Coordinated Aquatic Monitoring Program

CAMP Twelve Year Data Report (2008-2019)

Technical Document 2:

Winnipeg River Region

Prepared by

Manitoba Hydro

And

North/South Consultants Inc.

2024

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CAMP TWELVE YEAR DATA REPORT (2008-2019)

TECHNICAL DOCUMENT 2: WINNIPEG RIVER REGION

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EXECUTIVE SUMMARY

This report presents the results of monitoring conducted under the Coordinated Aquatic Monitoring Program (CAMP) for years 1 through 12 (i.e., 2008/2009 through 2019/2020) in the Winnipeg River Region. The Winnipeg River Region is composed of the Winnipeg River from the Manitoba-Ontario border downstream to the mouth of the river at Traverse Bay on Lake Winnipeg. Waterbodies and sites monitored in this region over this period included three on-system and two off-system waterbodies or river reaches as follows:

- the Pointe du Bois Forebay;
- Lac du Bonnet;
- the Pine Falls Forebay;
- Manigotagan Lake (off-system); and
- Eaglenest Lake (off-system).

Monitoring on-system waterbodies addresses the primary objective of CAMP – to monitor aquatic ecosystem health along Manitoba Hydro's hydraulic operating system. The off-system waterbodies were included in CAMP to provide regional information collected in a manner consistent with monitoring of on-system waterbodies that will assist in interpreting any observed environmental changes over time. Such comparisons are intended to help distinguish between hydroelectric-related effects and other external factors (e.g., climate change) in each CAMP region.

Monitoring was conducted annually at some waterbodies and river reaches and on a three-year rotation at other sites. Components monitored under CAMP in the Winnipeg River Region presented in this report include the physical environment (water regime and sedimentation), water quality, benthic invertebrates, fish community, and mercury in fish. Climatological data for the region are also included to provide supporting information to assist with interpretation of CAMP monitoring results.

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ABBREVIATIONS, ACRONYMS, AND UNITS

ANN	Annual
CAMP	Coordinated Aquatic Monitoring Program
CCME	Canadian Council of Ministers of the Environment
CL(s)	Confidence limit(s)
cms	Cubic metres per second
CONT	Continuous
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPUE	Catch-per-unit-effort
DELTs	Deformities, Erosion, Lesions, and Tumours
DL(s)	Detection limit(s)
DO	Dissolved oxygen
ECCC	Environment and Climate Change Canada
EPT	Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)
FA	Fall
FLA	Fork length-at-age
FNU	Formazin nephelometric unit
GN	Standard gang index gill net
GS(s)	Generating station(s)
h	hour
IC	Ice-cover season
IQR	Interquartile range
KF	Fulton's Condition Factor
LWCB	Lake of the Woods Control Board
m	Metre
m^2	Metre squared
Max	Maximum
µg/L	Micrograms per litre
mg/L	Milligrams per litre
Min	Minimum
mm	Millimetre
MWQSOGs	Manitoba Water Quality Standards, Objectives, and Guidelines
MWS	Manitoba Water Stewardship
n	Sample size or number of samples
n_F	Number of fish
n_S	Number of sites

ND	No data
no.	Number
NS	Nearshore
n_{spp}	Number of species caught in standard and small mesh gill nets
NTU	Nephelometric turbidity units
O+C	Oligochaeta and Chironomidae
OECD	Organization for Economic Cooperation and Development
OS	Offshore
OW	Open-water season
PAL	Protection of aquatic life
ppm	Parts per million
ROT	Rotational
RSA	Relative species abundance
RYCS	Relative year-class strength
SD	Standard deviation
SE	Standard error
SN	Small mesh index gillnet gang
SP	Spring
SU	Summer
T/day	Tonnes per day
TN	Total nitrogen
TOC	Total organic carbon
TP	Total phosphorus
TSS	Total suspended solids
unid.	unidentified
WI	Winter
Wr	Relative weight
°C	Degrees Celsius

WATERBODY ABBREVIATIONS

Abbreviation	Waterbody
EAGLE	Eaglenest Lake
LDB	Lac du Bonnet
MANIG	Manigotagan Lake
PDB	Pointe du Bois Forebay
PFF	Pine Falls Forebay

FISH SPECIES LIST

Abbreviation	Common Species Name	Species Name
BLBL	Black Bullhead	*Ameiurus melas*
BLCR	Black Crappie	*Pomoxis nigromaculatus*
BRBL	Brown Bullhead	*Ameiurus nebulosus*
BURB	Burbot	*Lota lota*
CHCT	Channel Catfish	*Ictalurus punctatus*
CISC	Cisco	*Coregonus artedi*
EMSH	Emerald Shiner	*Notropis atherinoides*
GOLD	Goldeye	*Hiodon alosoides*
LGPR	Logperch	*Percina caprodes*
LKST	Lake Sturgeon	*Acipenser fulvescens*
LKWH	Lake Whitefish	*Coregonus clupeaformis*
LNSC	Longnose Sucker	*Catostomus catostomus*
MOON	Mooneye	*Hiodon tergisus*
MTSC	Mottled Sculpin	*Cottus bairdii*
NRPK	Northern Pike	*Esox lucius*
RCBS	Rock Bass	*Ambloplites rupestris*
RNSM	Rainbow Smelt	*Osmerus mordax*
SAUG	Sauger	*Sander canadensis*
SHRD	Shorthead Redhorse	*Moxostoma macrolepidotum*
SLLM	Silver Lamprey	*Ichthyomyzon unicuspis*
SLRD	Silver Redhorse	*Moxostoma anisurum*
SLSC	Slimy Sculpin	*Cottus cognatus*
SMBS	Smallmouth Bass	*Micropterus dolomieu*
SPSH	Spottail Shiner	*Notropis hudsonius*
TRPR	Trout-perch	*Percopsis omiscomaycus*
WALL	Walleye	*Sander vitreus*
WHSC	White Sucker	*Catostomus commersonii*
YLPR	Yellow Perch	*Perca flavescens*

1.0 INTRODUCTION

This report presents the results of monitoring conducted under the Coordinated Aquatic Monitoring Program (CAMP) for years 1 through 12 (i.e., 2008/2009 through 2019/2020) in the Winnipeg River Region. The Winnipeg River Region is composed of the Winnipeg River from the Manitoba-Ontario border downstream to the mouth of the river at Traverse Bay on Lake Winnipeg. Waterbodies and sites monitored in this region over this period included three on-system and two off-system waterbodies or river reaches as follows:

- the Pointe du Bois Forebay;
- Lac du Bonnet;
- the Pine Falls Forebay;
- Manigotagan Lake (off-system); and
- Eaglenest Lake (off-system).

Monitoring on-system waterbodies addresses the primary objective of CAMP – to monitor aquatic ecosystem health along Manitoba Hydro's hydraulic operating system. The off-system waterbodies were included in CAMP to provide regional information collected in a manner consistent with monitoring of on-system waterbodies that will assist in interpreting any observed environmental changes over time. Such comparisons are intended to help distinguish between hydroelectric-related effects and other external factors (e.g., climate change) in each CAMP region.

A summary of monitoring conducted by waterbody or river reach presented in this data report is provided in Table 1-1 and monitoring areas are shown in Figure 1-1. As noted in Table 1-1, monitoring was conducted annually at some waterbodies and river reaches and on a three-year rotation at other sites. Components monitored under CAMP in the Winnipeg River Region presented in this report include the physical environment (water regime and sedimentation), water quality, benthic invertebrates, fish community, and mercury in fish. Climatological data for the region are also included to provide supporting information to assist with interpretation of CAMP monitoring results.

Table 1-1. Winnipeg River Region CAMP monitoring summary.

Waterbody/ Area	Abbreviation	On/Off-System		Component					
		On-System	Off-System	Water Regime	Sedimentation	Water Quality	Benthic Invertebrates	Fish Community	Fish Mercury
Pointe du Bois Forebay	PDB	●		CONT		ANN	ANN	ANN	ROT
Slave Falls GS	SFGS	●		CONT					
Lac du Bonnet	LDB	●		CONT		ANN	ANN	ANN	
Pine Falls Forebay	PFF	●		CONT		ROT	ROT	ROT	ROT
Manigotagan Lake	MANIG		●	CONT		ANN	ANN	ANN	
Eaglenest Lake	EAGLE		●			ROT	ROT	ROT	

Notes:

1. CONT = site monitored continuously; ANN = site sampled each year; ROT = site sampled every 3 years.

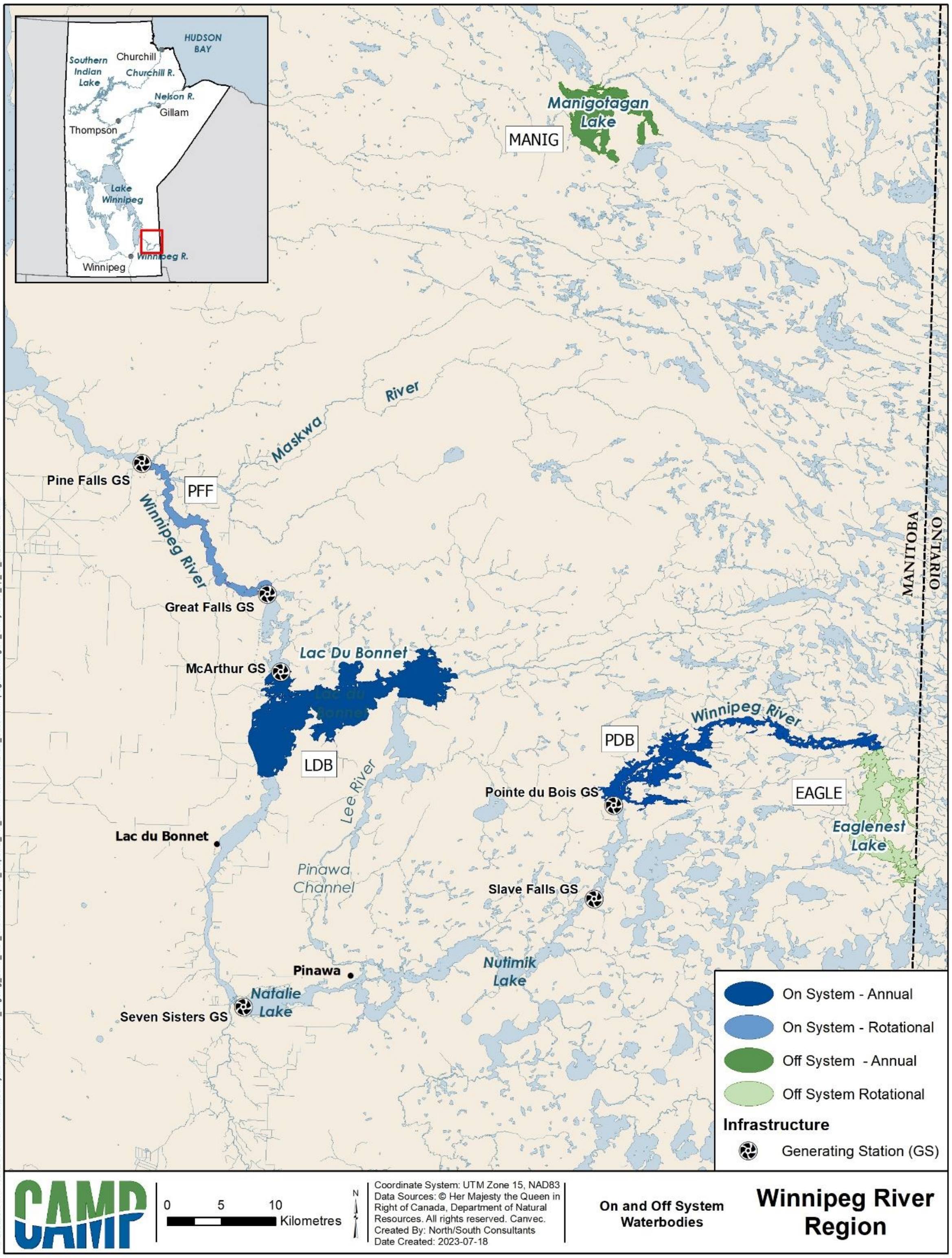


Figure 1-1. On-system and off-system waterbodies and river reaches sampled under CAMP in the Winnipeg River Region: 2008-2019.


Photograph 1. The Pointe du Bois Forebay.


Photograph 2. Lac du Bonnet.

Photograph 3. The Pine Falls Forebay.

Photograph 4. Manigotagan Lake.

Photograph 5. Eaglenest Lake.

2.0 PHYSICAL ENVIRONMENT

2.1 INTRODUCTION

The following presents the results of the physical environment monitoring conducted from 2008 to 2019 in the Winnipeg River Region. Five waterbodies were monitored in the Winnipeg River Region: Three on-system sites (Pointe du Bois Generating Station (GS) forebay, Lac du Bonnet (McArthur Falls GS forebay), and the Pine Falls GS forebay) and two off system sites (Manigotagan Lake; Eaglenest Lake). Although Slave Falls GS is not part of CAMP monitoring, Winnipeg River flow is reported from Slave Falls GS because it has the longest and most reliable flow record and flows do not change significantly along the Winnipeg River within Manitoba. A continuous water quality monitoring station was installed at the Pointe du Bois GS in 2020, after the monitoring period for this report and this data will be presented in the next reporting cycle. Though CAMP does not directly monitor climate, data from Environment and Climate Change Canada (ECCC) is included in reporting to contextualize the data collected under each CAMP component. For the Winnipeg River Region, meteorological conditions from ECCC's Pinawa station are reported.

Three indicators (climate; water regime; and sedimentation) were selected for detailed reporting (Table 2.1-1). Metrics for these indicators include temperature, precipitation, water flow, level and variability, water temperature, continuous turbidity, and suspended sediment load (Table 2.1-1). A detailed description of these indicators is provided in CAMP (2024).

A detailed description of the program design and sampling methods is provided in Technical Document 1, Sections 2.1 and 2.2.

Table 2.1-1. Physical Environment indicators and metrics.

Indicator	Metric	Units
Climate[1]	• Temperature	Degrees Celsius (°C)
	• Precipitation	Millimetres (mm)
Water Regime	• Flow	Cubic meters per second (cms)
	• Water Level and Variability	Metres (m)
	• Water Temperature	Duration of temperature in 5-degree Celsius increments (#days/5 °C)
Sedimentation	• Continuous Turbidity	Formazin nephelometric unit (FNU)
	• Suspended Sediment Load	Tonnes/day (T/day)

Notes:
1. Climate is not monitored through CAMP; data are included for reporting purposes only.

2.2 CLIMATE

In this section, mean monthly air temperatures and total monthly precipitation for each year in the monitoring program (2008-2020) are compared to ECCC climate normals to provide a summary of the Pinawa station meteorological conditions. Climate normals are used to summarize the average climatic conditions of a particular location. As recommended by the World Meteorological Organization, ECCC calculates climate normals using a 30-year period (e.g., 1981-2010). The Pinawa station is used herein to illustrate climate conditions in the Winnipeg River Region.

Historical monthly average air temperature and total monthly precipitation during the monitoring period were calculated based on daily data from ECCC at multiple stations. It is important to note that the use of multiple stations could introduce inhomogeneities in observations between various stations and the station used for climate normals (Climate ID: 5032162). For instances where datasets were missing more than 10% of the daily data in a month, monthly values were gap-filled using ERA5-Land data (Muñoz Sabater 2019). Seasonal and annual maps derived from ERA5-Land data are also provided in Appendices 2-1 and 2-2 to complement the station data and offer a broader spatial representation of temperature and precipitation conditions across Manitoba. Although the ERA5-Land data correlated well with the actual observed ECCC data for the Pinawa station, it should be noted that ERA5-Land is a gridded reanalysis product, meaning the dataset combines modelled data with observations, and therefore may not provide an entirely accurate representation of observed climate.

2.2.1 TEMPERATURE

Figure 2.2-1 illustrates the mean monthly air temperatures (in ºC) for each year during the monitoring period compared to the 1981-2010 normal mean temperature. As shown, air temperatures at this location follow a distinct seasonal pattern; warmer in the summer (warmest in July) and cooler in the winter (coldest in January). In general, recorded air temperatures for the monitoring period were consistent with the climate normal pattern. Some deviations can be seen, for example, 2014 recorded considerably cooler temperatures from January to April.

Table 2.2-1 summarizes the mean monthly air temperature data and categorizes each month in the monitoring period as "below normal", "near normal" or "above normal" conditions. It should be noted that the "near normal" category was subjectively defined as +/- 1ºC of the ECCC climate normal. Months "below normal" are highlighted in blue, "near normal" are highlighted in grey, and "above normal" are highlighted in orange. Over the monitoring period, October and November generally experienced warmer than normal conditions (≥ 7 out of 13 months above normal), while April generally experienced below normal conditions (≥ 7 out of 13 months below normal). On an annual basis, no distinct patterns in the data were identified as there was nearly equal number of years below, near, and above normal conditions; 2012 had the warmest annual average temperature at 4.0ºC, while 2014 had the coolest annual average temperature at 0.9ºC. The maximum and minimum monthly average air temperatures during the monitoring period were 21.3ºC (July 2012) and -20.6ºC (January 2014), respectively.

Table 2.2-1. Pinawa mean monthly and annual air temperature (in ˚C) compared to 1981-2010 normal.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2008	-16.2	-17.8	-9.0	2.1	8.0	15.1	17.8	18.4	12.5	6.6	-3.4	-20.0	1.2
2009	-19.4	-14.2	-7.6	2.8	7.2	14.4	15.7	16.7	17.2	3.9	1.4	-14.5	2.0
2010	-13.7	-13.2	0.2	7.5	11.1	15.4	19.5	18.5	10.9	7.7	-2.8	-14.0	3.9
2011	-19.5	-14.4	-8.8	3.7	10.4	16.2	20.3	19.2	13.4	8.3	-1.6	-8.6	3.2
2012	-11.0	-9.8	1.2	4.9	11.5	17.4	21.3	17.9	11.8	3.4	-5.7	-14.6	4.0
2013	-17.8	-14.1	-9.8	-1.3	10.5	16.4	18.4	18.6	14.9	5.4	-5.3	-20.5	1.3
2014	-20.6	-19.9	-13.4	-0.2	10.6	16.3	17.9	18.4	12.8	6.3	-8.3	-9.5	0.9
2015	-14.7	-20.1	-3.8	4.2	10.1	17.4	19.7	17.7	15.5	7.2	-0.3	-7.1	3.8
2016	-15.0	-12.5	-2.6	1.2	12.6	16.2	19.0	18.3	13.9	6.7	2.9	-13.3	3.9
2017	-12.6	-10.1	-6.1	4.3	10.8	16.2	18.7	16.7	13.6	6.3	-6.4	-16.2	2.9
2018	-15.9	-17.6	-4.5	-0.4	13.0	18.2	19.8	18.3	10.5	2.5	-8.0	-10.0	2.2
2019	-18.6	-18.9	-7.9	3.1	8.6	16.1	18.9	17.4	12.5	3.5	-5.4	-12.8	1.4
2020	-12.8	-13.2	-5.3	0.6	10.0	17.7	20.2	18.7	11.2	1.8	-2.6	-9.2	3.1
1981-2010 Normal	-16.6	-13.2	-5.7	3.9	11.2	16.4	19.3	18.2	12.3	5.1	-4.5	-13.1	2.8

Below Normal	**Near Normal**	**Above Normal**

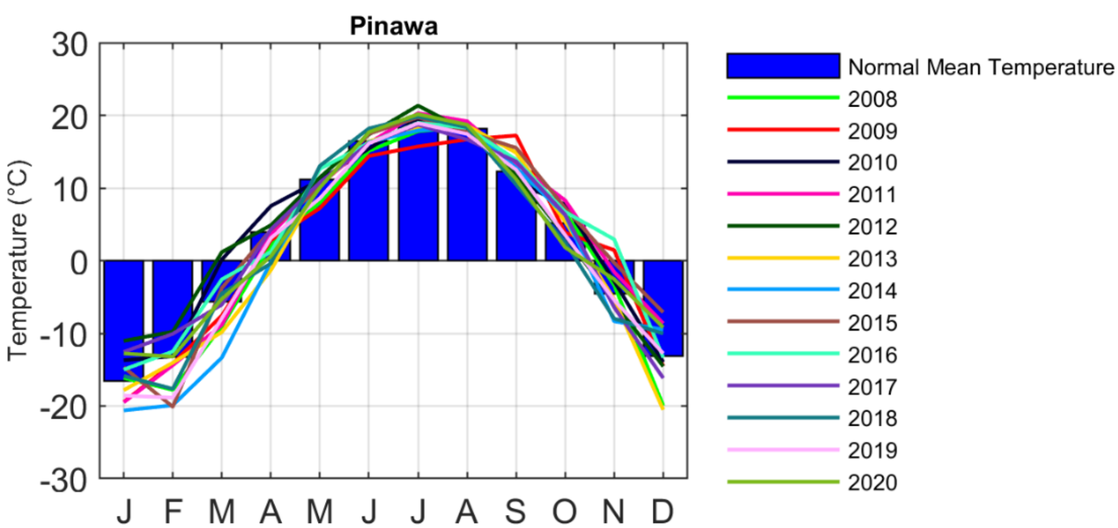


Figure 2.2-1. Pinawa mean monthly air temperature (in ºC) compared to 1981-2010 normal.

2.2.2 PRECIPITATION

Figure 2.2-2 illustrates the monthly total precipitation (in mm) for each year during the monitoring period compared to the 1981-2010 normal total precipitation. Total precipitation refers to the water equivalent of all types of precipitation. The total precipitation at Pinawa follows a noticeable seasonal pattern, where generally the highest amounts of precipitation fall during the summer months (June and July) and the lowest amounts fall during the winter months (January and February). Overall, recorded precipitation for the monitoring period followed similar patterns to the climate normal pattern. Some deviations can be seen, such as 2010, where the recorded total precipitation for May and August was much higher than normal and for 2011 (July), which recorded total precipitation well below the normal condition.

Table 2.2-2 summarizes the total monthly precipitation data and categorizes each month in the monitoring period as “below normal”, “near normal” or “above normal” conditions. It should be noted that the “near normal” was subjectively defined as +/- 10% of the ECCC climate normal. Months “below normal” are highlighted in light brown, “near normal” are highlighted in grey and “above normal” are highlighted in green. Over the monitoring period, February, April, July, and September generally experienced more than normal precipitation (≥ 7 out of 13 months above normal). On an annual basis, no distinct patterns in the data were identified as there was nearly equal number of years below, near, and above normal conditions; 2010 had the highest annual total precipitation (870.8 mm), while 2011 had the lowest annual total precipitation (389.0 mm). The maximum and minimum monthly total precipitation recorded during the monitoring period were 184.3 mm (September 2019) and 0.5 mm (April 2018), respectively.

Table 2.2-2. Pinawa total monthly and annual precipitation (in mm) compared to 1981-2010 normal.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2008	2.6	10.8	26.5	15.9	39.8	100.2	139.6	47.0	83.0	63.0	51.2	24.4	604.0
2009	14.1	31.2	46.7	18.5	74.4	143.1	133.8	100.5	111.3	26.3	14.2	18.8	732.9
2010	29.3	13.7	9.8	34.7	162.4	129.9	115.6	175.2	78.1	69.3	43.4	9.4	870.8
2011	30.5	7.6	24.6	44.0	51.1	64.6	15.7	23.9	68.7	21.8	25.5	11.0	389.0
2012	22.8	21.8	40.8	27.3	119.1	89.8	45.4	85.7	21.6	90.2	40.3	12.5	617.3
2013	32.3	11.1	20.1	41.9	60.2	55.5	71.6	35.9	59.2	24.6	41.4	32.4	486.2
2014	41.8	26.0	17.4	41.0	71.8	143.1	30.5	59.2	32.2	47.7	32.1	14.7	557.5
2015	22.2	37.2	25.3	24.4	85.2	80.2	121.5	100.8	34.6	50.9	53.1	48.6	683.9
2016	19.0	22.9	64.2	55.0	61.1	113.5	98.1	115.1	71.4	50.7	37.3	80.3	788.6
2017	47.8	22.5	29.0	42.0	28.1	64.1	112.6	23.4	84.7	49.1	31.1	27.9	562.3
2018	21.0	7.3	5.1	0.5	64.9	124.4	30.9	35.5	74.5	52.8	16.8	33.7	467.4
2019	68.0	33.6	14.5	25.0	45.8	57.4	139.5	48.6	184.3	97.4	13.8	11.8	739.8
2020	19.4	6.6	8.4	32.3	26.2	72.3	90.0	111.3	20.8	22.4	7.9	23.8	441.4
1981-2010 Normal	21.7	16.7	25.8	29.1	66.6	98.8	89.1	65.3	61.9	48.2	29.5	25.6	578.3

Below Normal	Near Normal	Above Normal

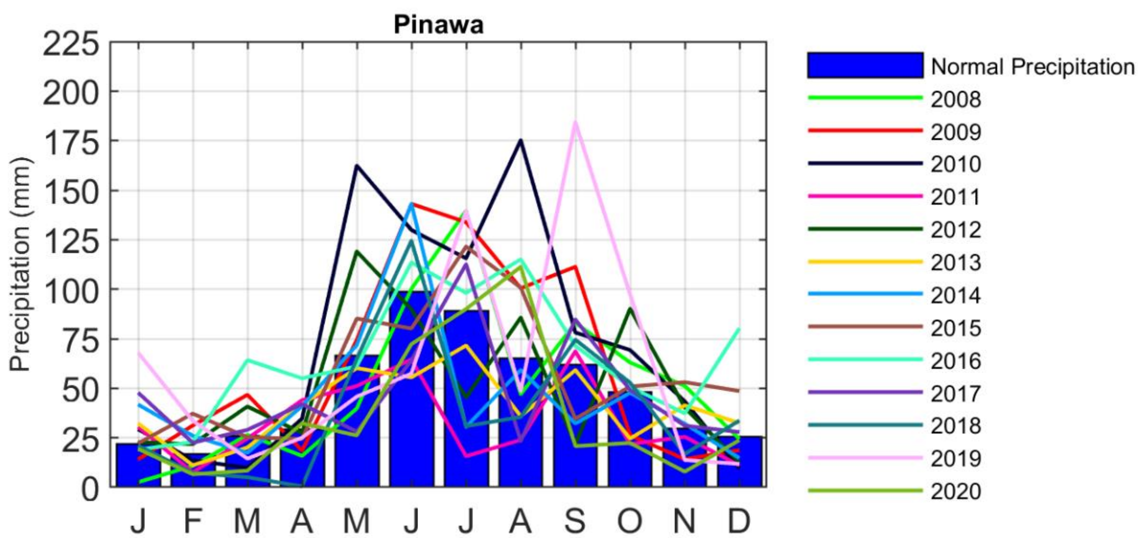


Figure 2.2-2. Pinawa total monthly precipitation (in mm) compared to 1981-2010 normal.

2.3 WATER REGIME

Winnipeg River flow is primarily determined by precipitation within the river's drainage basin, however a major influence on flow is releases from upstream storage reservoirs in Ontario, which are regulated by the Lake of the Woods Control Board (LWCB). The LWCB regulates the water levels of Lake of the Woods and Lac Seul, and the flows in the Winnipeg and English Rivers downstream of these lakes for the long-term benefit of all users and interests. More information is available online at Lake of the Woods Control Board (lwcb.ca). Outflows from Lake of the Woods on the Winnipeg River and Lac Seul on the English River combine at Boundary Falls just east of the Manitoba-Ontario border. Within Manitoba, six Manitoba Hydro generating stations along the Winnipeg River (Figure 2.3-1) create stable water levels in the forebays upstream of the generating stations under most flow conditions. Water levels downstream from generating stations continue to vary with flow in the Winnipeg River.

On-System Sites

On-system CAMP monitoring along the Winnipeg River occurred on the Pointe du Bois GS forebay, Lac du Bonnet (McArthur Falls GS forebay), and the Pine Falls GS forebay (Figure 2.3-1). Although Slave Falls GS is not part of CAMP monitoring, Winnipeg River flow is reported from Slave Falls GS because it has the longest and most reliable flow record and flows do not change significantly along the Winnipeg River within Manitoba. CAMP water level measurements occur on the upstream side of the GS for both Pointe du Bois and Pine Falls forebays and at Water Survey of Canada gauge 05PF062 at Lac du Bonnet. Continuous water temperature is measured at the Pointe du Bois GS at the continuous water quality monitoring site because it is the most upstream CAMP location. Monitoring at this station was initiated in 2020, therefore no data is available for the time period presented in this report.

Off-System Sites

CAMP monitors Manigotagan and Eaglenest lakes as the off-system waterbodies for this region. Manigotagan River is located north of the Winnipeg River and is a smaller river that flows into the east side of Lake Winnipeg. Water levels are not measured on Manigotagan Lake, but the level varies up and down with the measured flow in the Manigotagan River. Manigotagan River flow is reported at Water Survey of Canada Gauge 05RA001 located about 50 km downstream from Manigotagan Lake (Figure 2.3-1). The Manigotagan River flow record at Gauge 05RA001 was discontinued by Water Survey of Canada in 1997 and was re-established as part of CAMP in 2010. As a result, Manigotagan Flow data is not available for the first two years of CAMP (2008 and

2009) and the historical 30-year reference period is selected as 1965-1996 rather than 1981 to 2010 as it is at other locations.

Eaglenest Lake is located on the Winnipeg River upstream from Pointe du Bois GS near the Manitoba Ontario border. Although it is along the Winnipeg River, water levels on Eaglenest Lake are not affected by Manitoba Hydro's operations and Eaglenest Lake is therefore considered an off-system site despite being affected by upstream regulation by LWCB. Water levels are not measured on Eaglenest Lake but varies up and down with the measured flow in the Winnipeg River (reported at Slave Falls as described above). Continuous water temperature is not monitored at the off-system waterbodies.

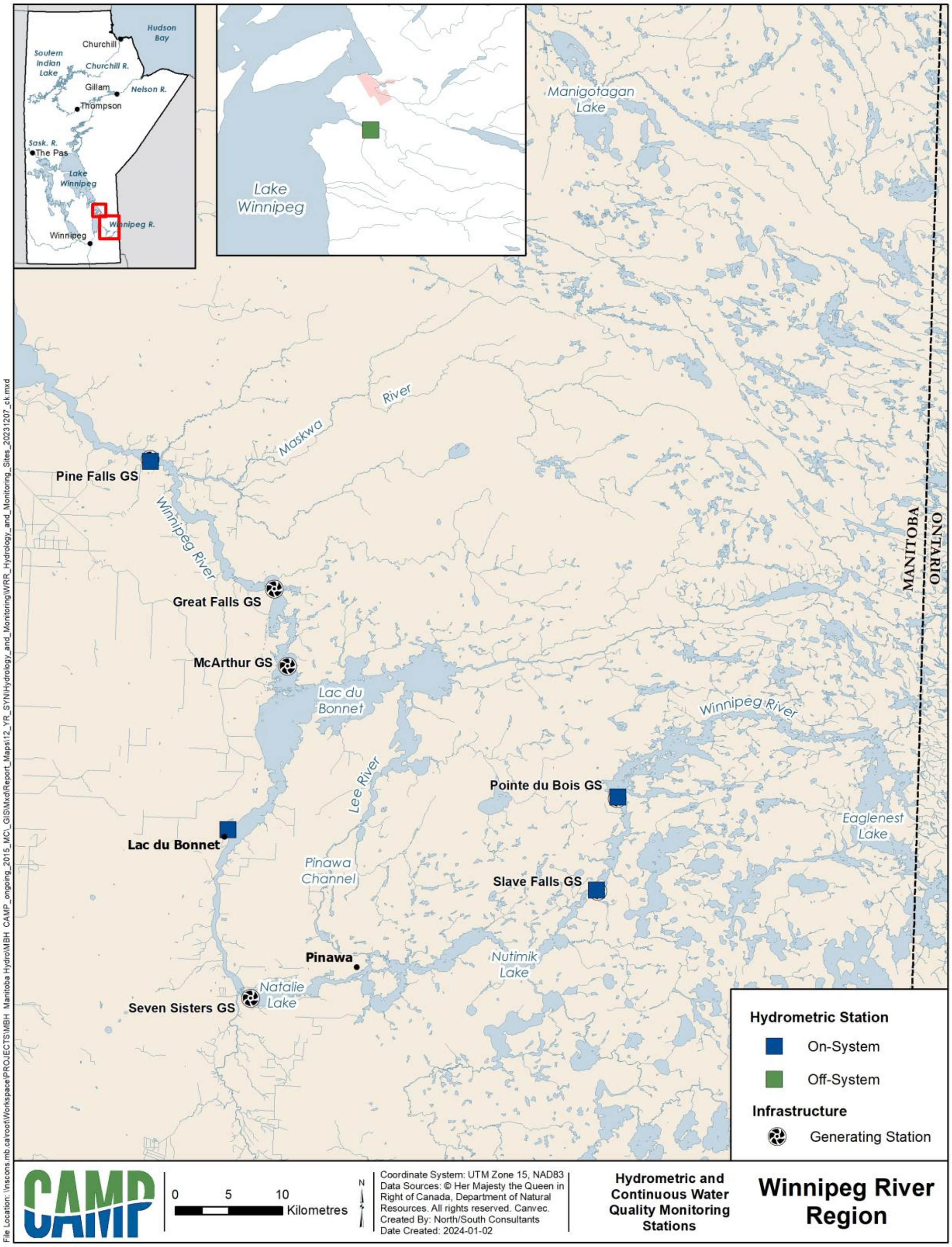


Figure 2.3-1. Hydrometric and continuous water quality monitoring stations in the Winnipeg River Region.

2.3.1 FLOW

2.3.1.1 ON-SYSTEM SITES

Winnipeg River

From 2008 to 2020, flow conditions on the Winnipeg River ranged from very dry to very wet and were more frequently above average than below average compared to the reference period from 1981 to 2010 (Figure 2.3-2 and Table 2.3-1). Monthly mean flow ranged from 278 to 2,503 cms with the overall mean from 2008 to 2020 at 1,025 cms. Flow conditions were very dry, defined as lower than 10th percentile, in parts of three years during the 2008 to 2020 CAMP monitoring period in August-November 2011, August and September 2018, and August-November 2020 (Table 2.3-1). Flow conditions were very wet, defined as above the 90th percentile, in seven years during CAMP, during the following months; June-August 2008, May-July, and September 2009, August 2010, May and June 2011, June and July 2013, May-September 2014, and October-December 2019 (Table 2.3-1).

2.3.1.2 OFF-SYSTEM SITES

Manigotagan River

From October 2010 to 2020, flow conditions on the Manigotagan River ranged from very dry to very wet and were more frequently above average than below average as compared to the reference period from 1965 to 1996 (Figure 2.3-3 and Table 2.3-2). There is no flow data available for the Manigotagan River from 1997 to September 2010. The monthly mean values ranged from 1.1 to 52.4 cms with the overall average from 2010 to 2020 at 10 cms. Flow conditions were very dry (below 10th percentile) with coincident very low Manigotagan Lake levels during the following months; January, February, November, and December 2012 (Table 2.3-2). Flow conditions were very wet (above 90th percentile) with coincident very high Manigotagan Lake levels during the following months; October 2010, May and June 2011, June, July and November 2012, May 2013, May-July 2014, September 2015, April and May 2016, and October and November 2019 (Table 2.3-2).

Table 2.3-1. Winnipeg River monthly average flow (cms).

