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A Limited Survey of Biota in Devils and Stump Lakes, North Dakota

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SUMMARY

A multi-jurisdictional, multi-agency biological survey was conducted on Devils and Stump lakes in late July 2005. The survey was initiated by the United States' Council on Environmental Quality. Participants included the Council on Environmental Quality, Minnesota Department of Natural Resources, North Dakota Game and Fish Department, North Dakota Department of Health, North Dakota State Water Commission, Manitoba Water Stewardship, Environment Canada, Fisheries and Oceans Canada, U.S. Army Corps of Engineers, U.S. Department of State, and U.S. Fish and Wildlife Service.

Devils Lake is nominally part of the Hudson Bay basin, but is located in a closed sub-basin which until recently, was only rarely connected hydraulically to the rest of the basin. The last major transfer of water from Devils Lake occurred naturally to the Sheyenne River about 1000 years ago. The purpose of this survey was to gain a better understanding of whether or not biological species of concern may be present in Devils Lake. Species of concern are those that may cause ecological or economic impacts if introduced to new habitats. While the focus of the survey was on 12 species known to be of concern elsewhere such as zebra mussels and on fish pathogens and parasites, the phytoplankton, zooplankton, and benthic invertebrate communities were also assessed. Striped bass was identified as the 13th species of concern but no specific sampling was conducted to target this fish.

The purpose of this report is to describe the findings from the assessment of the phytoplankton, zooplankton, and benthic invertebrate component of the collaborative assessment undertaken by Manitoba Water Stewardship and to provide an overview of results from components completed by other participating agencies.

Principle findings are as follows:

(1) Not unexpectedly, this brief survey of biota in Devils and Stump lakes identified some differences in the biological communities compared to Lake Winnipeg, the world's 10th largest freshwater lake, and its contributing basin.

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(2) None of the targetted 12 known species of concern were found in this survey of Devils Lake. While efforts were not undertaken in this survey to specifically target striped bass, a 13th species of concern, it is unlikely that this stocked species still survives in Devils Lake since the last one was captured in 1993. No unique taxa were found in the benthic invertebrate community from Devils and Stump lakes that have not been found in Manitoba.

(3) Phytoplankton species *Nodularia spumigena, Chaetoceros muelleri*, *Campylodiscus clypeis*, and *Surirella peisonis* and the crustacean calanoid copepod *Diaptomus nevadensis* are present in Devils and Stump lakes and not in Lake Winnipeg almost certainly because of their preference for highly saline habitats, and likely would not survive if introduced to Lake Winnipeg. Consequently, they are likely not species of concern.

(4) The cyanobacterial community in Devils and Stump lakes is dominated by several species in the *Microcystis* complex whereas few species of *Microcystis* are found in Lake Winnipeg. Species potentially unique to Devils Lake include the tropical or subtropical *M. cf panniformis*, and *M. cf protocystis*, and what appears to be a *Pannus* sp.. In addition, a fourth tropical or subtropical blue-green was also identified as probably *Sphaerocavum* sp. and has not been previously observed in Lake Winnipeg. It is not known whether these four blue-greens are ecomorphs that have adapted to the environment (temperature, nutrient status, and trophic condition) in Devils and Stump Lakes or whether they are indeed separate species. It is also not known whether these taxa have had recent and regular opportunity to colonize Lake Winnipeg, but none have been identified in studies conducted between 1994 and 2004. In addition, insufficient information is available to determine whether these species are capable of adapting and becoming established in Lake Winnipeg and becoming species of concern if introduced to Lake Winnipeg for the first time.

(5) With the exception of *Renibacterium salmoninarum,* no fish pathogens listed in the U.S. Fish and Wildlife Service's *National Wild Fish Health Survey* were detected. These are fish pathogens known to cause disease in cultured or wild fish and that are included in most fish health inspection programs. Antigens for *Renibacterium salmoninarum*, the agent responsible for bacterial kidney disease, were detected in 97.4 % of the 313 fish specimens by the ELISA screening test. However, 21 fish were tested with a more specific assay and the presence of *Renibacterium salmoninarum* could not be confirmed. Infestations of bacterial kidney disease have occurred in the past in Manitoba fish hatcheries where it has affected trout species

(6) Three fish parasites remain potential species of concern for Manitoba:

(a) Although *Gyrodactylus hoffmani* was not detected in the present survey, it was detected in an earlier survey of Devils Lake. It is not known whether *Gyrodactylus hoffmani* is no longer present in Devils Lake or was not detected during the present survey because it is not widespread and the sample size was too small to allow its presence to be detected. If it still exists in Devils Lake, it would remain a species of potential concern to Manitoba. This parasite normally affects fathead minnows, a small baitfish.

(b) The external parasite *Epistylis* sp., also previously known to exist in Devils Lake but not elsewhere in the Hudson Bay basin including Lake Winnipeg, was detected in the present survey. This parasite is a species of potential concern since it has not been reported from Manitoba and because it has been reported to cause disease and sometimes mortality in members of the Centrarchidae or bass family.

(c) *Trichodina* sp. was detected on walleye, white bass, and yellow perch from Devils Lake during the present survey. This external fish parasite had not previously been found in Devils Lake but has been reported to be widespread in both fresh and marine waters. However, it has not been reported from Manitoba including Lake Winnipeg, so it is a potential species of concern to Manitoba. Most if not all trichodines are potentially pathogenic to fish and sometimes cause mortality.

