and Fisheries Branch. 13 pp.

A brief report on an investigation conducted in 1954 to examine the potential of various water bodies around Lake Winnipeg for muskrat habitat. Sites examined included Duck Marsh, Pickerel Lake, Pickerel Creek, Blink Lake and Soul Lake Marsh, Sisib Lake, Chitek Lake, and Waterhen Lake. A brief description of each site is given, with most of the descriptions includes information on location, soils, and vegetation. Each site was assessed for potential as muskrat habitat based on soils, vegetation, and water levels. The sites found to have the most potential for muskrat habitat included marshes along the creek from Soul Lake to Pickerel Lake, and from Blind Lake to Lake Winnipegosis. The Duck Bay marsh could also be potential habitat for breeding stock, except for its inferior quality vegetation and erratic fluctuating water levels. Blind, Pickerel, Soul and Sisib Lakes were found to have potential as habitat, except for the susceptibility of wave during storms disturbing muskrats and their homes. Pictures of the sites also included in the report.

Location: Manitoba Conservation and Environment Library, Call No. QL 737 R666 M35 1954

McLeod, J. A., S. L. Baldwin and R. E. McGirr. 1948. An Interim Report on a Biological Investigation of Muskrat Production in Manitoba, 1948.

An interim report of studies conducted in the summer of 1947 and 1948 examining the biology of the muskrat in Manitoba. The investigation takes place near several water bodies in Manitoba: Whitewater Lake, Oak Lake, Netley Marsh, Delta Marsh, and Proven Lake. General descriptions of each study area are given, which included location, area, soils, hydrology, abundance of water, and climate. During the surveys physical and chemical conditions of the study sites were examined including analysis of water for concentrations various forms of phosphorus and nitrogen, pH, alkalinity, and redox potential. Soil samples were analyzed for nitrogen and phosphorus concentrations, moisture content, and organic matter content. Results of the chemical analysis at each site are discussed, and examined for their possible influence on vegetation at each site. The report examines several biological aspects of the muskrat including its food and cover requirements, effects of water conditions, population densities, factoring tending to increase/decrease muskrat population abundance (climatic, physiological and biotic factors), features of muskrat houses, reproduction rates, predators, parasites and disease, and mortality rates and causes. The report includes several aerial and ground pictures of the study sites.

Location: Manitoba Conservation and Environment Library, Call No. QL 737 R6 M35 1948

McLeod, J. A. and G. F. Bondar. (no date). Muskrat – Summary and Conclusions. Manitoba Game and Fisheries Branch, Winnipeg, MB. 6 pp.

A summary report of a five-year investigation of the biology of the muskrat in Delta Marsh, Netley Marsh, and Summerberry Marsh, Manitoba. The report is undated, but summarizes results similar to a five year study done in the same three marsh from 1947 to 1951. The investigation summarizes information in the muskrat found to be pertinent to the management of marshes for muskrat, including food and shelter vegetation requirements of the muskrat, reproduction rates and mortality of the muskrat, effects of varying water levels on the muskrat and marsh vegetation, and disease among muskrats.

Location: Manitoba Conservation and Environment Library, Call No. QL 737 M35

McLeod, J. A., G. F. Bondar and A. Diduch. 1951. An Intern Report on a Biological Investigation of the Muskrat in Manitoba – 1950 & 1951. Manitoba Game and Fisheries Branch, Winnipeg, MB. 65 pp.

The report examines the biology of the muskrat in Manitoba, focusing on four aspects of muskrat biology which were considered to be important by the authors: the reaction of marsh vegetation to varying water levels and other factors, the breeding habits of the muskrat and survival rates of young, factors which contribute the mortality in muskrats, and the pelt quality of muskrats at different ages and seasons. The investigation takes place over a five year period from 1947 to 1951, and centers around three marshes in Manitoba: Netley Marsh, Delta Marsh, and Summerberry Marsh. The report includes a discussion of vegetation used by muskrats for food and shelter; vegetation dynamics in marshes with differing water levels; the degeneration and regeneration processes for marsh vegetation; reproduction rates, growth, and mortality of the muskrat; effects of fluctuating water levels on muskrat populations. The report contains photographs of macrophyte vegetation in Delta Marsh, Netley Marsh, and Summerberry Marsh during the summers of 1949, 1950, and 1951.

Location: Manitoba Conservation and Environment Library, Call No. QL 737 R666 M355 1951

McLeod, J. A., G. F. Bondar and A. Diduch. 1959. Interim Report on a Biological Investigation of the Muskrat in Manitoba During 1949. Manitoba Game and Fisheries Branch, Winnipeg, Mb. 202 pp.

An interim report of the third year of the five-year study, 1947 to 1951, examining the biology of the muskrat in Manitoba. The investigation takes place around several water bodies in Manitoba: Whitewater Lake, Netley Marsh, Delta Marsh, and Summerberry Marsh. The report examines several biological aspects of the muskrat including its optimum food and cover requirements, optimum water conditions, optimum population density, factoring tending to increase/decrease muskrat population abundance (climatic, physiological and biotic factors), features of muskrat houses, reproduction rates, and mortality rates and causes. The report also contains a detailed description and pictures of the vegetative composition of the study sites in 1948. The report also includes a hand drawn map of Netley Marsh in 1949 illustrating the vegetation composition of sections of the marsh.

Location: Manitoba Conservation and Environment Library, Call No. QL 737 R666 M355 1949

Milani, D. W. and T. D. Milani. 2000. Fish Habitat Inventory of Selected Lake Manitoba North Basin Tributaries. Phase I Report. Unpublished CD Report.

A report discussing a fish habitat inventory conducted in tributaries on the east side of the north basin of Lake Manitoba in the Spring of 2000. Tributaries examined include Dolly Creek, Moosehorn Creek, Ditchfield Drain, Watchorn Creek, Mercer Creek, Rendall's Creek, Crossen Drain, Sandy Beach Creek, Powderhorn Creek, Baskcet River, Bear Creek, Boggy Creek, and Proulx Creek. Descriptions of the hydrology of the study areas are given. Inventories included examination of the sites, fish egg collection, larval sampling, and aerial video surveys of the study sites. Cumulative impacts that had potential to influence fish habitat quality at each of the samples sites was also recorded, including obstructions to fish passage, nutrient and sediment sources from the surrounding watershed, the segmentation of habitat, removal of riparian buffer vegetation, wetland drainage and filling, waterfowl management water level control structures, and the regulation of water levels on Lake Manitoba. The report discusses observations of fish usage at each of the sample sites and includes recommendation for future fish habitat enhancement work, and future research needs.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Miller, W. R. and D. D. Moore. 1967. History of The Delta Marsh. Unabridged draft report of the technical committee for development of Delta Marsh. Unpublished. 122 pp.

A report reviewing of the history of Delta Marsh to attempt to determine causes for the decline in marshes productivity, with recommendations for the development and management of the marsh to increase productivity, emphasizing waterfowl. For the study files from various private and government office, which contained information on the marsh, were examined. Information examined included contours, profiles, water levels, construction, photography, land ownership, land value, shooting lodges, wildlife utilization, vegetation, and wildlife harvest records. Much of this information is summarized and discussed in the report. Field studies were also conducted for the report in the summers of 1964 to 1966. Data gathered during the field studies included water levels, contour information, weather data, aerial photographs for vegetative mapping, waterfowl surveys, hunting success data, soil profiles, water chemistry data. The report includes a physical description of the marsh, which includes geology, climate, soils, vegetation, water sources and levels, topography, and wildlife, waterfowl, and fish usage.

The majority of the report focuses on historical changes in waterfowl and wildlife productivity of the marsh and its current state, with recommendations to increase waterfowl productivity in the marsh. The development of the marsh for increased waterfowl and muskrat productivity is also discussed. The development calls for the

impoundment of the marsh to enable the manipulation of water levels in the marsh to increase vegetation productivity, enhancing waterfowl habitat, with the hope of increasing waterfowl and muskrat productivity. The development will include the use of the Assiniboine River Diversion as a source of water for water level management in the marsh. The report also includes discussion of the Assiniboine River Diversion, which was under construction at the time of field studies, and its potential to have negative effects on the marsh including increased turbidity, and nutrient loading. A carp study that was initiated in 1964 to examine the effects of carp on the marsh, is also briefly discussed.

Conclusion of the report regarding major reasons for the decline in waterfowl and marsh productivity include the long-term stabilization of water level in the marsh resulting from the regulation of Lake Manitoba, agricultural encroachment of the marsh, increased turbidity in the marsh probably from carp in the marsh, increased algal blooms, and little biological background information on which to base management recommendations. Recommendations for the development and management of the marsh, and research are also presented. Some of the more important of these recommendations includes that the marsh should be developed using this report as a guide; a permanent headquarters should be established at the marsh; increased enforcement of the Wildlife Act in the marsh; co-ordination of development-management plans, land use and research; and increased efforts to alleviate waterfowl-sportsmen-farmer problems.

Various figures and graphs are included illustrating historical water levels on Lake Manitoba, trends in waterfowl populations, weather data, and land ownership, along with several photographs of the marsh, and list of plants, wildlife, waterfowl, and fish known to occur in the marsh.

Location: Delta Waterfowl Research Station, David Winton Bell Memorial Library

Morris, W. V. 1955. Report on Assiniboine River Flooding. Manitoba Department of Mines, Resources, and Environmental Management, Water Resources Branch. 126 pp.

An examination of historical flooding along Assiniboine River, and a discussion of possible flood control measures. A description of the Assiniboine River is given, which includes drainage area, tributaries, topography, geology and glacial history. The history of flooding along the river from 1852 to 1955 is the focus of the report, along with proposed methods to control floods along the river. Flood control measures discussed include channel improvements and diking, the diversion of water from the river in the vicinity of Portage la Prairie into Lake Manitoba (Assiniboine River Diversion), water storage reservoirs, improve land drainage, and improved flood forecasting. Figures are included illustrating the drainage basin of the river, water discharge and velocity rates, and water levels along the Assiniboine River.

Location: Delta Waterfowl Research Station, David Winton Bell Memorial Library

Muir, R. J. 1971. Summary of the Quantitative Analysis of the Lake Manitoba Flood Survey (the Agricultural Picture). Manitoba Water Commission. 43 pp.

A study examining the extent of agricultural land surrounding Lake Manitoba, that is subject to flooding from the lake. The report was prepared as part of the Manitoba Water Commissions Report examining a practical range of regulation for water levels on Lake Manitoba (Manitoba Water Commission 1973a and 1973b). The report is a result of a survey conducted during the summer of 1970 examining the flood damage suffered by farmers and ranches in the areas surrounding Lake Manitoba during the floods of 1969 and 1970. It was found that an estimated total of 225-250 farms were subject to flooding. The report includes a description of the types of farming that take place around the lake including haying, cereal grains, and pasture land. The direct cause of flooding to farmlands around the lake is primarily due to wind set-up on the lake, which can raise the lake 2 to 3 feet or more. The combination of wind set-up and heavy rains can cause flooding to shallow sloping shorelines. The worst flooding takes place around the Narrows of Lake Manitoba, where water flow is constricted. The report examines how much of farmers land was flooded in the area surveyed, and the monetary implications of the flooding. The total flooded acreage during the two years represented 20 314 acres.

Location: Manitoba Conservation and Environment Library, Call No. GB 1399.5 C2 M85
1971

Mundy, N. 1951. Interim Report on the Dauphin River Power Project. Manitoba Department of Mines and Natural Resources, Water Resources Branch. Winnipeg, MB. 12 pp.

A 1951 report on the Dauphin River Power Project, which consisted of the diversion of the Saskatchewan River from Cedar Lake into Lake Winnipegosis, and through Lake Manitoba, the Fairford River, and Lake St. Martin to a power house on the shore of Sturgeon Bay, Lake Winnipeg. Cedar Lake, Lake Manitoba and Lake Winnipegosis would be used for water storage. The power project has the potential to generate some 733 and 794 million kilowatt hours of electricity annually. The report discusses the proposed project and layout of various structures (i.e. canals, control works, dykes, spillways penstocks and the power house) on the water bodies involved in the scheme. A description of work done to date is given, along with cost estimates of the project. Several figures are included illustrating water flow and levels on the Saskatchewan and Fairford Rivers, and the various structures that will be constructed as part of the power project.

Location: Manitoba Conservation and Environment Library, Call No. storage box WSC #2

Munro, J. A. 1927. Observations n the double-crested cormorant (*Phalacrocorax auritus*) on Lake Manitoba. Canadian Field Naturalist 41: 102-108.

A discussion of the biology and food habitats of the Double-crested Cormorant on Lake Manitoba. Studies were conducted near the north end of Lake Manitoba during July, 1925. A list of all the species of land birds observed during the field study is included. The paper includes an excellent description of the type of shoreline and reefs present around Lake Manitoba. It also lists and discusses the major fish species present in Lake Manitoba in order of their commercial importance: pickerel, pike, tullibee, common whitefish, perch, sauger, mullet or redhorse, brook stickleback, and lake shiner. The author suggests that there is a complex relationship between birds, fishes, Crustacea, plants and insects in Lake Manitoba, and this relationship has been permanently disrupted by human activity.

Location: University of Manitoba, Science and Technology Library, Call No. 574 C16 Fi Na

Murkin, H. R. and J. A Kadlec 1986. Responses of Benthic macroinvertebrates to prolonged flooding of marsh habitat. Canadian Journal of Zoology 64: 65-72.

A study examining the effect of prolonged above-normal flooding conditions on benthic invertebrates. Studies were conducted in ten experimental cells of the Marsh Ecology Research Program at Delta Marsh during the summers of 1980 to 1982. Marshes cells were flooded to 1 m above normal conditions for 2 years. Results of the study showed that benthic invertebrate densities and biomass were low during periods of normal water depths when compared to flooded water levels. All cover types other than the former open-water sites showed increases in benthos densities, biomass, and numbers following flooding.

Location: University of Manitoba, Science and Technology Library, Call No. Sci tech 4th
590 C16 Jo Zo

Murkin, H. R., A. G. van der Valk and W. R. Clark (editors). 2000. Prairie Wetland Ecology The Contributions of the Marsh Ecology Research Program. Iowa State University Press, Ames, Iowa. 413 pp.

A book summarizing the contributions of the Marsh Ecology Research Program (MERP), a long-term interdisciplinary study examining the ecology of prairie marshes. The study examined the long-term effects of water-level manipulation on the ecology of prairie marshes including hydrology, water chemistry, vegetation, algae, invertebrates and vertebrates, during a 10 year period from 1980 to 1989. Studies were conducted in ten experimental cells located at Delta Marsh. Water manipulations in the cells simulated the wet-dry cycle of prairie wetlands. In the first year of the project cells were kept at normal water levels of Delta Marsh then in the following two years all cells were flooded to 1 m above normal water levels. The deep flooding was planned to kill off the existing emergent vegetation. Following the flooding years the cells experienced full water drawdown, to allow vegetation to reestablish in the marsh cells. Cells were then reflooded to one of three water depths normal level (long-term mean level of Delta Marsh 247.50 m ASL), medium (30 cm above the mean) and high (60 cm above the mean). The various ecological compartments of the marsh (i.e. vegetation, invertebrates, algae and water chemistry) in the cells were monitored during the 10 year period to examine the effects of various water levels on the various ecological compartments. The results from a variety of studies that were conducted during MERP are separately discussed in the book, including observations during the baseline and deep-flood years, and drawdown and reflooding years, and effects on vegetation dynamics, nutrient budgets, algae, invertebrates, avian usage and muskrats.

Descriptions of Delta Marsh, including a physical description, the geological history of the marsh and current condition of the marsh are also given. The descriptions include location, size, geology, soils, water chemistry, climate, vegetation and fauna. Recent developments in the marsh that are discussed include stabilization of water levels on Lake Manitoba and hence the marsh, introduction of carp, and the Assiniboine River Diversion. The regulation of Lake Manitoba since 1961 has reduced the magnitude of water level fluctuations in the lake and the marsh from 2.2 m prior to regulation, to 0.6 m post regulation. Thus, the natural wet/dry cycles in the marsh have been dampened, and as a results species diversity and productivity has decreased. Carp are known to root up aquatic macrophytes, increasing water turbidity in marsh, and compete with other fish species. The Assiniboine River Diversion has results in the introduction of new fish species into Lake Manitoba and Delta Marsh.

A section is included in the publication listing the vast array of publications and theses that have resulted from studies conducted during the Marsh Ecology Research Program.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 P73 2000

Murray, A. S. 1960. List and Resume of Early Report on Manitoba Fishery Resources With Comments. Manitoba Department of Mines and Natural Resources, Fisheries Branch. 14 pp.

A short chronological list of 14 main reports, from 1865 to 1955, which have examined the regulation Manitobas fishery resources. The majority of the report examines various regulations that have been imposed on fishing in the province, and various aspects of the fishery market. The report also discusses the decline of the Lake Winnipeg whitefish fishery, but there is no mention specifically of the fishery conditions in Lake Manitoba. Also included are short comments on each report and a general brief summary of the author's opinion of the regulation of the province's fishery since 1865, and areas that require further attention.

Location: Manitoba Conservation and Environment Library, Call No. SH 327.5 M87 1960
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Nambudiri, E. M. V. and C. T. Shay. 1986. Late Pleistocene and Holocene Pollen Stratigraphy of the Lake Manitoba Basin, Canada. *Palaeontographica Abteilung B* 202: 155-177.

A study examining the Quaternary pollen stratigraphy in Lake Manitoba sediments to establish the types of vegetation present in region during the late Pleistocene and Holocene periods. The article includes a description of the geological history, morphological features, and current vegetation around the lake. The six cores processed for palynological analysis were collected from the south basin of Lake Manitoba during the winters of 1978 and 1979. The article reconstructs the vegetative history in and around the south basin of Lake Manitoba from the Late Glacial (early Lake Agassiz) Phase, 11 500 years B.P. to Present. Several figures and graphs are included illustrating the sampling location of sediment core, the vegetation around the lake, and pollen and spores assemblages in the sediment cores.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Nash, R. 1995. Lake Francis Wildlife Management Area: Natural Resources Inventory. Technical Report No. 95-04. Manitoba Natural Resources, Wildlife Branch. 61 pp.

An inventory of the plant and animal communities Lake Francis Wildlife Management Area, near Delta Marsh, conducted from June to September, 1994. The inventory includes a survey of vegetation, birds and other wildlife. Results of the survey indicate that non-native plant species are invading the areas native tall grass prairie, and the native plants and animals are being negatively affected. The report also notes that the stabilization of water levels on Lake Manitoba has negatively effects the marshes and lakes of the area, resulting in static water levels, and the advancement of cattail and reed grasses, which closes out open water areas. Changes in water levels are needed to sustain a health diverse marsh. The stabilization of Lake Manitoba has also increased erosion rates of the barrier beach ridge that separates Lake Francis from Lake Manitoba. Lists of the bird and plants species found during the survey are also included.

Location: Manitoba Conservation and Environment Library, Call no CA2 MNR tr 95-04 1995

Neill, C. 1989. Effects of nutrients and water levels on emergent macrophytes biomass in a prairie marsh. *Canadian Journal of Botany* 68: 1007-1014.

A study examining the effects of nitrogen and phosphorus fertilization on the biomass of emergent macrophytes in a marsh undergoing water level fluctuations. Studies were conducted in Delta Marsh from May to October of 1986 and 1987. A general description of Delta Marsh is given including soils, location and area, and water chemistry. Two species of emergent macrophytes were studied: whitetop grass (*Scolochloa festucacea*) and hybrid cattail (*Typha glauca* Godr.). Water levels were high during the first year of nutrient additions and low during the second year. Results of the study showed that whitetop and cattail were both experienced nitrogen limitation and not phosphorus limitation. Changes in nitrogen limitation were observed with flooding, suggesting that annual water level fluctuations, generating alternating flooded and dry conditions, may influence macrophyte productivity through effects on the nitrogen cycle.

Location: University of Manitoba, Science and Technology Library, Call No. 580 C16 Bo

Neily, W. 2000. Whitemud Watershed Wildlife Management Area: Wildlife Inventory Edrans and Hummerston Units. Technical Report No. 2000-03W. Wildlife Branch, Manitoba Conservation, Winnipeg, MB. 153 pp.

An inventory of major plant and animal species and communities of the Whitemud Watershed Management Area, conducted from June to September, 1995. Approximately 354 species of vascular plants and 124 species

of birds were observed during the study. A description of the study area is given, which includes topography, drainage, geology, and soils. Annotated lists of flora species found in the study area are given, along with their density and dominance percent cover. Annotated lists of fauna are also given, and include birds, mammals, reptiles, amphibians, ticks and insects. Information on animals includes abundance and dominant species.

Location: University of Manitoba, Science and Technology Library, Call No. QH 106.2 M3 T434 no. 2000-03W

Location: Manitoba Conservation and Environment Library, Call No. CA2 MC tr 2000-03

Nero, R. W. 1971. A Response to the Proposal to Lower the Water Level of Lake Manitoba by Six Inches. 7 pp.