Year	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	1216	1230	1182	1053	882	996	1628	2062	1939	968	719	885	1029
2009	1340	1000	1055	1176	1262	1873	2140	1754	1423	1466	1115	890	908
2010	1004	952	979	998	821	528	840	1078	1459	1193	1177	1041	972
2011	867	987	1052	1073	1222	1631	1533	1036	354	278	338	372	545
2012	725	607	649	600	587	606	878	1192	891	690	526	702	767
2013	997	776	868	934	674	814	1616	1526	1062	1004	1008	851	823
2014	1343	851	985	1003	945	1620	2267	2495	2124	1565	757	691	780
2015	931	849	897	894	692	528	1009	1162	1064	1025	855	866	1321
2016	1216	1358	1265	1168	1333	1406	1055	1289	1085	946	1261	1223	1195
2017	1020	1235	1260	1281	1396	1135	840	948	787	535	864	1067	904
2018	686	863	971	927	612	488	555	507	391	323	537	1080	998
2019	1198	979	945	1025	1160	1263	923	759	668	764	2161	2199	1518
2020	778	1361	1267	1205	1193	698	656	690	417	436	402	395	637

Very Dry Lower than 10th percentile	**Dry** 10th to 30th percentile	**Average** 30th to 70th percentile	**Wet** 70th to 90th percentile	**Very Wet** Higher than 90th percentile

Table 2.3-2. Manigotagan River monthly average flow (cms).

Year	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008													
2009													
2010	15										21	19	10
2011	11	6	5	4	16	39	29	12	5	4	3	2	1
2012	12	1	1	3	4	5	27	34	19	10	10	21	12
2013	8	7	5	3	4	23	18	8	6		3	3	3
2014	13	3	3	3	8	52	34	22	10	7	8	5	4
2015	12	3	3	3	6	14	18	11	19	30	14	14	14
2016	13	10	6	8	26	29	18	12	7	10	10	13	12
2017	7	8	6	5	14	15	8	5	4	4	5	7	6
2018	4	4	4	3	3	3	3	3	2	2	4	8	7
2019	10	5	4	3	7	17	10	9	5	5	23	25	10
2020	8	6	5	3	8	18	18	17	6	4	4	4	3

Very Dry Lower than 10th percentile	**Dry** 10th to 30th percentile	**Average** 30th to 70th percentile	**Wet** 70th to 90th percentile	**Very Wet** Higher than 90th percentile

Notes:

1. Blank cell indicates no data.

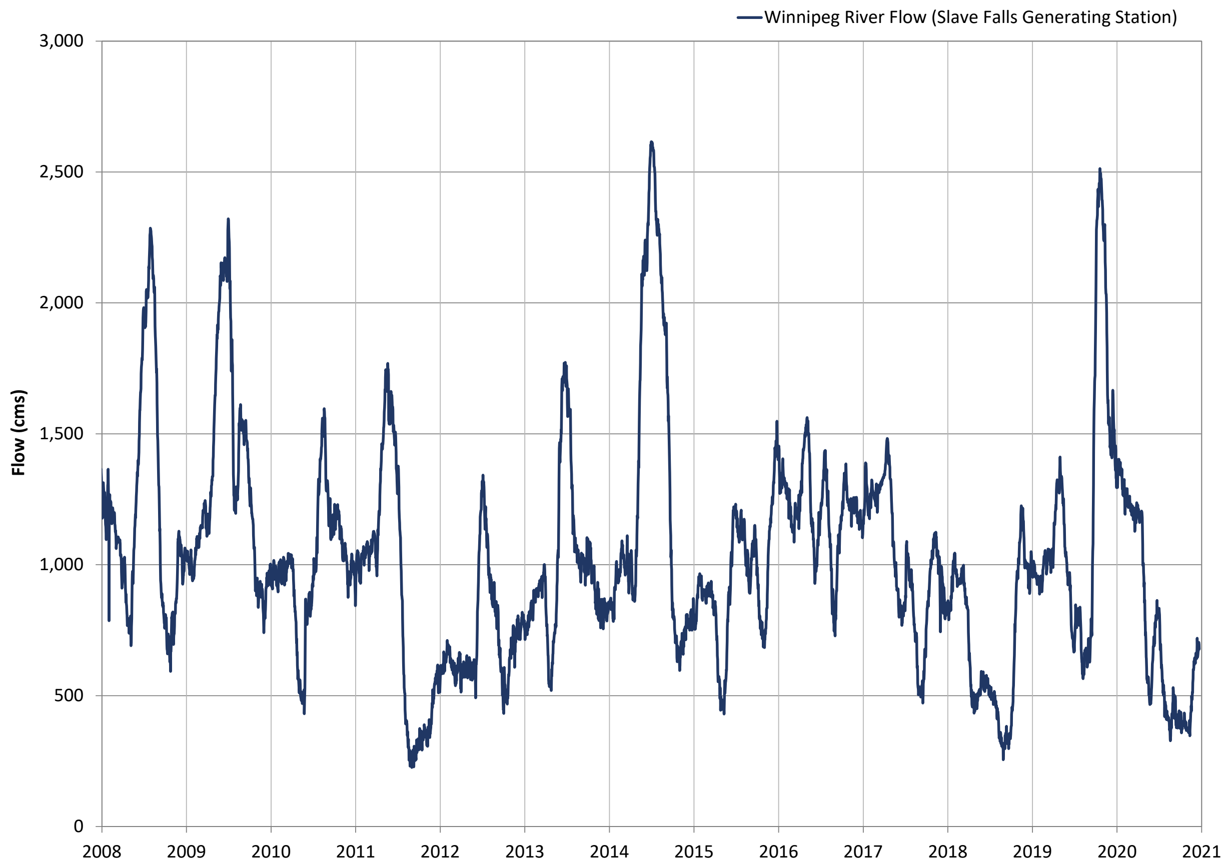


Figure 2.3-2. 2008-2020 Winnipeg River daily mean flow.

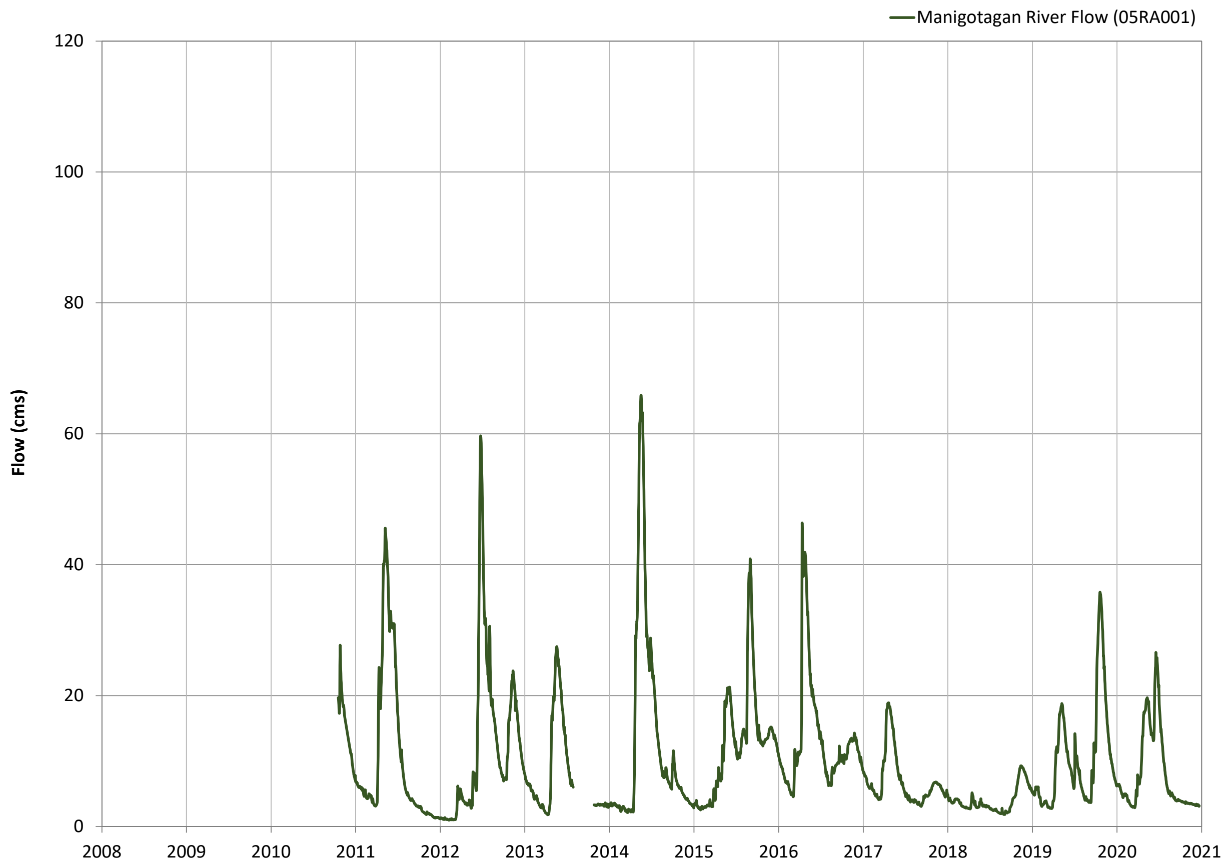


Figure 2.3-3. 2010-2020 Manigotagan River daily mean flow.

2.3.2 WATER LEVEL AND VARIABILITY

2.3.2.1 ON-SYSTEM SITES

Despite the changing flow conditions on the Winnipeg River, the water level at the three on-system CAMP locations (the Pointe du Bois Forebay, Lac du Bonnet (McArthur Forebay), and the Pine Falls Forebay) remained very stable as the flow through the generating stations are regulated to maintain stable upstream water levels.

Pointe du Bois Forebay

The Pointe du Bois forebay water level remained just below 299.1 m and close to average (within 0.5 m above or below) from 2008 to 2020 (Figure 2.3-4 and Table 2.3-3). Monthly average water levels ranged from 299.02 to 299.08 m. Water level variability remained low (less than 0.25 m) for the entire period from 2008 to 2020 (Table 2.3-4).

Lac du Bonnet

The water level on Lac du Bonnet remained steady near 254.9 m from 2008 to 2020 (Figure 2.3-5 and Table 2.3-5). Monthly average water levels ranged from 254.82 to 255.01 m. Water level variability also remained low (less than 0.25 m) for most of the period from 2008 to 2020, with the exception of six one-month periods in the record showing moderate variability (0.25 to 0.75 m; Table 2.3-6).

ROTATIONAL SITES

Pine Falls Forebay

The Pine Falls forebay remained near 229.1 m from 2008 to 2020 (Figure 2.3-6 and Table 2.3-7). Monthly average water levels ranged from 229.04 to 229.16 m. Water level variability remained low (less than 0.25 m) during this period, with the exception of three one-month periods in the record with moderate variability (0.25 to 0.75 m; Table 2.3-8).

2.3.2.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Water levels are not recorded on off-system Manigotagan Lake. Water levels vary with Manigotagan River flow, which is measured downstream from Manigotagan Lake (Figure 2.3-1). As a result, Manigotagan specific water levels are not provided but rather may be inferred/visualized from Manigotagan flow presented in Figure 2.3-3 and Table 2.3-2 above).

ROTATIONAL SITES

Eaglenest Lake

Water levels are also not recorded on off-system Eaglenest Lake. Water levels vary with Winnipeg River flow, which is measured downstream from Eaglenest Lake. As a result, Winnipeg River Flow summary information in Figure 2.3-2 and Table 2.3-1 may be used to visualize water level changes on Eaglenest Lake.

Table 2.2-3. Pointe du Bois Forebay monthly average water level (m).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	299.07	299.06	299.07	299.08	299.08	299.08	299.08	299.07	299.07	299.07	299.08	299.06
2009	299.06	299.07	299.07	299.07	299.08	299.07	299.06	299.06	299.06	299.07	299.07	299.07
2010	299.08	299.07	299.08	299.06	299.06	299.07	299.07	299.08	299.07	299.08	299.07	299.07
2011	299.07	299.07	299.07	299.07	299.07	299.07	299.07	299.05	299.06	299.06	299.05	299.02
2012	299.04	299.04	299.05	299.05	299.07	299.07	299.06	299.06	299.06	299.06	299.04	299.05
2013	299.05	299.06	299.06	299.05	299.06	299.06	299.05	299.06	299.07	299.06	299.06	299.06
2014	299.07	299.06	299.06	299.06	299.07	299.06	299.05	299.06	299.06	299.08	299.07	299.08
2015	299.08	299.08	299.08	299.07	299.08	299.08	299.07	299.07	299.08	299.06	299.08	299.08
2016	299.07	299.07	299.08	299.08	299.07	299.07	299.08	299.07	299.07	299.07	299.08	299.08
2017	299.08	299.08	299.08	299.08	299.06	299.08	299.08	299.08	299.08	299.08	299.08	299.08
2018	299.08	299.08	299.08	299.07	299.08	299.07	299.07	299.07	299.07	299.08	299.08	299.08
2019	299.08	299.07	299.06	299.04	299.07	299.07	299.07	299.07	299.08	299.08	299.07	299.06
2020	299.07	299.06	299.08	299.07	299.06	299.07	299.07	299.07	299.07	299.07	299.08	299.08

Lower Lower than 0.5 m below average	**Average** Within 0.5 m below and above average	**Higher** More than 0.5 m above average

Table 2.2-4. Pointe du Bois Forebay monthly water level range (m).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	0.08	0.06	0.06	0.06	0.05	0.08	0.05	0.07	0.09	0.10	0.06	0.05
2009	0.05	0.06	0.04	0.05	0.02	0.03	0.05	0.04	0.04	0.06	0.04	0.04
2010	0.03	0.03	0.05	0.07	0.08	0.05	0.06	0.07	0.04	0.03	0.05	0.06
2011	0.05	0.03	0.03	0.03	0.02	0.03	0.04	0.09	0.06	0.07	0.09	0.07
2012	0.07	0.06	0.05	0.06	0.06	0.05	0.09	0.04	0.05	0.04	0.07	0.05
2013	0.04	0.03	0.04	0.04	0.07	0.05	0.06	0.05	0.05	0.05	0.05	0.04
2014	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.05	0.04
2015	0.05	0.06	0.03	0.05	0.04	0.03	0.06	0.06	0.05	0.06	0.04	0.05
2016	0.04	0.04	0.04	0.05	0.04	0.05	0.03	0.05	0.04	0.04	0.03	0.03
2017	0.03	0.04	0.02	0.03	0.06	0.04	0.02	0.04	0.04	0.03	0.04	0.04
2018	0.04	0.11	0.03	0.10	0.03	0.04	0.04	0.04	0.05	0.04	0.03	0.03
2019	0.03	0.06	0.09	0.18	0.06	0.06	0.12	0.06	0.04	0.04	0.05	0.07
2020	0.05	0.06	0.05	0.11	0.06	0.05	0.05	0.05	0.05	0.04	0.04	0.05

Lower Variability Below 0.25 m	**Moderate Variability** 0.25 to 0.75 m	**Higher Variability** Above 0.75 m

Table 2.2-5. Lac du Bonnet Monthly average water level (m).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	254.90	254.93	254.92	254.90	254.90	254.91	254.94	254.91	254.82	254.86	254.88	254.90
2009	254.90	254.92	254.93	254.92	254.95	254.95	254.92	254.92	254.90	254.89	254.88	254.89
2010	254.89	254.91	254.90	254.86	254.88	254.89	254.90	254.91	254.88	254.88	254.87	254.90
2011	254.89	254.92	254.92	254.92	254.92	254.90	254.86	254.88	254.89	254.87	254.87	254.87
2012	254.87	254.88	254.85	254.87	254.84	254.88	254.89	254.87	254.87	254.84	254.90	254.89
2013	254.92	254.92	254.88	254.86	254.92	254.92	254.92	254.90	254.88	254.88	254.88	254.93
2014	254.95	254.91	254.91	254.89	254.94	254.99	255.01		254.91	254.89	254.93	254.95
2015	254.93	254.89	254.88	254.87	254.88	254.91	254.90	254.89	254.89	254.88	254.91	254.90
2016	254.93	254.92	254.92	254.92	254.89	254.88	254.90	254.87	254.88	254.88	254.87	254.89
2017	254.93	254.92	254.91	254.90	254.88	254.85	254.86	254.84	254.85	254.89	254.86	254.87
2018	254.91	254.88	254.90	254.88	254.91	254.89	254.84	254.86	254.89	254.90	254.90	254.90
2019	254.90	254.91	254.90	254.91	254.91	254.86	254.90	254.87	254.88	254.97	254.91	254.91
2020	254.93	254.93	254.92	254.92	254.88	254.90	254.87	254.89	254.89	254.88	254.89	254.90

Lower	Average	Higher
Lower than 0.5 m below average	Within 0.5 m below and above average	More than 0.5 m above average

Notes:

1. Blank cell indicates no data.

Table 2.2-6. Lac du Bonnet monthly water level range (m).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	0.10	0.07	0.08	0.22	0.09	0.15	0.12	0.16	0.16	0.11	0.09	0.08
2009	0.06	0.05	0.10	0.08	0.10	0.12	0.17	0.14	0.05	0.11	0.12	0.07
2010	0.08	0.06	0.06	0.19	0.17	0.10	0.10	0.10	0.10	0.10	0.08	0.08
2011	0.11	0.06	0.07	0.08	0.09	0.11	0.13	0.16	0.09	0.06	0.04	0.11
2012	0.17	0.08	0.14	0.08	0.25	0.14	0.06	0.10	0.12	0.25	0.14	0.13
2013	0.08	0.10	0.07	0.25	0.12	0.08	0.08	0.05	0.10	0.10	0.16	0.12
2014	0.05	0.11	0.12	0.13	0.12	0.08	0.07		0.09	0.07	0.14	0.15
2015	0.11	0.10	0.13	0.25	0.30	0.12	0.09	0.07	0.06	0.20	0.13	0.10
2016	0.08	0.07	0.06	0.09	0.12	0.11	0.10	0.11	0.14	0.10	0.08	0.06
2017	0.08	0.06	0.05	0.04	0.06	0.11	0.15	0.18	0.27	0.14	0.04	0.15
2018	0.14	0.07	0.10	0.16	0.11	0.09	0.21	0.18	0.08	0.11	0.07	0.07
2019	0.07	0.06	0.11	0.07	0.05	0.14	0.15	0.11	0.13	0.16	0.10	0.07
2020	0.08	0.04	0.05	0.08	0.13	0.14	0.14	0.07	0.08	0.10	0.13	0.06

Lower Variability	Moderate Variability	Higher Variability
Below 0.25 m	0.25 to 0.75 m	Above 0.75 m

Notes:

1. Blank cell indicates no data.

Table 2.2-7. Pine Falls Forebay monthly average water level (m).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	229.13	229.15	229.13	229.11	229.12	229.12	229.12	229.11	229.14	229.09	229.10	229.12
2009	229.14	229.15	229.16	229.15	229.14	229.13	229.13	229.14	229.14	229.15	229.13	229.14
2010	229.13	229.15	229.14	229.13	229.11	229.15	229.14	229.14	229.14	229.14	229.15	229.14
2011	229.15	229.16	229.15	229.16	229.15	229.16	229.14	229.13	229.15	229.10	229.13	229.11
2012	229.11	229.12	229.10	229.11	229.09	229.13	229.15	229.09	229.11	229.10	229.08	229.07
2013	229.08	229.08	229.11	229.09	229.15	229.15	229.15	229.16	229.15	229.16	229.11	229.10
2014	229.11	229.15	229.16	229.16	229.15	229.13	229.11	229.11	229.14	229.11	229.11	229.09
2015	229.10	229.10	229.11	229.10	229.10	229.14	229.15	229.15	229.14	229.12	229.12	229.14
2016	229.14	229.15	229.15	229.15	229.15	229.14	229.15	229.15	229.14	229.15	229.15	229.15
2017	229.15	229.15	229.15	229.15	229.15	229.13	229.15	229.11	229.10	229.11	229.15	229.12
2018	229.11	229.14	229.11	229.08	229.09	229.07	229.09	229.10	229.09	229.06	229.15	229.12
2019	229.10	229.10	229.14	229.15	229.15	229.11	229.08	229.07	229.04	229.10	229.11	229.11
2020	229.14	229.14	229.15	229.14	229.09	229.10	229.07	229.08	229.06	229.08	229.06	229.08

Lower Lower than 0.5 m below average	**Average** Within 0.5 m below and above average	**Higher** More than 0.5 m above average

Table 2.2-8. Pine Falls Forebay monthly water level range (m).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	0.20	0.07	0.11	0.16	0.16	0.11	0.12	0.13	0.09	0.24	0.14	0.26
2009	0.11	0.08	0.04	0.06	0.08	0.08	0.09	0.08	0.09	0.08	0.09	0.11
2010	0.10	0.10	0.12	0.10	0.11	0.08	0.06	0.10	0.07	0.10	0.10	0.07
2011	0.08	0.07	0.04	0.06	0.05	0.06	0.08	0.12	0.09	0.21	0.09	0.12
2012	0.10	0.09	0.08	0.09	0.14	0.09	0.07	0.13	0.10	0.12	0.13	0.15
2013	0.09	0.16	0.11	0.15	0.08	0.06	0.04	0.02	0.08	0.06	0.16	0.19
2014	0.12	0.10	0.02	0.04	0.05	0.07	0.07	0.06	0.05	0.12	0.11	0.17
2015	0.10	0.16	0.17	0.11	0.15	0.11	0.06	0.06	0.06	0.09	0.12	0.06
2016	0.09	0.03	0.04	0.02	0.06	0.12	0.05	0.06	0.13	0.06	0.06	0.04
2017	0.05	0.03	0.04	0.03	0.05	0.18	0.14	0.16	0.16	0.22	0.06	0.15
2018	0.14	0.08	0.20	0.11	0.14	0.11	0.13	0.09	0.19	0.25	0.06	0.11
2019	0.18	0.12	0.15	0.04	0.04	0.14	0.13	0.11	0.42	0.14	0.08	0.11
2020	0.07	0.06	0.05	0.06	0.16	0.14	0.15	0.13	0.16	0.17	0.20	0.11

Lower Variability Below 0.25 m	**Moderate Variability** 0.25 to 0.75 m	**Higher Variability** Above 0.75 m

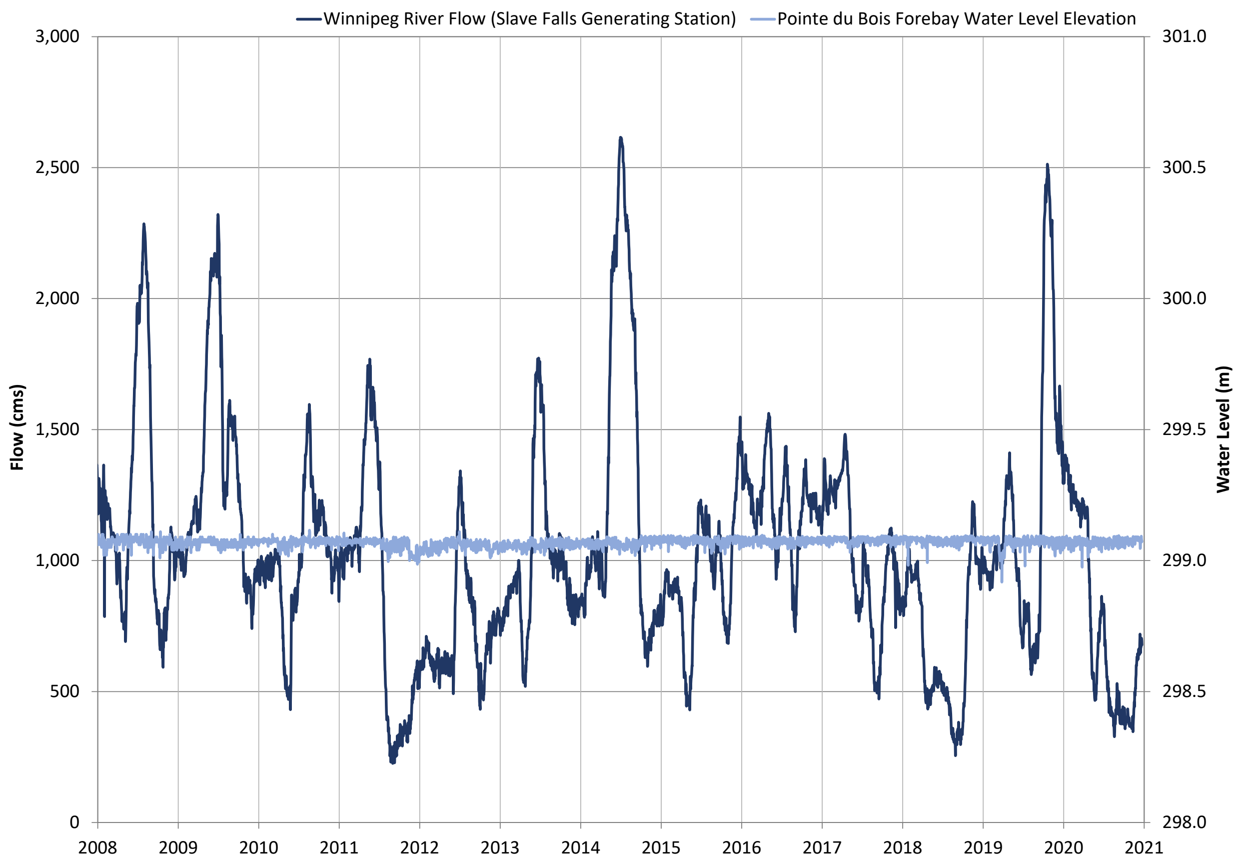


Figure 2.3-4. 2008-2020 Winnipeg River daily mean flow and Pointe du Bois Forebay daily average water level.

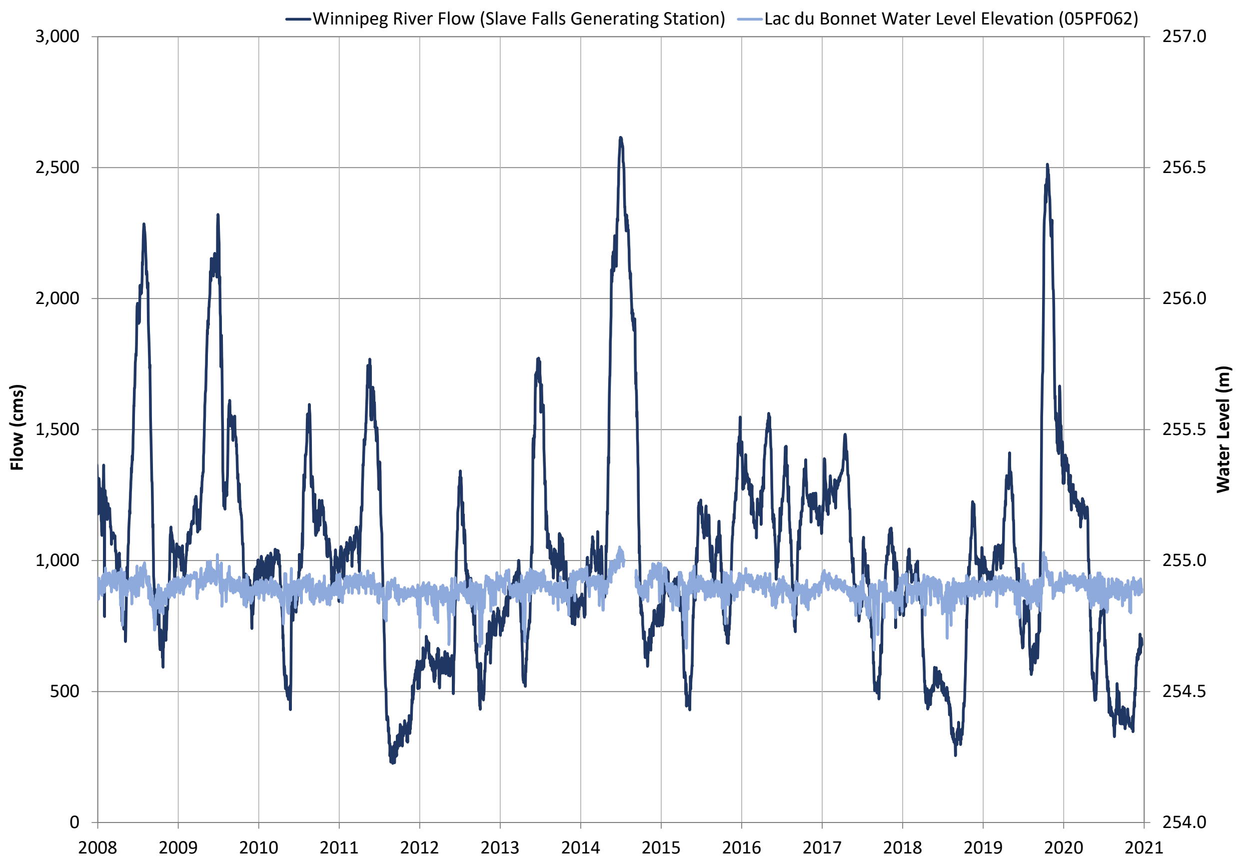


Figure 2.3-5. 2008-2020 Winnipeg River daily mean flow and Lac du Bonnet daily average water level.

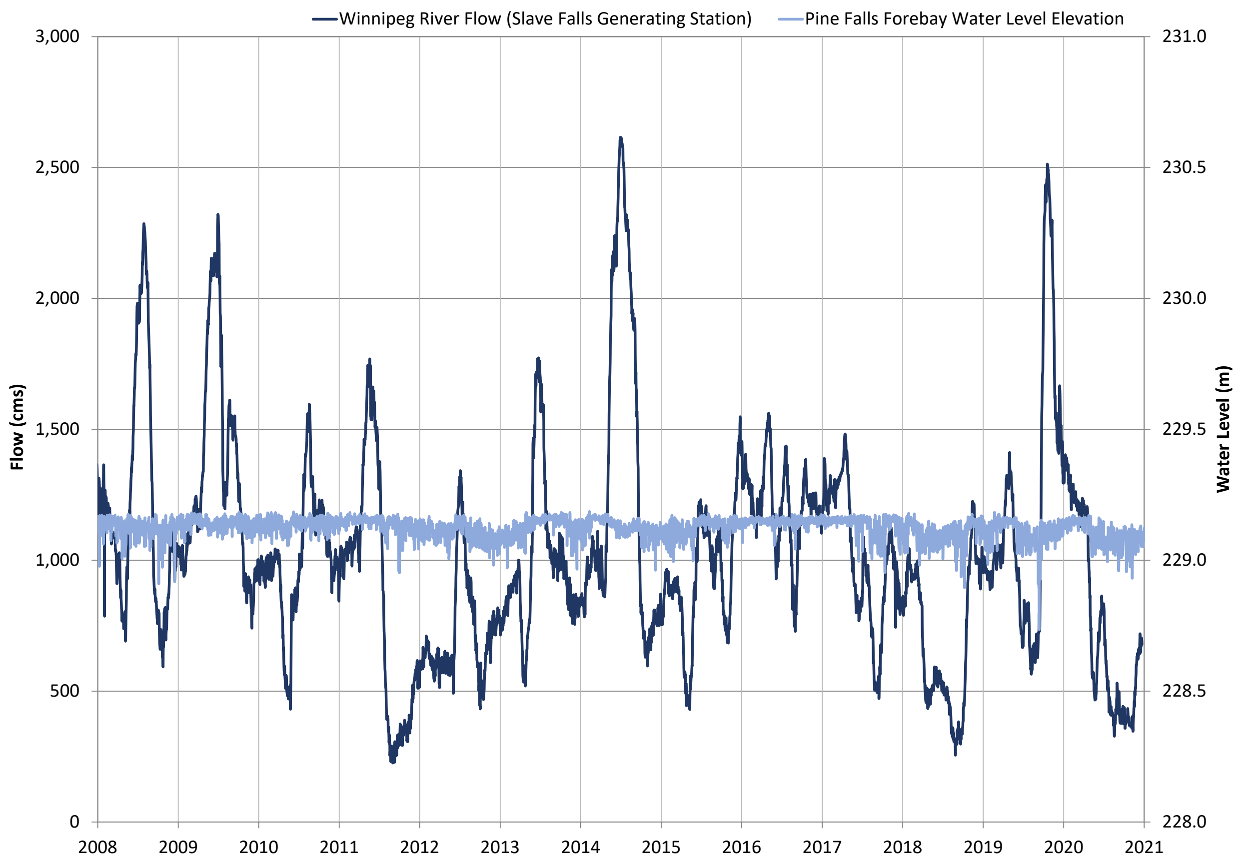


Figure 2.3-6. 2008-2020 Winnipeg River daily mean flow and the Pine Falls GS Forebay daily average water level.

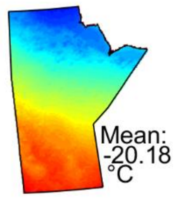
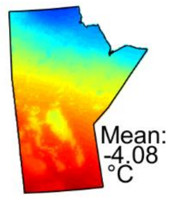
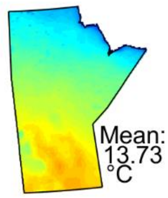
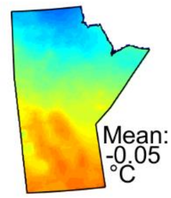
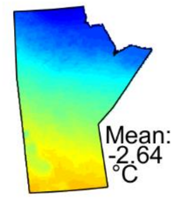
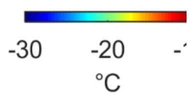
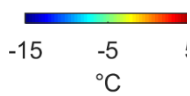
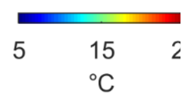
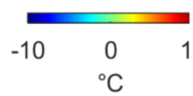
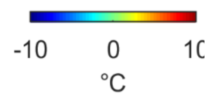
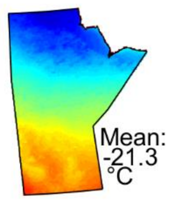
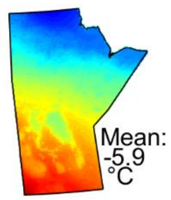
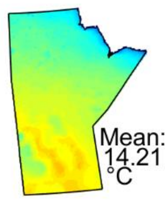
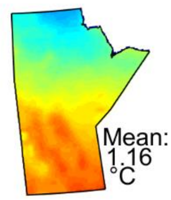
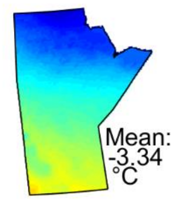
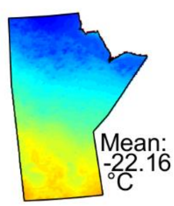
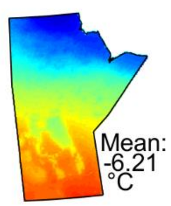
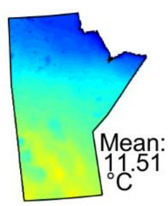
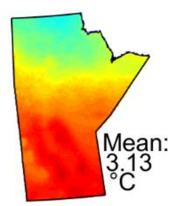
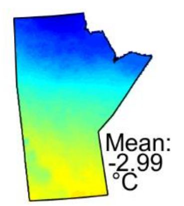
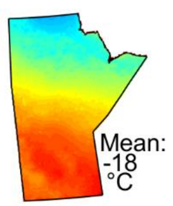
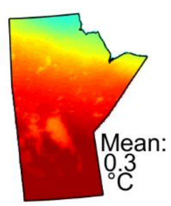
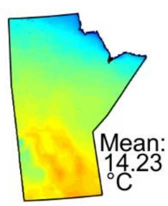
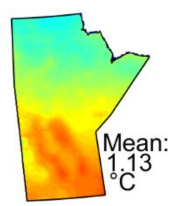
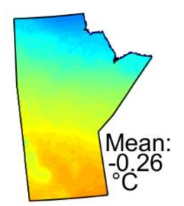
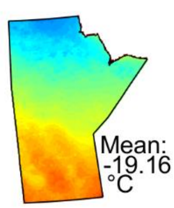
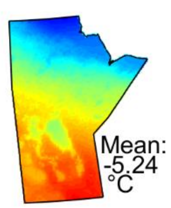
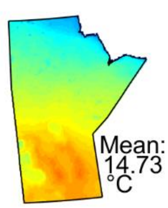
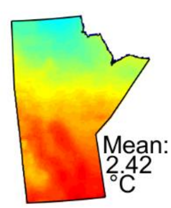
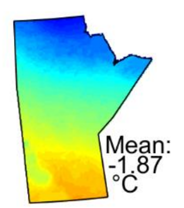
2.3.3 WATER TEMPERATURE

Continuous water temperature data are not available for this region during the period from 2008 to 2020. Continuous water temperature monitoring was initiated at the Pointe du Bois GS in 2020, after the monitoring period for this report and this data will be presented in the next reporting cycle.