ACKNOWLEDGEMENTS

Special thanks are extended to Mr. Bryan Arroyo of the United States' Council on Environmental Quality for providing overall coordination of this survey and to Mr. Terry Steinwand of the North Dakota Department of Game and Fish for managing field logistics. The survey was guided throughout by representatives from participating agencies including Dr. Kevin Cash, Environment Canada; Mr. Randall Devendorf, U.S. Army Corps of Engineers – St. Paul District; Dr. Jeffrey Fisher and Ms. Charity F. Dennis, U.S. Department of State; Dr. William Franzin, Fisheries and Oceans Canada; Mr. Mike Noone, North Dakota State Water Commission; Ms. Lee Pfannmuller, State of Minnesota Department of Natural Resources; Mr. Mike Sauer, North Dakota Department of Health; Mr. Terry Steinwand, North Dakota Game and Fish Department; and Dr. Dave Wright, State of Minnesota Department of Natural Resources.

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INTRODUCTION

Devils Lake is nominally part of the Hudson Bay basin (Figure 1), but is located in a closed sub-basin which until recently, was only rarely connected hydraulically to the rest of the basin. The last major transfer of water from Devils Lake occurred naturally to the Sheyenne River about 1000 years ago. Within Manitoba, the Hudson Bay basin includes Lake Winnipeg, the world's 10^{th} largest freshwater lake. Manitoba Water Stewardship was invited to participate by the U.S. President's Council on Environmental Quality in a multi-jurisdictional, multi-disciplinary effort to undertake a biological survey of Devils and Stump lakes, North Dakota. The purpose of this survey was to gain a better understanding of whether or not biological species of concern may be present in Devils Lake. Species of concern are those that may cause ecological or economic impacts if introduced to new habitats. In addition to providing assistance to other members of the team to target a number of known invasive species or species of concern including fish pathogens and parasites, Manitoba Water Stewardship with the kind assistance of personnel from North Dakota Health, collected samples throughout the lakes for analyses of phytoplankton, zooplankton, and benthic invertebrates. A brief overview follows of these findings and, in addition, the main results of principal interest to Manitoba from other components of the collaborative assessment are also summarized from Arroyo (2005), Hudson and Peters (2005), Montz (2005), and Perleberg (2005).

METHODS

Sampling locations are shown in Figure 1. Samples were collected from Devils and Stump lakes during the period July 27, 2005 to July 29, 2005. Samples were collected in duplicate in a few cases and triplicate at most sites. Sample locations were recorded using a Global Positioning System.

The boat was anchored during sample collection and time, general weather conditions such as wind direction and estimated velocity, cloud cover, surface water temperature, and sampling depth were recorded. Surface water temperature and depths at each site were determined with an electronic echo sounder. Phytoplankton samples were collected with the use of a Wisconsin-style net with a mouth opening of 10 cm and a total length of 52 cm. The mesh size of the net was approximately 45 to 50 μm. Samples were fixed in the field with Lugol's solution and 70 % alcohol was added later for full preservation. One quarter to ½ mL aliquots were taken from each sample bottle and analyzed in a 2 mL utermohl chamber using an M40 Wild Inverted Microscope at magnifications of 234X, 468X, and 938X. The phytoplankton present were assessed qualitatively primarily for dominant taxa. The following taxonomic references were used for identifying the dominant cyanobacteria: Komarek and Anagnostidis (1999), Komarek and Komarkova (2002), Azevedo and Sant'Anna (2003), and Sant'Anna *et al*. (2004).

Zooplankton samples were collected with a Wisconsin-style net with a mouth opening of 25 cm and length of 100 cm. The first three sites (3C01, 3C02, and 3C03) were sampled with a net of 72 μm mesh and the remainder were sampled with a net of 65 μm. Use of the slightly finer second net, necessitated by damage to the first, did not bias zooplankton species composition. Samples were immediately preserved with 70 % alcohol. Two - 1 mL aliquots