A brief report examining the possible effects of lowering the target range of Lake Manitoba water levels by six inches, on the marsh habitat surrounding the lake, and related productivity of both plants and animals in the marshes. The report briefly discusses the importance of marsh habitat for production of furbearer (mink and muskrat) and waterfowl, for recreational and hunting purposes. A number of factors have led to detrimental changes in the condition of marshes surrounding the lake and resultant reductions in wildlife production in the marshes including the introduction of carp, regulated water levels of Lake Manitoba and hence the marshes, increased nutrient enrichment, and increased siltation. The report discusses the conflict between agricultural demands for increase use of marsh habitat and the lowering the Lake Manitoba to reduce flooding, and the well being of marsh habitat surrounding the lake.

Generally, the lowering the lake will reduce the size and productivity of the marshes surrounding the lake. According the author the lowering of Lake Manitoba would not reducing all flooding to surrounding agricultural lands, because lower lake levels would results in increased wind tides effects bringing water into adjoining meadows were agricultural activities occur. The report examines some of the effects the lower water level on Lake Manitoba would have on Delta Marsh, including decreased marsh area, and resultant economic implications from reduced waterfowl and muskrat production. According to the report a six-inch reduction in the water level of the lake would cause a loss of at least 112 536 acre-feet of marsh habitat around Lake Manitoba. The effects of reduced water levels on fish production in Lake Manitoba area also examined, and effects included reduced spawning and foraging marsh habitat and a resultant reduction in the commercial and sport fishery of the lake. The resultant possible increased the instance of winterkills by 'death waves' in the lake is also discussed. The salinity of the lake is also expected to increase to a possible hazardous degree if the water level of the lake is lowered.

Location: Manitoba Conservation and Environment Library, Call No. SF 84.64 C2 W43 1971

Nero, R. W. 1973. Delta Marsh framework plan, 1973. Manitoba Department of Mines, Resources and Environmental Management, Wildlife Programs Development and Extension Services. Winnipeg MB. 44 pp.

An overview of plans for development of Delta Marsh as a wildlife management area, to increase waterfowl and wildlife productivity, and to increase recreational opportunities for the public. The report recommends several initial steps for the rehabilitation of the marsh including: land acquisition around the marsh, gathering of further information on the ecology of the marsh, interpretive facilities, a marsh manager, a citizen advisory group, and preservation of the natural aspects of the marsh. The report includes a schedule and costs for the development of the marsh. The 1968 publication "The Delta Marsh: Its Values, Problems, and Potentials" (Bossenmaier 1968), is the basis for development scheme in the marsh. The report gives an overview of the proposed development plan including aspects such as public participation, agricultural aspects, land acquisition, implications of water usage from the Assiniboine Diversion for the project, fisheries aspects, waterfowl populations and furbearers, and interpretive centers. Detailed development plans for each section of the marsh

(West Marsh, Center Marsh, East Marsh, Sioux Pass Marsh and Lake Francis Marsh) are discussed. Figures illustrating the development project are included.

Location: Manitoba Conservation and Environment Library, Call No. QH 541.5 .M3 .N449

Newton, M. V. B. 1932. The Biology of *Triaenophorus tricuspoidatus* (Bloch 1779) in western Canada. MSc Thesis, University of Manitoba. Winnipeg, MB. and Contributions to Canadian Biology and Fisheries 8(28) (Series A, General, No. 25): 343-360.

A study examining the incidence of infection of *Triaenophorus tricuspoidatus* (Bloch 1779) in *Coregonus* and *Leucichthys* fish species in Manitoba. For the study 7,000 fishes were collected and examined from thirty lakes in southern Manitoba, and a few from Saskatchewan in 1931 and 1932. Some of the lakes sampled in Manitoba included Lakes Manitoba, Winnipegosis, Winnipeg, Dauphin, St. Martin, and other lakes in the Pas district. Of all the fish sampled from Lake Manitoba, none were infected with *T. tricuspoidatus*. Of the 15 *Coregonus* fish species caught in Lake St. Martin, only one was parasite was found in each of the five fish found to be infected. The report includes a description of the morphology and biology of the larvae and adult stages, along with a description of the life cycle. The possibilities of economic control are also discussed.

Location: University of Manitoba, Department of Zoology, Dissertations.

Location: University of Manitoba, Science and Technology Library, Call No. 574.05 C16 CO

Newton, B. J. 1935. A Contribution to the Biology of the Yellow Pickerel (*Stizostedion vitreum*) and Sauger (*Cynoperca canadense*) in Manitoba. MSc Thesis, University of Manitoba, Winnipeg, MB. 44 pp.

A study examining the growth and eating characteristics of the yellow pickerel (*Stizostedion vitreum*) and sauger (*Cynoperca canadense*). Field Studies were conducted during the winter of 1933 to 1934, and the summer and winter of 1934 to 1935. According to the study yellow pickerel is found in lakes Manitoba, St. Martin, Waterhen and Winnipegosis, and sauger is found in lakes Manitoba and Winnipegosis, as well both are found in various other lakes throughout the Manitoba. The report includes a discussion of the two fish species including commercial importance, fishing methods and regulations, and the habitat for spawning and rearing. Observations of the study include: sauger growth is slower than pickerel, the greatest growth of both species occurs in the first year, sauger are mature at 13 to 13½ inches, pickerel are mature at 14½ to 15 inches, and the main food of both species is small fish (sheepheads, suckers, minnows, trout-perch and perch).

Location: University of Manitoba, Elizabeth Dafoe Library, Thesis N481

Nicholson, D. 1928. Fish Tapeworm: intestinal infection in man, the infestation in Manitoba Lakes. Canadian Medical Association Journal 19: 25-33.

A study examining the human infection with a tapeworm, *Diphyllobothrium latus*, acquired from Manitoba fish. Feeding experiments were conducted during 1927 and 1928, and showed that 20 percent of pike (*Esox lucius*) and two of the seven pickerel (*Stizostedion vitreum*) from lakes Winnipeg and Manitoba were infected with the larvae of this tapeworm. Seven out of the 35 pike examined for the experiment, from lakes Winnipeg and Manitoba were infected with fish tapeworm larvae. Two of the seven pickerel studied were similarly infected. Examination of goldeye, sucker, tullibee, herring and whitefish showed no larvae in the flesh or viscera of the fish. The paper discusses the lifecycle of the tapeworm, along with methods of infection in humans, and methods to prevent infection.

Location: University of Manitoba, Neil John MacLean Health Sciences Library, 3rd floor

Olson, P. 1955. Preliminary Report Muskrat investigations of the Delta Waterfowl Research Station, June - Sept. 1955. Manitoba Department of Mines and Natural Resources, Wildlife Branch. Winnipeg, MB. 9 pp.

Investigations of the population and productivity of muskrat in Delta Marsh during the summer of 1955, in Delta Marsh. The report examines muskrat populations in 1955, and discusses their main food sources, productivity, population estimates, parasites and disease. The report includes a discussion of the effect of the high water levels in Lake Manitoba and Delta Marsh during study year on muskrat populations. The high water levels resulted in the flooding of numerous muskrat houses, some litter mortality, and reduced food and habitat availability. The high water level flooded out and drowned emergent vegetation including *Phragmites*, white top, and cattail. Management suggestions for muskrat populations at Delta Marsh are also discussed including different trapping seasons.

Location: Manitoba Conservation and Environment Library, Call No. QL 737 R6 047

O'Malley, B. and H. E. Welch. 1978. Paratism of Lake Manitoba Fish by *Ergasilus spp.* University of Manitoba Field Station (Delta Marsh) 1977 Annual Report 12: 51-57.

An examination of ergasilids gill ectoparasites in sauger (*Stizostedion canadense* Smith), walleye (*Stizostedion vitreum* Mitchill), yellow perch (*Perca flavescens*), and lake cisco (*Coregonus artedi*) in Lake Manitoba. Sampling was conducted in the south end of the lake from May to August 1976. Fish sampled include 63 sauger, 29 walleye, 100 yellow perch, 41 lake cisco, 7 northern pike, 18 white suckers and 22 trout-perch. The paper discusses the biology of various ergasilids species present in the gills of fish sampled, and the relationship between ergasilids infestation and fish size is also discussed. The reaction of host fish to the parasites is also examined. See Pearson and Welch (1977) and Welch (1976) for earlier reports.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Ould, P. 1980a. Delta Marsh conceptual review. Ducks Unlimited Canada, Winnipeg, MB. 280 pp.

An overview of the physical, chemical, and biological properties of Delta Marsh, as background material for the proposed development of the marsh as a wildlife management area, primarily to increase waterfowl production. A historical review of Delta Marsh is given, which discusses geology; climate; vegetation; influence of Lake Manitoba on marsh water levels; fur harvests, waterfowl harvests, and other wildlife; and the introduction of carp. A general physical description of the marsh is also given, which includes morphology, soils, water chemistry, waterfowl use and vegetation. An overview of Management plan is given, along with specific treatments required to manage the marsh including water level management with periodic drawdowns and flooding, selective thinning of vegetation, and controlled burns, and the management of pike and carp. Some specific areas of the marsh are examined individually in terms management, and their potential for waterfowl production under managed conditions. The sites examined include School Bay, Cadham Bay, Simpson Bay, Bluebill Bay, Clandeboye Bay, Lake Francis, and the West Unit of the marsh (between Lynch's Point and the west dike of the Assiniboine Diversion). Water samples were also collected from select sites during the summer of 1979 for analysis of water chemistry and the results are presented in the report. Chemical parameters examined include pH, specific conductance, alkalinity, hardness, and concentrations of sulfate and chloride. Samples of invertebrates were also collected from sites in the marsh.

Location: Ducks Unlimited Canada, Institute for Wetlands and Waterfowl Research Library, Call No. OUL

Ould, P. 1980b. Pineimuta Marsh: Waterfowl Production Potential and Management Recommendations. Ducks Unlimited Report, Biological Services Group. 110 pp.

A study examining the effects of extreme fluctuating water levels, from the regulation of water levels on Lake Manitoba, on waterfowl and waterfowl habitat in Pineimuta Marsh. The report also includes several recommendations for the management of water levels in the marsh to optimize waterfowl habitat, including the construction of large dykes and a control structure to isolate the marsh from the extreme and erratic flows of the Fairford River, and the construction of smaller dykes and control structures to develop back-marshes around Pineimuta Lake. The report includes a physical description of Pineimuta Marsh, which includes location, climate, geology, topography, soils and vegetation. To conduct the study methods includes breeding pair surveys, broad surveys, vegetative cover and habitat determination, invertebrate sampling, water chemistry sampling, and examination of available waterfowl food resources, waterfowl usage surveys, and observation of other wildlife present in the marsh. Water chemistry analysis included pH, specific conductance, alkalinity, total hardness, and sulphate and chloride concentrations. The report found that waterfowl production in the marsh was low largely due to extreme and erratic fluctuations in water levels, which are deteriorating marsh habitat and creating a shortage of upland nesting habitat. Several tables and figures are included in the report illustrating waterfowl and vegetation surveys, as well as photographs of various aspects of the marsh.

Location: Ducks Unlimited Canada, Institute for Wetlands and Waterfowl Research Library, Call No. OUL (Library no. 1380)

Park, K. 1971. Lake Manitoba Fishery: Fishing Bulletin 5:16-17.

A short article on the fishery in Lake Manitoba, containing information on the 10-year average for fish catches, which is approximately 4 000 000 pounds for all fish species. During 1967-68 there was a drastic drop in catches, but since then they had been increasing, as in 1970 catches were just over half of what they used to be, with a catch of approximately 2 385 000 pounds. The sauger catches in the Lake have remains constant over the last few years, with about 580 000 pound in 1970. The article also contains a brief discussion of concerns related to effects of the Portage Diversion on Lake Manitoba, including mercury level in fish and effects of sediments from the diversion on fish.

Location: National Library of Canada, Call No. SH224

Patterson, E. B. 1949. Preliminary Study Assiniboine River Diversion Project. Department of Mines and Natural Resources. Winnipeg, MB.

A copy of the publication could not be obtained for examination. The copy of this publication located at the Manitoba Conservation and Environment Library was missing when this bibliography was compiled.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MNR WR ps 1949

Pearce, T. J. 1973. A Brief Examination of Recreation on Lake Manitoba and a Preliminary Statement of Impact on Recreation Resulting from the Proposed Lowering of the Lake's Mean Water Level. Planning Section, Provincial Parks Branch. Winnipeg, MB. 53 pp.

A preliminary study examining the effects of the proposed lowering of the target regulation water level of Lake Manitoba by six-inches from 812.17 to 811.67 feet ASL, on outdoor recreation around Lake Manitoba. The study was commissioned by the Manitoba Water Commission. The report gives a brief overview of the physical characteristics of Lake Manitoba, recreational opportunities on the lake, and an examination of how these opportunities could change due to the lowering of Lake Manitoba. Recreational activities based on the lakes natural resources are discussed included camping, cottages, nature walks and hiking, picnicking, swimming,

canoeing, sailing and boating, sport fishing, and hunting. Some of the possible effects of lowering the water level of Lake Manitoba discussed included a moderate deterioration in swimming and boating quality in some areas, deterioration of beach quality, and deterioration of marsh habitat for waterfowl and muskrat hunting. The report recommends that the target water level of Lake Manitoba should not be lowered, and that the present water level of the lake should be maintained to preserve the present quality of the beaches and hunting and fishing in the area. Further research to accurately determine a water regime for the lake that would be optimal for recreation is also recommended.

Location: Manitoba Conservation and Environment Library, Call No. GV 56 M3 P43 1973

Pearson, J. and H. E. Welch. 1977. *Ergasilus* spp. Parasites of Lake Manitoba Fish. University of Manitoba Field Station (Delta Marsh) 1976 Annual Report 11: 19-26.

In 1975 preliminary observation were made into the infestation of the parasitic copepod, *Ergasilus* sp. in sauger (*Stizostedion canadense* Smith) and walleye (*Stizostedion vitreum* Mitchill), in Lake Manitoba (Welch 1976). Samples of were collected in the north and south basins of Lake Manitoba during the summer of 1975 for examination. The parasite was found in the gills of both sauger and walleye, but not in sucker and perch caught in the lake. The abundance of parasite egg sacs in the gills of the fish sampled decreased though the summer. The sauger and walleye of northern Lake Manitoba were found to have the highest infestation of *Ergasilus luciopercarum*, record so far for any *Ergasilus* sp. Infestations were higher in the northern portion of the lake compared to the southern portion.

In the summer of 1976 the study was expanded to sampling twice a month, of all common species of fish found in the southern basin of Lake Manitoba. The study examined all ergasilid gill ectoparasites of fish in the lake and observed their pattern of seasonal abundance and development. Fish species sampled included sauger, walleye, yellow perch, trout-perch, lake ciscoes, white sucker, burbot, pike and darter. Three species of ergasilids were found on fish from the lake: *E. luciopercarum*, *E. nerkae*, and *E. versicolor*. The paper discusses the distribution, development and seasonal abundance of the ergasilids species on the gills of different fish species. See O'Malley and Welch (1978) for a later report.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Penner, F., T. R. Yuzyk and R. Oshoway. 1987. A Compilation of Manitoba Sediment Data to 1985. Manitoba Natural Resources and Environment Canada, Water Resources Branch Western and Northern Region. Winnipeg, MB.

A summary of suspended sediment and bed material data at 63 sites in select rivers in Manitoba up to 1985, gathered by the Water Survey of Canada, the Manitoba Water Resources Branch and other agencies. Some of the rivers in Manitoba examined in the report include the Assiniboine River, Portage Diversion and Whitemud River. Information presented in the report for the rivers examined includes drainage area, regulated or natural flow, period of sampling, mean daily and annual suspended solid concentrations, mean annual loads, mean annual and daily discharge. Graphs of data are also presented and include discharge frequency curves, stage-discharge rating curves, hydrographs, sediment concentration curves, and suspended sediment versus discharge curves.

Location: Manitoba Conservation and Environment Library, Call No. GB 1399.9 M3 P46 1987

Peterdy, S. 1961. Lake Manitoba Regulation: Operation Rules for the Fairford River Dam. Water Control & Conservation Branch, Department of Agriculture and Conservation. Winnipeg, MB. 11 pp.

An overview of the methods of operation for the Fairford Dam, for the regulation of the water level of Lake Manitoba between 810.51 and 813.05 feet ASL, with a mean required elevation of 812.3 feet ASL. Operation of the Fairford Dam began on July 1, 1961. The report gives an overview of data necessary for the regulation of Lake Manitoba and the operation rules of the Fairford Dam for maximum efficiency.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MMWR 61/11

Phillips, F. 1970. A preliminary investigation of water fluctuations in Delta Marsh. University of Manitoba Field Station (Delta Marsh) 1969 Annual Report 3: 54-57.

A discussion of a preliminary examination of the relationship between water used by marsh plants and fluctuations in the shallow water table. The study was conducted because during a survey of groundwater and soil permeability in the area of Delta Marsh for the proposed location of the Assiniboine Diversion (Gilliland 1965), a diurnal fluctuation in the water table was observed in the regions covered by marsh vegetation. It was thought that marsh vegetation, especially *Phragmites communis* could be causing the diurnal fluctuations by taking up more water during the day from the soil to replace losses by transpiration. Studies were conducted in August of 1969. Preliminary results show that water levels in sites with *Phragmites communis* experienced rapid decreases in the water table during the daylight hours.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Phillips, F. 1976. The relationship Between Evapotranspiration by *Phragmites communis* Trin. and Water Table Fluctuations in the Delta Marsh, Manitoba. PhD Thesis, University of Manitoba. Winnipeg, MB. 167 pp.

A study examining the relationship between water used by *Phragmites communis* Trin. var. *lerlandieri* (Fourn.) and fluctuations in the shallow water table of the Delta Marsh area. The study was conducted because during a survey of groundwater and soil permeability in the area of Delta Marsh for the proposed location of the Assiniboine Diversion (Gilliland 1965), a diurnal fluctuation in the water table was observed in the regions covered by marsh vegetation. It was thought that marsh vegetation, especially *Phragmites communis* could be causing the diurnal fluctuations by taking up more water during the day from the soil to replace losses by transpiration. Studies were conducted in the summers of 1970 and 1971. Preliminary results show that water levels in sites with *Phragmites communis* experienced rapid decreases in the water table during the daylight hours. Mean daily evapotranspiration rates were highest in July. Transpiration by *Phragmites communis* accounted for 75 to 90 percent of evapotranspiration at study site in the marsh. A description of Delta Marsh is included in the report, which discusses location and area, geology, soils, climate, and hydrology. Environmental parameters measured during the study included shortwave radiation, air and soil temperature, net radiation, relative humidity, and precipitation. Soil samples were also collected at the study site and analyzed for texture, particle size, moisture content, and organic content.

Location: University of Manitoba, Elizabeth Dafoe Library, Thesis.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Pip E. 1977. A Study of Aquatic Plant-Snail Associations. PhD Thesis, University of Manitoba. Winnipeg, MB. 503 pp.

A study of aquatic plant-snail association at five sites in Delta Marsh, and one site located in the south end of Lake Manitoba. Studies were conducted in the summers of 1972 to 1974, during which benthic mollusc and vegetation samples were collected from the six sample sites, along with water samples for analysis of total filterable residue, optical clarity, temperature, alkalinity, pH, dissolved oxygen, and concentrations of chloride, sulphate, calcium, nitrite, nitrate, and phosphate. The study includes a description of Lake Manitoba and Delta Marsh, which includes geology, soils, vegetation and mollusc community.

Results of the study showed that the majority of mollusc species have a tendency to be found more often in vegetated area than in non-vegetated areas, and some had a tendency to occur in stands of specific aquatic plant species at particular times of the season. Mean numbers of snails per macrophyte also appeared to demonstrated peaks during phases of active host plant growth, and peaks consisted of newly hatched young, and reproduction and hatching episodes appeared to correspond with the growth of favored host macrophytes. During the study macrophytes were also examined for total soluble carbohydrates, total titratable acids, total extractable proteins and carotenes, to determine if any of these characteristics were related to the periods of peak snail numbers.

A second part of the study also consisted of a survey of submerged macrophytes and gastropods at 305 sites in southern Manitoba, and adjoining provinces. During this survey several new aquatic plants were identified in Manitoba. Variations in associations between snail and plant communities among the sample sites are discussed, along with environmental variables, including water chemistry. Some of the sample sites were located in Lake Manitoba, Lake St. Martin, Big Grass Marsh, and Assiniboine River.

Location: University of Manitoba, Elizabeth Dafoe Library, Thesis P66

Pip, E. 1990. A stratigraphy study of mollusks in Lake Manitoba, Canada. Walkerana 4: 271-277.