2.4 SEDIMENTATION

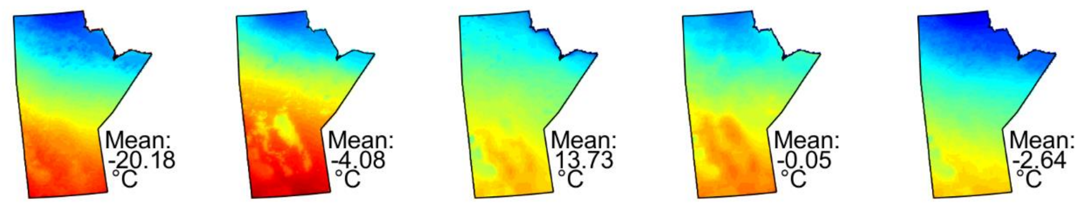
Sedimentation data are not available for this region during the period from 2008 to 2020. Monitoring was initiated at the Pointe du Bois GS in 2020, after the monitoring period for this report and this data will be presented in the next reporting cycle.

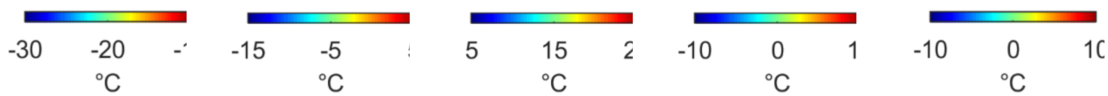
APPENDIX 2-1. SEASONAL AND ANNUAL TEMPERATURE NORMALS DERIVED FROM ERA5-LAND DATA

Year	Winter (DJF)	Spring (MAM)	Summer (JJA)	Fall (SON)	Annual
Normals (1981-2010)					
					
2008					
2009					
2010					
2011					

Year	Winter (DJF)	Spring (MAM)	Summer (JJA)	Fall (SON)	Annual

Normals (1981-2010)





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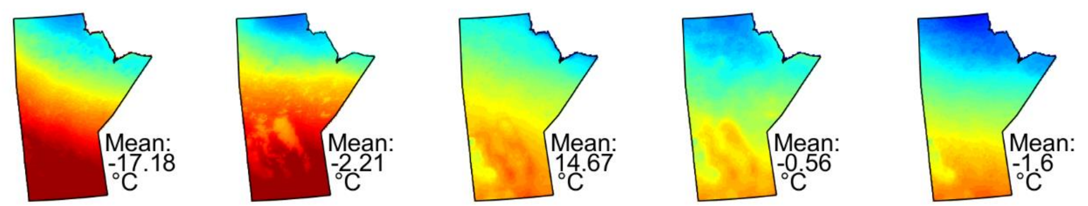
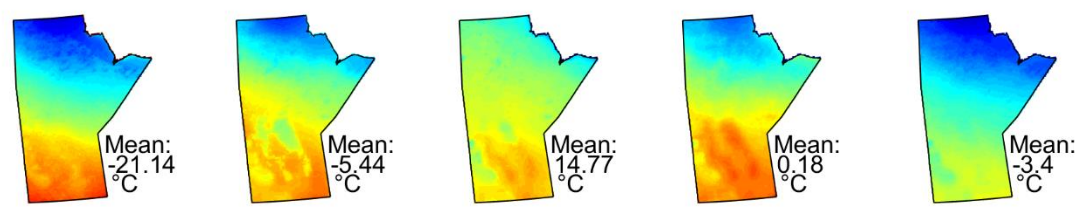


2013



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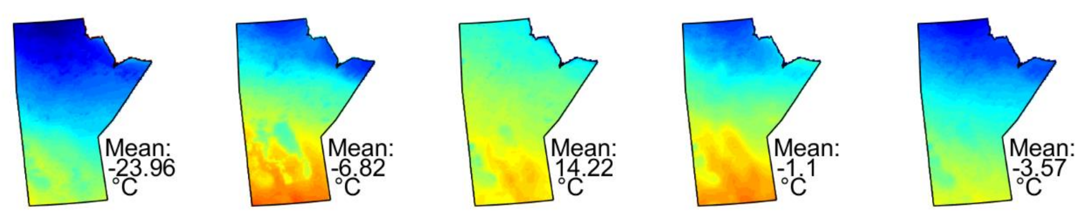

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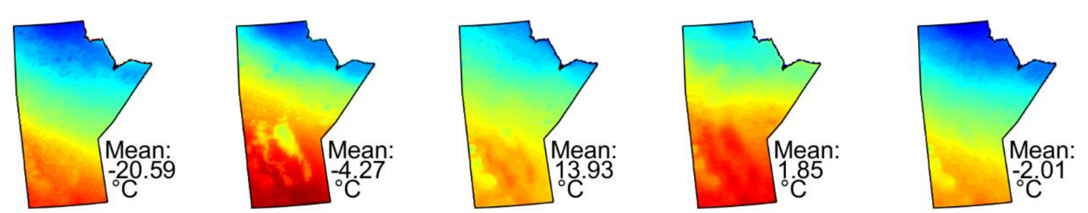
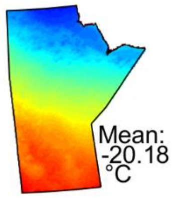
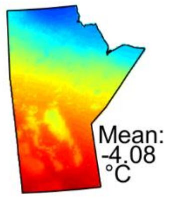
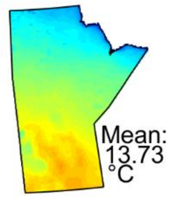
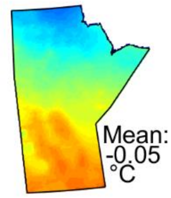
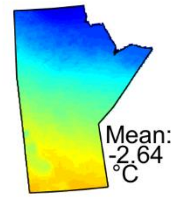
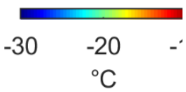
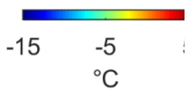
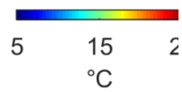
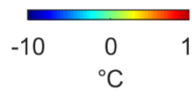
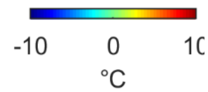
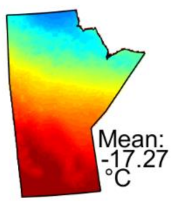
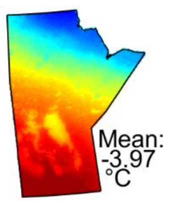
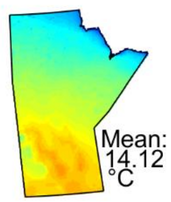
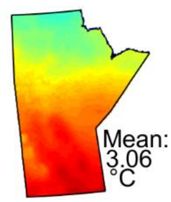
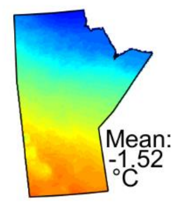
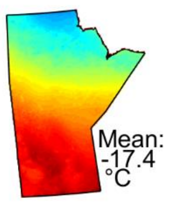
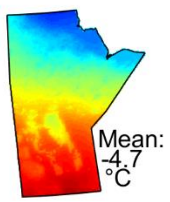
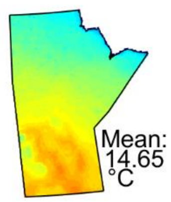
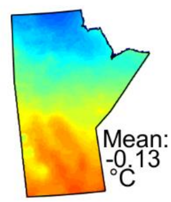
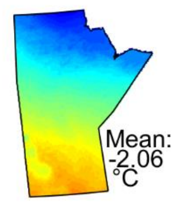
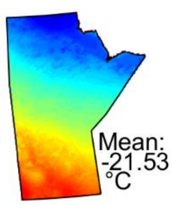
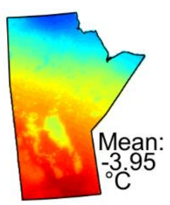
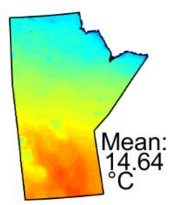
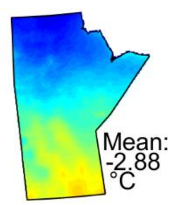
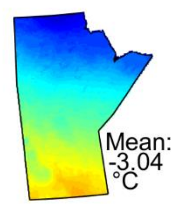
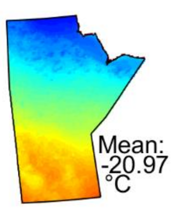
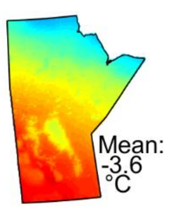
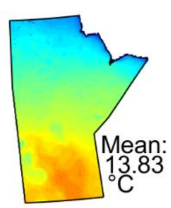
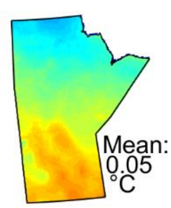
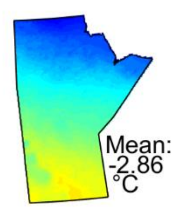
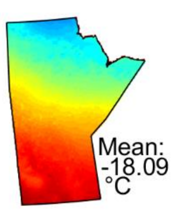
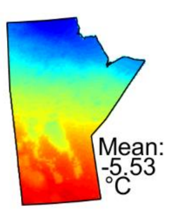
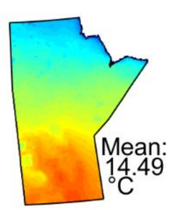
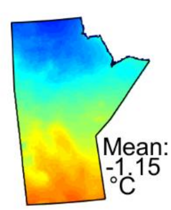
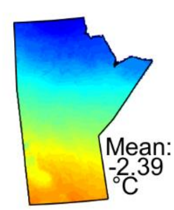
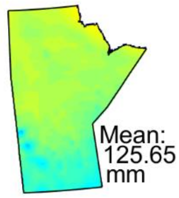
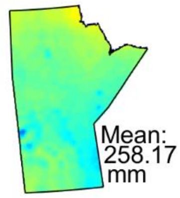
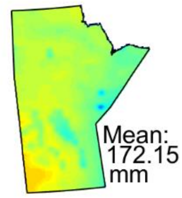
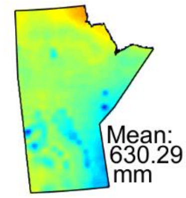
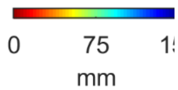
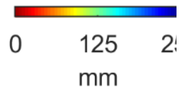
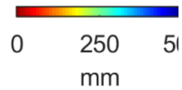
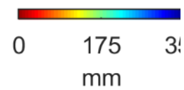
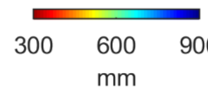
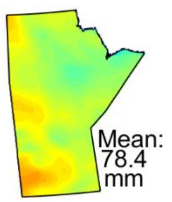
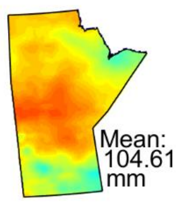
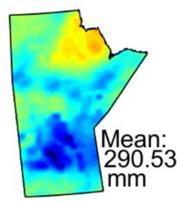
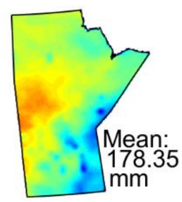
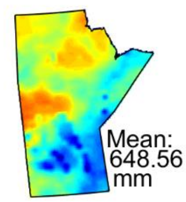
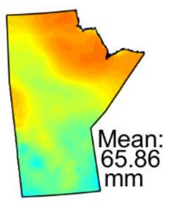
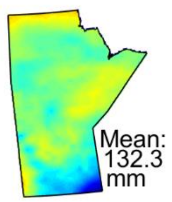
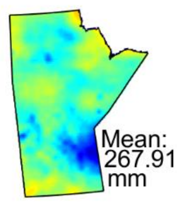
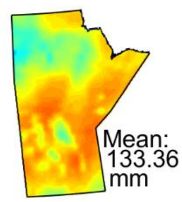
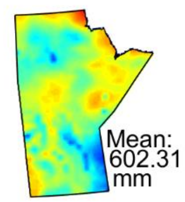
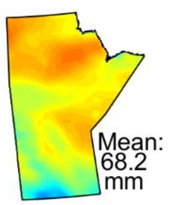
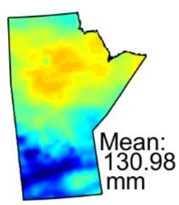
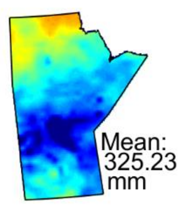
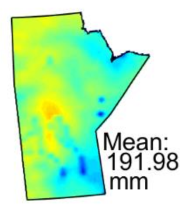
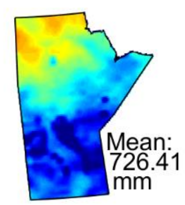
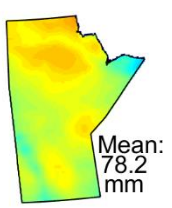
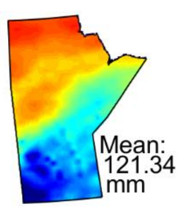
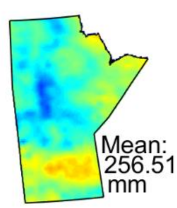
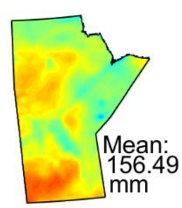
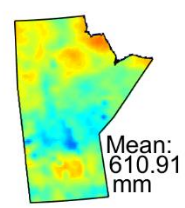


Year	Winter (DJF)	Spring (MAM)	Summer (JJA)	Fall (SON)	Annual
Normals (1981-2010)					
					
2016					
2017					
2018					
2019					
2020					

APPENDIX 2-2. SEASONAL AND PRECIPITATION NORMALS DERIVED FROM ERA5-LAND DATA

Year	Winter (DJF)	Spring (MAM)	Summer (JJA)	Fall (SON)	Annual
Normals (1981-2010)					
					
2008					
2009					
2010					
2011					

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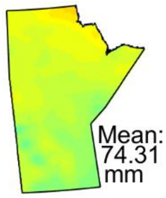
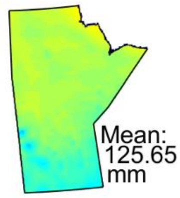
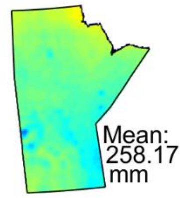
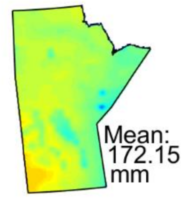
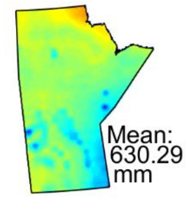
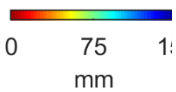
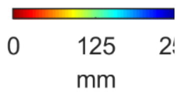
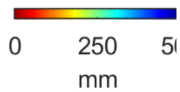
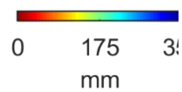
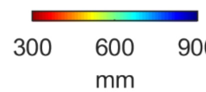
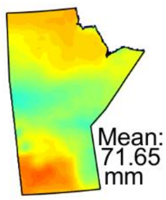
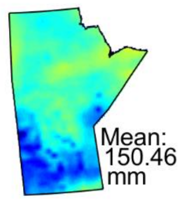
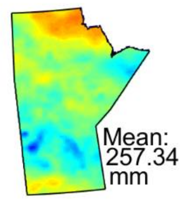
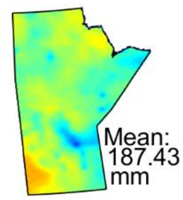
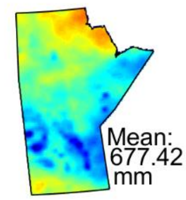
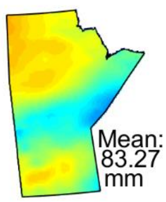
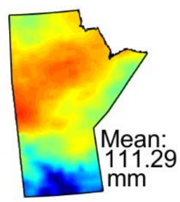
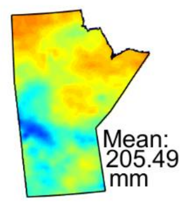
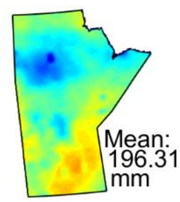
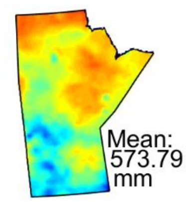
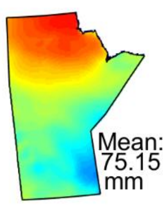
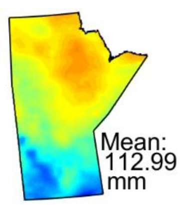
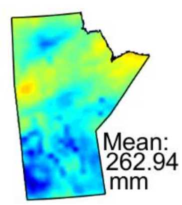
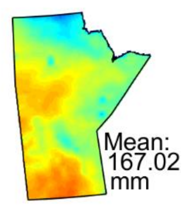
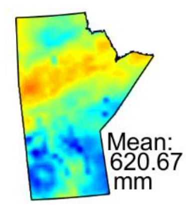
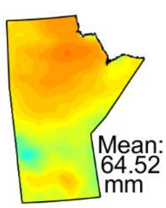
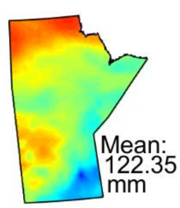
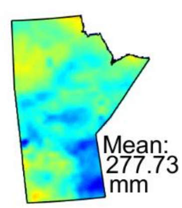
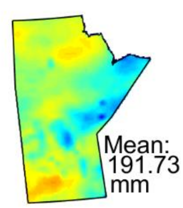
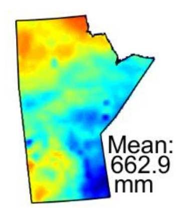
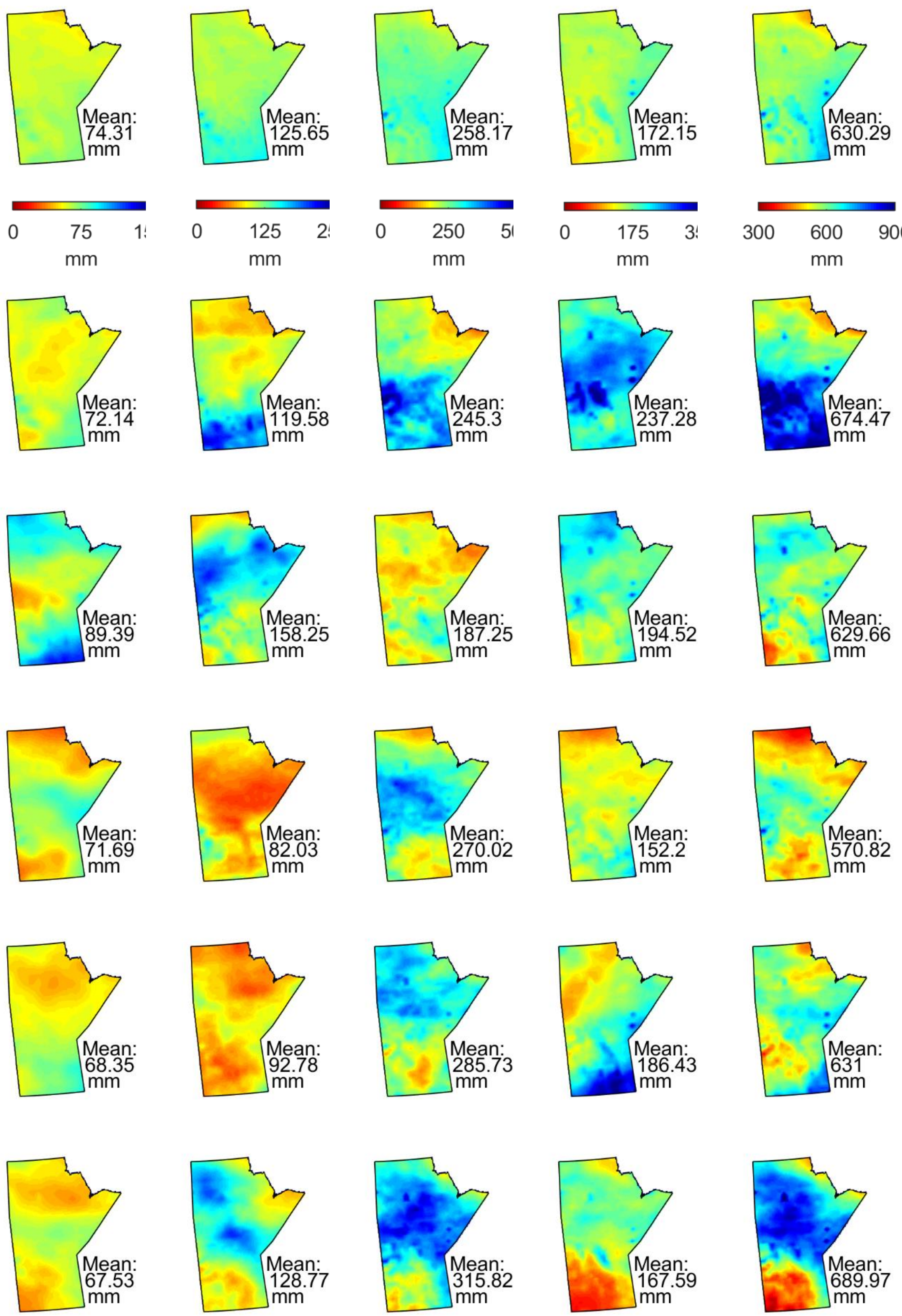
Normals (1981-2010)					
					
2012					
2013					
2014					
2015					



Year	Winter (DJF)	Spring (MAM)	Summer (JJA)	Fall (SON)	Annual
Normals (1981-2010)	Mean: 74.31 mm	Mean: 125.65 mm	Mean: 258.17 mm	Mean: 172.15 mm	Mean: 630.29 mm
	0 75 1! mm	0 125 2! mm	0 250 5(mm	0 175 3! mm	300 600 90(mm
2016	Mean: 72.14 mm	Mean: 119.58 mm	Mean: 245.3 mm	Mean: 237.28 mm	Mean: 674.47 mm
2017	Mean: 89.39 mm	Mean: 158.25 mm	Mean: 187.25 mm	Mean: 194.52 mm	Mean: 629.66 mm
2018	Mean: 71.69 mm	Mean: 82.03 mm	Mean: 270.02 mm	Mean: 152.2 mm	Mean: 570.82 mm
2019	Mean: 68.35 mm	Mean: 92.78 mm	Mean: 285.73 mm	Mean: 186.43 mm	Mean: 631 mm
2020	Mean: 67.53 mm	Mean: 128.77 mm	Mean: 315.82 mm	Mean: 167.59 mm	Mean: 689.97 mm

3.0 WATER QUALITY

3.1 INTRODUCTION

The following presents the results of water quality monitoring conducted from 2008 to 2019 in the Winnipeg River Region. Five waterbodies were monitored in the Winnipeg River Region: two on-system annual sites (the Pointe du Bois Forebay and Lac du Bonnet) and one on-system rotational site (the Pine Falls Forebay); and one off-system annual site (Manigotagan Lake) and one off-system rotational site (Eaglenest Lake; Table 3.1-1 and Figure 3.1-1). Annual sites are sampled each year, whereas rotational sites are sampled once every three years on a rotational basis and are therefore limited to three or four years of data for the 12-year period. Eaglenest Lake is located on the Winnipeg River upstream of the Pointe du Bois Forebay and is not affected by Manitoba Hydro's hydraulic operating system and is therefore identified as an "off-system" site.

The CAMP water quality program includes four sampling periods (referred to as spring, summer, fall, and winter) per monitoring year (i.e., April-March) at a single location within each waterbody or area of a waterbody/river reach. Over the 12-year period, water quality sampling was conducted at each sampling location during each sampling period (i.e., n=48 for annual sites) with two exceptions (Table 3.1-1; Appendix 3-1):

- sampling could not be completed in the Pointe du Bois Forebay due to thin ice in the winter of 2009 therefore only 11 winter samples were collected over the 12-year period (i.e., n=47); and
- sampling could not be completed in Eaglenest Lake due to thin ice in the winter of 2019, therefore only three winter samples were collected over the 12-year period (i.e., n=15).

A detailed description of the program design and sampling methods is provided in Technical Document 1, Section 2.3.

Three indicators (dissolved oxygen (DO); water clarity; and nutrients/trophic status) were selected for detailed reporting (Table 3.1-2). Metrics for these indicators include DO and its supporting metric temperature/stratification, Secchi disk depth, turbidity, total suspended solids (TSS), total phosphorus (TP), total nitrogen (TN), and chlorophyll *a* (Table 3.1-2). A detailed description of these indicators is provided in CAMP (2024).

Table 3.1-1. 2008-2019 Water quality sampling inventory.

Waterbody/ Area	Sampling Year [1]											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
PDB	●	● [2]	●	●	●	●	●	●	●	●	●	●
LDB	●	●	●	●	●	●	●	●	●	●	●	●
PFF				●			●			●		
MANIG	●	●	●	●	●	●	●	●	●	●	●	●
EAGLE			●			●			●			● [2]

Notes:

1. Sampling year is from April-March.
2. No winter sample collected due to unsafe ice conditions.

Table 3.1-2. Water quality indicators and metrics.

Indicator	Metric	Units
Dissolved Oxygen	• Dissolved oxygen (DO)	milligrams per litre (mg/L) and percent (%) saturation
	• Temperature/stratification [1]	°C
Water Clarity	• Secchi disk depth	m
	• Turbidity	Nephelometric turbidity units (NTU)
	• Total suspended solids (TSS)	mg/L
Nutrients and Trophic Status	• Total phosphorus (TP)	mg/L
	• Total nitrogen (TN)	mg/L
	• Chlorophyll *a*	micrograms per litre (µg/L)

Notes:

1. Supporting metric.

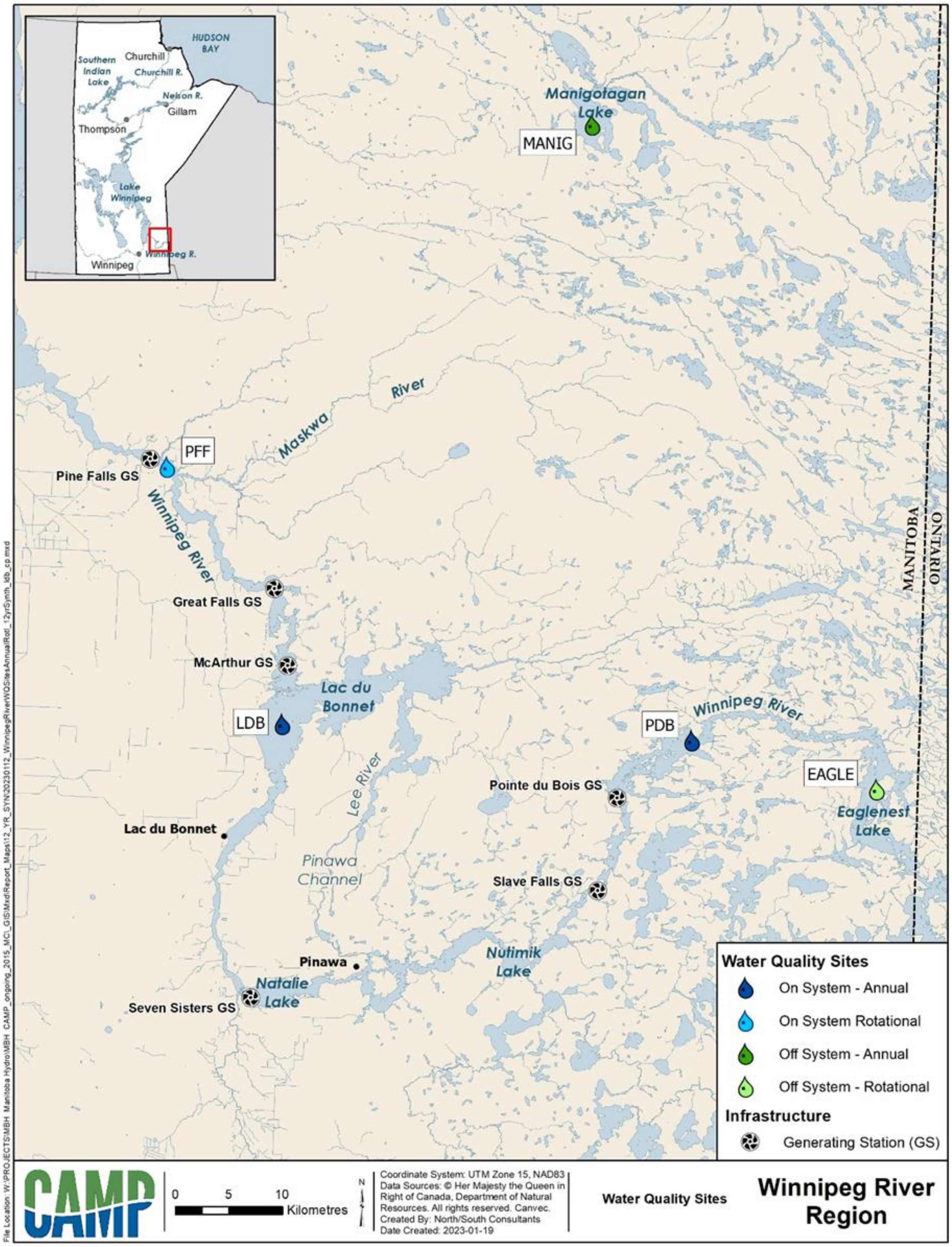


Figure 3.1-1. 2008-2019 Winnipeg River Region water quality sites.

3.2 DISSOLVED OXYGEN

3.2.1 DISSOLVED OXYGEN

3.2.1.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

The Pointe du Bois Forebay was well-oxygenated year-round and DO concentrations throughout the water column consistently met the Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOGs) instantaneous minimum objectives for cool- and cold-water aquatic life during the open-water and ice-cover seasons (Manitoba Water Stewardship (MWS) 2011; Table 3.2-1).

The Pointe du Bois Forebay was isothermal (i.e., thermal stratification was not observed) and DO concentrations were similar throughout the water column during each sampling period (Figures 3.2-1 and 3.2-2). During the open-water season, DO concentrations ranged from 7.22 to 14.04 mg/L at the surface and 7.19 to 14.07 mg/L near the bottom (maximum site water depth = 22.0 m). During the ice-cover season, DO concentrations ranged from 11.86 to 15.48 mg/L at the surface and 11.74 to 15.56 mg/L near the bottom (Table 3.2-2 and Figure 3.2-3).

DO concentrations varied between seasons with seasonal mean DO concentrations being higher in winter and spring when the water was cooler, and lower in the summer and fall when the water was warmer (Figure 3.2-4).

DO saturation was near 100% at both the surface and near the bottom during each season sampled (Figure 3.2-5). During the open-water season, surface DO saturation ranged from 86.1 to 121.9% with a mean of 101.4% and a median of 100.9% over the 12 years of monitoring. Mean surface DO saturation levels in the open-water season were similar from year to year ranging from 91.4 to 108.6% and were within or near the interquartile range (IQR) of 93.3 to 107.4%. Bottom DO saturation during the open-water season ranged from 85.6 to 122.1% with a mean of 100.3% and a median of 98.4% over the 12 years of monitoring. Mean bottom DO saturation levels in the open-water season were similar from year to year ranging from 90.9 to 107.2% and were within or near the IQR of 92.4 to 106.5% (Table 3.2-2 and Figure 3.2-6).

During the ice-cover season, DO saturation at the surface ranged from 81.1 to 110.3% with a mean of 96.4% and a median of 97.1%. The IQR was 94.0 to 98.7%. Bottom DO saturation during the ice-cover season ranged from 80.3 to 111.0% with a mean of 95.5% and a median of 94.9%. The IQR was 92.4 to 98.6% (Table 3.2-2 and Figure 3.2-7).

Lac du Bonnet

Lac du Bonnet was well-oxygenated year-round and DO concentrations throughout the water column consistently met the MWQSOGs instantaneous minimum objectives for cool- and cold-water aquatic life during the open-water and ice-cover seasons (Table 3.2-1).

Lac du Bonnet was typically isothermal; however, there were two occurrences of thermal stratification near the surface (thermocline at 0-1 m) in spring (2015 and 2018; Table 3.2-1 and Figure 3.2-1).

DO concentrations were similar throughout the water column during each sampling period (Figure 3.2-2). During the open-water season, DO concentrations ranged from 7.38 to 14.11 mg/L at the surface and 6.92 to 13.63 mg/L near the bottom (maximum site water depth = 23.8 m). During the ice-cover season, DO concentrations ranged from 13.60 to 15.62 mg/L at the surface and 13.56 to 15.36 mg/L near the bottom (Table 3.2-2 and Figure 3.2-8).

DO concentrations varied between seasons, with seasonal mean DO concentrations being higher in winter and spring when the water was cooler, and lower in the summer and fall when the water was warmer (Figure 3.2-4).

DO saturation was near 100% at the surface and near the bottom during each season sampled (Figure 3.2-5). During the open-water season, surface DO saturation ranged from 88.1 to 124.2% over the 12 years of monitoring, with a mean of 104.0% and a median of 102.2%. Mean surface DO saturation levels in the open-water season were similar from year to year ranging from 93.9 to 112.7 % and were within or near the IQR of 95.1 to 113.1%. Bottom DO saturation during the open-water season ranged from 80.1 to 124.0% with a mean of 100.5% and a median of 99.0% over the 12 years of monitoring. Mean bottom DO saturation levels in the open-water season were similar from year to year ranging from 90.2 to 109.0% and were within or near the IQR of 92.3 to 108.4% (Table 3.2-2 and Figure 3.2-6).

During the ice-cover season, DO saturation at the surface ranged from 94.1 to 110.0% with a mean of 104.8% and a median of 105.3%. The IQR was 102.7 to 108.7%. Bottom DO saturation during the ice-cover season ranged from 93.0 to 107.7% with a mean of 103.8% and a median of 105.1%. The IQR was 103.4 to 106.2% (Table 3.2-2 and Figure 3.2-7).

ROTATIONAL SITES

Pine Falls Forebay

The Pine Falls Forebay was well-oxygenated year-round and DO concentrations throughout the water column consistently met the MWQSOGs instantaneous minimum objectives for cool- and cold-water aquatic life during the open-water and ice-cover seasons (Table 3.2-1).

The Pine Falls Forebay was isothermal and DO concentrations were similar throughout the water column during each sampling period (Table 3.2-1, and Figures 3.2-1 and 3.2-2). During the open-water season, DO concentrations ranged from 8.09 to 13.83 mg/L at the surface and 8.06 to 13.68 mg/L near the bottom (maximum site water depth = 39.0 m). During the ice-cover season, the surface DO concentration was 13.66 mg/L in 2011 and 15.31 mg/L in 2017 and near the bottom it was 13.70 mg/L in 2011 and 14.87 mg/L in 2017 (Table 3.2-2 and Figure 3.2-9).