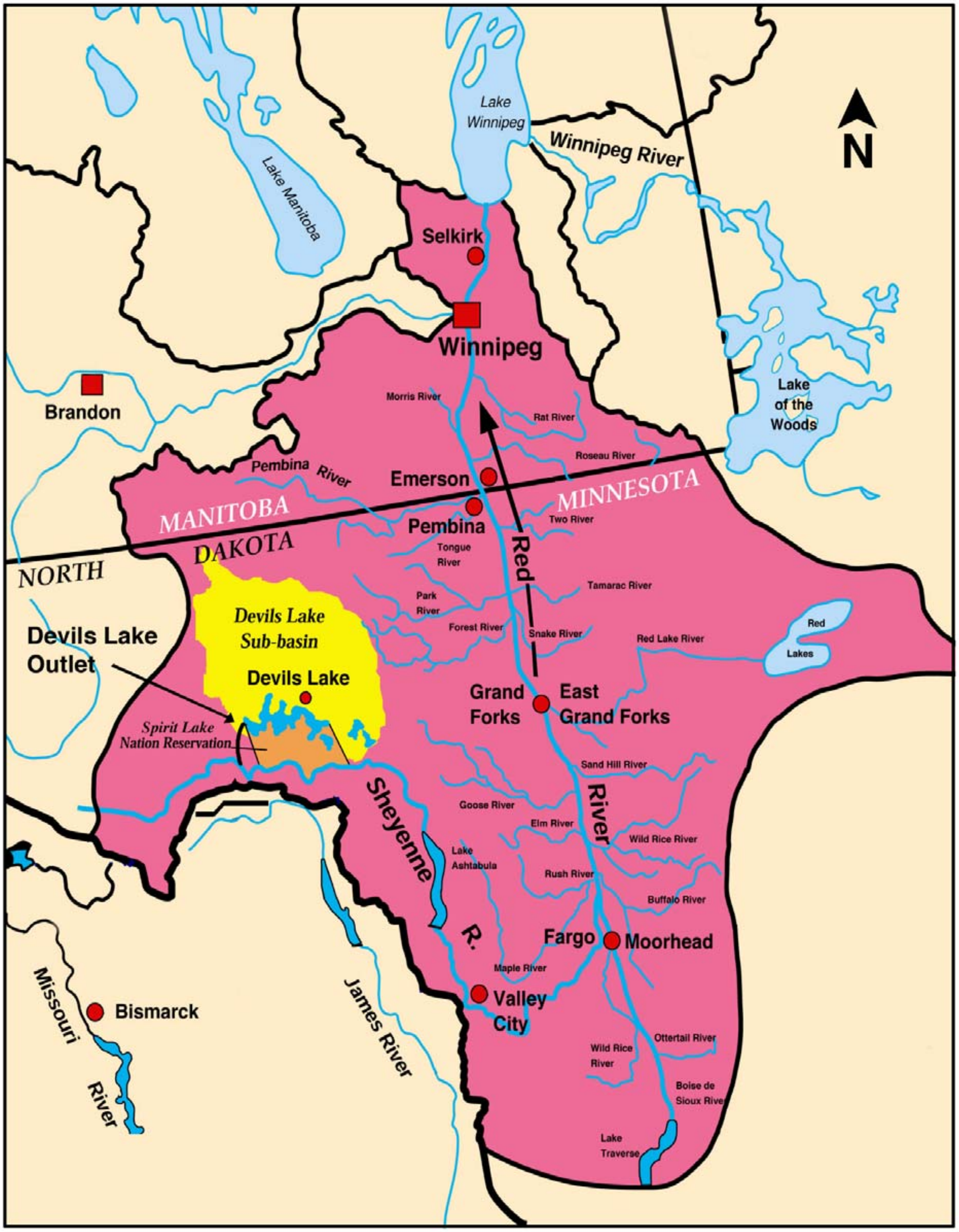

Figure 1. Devils Lake, North Dakota, and its sub-basin within the international Red River basin.