A study examining the mollusc remains in a short (1.3 m) sediment core and long (13.5 m) sediment core taken from the center of the south basin of Lake Manitoba. The sediment cores were collect by Teller and Last during the winters of 1978 and 1978 (see Last 1980; Teller and Last 1981, 1982; Last and Teller 1983). The cores represents a time span of 12 000 years from glacial time to present. The post-glacial history of Lake Manitoba is discussed along with changes in the abundance and occurrence of mollusc assemblages, and related changes in water levels, water chemistry, climate, and the flow of the Assiniboine River into Lake Manitoba (from 4500 yr B.P. to 2000 yr B.P.). Mollusc remains were present in the most of the long core, except for the section spanning 12000 to 9 000 B.P. where there were very few mollusc shells and few individual species. The fossil lymnaeids was characteristic of period when water levels were low in Lake Manitoba. From the cores it appears the species *Pseudosuccinea columella* was once common the sediments of the lake, but it no longer is found in central Canada. Since approximately 4500 years B.P. the mollusc species found in Lake Manitoba have been similar to groups found in the lake today. The paper includes lists of mollusc species that presently occur in Lake Manitoba, and those found at various depths (representative of various time periods) in the short and long cores.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Pip, E. and W. F. Paulishyn. 1971. The Ecology and Distribution of *Promenetus exacuous* Say (Gastropoda: Planorbidae) in Southern Manitoba. Canadian Journal of Zoology 49: 367-372.

A study of the distribution and ecology of *Promenetus exacuous* in water bodies throughout southern Manitoba. The environmental factors that seem to influence the distribution of *P. exacuous* in southern Manitoba are discussed. Some of the environmental variables that seemed to be important factors affecting the distribution of *P. exacuous* included water depth and vegetation, along with sulphate concentrations. Other environmental variables examined include temperature, substrate characteristics, type of water body, turbulence, and concentrations of sulphate. The presence of other molluscs at sites where *P. exacuous* was found was also noted. Seasonal fluctuations in populations of *P. exacuous* are also discussed. The Whitemud River and Lynch's Point, on the south shore of Lake Manitoba were among the sample sites.

Location: University of Manitoba, Science and Technology Library, Call No. 590 C16 Jo Zo

Pip, E. and J. M. Stewart. 1976. The dynamics of two aquatic plant-snail associations. Canadian Journal of Zoology 54: 1192-1205.

A study examining snail-aquatic plant relationships in Delta Marsh, located on the south shore of Lake Manitoba. Studies were conducted at two sites in the marsh during the summer of 1972. For the study the distribution and composition of macrophytes and molluscs were examined at each site, and surface waters were sampled for pH, total filterable residue, alkalinity, temperature, optical clarity, and concentrations of chloride, sulphate, chloride, calcium, phosphate, nitrate. From the study two major snail-aquatic plant associations were found in the marsh: *Physa gyrina* and *Potamogeton pectinatus*, and *Lymnaea stagnalis* and *P. richardsonii*. The two snail-plant associations are examined and discussed in terms of numbers of snails per unit dry plant surface area, snail biomass per unit dry plant weight, correlations in peak snail and plant biomass and growth, and characteristics of the peaks and possible reasons for the peaks.

Location: University of Manitoba, Science and Technology Library, Call No. 590 C16 Jo Zo

Planning Division. 1971. Diversion of the Dauphin River System. Manitoba Department of Mines, Resources and Environmental Management, Water Resources Branch, Planning Division. Winnipeg, MB.

A copy of the publication could not be obtained for examination. The copy of this publication located at the Manitoba Conservation and Environment Library was missing from circulation during the compilation of this bibliography.

Location: Manitoba Conservation and Environment Library, Call No. TD 227 M3 D38 1971

Pollard, W. R. 1973. Interim Report on the Impact of Water Regulation Patterns Upon Lake Manitoba, Lake St. Martin, and Sturgeon Bay Fisheries. Department of Mines, Resources and Environmental Management, Winnipeg, MB.

The purpose of the interim report was to review and report on fisheries resources affected by the water level regulation of Lake Manitoba, in order to provide interim recommendations for a water level regulation scheme that would protect commercial and recreational fisheries, and recommend areas that require further research regarding the effects of water level regulation on fisheries. The report includes brief background description of the fishery in Lake Manitoba, Lake St. Martin, and the Dauphin River; a general discussion of the effects of water levels on major commercial fish species, including pickerel (Walleye), sauger, whitefish and pike; and a discussion of the effects of Lake Manitoba regulation on specific fisheries in Lake Manitoba, Lake St. Martin, Sturgeon Bay and Dauphin River. Some of the recommendation and conclusion of the report include: the present regulated meand water level on Lake Manitoba (812.17 feet) is not satisfactory, and higher water levels

could be beneficial by improving water conditions in spawning areas; any changes in the minimum regulated water level would be detrimental, aggravating winter stagnation, so Lake St. Martin winter water levels should be maintained at 800 feet; the current regulation patterns on Lake Manitoba adversely affect the production of whitefish in Lake St. Martin, when January Lake St. Martin water levels are below 796 to 797 feet. The report also recommends several areas that need further study in the water bodies discussed including: the identification of spawning and nursery areas for the fish species mentioned; a better understanding of winter stagnation and its relationship to water level regulation; and fish tagging studies to determine the relationship between fish populations of Sturgeon Bay and Lake St. Martin. Tables and graphs are also included illustrating commercial fish production in Lake Manitoba, and the relationship between January water levels in Lake St. Martin and commercial whitefish production in the following four years.

Location: Manitoba Conservation and Environment Library, Call No. SH 331.5 H93 P65
1973

Location: Ducks Unlimited Canada, Institute for Wetlands and Waterfowl Research Library,
Call No. Library no. 1296

Pollard, W. R. and A. Storimans. 1978. Dauphin River Creel Census, 1972 and 1973. Manitoba Department of Renewable Resources and Transportation Services, Eastern Region. MS Report No. 78-23. Winnipeg, MB. 51 pp.

An examination of the fishery in the lower 1½ miles of the Dauphin River between 1972 and 1973. In the late 1960s, commercial fishermen became concerned large sport fish harvests were posing a threat to the commercial fishery; however these concerns were found to be unsubstantiated. The commercial fishery was closed in the spring of 1970 due to high mercury levels and was reopened in 1971. In July 1972 an intensive walleye census program was initiated to estimate: walleye catches, the biological impact of harvest on fish stocks in Sturgeon Bay, and total numbers of anglers in the area. The majority of fish caught in the Dauphin and Mantagao Rivers were walleye, other fish species caught in the river included north pike, sauger, yellow perch, sheepsheads and whitefish. Catches of walleye per unit effort were greater in 1972 than in 1973. Possible reasons for this decrease in walleye catches are discussed.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MRR msr 78-23
1978

Prairie Farm Rehabilitation Administration. 1958. Water Yields and Flood Potential in the Whitemud River Basin. Prairie Farm Rehabilitation Administration (PFRA), Hydrology Division. Winnipeg, MB.

A copy of this report could not be obtained for examination. The copy of this report located at the Manitoba Conservation and Environment Library was missing from circulation when this bibliography was compiled.

Location: Manitoba Conservation and Environment Library, Call No. CA 1 PFRA HD hr 27

Provincial Sanitary Control Commission. 1958. Sanitary Survey of the Whitemud River 1954-1956. Minister of Mines and Natural Resources. Winnipeg, MB. 14 pp.

The report summarizes the results of a pollution survey conducted on the Whitemud River from 1954 to 1956. Water Samples were collected from the Whitemud River and analyzed for bacteriological and chemical parameters, including water temperature, dissolved oxygen, biological oxygen demand (BOD), coliforms, and chloride. General descriptions of the physical characteristics of the Whitemud River are given in the report, which include drainage area, tributaries, topography, climate and hydrology. The report also briefly describes the historical and economic use of the river including, water supply usage, waste disposal, fishing, and possible municipal and industrial sources of pollution to the river. A map illustrating the sampling points along the

Whitemud River is included in the report. Several graphs are included in the report illustrating trends in the bacteriological and chemical parameters analyzed.

Location: University of Manitoba, Elizabeth Dafoe Library, Call No. Dafoe Gov Docs Can 6 Man 1 M5.7 Sa65W55 1958

Rannie, W. F., L. H. Thorleifson and J. T. Teller. 1989. Holocene evolution of the Assiniboine River paleochannels and Portage la Prairie alluvial fan. Canadian Journal of Earth Science 26: 1834-1841.

A discussion of the historical formation of the Portage la Prairie alluvial fan constructed by numerous paleochannels of the Assiniboine River when it flowed into Lake Manitoba. Pollen, diatom, and ostracods in sediment cores taken near the Assiniboine River drainage basin were examined to determine the flow the river, and the climate of the area during the Holocene. The River carried water northward across the fan in to Lake Manitoba from about 6000 years B.P. to 3000 years B.P. After 3000 years B.P, the Assiniboine River abandoned its route into Lake Manitoba and flowed into the Red River.

Location: University of Manitoba, Science and Technology Library, Call No. 550 C16 Ea

Ransom, B. A. 1971. Some Interrelationships of vegetation, Wildlife and Settlement of the Whitemud River Watershed. Whitemud River Watershed Resource Study Phase I: Some Interrelationships of vegetation, Wildlife and Settlement. Manitoba Department of Mines, Resources and Environmental Management. Winnipeg, MB. 34 pp.

A report describing the vegetation and wildlife of the Whitemud River Watershed, prior to settlement and its resultant impacts on the landscape of the watershed. The report is part of the Whitemud River Watershed Resource study Phase I. Descriptions of vegetation in the area prior to settlement are given, which were primarily obtained from land surveyor's reports and maps. Information on wildlife life prior to settlement was also obtained from surveyor's report and historical records, and is quite general and includes wildlife species that were most visible to early observers. The pattern of settlement in the area is briefly described. Impacts of settlement discussed include drainage of wetlands, the breaking of prairie and the clearing of forest, the introduction of exotic species, control of wildfires, extinction of native species and other related effects.

Other volumes of the Whitemud River Watershed Resources Study Phase I include: Fish (Falkner 1992), Land use (Hodgson 1972), Wildlife (Goulden *et al.* 1972) Agriculture (Jenkins 1972), and Outdoor recreation (Searth 1972).

Location: Manitoba Conservation and Environment Library, Call No. QK 910 R36 1971

Rawson, D. S. 1955. Morphology as a Dominant Factor in the Productivity of Large Lakes. Proceedings of the International Association of Theoretical and Applied Limnology 12:164-175.

An article examining the influence of morphology on fish productivity in eleven large lakes in Manitoba and Ontario. Lake Manitoba is among the lakes discussed. The study found that there was a logarithmic relationship between mean lake depth and average fish production in the lakes examined. Lake Manitoba was noted as having a mean depth of 16 feet, an area of 1 817 miles, and a 25-year average annual fish production of 4.75 pound per acre. Of the lakes examined Lake Manitoba was the second shallowest, and had the seconded lowest 25-year average commercial fish production in pounds per acre.

Location: Fisheries and Oceans Canada, Eric Marshall Aquatic Research Library

Rayner, M. 1976. Some Aspects of the ecology and management of *Chenopodium rubrum* in the Delta Marsh. University Field Station (Delta Marsh) 1975 Annual Report 10: 19-20.

A study examining the ecology and management of macrophytes *Chenopodium rubrum* and *Senecio congestus* in Delta Marsh. The two macrophyte species colonize mud flat during water level drawdown periods, and are attract waterfowl during the fall migration due to their seeds which are a desirable food item. During the spring and summer of 1974 and 1975 the phenology and growth of *Chenopodium* was investigated in four area of the marsh that were manipulated by various sequences of burning or cutting, rotovating, flooding, and draining. From the study it appears that time of seed germination and subsequent moisture regime are two main factors controlling the growth of *Chenopodium*. The conditions most favorable for wildlife use appear to be open areas with *Chenopodium* growing in association with a few other species.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Rayner, M. 1978. Some Aspects of the Ecology and Management of *Chenopodium rubrum* L. in the Delta Marsh, Manitoba. MSc Thesis, University of Manitoba. Winnipeg, MB. 86 pp.

A study examining the ecology and management of the aquatic plant *Chenopodium rubrum* in Delta Marsh. The species is an annual mud flat colonizer, during water level drawdown periods, and attract waterfowl during the fall migration due to their seeds, which are a desirable food item. During the spring and summer of 1974 and 1975 the phenology and growth of *C. rubrum* was investigated in four areas of the marsh that were manipulated by various sequences of burning or cutting, rotovating, flooding, and draining. From the study it appears that time of seed germination and subsequent moisture regime are two main factors controlling the growth of *C. rubrum*. The survival and growth of *C. rubrum* under varying water levels and soil flooding and/or drawdown conditions is examined and discussed. During the study soil and water samples were also collected from study sites. Soils samples were analyzed for pH, conductivity, water content, and organic matter content. Water samples were analyzed for pH. A complete list of plant species found at each sample site is included. The study also includes a description of Delta Marsh, which includes location and area, soils, geology, climate, vegetation and hydrology.

Location: University of Manitoba, Elizabeth Dafoe Library, Thesis R213.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Resources Allocation Working Group. 1982. Rural Municipality of Portage la Prairie Background/Development Plan Report. Manitoba Department of Natural Resources. No pagination.

A study examining the resources in the vicinity of Portage La Prairie. The report discusses such resources as fisheries, forestry, outdoor recreation, water, and wildlife, along with concerns and objectives related to their use, and policies and guidelines related to their use and protection. Fishery resources are examined in such water bodies as the Assiniboine River, Lake Manitoba and Delta Marsh. Outdoor recreation resources include those on and around Lake Manitoba and Delta Marsh, including waterfowl hunting and the provincial parks located in the area. Water resources discussed focus on the groundwater supplies for Portage la Prairie. Some of the wildlife resources discussed included waterfowl, furbearers, upland game, and other wildlife located around the south shore of Lake Manitoba, Delta Marsh, Assiniboine River, and Whitemud River, along with other areas near Portage la Prairie. Maps illustrating the location and area of the various resources in the vicinity of Portage la Prairie are included.

Location: Delta Waterfowl Research Station, David Winton Bell Memorial Library

Riesen, H. G. 1961. Proposed Shellmouth and Holland Reservoirs and Portage Diversion: A Study of the Flood Control and Conservation Benefits of These Projects Alone and In Combination. Canada Department of Agriculture, Prairie Farm Rehabilitation Administration (PFRA), Engineering Branch. Winnipeg, MB. 33 pp.

A report on examining the flood control benefits and cost of the proposed Portage Diversion, and Shellmouth and Holland Reservoirs, on the Assiniboine River. The report includes a description of the three proposed projects and their operation. Descriptions of the water flow and flood characteristics along the Assiniboine River are given. Flooding is frequent and severe between Portage la Prairie and Winnipeg. Results of the study showed that the Portage Diversion would provide the greatest flood control benefit to this area. The study also determined the diversion would not have a great effect on water levels in Lake Manitoba.

Location: Manitoba Conservation and Environment Library, Call No. CA 1 PFRA ER 28

Risberg, J., P. Sandgren, J. T. Teller and W. M. Last. 1999. Siliceous microfossils and mineral magnetic characteristics in a sediment core from Lake Manitoba, Canada: remnant of glacial Lake Agassiz. Canadian Journal of Earth Science 36: 1299-1314.

A study examining the siliceous microfossils, mineral magnetic properties, and radiocarbon dates from a 14.2 m long core taken from the south basin of Lake Manitoba, in the winter of 1993. The report includes a physical description of the lake including location, size, hydrology and geology. From the core, data on the postglacial history and changes that have occurred in Lake Manitoba and Lake Agassiz are summarized including changes in water levels, water chemistry and climatic conditions. Various figures and tables are included illustrating sample sites, and mineral magnetic parameters and siliceous microfossil in the core.

Location: University of Manitoba, Science and Technology Library, Call No. 550 C16 Ea

Robb, T. 2000. The role of Hypoxia in a Fresh Water Environment: The Ecological Implications in a Piscine Predator-Prey Relationship. MSc Thesis, University of Manitoba. Winnipeg, MB. 11pp.

A study examining the influence of fish body size on the tolerance of hypoxia (low oxygen conditions) in fish, and the resultant effects on predator and prey relationships. Field studies were conducted in Delta Marsh during 1998 and 1999. The hypoxia studies focused on two species of fish, the smaller fathead minnow, *Pimephales promelas* (the prey species) and yellow perch, *Perca flavescens* (the larger predator). The study found that a size sensitive relationship existed; in which smaller prey (fathead minnows, *Pimephales promelas*) were better able to withstand low oxygen condition than the larger predatory yellow perch (*Perca flavescens*). The results of this study suggest that small size classes of fish may have an advantage in waters where dissolved oxygen conditions fluctuate, and the creation of temporary low oxygen areas may provide refuges, intolerable to larger piscine predators, where smaller fish populations can establish.

Location: University of Manitoba, Elizabeth Dafoe Library, Thesis R533.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Sandilands, K. A. and B. J. Hann. 1997. Effects of fish and submersed macrophytes on the abundance of zooplankton in a prairie wetland. University of Manitoba Field Station (Delta Marsh) 1996 Annual Report 31: 58-66.

A study examining the effects of planktivorous fish on the zooplankton community, to determine if submerged macrophytes provide refuge for zooplankton. Studies were conducted in enclosures in the Blind Channel of Delta Marsh, summers of 1995 and 1996. Generally, in the absence of fish cladocerans populations increased quickly, but did not persist as food resources were removed by increasing populations of zooplankton, and populations declined as a result of decreases in food availability, whereas copepods densities decreased in the absence of fish. In the presence of fish, cladocerans and copepods showed declines in density throughout the season. Experiments with macrophyte refuges showed that macrophytes provide refuge as fish foraged in open water, until that food supply is used up, and then move into macrophytes to forage. This was shown as cladoceran number declined first in the water column, and then in the macrophytes.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Schellenberg, H. D. 1978. Wildlife Report: Lower Whitemud and Big Grass Marsh Flood Control Study: Phase II Report. Grass Marsh Wildlife Study Committee, Manitoba Department of Mines, Natural Resources and Environment, Water Resources Division.

A study examining the feasibility of improving Big Grass Marsh as a wildlife management area, through water level management, and the control of land use in the basin. The study was initiated due to an observed decline in the waterfowl, muskrat, and fish populations and production in the marsh, due to unstable water levels, and the encroachment of agricultural practices into the basin. The proposed project would involve the construction of six cells in the Marsh, a diversion ditch for the Big Grass River, and the establishment of the marsh as wildlife management area, comprising 52000 acres.

A general description of Big Grass Marsh is included in the report, as well as a discussion of various factoring limiting waterfowl, muskrat and fish production in the marsh, the need for developing the marsh as a wildlife management area, the proposed development, wildlife benefits of the development, and an analysis of cost associated with the proposed development. The report also discusses the fishery of Lake Manitoba, and how it has declined since 1952, for several possible reasons, including increased sedimentation, habitat loss, damming, and channelization. The report recommends in part the development of Big Grass Marsh for fish rearing habitat to help improve the fishery of Lake Manitoba.

Location: Manitoba Conservation and Environment Library, Call No. TC 530 M3 S34 1979

Schellenberg, H. D. 1979. Lower Whitemud River and Big Grass Marsh Flood Control Study: Phase II. Winnipeg, Man. Manitoba Department of Mines, Resources and Environmental Management, Water Resources Branch, Planning Branch, Winnipeg, MB. 75 pp.

Phase II of a study examining the technical and economical feasibility of providing flood control along the lower Whitemud River and around Big Grass Marsh. See Huggins (1977) for phase I of the study. This phase of the study focuses on one of the nine schemes evaluated in the first phase; the diversion of the Whitemud River around the Town of Gladstone via Gopher Creek, water storage in Big Grass Marsh, and controlled water discharge from the marsh. From this flood control schemes, six other schemes were developed involving combinations of various sizes of the Gopher Creek Diversion and of the Whitemud Channel enlargement below Big Grass Marsh. These six schemes are evaluated in this phase of the report in terms of their benefit/cost ratio

for flood control in the watershed. The report attempts to quantify effects of the schemes upon wildlife, agriculture, and related resource in the watershed. This includes the possible complementary enhancement of Big Grass Marsh for wildlife habitat enhancement, resulting from its use as a flood storage reservoir. The report also includes a physical description of the Whitemud Watershed including area, hydrology, climate, wildlife and land use, as well as, a discussion of the nature and extent of flooding and flood damage in the watershed. Several figures are included illustrating the study area, the flood control schemes, land use around Big Grass Marsh, and the wildlife development scheme for Big Grass Marsh. Several appendixes are also included in report that contains detailed information on hydrology; flood history, damage, and reduction schemes; wildlife; and agriculture in the Whitemud Watershed.

Location: Manitoba Conservation and Environment Library, Call No. TC 530 M3 S34 1979

Schindler, D. T. 1991. Soil and Vegetation Relationships in the Agricultural Periphery of the Delta Marsh, Manitoba. MSc thesis, University of Manitoba. Winnipeg, MB. 42 pp.