DO saturation in the Pine Falls Forebay was near 100% at both the surface and near the bottom of the water column during each season sampled. During the open-water season, surface DO saturation ranged from 92.4 to 122.5% with a mean of 106.7% and a median of 109.6% over the three years of monitoring. Mean surface DO saturation levels in the open-water season were similar from year to year ranging from 100.8 to 116.3% and were within or near the IQR of 93.7 to 118.2%. Bottom DO saturation during the open-water season ranged from 91.2 to 121.2% with a mean of 105.4 and median of 108.5% over the three years of monitoring. Mean bottom DO saturation levels in the open-water season were similar from year to year ranging from 99.2 to 115.3% and were within or near the IQR of 92.2 to 116.7% (Table 3.2-2 and Figure 3.2-6).

During the ice-cover season, DO saturation at the surface was 100.9% in 2011 and 108.6% in 2017 with a mean of 104.7%. Bottom DO saturation during the ice-cover season was 101.2% in 2011 and 105.5% in 2017 with a mean of 103.3% (Table 3.2-2 and Figure 3.2-7).

3.2.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Manigotagan Lake was well-oxygenated near the surface and DO concentrations met the MWQSOGs during all sampling periods. DO concentrations decreased with water depth and fell below the MWQSOGs instantaneous minimum objectives for cool- and cold-water aquatic life in the open-water season.

Manigotagan Lake was thermally stratified during most open-water sampling events conducted over the 12 years of monitoring (Figure 3.2-1). Specifically, stratification was observed in five of the 12 spring monitoring events (2008, 2010, 2014, 2015, and 2018), during each summer sampling event, and all but one (2012) fall sampling event (Table 3.2-3).

During late summer or fall of each year, DO concentrations decreased down the water column in Manigotagan Lake to levels below one or more of the MWQSOGs instantaneous minimum objectives for cool- and cold-water aquatic life (5.0 and 4.0 mg/L, respectively) at approximately 14-20 m from the surface (Table 3.2-3 and Figure 3.2-2). During the open-water season, DO concentrations ranged from 7.29 to 12.93 mg/L at the surface and from 0.12 to 13.39 mg/L near the bottom (maximum site water depth = 24.0 m; Table 3.2-4 and Figure 3.2-10).

Similarly, during the ice-cover season Manigotagan Lake was well-oxygenated near the surface while DO concentrations decreased with depth and fell below the MWQSOGs instantaneous minimum objectives for cold-water aquatic life near the bottom of the water column in some winters (Figure 3.2-2). Specifically, DO concentrations near the bottom were below the MWQSOGs instantaneous minimum objectives for cold-water aquatic life (8.0 mg/L) in the winters of 2009, 2018, and 2019 (Table 3.2-3). In the ice-cover season, DO concentrations ranged from 11.87 to 15.16 mg/L at the surface and from 4.67 to 10.82 mg/L near the bottom (Table 3.2-4 and Figure 3.2-10). The decrease in DO concentrations with depth occurred despite the lake being isothermal in winter (Table 3.2-3 and Figure 3.2-1).

DO concentrations varied between seasons with seasonal mean DO concentrations being higher in winter and spring when the water was colder, and lower in the summer and fall when the water was warmer (Figure 3.2-11).

DO saturation was near 100% at the surface during each season sampled (Figure 3.2-12). In the open-water season, surface DO saturation ranged from 83.6 to 117.4% with a mean of 100.2% and a median of 100.0% over the 12 years of monitoring. Mean surface DO saturation levels in the open-water season were similar from year to year ranging from 92.1 to 108.7% and were within or near the IQR of 94.6 to 106.0% (Table 3.2-4 and Figure 3.2-13). During the ice-cover season, surface DO saturation ranged from 85.4 to 112.3% with a mean of 100.3% and a median of 102.2%. The IQR for the ice-cover season was 96.9 to 106.5% (Table 3.2-4 and Figure 3.2-14).

Seasonal differences in both DO concentration and percent saturation occurred near the bottom of the water column where DO saturation decreased throughout the open-water season and was somewhat reduced in winter (Figures 3.2-11 and 3.2-12). During the open-water season, bottom DO saturation ranged from 0.8 to 111.6% with a mean of 57.7% and a median of 56.2% over the 12 years of monitoring (Table 3.2-4). Bottom DO saturation tended to be above the IQR for the open-water season (31.3 to 93.4%) in spring (mean = 99.0%) and below the IQR in fall (mean = 26.4%; Figure 3.2-13). During the ice-cover season, bottom DO saturation ranged from 35.3 to 85.0% with a mean of 62.2% and a median of 66.3%. The IQR for the ice-cover season was 44.3 to 74.6% (Table 3.2-4 and Figure 3.2-14).

ROTATIONAL SITES

Eaglenest Lake

Eaglenest Lake was well-oxygenated year-round and DO concentrations throughout the water column consistently met the MWQSOGs instantaneous minimum objectives for cool- and cold-water aquatic life during the open-water and ice-cover seasons (Table 3.2-3).

Eaglenest Lake was isothermal with the exception of spring 2010 when thermal stratification occurred near the surface (thermocline at 0-1 m; Table 3.2-3 and Figure 3.2-1).

DO concentrations were similar throughout the water column during each sampling period (Figure 3.2-2). During the open-water season, DO concentrations ranged from 8.23 to 13.24 mg/L at the surface and from 8.06 to 13.21 mg/L near the bottom (maximum site water depth = 21.6 m). During the ice-cover season, the DO concentration at the surface was 13.65 mg/L in 2013 and 14.19 mg/L in 2016, and near the bottom it was 13.32 mg/L in 2013 and 14.20 mg/L in 2016 (Table 3.2-4 and Figure 3.2-15).

DO saturation in Eaglenest Lake was near 100% at both the surface and near the bottom of the water column during each season sampled. During the open-water season, surface DO saturation ranged from 90.5 to 118.3% with a mean of 102.7% and a median of 103.7% over the four years of monitoring. Mean surface DO saturation levels in the open-water season were similar from year to year ranging from 97.2 to 105.0% and were within the IQR of 95.9 to 105.9%. Bottom DO saturation during the open-water season ranged from 90.0 to 114.7% with a mean of 100.3 and median of 97.9% over the four years of monitoring. Mean bottom DO saturation levels in the open-water season were similar from year to year ranging from 91.8 to 103.8% and were within or near the IQR of 94.3 to 104.8% (Table 3.2-4 and Figure 3.2 13).

During the ice-cover season, DO saturation at the surface was 101.5% in 2013 and 106.7% in 2016 with a mean of 104.1%, and bottom DO saturation during the ice-cover season was 99.1% in 2013 and 100.9% in 2016 with a mean of 100.0% (Table 3.2-4 and Figure 3.2-14).

Table 3.2-1. 2008-2019 On-system sites summary of thermal stratification and DO concentrations.

Metric	Sampling Year	Surface or Bottom	PDB				LDB				PFF			
			Open-Water			Ice-Cover	Open-Water			Ice-Cover	Open-Water			Ice-Cover
			SP	SU	FA	WI	SP	SU	FA	WI	SP	SU	FA	WI
Thermal Stratification	2008		No	No	No	No	No	No	No	No				
	2009		No	No	No	ND	No	No	No	No				
	2010		No	No	No	No	No	No	No	No				
	2011		No	No	No	No	No	No	No	No	No	No	No	No
	2012		No	No	No	No	No	No	No	No				
	2013		No	No	No	No	No	No	No	No				
	2014		No	No	No	No	No	No	No	No	No	No	No	No
	2015		No	No	No	No	2015	No	No	No				
	2016		No	No	No	No	No	No	No	No				
	2017		No	No	No	No	No	No	No	No	No	No	No	No
	2018		No	No	No	No	2018	No	No	No				
	2019		No	No	No	No	No	No	No	No				
DO met MWQSOGs PAL objectives	2008	Surface	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
		Bottom	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
	2009	Surface	Yes	ND	Yes	ND	Yes	ND	Yes	Yes				
		Bottom	Yes	ND	Yes	ND	Yes	ND	Yes	Yes				
	2010	Surface	ND	Yes	Yes	ND	ND	Yes	Yes	ND				
		Bottom	ND	Yes	Yes	ND	ND	Yes	Yes	ND				
	2011	Surface	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
		Bottom	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	2012	Surface	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
		Bottom	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
	2013	Surface	ND	Yes	Yes	Yes	ND	Yes	Yes	Yes				
		Bottom	ND	Yes	Yes	Yes	ND	Yes	Yes	Yes				
	2014	Surface	Yes	Yes	Yes	ND	Yes	Yes	Yes	ND	Yes	Yes	Yes	ND
		Bottom	Yes	Yes	Yes	ND	Yes	Yes	Yes	ND	Yes	Yes	Yes	ND
	2015	Surface	ND	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
		Bottom	ND	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
	2016	Surface	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
		Bottom	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
	2017	Surface	ND	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
		Bottom	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	2018	Surface	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
		Bottom	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
	2019	Surface	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
		Bottom	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				

Notes:

1. SP = spring; SU = summer; FA = fall; WI = winter.
2. ND = No data.
3. MWQSOGs = Manitoba Water Quality Standards, Objectives, and Guidelines; PAL = Protection of aquatic life.
4. DO concentrations were compared to the most stringent MWQSOGs instantaneous minimum PAL objectives for each season; i.e., 5 mg/L for cool-water early life for the open-water season and 8 mg/L for cold-water early life the ice-cover season.
5. Cells with a year indicated denote instances of stratification or non-compliance with MWQSOGs instantaneous minimum objectives.
6. [ ] = Sampling did not occur.

Table 3.2-2. 2008-2019 On-system sites DO, water depth, and ice thickness summary statistics.

Site	Statistic	Dissolved Oxygen								Water Depth at Site (m)		Ice Thickness at Site (m)
		DO - Surface (mg/L)		DO - Bottom (mg/L)		DO Saturation - Surface (%)		DO Saturation - Bottom (%)				
		OW	IC	OW	IC	OW	IC	OW	IC	OW	IC	IC
PDB	Mean	9.92	13.51	9.83	13.37	101.4	96.4	100.3	95.5	14.0	8.3	0.57
	Median	9.21	13.28	9.19	13.24	100.9	97.1	98.4	94.9	14.0	8.2	0.52
	Minimum	7.22	11.86	7.19	11.74	86.1	81.1	85.6	80.3	6.0	7.5	0.38
	Maximum	14.04	15.48	14.07	15.56	121.9	110.3	122.1	111.0	22.0	8.9	0.77
	SD	2.01	1.04	1.99	1.09	10.4	7.63	10.42	8.33	3.75	0.45	0.12
	SE	0.361	0.348	0.358	0.365	1.87	2.54	1.87	2.78	0.62	0.10	0.00
	Lower Quartile	8.57	13.07	8.40	12.73	93.3	94.0	92.4	92.4	20.8	8.8	0.80
	Upper Quartile	10.27	14.04	10.13	13.87	107.4	98.7	106.5	98.6	7.1	7.7	0.40
	n	31	9	31	9	31	9	31	9	36	11	11
	% Detections	100	100	100	100	100	100	100	100	-	-	-
LDB	Mean	10.14	14.65	9.94	14.51	104.0	104.8	100.5	103.8	13.5	13.3	0.71
	Median	9.50	14.77	9.47	14.66	102.2	105.3	99.0	105.1	13.0	12.7	0.68
	Minimum	7.38	13.60	6.92	13.56	88.1	94.1	80.1	93.0	8.6	7.6	0.5
	Maximum	14.11	15.62	13.63	15.36	124.2	110.0	124.0	107.7	18.3	23.8	1.15
	SD	1.87	0.638	1.92	0.645	10.3	4.91	10.6	4.37	2.77	4.16	0.19
	SE	0.325	0.202	0.335	0.204	1.80	1.55	1.84	1.38	0.46	1.20	0.10
	Lower Quartile	8.74	14.30	8.66	14.04	95.1	102.7	92.3	103.4	17.7	19.1	1.1
	Upper Quartile	11.51	14.92	11.45	14.91	113.1	108.7	108.4	106.2	9.8	8.2	0.5
	n	33	10	33	10	33	10	33	10	36	12	12
	% Detections	100	100	100	100	100	100	100	100	-	-	-
PFF	Mean	10.60	14.49	10.53	14.29	106.7	104.7	105.4	103.3	27.4	21.0	0.84
	Median	10.53	-	10.51	-	109.6	-	108.5	-	26.6	19.6	0.84
	Minimum	8.09	13.66	8.06	13.70	92.4	100.9	91.2	101.2	13.0	15.8	0.81
	Maximum	13.83	15.31	13.68	14.87	122.5	108.6	121.2	105.5	39.0	27.5	0.87
	SD	2.19	-	2.21	-	12.4	-	12.9	-	8.32	5.97	0.04
	SE	0.732	-	0.736	-	4.15	-	4.30	-	2.77	3.40	0.00
	Lower Quartile	8.98	-	8.99	-	93.7	-	92.2	-	37.7	26.7	0.9
	Upper Quartile	12.03	-	12.10	-	118.2	-	116.7	-	16.2	16.2	0.8
	n	9	2	9	2	9	2	9	2	9	3	2
	% Detections	100	100	100	100	100	100	100	100	-	-	-

Notes:

1. OW = Open-water season; IC = Ice-cover season.
2. SD = standard deviation; SE = standard error; n = number of samples.

Table 3.2-3. 2008-2019 Off-system sites summary of thermal stratification and DO concentrations.

Metric	Sampling Year	Surface or Bottom	MANIG				EAGLE			
			Open-Water			Ice-Cover	Open-Water			Ice-Cover
			SP	SU	FA	WI	SP	SU	FA	WI
Thermal Stratification	2008		2008	2008	2008	No				
	2009		No	2009	2009	No				
	2010		2010	2010	2010	No	2010	No	No	No
	2011		No	2011	2011	No				
	2012		No	2012	No	No				
	2013		No	2013	2013	No	No	No	No	No
	2014		2014	2014	2014	No				
	2015		2015	2015	2015	No				
	2016		No	2016	2016	No	No	No	No	No
	2017		No	2017	2017	No				
	2018		2018	2018	2018	No				
	2019		No	2019	2019	No	No	No	No	ND
DO met MWQSOGs PAL objectives	2008	Surface	Yes	Yes	Yes	Yes				
		Bottom	ND	Yes	2008	Yes				
	2009	Surface	Yes	ND	Yes	Yes				
		Bottom	ND	ND	Yes	2009				
	2010	Surface	Yes	Yes	Yes	ND	Yes	Yes	Yes	ND
		Bottom	ND	Yes	2010	ND	ND	Yes	Yes	ND
	2011	Surface	Yes	Yes	Yes	Yes				
		Bottom	Yes	Yes	2011	Yes				
	2012	Surface	Yes	Yes	Yes	Yes				
		Bottom	Yes	2012	Yes	Yes				
	2013	Surface	ND	Yes	Yes	Yes	ND	Yes	Yes	Yes
		Bottom	ND	ND	ND	Yes	ND	Yes	Yes	Yes
	2014	Surface	Yes	Yes	Yes	ND				
		Bottom	Yes	ND	ND	ND				
	2015	Surface	Yes	Yes	Yes	Yes				
		Bottom	Yes	Yes	2015	Yes				
	2016	Surface	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
		Bottom	Yes	Yes	2016	Yes	Yes	Yes	Yes	Yes
	2017	Surface	Yes	Yes	Yes	Yes				
		Bottom	Yes	2017	2017	Yes				
	2018	Surface	Yes	Yes	Yes	Yes				
		Bottom	Yes	Yes	2018	2018				
	2019	Surface	Yes	Yes	Yes	Yes	Yes	Yes	Yes	ND
		Bottom	Yes	Yes	2019	2019	Yes	Yes	Yes	ND

Notes:

1. SP = spring; SU = summer; FA = fall; WI = winter; DO = dissolved oxygen; MWQSOG = Manitoba Water Quality Standards, Objectives, and Guidelines; PAL = Protection of Aquatic Life.
2. ND = No data.
4. DO concentrations were compared to the most stringent MWQSOGs instantaneous minimum PAL objectives for each season; i.e., 5 mg/L for cool-water early life for the open-water season and 8 mg/L for cold-water early life the ice-cover season.
5. Cells with a year indicated denote instances of stratification or non-compliance with MWQSOGs instantaneous minimum objectives.
6. = Sampling did not occur.

Table 3.2-4. 2008-2019 Off-system sites DO, water depth, and ice thickness summary statistics.

Site	Statistic	Dissolved Oxygen								Water Depth at Site (m)		Ice Thickness at Site (m)
		DO - Surface (mg/L)		DO - Bottom (mg/L)		DO Saturation - Surface (%)		DO Saturation - Bottom (%)				
		OW	IC	OW	IC	OW	IC	OW	IC	OW	IC	IC
MANIG	Mean	9.86	13.71	6.71	7.84	100.2	100.3	57.7	62.2	21.2	20.1	0.65
	Median	9.22	13.87	6.45	8.48	100.0	102.2	56.2	66.3	21.0	20.6	0.62
	Minimum	7.29	11.87	0.12	4.67	83.6	85.4	0.8	35.3	19.1	13.8	0.49
	Maximum	12.93	15.16	13.39	10.82	117.4	112.3	111.6	85.0	23.8	24.0	0.9
	SD	1.55	1.06	4.13	2.20	9.20	8.65	34.4	18.8	1.00	2.45	0.13
	SE	0.266	0.334	0.780	0.696	1.58	2.74	6.50	5.93	0.17	0.70	0.00
	Lower Quartile	8.73	13.02	3.47	5.86	94.6	96.9	31.3	44.3	23.2	22.6	0.9
	Upper Quartile	11.47	14.21	11.01	9.22	106.0	106.5	93.4	74.6	19.9	16.1	0.5
	n	34	10	28	10	34	10	28	10	36	12	12
	% Detections	100	100	100	100	100	100	100	100	-	-	-
EAGLE	Mean	10.04	13.92	9.79	13.76	102.7	104.1	100.3	100.0	19.8	15.7	0.47
	Median	9.45	-	9.43	-	103.7	-	97.9	-	20.4	16.0	0.47
	Minimum	8.23	13.65	8.06	13.32	90.5	101.5	90.0	99.1	14.9	10.0	0.42
	Maximum	13.24	14.19	13.21	14.20	118.3	106.7	114.7	100.9	21.6	21.2	0.51
	SD	1.74	-	1.90	-	8.46	-	8.99	-	1.89	5.60	0.05
	SE	0.524	-	0.600	-	2.55	-	2.84	-	0.54	3.20	0.00
	Lower Quartile	8.85	-	8.41	-	95.9	-	94.3	-	21.6	20.7	0.5
	Upper Quartile	10.77	-	9.75	-	105.9	-	104.8	-	16.8	10.6	0.4
	n	11	2	10	2	11	2	10	2	12	3	3
	% Detections	100	100	100	100	100	100	100	100	-	-	-

Notes:

1. OW = Open-water season; IC = Ice-cover season.
2. SD = standard deviation; SE = standard error; n = number of samples.

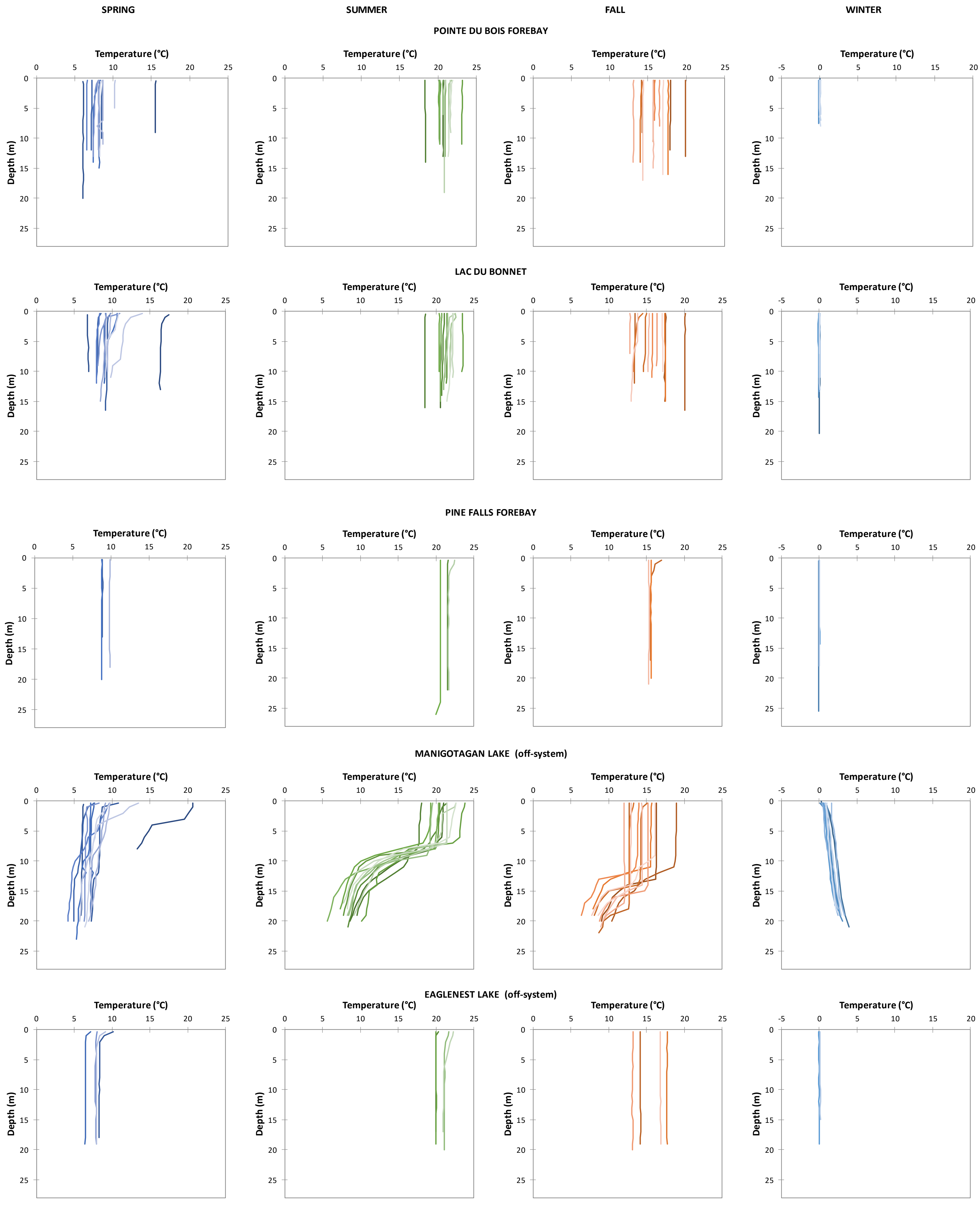


Figure 3.2-1. 2008-2019 On-system and off-system water temperature depth profiles.

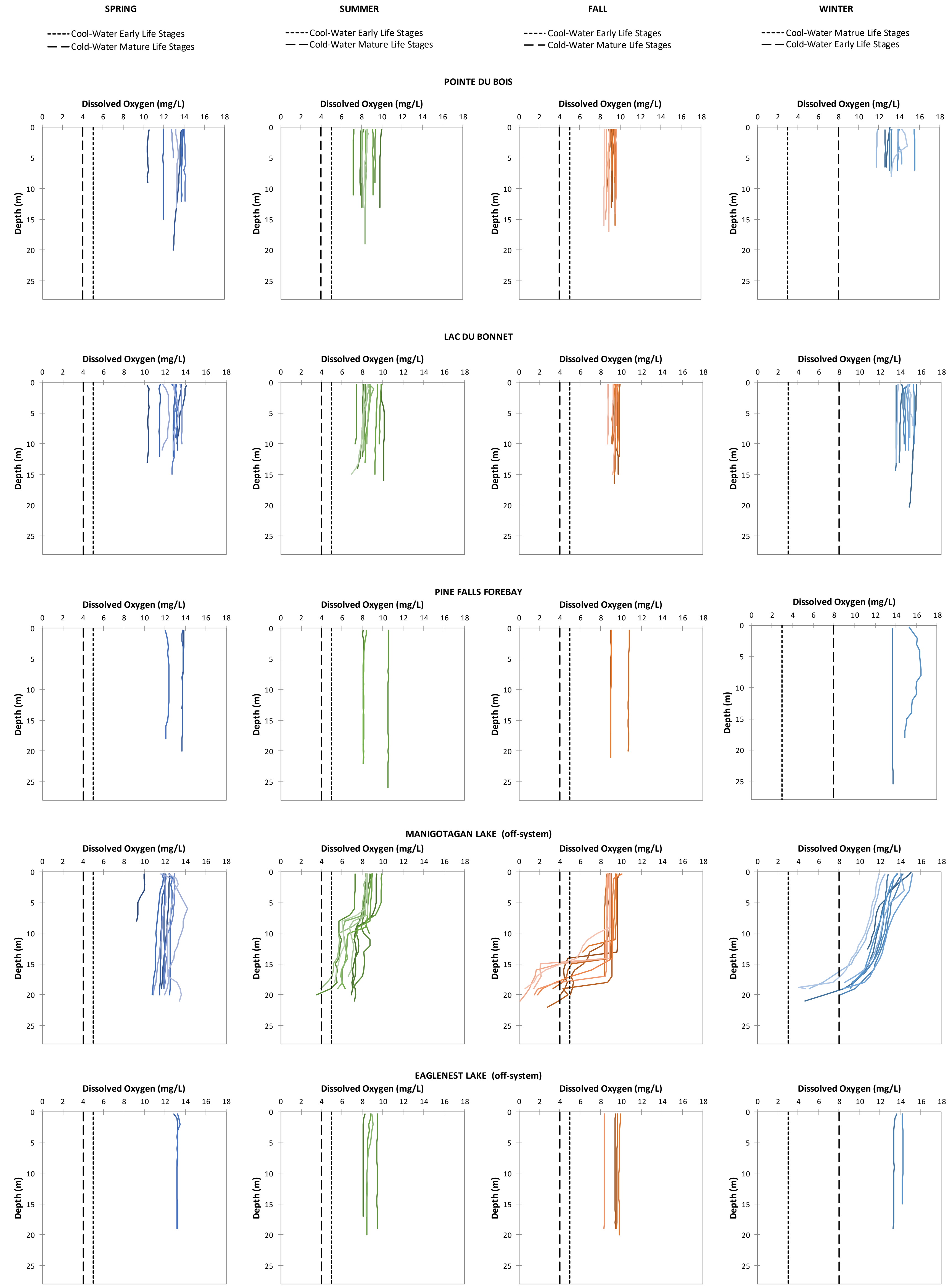


Figure 3.2-2. 2008-2019 On-system and off-system dissolved oxygen depth profiles and comparison to instantaneous minimum objectives for the protection of aquatic life.

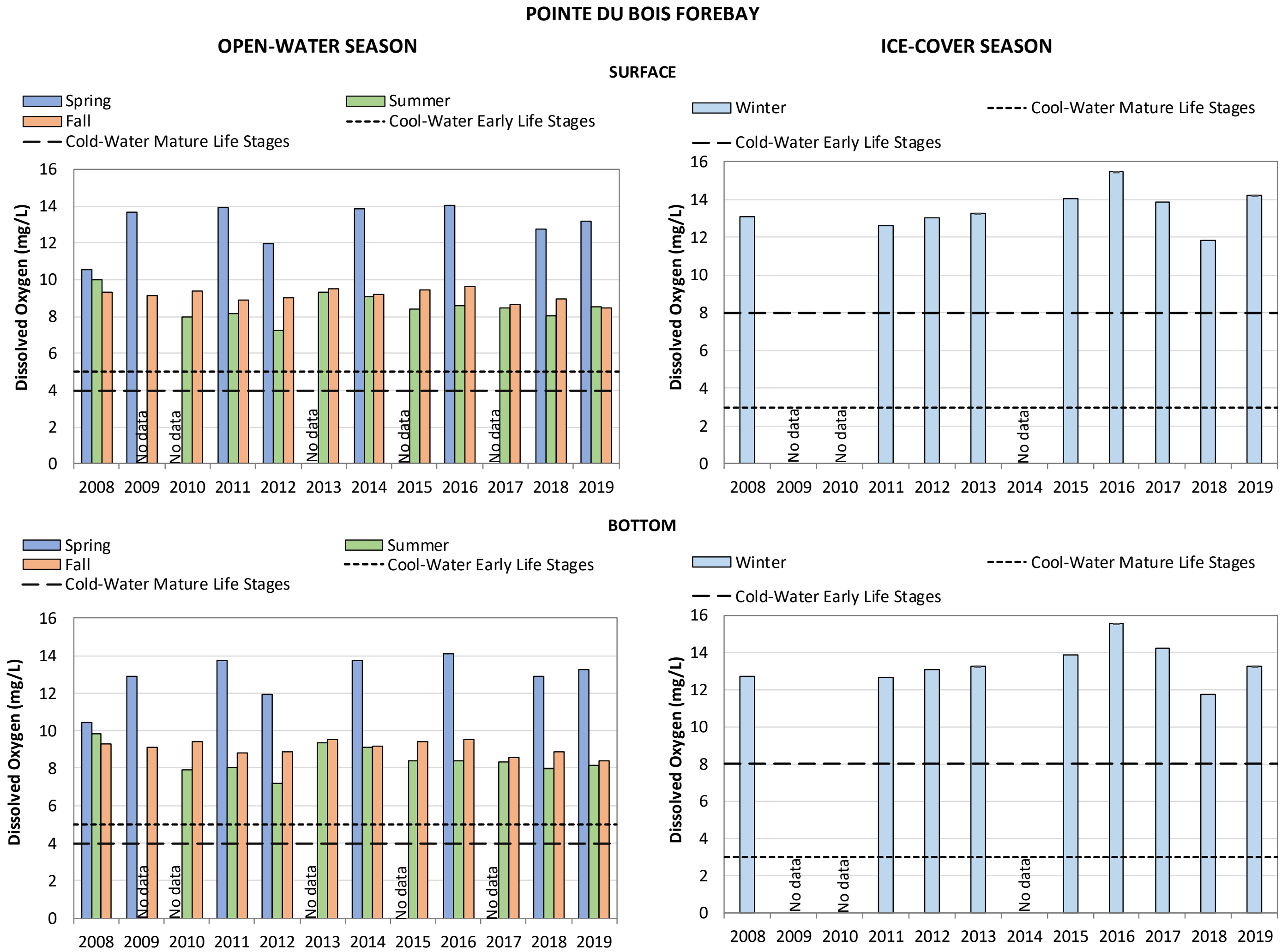


Figure 3.2-3. 2008-2019 Pointe du Bois Forebay surface and bottom dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

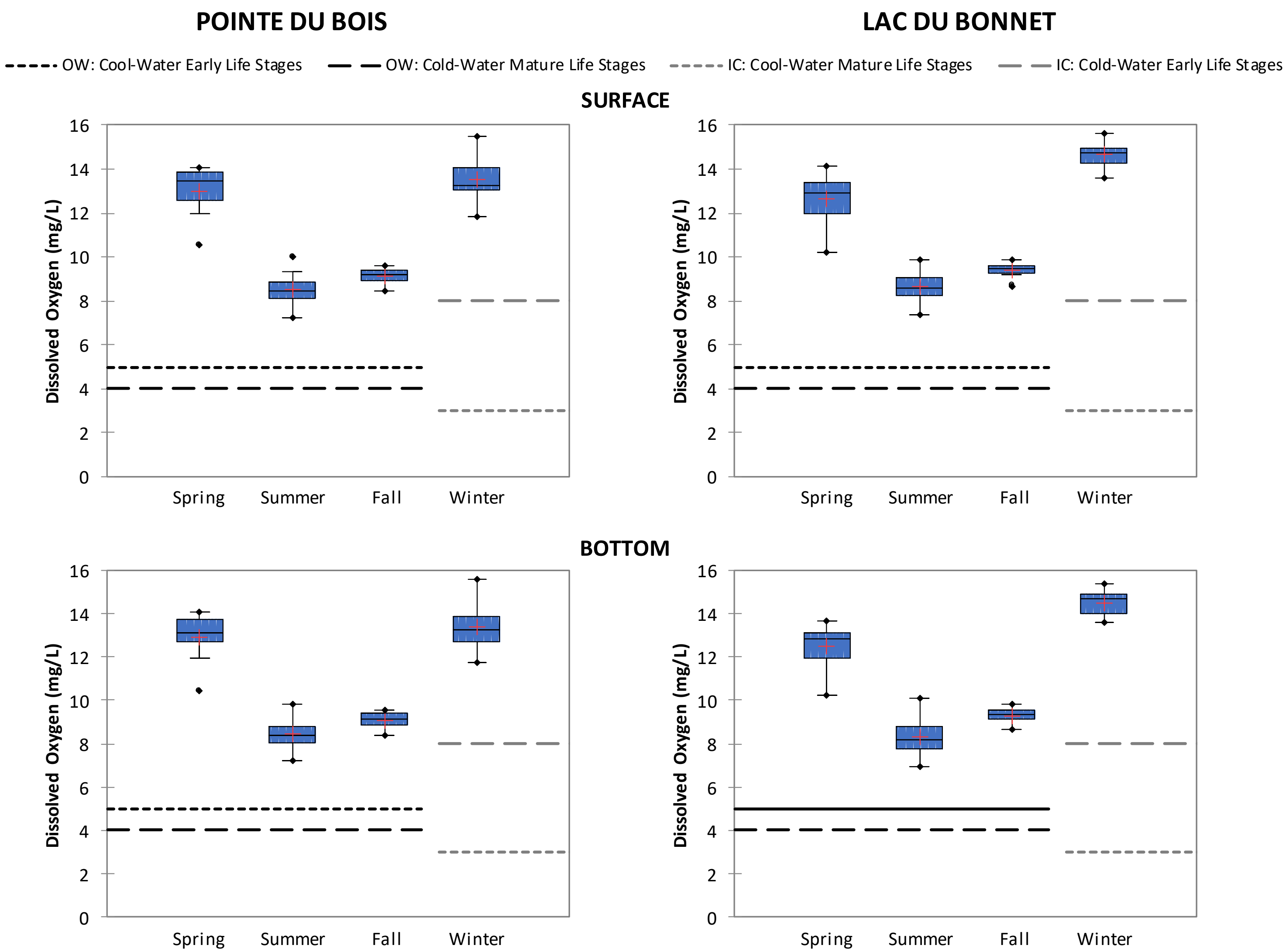


Figure 3.2-4. 2008-2019 On-system seasonal surface and bottom dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

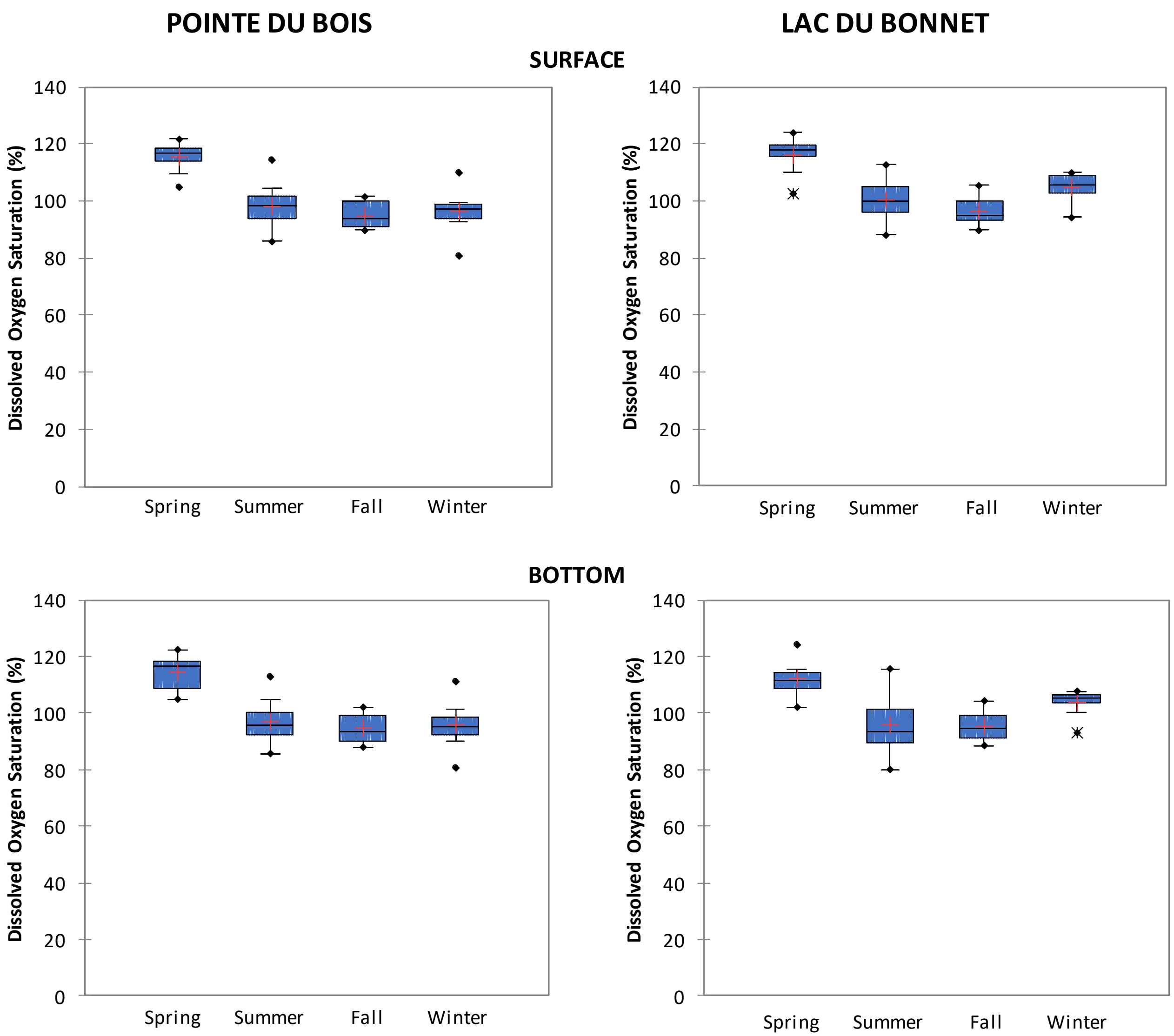


Figure 3.2-5. 2008-2019 On-system seasonal surface and bottom dissolved oxygen saturation.