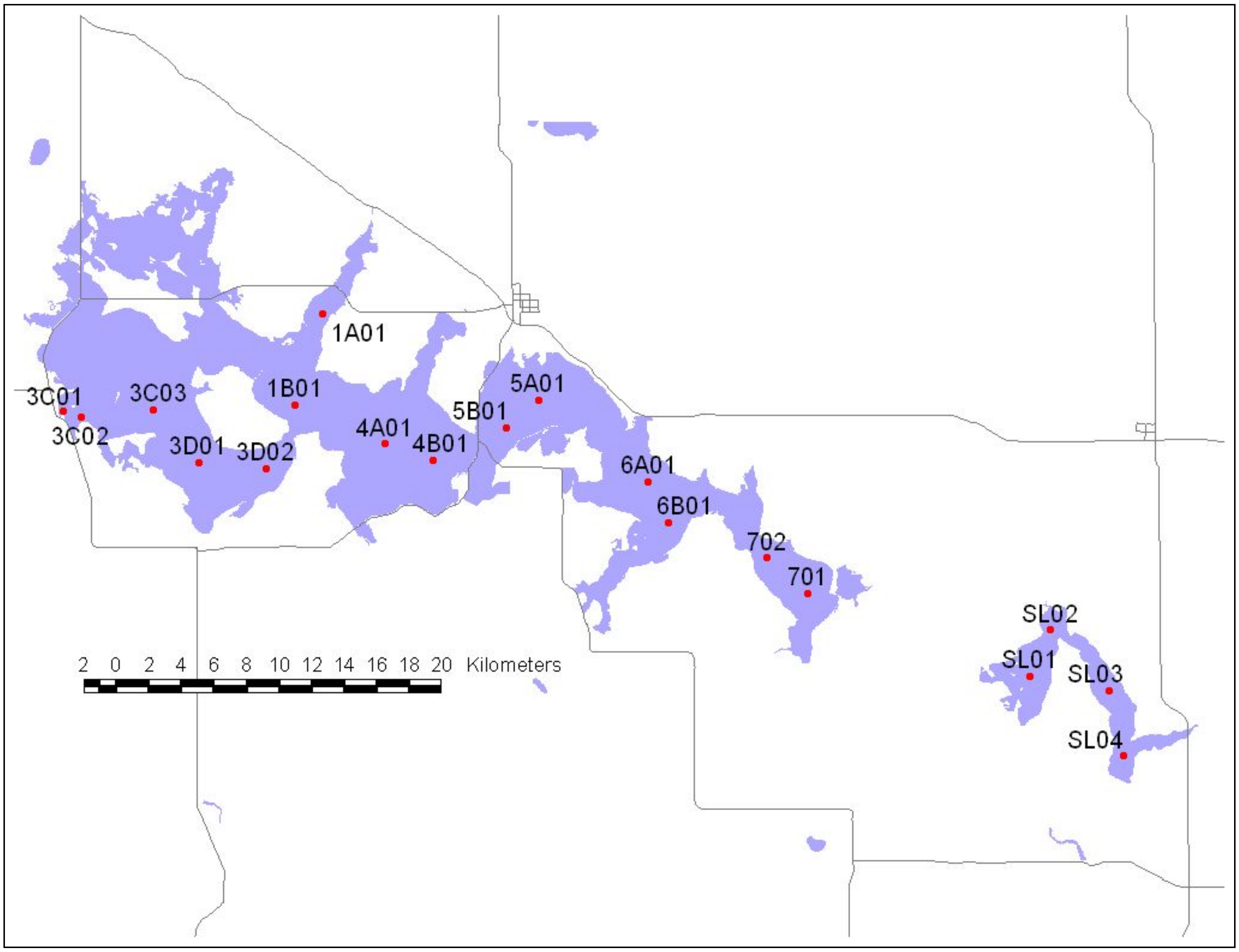

Figure 2. Sampling sites for phytoplankton, zooplankton, and benthic invertebrates on Devils and Stump lakes.

were taken from each sample and examined under a compound microscope at several magnifications (25X to 160X). The crustacean plankton present were qualitatively but not quantitatively assessed. Identifications followed Brooks (1957), Wilson (1959), and Yeatman (1959).

Benthic invertebrate samples were collected from the lake bottom with a 23 cm by 23 cm by 32 cm Ekman dredge. Dredge samples were washed through a Nitex nylon bag with a 500 μm mesh. Samples were immediately preserved with 70 % alcohol.

RESULTS AND DISCUSSION

Phytoplankton data are listed in Table 1. Within the phytoplankton community of Devils and Stump lakes, there were two features that differed from Lake Winnipeg and the downstream environment. First, there are a number of typically saline species present in samples collected from eastern portions of Devils Lake and Stump Lake that are not found in Lake Winnipeg. These included the nitrogen-fixing filamentous blue green *Nodularia spumigena* and the diatoms *Chaetoceros cf muelleri*, *Campylodiscus clypeis*, and *Surirella peisonis*. It is likely that these species could not survive in Lake Winnipeg because of its low salt content. The three diatoms were present historically in nearby Lake Manitoba and *Nodularia* is present in saline lakes in Saskatchewan. The species of *Chaetoceros* currently in the northern part of Lake Manitoba appears much smaller and more fragile than *Chaetoceros cf muelleri* from Devils Lake so it may be a different species (this can only be confirmed by viewing the resting stages and by examination of the specimens with scanning electron microscopy).

Second, the cyanobacterial community in Devils Lake is dominated by several species in the *Microcystis* complex whereas few *Microcystis* spp. are found in Lake Winnipeg. A number of these *Microcystis* species were identified from Devils Lake that have not been found in Lake Winnipeg. Species potentially unique to Devils Lake include *M. cf panniformis*, and *M. cf protocystis*, and what appears to be a species similar to *Pannus spumosa* in cell arrangement and colony format but with larger cells arranged in 1 to 3 layers. These specimens are also similar to species described from Belgium as *Pannus leloupii* but recently transferred to the genus *Sphaerocavum* (Azevedo and Sant'Anna 2003). Both genera are new and relatively poorly known so it is possible that they are new species. It would be necessary to compare these specimens to type material to confirm their identity. The first two are tropical or subtropical species that typically inhabit lakes and reservoirs at more southern latitudes. In addition, a fourth taxon was also identified as *Sphaerocavum* sp. and it similarly has not been previously observed in Lake Winnipeg. This genus *Sphaerocavum*, was initially described from Brazil but as mentioned above, has since had non-tropical species transferred to the genus. Morphotypes typical of the above taxa are uncommon in temperate lakes but were observed in Devils Lake plankton samples and have not been found in Lake Winnipeg in studies conducted between 1994 and 2004. Little is known about these species or their toxicity in Devils Lake or other temperate North American waters. Cyanobacteria are an important component of the algal community since many species can produce potent toxins. The *Microcystis* species, with the exception of *M. wesenbergii* and *M. botrys*, have been recorded as being capable of producing toxins. To-date, species of both *Pannus* and *Sphaerocavum* are not known to produce toxins but available information is limited.

It is not known whether these four blue-greens are eco-types that have adapted to the environment (temperature, nutrient status, and trophic condition) in Devils and Stump Lakes, whether they are morphotypes of other taxa, or are well-defined species. It is also not known whether they have had recent and regular opportunity to colonize Lake Winnipeg. However, it is known from analysis of phytoplankton samples since the mid-1990s, that these morphotypes are currently not present in the Lake Winnipeg phytoplankton community. In addition, insufficient information is available to determine whether they are species of concern if introduced to Lake Winnipeg for the first time. Since many of the algal species from Devils Lake and Lake Winnipeg are similar, it is reasonable to assume that some of morphotypes in Devils Lake will eventually be able to adapt to the Lake Winnipeg environment.