A study examining the plant species composition in Delta Marsh as it relates to the soil and groundwater salinity gradient that exists in the marsh. Studies were conducted in the summer of 1990 at selected transect sites, at which forage species composition was determined. Soil plots were dug to determine soil properties, and soil conductivity was measured as an indicator of salinity, along with determination of soluble cations and anions, and pH. Salinity dynamics in the marsh soils are thought to be the result of regional and local ground water flows. The study discusses changes in plant species composition along the transects and it relates to changes in soluble ions, pH, salinity, and conductivity along the transect sites. Results of the study showed that salinity and soluble salt concentrations were the determining factors affecting of the plant species composition of the marsh. A physical description of Delta Marsh is given, which includes geology, soils, hydrology, vegetation and climate.

Location: Delta Waterfowl Research Station, David Winton Bell Memorial Library

Schneider, F. 1984. Movement of forage fish between Lake Manitoba and Delta Marsh. University of Manitoba Field Station (Delta Marsh) 1983 Annual Report 18: 135-145.

A study examining the movement of fish between Lake Manitoba and Delta Marsh. Studies were conducted in the Blind Channel of Delta Marsh during the summer of 1983. Results of the study showed that in the spring mature fathead minnows, spottail shiners, nine-spined sticklebacks and five-spined sticklebacks entered the marsh from the lake. The first fry were observed in the mid-summer, and the movement of fry from the marsh into the lake occurred in August. Yellow perch and carp, which were caught as juveniles leaving the marsh, and it was assumed they used the marsh for the abundant food. Bullhead was also observed entering the marsh in the fall. Other species caught in the marsh included white sucker, northern pike, Iowa darter, Johnny darter, emerald shiner, logperch, trout perch and mud minnow.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Scott, V. H. and L. M. Nelson. 1972. The Kinds and number of Wildlife in the Whitemud River Watershed Study Area. Manitoba Department of Mines, Resources and Environmental Management. Winnipeg, MB.

A report describing wildlife present in the Whitemud River Watershed during a survey conducted in the summer of 1971. A list of bird, waterfowl, amphibian, reptiles and mammals observed during the survey is given along with comments on the location and data of observations and numbers observed. Approximately 20

different species of fish, 6 amphibians, 7 reptiles, 250 birds and 50 mammals were observed in the study area during the survey. Invertebrates were not examined.

Location: Manitoba Conservation and Environment Library, Call No. SK 471 M3 S34 1972

Searth, T. N. W. 1972. Outdoor Recreation of the Whitemud Watershed Area. Whitemud River Watershed Resource Study Phase I: Outdoor Recreation Existing Places and Capability. Manitoba Department of Mines, Resources and Environmental Management. Winnipeg, MB. 96 pp.

A study describing the existing natural capacity of outdoor recreation in the Whitemud Watershed, as part of the Whitemud River Watershed Resources Study Phase I. Existing outdoor recreation locations in the watershed make up 4.1 percent of the total acreage of the area. Forty outdoor recreation areas were inventoried in the watershed including wayside parks, park/recreational area, wildlife areas, historical sites, and golf courses. Each of the recreational areas is listed and described. Much of the existing outdoor recreational acreage, 98.3 percent, is made up of three wildlife management areas (Lynch's Point Game Bird Refuge, Langruth Wildlife Management area, and Big Grass Marsh Game Bird Refuge) and Riding Mountain National Park. The watershed is divided into three recreational landscape categories: the cultural/farmscape region (54%), the wetland region (27%), and the upland region (19%). The wetland region provides viewing and hunting of waterfowl at Big Grass Marsh. Recreational fishing, swimming, and/or boating in the area is only available at a few locations, and future damming of sections of water course is seen as a possible way to provide more water-orientated out recreation. Recommendations are given regarding future outdoor recreational use and development of the area. Maps are included illustrating outdoor recreation area in the watershed.

Other volumes of the Whitemud River Watershed Resources Study Phase I include: Fish (Falkner 1992), Interrelationships of vegetation, wildlife, and settlement (Brian 1971), Land use (Hodgson 1972), Wildlife (Goulden *et al.* 1972) Agriculture (Jenkins 1972), and Outdoor recreation (Searth 1972).

Location: Manitoba Conservation and Environment Library, Call No. GV 182 S43 1972

Shay, J. M. and R. A. Janusz. 1972. Mercury levels in the Assiniboine Diversion and south end of Lake Manitoba. University of Manitoba Field Station (Delta Marsh) 1971 Annual Report 6: 7-22.

The study examines possible mercury inputs from the Assiniboine River into the south basin of Lake Manitoba. Representative planktonic and benthic fauna was collected from a total of 20 sites in the Assiniboine River, Lake Manitoba, and Delta Marsh (Cram Creek), for analysis of mercury concentrations. Water samples were also collected from select sample sites for analysis of water chemistry parameters, which included: conductivity, pH, water clarity, hardness, alkalinity, temperature, dissolved oxygen, water level, chemical oxygen demand, and concentrations of nutrients. Water samples were also collected from select sites for mercury analysis. Results of the study show that the water chemistry of Lake Manitoba, Cram Creek, and Assiniboine River are typically similar in late August. Turbidity and phosphorus concentrations were significantly higher in the Assiniboine River compared to the south basin of Lake Manitoba. From the 49 samples of aquatic fauna collected, the overall range in mercury concentrations was 0.02 to 0.32 ppm, which are low and close to natural background levels. A description of the distribution and composition of the fauna present in the different sample site is also given. The study also concludes that the Assiniboine Diversion could have adverse effects on the flora and fauna in and around Lake Manitoba, as the waters from the Assiniboine River are nutrient rich and contain associated indicator organisms indicative of polluted water such as tubificid *Oligochaetes* and *Tendipedid* larvae. The authors recommend further studies to prove or disprove this, and to determine whether or not this change will be beneficial or detrimental.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Shay, J. M., P. M. J. de Geus and M. R. M. Kapinga. 1999. Changes in shoreline vegetation over a 50-year period in the Delta Marsh, MB, in response to water levels. *Wetlands* 19: 413-424.

The study examines the effects of the water level stabilization and natural high and low water levels of Lake Manitoba on the distribution of *Typha*, *Phragmites*, and *Scolochloa* in Delta Marsh, between 1948 and 1997. Water levels on Lake Manitoba have been regulated at a target level of 247.5 m ASL, via the Fairford Dam since 1961. Prior to 1961, water levels of Lake Manitoba and Delta Marsh fluctuated within a range greater than 2.2 m, however since regulation water levels have fluctuated within a range less than 0.6 m. Aerial photographs were used to quantify changes in vegetation of Delta Marsh prior to and after the stabilization of water levels on Lake Manitoba. Results from the study show that before regulation shorelines of the marsh were dominated by *Phragmites*, and since regulation, *Typha* has expanded up the elevation gradient, encroaching on *Phragmites*, and down the gradient invading shallow open waters. The author suggests that if water levels on the lake continue to undergo stabilized conditions, *Typha* will continue to move up and down the elevation gradient leading to the infilling of Delta Marsh. The paper includes a description of Delta Marsh, which includes location, vegetation, hydrology, morphology, sediments/soils, water chemistry and climate. Figures are included that illustrate study sites; water levels on Lake Manitoba; aerial photographs of study sites; percent water, mudflat, and vegetation from 1948 to 1980; and elevation profiles of *Typha*, *Phragmites* and *Scolochloa*.

Location: University of Manitoba, Science and Technology Library, Call No. 333 W5343

Shortt, T. M. and S. Waller 1937. Contributions of the Royal Ontario Museum of Zoology No. 10: The Birds of The Lake St. Martin Region, Manitoba. The Reuben Wells Leonard Request. 52 pp.

An annotated list of bird species present in the Lake St. Martin area. A general description of Lake St. Martin and its surrounding uplands is given which includes location and area, geology, hydrology, soils, vegetation and climate, as well as a description of the First Nations settlements. Field surveys of bird species were conducted from 1930 to 1934. Information given on the bird species present in the area includes degree of commonness or rarity of occurrence, breeding habits, feeding, and date of collection of each species.

Location: Manitoba Conservation and Environment Library, Call No. CA2 OROM 1sc 10

Sieminiuk, L. 1971. Preliminary Investigation of Benthos in Lake Manitoba (pertaining to the Assiniboine River Diversion). University of Manitoba Field Station (Delta Marsh) 1970 Annual Report 5: 45-48.

An examination of the benthic fauna and bottom sediments collected from Lake Manitoba, to examine the potential effects of the Assiniboine River Diversion on sediments and benthic fauna of the lake. Samples were collected 75 m and 150 m north of the outlet of Cram Creek (Delta Marsh), 75 m and 150 m north of the Assiniboine Diversion outlet, and 150 m north of Mallard Lodge at the University of Manitoba Field Station. Samples were collected weekly from July to August, 1970. Sediments were analyzed for percent sand, silt and clay, and organic matter content. Results from the study identified 87 organisms north of the Diversion, 78 at Cram Creek, and none north of Mallard Lodge. The organic content of the sediments in Lake Manitoba both north of the Diversion (7.6%) and Cram Creek (7.2%) were higher than that of the sediments north of Mallard Lodge (0.4%). From the sampling the effect of the Assiniboine Diversion on the composition of benthic fauna in Lake Manitoba was found to be minimal. Although the author indicated that the Diversion may be causing an increase in the organic content of the sediments immediately north of the outlet.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Skaptason, J. B. 1926. The Fish Resources of Manitoba. Industrial Development Board of Manitoba. Winnipeg, MB.

The report discusses various lakes and rivers in the province of Manitoba, and their associated commercial and sport fisheries around 1926. Some of the more important lakes discussed in the report include Lake Winnipeg, Lake Winnipegosis, Lake Manitoba, Moose Lake, Cedar Lake, Lake Dauphin and Lake St. Martin. The discussion of Lake Manitoba includes its size (1775 mi²), fishing industry (limited to the winter season), and economically important fish species present (pickerel, tullibee, whitefish, pike, yellow perch, and mullets). The discussion of Lake St. Martin includes its size (125 mi²), fishing industry (limited to the winter season, and a reduction in whitefish over the last three or four years), and economically important fish species present (pickerel, whitefish, yellow perch, pike, tullibee, and mullets).

Several rivers in the Manitoba, that are economically important for the fishery of the province are also discussed including the Big Saskatchewan River, Nelson River, and Churchill River, to name a few. The report also compares the fishery in Manitoba to that of other the other provinces in Canada. The success of artificial fish hatcheries, by-products of fish, the overall market, and fishery regulations in the province are also discussed. The report also discusses the rapid decrease of sturgeon in North American, and conditions in Manitoba around the time of the report.

Location: Manitoba Conservation and Environment Library, Call No. SH 327.5 S57 1926

Smith, C. K. 1978. Recreation Land Use of the South Shore of Lake Manitoba. Task Force Report, Manitoba Department of Northern Affairs, Renewable Resources, and Transportation Services. Technical Report No. 78-5. Winnipeg, MB. 25 pp.

The report examines recreational use of the south shore of Lake Manitoba, and land use conflicts that have resulted from the increased demand for recreational space along the south shore of the lake. The report also discusses various concerns related to the recreational use south shore of Lake Manitoba including beach ridge erosion from wave action and excessive human use, shortage of recreational facilities along the beach, user conflicts, management of the area by many different agencies, congestion at the Portage Diversion outlet, and the regulation of Lake Manitoba water levels. The overall goal of the report was to provide guidelines for improving land use management along the south shore of the lake while emphasizing the importance of providing recreational resources for the public and preserving the natural and cultural features of the area. Recommendations of the report included that no development should be detrimental to the beach ridge, marshes, and farmland; more recreational facilities and public access are need on the south shore of the lake; recreational facilities should be developed on the vicinity of Tower Road and Twin Lakes Beach to reduce pressure on the existing recreational facilities, and a public program should be developed and initiated to educate the public on the importance of the beach ridge to Delta Marsh and Lake Francis Marshes. Background information for the study is also included in the report discussing the importance of the beach ridge and its erosion, increases in the recreational use of the beach ridge, the importance of Delta Marsh, vegetation on the beach ridge, wildlife values of the beach ridge, and the climate, soils, and the archaeological and historical significance of the area.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library, Call No. Delta Gov Docs Man NRT 8

Location: Manitoba Conservation and Environment Library, Call No. GV 182.3 S65 1978

Smith, T. G. 1968. Crustacea of the Delta Marsh Region, Manitoba. Canadian Field Naturalist 82: 120 –139.

A study examining the ecology of Crustacea present in Delta Marsh. Sampling was conducted at 26 sites in Delta Marsh, from May to September of 1965 and 1966, by the means of plankton tow nets. Notes on the ecology and geological distribution of the species found in the marsh are included, especially previous records in Manitoba and the surrounding area. An annotated species list is given and includes specific species in the groups Anostraca, Notostracea, Conchostraca, Cladocera, Copepoda, and Amphipoda. Forty-nine species of Crustacea were identified in the waters of Delta Marsh. Two species of Conchostraca, 16 of Cladocera, and one each of Cyclopoida and Harpacticoida were found in the marsh, which at the time of the study had not been previously recorded in Manitoba.

Location: University of Manitoba, Science and Technology Library, Call No. 574 C16 Fi Na

Somers, G. T. 1972. Report and Summary of Lake Manitoba Agricultural Damage Survey. Manitoba Department of Agriculture, Marketing and Production Division, Winnipeg, Manitoba. 31 pp.

A survey conducted in 1972 to determine the extent of flood damage to agricultural land along the shores of Lake Manitoba from 1964 to 1970, resulting from fluctuating water levels in Lake Manitoba. Only the area south of township 27 was included. The majority of the report summarizes the acreage of lands around Lake Manitoba that experienced flood damage, the type of crops on these lands, and the resultant revenue lost due to flooding. Results of the survey revealed native hay and pastures lands were most affected by water levels, and damage has occurred annually from 1964 to 1970. The damage to agricultural lands was found to be related to the average mean daily water elevations on Lake Manitoba, including wind set-up. The report estimated the cost to farmers resulting from lost agricultural products was substantial, reaching a value of 447 thousand dollars.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MA r 210 (copy 1), Call No. 494.5 E8 R47 1972 (copy 2)

Sproule, T. A. 1972. A Paleoecological Investigation into the Post-glacial History of Delta Marsh, Manitoba. MSc Thesis, University of Manitoba, Winnipeg, Manitoba. 49 pp.

A paleoecological study examining the post-glacial history of Delta Marsh, located on the south shore of Lake Manitoba. Three sediment cores were taken from the marsh during December 1967 and March 1969, and analyzed for sediment type, stratigraphy, pollen types, seeds, and select invertebrate macrofossils (Byozoa, Mollusca, Cladocera and Ostracoda). The study includes a brief description of Delta Marsh, which includes geology, hydrology, morphology, climate, vegetation and soils. Results from the cores illustrate changes in the water levels and vegetate composition of the marsh since $2\,400 \pm 230$ year B.P. Overall, succession and the build-up of sedimentation in the marsh has been slow, possibly attributed to the periodic elimination of emergent vegetation in marsh by high water level from Lake Manitoba. The recurring zones of vegetation in the cores in several zones interrupted periodically by deep-water zones, suggest that flooding may be a necessity for the perpetuation of marsh conditions. Figures illustrating variation in macrofossils, particle size, seed types, and pollen types with depth are included.

Location: University of Manitoba, Elizabeth Dafoe Library 3rd floor, Thesis S7693

Stewart, B. 1974. Particle size distribution analysis of suspended sediment samples from Lake Manitoba. Mining Research Centre, Mines Branch, Department of Energy, Mines and Resources.

A copy of this report could not be found in any public, government or private library in Canada.

Location: unknown

Stewart, K. W. (unpublished, in preparation). Guide to the Freshwater Fisheries of Manitoba. Fisheries and Oceans Canada. 290 pp.

A guide of native and introduced fish species found in water bodies throughout Manitoba. Fourteen other freshwater species that have not yet been found in Manitoba, but have been found in the Hudson Bay Drainage system in Ontario, northwestern Minnesota, eastern North Dakota and northeastern South Dakota, have also been included in the guide as some of these species could be found in Manitoba waterways in the near future. Eight-nine freshwater fish species (including 12 introduced species) are present in Manitoba, and as such the province has the third most diverse freshwater fish species composition in Canada. The guide includes a description of the post colonization of fish into water bodies in Manitoba, and the probable route and time of entry of the various freshwater fisheries species now present in Manitoban water bodies. The guide gives an introduction to each family of fishes in Manitoba, including common and Latin names, diversity, history, unique adaptations, identification key for each species, physical characteristics, color photographs, distribution in Manitoba, biological features (spawning, growth and adult size, feeding, habitat and ecological role), importance to people, committee on the status of Endangered Wildlife (OSEWIC) status, Manitoba Conservation Data Centre (MBCDC) status, and Manitoba Endangered Species Act (MBESA) status. A glossary of terms used in the identification of various freshwater fisheries in Manitoba is included.

Location: in preparation

Stewart, K. W., I. M. Suthers and K. Leavesley. 1985. New fish distribution records in Manitoba and the role of a man-made interconnection between two drainages as an avenue of dispersal. Canadian Field Naturalist 99: 317-326.

The study examines the effects of man-made drainage basin connections on the introduction of some fish species into water bodies in Manitoba. The study includes an examination of fish species that have been introduced to Lake Manitoba via the Assiniboine River Diversion. The Assiniboine River Diversion was first operational in 1971, channeling water from the Assiniboine River into Lake Manitoba for the first time in over 2000 years. Fish species that have been introduced to Lake Manitoba through the Assiniboine River Diversion include central mudminnow (*Umbra limi*), bigmouth bass (*Ictiobus cyrinellus*), black bullhead (*Ictalurus melas*), tadpole madtom (*Norturus gyrinus*), and probably channel catfish (*Ictalurus punctatus*). A brief overview of each fish species is given and includes, date and location that each species was found in Lake Manitoba, and the morphological features of each species.

Location: University of Manitoba, Science and Technology Library, Call No. 574 C16 Fi Na

Stone, D. D. 1963a. Winter Surveys of Lake St. Martin. Manitoba Department of Mines and Natural Resources, Fisheries Branch. Winnipeg, MB. 10 pp.

During December 1962 and February 1963, soundings (for depth measurements) and water quality sampling was carried out at 39 sample sites in Lake St. Martin. Parameters examined included depth, dissolved oxygen, carbon dioxide, pH, alkalinity, hardness, and various dissolved minerals and ion concentrations. The main results of the study showed very low dissolved oxygen concentrations, and high carbon dioxide and alkalinity levels in the lake. Brief summaries of commercial fishing in Lake St. Martin, and water levels in the lake resulting from the use of the Fairford Dam to regulation of Lake Manitoba water levels, are given. From the

water quality results, and baring effect of the Fairford Dam on fish movement between Lake St. Martin into Lake Manitoba, the author raise cause for concern over the future of commercial fishing in Lake St. Martin.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MMFB msr sto 1 1963

Stone, D. D. 1963b. Lake St. Martin Fish Production and Water Control. Manitoba Department of Mines and Natural Resources, Fisheries Branch. Winnipeg, MB. 15 pp.

As a result of dissolved oxygen tested conducted in the winter of 1962-1963 in Lake St. Martin (stone 1963a), which revealed low winter dissolved oxygen near critical levels for fish respiration, a proposal to increase the winter oxygen concentrations in the lake through the stabilize the water level in Lake St. Martin at 800 feet MSL, via a control structure on the Dauphin River reserve is discussed. The winter fish catch composition of Lake St. Martin from 1924 to 1962 is examined to determine the possible effects that have resulted from low fall and winter water levels in Lake St. Martin, resulting from the closure of the Fairford dam in the in the fall through to spring to stabilize Lake Manitoba. The hazards of low lake water levels on recreational use of the lake for boating and swimming are also discussed. The report recommends several remedial measures including maintaining the water level in Lake St. Martin at a minimum of 800 feet above MSL throughout the year, through a control structure on the Dauphin River; and a minimum flow of 400 c.f.s in the Dauphin River, between September 15 and May 1.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MMFB msr sto 2 1963

Stone, D. D. 1963c. Pollution Investigations Interim Report. Manitoba Department of Mines and Natural Resources, Fisheries Branch. Winnipeg, MB. 9 pp.

A report discussing results of water quality and fisheries studies conducted in lakes St. Martin and Winnipeg from 1962 to 1963. Studies included fish tagging, depth soundings, and water ampling for various parameters of water quality. The studies were conducted because it was though that the fishery in Lake St. Martin could be damaged by the effects of the Fairford Dam, due to its effects on water levels in the lake (increasing the occurrence of extreme high and low water levels). See Stone (1963a and 1963b) for detailed results of the water quality sampling and fisheries studies. The majority of the report discusses surveys conducted in Lake Winnipeg examining benthic organism composition, and various water quality parameters. Sampling for oil and phenol concentrations was also conducted in the Red River, and results are discussed in the report.

Location: Manitoba Conservation and Environment Library, Call No. SH 174 S76 1963

Stone, D. D. 1965. Some Limnological Consequences of a Decline in Water Levels in a shallow Productive Lake in Manitoba. . Manitoba Department of Mines and Natural Resources, Fisheries Branch. Winnipeg, MB. 15 pp.