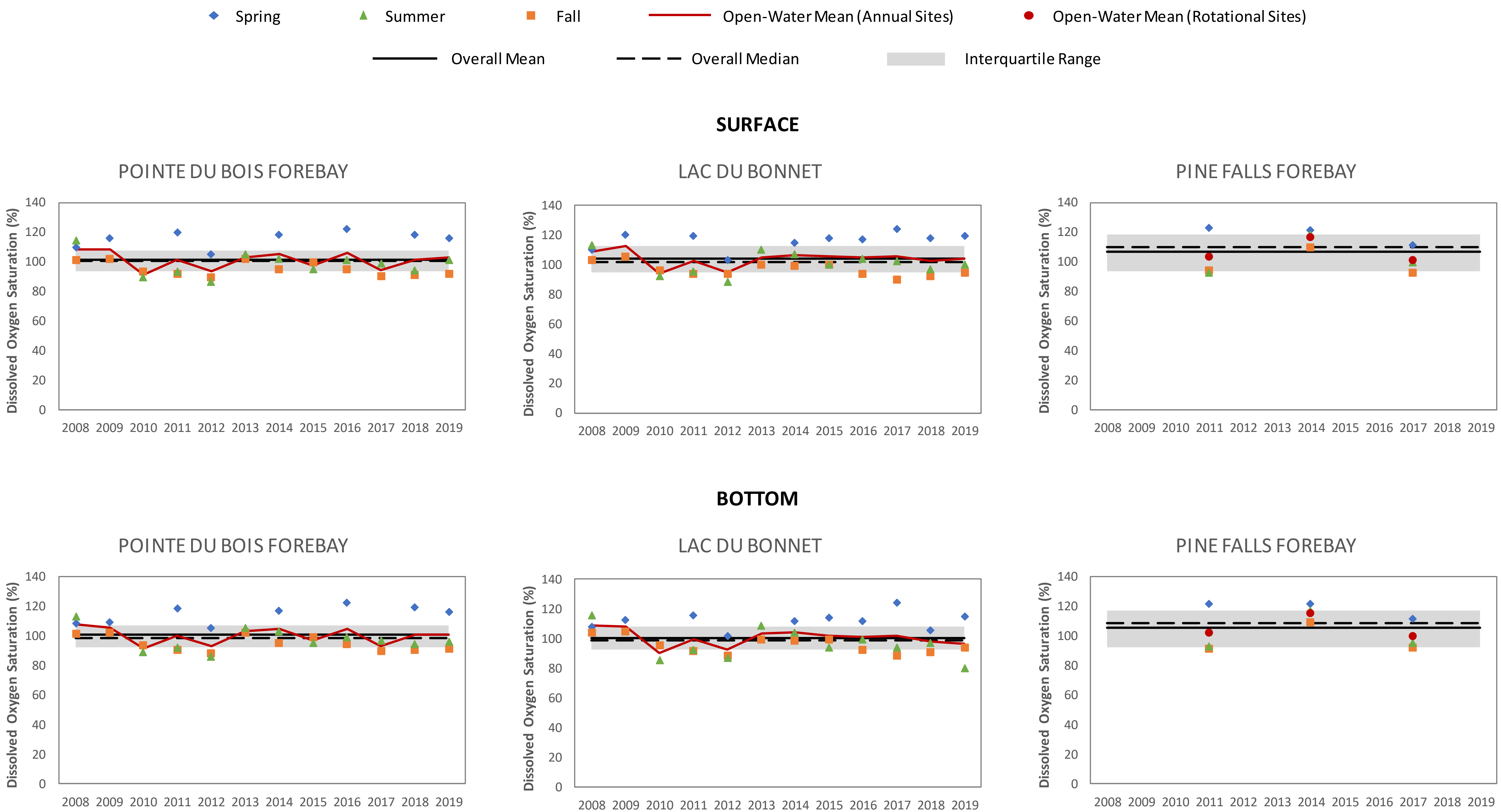


Figure 3.2-6. 2008-2019 On-system open-water season surface and bottom dissolved oxygen saturation.

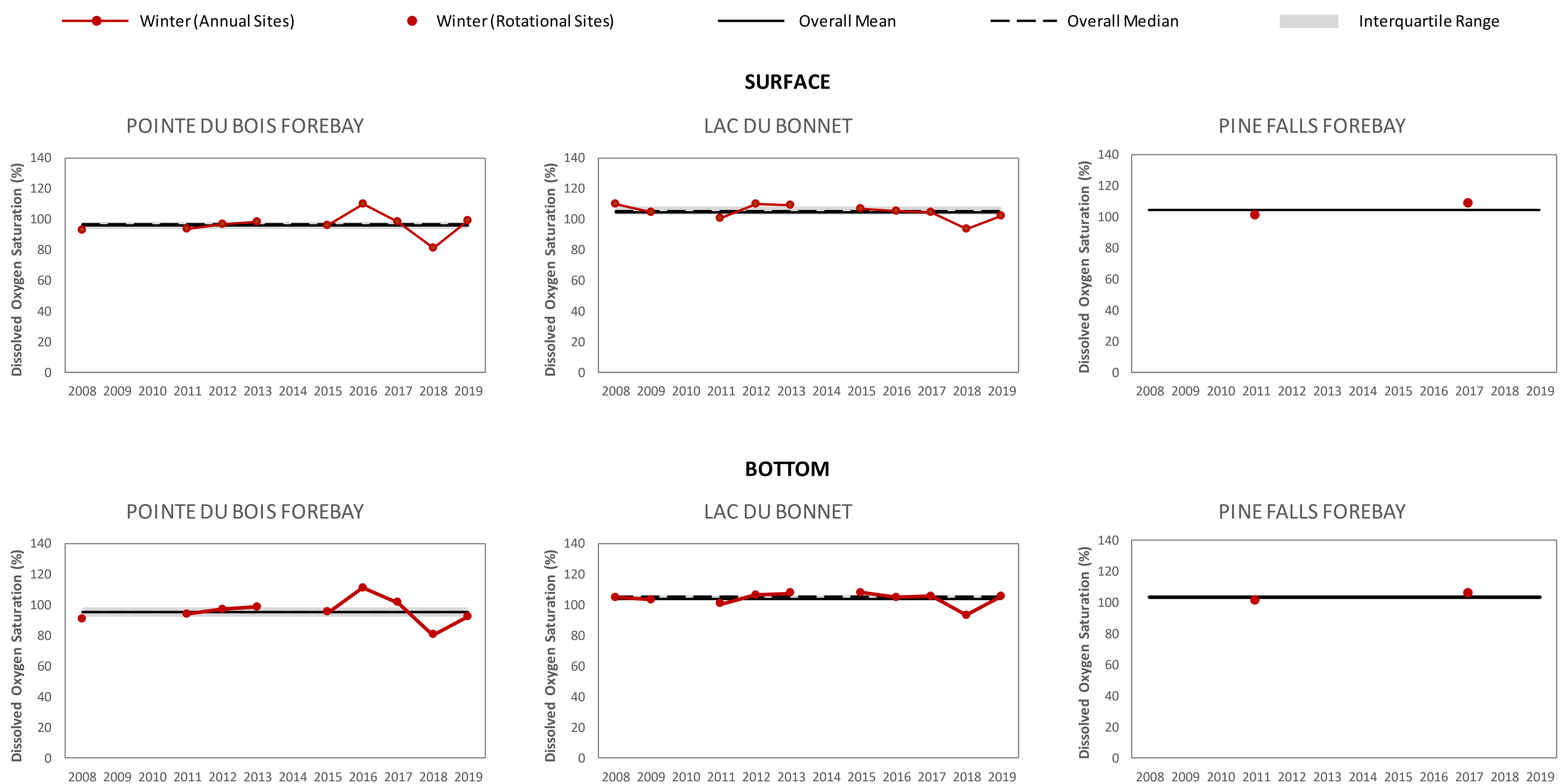


Figure 3.2-7. 2008-2019 On-system ice-cover season surface and bottom dissolved oxygen saturation.

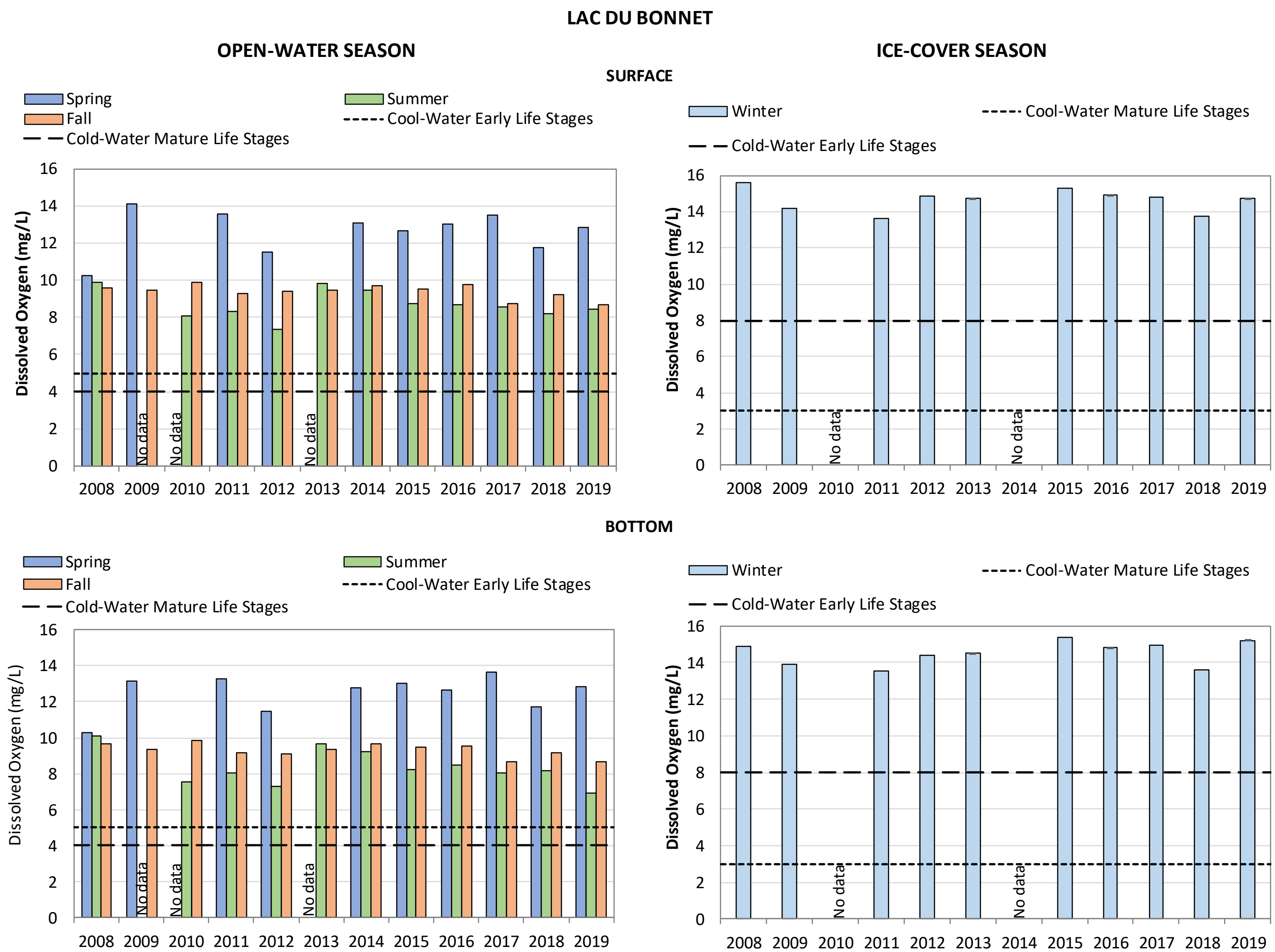


Figure 3.2-8. 2008-2019 Lac du Bonnet surface and bottom dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

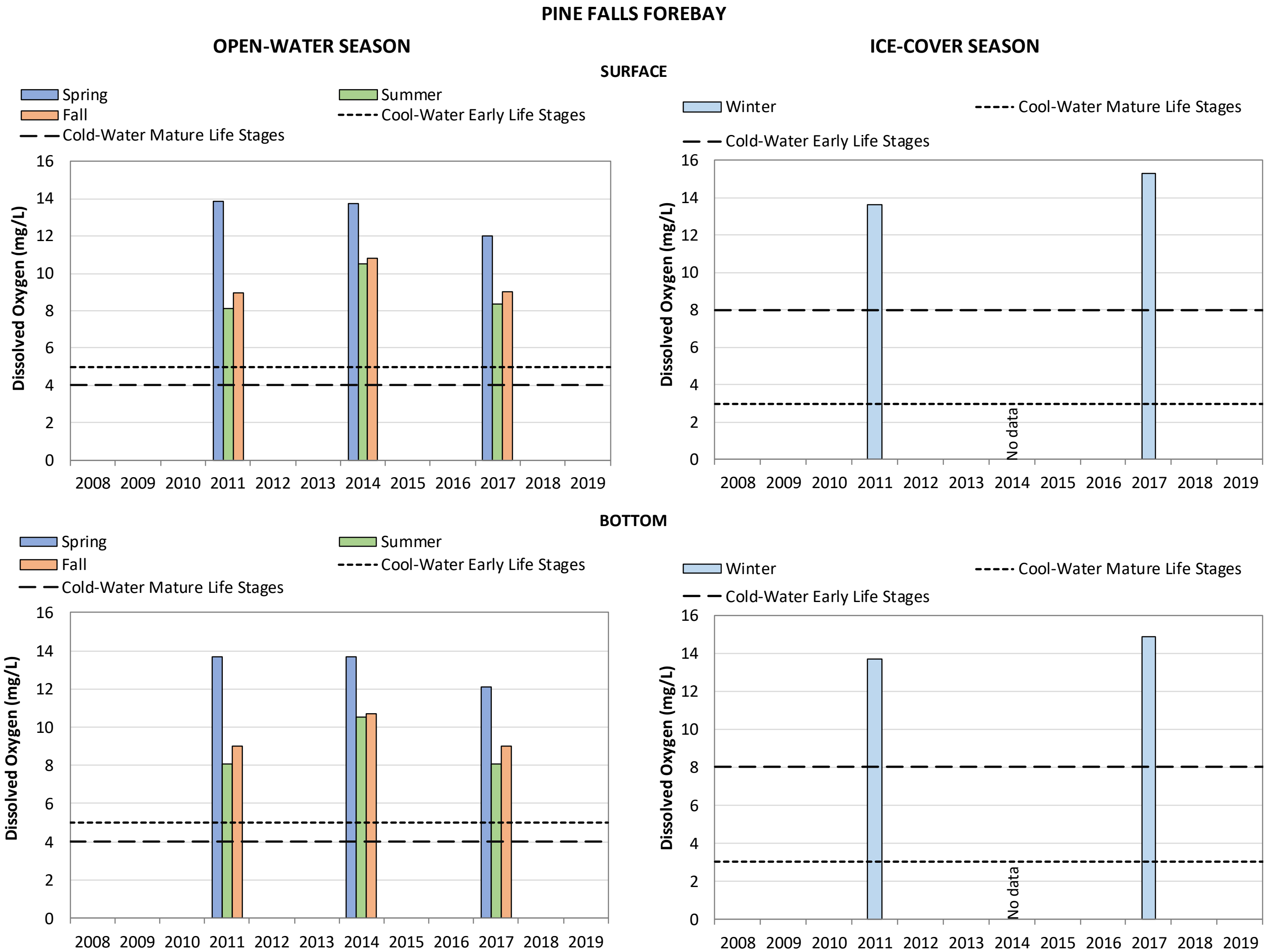


Figure 3.2-9. 2008-2019 Pine Falls Forebay surface and bottom dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

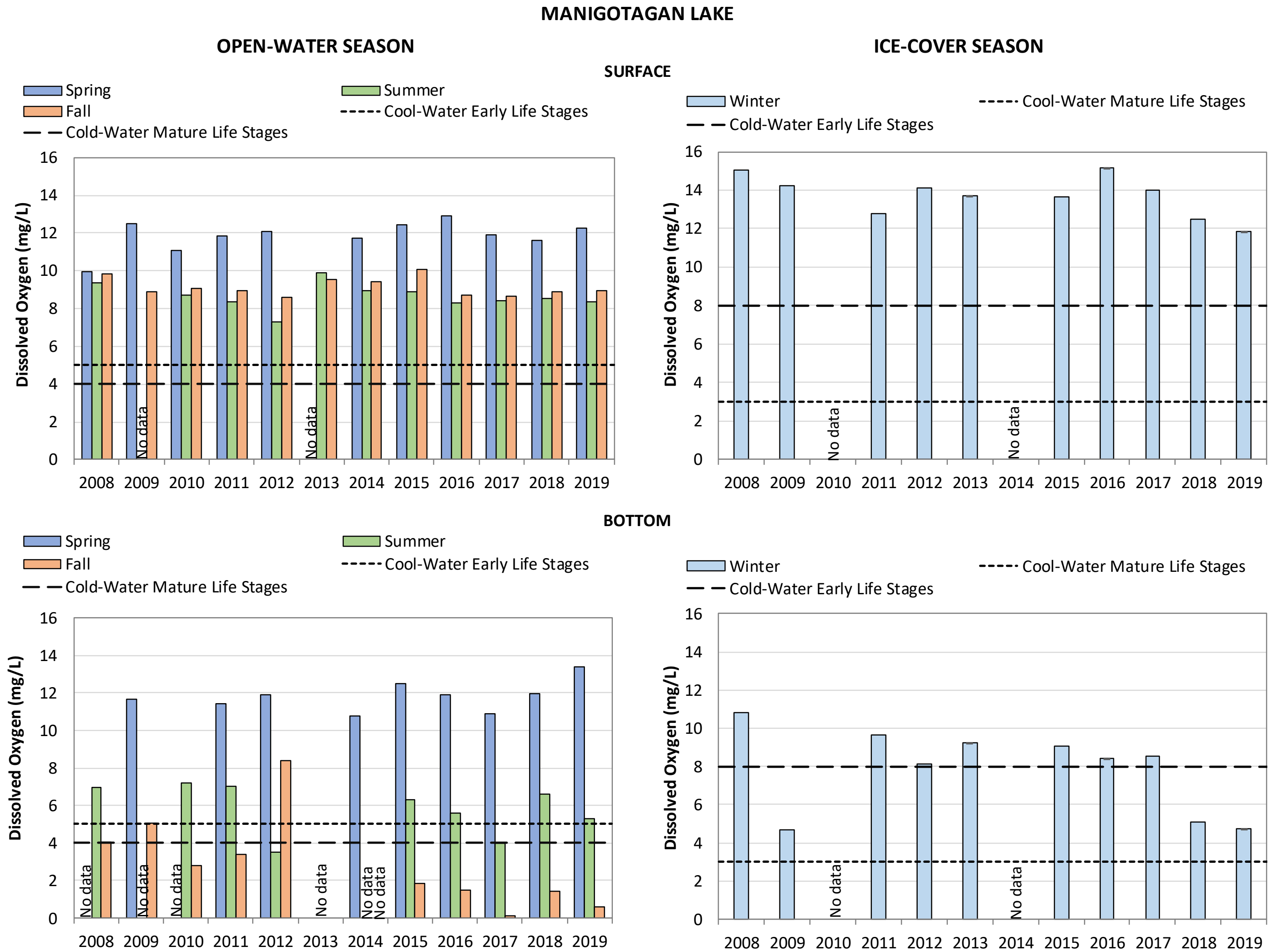


Figure 3.2-10. 2008-2019 Manigotagan Lake surface and bottom dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

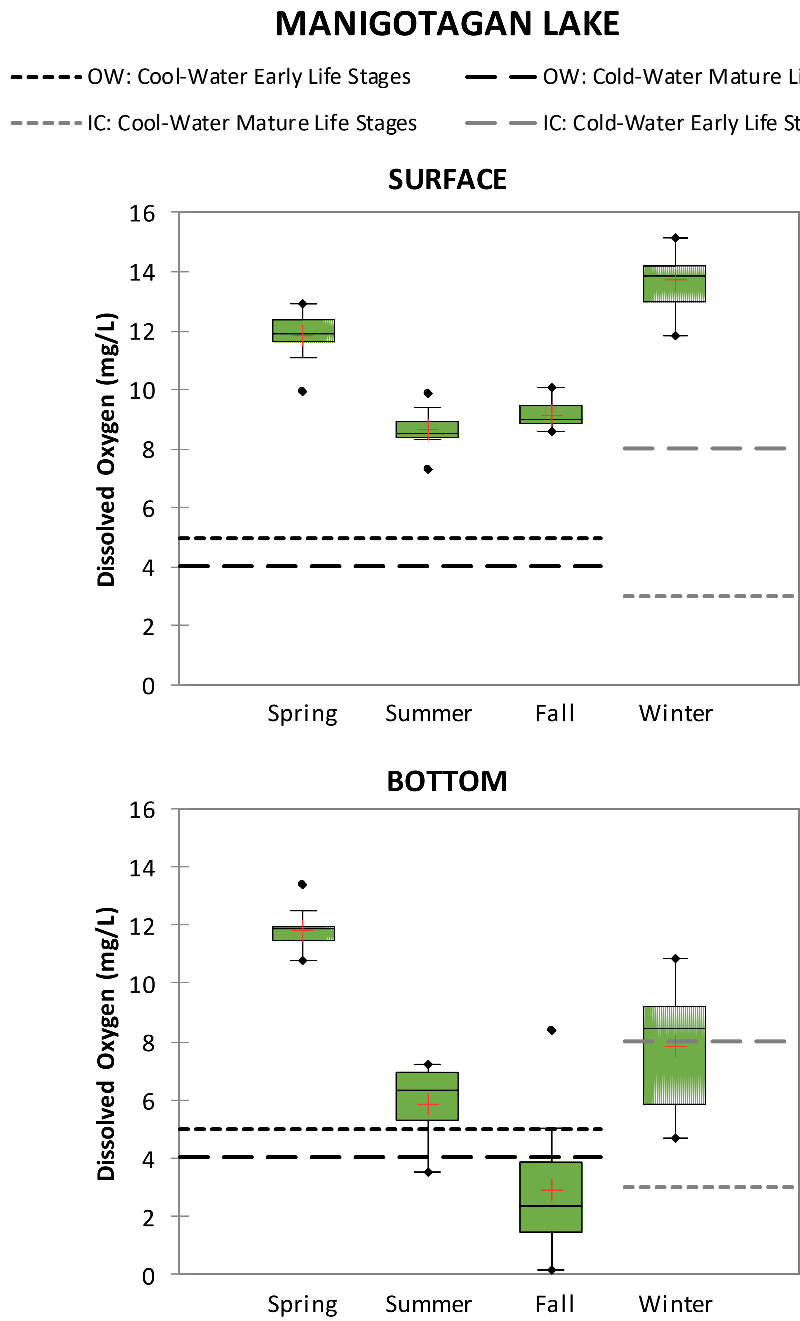


Figure 3.2-11. 2008-2019 Off-system seasonal surface and bottom dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

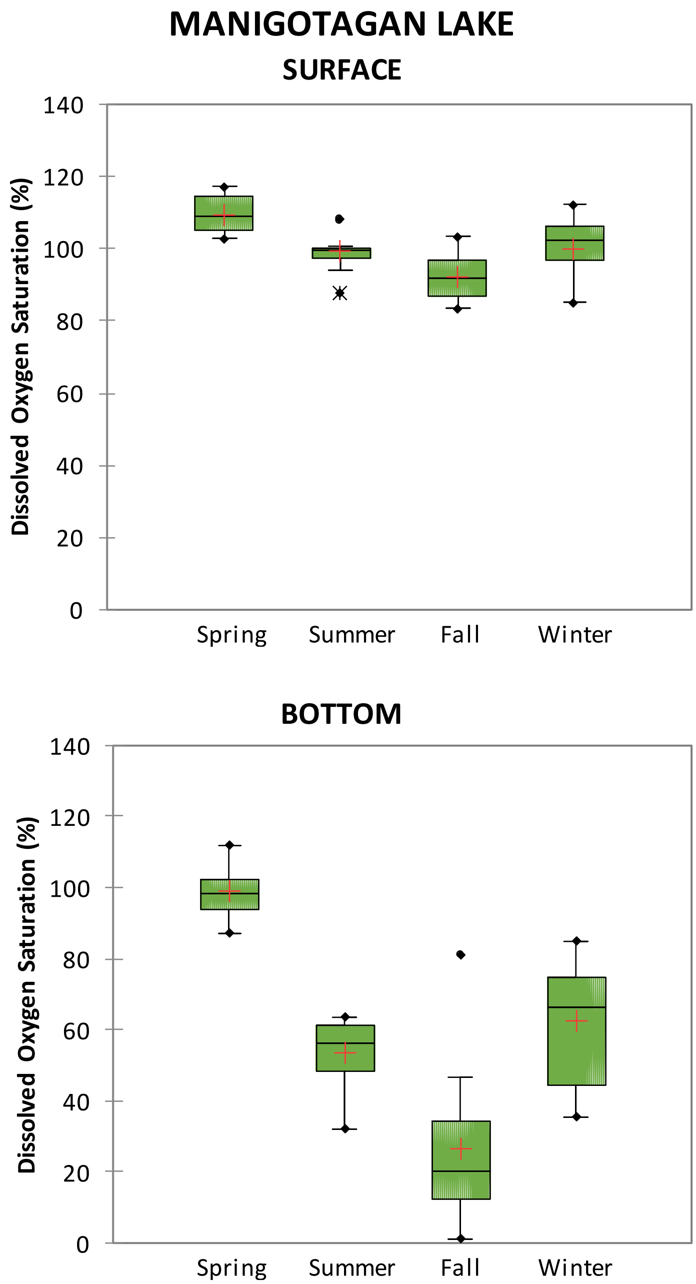


Figure 3.2-12. 2008-2019 Off-system seasonal surface and bottom dissolved oxygen saturation.

Figure 3.2-13. 2008-2019 Off-system open-water season surface and bottom dissolved oxygen saturation.

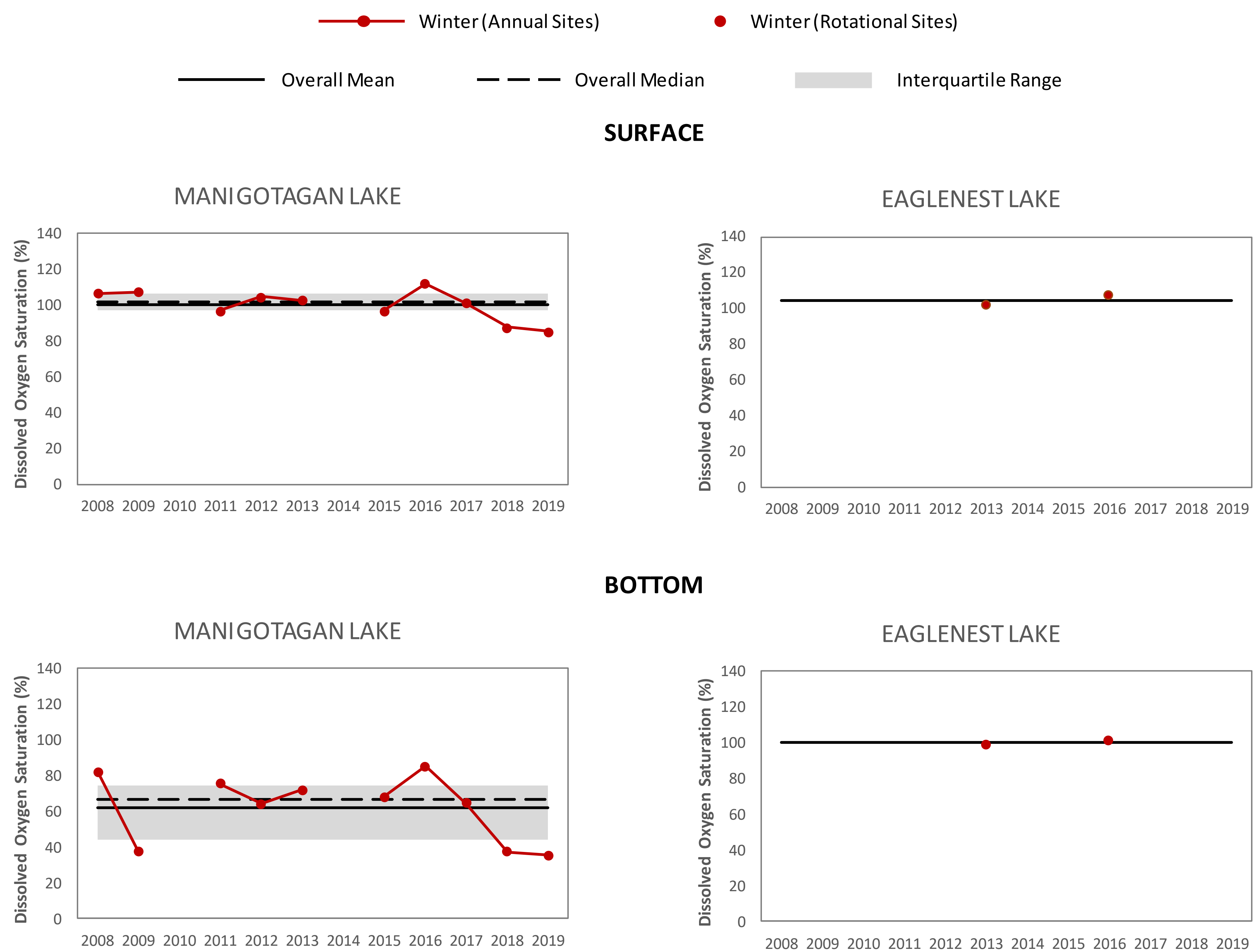


Figure 3.2-14. 2008-2019 Off-system ice-cover season surface and bottom dissolved oxygen saturation.

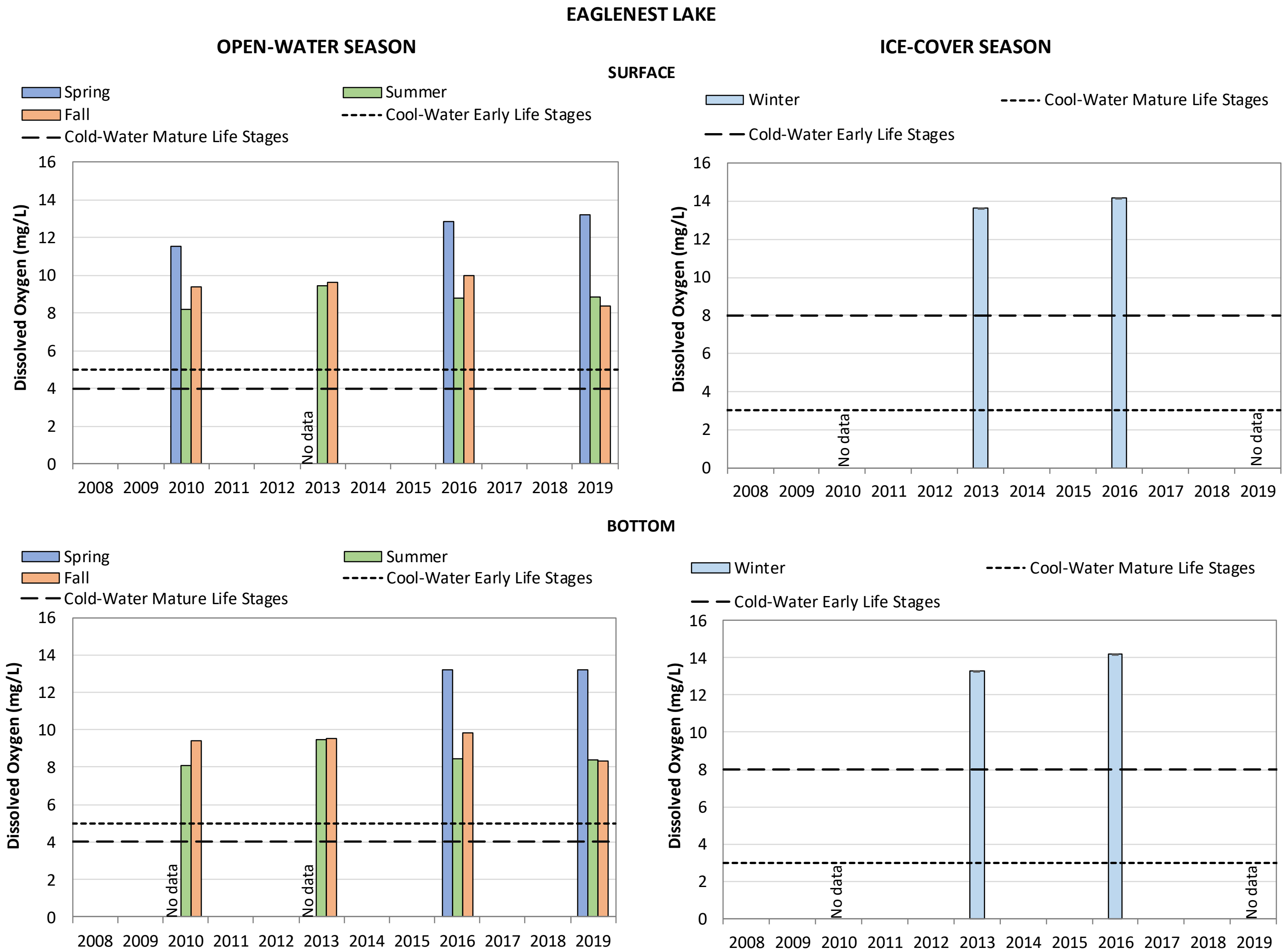


Figure 3.2-15. 2008-2019 Eaglenest Lake surface and bottom dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

3.3 WATER CLARITY

3.3.1 SECCHI DISK DEPTH

3.3.1.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Secchi disk depth in the Pointe du Bois Forebay ranged from 0.70 to 2.35 m during the open-water season. The mean and median measurements for the 12 years of monitoring were 1.64 and 1.65 m, respectively. Mean annual Secchi disk depths ranged from 1.21 to 2.28 m and were within the IQR (1.36 to 1.90 m) in ten of the 12 years. Mean Secchi disk depths were below the IQR in 2012 and above the IQR in 2019 (Table 3.3-1 and Figure 3.3-1).