Morphotypes among the main nitrogen fixing cyanobacteria *Aphanizomenon* and *Anabaena* from Devils Lake appear to be similar to those found in Lake Winnipeg. The exception is the presence of *Nodularia spumigena*, a species typical of more saline lakes. It is not currently found in Lake Winnipeg, nor in Lake Manitoba but has been found in saline lakes further west in Saskatchewan. Its survival in Lake Winnipeg is unlikely but also unknown.

The crustacean zooplankton community data are listed in Table 2. The network of sampling stations on Devils Lake and Stump Lake was judged to be adequate to characterize the mid-summer zooplankton community composition. A more complete assessment of the plankton community would be gained from sampling during the spring and fall periods as well.

Each of the zooplankton species identified in the Devils Lake and Stump Lake samples are known to occur in the Nelson River drainage basin and other parts of Canada (Patalas *et al.*, 1994). However, *Diaptomus nevadensis*, found in samples collected from Stump Lake, has not been previously recorded from Lake Winnipeg. This species has been identified in 15 lakes in western Canada, mainly in Saskatchewan and Alberta, as well as in Montana and Nevada. At least in western Canada, *D. nevadensis* is found in highly saline bodies of water that are also endorheic (closed basins) (Hammer 1998), so it is uncertain whether this species had opportunity to colonize Lake Winnipeg in recent times. However, during the early part of the post-glacial period, it would have had opportunity to reach Lake Winnipeg but likely did not become established because of its preference for more saline conditions.

Benthic invertebrates are listed in Table 3. No taxa were found that have not been previously identified from Manitoba.

OVERVIEW OF TARGETTED SURVEYS FOR KNOWN SPECIES OF CONCERN, FISH PATHOGENS, AND FISH PARASITES

Sampling efforts on Devils Lake were focussed on locating specimens of the following 12 known species of concern (Arroyo 2005, Montz 2005, and Perleberg 2005):

Macrophytes

- flowering rush (*Butomus umbellatus*)
- Eurasian water milfoil (*Myriophyllum spicatum*)
- curly leaf pondweed (*Potamogeton crispus*)
- brittle naiad (*Najas minor*)

Invertebrates

- rusty crayfish (*Orconectes rusticus*)
- zebra mussels (*Dreissena polymorpha*)
- quagga mussel (*Dreissena bugensis*)
- Chinese mystery snail (*Cipangopaludina spp*.)
- spiny water flea (*Bythotrephes cederstroemi*)
- an exotic daphniid (*Daphnia lumholtzi*)
- New Zealand mud snail (*Potamopyrgus antipodarum*)
- an exotic amphipod (*Echinogammarus ischnus*)

None of these 12 known species of concern were located during the limited survey conducted in Devils Lake from July 25 to 30, 2005.

While striped bass (*Morone saxatilis*) was also identified as an additional known species of concern in Devils Lake, no specific sampling was targetted during this limited survey for this species. Arroyo (2005) indicated that past work conducted in Devils Lake by the North Dakota Department of Game and Fish did not yield surviving adults since 1993 and therefore, it is unlikely that striped bass still exist in Devils Lake.

About 300 fish were collected from Devils Lake and tested for specific fish pathogens tested (Hudson and Peters 2005) using protocols from the U. S. Fish and Wildlife Service's National Wild Fish Health Survey. Fish species collected included northern pike, walleye, yellow perch, common sucker, black crappie, white bass, and fathead minnow. The antigen of the bacterium *Renibacterium salmoninarum*, responsible for bacterial kidney disease, was detected at low levels in almost all fish (97.4 %) using enzyme-linked immunosorbent assay (ELISA) screening procedures. However, active infection could not be confirmed using a specific DNA-based polymerase chain reaction (PCA) assay, although only 21 individuals out of the 313 fish collected were subjected to this latter specific assay. Infestations of bacterial kidney disease have occurred in the past in Manitoba fish hatcheries where it has affected trout species.

No other fish pathogens listed by the U.S. Fish and Wildlife Service's *National Wild Fish Health Survey* were detected. These are fish pathogens known to cause disease in cultured or wild fish and that are included in most fish health inspection programs. Hudson and Peters (2005) reported that no external or internal signs of bacterial kidney disease, other fish diseases, or abnormalities were observed.

Manitoba had previously identified the fish parasite *Gyrodactylus hoffmani* as being a species of concern since it had been found in Devils Lake on fathead minnows (*Pimephales promelas)* (Reinesch 1981) but had not been reported elsewhere from the Hudson Bay basin including Lake Winnipeg. *Gyrodactylus* is comprised of a number of species of flatworms that attach themselves to the gills of fish, destroy gill tissue, and sometimes becoming lethal particularly in fish rearing ponds. During the present survey on Devils Lake by the U.S. Fish and Wildlife Service, *Gyrodactylus hoffmani* was not found (Hudson and Peters 2005). It is not known whether *Gyrodactylus hoffmani* is no longer present in Devils Lake or was not detected during the present survey because it is not widespread and the sample size was too small to allow its presence to be detected.