A report examining the effect of lower water levels in Lake St. Martin resulting from the regulation of water levels in Lake Manitoba via the Fairford Dam on the water quality and fish production in Lake St. Martin. A general description of Lake St Martin is given including depth, area, geology, climate, general water quality and the fishery. The report discusses how water levels, water quality and the fishery of the lake have changed since the operation of the Fairford Dam in 1961. Water quality parameters examined include pH, dissolved solids, alkalinity, total hardness, dissolved oxygen, and concentrations of other ions and minerals.

Of the most importance, winter surveys conducted from 1962 to 1964 showed that dissolved oxygen levels in the lake have started to declined to levels fatal to fish survival during the later winter months, since the operation of the Fairford Dam. Also, in the fall of 1964 no whitefish entered Lake St. Martin from the Dauphin River due to the low water levels on lake, and as a result the fish catch dropped from 101 000 pounds to 3 300

in one year. The report concludes that a control structure is needed on the Dauphin River to increase water levels and flushing rates in Lake St. Martin.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MM fms .S877 .S6 (not in circulation)

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Suthers, I. M. 1983. A preliminary study of the daily and seasonal distribution of fish in Blind Channel, Delta Marsh. University of Manitoba Field Station (Delta Marsh) 1982 Annual Report 17: 90-105.

A study examining the influence of dissolved oxygen on the distribution of fish in Delta Marsh. Fish sampling and oxygen/temperature readings were collected in the Blind Channel of Delta Marsh from June to August, 1982. Fish caught in the marsh included bullheads, carp, fathead minnows and yellow perch. Preliminary results of the study indicated that dissolved oxygen concentrations can influence the daily and seasonal distribution of yellow perch in the marsh. A correlation between low oxygen concentrations and low yellow perch populations was apparent, but difficult to prove. Further studies are planned for 1983. See Suthers (1984a and 1984b) for the results of further studies.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Suthers, I. M. 1984a. The Role of Habitat and Dissolved Oxygen in the Distribution of Yellow Perch at Delta Marsh. University of Manitoba Field Station (Delta Marsh) 1983 Annual Report 18: 155-163.

In 1982 preliminary study were conducted examining the influence of dissolved oxygen concentrations on the distribution of fish in Delta Marsh (Suthers 1983). Fish caught in the marsh included bullheads, carp, fathead minnows, and yellow perch. Preliminary results of the study showed that dissolved oxygen can influence the daily and seasonal distribution of yellow perch in the marsh. A correlation between low oxygen and low yellow perch populations was apparent, but difficult to prove. So, sampling in 1983 was concentrated in early summer, until mid-July, and trapping was conducted four times daily. Growth of dominant vegetation and phytoplankton distribution at the sample sites was documented. Daily seasonal fish distribution, and oxygen and temperature conditions were sampled at site in the marsh. Results of the study show that yellow perch prefer dead cattail, a habitat that is exposed to diurnally hypoxic conditions, and can become anaerobic. So the cattail habitat is only inhabited during certain times of the day when oxygen concentrations are favorable. Yellow also are forced out of this unfavorable habitat during anaerobic conditions. Other factors influencing yellow perch distribution such as predation, temperature and reproductive behavior appear to be minor. See Suthers (1984b) for the full report on study results.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Suthers, I. M. 1984b. Role of Dissolved Oxygen in Limiting Diel and Summer Distribution of Yellow Perch in a Prairie Marsh. MSc Thesis, University of Manitoba. Winnipeg, MB. 63 pp.

An examination of effect of oxygen on the diurnal and summer distribution of yellow perch (*Perca flavescens*) in Delta Marsh, located on the south shore of Lake Manitoba. Experiments were conducted in the Blind Channel of Delta Marsh in the summers of 1982 and 1983.

Results of the study indicated that yearling yellow perch were abundant in areas of the marsh with cattail during the spring, but toward early summer oxygen concentrations decrease substantially in the cattail areas and hypoxia (low oxygen) conditions occurred causing the a shift in the distribution of yellow perch out of the cattail areas. Hypoxic conditions occur in the cattail during summer and the evening due to the increased rate of cattail photosynthesis and decomposition. Significant shifts also occurred in the daily night and day oxygen conditions of the cattail areas, as these area become severely hypoxic during the night, and as a results yellow perch leave the cattail area during the evening and returned during the daytime. Brook stickleback (*Culaea inconstans*) also showed diurnal avoidance of the severe hypoxic conditions, and as a result they moved vertically and horizontally to avoid such conditions in the cattail areas.

Location: University of Manitoba, Elizabeth Dafoe Library, Thesis S96653

Swain, D. P. 1979. Biology of Carp (*Cyprinus carpio* L.) in North America and its Distribution in Manitoba, North Dakota and Neighboring U.S. Waters. MS Report No. 79-73. Department of Natural Resources, Fisheries Branch. Winnipeg, MB. 35 pp.

A discussion of the biology of carp in North American, along with its distribution in Manitoba, North Dakota and neighboring U.S. waters, and the effects of carp on habitat. In 1885, 1886 and 1889, carp were planted in ponds in Manitoba at Springfield, Portage la Prairie, Minnedosa, Rapid City and in Lake Minnewawa near Glenboro. However, these stocking attempts were apparently unsuccessful. The first recorded appearance of carp in the Canadian waters of the Nelson River Drainage Basin was in the Red River at Lockport in 1938. Carp were present in the Assiniboine River watershed (at Virden) and in Lake Manitoba in 1948. The report discusses the habitat and seasonal distribution of the carp including: spawning area, season and behavior; sexual maturity, fecundity; early development and growth; and food and feeding habits. The effects of carp on flora and fauna are examined and include, uprooting and destruction of aquatic vegetation, increased turbidity, predation and competition with other fish species, and other related effects on flora and fauna. Control methods for carp are also discussed including sport and commercial fishing, fences and barriers, eletrofishing, toxicants, and water level control.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MRRB msr 79-73 1979

Tamsitt, J. R. 1962. Mammals of the Delta Marsh region of Lake Manitoba, Canada. Canadian Field Naturalist 76: 71-78.

A study conducted from June to August, 1958 in Delta Marsh examining mammals present in the area. Seventy-two specimens of 19 species of mammals were collected in the area, and records of another seven species were made. A description of Delta marsh is included which discusses location, size, geology, soils, vegetation and climate. The list of species found in the Delta Marsh area includes masked shrew, arctic shrew, water shrew, short-tailed shrew, little brown bat, silver-haired bat, white-tailed jack rabbit, snowshoe hare, woodchuck, Richardson's ground squirrel, thirteen-lined ground squirrel, Franklin's ground squirrel, gray squirrel, northern pocket gopher, deer mouse, gapper's red-backed mouse, meadow vole, muskrat, Norway rat, house mouse, meadow jumping mouse, coyote, timber wolf, red fox, raccoon, marten, ermine, least weasel, long-tailed weasel, mink, badger, striped skunk, and white-tailed deer.

Location: University of Manitoba, Science and Technology Library, Call No. 574 C16 Fi Na

Tande, G. F. and M. G. See. 1978. Dendrochronological Reconstruction of Water Levels for Lake Manitoba: A Preliminary Report. University of Manitoba Field Station (Delta Marsh) 1977 Annual Report 12: 59-62.

A study examining the tree-ring width of trees in the Delta Marsh area as an indicator of historical long-term changes hydrological conditions of Lake Manitoba and the marsh. Water levels have been record on Lake Manitoba since 1914, but no records exist prior to that data. So dendrochromology, the study of tree rings, provides for an opportunity to study long-term historical changes in water levels. Water levels on Lake Manitoba fluctuated in a large range prior to the regulation of Lake Manitoba, via the Fairford Dam in 1961. Since then water levels on Lake Manitoba have been regulated at a fixed level, and as a results concern has arose regarding the consequence of stable water levels on the environment of Delta Marsh, along with effects on the barrier-beach ridge that separates the marsh from the lake such as increase erosion.

Tree core samples were collected from bur oak on the Blind Channel levee at the southern end of the Oxbow Wood in October and November 1977. The ages of the bur oak sampled range from 85 to 154 years. At the time of the report the analysis of the tree rings still needed to be completed before the historical water levels of the lake and marsh could be determined.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Teller, J. T. and W. M. Last. 1979. Post-Glacial Sedimentation and History in Lake Manitoba. Manitoba Department of Mines, Natural Resources, and Environmental Management. Report No. 79-41.

The report identifies and quantifies the physical and chemical changes that have taken place in and around Lake Manitoba during the post post-glacial period (since 13, 500 years B.P), through analysis of sediment cores from Lake Manitoba. Changes in the nature of the lake's floor sediments, documents the varying paleoenvironmental conditions that have influenced, and are continuing to influence Lake Manitoba, and help to identify trends in natural environmental changes in the lake and surrounding environment, which can then be compared to the human-influenced environment of the past century. The authors indentifies some of the human-induced factors that have most likely influenced Lake Manitoba, including agriculture, urbanization, and corrective schemes such as river diversions for flood control, and dam and dikes for lake water level stabilization.

Sediment core samples were collected from the south basin of Lake Manitoba, where the majority of natural and anthropogenic factors have affected the physical and chemical environment of the lake. During February and March, 1978, and February 1979, 51 sediment cores were collected, 3 long (> 9 m in length) and 48 short (< 4 m in length), and analyzed for numerous physical, chemical and mineralogical properties and trends. The report includes a detailed description of changes that have occurred in the lake since glaciation (13500 years B.P), and describes that more recent, since 2000 B.P., when the Assiniboine River ceased to discharge into Lake Manitoba. Since then there has been little change in the lake or its sediment characteristics. Present day water levels and salinities were probably reached about 3500 years B.P., while productivity and calcite precipitation continue to increase. The authors point out that the only human activity in the watershed that has altered the relatively stable lake conditions established about 2000 years B.P., is the Portage Diversion, and this activity has not caused any substantial changes, except for the introduction of additional sediment loads, waters with somewhat different ionic composition, and a slight increase in mercury content in surface sediments near the Portage Diversion. But according to the author at the time of publication, this had not appeared to have caused any important changes in the environmental state of the lake.

In addition to sediment samples, water samples were also collected in the winter of 1978, from the south basin and analyzed for water chemistry, and general observations of the winter condition of the lake were also recorded. Water chemistry parameters examined include water temperature profiles, depth, pH, total alkalinity, specific conductance, total dissolved solids, nitrate, phosphate, and other major minerals and ions. The report also contains a table summarizing available water chemistry data for Lake Manitoba from 1928 to 1978, and a description of the general historical trends in water chemistry characteristics of the lake from 1928 to 1978. The report points out that during the last 50 years the lake has undergone significant temporal changes in its chemical characteristics, including significant enrichment in many of the major ions, as the lake has gone from a freshwater lake during the 1920's to a brackish water lake today.

The report also includes a description of the lake's physical and morphometric characteristics, and hydrology, including a water budget for Lake Manitoba with mean annual inflow and outflows from Waterhen River, Whitemud River, Assiniboine River Diversion, Burnt Lake Drains one and two, and the Fairford River. Mean monthly lake levels for Lake Manitoba, Lake Winnipegosis and Lake Winnipeg, from 1914 to 1979, are also illustrated graphically.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MMNR r 79-41

Teller, J. T. and W. M. Last. 1981. Late Quarterly History of Lake Manitoba, Canada. Quaternary Research 16: 97-116.

From January to March, 1978 and 1979, fifty-one sediment cores were collected from the south basin of Lake Manitoba for chemical, mineralogical and biological analysis in order to determine the post-glacial history of Lake Manitoba. The article includes a general physical description of Lake Manitoba, which includes morphological characteristics, location, hydrology and geology. Based on core description and variations in measured parameters six lithostratigraphic units were identified in the post-glacial sediment of the lake. The six stratigraphic units date from the early postglacial period, about 12 000 to 10 000 yr B.P. (bottom unit), to 2200 yr B.P. to present (top unit). The authors use the chemical, mineralogical and biological features of these stratigraphic sediment units to reconstruct the history of lakes Agassiz and Manitoba since the early postglacial period (12 000 B.P.). Historical analysis of Lake Manitoba includes fluctuations in water levels; lake size; climatic conditions; vegetation surrounding the basin; general water chemistry conditions; sediment physical, chemical, and biological composition; and flow of the Assiniboine Delta into south end of the lake. Several figures and graphs are included illustrating the location of sampling sites; variations in major physical, chemical and mineralogical parameters in sediment cores; and the chorological development of the Assiniboine River Delta on the south end of the lake.

Location: University of Manitoba, Science and Technology Library, Call No. 550 Q286 Re

Teller, J. T. and W. M. Last. 1982. Pedogenic zones in post glacial Lake Manitoba, Canada. Earth Surface Processes and landforms 7: 367-379.

During the winters of 1978 and 1979, 51 sediment cores were collected from the south basin of Lake Manitoba and analyzed for 31 physical, chemical and mineralogical parameter in addition to a detailed palynological study. A physical description of Lake Manitoba is given that includes location, morphological features, geology and hydrology. The postglacial sediment characteristics of Lake Manitoba are dominated by silty clay to clayey silt with little change in the majority of physical, chemical and mineralogical properties. However, there are four distinct zones that have low moisture content, crumbly blocky texture and greyed color. The article examines several hypotheses for these distinct marker zones including: slower sedimentation rates, clay mineralogy, variations in water chemistry, cryogenesis and pedogenesis. Of these hypotheses the authors conclude that the later is the most likely explanation, was caused by periods of extremely low water levels or the drying of the lake. These four marker zones formed during the hottest and driest postglacial period in the region from 9500 to 4500 yr B.P., when many lakes in the region are known to have dried up. These findings show that Lake Manitoba must have dried up entirely or nearly completely at least four times since the postglacial period. Figures are included illustrating sampling locations and variation in physical properties with depth in sediment cores.

Location: University of Manitoba, Science and Technology Library, Call No. 550 E12 SUPR

Teller, J. T. and L. Clayton. 1983. An introduction to Glacial Lake Agassiz. Geological Association of Canada Special Paper 26: 3-5.

A description of history of expansion and retreat of Glacial Lake Agassiz, which extend from the Rocky Mountains of Alberta to Lake Superior, and from Hudson Bay south to South Dakota. Glacial Lake Agassiz existed from approximately 12 000 to 11 500 yr B.P. to 7500 yr B.P. The lake reached it's maximum extent of approximately 350 000 km² during 9900 and 9599 B.P. Lake Manitoba is a remnant of Lake Agassiz.

Location: University of Manitoba, Elizabeth Dafoe Library, Call No. QE 697 G564 1983

Thomas, J. F. J. 1959. Industrial Water Resources of Canada, Water Survey Report No. 10, Nelson River Drainage Basin in Canada, 1953-1956. Canada Department of Mines and Technical Surveys, Mines Branch, Industrial Minerals Division. Ottawa, Ont. 147 pp.

A report examining the chemical quality of surface and municipal water in Canada, covering the area of Canada drained by the Nelson River and its tributaries from 1953 to 1956. The report is part of a series that examines chemical water quality across Canada, and parts northern United States. A general description of the Nelson River Drainage Basin is given in the report including area, water bodies, climate and geology. The survey and analytical procedures used in the study are also discussed. Some of the specific water bodies included in the survey included the Assiniboine River, Whitemud River, Fairford River and Lake Manitoba. Chemical parameters examined included temperature, pH, color, turbidity, suspended solids, specific conductance, total hardness, alkalinity, nitrate, and various minerals and dissolved ions. Results of water chemical analysis are presented in tabular format, and some graphs of trends are included for select parameters. A summary of overall water chemistry conditions present in the Nelson River Drainage basin during the sampling period is also presented in the report.

Location: Manitoba Conservation and Environment Library, Call No. TD 227 M32 N45 1959

Toye, J. S. P., H. J. Adams, L. C. T. Leung, J. P. Parry, H. M. Surminski and A. A. Warentin. 1972a. Whitemud River Watershed Resource Study Phase I: Water Resources Inventory and Problems Identified. Manitoba Department of Mines, Resources and Environmental Management, Winnipeg, MB. 71 pp.

The report summarizes the results of investigations carried out to provide an inventory of the water resources and climate characteristics of the Whitemud River Watershed. Information on water resources of the watershed includes the location and availability of surface and ground waters, the quality of surface and ground waters, estimates of average annual flooding and associate damage, and rates of erosion and deposition. Climatological information includes precipitation, temperature, wind, sunshine, humidity, snow depth, evaporation and transpiration. Water quality parameters examined included color, turbidity, pH, suspended solids, alkalinity, coliforms, dissolved oxygen, temperature, stream flow, various forms of nitrogen and phosphorus, various metal, and dissolved mineral and ions. The appendixes of the report, containing tables and figures, is a separate document entitled, Whitemud River Watershed resource study phase I: appendix tables and figures, water resources inventory and problems identified (Toye *et al.* 1972b).

Location: Manitoba Conservation and Environment Library, Call No. TC 426.5 M3 T69 1972

Toye, J. S. P., H. J. Adams, L. C. T. Leung, J. P. Parry, H. M. Surminski and A. A. Warentin 1972b. Whitemud River Watershed Resource Study Phase I: Appendix Tables and Figures, Water Resources Inventory and Problems Identified. Manitoba Department of Mines, Resources and Environmental Management, Winnipeg, MB.

Appendixes of the report, Whitemud River Watershed resource study phase I: water resources inventory and problems identified (Toye *et al.* 1972a), containing tables and figures with information on various parameters of climate, water quality, hydrology and watershed drainage for the Whitemud River Watershed.

Location: Manitoba Conservation and Environment Library, Call No. TC 426.5 M3 T69 1972

Traverse, M. J. 1999. Analyzing the Effects of the Fairford Dam on Lake St. Martin First Nation. MSc Thesis, University of Manitoba, Winnipeg, MB. 112 pp.

A study examining the effects of Lake Manitoba water level regulation, via the Fairford Dam in 1961, on the First Nation communities of Lake St. Martin, and other communities downstream from the dam. The study used the observations and traditional knowledge of First Nations Communities, and records of water levels to determine if water levels on Lake St. Martin have increased since the construction of the Fairford Dam, and if these increases in water levels had negative effects on the physical and biological resources of Lake St. Martin and the First Nation Communities of the lake. Downstream effects resulting from the Fairford Dam discussed in the study include effects on agricultural, recreation, roads, fishing, waterfowl, vegetation and wildlife. Maps, aerial photographs, and ground photographs were also used to determine changes in vegetation at Lake St. Martin prior to and after the construction of the Fairford Dam. From the comparison of the photographs it appears that subtle changes have occurred to the landscape of the area due to flooding. The study includes background information on the construction and operation of the Fairford Dam, water level regulation on Lake Manitoba, and the operation of the Assiniboine River Diversion. A relationship was also found between water levels in the Assiniboine River and Lake St. Martin, indicating that waters diverted from the Assiniboine River have an effect on water levels in Lake St. Martin. The study concludes that while statistically analysis did not show that significant changes have occurred in environment of the lake since the operation of the Fairford Dam, the First Nations people of Lake St. Martin have been able observed subtle changes in the environment of the lake. The study includes recommendations to alleviate the effects of the Fairford Dam, which includes collaboration between First Nations and the Department of Natural Resources regarding the alternative methods for the operation of the dam, replacement of land, and the construction of permanent dikes. Photographs are included showing the Fairford Dam, and flooding on Lake St. Martin. Hydrographs are included illustrate historical water levels on Lake Manitoba (1923 to 1997) and Lake St. Martin (1955 to 1997).

Location: University of Manitoba, Elizabeth Dafoe Library, Thesis T695

Treherne, H. S. 1881. An ancient outlet of Lake Manitoba. Ninth Annual Report of the Geological Survey of Canada for 1880. pp. 380-392.

A brief article discussing a possible former outlet of Lake Manitoba into the Assiniboine River via Long Lake Creek and Long Lake. The article physically describes Long Lake and Long Lake Creek, along with the surrounding land between Lake Manitoba and the Assiniboine River. The article includes water and land elevations of Lake Manitoba, Assiniboine River, and Long Lake in 1874.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Tudorancea, C. 1974. Productivity of the Benthic Fauna of Lake Manitoba. University of Manitoba Field Station (Delta Marsh) 1973 Annual Report 8: 75-80.

A study examining the role of benthic fauna in the productivity of the southern portion of Lake Manitoba. Monthly samples of benthic fauna were collected from May to October, 1973, at eight sites in the southern portion of Lake Manitoba, near the Delta Marsh Field Station. In association with benthic samples, water samples were also analyzed for pH, dissolved oxygen, optical clarity and alkalinity. Sediments at sampling locations were also analyzed for particle-size and organic content. The water chemistry and soil analyses results are not presented in this report, see Tudorancea and Green (1975) for the results. Preliminary results of the benthic fauna composition show the numerically dominant groups were (in order of abundance): Ostracoda, Nematoda, Chironomidae, Sphaeriidae, Gastropoda, Oligochaeta and Trichoptera. Other groups present in low densities include Hirudinea, Hydracarina, Coelenterata, Ceratopogonidae, Culicidae and Ephemeroptera.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Tudorancea, C. 1975. Distribution and Seasonal Variation of Benthic Fauna in Lake Manitoba. University of Manitoba Field Station (Delta Marsh) 1974 Annual Report 9: 127-138.