No clear seasonality was observed for Secchi disk depth in the Pointe du Bois Forebay over the 12 years of monitoring. However, the largest mean Secchi disk depth occurred in spring (1.76 m) and the smallest in fall (1.54 m; Figure 3.3-2).

Lac du Bonnet

Secchi disk depth in Lac du Bonnet ranged from 0.55 to 2.10 m during the open-water season. The mean and median measurements for the 12 years of monitoring were 1.26 and 1.20 m, respectively. Mean annual Secchi disk depths ranged from 0.88 to 1.55 m and were within the IQR (1.00 to 1.51 m) in nine of the 12 years. Mean Secchi disk depths were below the IQR in 2009 and above the IQR in 2018, and 2019 (Table 3.3-1 and Figure 3.3-1).

On average, Secchi disk depths were higher in the spring (1.55 m) than in the summer and fall (1.14 and 1.09 m, respectively; Figure 3.3-2).

ROTATIONAL SITES

Pine Falls Forebay

Secchi disk depth in the Pine Falls Forebay ranged from 0.80 to 1.65 m during the open-water season. The mean was 1.14 m, the median was 1.05 m, and the IQR was 0.95 to 1.30 m for the three years of monitoring. Mean annual Secchi disk depths ranged from 0.93 to 1.27 m and were within the IQR in 2011 and 2017 but below the IQR in 2014 (Table 3.3-1 and Figure 3.3-1).

3.3.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Secchi disk depth in Manigotagan Lake ranged from 1.25 to 4.90 m during the open-water season. The mean and median for the 12 years of monitoring were 2.15 and 2.03 m, respectively. Mean annual Secchi disk depths ranged from 1.60 to 3.17 m and were within the IQR (1.69 to 2.33 m) in seven of the 12 years. Mean Secchi disk depths were below the IQR in 2008, 2009, and 2010 and above the IQR in 2017, and 2019 (Table 3.3-2 and Figure 3.3-3).

No clear seasonality was observed for Secchi disk depth in Manigotagan Lake over the 12 years of monitoring. However, the largest mean Secchi disk depth occurred in summer (2.45 m) and the smallest in spring (1.86 m; Figure 3.3-4).

ROTATIONAL SITES

Eaglenest Lake

Secchi disk depth in Eaglenest Lake ranged from 1.10 to 2.60 m during the open-water season. The mean and median measurements for the four years of monitoring were 1.89 and 1.92 m, respectively, and the IQR was 1.73 to 2.14 m. Mean annual Secchi disk depths ranged from 1.59 to 2.43 m and were within the IQR in 2013 and 2016 but were below the IQR in 2010 and above the IQR in 2019 (Table 3.3-2 and Figure 3.3-3).

Table 3.3-1. 2008-2019 On-system sites water clarity summary statistics.

Site	Statistic	Secchi Disk Depth (m)		Turbidity (NTU)		TSS (mg/L)	
		OW	IC	OW	IC	OW	IC
PDB	Mean	1.64	-	3.72	3.65	3.8	<2.0
	Median	1.65	-	3.57	3.22	3.6	<2.0
	Minimum	0.70	-	2.38	2.83	<2.0	<2.0
	Maximum	2.35	-	6.10	4.88	8.0	4.0
	SD	0.398	-	0.994	0.749	1.51	0.92
	SE	0.067	-	0.166	0.226	0.25	0.28
	Lower Quartile	1.36	-	2.93	3.11	2.8	<2.0
	Upper Quartile	1.90	-	4.27	4.15	4.7	<2.0
	n	35	-	36	11	36	11
	% Detections	100	-	100	100	92	18
LDB	Mean	1.26	-	5.22	3.96	5.4	<2.0
	Median	1.20	-	5.30	3.90	5.2	<2.0
	Minimum	0.55	-	1.69	3.37	<2.0	<2.0
	Maximum	2.10	-	9.39	5.48	9.6	3.2
	SD	0.353	-	1.65	0.61	2.13	0.75
	SE	0.059	-	0.275	0.177	0.35	0.22
	Lower Quartile	1.00	-	4.17	3.49	3.9	<2.0
	Upper Quartile	1.51	-	6.11	4.13	6.6	2.0
	n	36	-	36	12	36	12
	% Detections	100	-	100	100	97	33
PFF	Mean	1.14	-	6.35	4.43	7.0	<2.0
	Median	1.05	-	6.35	-	6.4	-
	Minimum	0.80	-	3.46	3.27	2.8	<2.0
	Maximum	1.65	-	9.80	5.22	11.7	2.0
	SD	0.261	-	1.98	1.02	3.55	0.58
	SE	0.087	-	0.661	0.592	1.18	0.33
	Lower Quartile	0.95	-	4.98	-	4.1	-
	Upper Quartile	1.30	-	7.69	-	11.2	-
	n	9	-	9	3	9	3
	% Detections	100	-	100	100	100	33

Notes:

1. OW = Open-water season; IC = Ice-cover season.
2. SD = standard deviation; SE = standard error; n = number of samples.

Table 3.3-2. 2008-2019 Off-system sites water clarity metric summary statistics.

Site	Statistic	Secchi Disk Depth (m)		Turbidity (NTU)		TSS (mg/L)	
		OW	IC	OW	IC	OW	IC
MANIG	Mean	2.15	-	1.94	1.36	<2.0	<2.0
	Median	2.03	-	1.99	1.39	<2.0	<2.0
	Minimum	1.25	-	0.55	0.75	<2.0	<2.0
	Maximum	4.90	-	3.07	2.21	3.3	<2.0
	SD	0.709	-	0.570	0.375	0.75	-
	SE	0.118	-	0.095	0.108	0.12	-
	Lower Quartile	1.69	-	1.58	1.05	<2.0	<2.0
	Upper Quartile	2.33	-	2.36	1.55	2.2	<2.0
	n	36	-	36	12	36	12
	% Detections	100	-	100	100	31	0
EAGLE	Mean	1.89	-	2.86	3.66	2.4	<2.0
	Median	1.92	-	2.86	-	2.5	-
	Minimum	1.10	-	1.86	3.19	<2.0	<2.0
	Maximum	2.60	-	4.86	4.55	4.0	3.2
	SD	0.459	-	0.766	0.766	1.15	1.27
	SE	0.133	-	0.221	0.442	0.33	0.73
	Lower Quartile	1.73	-	2.38	-	<2.0	-
	Upper Quartile	2.14	-	3.06	-	3.3	-
	n	12	-	12	3	12	3
	% Detections	100	-	100	100	67	33

Notes:

1. OW = Open-water season; IC = Ice-cover season.
2. SD = standard deviation; SE = standard error; n = number of samples.

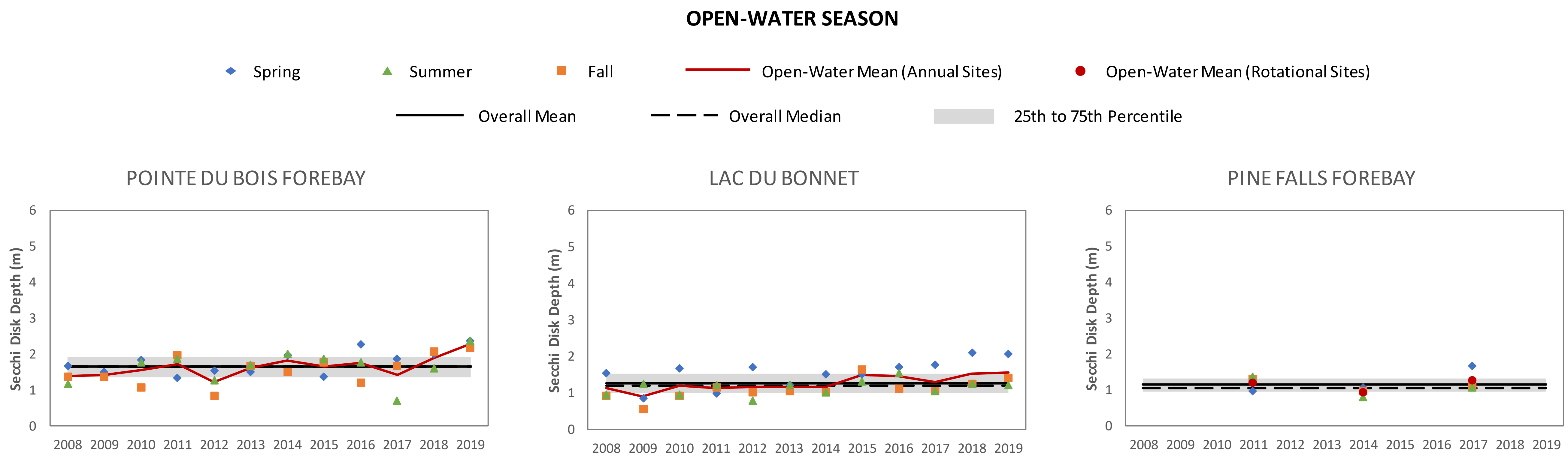


Figure 3.3-1. 2008-2019 On-system open-water season Secchi disk depths.

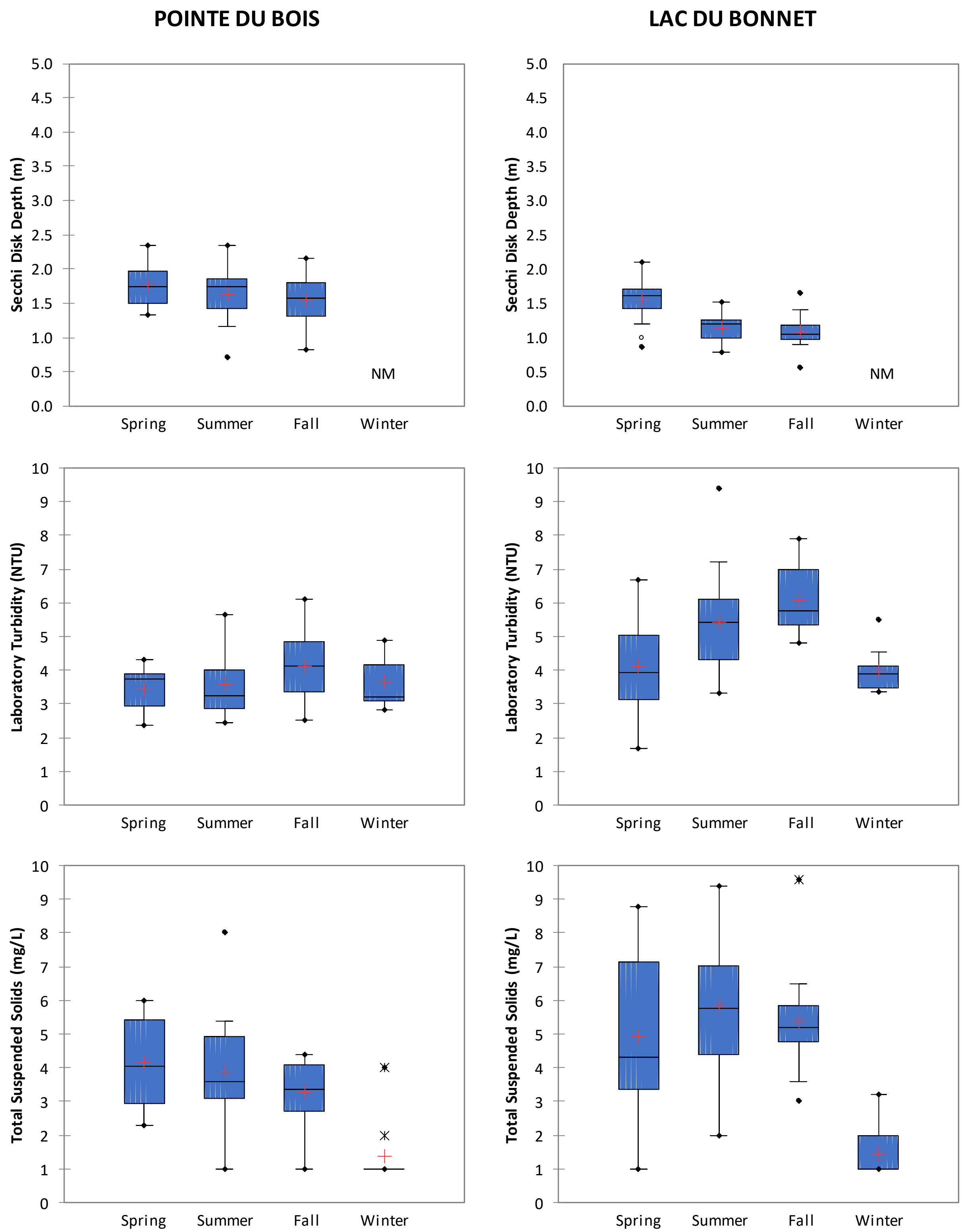


Figure 3.3-2. 2008-2019 On-system seasonal Secchi disk depth, turbidity, and TSS concentrations.

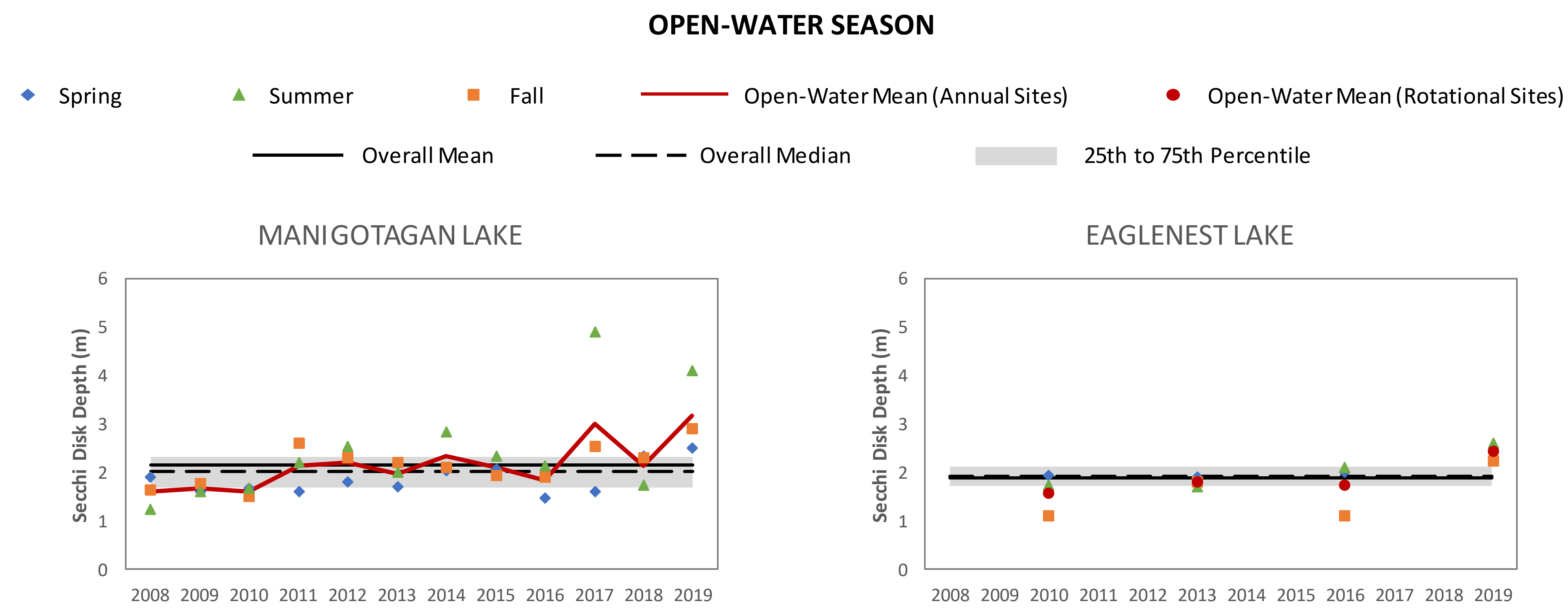


Figure 3.3-3. 2008-2019 Off-system open-water season Secchi disk depths.

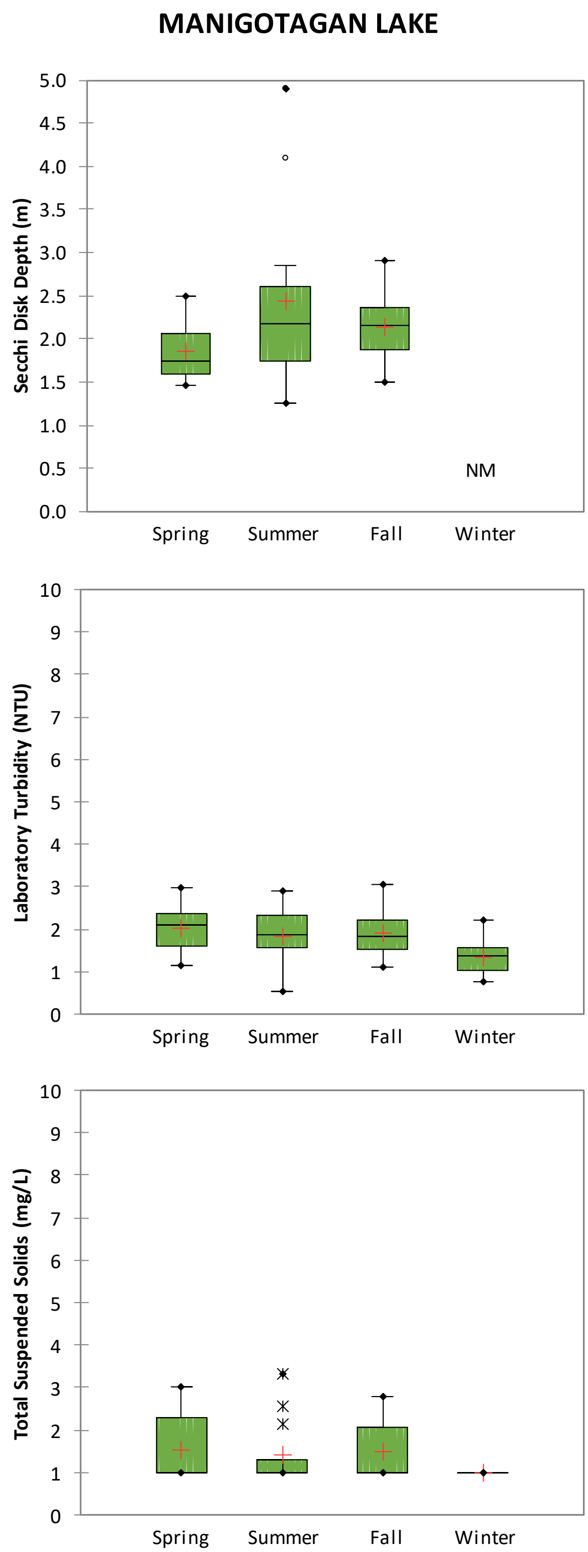


Figure 3.3-4. 2008-2019 Off-system seasonal Secchi disk depth, turbidity, and TSS concentrations.

3.3.2 TURBIDITY

3.3.2.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Turbidity in the Pointe du Bois Forebay ranged from 2.38 to 6.10 NTU during the open-water season. The mean and median turbidity for the 12 years of monitoring were 3.72 and 3.57 NTU, respectively. Open-water season mean annual turbidity ranged from 2.45 to 4.93 NTU and was within the IQR (2.93 to 4.27 NTU) in seven of the 12 years. Mean turbidity was below the IQR in 2018, and 2019 and above the IQR in 2008, 2009, and 2012 (Table 3.3-1 and Figure 3.3-5).

Turbidity in the ice-cover season ranged from 2.83 to 4.88 NTU, with a mean of 3.65 NTU and a median of 3.22 NTU for the 11 years of monitoring. The IQR was 3.11 to 4.15 NTU (Table 3.3-1 and Figure 3.3-5).

No clear seasonality was observed for turbidity in the Pointe du Bois Forebay over the 12-year period. However, the lowest mean turbidity occurred in spring (3.45 NTU) and the highest in fall (4.13 NTU; Figure 3.3-2).

Lac du Bonnet

Turbidity in Lac du Bonnet ranged from 1.69 to 9.39 NTU during the open-water season. The mean and median turbidity for the 12 years of monitoring were 5.22 and 5.30 NTU, respectively. Open-water season mean annual turbidity ranged from 3.43 to 5.22 NTU and was within the IQR (4.17 to 6.11 NTU) in six of the 12 years. Mean turbidity was below the IQR in 2016, and 2018 and above the IQR in 2008, 2009, 2011, and 2012 (Table 3.3-1 and Figure 3.3-5).

Turbidity in the ice-cover season ranged from 3.37 to 5.48 NTU, with a mean of 3.96 NTU and 3.90 NTU for the 12 years of monitoring. The IQR was 3.49 to 4.13 NTU (Table 3.3-1 and Figure 3.3-5).

No clear seasonality was observed for turbidity in the Lac du Bonnet over the 12 years of monitoring. However, the lowest mean turbidity occurred in winter (3.96 NTU) and the highest in fall (6.09 NTU; Figure 3.3-2).

ROTATIONAL SITES

Pine Falls Forebay

Turbidity in the Pine Falls Forebay ranged from 3.46 to 9.80 NTU during the open-water season. The mean and median were both 6.35 NTU, and the IQR was 4.98 to 7.69 NTU for the three years of monitoring. Mean annual turbidity in the open-water season ranged from 5.10 to 8.08 NTU and was within the IQR in 2011, and 2017 but above the IQR in 2014 (Table 3.3-1 and Figure 3.3-5).

During the ice-cover season, turbidity was relatively similar in the three years of sampling, ranging from 3.27 to 5.22 NTU, with a mean of 4.43 NTU (Table 3.3-1 and Figure 3.3-5).

3.3.2.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Turbidity in Manigotagan Lake ranged from 0.55 to 3.07 NTU during the open-water season. The mean was 1.94 NTU and the median was 1.99 NTU for the 12 years of monitoring. Open-water season mean annual turbidity ranged from 1.35 to 2.34 NTU and was within the IQR (1.58 to 2.36 NTU) in nine of the 12 years. Mean turbidity was below the IQR in 2008, 2017, and 2019 (Table 3.3-2 and Figure 3.3-6).

Turbidity in the ice-cover season ranged from 0.75 to 2.21 NTU, with a mean of 1.36 NTU and a median of 1.39 NTU for the 12 years of monitoring. The IQR was 1.05 to 1.55 NTU (Table 3.3-2 and Figure 3.3-6).

No clear seasonality was observed for turbidity in Manigotagan Lake over the 12 years of monitoring. However, the lowest mean turbidity occurred in winter (1.36 NTU) and the highest in spring (2.04 NTU; Figure 3.3-4).

ROTATIONAL SITES

Eaglenest Lake

Turbidity in Eaglenest Lake ranged from 1.86 to 4.86 NTU during the open-water season. The mean and median for the four years of monitoring were both 2.86 NTU, and the IQR was 2.38 to 3.06 NTU. Open-water season mean annual turbidity ranged from 2.36 to 3.45 NTU and was within the IQR in 2013 and 2016 but was below the IQR in 2010 and above the IQR in 2019 (Table 3.3-2 and Figure 3.3-6).

During the ice-cover season, turbidity was relatively similar in the three years of sampling, ranging from 3.19 to 4.55 NTU, with a mean of 3.66 NTU (Table 3.3-2 and Figure 3.3-6).

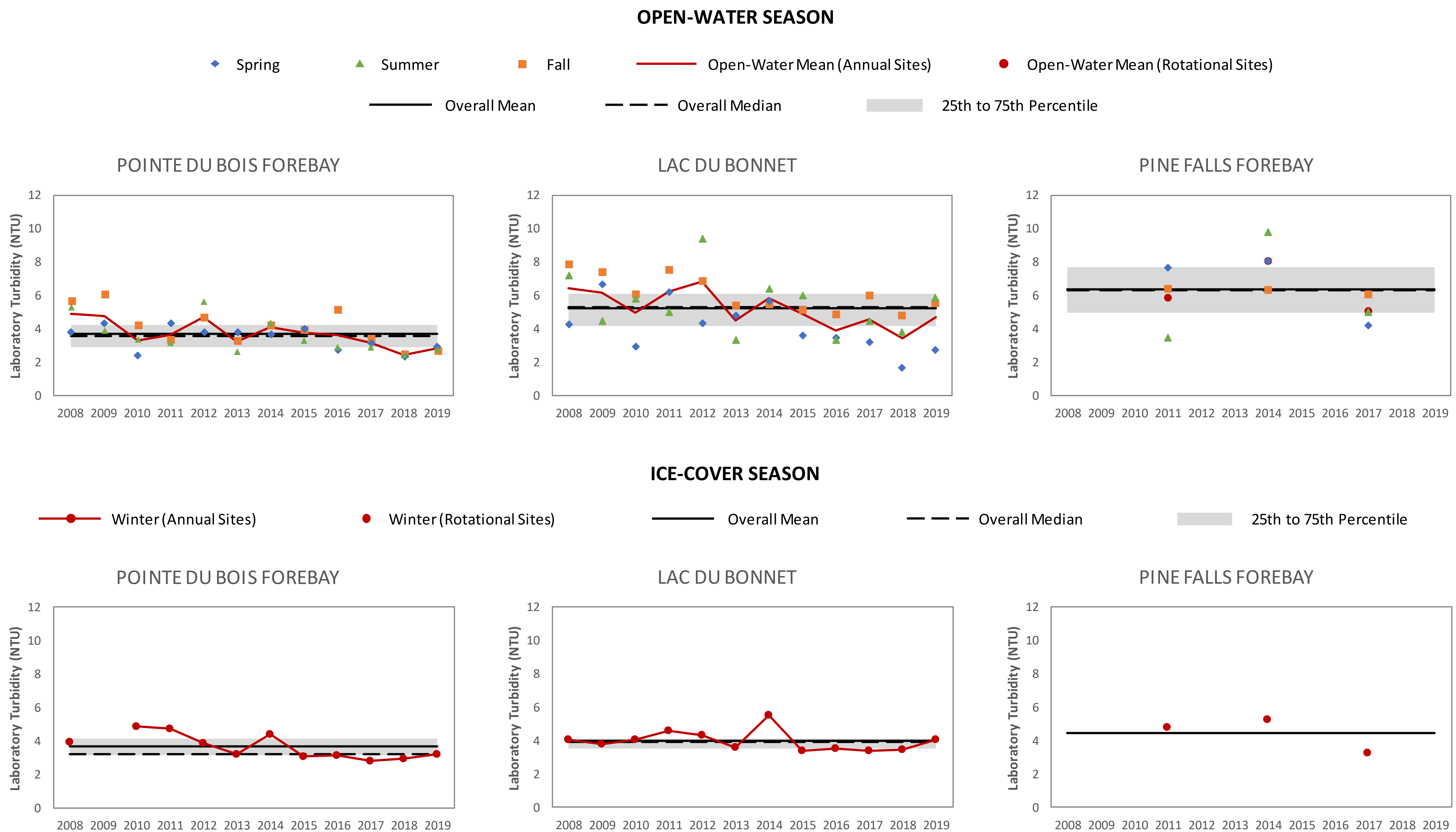


Figure 3.3-5. 2008-2019 On-system open-water and ice-cover season turbidity levels.

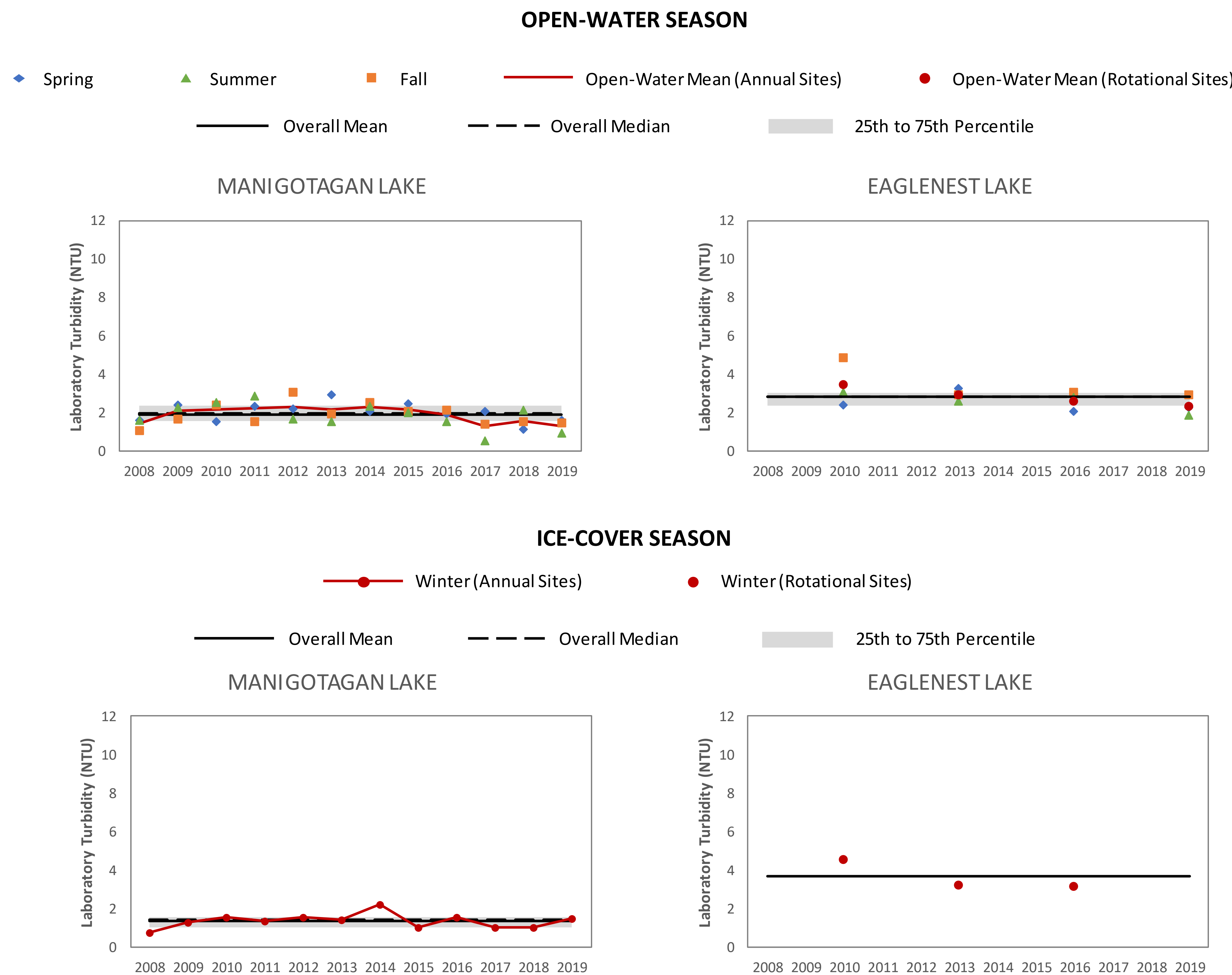


Figure 3.3-6. 2008-2019 Off-system open-water and ice-cover season turbidity levels.

3.3.3 TOTAL SUSPENDED SOLIDS

3.3.3.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

TSS concentrations in the Pointe du Bois Forebay ranged from <2.0 to 8.0 mg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were 3.8 and 3.6 mg/L, respectively. Open-water season mean annual TSS concentrations ranged from <2.0 to 5.1 mg/L and were within the IQR (2.8 to 4.7 mg/L) in nine of the 12 years. Mean TSS concentrations were below the IQR in 2018 and above the IQR in 2011, and 2014. TSS concentrations were typically above the detection limit (DL; 2.0 mg/L) during the open-water season (percent detections = 92; Table 3.3-1 and Figure 3.3-7).

TSS concentrations in the ice-cover season ranged from <2.0 to 4.0 mg/L, both the mean and median were <2.0 mg/L, and the IQR was <2.0 to <2.0 mg/L for the 11 years of monitoring. TSS concentrations were often below the DL (2.0 mg/L) during the ice-cover season (percent detections = 18; Table 3.3-1 and Figure 3.3-7).

TSS concentrations in the Point du Bois Forebay were lower in winter (mean <2.0 mg/L), often below the DL, than during the open-water season. No clear seasonality was observed for TSS concentrations in the open-water season over the 12-year period; however, the lowest mean TSS concentration occurred in fall (3.3 mg/L) and the highest in spring (4.2 mg/L; Figure 3.3-2).

Lac du Bonnet

TSS concentrations in Lac du Bonnet ranged from <2.0 to 9.6 mg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were 5.4 and 5.2 mg/L, respectively. Open-water season mean annual TSS concentrations ranged from 2.2 to 8.3 mg/L and were within the IQR (3.9 to 6.6 mg/L) in ten of the 12 years. Mean TSS concentrations were below the IQR in 2018 and above the IQR in 2014. TSS concentrations were typically above the DL (2.0 mg/L) during the open-water season (percent detections = 97; Table 3.3-1 and Figure 3.3-7).

TSS concentrations in the ice-cover season ranged from <2.0 to 3.2 mg/L, both the mean and median were <2.0 mg/L, and the IQR was <2.0 to 2.0 mg/L for the 12 years of monitoring. TSS concentrations were often below the DL (2.0 mg/L) during the ice-cover season (percent detections = 33; Table 3.3-1 and Figure 3.3-7).

TSS concentrations in Lac du Bonnet were lower in winter (mean = <2.0 mg/L), often below the DL, than during the open-water season. No clear seasonality was observed for TSS concentrations in the open-water season over the 12 years of monitoring; however, the lowest mean TSS concentration occurred in spring (4.9 mg/L) and the highest in summer (5.8 mg/L; Figure 3.3-2).

ROTATIONAL SITES

Pine Falls Forebay

TSS concentrations in the Pine Falls Forebay ranged from 2.8 to 11.7 mg/L during the open-water season. The mean was 7.0 mg/L and median was 6.4 mg/L, and the IQR was 4.1 to 11.2 mg/L for the three years of monitoring. Mean annual TSS concentrations in the open-water season ranged from 5.3 to 9.8 mg/L and were within the IQR in all years. TSS concentrations were consistently above the DL (2.0 mg/L) during the open-water season (Table 3.3-1 and Figure 3.3-7).

During the ice-cover season, TSS concentrations ranged from <2.0 to 2.0 mg/L, with a mean of <2.0 mg/L. TSS concentrations were below the DL (2.0 mg/L) in two of three samples collected in winter (i.e., percent detections = 33; Table 3.3-1 and Figure 3.3-7).

3.3.3.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

TSS concentrations in Manigotagan Lake ranged from <2.0 to 3.3 mg/L during the open-water season. The mean and median were both <2.0 mg/L for the 12 years of monitoring. Open-water season mean annual TSS concentrations ranged from <2.0 to 2.6 mg/L and were within the IQR (<2.0 to 2.2 mg/L) in 11 of the 12 years. Mean TSS concentrations were above the IQR in 2014. TSS concentrations were above the DL (2.0 mg/L) in approximately one third of the samples collected during the open-water season (percent detections = 31; Table 3.3-2 and Figure 3.3-8).