The external parasite *Epistylis* sp., also previously known to exist in Devils Lake (Peterson Environmental Consulting Ltd. 2002) but not elsewhere in the Hudson Bay basin including Lake Winnipeg, was detected in skin scrapings from a single yellow perch in the present survey. *Epistylis* sp. has been reported from the southwestern United States where it has caused "red sore disease" and sometimes mortality in members of the Centrarchidae or bass family. It has been reported in water bodies with high organic loads, thermal pollution, and in combination with the bacterial pathogen *Aeromonas hydrophila*.

Trichodina sp. was detected in skin scrapings from walleye, white bass, and yellow perch from Devils Lake during the present survey and had not been reported previously (Peterson Environment Consulting Ltd. 2002). This external parasite has been reported to be widespread in both fresh and marine waters but has not been reported from Manitoba including Lake Winnipeg. Most if not all trichodines are potentially pathogenic to fish and sometimes cause mortality. About 190 species have been described worldwide. This parasite is found on the surface of the body, gills, opercular cavity, and nasal pits. They occur in low numbers on healthy fish but can rapidly proliferate on fish that become stressed for example, during over-wintering. Chronic impairment of health is probably more important than outbreaks of mortality but reduced growth in infected fish has been reported.

As with other components of this limited survey of Devils Lake, Hudson and Peters (2005) cautioned that while an adequate sample size was obtained for some species at some sample sites, too few samples were obtained for other species to establish the presence or absence of fish pathogens with good confidence. As well, fish diseases may be more apparent at times of the year other than late July when individuals are under stress, such as immediately after spawning.

CONCLUSIONS

It is concluded that:

(1) Not unexpectedly, this brief survey of biota in Devils and Stump lakes identified some differences in the biological communities compared to Lake Winnipeg and its contributing basin.

(2) None of the targetted 12 known species of concern were found in this survey of Devils Lake. While efforts were not undertaken in this survey to specifically target striped bass, it is unlikely that this stocked species still survives in Devils Lake since the last one was captured in 1993. No unique taxa were found in the benthic invertebrate community from Devils and Stump lakes that have not been found in Manitoba.

(3) It is almost certain that the phytoplankton species *Nodularia spumigena*, *Chaetoceros muelleri*, *Campylodiscus clypeis*, and *Surirella peisonis* and the crustacean calanoid copepod *Diaptomus nevadensis* are present in Devils and Stump lakes and not in Lake Winnipeg because of their preference for highly saline habitats, and that they likely would not survive if introduced to Lake Winnipeg. Consequently, they are likely not species of concern.

(4) The cyanobacterial community in Devils and Stump lakes is dominated by several species in the *Microcystis* complex whereas few species of *Microcystis* are found in Lake Winnipeg. Species potentially unique to Devils Lake include the tropical or subtropical *M. cf panniformis*, and *M. cf protocystis*, and what appears to be a *Pannus* sp.. In addition, a fourth tropical or subtropical blue-green was also identified as probably *Sphaerocavum* sp. and has not been previously observed in Lake Winnipeg. It is not known whether these four blue-greens are ecomorphs that have adapted to the environment (temperature, nutrient status, and trophic condition) in Devils and Stump

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(5) With the exception of *Renibacterium salmoninarum,* no fish pathogens listed in the U.S. Fish and Wildlife Service's *National Wild Fish Health Survey* were detected. These are fish pathogens known to cause disease in cultured or wild fish and that are included in most fish health inspection programs. Antigens for *Renibacterium salmoninarum,* the agent responsible for bacterial kidney disease, were detected in 97.4 % of the 313 fish specimens by the ELISA screening test. However, 21 fish were tested with a more specific assay and the presence of *Renibacterium salmoninarum* could not be confirmed. Infestations of bacterial kidney disease have occurred in the past in Manitoba fish hatcheries where it has affected trout species

(6) Three fish parasites remain potential species of concern for Manitoba:

(a) Although *Gyrodactylus hoffmani* was not detected in the present survey, it was detected in an earlier survey of Devils Lake. It is not known whether *Gyrodactylus hoffmani* is no longer present in Devils Lake or was not detected during the present survey because it is not widespread and the sample size was too small to allow its presence to be detected. If it still exists in Devils Lake, it would remain a species of potential concern to Manitoba. This parasite normally affects fathead minnows, a small baitfish.

(b) The external parasite *Epistylis* sp., also previously known to exist in Devils Lake but not elsewhere in the Hudson Bay basin including Lake Winnipeg, was detected in the present survey. This parasite is a species of potential concern since it has not been reported from Manitoba and because it has been reported to cause disease and sometimes mortality in members of the Centrarchidae or bass family.

(c) *Trichodina* sp. was detected on walleye, white bass, and yellow perch from Devils Lake during the present survey. This external fish parasite had not previously been found in Devils Lake but has been reported to be widespread in both fresh and marine waters. However, it has not been reported from Manitoba including Lake Winnipeg, so it is a potential species of concern to Manitoba. Most if not all trichodines are potentially pathogenic to fish and sometimes cause mortality.

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Table 1: Phytoplankton in samples collected from Devils and Stump lakes (A = abundant, P = present, and R = rare).