A study examining the seasonal distribution of benthic fauna in the south basin of Lake Manitoba. Sampling was conducted at six sampling sites from June to August, and October, 1973; and January, May and June, 1974. In association with benthic samples, water and sediment samples were also taken from sampling sites. Water quality parameters included depth, clarity, pH, dissolved oxygen, total alkalinity, hardness, total dissolved solids and sodium chloride. Sediment analysis parameters included temperature, percent organic matter, mean grain size, percent silt-clay and sorting coefficient. Results from the study indicated that the numerically dominant groups are: Nematoda, Ostracoda, Chironomidae, Gastropoda, Sphaerilidae and Oligochaeta. Other groups represent in smaller numbers include: Trichoptera, Hydracarina, and Ceratopogonidae. Of the 35 taxa identified, only six occurred with a mean frequency greater than 50 percent: *Procladius freemani*, *Harnischia curtilamellata*, *Candora rawsoni*, *Cadona ohioensis*, *Ammicola* spp. and *Pisidium* spp. For complete results of the study see (Tudorancea and Green 1975).

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Tudorancea, C. and R. H. Green 1975. Distribution and seasonal variation of Benthic fauna in Lake Manitoba. Proceedings of the International Association of Theoretical and Applied Limnology 19: 616-623.

A study examining the seasonal distribution of benthic fauna in the south basin of Lake Manitoba. Sediment sampling for benthic fauna was conducted in June, July, August and October, 1973; and January, 1974 at seven location in the south basin of Lake Manitoba. In association with the benthic fauna samples, water and sediment samples were also collected. Water chemistry parameter examined included temperature, pH, water clarity, dissolved oxygen, alkalinity, total and calcium hardness and total dissolved solids. Sediment core analysis included particle-size distribution and organic content. The dominant benthic fauna groups found in the south basin include Nematoda, Ostracoda, Chironomidae, Gastropoda, Sphaeriidae and Oligochaeta. Other groups present in lower densities include Trichoptera, Hydracarina and Ceratopogonidae. According to the authors due to the large surface area (473,600 ha) and shallow depth, the lake is strongly influenced by climatic factors such

as wind, temperature, light, precipitation and evaporation. Of these factors wind velocity and direction are the two most significant, completely mixing the entire water body and sustaining its chemical and physical homogeneity.

Location: Fisheries and Oceans Canada, Eric Marshall Aquatic Research Library

Tudorancea, C., R. H. Green and H. Huebner. 1979. Structure dynamics and production of the benthic fauna in Lake Manitoba. *Hydrobiologia* 64:59-95.

The study assesses the role of benthic fauna in the productivity of Lake Manitoba, focusing on the trophic links and the energy flow of the ecosystem. The study was conducted from June to August, and October of 1973, and January of 1974 at seven stations in the south basin of Lake Manitoba, located five miles offshore from the University of Manitoba Delta Marsh Field Station. In association with biological samples of benthic fauna, some chemical parameters of the water and sediments were also analyzed. Water chemistry parameters included pH, dissolved oxygen, water clarity, alkalinity, hardness, total dissolved solids and salinity. This report includes the first published data on bottom sediments characteristics of Lake Manitoba, including size (mean, sorting, and percent silt and clay), percent organic matter and temperature.

A total of 47 taxa belonging to 22 families were identified in the benthic fauna of south basin of the lake. Of the 47 taxa, seven species represented approximately 90 percent of the total fauna: *Candona rawsoni*, *Pisidium* spp., *Procladius freemani*, *Cytheromorpha fuscata*, *Harnischia curtilamellata*, *Ammicola limosa*, and *Chronomus* sp. The mollusk species dominated the biomass followed by *Candona rawsoni*, *Procladius freemani*, *Harnischia curtilamellata*, and *Chronomus* sp. The highest density of all organisms occurred in June, 1973 and the lowest in January, 1974. The report also discusses density and biomass variations in species, life cycles, dispersion of populations, energy budgets, assimilation, production, and efficiency. A brief description of Lake Manitoba is included, which discusses location, climate and hydrology. Various graphs are included illustrating trend in the data.

Location: University of Manitoba, Science and Technology Library, 4th floor, Call No. 574 H989

Tuthill, S. J. 1967. Paleo-zoology and Molluscan paleontology of the Glacial Lake Agassiz region. In W.J. Mayer-Oakes (ed.) *Life, Land and Water*. University of Manitoba Press. Winnipeg, MB. p 299-312.

A discussion of the paleo-zoology of the area formerly covered by Glacial Lake Agassiz, including the nature of the fossils and modern invertebrates records, with emphasis on molluscs. The study area covers areas in Manitoba, Minnesota, North Dakota and Ontario underlain by sediments deposited in Glacial Lake Agassiz. The paper organizes molluscs present in the area into three time units: Wisconsin, post-Hypsithermal, and modern. Thirty-three species are listed for the Wisconsin period, thirty-two for the post-Hypsithermal, and six-one species for the modern fauna. The paper discusses changes in the occurrence or disappearance of certain species over the three periods, and possible reasons for such changes.

Location: unknown

Underwood McLellan Ltd. 1980. Delta Marsh Ground Water and Soil Salinity Study. Ducks Unlimited, Winnipeg, MB. 22 pp.

A 1980 report discussing results of groundwater and soil salinity tests conducted in Delta Marsh and the surrounding area. The purpose of the study was to determine any detrimental effects that could result from a proposed water level regulation project by Duck Unlimited for Delta Marsh, on ground water users and the soil salinity in the area surrounding the marsh. The proposed control cycle in the marsh consists of two years of high water levels water at 1.5 feet above natural operating conditions; followed by two years of drawdown,

with water levels kept 3 to 4 feet below natural operating levels. This cycle would be followed by a 5 to 6 year period during which water level in the marsh would fluctuate naturally. A description of the geology, and groundwater flows in the marsh and surrounding area are included in the study. Results of the study indicate that regulation of marsh water levels should only have minor impacts on groundwater users in the immediate area surrounding the marsh. During high water levels, the existing saline soil area surrounding the marsh may expand due to an increase in the water table near the marsh. However, impermeability of the soil surrounding the marsh and the limited time period for the high water levels should limited the extent of the affected area. Maps of Delta Marsh are included, which contain information on soil composition characteristics and soil salinity.

Location: Ducks Unlimited Canada, Institute for Wetlands and Waterfowl Research Library, Call No. 1103

Unies Ltd. 1973. Physical effects of modifying Lake Manitoba regulation. Report for Canadian Wildlife Service, Winnipeg. 83 pp.

A preliminary study examining the physical effects that would result from lowering the target water level of Lake Manitoba by six inches, from 812.17 to 811.67 feet ASL, on marshes bordering the lake. The report includes a description of Lake Manitoba, which includes location, hydrology, inflow and outflows, wind setup, shoreline processes, geology, soils and surrounding land use. The marshes surrounding Lake Manitoba examined in the study include Skunk Bay, Nina Lake, Moosehorn Lake, Marshy Point, Johnston Lake, Bluff Harbour, Davis Point and Lucier. The report also discusses details of the proposed changes to the regulation of Lake Manitoba, and reasons for the proposed changes. Some of the physical process in the lake that could be affected by the proposed lowering of the target level of the lake include changes in wind setup; inter basin water transfer, and shoreline and beach deposition and erosion, and water levels in Pineimuta Lake and Lake St. Martin. The study found that potential effects to marshes could include, a reduced response of the marshes to short-term lake level fluctuation, and some marshes may become completely isolated from the lake. Various graphs and figures are included illustrating lake inflow and outflows, locations of marshes studied, and marsh responses to short-term lake level fluctuations and typical wind setup events.

Location: Unies Consulting Engineers

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Upham, W. 1980. Report of exploration of the Glacial Lake Agassiz in Manitoba. In Geological and Natural History Survey of Canada, Annual Report Volume IV 1888-89, W.F. Brown & Co., Montreal, Que. Section E.

A report resulting from a survey of the area in Manitoba previously occupied by Glacial Lake Agassiz. The report includes a description of the history of Glacial Lake Agassiz; and the topography of the region where the lake previously existed, including shores lines, deltas, and dunes; and existing lakes and rivers. Lakes Manitoba, St. Martin, and Winnipegosis are among the lakes described, along with the Fairford and Assiniboine Rivers. The location, area and depth of the water bodies are discussed. Drift formations that formed from the receding of the glacier north of Lake Agassiz are described.

Location: University of Manitoba, Science and Technology Library, Call No. QE 185 A558 v. 4 rpt. E

Van Everdingen, R. O. 1971. Surface-water composition in southern Manitoba reflecting discharge of saline subsurface water and subsurface solution of evaporates. In Turnock, A.C., ed., Geoscience studies in MB: Geological Association of Canada, Special Paper no 9, p 343-352.

A study examining the source and diffusion of saline ground water from brine springs into Lakes Manitoba and Winnipegosis, and other adjoining water bodies. A description of the physiography and geology of the two lakes are given, along with the location of brine spring in the area. Brine spring in the area are located along the western shore of Lake Winnipegosis, and few are located in the valley of Red Deer River, and the Whitemud River. The study uses the results of chemical analysis from twenty-four location within the area of study during the period from 1953 to 1959 published by Thomas (1959), and samples from lakes and rivers in the area in 1968 and 1969 carried out by D.L. Delorme. Samples were examined for concentrations of Ca^{++} , Mg^{++} , Na^+ , Cl^- , SO_4^- and HCO_3^- . High concentration of Na^+ and Cl^- (7.5 to 17.5 meq NaCl/L versus the usual 0.05 to 1.0 meq NaCl/L) were found in the waters of Lake Winnipegosis, Lake Manitoba and Waterhen Lake, reflecting the discharge of sodium-chloride brine into normal surface water runoff. High concentrations of Na^+ and Cl^- were also found in the Fairford River and Lake St. Martin. According to the author these results show that lowering water levels in any of the major lakes between the Manitoba Escarpment and Lake Winnipeg, whether natural or human-induced, will improve drainage conditions in the surrounding terrain and can be expected to cause increases in the salinity problem, as the hydraulic gradient between recharge and discharge area would increase. A map is also included showing sample sites in the area.

Location: University of Manitoba, Science and Technology Library, Call No. QE 188 G462

Valiant, H. and T. Smith. 1979. Angler Creel Census in the Lake Winnipegosis Waterhen, Lake Manitoba and Dauphin River Areas in 1977 and 1978. Manitoba Department of Natural Resources. MS Report No. 79-68. Winnipeg, MB. 80 pp.

A summary of an angler creel census conducted at sites in lakes Manitoba, Winnipegosis, Waterhen, St. Martin; and the Fairford and Dauphin Rivers, from May to October of 1977 and 1978. Catches of species, hours spent angling, and number anglers were recorded at each site. Samples of walleye were collected from each site for determination of length and weight. Other species examined include sauger, pike and perch. Trends in catches over the two years at the various sample sites are examined.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MRRB mrs 79-68

van der Valk, A. G., L. Squires and C. H. Welling. 1994. Assessing the impact of an increase in water level on wetlands vegetation. Ecological Applications 4: 525-534.

A long-term examination of the effects of permanent high water levels on wetland macrophyte vegetation in Delta Marsh. Vegetation in ten cells in the experimental wetland complex of the Marsh Ecology Research Program (MERP) were kept at normal water levels, and at 30 or 60 cm above normal water levels for five years from 1985 to 1989. Overall, during study period there was little change in the flora present in the cells, however the abundance and distribution of species was affected by higher water levels. There was a substantial reduction in the percentage cover of emergent vegetation by 40 percent, accompanied by an increase in the cover of submergent and floating leaved species.

Location: University of Manitoba, Science and Technology Library, 4th floor, Call No. 574 E19 Ap

Vascatto, G. 1970. A summary of Benthic investigations at Delta Marsh: University of Manitoba Field Station (Delta Marsh) 1969 Annual Report 4: 63-65.

Results of a survey of benthic fauna conducted between July and August, 1969 in Lake Manitoba, north of the Assiniboine Diversion outlet. At the time of the survey, construction on the Assiniboine Diversion, which would divert waters from the Assiniboine River into Lake Manitoba, was nearing completion. The survey was conducted since it was thought that the Diversion would bring a considerable silt load and suspended nutrients into south end of Lake Manitoba (near Delta Beach) during its spring operation, and this could cause changes in the present aquatic system of the area. Surveys were conducted at a number of sampling sites in Lake Manitoba, established on transects running north from the Diversion outlet in Lake Manitoba. At each sampling site the depth of the water column was measured and benthic samples were gathered. The percent dry weight, organic carbon and particle size range of the sediment samples was also calculated. Results of the survey showed that total numbers of organism increased with depth in the sediments, along with organic content of the sediments, whereas mean particle size decreased. The genus *Chironomus* (Diptera) made the greatest contribution to the total numbers of organism present at all sample sites. Gastropods, *Cincinnatia sp.* and *Valvata sp.* numbers increased with depth, and represented the second largest contributors to total numbers of organisms. The author recommends further sampling to examine any changes that may occur in the composition and occurrence of benthic organisms after the Diversion is operational, such as increases in the number of Oligochaetes due to an anticipated increase in nutrients, and a depression of Chironomidae.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Vergeer, T. 1928. Canadian Fish, a Source of the Broad Tapeworm of Man in the United States. Journal of the American Medical Association 90: 1987-1688.

A study of the presence of the broad tapeworm *Diphyllobothrium latum* in four species of fish: *Stizostedion canadense-griseum* De Kay, *Stizostedion vitreum* Mitc., *Esox lucius* L., and *Lota maculosa* Le Sueur. According to the author lakes Winnipeg, Manitoba, Winnipegosis, and Lake of the Woods are important sources of these fish species, which can be infected with this tapeworm.

Location: University of Manitoba, Neil John MacLean Health Sciences Library, 3rd floor

Verner, J. S. 1954. Investigations of means of lowering Lake Manitoba. Manitoba Department of Mines, Resources and Environmental Management, Water Resources Branch. 6 pp.

A report summarizing surveys undertaken in the summer of 1954 on the Fairford and Dauphin Rivers and adjacent areas, in connection with the proposed lowering of Lake Manitoba with an auxiliary channel near the outlet of Lake Manitoba into the Fairford River. The main purpose of the surveys was to obtain information on topography in the area of the proposed channel, located on left of the Fairford River. Water level profiles were obtained along the full reach of the Fairford River between Lake Manitoba and Lake St. Martin. Two of the water level gauges installed during the water level profiles, will be permanently maintained on Pineimuta Lake and Lake St. Martin, to determine a stage relationship between Lake Manitoba, Pineimuta Lake and Lake St. Martin, produced by a proposed increase in the discharge of the Fairford River. The report discusses the topography of the area, results of hydrometric data gathered from the gauges set-up on the Fairford River, and results of sounding taken from Pineimuta Lake during the survey. Figures are included illustrating the location of the proposed channel, water level profiles of the river, location of the water gauges on the river, results of sounding in Lake Pineimuta, and results of cross sections taken on the Fairford and Dauphin Rivers.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MMWR 54/7

Vitkin, N. 1978. Erosion and Sedimentation Study of the Assiniboine River Diversion and Red River Floodway. Manitoba Natural Resources, Water Resources Branch, Planning Division. Winnipeg, MB. 22 pp.

A study examining erosion and sedimentation rates in the Assiniboine Diversion and the Red River Floodway. A general physical description of both structures is given, along with their designed operation, and the properties of the bottom sediments of the Assiniboine Diversion. Peak flow rates in the Assiniboine Diversion from 1970 to 1976 are given. Sediment sampling was conducted in the Diversion at six samples sites along its reach from the Assiniboine River to Lake Manitoba, from 1970 to 1972, and in 1974. Channel degradation of the Diversion was found to be roughly proportional to peak flow for any flow period. Data indicated that in areas in the channel where lacustrine clays were present, erosion was negligible (or deposition occurs) at peak velocities of less than two feet per second. Erosion can become severe, exceeding one foot per year, as velocities approach three feet per second. Figures are included illustrating sampling sites, cross section and profile of the Assiniboine Diversion, flow rates, and erosion and sedimentation rates. From the study it appears that severe erosion is occurring in some reaches of the Diversion under maximum flow design conditions, along with severe deposition in most downstream reach.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MNR WR ess 1978

Vitkin, N. 1979. Review of suspended sediment sampling program in Manitoba. Manitoba Department of Natural Resources, Water Resources Branch, Planning Division. Winnipeg, MB. 21 pp.

An overview of the suspended sediment sampling studies that have been conducted at 30 stations in southern Manitoba in the 7 to 18 year period prior to and including 1979. Some of the sampling sites examined included the Assiniboine River Diversion, Portage Reservoir, Assiniboine River and Whitemud River. The report includes a brief overview of suspended sediment studies that have been conducted in each of the sampling sites. From a study conducted examining the Assiniboine River Diversion in 1978 (Vitkin 1978) it appears that severe erosion is occurring in some reaches of the Diversion under maximum flow design conditions, along with severe deposition in the most downstream reach. Studies have also been conducted in the Portage Reservoir, located at the head of the Assiniboine Diversion, examining siltation problem in the reservoir. Studies were also conducted on the Whitemud River and Assiniboine River from approximately 1963 to 1979, and results are briefly reviewed. Graphs are included illustrating relationships between daily suspended sediment load and daily water discharge, total sediment loads per year, and peak water discharge or total water discharge per year.

Location: Manitoba Conservation and Environment Library, Call No. QE 571 R48 1979

Vitkin, N., F. Penner and Mudry. 1979. Review of erosion and deposition in the Assiniboine River Diversion and options for action. Manitoba Department of Mines, Resources and Environmental Management, Water Resources Division, Planning Branch.

A copy of this publication could not be found for review, at any public, governmental, or private library in Canada.

Location: unknown

Walker, J. M. 1959. Vegetation Studies on the Delta Marsh, Delta, Manitoba. MSc Thesis, University of Manitoba, Winnipeg, MB. 203 pp.

The study examines the vegetation composition of Delta Marsh, Manitoba during the period from 1955 to 1958, and investigates the influence of water levels and soil composition on the growth and composition of emergent vegetation in the marsh. Water levels in Lake Manitoba reached unusually high levels in 1955, resulting in extensive flooding in Delta Marsh, and since 1955 the water levels have been decreasing exposing mud flats. In 1958 a considerable amount vegetation recolonization of the mud flats was observed. To describe the vegetation composition of the marsh, aerials photographs of the marsh from 1954 were used in conjunction with detailed ground surveys of vegetation and soil composition in various parts of the marsh. The study includes a physical description of Lake Manitoba and Delta Marsh, which includes geology, geography, climate, detailed vegetation composition, and the influence of Lake Manitoba on water levels in the marsh. The main biological aspects of some of the dominant species found in the marsh are also discussed, which includes *Typha latifolia*, *Puccinellia nuttalliana*, *Scolochloa festucacea*, *Phragmites communis*, *Rumex maritimus* var. *fuiginus*, *Chenopodium rubrum*, *Atriplex patula*, *Ranunculus sceleratus*, *Ranunculus cymbalaria*, *Aster brachyactis*, and *Senecio congestus* var. *tonsus*. Figures illustrating Delta Marsh are included, along with photographs of the vegetation present in the marsh at sample sites. A graph showing water levels in Lake Manitoba from 1913 to 1958 is also included.

Location: University of Manitoba, Elizabeth Dafoe Library, 2nd floor, Thesis W1519

Walker, J. M. 1965. Vegetation Change with Falling Water Levels in the Delta Marsh Manitoba. PhD Thesis, University of Manitoba, Winnipeg, MB. 272 pp.

A study examining changes in the vegetation at twenty sites in Delta Marsh from 1959 to 1961, under the influence of falling water levels. Water levels in Lake Manitoba reached there greatest recorded level of 248.4 m in 1955, and for the next three following years the water levels in lake were higher than the recorded mean of 247.4 m. Since this time waters levels continually dropped in the lake for the length of the study period. The study includes a description of Delta Marsh which includes location and area, geology, soils, topography and climate. The high water levels of 1955 killed large areas of *Phragmites communis*, *Typha latifolia*, *Scirpus acutus*, and *Scirpus validus*, leaving stubble. As water levels receded and mud flat became exposed in 1959, mudflats were colonized by a number pioneer species including *Ranunculus sceleratus*, *R. cymbalaria*, *Senecio congestus*, *Epilobium glandulosum*, *Rumex maritimus*, *Aster brachyactis* and *Galium trifidum*. Some of the most important pioneer species included *Chenopodium rubrum*, *Scolochloa festucacea*, *Atriplex patula*, and occasionally *Typha latifolia*. In the site throughout the study period the most prevalent species were (in diminishing order): *Phragmites communis* var. *berlandieri*, *Scolochloa festucacea*, *Atriplex patula*, *Chenopodium rubrum*, *Sonchus arvensis antherodes*, *Hordeum jubatum*, *Typha latifolia*, *Scirpus paludosus*, *Ranunculus sceleratus*, and *Scirpus validus*.