TSS concentrations in the ice-cover season were consistently below the DL (2.0 mg/L) over the 12 years of monitoring (Table 3.3-2 and Figure 3.3-8).

Although TSS concentrations were more frequently above the DL during the open-water season than in winter, no clear seasonality was observed for TSS concentrations in Manigotagan Lake over the 12 years of monitoring. Mean TSS concentrations were below the DL (2.0 mg/L) in spring, summer, fall and winter (Figure 3.3-4).

ROTATIONAL SITES

Eaglenest Lake

TSS concentrations in Eaglenest Lake ranged from <2.0 to 4.0 mg/L during the open-water season. The mean was 2.4 mg/L, median was 2.5 mg/L, and the IQR was <2.0 to 3.3 mg/L for the four years of monitoring. Open-water season mean annual TSS concentrations ranged from 2.1 to 2.7 mg/L and were within the IQR in all years. TSS concentrations were above the DL (2.0 mg/L) in 67 percent of samples collected during the open-water season (Table 3.3-2 and Figure 3.3-8).

During the ice-cover season, TSS concentrations ranged from <2.0 to 3.2 mg/L, with a mean of <2.0 mg/L. TSS concentrations were below the DL (2.0 mg/L) in two of three samples collected in winter (percent detections = 33; Table 3.3-2 and Figure 3.3-8).

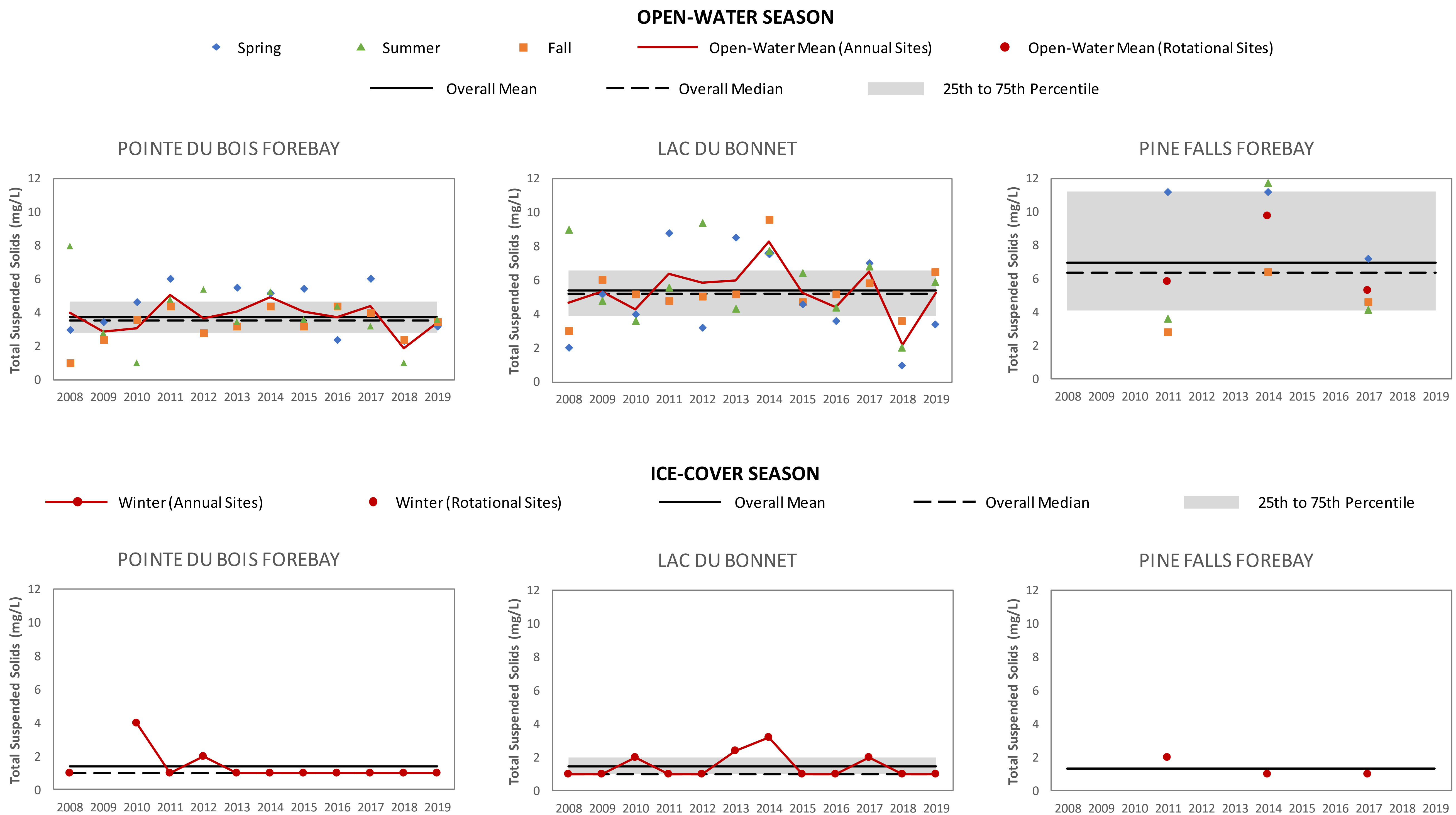


Figure 3.3-7. 2008-2019 On-system open-water and ice-cover season TSS concentrations.

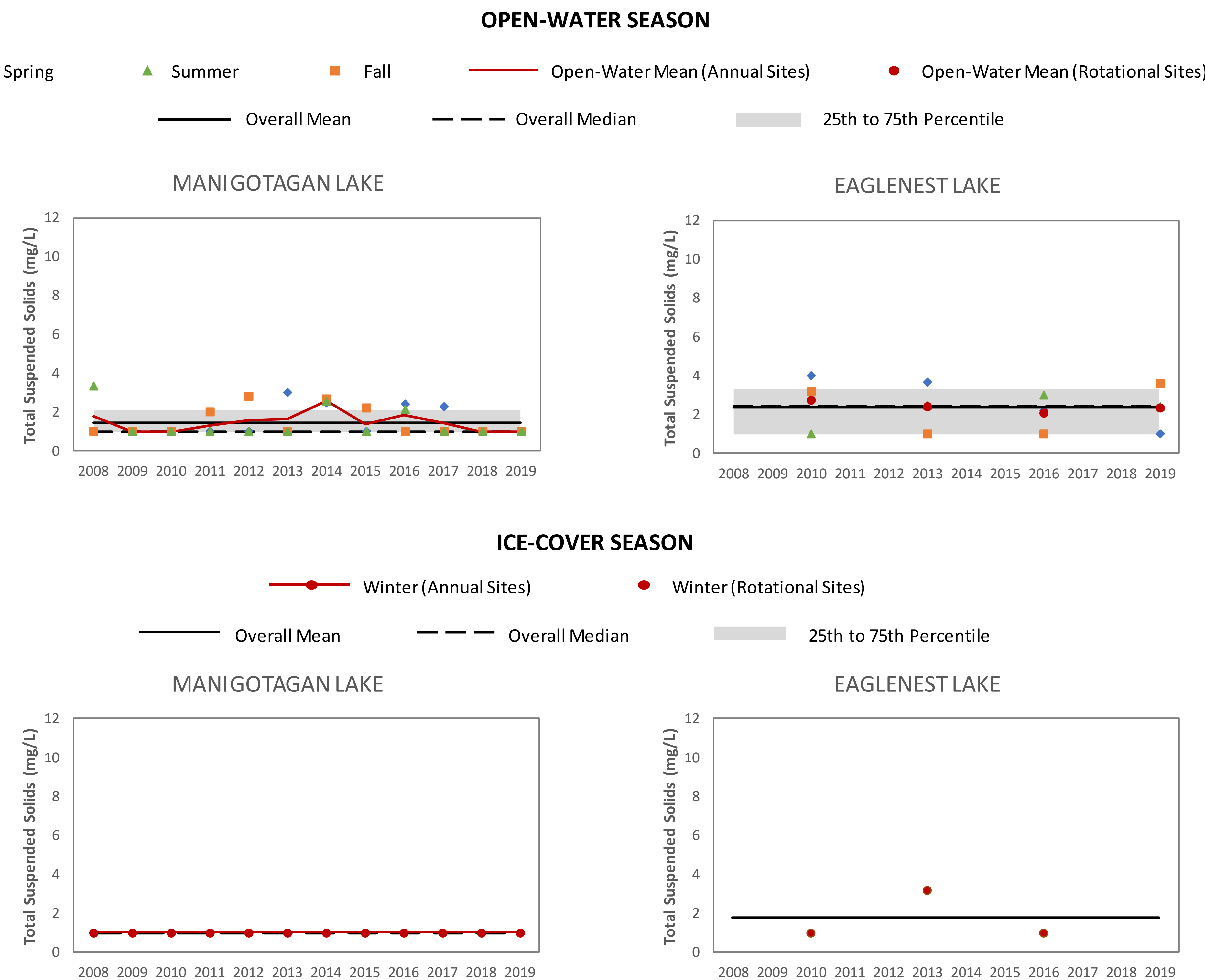


Figure 3.3-8. 2008-2019 Off-system open-water and ice-cover season TSS concentrations.

3.4 NUTRIENTS AND TROPHIC STATUS

3.4.1 TOTAL PHOSPHORUS

3.4.1.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

TP concentrations in the Pointe du Bois Forebay ranged from 0.015 to 0.043 mg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were both 0.023 mg/L. Open-water season mean annual TP concentrations ranged from 0.019 to 0.029 mg/L and were within the IQR (0.020 to 0.025 mg/L) in nine of the 12 years. Mean TP concentrations were below the IQR in 2011 and above the IQR in 2015, and 2016 (Table 3.4-1 and Figure 3.4-1).

TP concentrations in the ice-cover season ranged from 0.022 to 0.036 mg/L, with a mean of 0.028 mg/L and a median of 0.027 mg/L for the 12 years of monitoring. The IQR was 0.025 to 0.030 mg/L (Table 3.4-1 and Figure 3.4-1).

No clear seasonality was observed for TP in the Pointe du Bois Forebay over the 12-year period. However, the lowest mean TP concentration occurred in spring (0.022 mg/L) and the highest in winter (0.028 mg/L; Figure 3.4-2).

The Pointe du Bois Forebay was meso-eutrophic (0.020 to 0.035 mg/L) on the basis of the 2008-2019 mean open-water season TP concentration (0.023 mg/L). Mean annual TP concentrations (0.019 to 0.029 mg/L) in the open-water season were within the meso-eutrophic range (0.020 to 0.035 mg/L) in all years except for 2011 when the mean (0.019 mg/L) was within the mesotrophic range (0.010 to 0.020 mg/L; Table 3.4-2).

Lac du Bonnet

TP concentrations in Lac du Bonnet ranged from 0.015 to 0.035 mg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were both 0.025 mg/L. Open-water season mean annual TP concentrations ranged from 0.021 to 0.029 mg/L and were within the IQR (0.023 to 0.028 mg/L) in eight of the 12 years. Mean TP concentrations were below the IQR in 2012, 2018, and 2019 and above the IQR in 2010 (Table 3.4-1 and Figure 3.4-1).

TP concentrations in the ice-cover season ranged from 0.024 to 0.036 mg/L, with a mean of 0.029 mg/L and a median of 0.028 mg/L for the 12 years of monitoring. The IQR was 0.027 to 0.030 mg/L (Table 3.4-1 and Figure 3.4-1).

On average, TP concentrations were lowest in spring (0.022 mg/L) and highest in winter (0.029 mg/L; Figure 3.4-2).

Lac du Bonnet was meso-eutrophic (0.020 to 0.035 mg/L) on the basis of the 2008-2019 mean open-water season TP concentration (0.025 mg/L). Mean annual TP concentrations (0.021 to 0.029 mg/L) in the open-water season were within the meso-eutrophic range in all years (Table 3.4-2).

ROTATIONAL SITES

Pine Falls Forebay

TP concentrations in the Pine Falls Forebay ranged from 0.012 to 0.031 mg/L during the open-water season. The mean was 0.025 mg/L, the median was 0.027 mg/L, and the IQR was 0.026 to 0.027 mg/L for the three years of monitoring. Mean annual TP concentrations in the open-water season ranged from 0.022 to 0.027 mg/L and were within the IQR in 2014 and 2017 but below the IQR in 2011 (Table 3.4-1 and Figure 3.4-1).

During the ice-cover season, TP concentrations ranged from 0.024 to 0.030 mg/L, with a mean of 0.027 mg/L (Table 3.4-1 and Figure 3.4-1).

The Pine Falls Forebay was meso-eutrophic (0.020 to 0.035 mg/L) based on the mean of the open-water season TP concentrations for the three years of monitoring (0.025 mg/L). Open-water season mean annual TP concentrations (0.022 to 0.027 mg/L) were also within the meso-eutrophic range in each year sampled (Table 3.4-2).

3.4.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

TP concentrations in Manigotagan Lake ranged from 0.008 to 0.034 mg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were 0.019 mg/L and 0.016 mg/L, respectively. Open-water season mean annual TP concentrations ranged from 0.012 to 0.025 mg/L but were within the IQR (0.014 to 0.023 mg/L) in nine of the 12 years. Mean TP concentrations were below the IQR in 2018 and above the IQR in 2010, and 2016 (Table 3.4-3 and Figure 3.4-3).

TP concentrations in the ice-cover season ranged from 0.022 to 0.035 mg/L, with a mean of 0.026 mg/L and a median of 0.025 mg/L for the 12 years of monitoring. The IQR was 0.023 to 0.029 mg/L (Table 3.4-3 and Figure 3.4-3).

On average, TP concentrations were higher in winter (0.026 mg/L) and spring (0.027 mg/L) than in summer (0.014 mg/L) or fall (0.017 mg/L; Figure 3.4-4).

Manigotagan Lake was mesotrophic (0.010 to 0.020 mg/L) on the basis of the 2008-2019 mean open-water season TP concentration (0.019 mg/L). Mean annual TP concentrations (0.012 to 0.025 mg/L) in the open-water season were within the mesotrophic range (0.010 to 0.020 mg/L) in eight of the 12 years of monitoring; however, they were within the meso-eutrophic range (0.020 to 0.035 mg/L) in 2010, 2011, 2014, and 2016 (Table 3.4-4).

ROTATIONAL SITES

Eaglenest Lake

TP concentrations in Eaglenest Lake ranged from 0.015 to 0.030 mg/L during the open-water season. The mean and median concentrations for the four years of monitoring were both 0.022 mg/L, and the IQR was 0.020 to 0.024 mg/L. Open-water season mean annual TP concentrations ranged from 0.019 to 0.025 mg/L and were within the IQR in 2013 and 2016 but were below the IQR in 2019 and above the IQR in 2010 (Table 3.4-3 and Figure 3.4-3).

During the ice-cover season, TP concentrations ranged from 0.026 and 0.028 mg/L, with a mean of 0.027 mg/L (Table 3.4-3 and Figure 3.4-3).

Eaglenest Lake was meso-eutrophic (0.020 to 0.035 mg/L) based on the mean of the open-water season TP concentrations for the four years of monitoring (0.022 mg/L). Open-water season mean annual TP concentrations (0.019 to 0.025 mg/L) were within the meso-eutrophic range in three of the four years of monitoring; however, the open-water season mean TP concentration was within the mesotrophic range (0.010 to 0.020 mg/L) in 2019 (Table 3.4-4).

Table 3.4-1. 2008-2019 On-system sites TP, TN, and chlorophyll *a* summary statistics.

Site	Statistic	TP (mg/L)		TN (mg/L)		Chlorophyll *a* (µg/L)	
		OW	IC	OW	IC	OW	IC
PDB	Mean	0.023	0.028	0.42	0.53	7.56	0.65
	Median	0.023	0.027	0.45	0.52	6.46	<0.60
	Minimum	0.015	0.022	<0.20	0.42	1.91	<0.60
	Maximum	0.043	0.036	0.68	0.65	26.3	2.06
	SD	0.0055	0.0043	0.129	0.072	4.55	0.524
	SE	0.0009	0.0013	0.021	0.022	0.758	0.158
	Lower Quartile	0.020	0.025	0.36	0.48	5.06	<0.60
	Upper Quartile	0.025	0.030	0.50	0.58	8.05	0.76
	n	36	11	36	11	36	11
	% Detections	100	100	92	100	100	45
LDB	Mean	0.025	0.029	0.44	0.56	7.02	1.19
	Median	0.025	0.028	0.46	0.53	6.21	0.73
	Minimum	0.015	0.024	<0.20	0.41	0.84	<0.60
	Maximum	0.035	0.036	0.68	0.98	17.8	4.96
	SD	0.0045	0.0035	0.118	0.143	3.33	1.35
	SE	0.0008	0.0010	0.020	0.041	0.554	0.390
	Lower Quartile	0.023	0.027	0.39	0.50	5.10	<0.60
	Upper Quartile	0.028	0.030	0.51	0.57	8.49	1.39
	n	36	12	36	12	36	12
	% Detections	100	100	94	100	100	50
PFF	Mean	0.025	0.027	0.43	0.47	7.46	1.72
	Median	0.027	-	0.46	-	5.54	-
	Minimum	0.012	0.024	<0.20	0.40	2.10	1.53
	Maximum	0.031	0.030	0.57	0.51	18.1	1.91
	SD	0.0056	0.0030	0.133	0.064	5.00	0.190
	SE	0.0019	0.0017	0.044	0.037	1.67	0.110
	Lower Quartile	0.026	-	0.44	-	4.28	-
	Upper Quartile	0.027	-	0.49	-	9.93	-
	n	9	3	9	3	9	3
	% Detections	100	100	89	100	100	100

Notes:

1. OW = Open-water season; IC = Ice-cover season.
2. SD = standard deviation; SE = standard error; n = number of samples.

Table 3.4-2. 2008-2019 On-system trophic status based on TP, TN, and chlorophyll *a* open-water season mean concentrations.

Trophic Categories	Total Phosphorus (mg/L)			Total Nitrogen (mg/L)			Chlorophyll *a* (µg/L)		
Ultra-oligotrophic	<0.004								
Oligotrophic	0.004-0.010			<0.350			<2.5		
Mesotrophic	0.010-0.020			0.350-0.650			2.5-8		
Meso-eutrophic	0.020-0.035								
Eutrophic	0.035-0.100			0.651-1.20			8-25		
Hypereutrophic	> 0.100			>1.20			>25		
Reference	CCME (1999; updated to 2024)			Nürnberg (1996)			OECD (1982)		
Sampling Year	**PDB**	**LDB**	**PFF**	**PDB**	**LDB**	**PFF**	**PDB**	**LDB**	**PFF**
2008	0.025	0.028	-	0.52	0.52	-	6.33	6.00	-
2009	0.024	0.025	-	0.40	0.40	-	5.60	6.63	-
2010	0.025	0.029	-	0.30	0.44	-	3.52	3.64	-
2011	0.019	0.026	0.022	0.50	0.50	0.48	9.73	10.4	9.56
2012	0.020	0.021	-	0.47	0.48	-	6.95	4.82	-
2013	0.020	0.025	-	0.43	0.43	-	9.54	8.70	-
2014	0.025	0.026	0.027	0.46	0.49	0.49	6.08	7.58	7.11
2015	0.029	0.024	-	0.43	0.42	-	12.2	7.95	-
2016	0.027	0.027	-	0.55	0.55	-	5.28	5.54	-
2017	0.024	0.026	0.026	0.32	0.35	0.33	6.44	6.73	5.73
2018	0.021	0.021	-	0.31	0.28	-	8.14	6.56	-
2019	0.021	0.022	-	0.38	0.39	-	10.9	9.77	-
Overall (2008-2019)	0.023	0.025	0.025	0.42	0.44	0.43	7.56	7.02	7.46

Notes:

1. CCME = Canadian Council of Ministers of the Environment
2. OECD = Organization for Economic Cooperation and Development

Table 3.4-3. 2008-2019 Off-system sites TP, TN, and chlorophyll *a* summary statistics.

Site	Statistic	TP (mg/L)		TN (mg/L)		Chlorophyll *a* (µg/L)	
		OW	IC	OW	IC	OW	IC
MANIG	Mean	0.019	0.026	0.50	0.55	6.73	1.85
	Median	0.016	0.025	0.52	0.55	6.06	1.31
	Minimum	0.008	0.022	<0.20	0.38	1.53	0.68
	Maximum	0.034	0.035	0.96	0.66	19.6	6.11
	SD	0.0072	0.0041	0.156	0.077	3.50	1.53
	SE	0.0012	0.0012	0.026	0.022	0.584	0.442
	Lower Quartile	0.014	0.023	0.45	0.51	4.34	0.99
	Upper Quartile	0.023	0.029	0.58	0.61	8.16	1.96
	n	36	12	36	12	36	12
	% Detections	100	100	94	100	100	100
EAGLE	Mean	0.022	0.027	0.43	0.59	6.48	<0.60
	Median	0.022	-	0.41	-	6.03	-
	Minimum	0.015	0.026	0.27	0.46	1.40	<0.60
	Maximum	0.030	0.028	0.70	0.77	15.1	<0.60
	SD	0.0041	0.0013	0.118	0.159	3.60	-
	SE	0.0012	0.0007	0.034	0.092	1.04	-
	Lower Quartile	0.020	-	0.35	-	4.78	-
	Upper Quartile	0.024	-	0.49	-	7.45	-
	n	12	3	12	3	12	3
	% Detections	100	100	100	100	100	0

Notes:

1. OW = Open-water season; IC = Ice-cover season.
2. SD = standard deviation; SE = standard error; n = number of samples.

Table 3.4-4. 2008-2019 Off-system trophic status based on TP, TN, and chlorophyll *a* open-water season mean concentrations.

Trophic Categories	Total Phosphorus (mg/L)		Total Nitrogen (mg/L)		Chlorophyll *a* (µg/L)	
Ultra-oligotrophic	<0.004					
Oligotrophic	0.004-0.010		<0.350		<2.5	
Mesotrophic	0.010-0.020		0.350-0.650		2.5-8	
Meso-eutrophic	0.020-0.035					
Eutrophic	0.035-0.100		0.651-1.20		8-25	
Hypereutrophic	> 0.100		>1.20		>25	
References	CCME (1999; updated to 2024)		Nürnberg (1996)		OECD (1982)	
Sampling Year	**MANIG**	**EAGLE**	**MANIG**	**EAGLE**	**MANIG**	**EAGLE**
2008	0.017	-	0.58	-	5.33	-
2009	0.020	-	0.46	-	6.11	-
2010	0.025	0.025	0.48	0.36	3.64	4.22
2011	0.020	-	0.55	-	5.16	-
2012	0.019	-	0.66	-	5.70	-
2013	0.020	0.021	0.43	0.39	7.56	6.91
2014	0.021	-	0.55	-	8.97	-
2015	0.019	-	0.52	-	6.67	-
2016	0.025	0.024	0.62	0.57	6.62	5.52
2017	0.017	-	0.36	-	8.52	-
2018	0.012	-	0.34	-	8.87	-
2019	0.016	0.019	0.47	0.38	7.63	9.29
Overall (2008-2019)	0.019	0.022	0.50	0.43	6.73	6.48

Notes:

1. CCME = Canadian Council of Ministers of the Environment.
2. OECD = Organization for Economic Cooperation and Development.

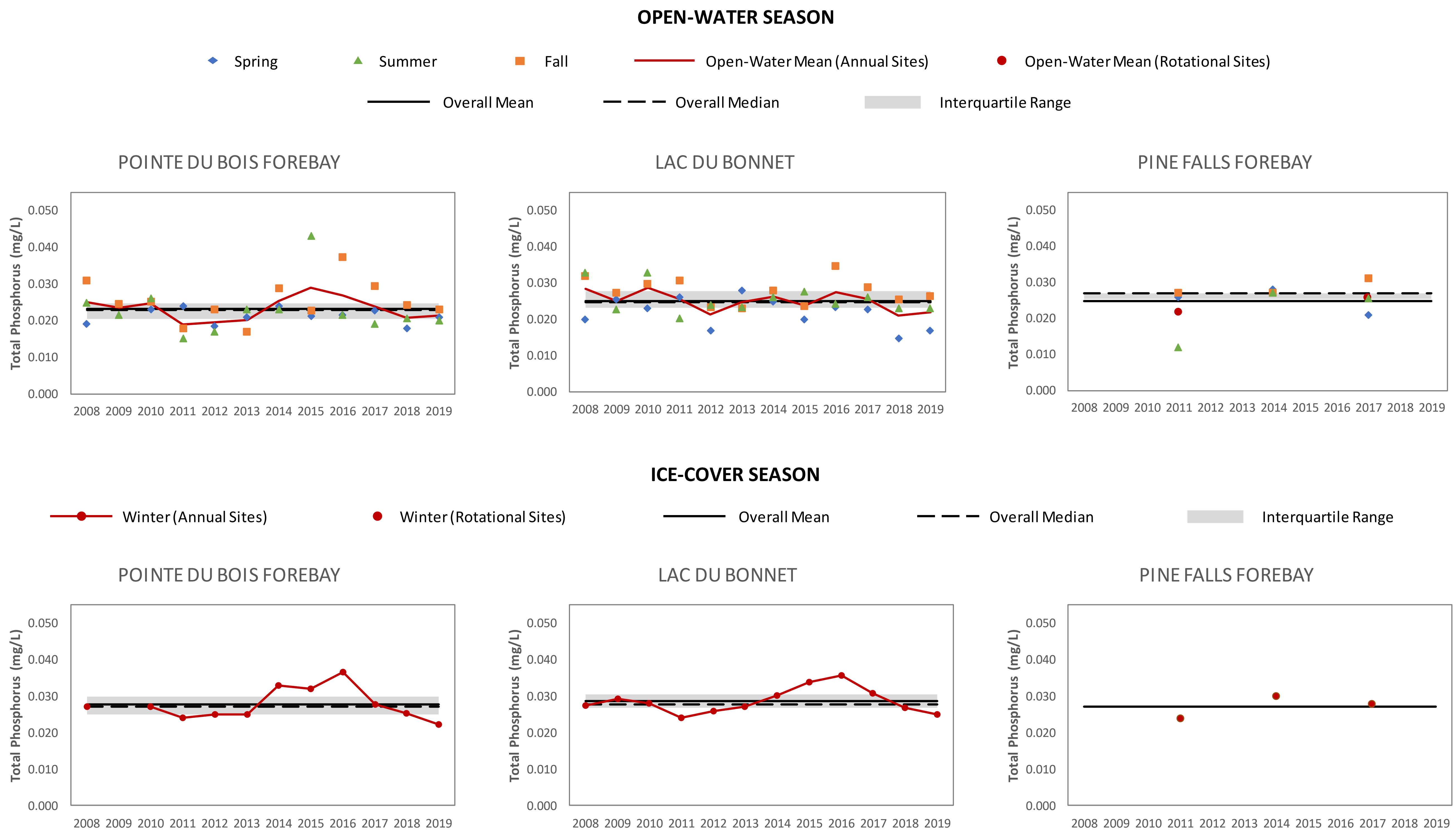


Figure 3.4-1. 2008-2019 On-system open-water and ice-cover season TP concentrations.

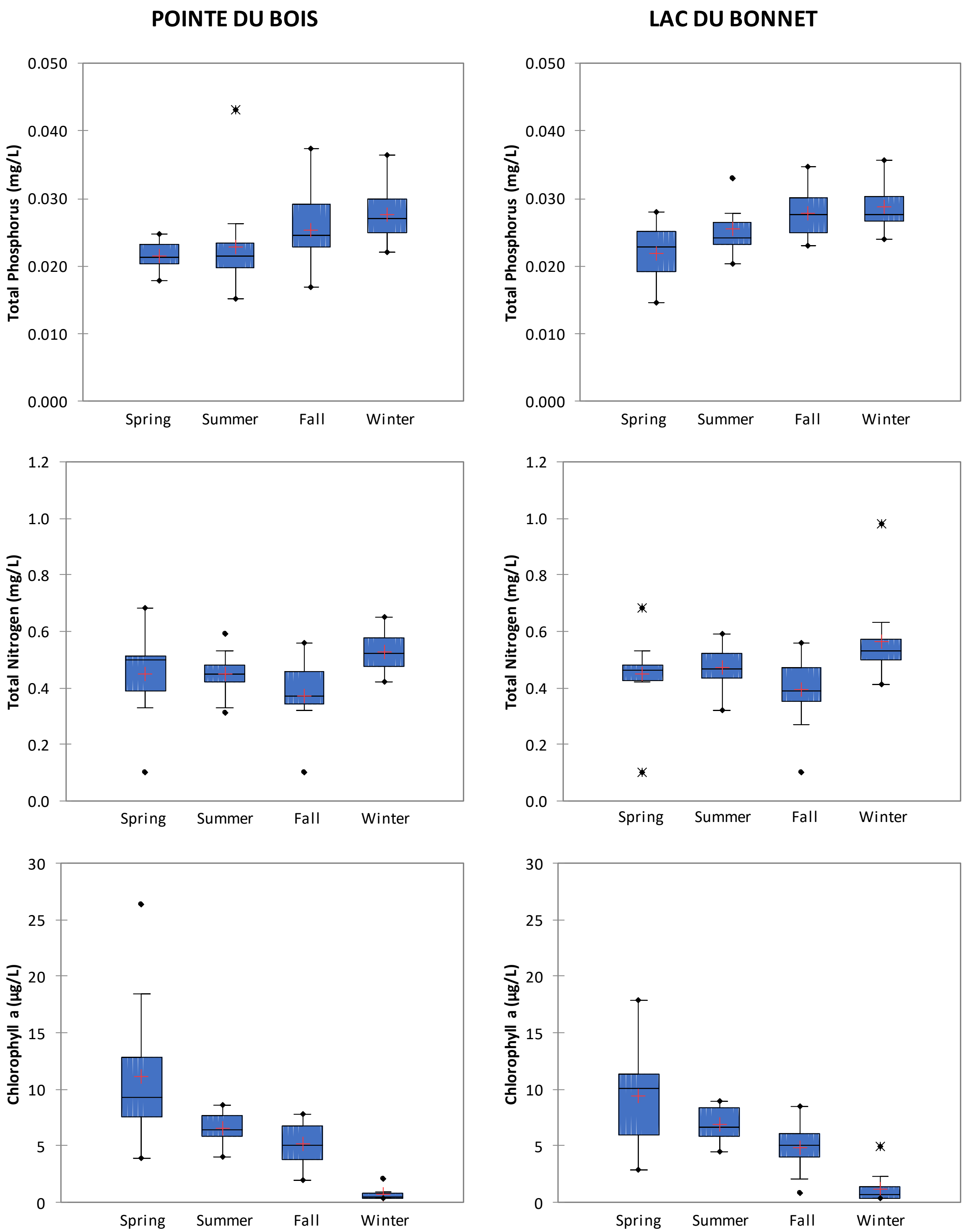


Figure 3.4-2. 2008-2019 On-system seasonal total phosphorus, total nitrogen, and chlorophyll *a* concentrations.

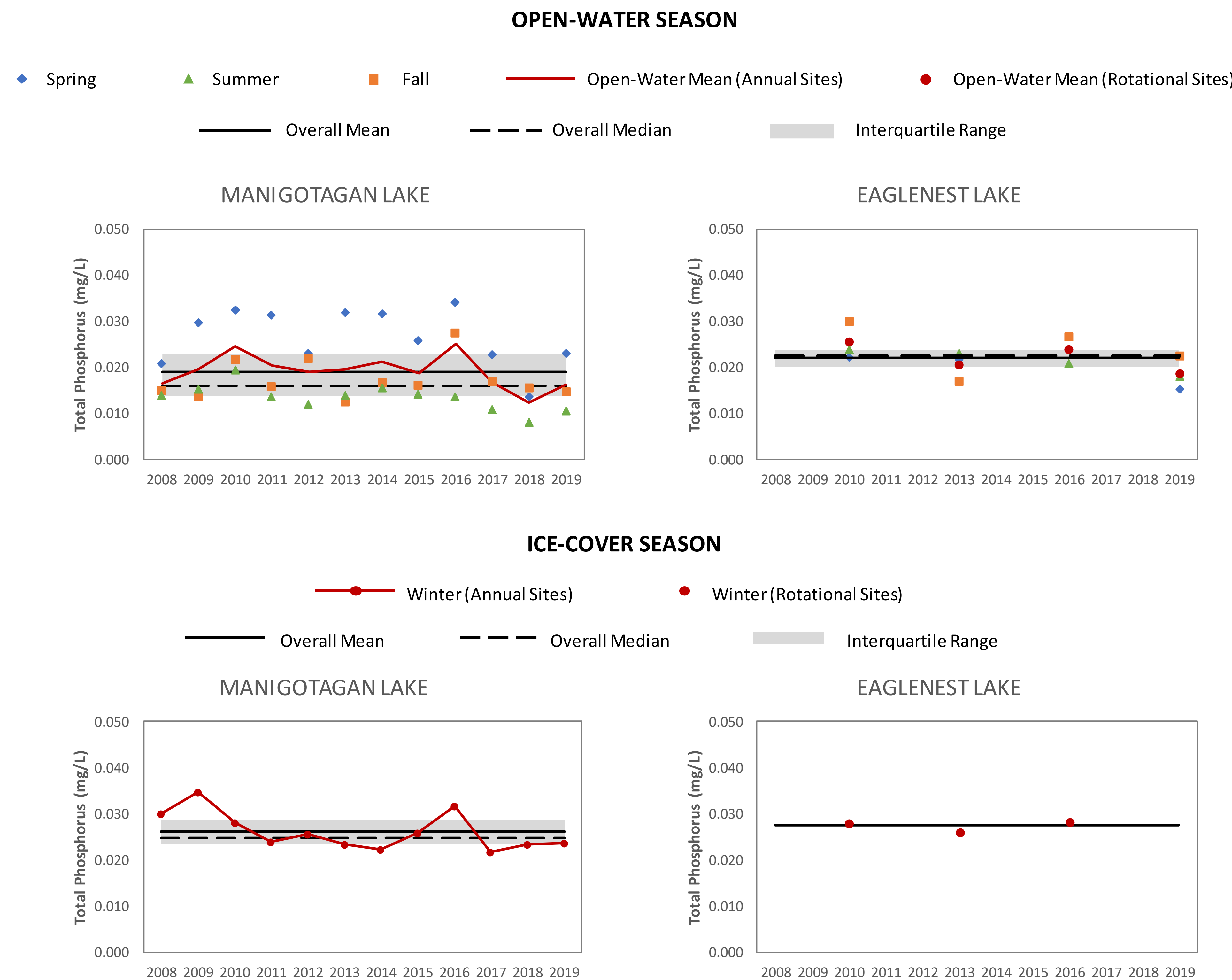


Figure 3.4-3. 2008-2019 Off-system open-water and ice-cover season TP concentrations.