Taxa	1B01 a	1A01 a	3COC a	3C02 a	3D01 a	3D02 a	4A01 b	4A01 c	4b0 1	5A01 a	5B01 a	6A01 a	6B01 a	701 a	702 a	SL01 a	SL03 a	SL02 a	SLO4 a
Anabaena flos aquae	A	P	P	A	P	A		P		A	A	A	A	A	P				
Anbaena cf mendotae	P	P												A					
Anabaena spiroides	A		P	A	P	A			A	A	A	A	A	A					
Anabaena cf compacta														R					
Aphanocapsa conferta	P							P							P				
Aphanocapsa sp														P					
Aphanocapsa delicatissima					P	P			P	P									
Aphanocapsa endophytica					P					P	P		P	P					
Aphanizomenon flos aquae and morphs	A		A	A	A	A		P	A			P	A	A	A	P			
Aphanothece floccosa	P	P	P											P			A		
Aphanocapsa holsatica	P	P	A		P	P	P	P	P	P		P		P	P	P			
Aphanizomenon klebhanii (flos aquae complex)	A	P	A	P	A	A	P	P	A				A	P	P	P	A		
Aphanocapsa nebulosa				P											P				
Aphanocapsa nubilum																		P	
Aphanothece minutissima	P	P			P	A								P					
Aphanothece bachmanii					P		P						P	P					
Aphanothece clathrata						P								P					
Aphanothece smithi											P			P	P				
Aulacoseira granulata						P	P	P	P										
Botryococcus braunii	P	P	P								P			P	P				
Botryococcus cf terribilis									P						P				
Campylodiscus clypeis																		P	
Ceratium furcoides	P		A	P	A	P	A		A	A	P	A	P	P	P	A			
Ceratium hiruninella	P		R				R			P		R				R			
Chaetoceros cf muellerii (additional analysis needed)														P	P	P		P	
Characium sp	A	P			P				P	P		P	P	P	P				
Chroomonas cf acuta	P													P					

Table 1: Continued.

Taxa	1B01 a	1A01 a	3COC a	3C02 a	3D01 a	3D02 a	4A01 b	4A01 c	4b0 1	5A01 a	5B01 a	6A01 a	6B01 a	701 a	702 a	SL01 a	SL03 a	SL02 a	SLO4 a
Chroococcus limneticus						P	P			P	P					P			
Chroococcus minutus														P					
Chroococcus cf prescottii (may be *Eucapsis carpatica)*			P		P										P				
Closterium aciculare					P														
Coelastrum sp (cf microporum)				P											P				
Coelomoron sp					P														
Cryptomonas reflexa						P					P								
Cyanodictyon reticulatum	P		P		P					P					P				
Dimorphococcus lunatus												R							
Eremosphaeria cf eremosphaeria						P	P	P	P	P	P	P		P	P				
Eudorina elegans					P		P	P		P		P					P		
Gomphosphaerica cf virieuxii	P	P	P		P			P		P	P	P	P	P		P			
Lyngbya birgei	A		A	P	A	A	A	A	P		P	A	P	A	P	A			
Merismopedia warminginiana		P																	
Microcystis aeruginosa	A	P	A	A	A	A	A	A	A	A	P	A	P	A	P	A	A	A	A
Microcystis botrys		P													P				
Microcystis flos aquae	A	P	A	P	P	A	P	P	P	A	P	P	P	A	P	A	P	A	P
Microcystis ichthyoblabe		P			P			P					P	P	P	P	P	A	A
Microcystis novacekii	P	A	A		P	P	P	P		P	P	P	P	P		P	P	A	
Microcystis cf panniformis (additional analysis required*)*	P		P					P	P		P			P		P			
Microcystis cf protocystis (additional analysis required*)*						P			P	P		P	P	P	A			P	P
Microcystis smithii	P		P				P						P					P	
Microcystis sp (reddish colour - additional analysis required)		P		P	P						P	P		P			P		P
Microcystis viridis	P		P											P					
Microcystis wesenbergii	P	P	A	A	P	A	A	P	A	P	P	A	P	P		P			
Nitzschia spp		P				P													

Table 1: Continued.

Taxa	**1B01 a**	**1A01 a**	**3COC a**	**3C02 a**	**3D01 a**	**3D02 a**	**4A01 b**	**4A01 c**	**4b0 1**	**5A01 a**	**5B01 a**	**6A01 a**	**6B01 a**	**701 a**	**702 a**	**SL01 a**	**SL03 a**	**SL02 a**	**SLO4 a**
Nitzschia fonticola (epiphytic on microcystis)											P		P		P	P	P	P	
Nodularia spumigena															P				
Cf Pannus sp.. similar to spumosa and microcystiodes (additional analysis required)	P		P								P	P							
Pediastrum duplex	P		P		P	P	P	P	P	P	P	P	P	P	P	P			
Pediastrum boryanum											P	P	P			P			
Pseudanabaean limnetica																			
Pseudanabaena mucicola (endogleic in sheats of microcystis)		P					A				P			P		P	P	A	
Radiocystis sp (cf fernandoi)		P																	
Rhodomonas minuta						P													
Sphaerocystis schroeteri				P				P			P								
Sphaerocavum sp (some reddish colonies appear similar to S. leloupii but additional analyses are necessary)		P		P				P			P	P	P	P					
Staurastrum cf chaetoceros	P	P	P				A		A							P			
Staurastrum pingue/ cingulum							P	P			P	P				P			
Synedra cyclopum		P																	
Stephanodiscus niagarae	A	P	P	P		A	A	A	P	A	A	A	P	A	P	P			
Surirella peisonis	P		P									P		P					
Wornichinia karalia										P	P	P			A	A			
Wornichinia naeglianum	A	P		P	P		A		P			P	P			P			

Table 2: Zooplankton in samples collected from Devils and Stump lakes.