Soil samples were also collected from the marsh in 1960, and analyzed for texture, colour, conductivity and pH. The chemistry of soils varied widely at various sites throughout the marsh. The pH of soils varied between 6.4 and 8.5, conductivity between 0.21 and 54.50 mmhos/cm, and soils generally had a high organic content. Aerial and ground photographs of the marsh during the study period are included, along with hydrograph of water levels in Lake Manitoba from 1914 to 1965.

Location: University of Manitoba, Elizabeth Dafoe Library, 2nd floor, Thesis W1519

Walker, J. M. and E. R. Waygood. 1966. Carp Investigation 1965. Interim Report, January 1966. Delta Marsh Management Committee (unpublished data). 3 pp.

A brief summary of water quality tests conducted in Cadham Bay, School Bay, and Round Pond of Delta Marsh. The study looked at the effects of the complete exclusion of carp from sections of the marsh on the water quality of those sections. Parameters examined include pH, conductivity, dissolved oxygen, temperature, nutrient cocentrations, and other ions and minerals. Artificial ponds were also established at the marsh to

examine the effects of fertilization with ammonium nitrate and phosphoric acid on water quality. Preliminary results of the study are discussed briefly.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Water Control and Conservation Branch, Planning Division. 1965. Summary Report Lake Winnipegosis Regulation Study. Water Control and Conservation Branch, Planning Division, Manitoba Highways Department, Winnipeg, MB.

A report on the regulation of Lake Winnipegosis that includes: related studies undertaken, the range of levels that could be maintained on Lakes Winnipegosis and Manitoba, and the amount of water that could be made available from conservation storage on Lake Winnipegosis. The report also includes a preliminary estimate of the costs associated with control structures on the Waterhen River. A brief physical description of Lake Winnipegosis is given which includes climate, physiography, soils, hydrology, historical lake levels, and its influence on the water regimes of Lake Manitoba. The report discusses the problems associated with extreme high and low water levels in Lake Winnipegosis, which includes negative effects on navigation, commercial fishery, waterfowl and waterfowl habitat, agriculture and forestry. The report found that overall low lake levels were more damaging than high lake levels. The report recommends the construction of the control structure on the Waterhen River, allowing Lake Winnipegosis to be regulated between 831.0 and 833.7 feet FSL. Water would also be released from Lake Winnipegosis into Lake Manitoba during dry years. The report includes figures illustrating the proposed control structure on the Waterhen River.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MMWR 65/83

Water Control and Conservation Branch, Planning Division. 1968. Lake Manitoba Supply Canal: Preliminary Report. Water Control and Conservation Branch, Planning Division, Manitoba Highways Department, Winnipeg, MB. 57pp.

A preliminary report and cost estimate on the construction of a water supply canal from Lake Manitoba to the Assiniboine River, to provide water to the river during low flow periods, primarily for sewage dilution purposes in the City of Winnipeg. The proposed supply canal would also have other purposes such as a source of water for the Management of water levels in Delta Marsh, to increase wildlife production, and as source of water for waterfowl habitat around Long Lake. The report describes the history of the problem of insufficient sewage dilution in the City of Winnipeg from flows from the Red and Assiniboine Rivers, and the history of the proposed supply channel, along with its design and route from Lake Manitoba to the Assiniboine River. Several figures are included illustrating the proposed location and design of the supply canal.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MMWR 68/17

Water Resources Branch, Planning Division. 1971. Effects of Lowering Range of Regulation of Lake Manitoba on Beach Erosion and Beach Availability. Water Resources Branch, Manitoba Department of Mines, Resources and Environmental Management, Winnipeg, MB. 10 pp.

A report evaluating the effect of lowering the regulation water level range of Lake Manitoba by 0.5 feet, from 810.87 to 812.87 feet, to 810.37 to 812.37 feet, on beach erosion and availability. On October 25 and 26, 1971 field surveys of several beaches were conducted including Lunder Beach, St. Laurent Beach, Twin Lakes Beach, St. Ambroise Beach, Delta Beach, Lynch's Point Beach, Amaranth Beach, and Tote Aides Beach. At each beach shore profiles were taken and beaches were evaluated for signs of erosions and abundance of sand. Figures illustrating the shore profile of each beach are included in the report, as well as, figures illustrating Lake Manitoba water levels from 1914 to 1971, and frequency of wind set up in Lake Manitoba at Delta. It would be that the proposed reduction in the regulation range of lake, could reduce the amount of erosion at all

the beaches surveyed. Erosion was only found to be a problem at St. Ambroise Beach. It was also determined that the reduced regulation range would temporarily increase sand beach exposure for a few years, and may have minor improvements in the bathing quality of a few of the beaches (Toutes Aides Beach and Twin Lakes Beach), while having detrimental effects on the swimming and boating qualities of most of the other beaches surveyed. The author of the report points out that an assessment of the net effect of lowering the regulation range of the lake is complicated since it may be beneficial to some qualities and detrimental to others, and the effects are not the same at all the beaches. Overall, the author concludes that the overall effects on the beaches would be minor, and that further studies examining potential effects on these and other beaches around Lake Manitoba are needed.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MMWR 71/11

Water Resources Division. 1974. Flood Control: Red River Floodway, City of Winnipeg Dykes, Portage Diversion, Shellmouth Reservoir, Fairford River, Assiniboine River Dykes. Manitoba Department of Mines, Resources and Environmental Management, Water Resources Division. Winnipeg, MB.

A brief summary of the history of flooding in Manitoba, and various dams, dykes and channel structures used by the province for flood control. Flood Control structures discussed include the Red River Floodway, various city of Winnipeg dykes, the Portage Diversion, Shellmouth Reservoir, Fairford River Dam, and dykes on the Assiniboine River. A brief description of each structure is given, which includes location, date they were built, importance for flood control, size, flood capacity and cost. Pictures of the structure are given.

Location: Manitoba Conservation and Environment Library, Call No. TC 531 M3 1974

Waters, I. and J. M. Shay. 1991. Effects of water depth on population parameters of *Typha glauca* stand. Canadian Journal of Botany 70: 349-351.

A study examining the growth of hybrid cattail *Typha glauca* Godr. along the water depth gradient, in the Crescent Pond of the Delta, during the summer of 1986. Results of the study showed that shoot density decreased considerably with increased depth, but increased again at 100 cm water depth. Mean shoot dry mass generally increased with depth, and stand biomass was fairly constant in shallow to intermediate water depths, but declined sharply at 85 cm and then reached a maximum at 100 cm. Results show that shoot density along the water depth gradient indicates a great deal of plasticity, and given the ability of *Typha glauca* to maintain high biomass over a range of water depths (0 to 100 cm) it is probable that it will continue to colonize the marsh, previously dominated by *T. latifolia*.

Location: University of Manitoba, Science and Technology Library, Call No. 580 C16 Bo

Webb, R. 1970. Anticipated Effects on Wildlife of the Suggested Lowering of the Water Level of Lake Manitoba. 6 pp.

A brief report examining the effects of lowering the target water level of Lake Manitoba by six inches, on wildlife dependent on several marshes surrounding the lake. The marshes examined include those at the mouth of East Waterhen River, base of Toutes Aides Bay, bays north of Garden Island, Crane Bay, base of Peonan Peninsula, bay south of Pine Island Peonan Peninsula, Elm Bay, Moosehorn Bay, Vanlaught Bay on Nina Lake, the Narrows, Dog Creek, Lily Bay, Marshy Point, Sandy Bay, south rim of Lake Manitoba, bay southwest of Point Asham, bay west of Reykjavik, and Delta Marsh.

The report points out that if the range of water levels on Lake Manitoba were raised to 812 to 814 feet ASL from the current operating level of 811 to 813 feet ASL, the additional water would enhance wildlife values, by increase the size of marsh habitat around the lake. The marshes adjacent to the lake have a large capacity for wildlife production. The importance of Delta Marsh for wildlife (waterfowl, muskrat, mink) production and

hunting is discussed. The lower water levels would cause the marsh area to decrease in size and reduce the wildlife value of the marshes for waterfowl, muskrat, and mink, and cause a decrease in their production. The report concludes that the range of water levels on Lake Manitoba should stay at 811 to 813 feet ASL, and should not be lowered.

Location: Manitoba Conservation and Environment Library, Call No. SF 84.64 C2 W43
1971

Weir, T. (editor). 1960. Economic Atlas of Manitoba. Department of Industry and Commerce, Province of Manitoba.

An atlas of the natural and human resources of Manitoba around 1960, which includes a compilation of various maps illustrating the resources of Manitoba, along with a more detailed description of the resources. A physical description of Manitoba is given along with topography, landforms, climate, soils, relief and drainage, geology, natural vegetation, and surface deposits and glaciation. Information given on the human resources of the province includes population densities, distribution, ethnic groups, and the location of various settlements. Some of natural resources discussed included agricultural lands (i.e. crops and livestock), water resources (i.e. electric power generation and flood control), forests, mines, commercial fishing, game birds and wildlife, recreation and transportation. Resources of the major water bodies in Manitoba are discussed, and Lake Manitoba is among the lakes discussed for its fishery, flood control structures, recreation, and game birds and wildlife.

Location: University of Manitoba, Elizabeth Dafoe Library

Welch, H. E. 1976. Preliminary Observations in the Infestation of Saugers and Walleyes with *Ergasilus sp.* University of Manitoba Field Station (Delta Marsh) 1975 Annual Report 10: 89-93.

A study examining infestations of the ectoparasite *Ergasilus sp.* in sauger (*Stizostedion canadense* Smith), and walleye (*Stizostedion vitreum*) in Lake Manitoba. Samples of fish were collected in the north and south basins of Lake Manitoba during the summer of 1975 for examination. The parasite was found in the gills of both sauger and walleye, but not in sucker and perch caught in the lake. The abundance of parasite egg sacs in the gills of the fish sampled decreased through the summer. The sauger and walleye of northern Lake Manitoba were found to have the highest infestation of *Ergasilus luciopercarum*, record so far for any *Ergasilus sp.* Infestations in both sauger and walleye were higher in the northern part of the lake than the southern portion. See Pearson and Welch (1977) and O'Malley and Welch (1978) for later reports.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3
U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Whitney, L. J. 1971. Diversions in the Dauphin River System. Prepared for the Saskatchewan-Nelson Basin Board. Manitoba Department of Mines, Resources and Environmental Management, Water Resources Branch, Planning Division. Winnipeg, MB. 101 pp.

A report on preliminary of designs and cost estimates of various schemes for diverting water from the Dauphin River Drainage Basin to provide increased water flow in the Assiniboine River and Lower Saskatchewan River. The proposed projects include the Lake Manitoba Supply Canal, the Lake Winnipegosis Control Works, and the Mossy Canal. The Manitoba Canal would divert water from Lake Manitoba into the Assiniboine River below Portage la Prairie. The proposed control works on Lake Winnipegosis would regulate the water level of the lake between a range of 829 and 832 feet ASL. The control works would consist of the Meadow Portage Diversion, the West Waterhen and Little Waterhen River Dam, and the Waterhen Lake Control Dam. Lake

Winnipegosis would be used to store water to provide large volumes of water from the Lake Manitoba supply Canal. The Mossy Canal would move water from Cedar Lake to Lake Winnipegosis, and vice versa. The Mossy Canal would be used to import water from the Dauphin River System.

An overview of previous studies that have been conducted concerning the various parts of the diversion project is given, along with an overview of the design of current proposed diversion project, and detailed cost estimates. A general description of the study area is given, which includes geology; hydrology; climate; historical water levels on lakes Manitoba, Winnipegosis, and Cedar; discharge and control structures on the Fairford River; and discharge on the Saskatchewan River. Maps illustrating the proposed project are included, along with profiles of the proposed canals and diversions. The report also includes an appended study examining the soils and geology of the proposed areas for the Lake Winnipegosis dykes and outlet control structure on the West and Little Waterhen Rivers.

Location: Manitoba Conservation and Environment Library, Call No. TD 227 M3 D38 1971

Williamson, D. A. 1976. An Investigation into the Nature, Extent, and Possible Causes of a Fish Kill in the Assiniboine River near the Spruce Woods Provincial Park. Manitoba Department of Mines, Resources and Environmental Management. Winnipeg, MB. 38 pp.

Due to a large fish kill in the Assiniboine River near Spruce Woods Provincial Park in July of 1976, water samples were collected and analyzed from the Assiniboine River, Souris River and Red River. Sediment samples, and fish tissue and brain samples were also collected from the Assiniboine River. Water samples were analyzed for pH, dissolved oxygen, color, turbidity, alkalinity, temperature, specific conductance, coliforms (total and fecal), biological oxygen demand, various forms nitrogen and phosphorus, various metals, dissolved ions, and pesticides. Fish brain tissue samples were analyzed for cholinesterase activity, and sediment samples were analyzed for the presence of organochlorine and organophosphate pesticide residues. Benthic samples were also collected from the Assiniboine and Souris rivers and analyzed for species composition, dry weight biomass, and mean diversity.

Results of the sampling were inconclusive and could not identify the cause of the fish kill, but several possible causes were eliminated including low oxygen, collapse of an algae bloom, municipal sewage discharge, thermal changes, pathogenic organisms, and/or organophosphate pesticides. However, the author points out that the possibility of a pesticide or herbicide contributing to fish kill still exists, as a large range of pesticides are hard to detect in the environment.

Location: Manitoba Conservation and Environment Library, Call No. MH EPL tr 29 1976

Williamson, D. A. 1988. Manitoba Surface Water Quality Objectives. Manitoba Environment and Workplace Safety and Health, Winnipeg, MB.

A summary of the surface water quality objectives for Manitoba published in 1988. Water quality objectives are stated for each general surface water use class in Manitoba that requires protection: domestic consumption, aquatic life and wildlife, industrial consumption, agricultural consumption, recreation and other uses. The objectives give the recommended limits for a variety of chemical, physical, and biological parameters including: colour, odor, turbidity, deposits, floating material, flow, litter, nutrients, oil and grease, and toxic substances. See (Williamson 2001) for the revised Manitoba water quality standard, objectives, and guidelines.

Location: Manitoba Conservation and Environment Library, Call No. CA2 ME wss mbw 1988

Williamson, D. A. 1995. An overview of water quality in Lake Manitoba near Delta Beach, Manitoba, Canada. Draft Report. Manitoba Department of Natural Resources. Environment Branch. 21 pp.

A brief overview of water quality in Lake Manitoba, near Delta Beach. Water samples were collected during two periods from 1973 to 1977, and 1991 to 1995, and results are summarized in the report. Results from the two periods are compared statistically to determine if water quality conditions have changed in the lake, as well results are compared to water quality objectives for Manitoba. In total 94 water quality parameters are examined, and of these only three parameters were found to vary significantly between the two periods; turbidity, total organic carbon, and total Kjeldahl nitrogen. Turbidity increased from about 9 NTU to 28.5 NTU, total organic carbon declined from about 18 to 15 mg/L, and mean total Kjeldahl nitrogen increased from 1.06 to 1.35 mg/L. Overall, from the data this portion of the lake is characterized as mesotrophic and alkaline, with a relatively high salinity, and good bacteriological characteristics.

Location: Manitoba Conservation and Environment Library, Call No. (None given)

Williamson, D. A. 2001. Manitoba Water Quality Standards, Objectives, and Guidelines. Manitoba Conservation Report 2001-01. Manitoba Conservation, Winnipeg, MB. 77pp.

A summary of the water quality standards and guidelines for Manitoba that covers both groundwater and surface water, lake and river bottom sediments, and fish tissues. The water quality standards are objectives set for various physical, chemical, and biological parameters of water quality including: nutrients, metals, dissolved ions, dissolved oxygen, bacteria, temperature, water clarity, conductivity, pesticides, and other toxic substances.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MC r 2001-01

Wolowich, E. A. 1985. Sediment Dynamics and Flow Analysis of the Assiniboine River. MSc Thesis, University of Manitoba, Winnipeg, MB. 284 pp.

An examination of the sediment dynamics in the Assiniboine River, from 1956 to 1976, including an investigation of the effects of the Assiniboine River Diversion and the Shellmouth dam on the sediment dynamics of the Assiniboine River. Both the Shellmouth Dam and Assiniboine River Diversion were put into operation in 1969. The section of the river from Russell to Headingley, Manitoba was examined in the study. The historical and present geology, geomorphology, and sediment conditions of the Assiniboine River are discussed in the report. The study discusses the state of sediment transport in the river, sources of sediment to the river (landslides, ground water springs and sand waves), slope-discharge relationships, and the significant effects of the Shellmouth dam and Assiniboine Diversion on the downstream regimes of the river. The report includes figures illustrating sampling sites on the Assiniboine River, and tables illustrating trends in the sediment dynamics, discharge, shear velocity, depth, width, and sediment grain size of the river, before and after the operation of the Assiniboine River Diversion and the Shellmouth dam.

Location: University of Manitoba, Elizabeth Dafoe Library, Thesis W838

Woo, H. 1979. Annotated Bibliography of the Publications of the Staff of the Manitoba Department of Mines, Natural Resources, and Environment, 1978. Manitoba Department of Mines, Natural Resources and Environment, Manuscript Report No. 79-1. 92 pp.

An annotated bibliography of publication of the staff of the Fish and Wildlife Division, Forest Division, Land and Surveys Division, Regional Services and Resources Economic Section of the Department of Mines, Natural Resources and Environment. Abstracts of publication are given. In total, 132 publications, dating from 1977 to 1979, are listed, containing information on economics, fisheries, forestry, lands, planning and wildlife in Manitoba.

Location: Manitoba Conservation and Environment Library, Call No. CA2 MRRB mrs 79-1

Wright, J. 1970. A Quantitative Survey of the Benthos and Phytomacrofauna of an Isolated Body of Water in the Delta Marsh. University of Manitoba Field Station (Delta Marsh) 1969 Annual Report 4: 65-70.

A study examining the benthos and phytomacrofauna of in the Crescent Pond of Delta Marsh. Samples were collected from the pond from June to September, 1969. Preliminary results of the study area discussed, along with seasonal distribution and abundance of the species found. Groups examined included Hirudinea, Crustacea, Trichoptera, Zygoptera, Hemiptera, Coleoptera, Diptera and Mollusca.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Wrubleski, D. A. 1998. The Fish Community of Delta Marsh: A Review. Institute for Wetland and Waterfowl Research, Ducks Unlimited Canada. 48 pp.

A review of all fisheries related studies conducted in Delta Marsh, located on the south shore of Lake Manitoba, up to 1998. Historical records indicate the marsh supported a commercial and recreation fishery in the early parts of the century. However, since the mid-1940s, control structures constructed to separate the marsh from Lake Manitoba have had a significantly negative effect on the fishery in the marsh. Since then all dams have been removed, but the fishery in the marsh has not appeared to recover to historic number. The report includes a discussion of fishery in Lake Manitoba and Delta Marsh, the seasonal and spatial movement of fish into and out of the marsh, the usage of the marsh by fish, and specific fish species that use the marsh. Twenty-nine fish species have been reported in the marsh, some of the dominant species include walleye, sauger, northern pike, yellow perch, white sucker, carp, fathead minnow, spottail shiner, bullhead and brook stickleback. Possible reasons given for the apparently slow recovery of the fishery in the marsh include the introduction of carp and bullhead, a decline in submersed vegetation, stabilized water levels and increased turbidity. A brief description of Delta Marsh is given which includes morphology, water levels, and waterfowl and wildlife usage.

Location: Delta Waterfowl Research Station, David Winton Bell Memorial Library

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Wu, K. H. 1955. Investigation of Means of Lowering Lake Manitoba Levels Upper Fairford River Channel Improvement Studies. Water Resources Branch, Manitoba Department of Mines, Resources and Environmental Management. Winnipeg, MB. 15 pp.

A study examining various schemes to improve the Lake Manitoba outlet into the Fairford River, as a means for lowering water levels in Lake Manitoba. The study primarily examines two proposals for increasing discharge from Lake Manitoba: improvement of the upper reach of the Fairford River; and construction of an auxiliary channel near the mouth of the Fairford River, along with improvements to the existing river channel below the Fairford Dam. Results of the investigations showed that lowering water levels on Lake Manitoba would be best achieved if there was a diversion channel to the north of the Fairford Dam coupled with an enlargement of the Fairford River below the Dam. Figures are included illustrating the proposed channel improvements on the Fairford River, Fairford River discharge curves, and Water levels on Lake Manitoba with and without the proposed channel improvement on the Fairford River (from 1914 to 1955).

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MMWR 55/19

Yake, J. B. 1978. A Management Plan for the Whitemud Watershed Wildlife Management Area. Wildlife Manuscript Report 78-36. Department of Renewable Resources and Transportation. Winnipeg, MB. 8 pp.

A report examining practices for the management of the Whitemud Watershed Wildlife Area. The report discusses management practices to date, and other types of management practices that should take place. A description of the area is included, which briefly discusses location and size; history and purpose; physiography; and soils, vegetation, wildlife, agriculture use.

Location: Manitoba Conservation and Environment Library, Call No. CA 2 MRR mr 78-36

Yale, B. 1977. The sport fishery on Big Grass Marsh and Whitemud River. Manitoba Department of Renewable Resources and Transport Services. 4 pp.

A copy of this report could not be found in for examination at any public, governmental or private library in Canada

Location: unknown

Young, D. A. and J. S. Scarth 1984. Waterfowl and Habitat Investigations at Five Wetlands in the Interlake Area of Manitoba, 1984: Volume I. Prepared for Ducks Unlimited Canada. Environmental Management Associates. Calgary, AB. 99 pp.

A study evaluating waterfowl production and habitat at five wetlands in the Interlake region of Manitoba, near the town of Lundar. The five wetland project sites include Lindal's, Big Swan, Spruce Lake, Vestfold and Harrell-Enis. A general description of the study area is given, which includes topography, geology, soils, climate and vegetation. Field studies included waterfowl pair and brood counts, and observations of other aquatic birds; classification of wetland habitats according to their water level and water permanence; aerial photography; vegetative mapping; vegetation decomposition rate experiments; and water quality sampling. However, the only water quality parameters discussed in the report is water depth. The report also discusses factors at each of the five marshes that have the potential to limit waterfowl production, and gives recommendations to enhance waterfowl production at each wetland. Aerial photographs of the wetlands are included in the report, along with maps of the wetlands. The report also has a second volume that contains the appendixes to the report. Information given in the appendixes includes waterfowl survey counts, vegetation species composition, maps of the study areas, and a summary of daily weather records for the study area during 1984.

Location: Ducks Unlimited Canada, Institute for Wetlands and Waterfowl Research Library, Call No. EMA

Zbigniewicz, M. W. 1982a. A comparison of the vegetation at the north end of the Assiniboine Diversion with that of the adjacent marsh. University of Manitoba Field Station (Delta Marsh) 1981 Annual Report 16: 73-88.

A study examining the effects of sediment and fertilizer rich waters from the Assiniboine River Diversion on the composition of vegetation in the Diversion channel. The Assiniboine Diversion was built in 1969 to carry floodwater from the Assiniboine River to Lake Manitoba. Vegetation in the channel was originally similar to that of the surrounding area. From June to September of 1981, transect information was gathered on three emergent macrophytes species (*Typha latifolia*, *Carex antherodes*, and *Scolochloa festucacea*) and soil samples were collected from several transsects that extend from the adjoining marsh (Delta Marsh) into the diversion channel. Soil samples were analyzed for pH, conductivity, salinity, texture, organic matter, and concentrations of various ions. Results from the study showed that in general species richness was greater in the diversion compared to the marsh along each transect. The diversion is an open system and in the spring flood waters carry seeds from the Assiniboine River watershed that settle out in the lower water velocities of the final 5 km of the diversion channel. Soil analysis showed that nutrient concentrations were lower in the diversion compared to the marsh, and that ion concentrations decreased in the diversion along the transect from the diversion dike wall to the channel bottom. Low nutrient levels in the diversion were attributed to the fact that the diversion had not received flow for two years (1979) and available nutrients would have been taken up by vegetation during this period depleting the soil nutrient pool. Also precipitation and runoff would have resulted in some leaching of nutrient from the channel, and the nutrient rich water that flows through the diversion may only deposit minimal nutrients in the diversion channel, with the majority entering Lake Manitoba.

Location: University of Manitoba, Science and Technology Library, Call No. QH 541.5 M3 U54

Zbigniewicz, M. W. 1982b. A Comparison of the Vegetation at the North End of the Assiniboine Diversion with that of the Adjacent Marsh. BSc Thesis, University of Manitoba. Winnipeg, MB. 95 pp.

A study examining the effect of sediment and fertilizer rich water from the Assiniboine River Diversion on the composition of vegetation in the lower reach of the Diversion channel. The Assiniboine Diversion was built in 1969 to carry floodwater from the Assiniboine River to Lake Manitoba. Vegetation in the channel was originally similar to that of the surrounding area. From June to September of 1981 transect information was gathered on three emergent macrophytes species (*Typha latifolia*, *Carex antherodes*, and *Scolochloa festucacea*), and soil samples were collected from several transsects that extend from the adjoining marsh (Delta Marsh) into the diversion channel. Soil samples were analyzed for pH, conductivity, salinity, texture, organic matter, and concentrations of various ions.

A general description of the study area is given, which includes geography, geology, soils, climate and vegetation. The history of the Assiniboine Diversion is also given which includes why it was built, when it was built, and its usage since. Since the diversion has been used, a large amount of silt has been carried the diversion and deposited within the diversion, mostly in the lower 5 km reach of the channel. In addition waters from the diversion carry agricultural fertilizers.

Results from the study showed that in general species richness was greater in the diversion compared to the marsh along each transect. The diversion is an open system and in the spring flood waters carry seeds from the Assiniboine River watershed that settle out in the lower water velocities of the final 5 km of the diversion channel, before it empties into Lake Manitoba. Soil analysis showed that nutrient concentrations were lower in the diversion compared to the marsh, and that ion concentrations decreased in the diversion along the transect from the diversion dike wall to the channel bottom. Low nutrient levels on the diversion were attributed to the fact that the diversion had not received flow for two years (1979) and available nutrients would have been taken

up by vegetation during this period depleting the soil nutrient pool. Also precipitation and runoff would have result in some leaching of nutrient from the channel, and the nutrient rich water that flows through the diversion may only deposit minimal nutrients in the diversion channel, with the majority entering Lake Manitoba.

Location: Delta Marsh Field Station (University of Manitoba), Alice K. Chambers Memorial Library

Zimmerman, R. D. 1975. Regime Consequences of the Assiniboine River Diversion. MSc Thesis, University of Manitoba, Winnipeg, MB. 32 pp.

An examination of the effects of the Assiniboine River Diversion on water and sediment flow in the Assiniboine River, downstream from the diversion. A description (past and present) of the Assiniboine River immediately downstream of the Portage Diversion is given, and the expected changes resulting from a disruption of water and sediment flow in the river is assessed quantitatively. Some of the expected changes resulting from the diversion that are discussed include: a reduction in mean and peak flows; blocking of bed-load transport in the river due to the diversion structure; and a reduction in water velocities in the reservoir allowing suspended particles to settle out, as the diversion inlet structure was designed to allow as little sediment as possible in the diverted flow through the diversion channel into Lake Manitoba. As a result of these changes other regime parameters of the river, downstream from the Diversion, could change including: degradation and flattening of the river's profile, decrease in the mean channel width, a decrease in the water surface elevation and mean velocity, and a reduction in the rate of lateral shift of the river channel. These changes are discussed and quantified. A description of the Assiniboine River Diversion, with figures is included. Several figures are included which illustrate water flows and sediment transport in the river under natural conditions and with the Diversion.

Location: University of Manitoba, Elizabeth Dafoe Library, Thesis Z6496.

2. Summary Table

The following is a summary table to further aid the reader in determining the subject matter of each publication included in the bibliography. Information given in the table includes the year(s) and season(s) of field studies discussed in the publication, the location(s) of the study, as well as information on parameters examined in the report including water chemistry, flora and fauna, recreation, agriculture, geology and soils.

3. Locations of Publications

The following is a list of locations where the publications in the bibliography can be found. Locations include public, government and private organization libraries, and private companies. Information given includes address, phone and fax number, e-mail address and website, if available, and hours of operation. Additional information regarding each locations policies on viewing publications and photocopying is also given.

- **DAVID WINTON BELL MEMORIAL LIBRARY**

Delta Waterfowl Research Station
R.R. #1, Box 1
Portage la Prairie, MB
Canada R1N 3A1

Phone: (204) 239-1900
Fax: (204) 239-5950
E-mail: wgorsuch@deltawaterfowl.org
Web site: www.deltawaterfowl.org

Hours: Monday to Friday: 8:30 am – 4:30 pm

Materials may be used in-house or borrowed through another library via interlibrary loan. Photocopies can be made for \$ 0.10 a page.

- **DUCKS UNLIMITED, INSTITUTE FOR WETLANDS & WATERFOWL RESEARCH LIBRARY**

Stonewall P.O. Box 1160,
Oak Hammock Marsh, MB
R0C 2Z0

Phone: (204) 467-3276
Fax: (204) 467-9028
E-mail: C_Hutchison@duck.ca
Web Site: www.ducks.ca/library/

Hours: Monday to Friday: 8:30 am – 4:30 pm

Persons who would like to use the library must make an appointment with the librarian, Carol Hutchison.

- **THE ERIC MARSHALL AQUATIC RESEARCH LIBRARY,
CANADA DEPARTMENT OF FISHERIES AND OCEANS**

Freshwater Institute, Central & Arctic Region
501 University Crescent
Winnipeg, MB
R3T 2N6

Phone: 983-5169

Fax: 984-4668

E-mail: library-fwi@dfo-mpo.gc.ca

Web site: www.ncr.dfo.ca/

Hours: Monday to Friday: 8:15 am– 4:15 pm

Open to the public. Materials must be used in the library, or interlibrary loans through other libraries can be arranged. A photocopier is available to use at a cost of \$ 0.10 per page, plus G.S.T. The library catalogue can also be accessed online on their web site.

- **HOBBS AND ASSOCIATES LTD.**

800-283 Portage Avenue
Winnipeg, MB.
R3B 2B5

Phone: (204) 947-9243

Fax: (204) 947-5624

Hours: Monday to Friday: 8:30 am – 5:30 pm

Materials may be used in-house, or photocopies can be made for a charge of \$ 0.10 a page.

- **MANITOBA CONSERVATION AND ENVIRONMENT LIBRARY**

160 - 123 Main Street (Union Station)
Winnipeg, MB.
R3C 1A5

Phone: (204) 945-7125

Fax: (204) 948-2357

E-mail: spenziwol@gov.mb.ca

Web site: www.gov.mb.ca/natres/library/index.html

Hours: Monday to Friday: 8:30 am - 4:30 pm

Open to the public. Materials must be used in the library, or interlibrary loans through other libraries can be arranged. A photocopier is available to use at a cost of \$ 0.20 per page. The library catalogue can also be accessed online at their home page.

- **MANITOBA MINERAL RESOURCE LIBRARY**

Industry, Trade and Mines
360-1395 Ellice Avenue
Winnipeg, MB Canada
R3G 3P2

Phone: (204) 945-6569

Fax: (204) 945-8427

E-mail: library@gov.mb.ca

Web site: www.gov.mb.ca/itm/mrd/info/library/index.html

Hours: Monday to Friday: 8:30 am – 4:30 pm

Materials may be used in-house, or borrowed through another library via interlibrary loan (including video/audio cassettes). Photocopying charges: no charge up to 10 pages; \$ 0.25 per additional page plus G.S.T. and P.S.T.

- **MANITOBA LEGISLATIVE LIBRARY**

200 Vaughan Street
Winnipeg, MB.
R3C 1T5

Phone: 204-945-4330

Fax: 204-948-1312

Email: legislative_library@gov.mb.ca

Web site: www.gov.mb.ca/chc/leg-lib/index.html

Hours: Monday to Friday: 10:00 am - 5:00 pm (Reference service and retrieval from closed stacks available until 4:30 pm)

Open to the public. Materials must be used in the library, or interlibrary loans through other libraries can be arranged. A photocopier is available to use at a cost of \$ 0.15 per page, plus GST. The library catalogue can also be accessed online at their home page.

- **NATIONAL LIBRARY OF CANADA**

Reference and Information Services
National Library of Canada
395 Wellington St.
Ottawa, ON
K1A 0N4

Phone: 1-877-896-9481 (Toll free in Canada)
Fax: (613) 943-1112
Email: reference@nlc-bnc.ca
Web site: www.nlc-bnc.ca/index-e.html

Hours (Reference room): Monday to Friday: 10:00 am - 5:00 pm

Documents in the National Library are identified and requested for consultation through the OPAC. Additional library locations can be found using the AMICUS system. Public workstations for searching the OPAC and AMICUS are available in the reference room at the National Library of Canada. There are also workstations that give public access to a selection of CD-ROM products, the National Library's Web site and to the vast resources of the Internet. Persons who are not able to visit the National Library in Ottawa, but whose information need requires use of the Library's resources, can also submit enquiries by completing the reference inquiry form (available on the web site) or by letter, electronic mail, facsimile or telephone. When ordering any publication, please identify the following: title, catalogue number (Cat. no.), ISBN or ISSN, if available.

- **PROVINCIAL ARCHIVES OF MANITOBA**

200 Vaughan Street
Winnipeg, MB
R3C 1T5

Phone: (204) 945-3738
Fax: (204) 948-2008
E-Mail: govrecs@gov.mb.ca
Web site: www.gov.mb.ca/chc/archives/hours.html

Hours: Tuesday to Saturday: 9:00 am – 4:00 pm (mid-September to mid-May)
Monday to Friday: 9 am – 4:00 pm (last week of May through mid-September)

Open to the public. Materials must be used in the library. Photocopies can be made by librarians at a cost of \$ 0.15 per page.

- **UNIES CONSULTING ENGINEERS**

1666 Dublin Ave.
Winnipeg, MB.
R3H 0H1

Phone: (204) 663-6363
Fax: (204) 632-1442
Web site: www.autobahn.mb.ca/~unies/

Hours: Monday to Friday: 9 am - 4:30 pm

Copies of publications can be obtained for a cost of \$ 0.10 per page.

- **DELTA MARSH FIELD STATION (UNIVERSITY OF MANITOBA)**

Box 38, R.R. #2
Portage la Prairie, MB
R1N 3A2

E-mail: delta_marsh@umanitoba.ca
Web site: www.umanitoba.ca/delta_marsh

Phone: (204) 857-8637
Fax: (204) 857-4683

Hours: Monday to Friday: 8:30 am - 4:30 pm

An online list of annual reports, publication, and theses is available on the Field Station's web site. Copies of publication can be viewed at the field station, and copies can be made for \$ 0.10 per page.

- **ELIZABETH DAFOE LIBRARY (UNIVERSITY OF MANITOBA)**

25 Chancellors Circle
University of Manitoba
Winnipeg, MB
R3T 2N2

Phone: (204) 474-9544
Fax: (204) 474-7577
Web site: www.umanitoba.ca/libraries/units/dafoe
Catalogue: bison2.umanitoba.ca

Hours*: Monday to Thursday: 8:15 am - 10:00 pm; Friday: 8:15 am - 5:00 pm; Saturday:
9:00 am - 5:00 pm; Sunday: 1:00 pm - 9:00 pm.

*Hours of operation are subject to change over the summer months.

Open to the public. Borrowing privileges are provided to all current and retired faculty, all staff and students, and qualified external borrowers who request a card. Faculty, staff, and students must have their ID cards validated, and the cards are not transferable. Loan periods and the number of items that may be borrowed will vary. Photocopying machines, which take coins or copy cards, are available in all libraries, at a cost of \$ 0.10 a page.

- **SCIENCES AND TECHNOLOGY LIBRARY (UNIVERSITY OF MANITOBA)**

211 Machray Hall
University of Manitoba
Winnipeg, MB
R3T 2N2

Phone: 474-9281
Fax: 474-7627
Web site: www.umanitoba.ca/libraries/units/science
Catalogue: bison2.umanitoba.ca

Hours*: Monday to Thursday: 8:30 am - 10:00 pm; Friday: 8:30 am - 5:00 pm; Saturday:
9:00 am - 5:00 pm; Sunday: 1:00 pm - 9:00 pm

*Hours of operation are subject to change over the summer months.

Open to the public. Borrowing privileges are provided to all current and retired faculty, all staff and students, and qualified external borrowers who request a card. Faculty, staff, and students must have their ID cards validated, and the cards are not transferable. Loan periods and the number of items that may be borrowed will vary. Photocopying machines, which take coins or copy cards, are available in all libraries, at a cost of \$ 0.10 a page.

- **WINNIPEG CENTENNIAL LIBRARY**

251 Donald Street
Winnipeg, MB

Phone: (204) 986-6450

Fax: (204) 986-4072

Web Site: wpl.city.winnipeg.mb.ca/default.htm

Catalogue: wpl.city.winnipeg.mb.ca/catalogue.htm

Hours: Monday to Thursday: 10:00 am – 9:00 pm; Friday to Saturday: 10:00 am – 5:00 pm;
Sunday: 1:00 pm – 5:00 pm

All city of Winnipeg residents may obtain a library card to borrow material from the library. Non-residents can obtain a library card for \$80.00 per year per family. Photocopies can be made at the library for a cost of \$ 0.10 a page.

- **UNIVERSITY OF MANITOBA NEIL JOHN MACLEAN HEALTH SCIENCES LIBRARY**

Brodie Centre
200 Level
727 McDermot Avenue
Winnipeg, MB
R3E 3P5

Phone: (204) 788-3342

Fax: (204) 789-3923

Web site: www.umanitoba.ca/libraries/units/health/

Catalogue: bison2.umanitoba.ca/

Hours*: Monday to Thursday: 8:15 am - 10:00 pm; Friday: 8:15 am - 5:00 pm; Saturday:
9:00 am - 5:00 pm; Sunday: 1:00 pm - 9:00 pm.

*Hours of operation are subject to change over the summer months.

Open to the public. Borrowing privileges are provided to all current and retired faculty, all staff and students, and qualified external borrowers who request a card. Faculty, staff, and students must have their ID cards validated, and the cards are not transferable. Loan periods and the number of items that may be borrowed will vary. Photocopying machines, which take coins or copy cards, are available in all libraries, at a cost of \$ 0.10 a page.

4. Photographs

The following is a partial list of photographs related to Lake Manitoba, and adjoining water bodies. All of these photos are located at the Provincial Archives of Manitoba. It is likely that many more photographs exist in archival holdings; however they are not sufficiently indexed to determine their location.

Photo Title	File name	Description
Fairford Dam 1 Construction, 1961	Fairford	Earthmovers clearing and leveling the land around the site for the Fairford Dam prior to its construction in 1961.
Fairford Dam 2 Construction, 1961	Fairford	Earthmovers constructing the earth wall for the Fairford Dam in 1961.
Fairford Dam 3 Construction, 1961	Fairford	Shows the preliminary construction of the Fairford Dam structure in 1961.
Water Survey Collection 118	Water Survey Collection	Canadian Northern Railway bridge and the wood structure for the early Fairford Dam under construction on the Fairford River. Picture taken on June 28, 1912.
FA 386/ 97-99 RCAF photos.	Air Photos	Air photograph of Lake Manitoba and Fairford River area in 1927. Photos from Manitoba Survey Branch.
Delta 1	Delta	Persons in rowboat on shore of Delta Beach, 1901.
Delta 2	Delta	Delta Beach camp group by cabin at Delta Beach, 1930.
Delta 3	Delta	Delta Beach, 1907. A couple having their photograph taken visible in background.
Delta 4	Delta	Two sail boats with people in the water near Delta Beach, 1910.
Delta 5	Delta	Sail boat in Lake Manitoba near Delta Beach, 1910.
Air Photos FA 538	Lake Manitoba	Air photograph of Lake Manitoba from Crane Narrows west to Lake Winnipegosis, 1927.

Photo Title	File name	Description
Air Photos FA 396/ 1-100	Lake Manitoba	Air photograph of Lake Manitoba from Lake St. Martin west to Dauphin Lake, 1927.
J.B. Tyrrell Collection # 26 N14812	J.B. Tyrrell Collection	Chief Wekemuwskunk building a canoe near the shore of Lake St. Martin, 1888.
J.B. Tyrrell Collection #2 N14798	J.B. Tyrrell Collection	Wigamouskunk Chief with family beside their hut, near the shore of Lake St. Martin, 1888.
Meadow Portage 1	Meadow Portage	Picture looking south from Hill's Camp at Lake Manitoba on June 8, 1964.
Farm 1	Meadow Portage	View west of Meadow Portage, one kilometer from Winnipegosis.
Farm 2	Meadow Portage	Meadow near mouth of the Waterhen River, which enters Lake Manitoba a ¼ of a mile downstream. Picture was taken in June, 1964.
Jessop Collection #37, N4030	Jessop Collection	Cattle, horse, and sheep wallowing in the water of Lake Manitoba near the Johnson farm, 1916. Photo also shows lake shoreline vegetation.
Jessop Collection #38, N4031	Jessop Collection	Cattle, horse, and sheep wallowing in the water of Lake Manitoba near the Johnson farm, 1916. Photo also shows lake shoreline vegetation.
Jessop Collection #149, N4031	Jessop Collection	Boating and persons bathing in Lake Manitoba, northeast of Gladstone, Manitoba, 1915. Six boats on shore with people in them. Shoreline vegetation is also visible.
Jessop Collection #150, N4031	Jessop Collection	People boating and bathing in Lake Manitoba, north of Gladstone Manitoba, 1915. People wading in shallow water, and three boats in the background.
George E. Finlay Collection #90	George E. Finlay Collection	Sketch of duck hunting on Lake Manitoba, 1847. Hunter in shoreline vegetation shoots water birds.