Taxa	**1A0 1-A**	**1B0 1-A**	**3C0 1-A**	**3C0 2-C**	**3C0 3-B**	**3D0 1-A**	**3D0 2-C**	**4A0 1-C**	**4B0 1-A**	**5A0 1-A**	**5B0 1-A**	**6A0 1-C**	**6B0 1-B**	**6B0 1-C**	**701 -A**	**702 -B**	**702 -A**	**SL0 1-A**	**SL0 2-B**	**SL0 3-C**	**SL0 4-C**
Diacyclops bicuspidatus thomasi Forbes	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√				
Acanthocyclops vernalis Fischer	√		√	√				√	√	√	√			√	√	√	√	√			
Mesocyclops edax (Forbes)	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√				
Eucyclops agilis (Koch)?								√													
Cyclops sps? Small			√																		
Cyclopoida nauplii	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√				
Diaptomus sicilis Forbes	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Diaptomus siciloides Lilljeborg	√	√	√	√																√	
Diaptomus nevadensis Light																		√	√	√	
Diaptomus clavipes Schacht	√			√	√					√				√		√					
Calanoida nauplii	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√		√		√
Daphnia pulex Leydig	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Diaphanosoma leuchtenbergianum	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√				
Ceriodaphnia quadrangula (O.F. Muller)															√		√				
Bosmina longirostris (O.F.Muller)			√																		
Gammarus lacustris Sars	√									√		√	√	√	√	√		√		√	√

Table 3: Benthic invertebrates in samples collected from Devils and Stump lakes.

	Chironomini	Orthocladiinae	*Gammarus lacustris*	Tubificidae (mainly *Quistandrilus* sp.)	Lumbriculidae (*Lumbriculus* sp. and *Stylodrilus* sp.)	Sphaeriidae (*Pisidium* sp.)	Glossiphonidae (*Erpodella* sp.)	Lymnaiedae (*Lymnaea* sp.)	Physidae	Hydrachnidia (*Hydracarina* sp.)	Nematomorpha (*Gordius* sp.)
1A01-A	82	4	4		4						
1A01-B	140	14		2	17	2					
1A01-C	96	8	4	8	20						
1B01-A	44	12	8			8		32			
1B01-B	80	116	36	24	8						
1B01-C	8	16	13	1		1					
3C01-A											
3C01-B											
3C01-C			2								
3C02-A	3	2	5								
3C02-B	52	4	24								
3C02-C	3		5			6					
3C03-A	96	8	8								
3C03-B	44										
3C03-C	40			4		4					
3D01-A	192	40	16				8				
3D01-B	236	4	4								
3D01-C	272		8								
3D02-A	472	104				4	16				
3D02-B	238	4				4	4				
3D02-C	61	1	1			1					
4A01-A-MB	14	38	32	2	5	2					
4A01-B-MB	22	33	22	1	2	2					
4A01-C-MB	1	17	10		1						
5A01-A-MB	69	37	19		18		1				5
5A01-B-MB	61	33	46		6						
5A01-C-MB	39	46	104								
5B01-A-MB	13	38	1		13			1			2
5B01-B-MB	36	60	92					64			4

Table 3: Continued.

	Chironomini	Orthocladiinae	*Gammarus lacustris*	Tubificidae (mainly *Quistandrilus* sp.)	Lumbriculidae (*Lumbriculus* sp. and *Stylodrilus* sp.)	Sphaeriidae (*Pisidium* sp.)	Glossiphonidae (*Erpodella* sp.)	Lymnaiedae (*Lymnaea* sp.)	Physidae	Hydrachnidia (*Hydracarina* sp.)	Nematomorpha (*Gordius* sp.)
5B01-C-MB	24	108	112		12			4			4
6A01-A-MB	103	92	71								12
6A01-B-MB	46	26	34								5
6A01-C-MB	90	58	66								7
6A01-C-MB	15	29	119		1						
6B01-A-MB	26	107	126		1						
6B01-B-MB	24	70	88		4			2			
701-A-MB	46	32									
701-B-MB	28	18									
701-C-MB	23	38	1								
702-A-MB	21	15	2								
702-B-MB	103	18	1								
702-C-MB	42	16	1								
AB01-A-MB	37	59	77	8	2	1				1	
AB01-B-MB	47	35	23	4	4	1					
AB01-C-MB	37	19	40	25		4					
SL02-A	82	10	10		16						
SL02-B	97	8	10		2						
SL02-C	73	8	6						3		
SL03-A	143	2									6
SL03-B	134	1									1
SL03-C	204										1
SL04-A	78	1	1								
SL04-B	161										
SL04-C	146										
SLO1-A	42	4			3						
SLO1-B	142	14	7		13				1		
SLO1-C	10	1			5						