MANIGOTAGAN LAKE

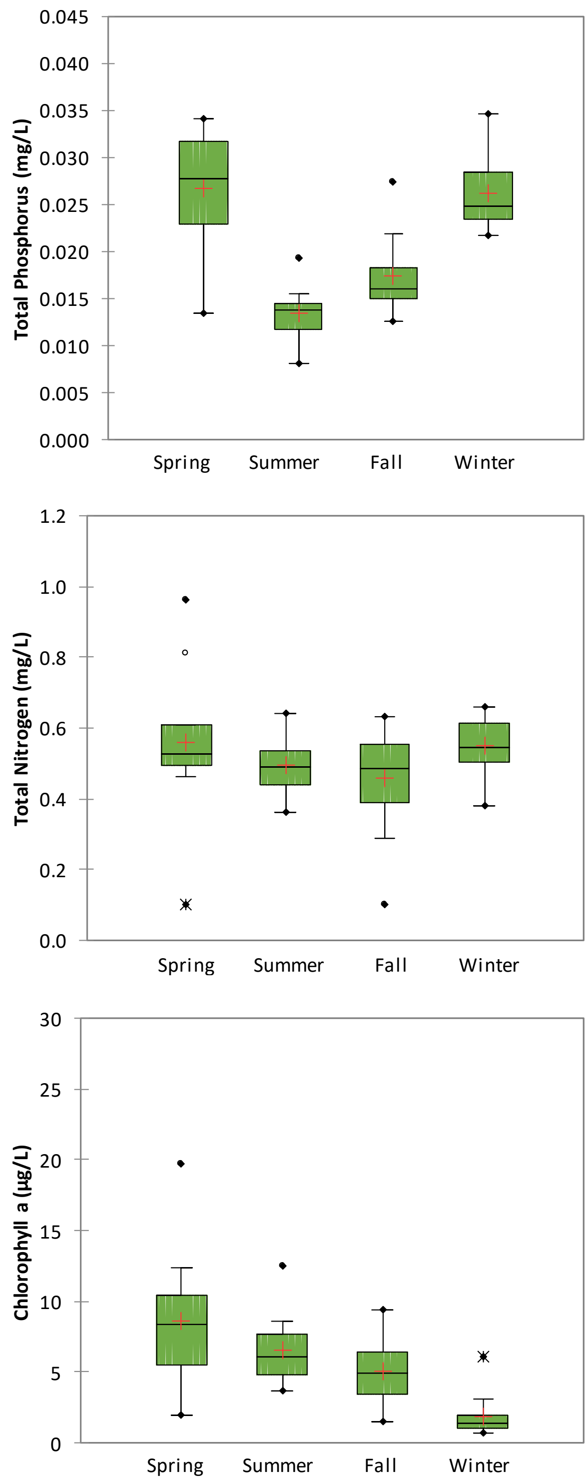


Figure 3.4-4. 2008-2019 Off-system seasonal total phosphorus, total nitrogen, and chlorophyll *a* concentrations.

3.4.2 TOTAL NITROGEN

3.4.2.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

TN concentrations in the Pointe du Bois Forebay ranged from <0.20 to 0.68 mg/L during the open-water season. The mean and median for the 12 years of monitoring were 0.42 mg/L and 0.45 mg/L, respectively. Open-water season mean annual TN concentrations ranged from 0.30 to 0.55 mg/L and were within or near the IQR (0.36 to 0.50 mg/L) in seven of the 12 years. Mean TN concentrations were below the IQR in 2010, 2017, and 2018 and above the IQR in 2008, and 2016 (Table 3.4-1 and Figure 3.4-5).

TN concentrations in the ice-cover season ranged from 0.42 to 0.65 mg/L, with a mean of 0.53 mg/L and a median of 0.52 mg/L for the 12 years of monitoring. The IQR was 0.48 to 0.58 mg/L (Table 3.4-1 and Figure 3.4-5).

No clear seasonality was observed for TN in the Pointe du Bois Forebay over the 12-year period. However, the lowest mean TN concentration occurred in fall (0.37 mg/L) and the highest in winter (0.53 mg/L; Figure 3.4-2).

The Pointe du Bois Forebay was mesotrophic (0.350 to 0.650 mg/L) on the basis of the 2008-2019 mean open-water season TN concentration (0.42 mg/L). Mean annual TN concentrations (0.30 to 0.55 mg/L) in the open-water season were within the mesotrophic range (0.350 to 0.650 mg/L) in all years except for 2010, 2017 and 2018 when mean TN concentrations were in the oligotrophic range (i.e., <0.350 mg/L; Table 3.4-2).

Lac du Bonnet

TN concentrations in Lac du Bonnet ranged from <0.20 to 0.68 mg/L during the open-water season. The mean and median for the 12 years of monitoring were 0.44 mg/L and 0.46 mg/L, respectively. Open-water season mean annual TN concentrations ranged from 0.28 to 0.55 mg/L and were within the IQR (0.39 to 0.51 mg/L) in eight of the 12 years. Mean TN concentrations were below the IQR in 2017, and 2018 and above the IQR in 2008, and 2016 (Table 3.4-1 and Figure 3.4-5).

TN concentrations in the ice-cover season ranged from 0.41 to 0.98 mg/L, with a mean of 0.56 mg/L and a median of 0.53 mg/L for the 12 years of monitoring. The IQR was 0.50 to 0.57 mg/L. TN concentrations were within or near the IQR except in 2013 when it was above the IQR (Table 3.4-1 and Figure 3.4-5).

No clear seasonality was observed for TN in Lac du Bonnet over the 12 years of monitoring. However, the lowest mean TN concentration occurred in fall (0.39 mg/L) and the highest in winter (0.56 mg/L; Figure 3.4-2).

Lac du Bonnet was mesotrophic (0.350 to 0.650 mg/L) on the basis of the 2008-2019 mean open-water season TN concentration (0.44 mg/L). Mean annual TN concentrations (0.28 to 0.55 mg/L) in the open-water season were within the mesotrophic range (0.350 to 0.650 mg/L) in all years except for 2018 when the mean TN concentration was in the oligotrophic range (i.e., <0.350 mg/L; Table 3.4-2).

ROTATIONAL SITES

Pine Falls Forebay

TN concentrations in the Pine Falls Forebay ranged from <0.20 to 0.57 mg/L during the open-water season. The mean was 0.43 mg/L, the median was 0.46 mg/L, and the IQR was 0.44 to 0.49 mg/L for the three years of monitoring. Mean annual TN concentrations in the open-water season ranged from 0.33 to 0.49 mg/L and were within the IQR in 2011 and 2014, but below the IQR in 2017 (Table 3.4-1 and Figure 3.4-5).

During the ice-cover season, TN concentrations ranged from 0.40 to 0.51 mg/L, with a mean of 0.47 mg/L (Table 3.4-1 and Figure 3.4-5).

The Pine Falls Forebay was mesotrophic (0.350 to 0.650 mg/L) based on the mean of the open-water season TN concentrations for the three years of monitoring (0.43 mg/L). Open-water season mean annual TN concentrations (0.33 to 0.49 mg/L) were also within the meso-eutrophic range in 2011 and 2014 but were within the oligotrophic range (i.e., <0.350 mg/L) in 2017 (Table 3.4-2).

3.4.2.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

TN concentrations in Manigotagan Lake ranged from <0.20 to 0.96 mg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were 0.50 mg/L and 0.52 mg/L, respectively. Open-water season mean annual TN concentrations ranged from 0.34 to 0.66 mg/L but were within the IQR (0.45 to 0.58 mg/L) in seven of the 12 years. Mean TN concentrations were below the IQR in 2013, 2017, and 2018 and above the IQR in 2012, and 2016 (Table 3.4-3 and Figure 3.4-6).

TN concentrations in the ice-cover season ranged from 0.38 to 0.66 mg/L, and the mean and median were both 0.55 mg/L for the 12 years of monitoring. The IQR was 0.51 to 0.61 mg/L (Table 3.4-3 and Figure 3.4-6).

No clear seasonality was observed for TN in Manigotagan Lake over the 12 years of monitoring. However, the lowest mean TN concentration occurred in fall (0.46 mg/L) and the highest in spring (0.56 mg/L; Figure 3.4-4).

Manigotagan Lake was mesotrophic (0.350 to 0.650 mg/L) on the basis of the 2008-2019 mean open-water season TN concentration (0.50 mg/L). Mean annual TN concentrations (0.34 to 0.66 mg/L) in the open-water season were also within the mesotrophic range in ten of the 12 years of monitoring. However, the mean TN concentration was within the oligotrophic range (i.e., <0.350 mg/L) in 2018 and within the eutrophic range (0.651-1.20 mg/L) in 2012 (Table 3.4-4).

ROTATIONAL SITES

Eaglenest Lake

TN concentrations in Eaglenest Lake ranged from 0.27 to 0.70 mg/L during the open-water season. The mean and median concentrations for the four years of monitoring were 0.43 mg/L and 0.41 mg/L, respectively. Open-water season mean annual TN concentrations ranged from 0.36 to 0.57 mg/L and were within the IQR (0.35 to 0.49 mg/L) in all years sampled except for 2016 when it was above the IQR (Table 3.4-3 and Figure 3.4-6).

During the ice-cover season, TN concentrations ranged from 0.46 to 0.77 mg/L, with a mean of 0.59 mg/L (Table 3.4-3 and Figure 3.4-6).

Eaglenest Lake was mesotrophic (0.350 to 0.650 mg/L) based on the mean of the open-water season TN concentrations for the four years of monitoring (0.43 mg/L). Open-water season mean annual TN concentrations (0.36 to 0.57 mg/L) were also within the mesotrophic range in each year of monitoring (Table 3.4-4).

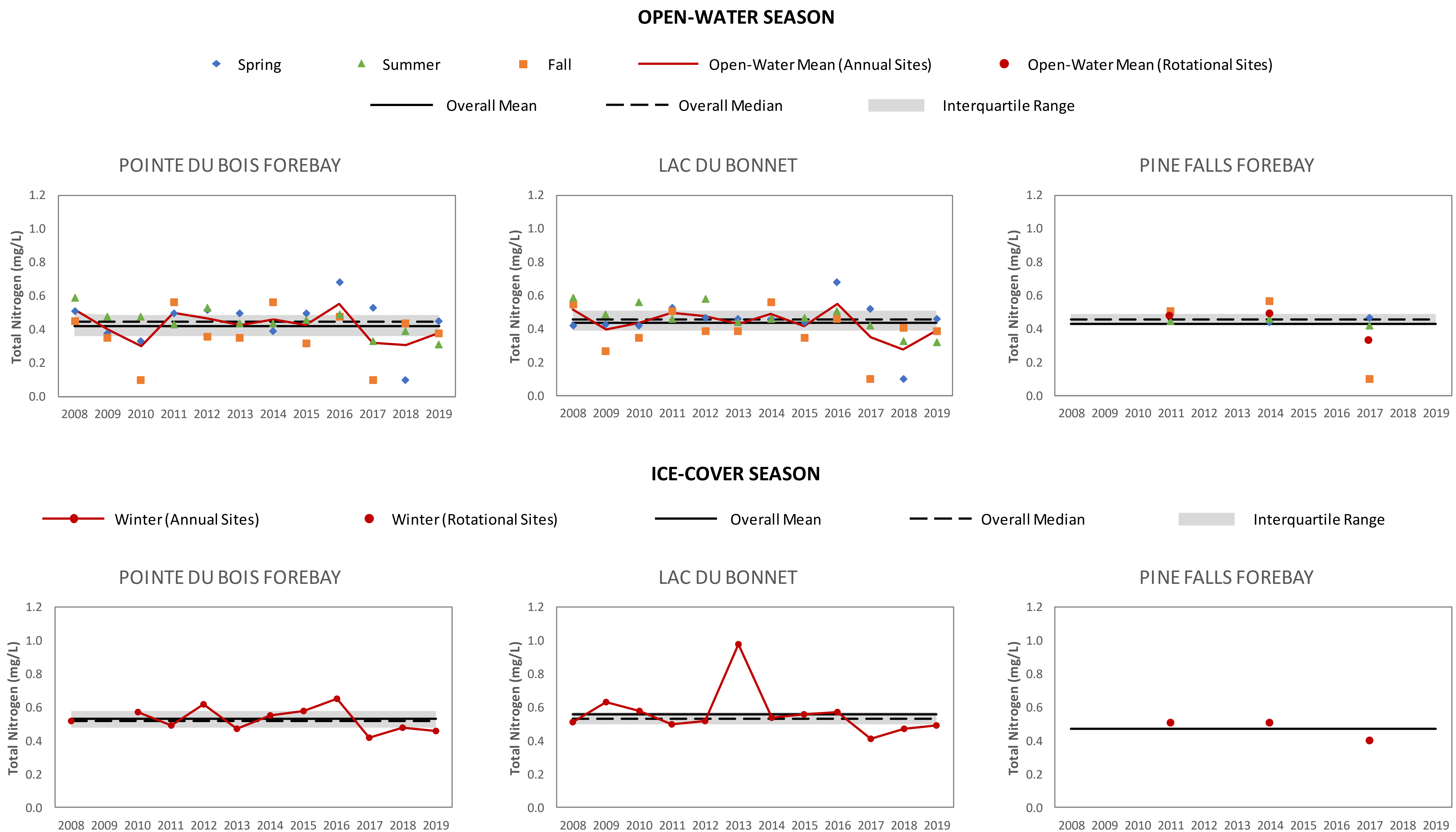


Figure 3.4-5. 2008-2019 On-system open-water and ice-cover season TN concentrations.

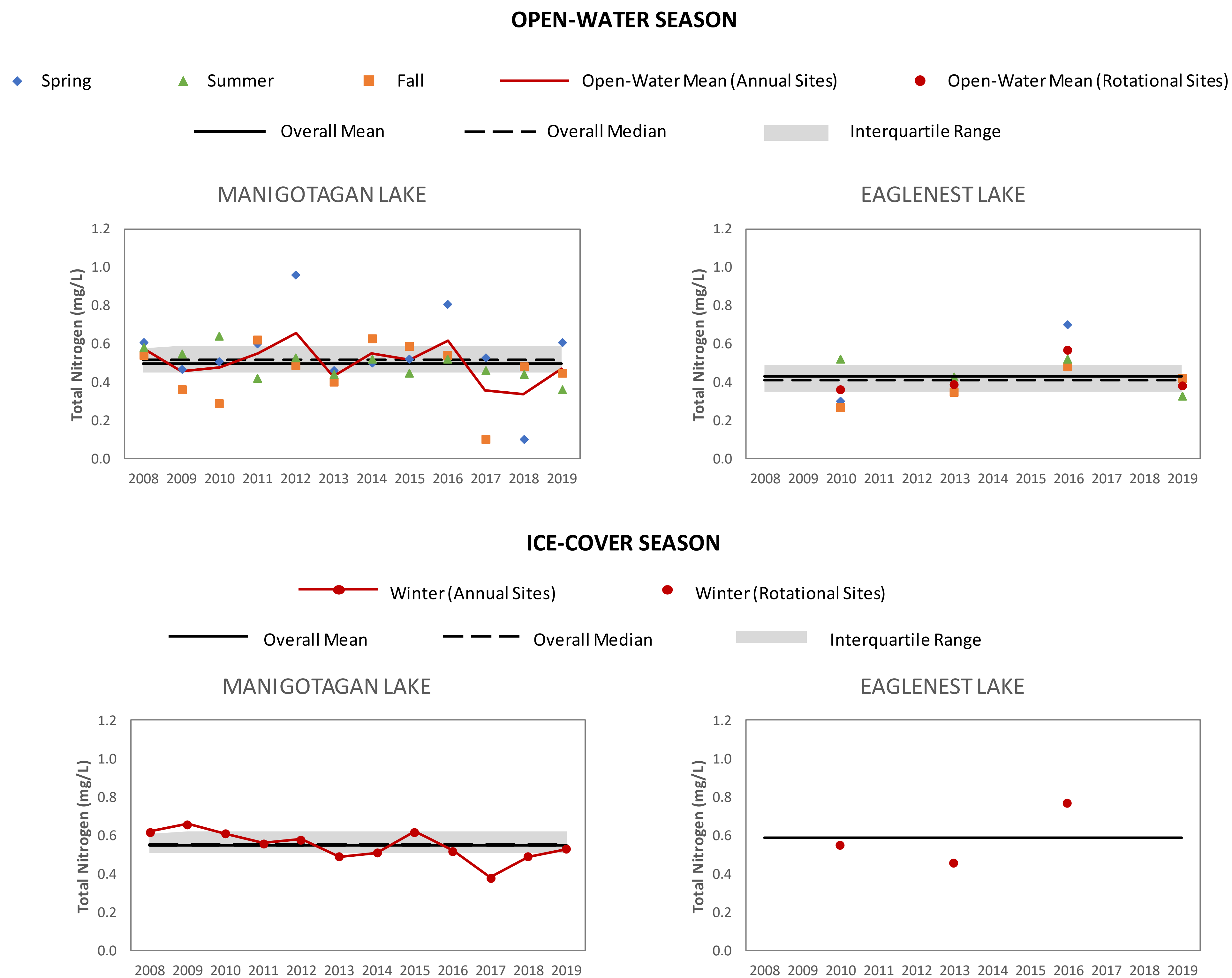


Figure 3.4-6. 2008-2019 Off-system open-water and ice-cover season TN concentrations.

3.4.3 CHLOROPHYLL *A*

3.4.3.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Chlorophyll *a* concentrations in the Pointe du Bois Forebay ranged from 1.91 to 26.3 µg/L during the open-water season. The mean and median for the 12 years of monitoring were 7.56 µg/L and 6.46 µg/L, respectively. Open-water season mean annual chlorophyll *a* concentrations ranged from 3.52 to 12.2 µg/L and were within the IQR (5.06 to 8.05 µg/L) in six of the 12 years. Mean chlorophyll *a* concentrations were below the IQR in 2010 and above the IQR in 2011, 2013, 2015, 2018, and 2019 (Table 3.4-1 and Figure 3.4-7).

Chlorophyll *a* concentrations in the ice-cover season ranged from <0.60 to 2.06 µg/L, with a mean of 0.65 µg/L and a median of <0.60 µg/L for the 12 years of monitoring. The IQR was <0.60 to 0.76 µg/L (Table 3.4-1 and Figure 3.4-7).

Chlorophyll *a* concentrations were lower in the winter, often less than the DL (0.60-1.0 µg/L; percent detection = 45), compared to the open-water season (Table 3.4-1). On average, chlorophyll *a* concentrations during the open-water season were lowest in fall (5.12 µg/L) and highest in spring (11.1 µg/L; Figure 3.4-2).

The Pointe du Bois Forebay was mesotrophic (2.5 to 8 µg/L) on the basis of the 2008-2019 mean open-water season chlorophyll *a* concentration (7.56 µg/L). Mean annual chlorophyll *a* concentrations (3.52 to 12.2 µg/L) in the open-water season were within the mesotrophic range (2.5 to 8 µg/L) in 2008-2010, 2012, 2014, 2016, and 2017; and within the eutrophic range (8 to 25 µg/L) in 2011, 2013, 2015, 2018, and 2019 (Table 3.4-2).

Lac du Bonnet

Chlorophyll *a* concentrations in Lac du Bonnet ranged from 0.84 to 17.8 µg/L during the open-water season. The mean and median for the 12 years of monitoring were 7.02 µg/L and 6.21 µg/L, respectively. Open-water season mean annual chlorophyll *a* concentrations ranged from 3.64 to 10.4 µg/L and were within the IQR (5.10 to 8.49 µg/L) in seven of the 12 years. Mean chlorophyll *a* concentrations were below the IQR in 2010 and 2012 and above the IQR in 2011, 2013, and 2019 (Table 3.4-1 and Figure 3.4-7).

Chlorophyll *a* concentrations in the ice-cover season ranged from <0.60 to 4.96 µg/L, with a mean of 1.19 µg/L and a median of 0.73 µg/L for the 12 years of monitoring. Chlorophyll *a* concentrations were within or near the IQR (0.60 to 1.39 µg/L) in most years, the exception was winter 2017 when it was above the IQR. (Table 3.4-1 and Figure 3.4-7).

Chlorophyll *a* concentrations were lower in the winter, often less than the DL (0.60-1.0 µg/L; percent detection = 50), compared the open-water season (Table 3.4-1). On average, chlorophyll *a* concentrations during the open-water season were lowest in fall (4.80 µg/L) and highest in spring (9.37 µg/L; Figure 3.4-2).

Lac du Bonnet was mesotrophic (2.5 to 8 µg/L) on the basis of the 2008-2019 mean open-water season chlorophyll *a* concentration (7.02 µg/L). Mean annual chlorophyll *a* concentrations (3.64 to 10.4 µg/L) in the open-water season were within the mesotrophic range (2.5 to 8 µg/L) in most years except for 2011, 2013, and 2019 when the mean chlorophyll *a* concentrations were within the eutrophic range (8 to 25 µg/L; Table 3.4-2).

ROTATIONAL SITES

Pine Falls Forebay

Chlorophyll *a* concentrations in the Pine Falls Forebay ranged from 2.10 to 18.1 µg/L during the open-water season. The mean was 7.46 µg/L, the median was 5.54 µg/L, and the IQR was 4.28 to 9.93 µg/L for the three years of monitoring. Mean annual chlorophyll *a* concentrations in the open-water season ranged from 5.73 to 9.56 µg/L and were within the IQR in all years (Table 3.4-1 and Figure 3.4-7).

During the ice-cover season, chlorophyll *a* concentrations ranged from 1.53 to 1.91 µg/L, with a mean of 1.72 µg/L (Table 3.4-1 and Figure 3.4-7).

The Pine Falls Forebay was mesotrophic (2.5 to 8 µg/L) based on the mean of the open-water season chlorophyll *a* concentrations for the three years of monitoring (7.46 µg/L). Open-water season mean annual chlorophyll *a* concentrations (5.73 to 9.56 µg/L) were also within the mesotrophic range in 2014 and 2017 but were within the eutrophic range (8 to 25 µg/L) in 2011 (Table 3.4-2).

3.4.3.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Chlorophyll a concentrations in Manigotagan Lake ranged from 1.53 to 19.6 µg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were 6.73 µg/L and 6.06 µg/L, respectively. Open-water season mean annual chlorophyll *a* concentrations ranged from 3.64 to 8.97 µg/L and were within the IQR (4.34 to 8.16 µg/L) in eight of the 12 years. Mean chlorophyll *a* concentrations were below the IQR in 2010 and above the IQR in 2014, 2017, and 2018 (Table 3.4-3 and Figure 3.4-8).

Chlorophyll *a* concentrations in the ice-cover season ranged from 0.68 to 6.11 µg/L, with a mean of 1.85 µg/L and a median of 1.31 µg/L for the 12 years of monitoring. Chlorophyll *a* concentrations during the ice-cover season were within or near the IQR (0.99 to 1.96 µg/L) in all years except 2016 when the concentration was above the IQR (Table 3.4-3 and Figure 3.4-8).

Chlorophyll *a* concentrations were lower under ice-cover (mean = 1.85 µg/L) than during the open-water season (mean = 6.73 µg/L). On average, chlorophyll *a* concentrations during the open-water season were lowest in fall (5.06 µg/L) and highest in spring (8.62 µg/L; Figure 3.4-4).

Manigotagan Lake was mesotrophic (2.5 to 8 µg/L) on the basis of the 2008-2019 mean open-water season chlorophyll *a* concentration (6.73 µg/L). Mean annual chlorophyll *a* concentrations (3.64 to 8.97 µg/L) in the open-water season were also within the mesotrophic range in nine of the 12 years. However, the mean chlorophyll *a* concentration was within the eutrophic range (8 to 25 µg/L) in 2014, 2017, and 2018 (Table 3.4-4).

ROTATIONAL SITES

Eaglenest Lake

Chlorophyll *a* concentrations in Eaglenest Lake ranged from 1.40 to 15.1 µg/L during the open-water season. The mean and median concentrations for the four years of monitoring were 6.48 µg/L and 6.03 µg/L, respectively. Open-water season mean annual chlorophyll *a* concentrations ranged from 4.22 to 9.29 µg/L and were within the IQR (4.78 to 7.45 µg/L) in 2013 and 2016 but were below the IQR in 2010 and above the IQR in 2019 (Table 3.4-3 and Figure 3.4-8).

During the ice-cover season, chlorophyll *a* concentrations were consistently below the DL (0.60 µg/L; Table 3.4-3 and Figure 3.4-8).

Eaglenest Lake was mesotrophic (2.5 to 8 µg/L) based on the mean of the open-water season chlorophyll *a* concentrations for the four years of monitoring (6.48 µg/L). Open-water season mean annual chlorophyll *a* concentrations (4.22 to 9.29 µg/L) were also within the meso-eutrophic range in 2010, 2013, and 2016 but were within the eutrophic range (8 to 25 µg/L) in 2019 (Table 3.4-4).

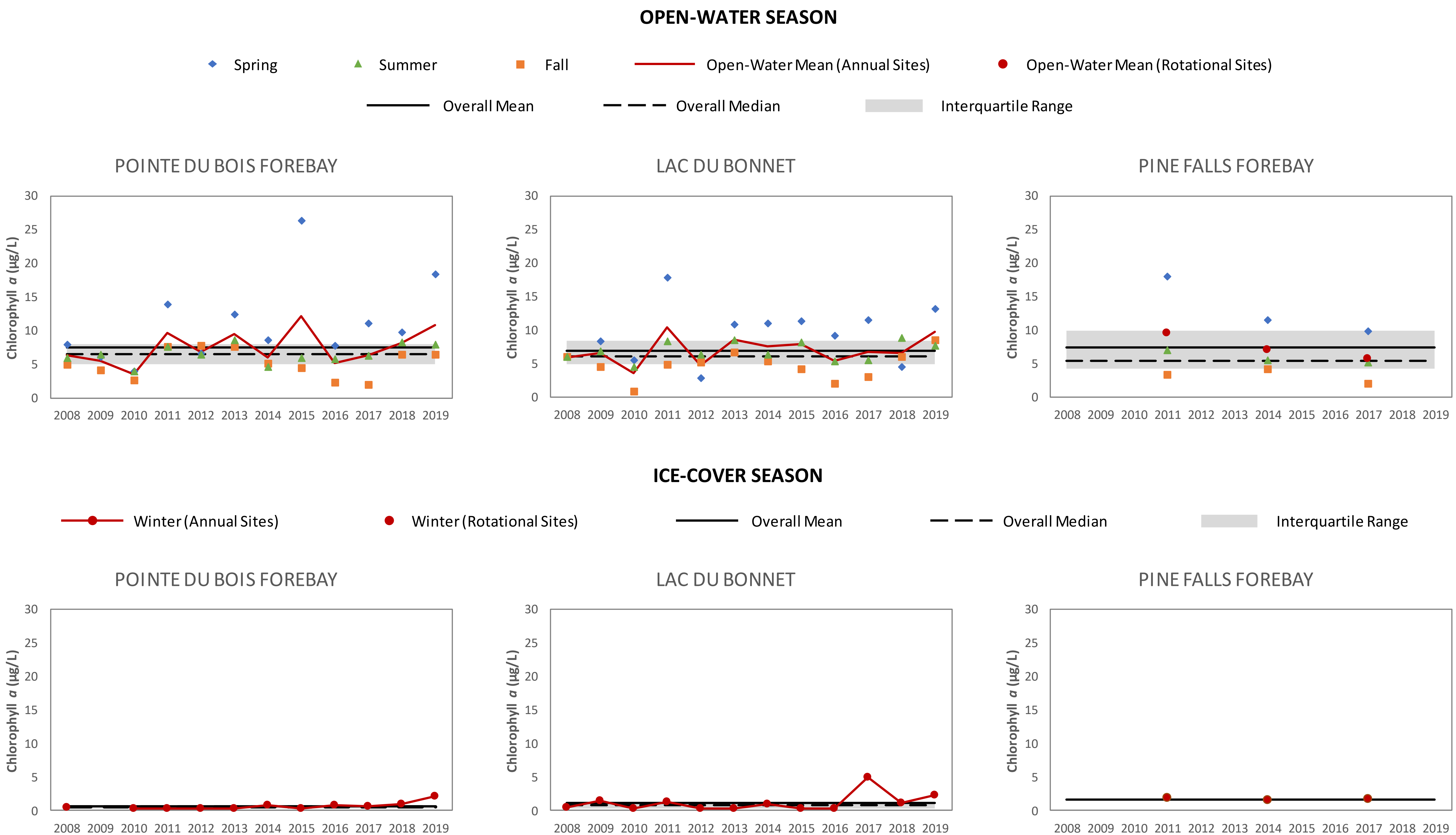


Figure 3.4-7. 2008-2019 On-system open-water and ice-cover season chlorophyll *a* concentrations.

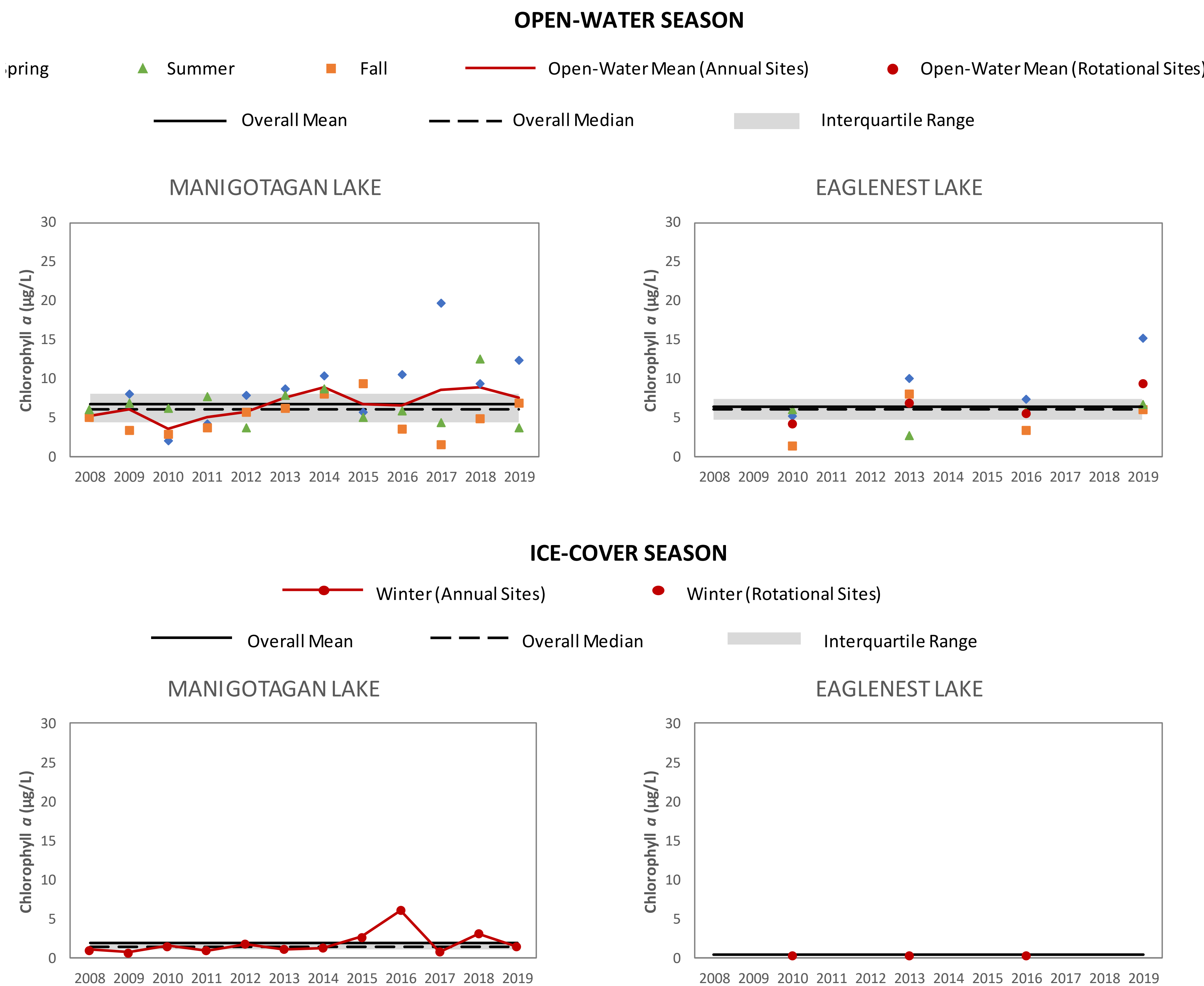


Figure 3.4-8. 2008-2019 Off-system open-water and ice-cover season chlorophyll *a* concentrations.

APPENDIX 3-1. WATER QUALITY SAMPLING SITES: 2008-2019

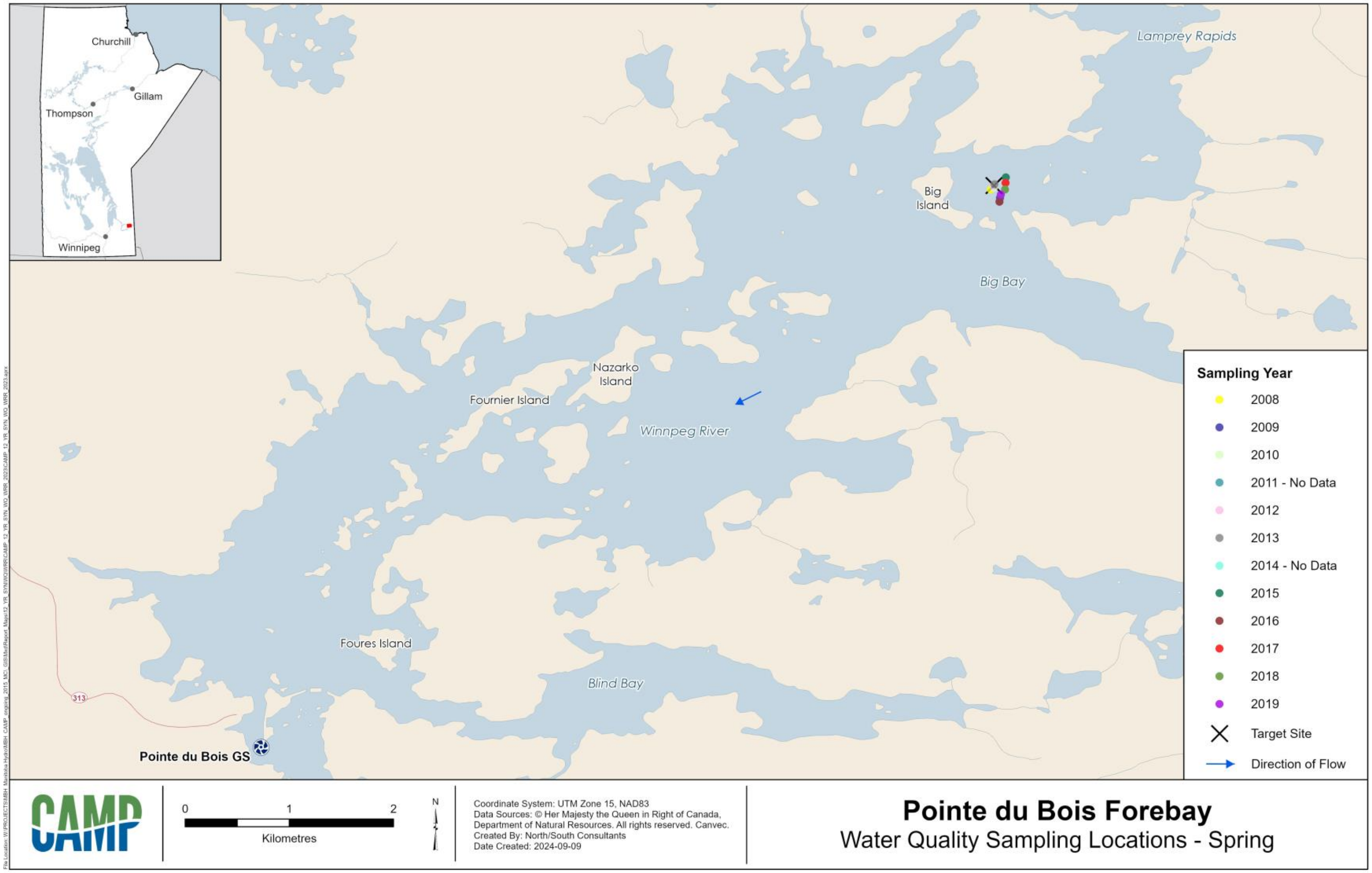


Figure A3-1-1. Spring water quality sampling locations: Pointe du Bois Forebay.

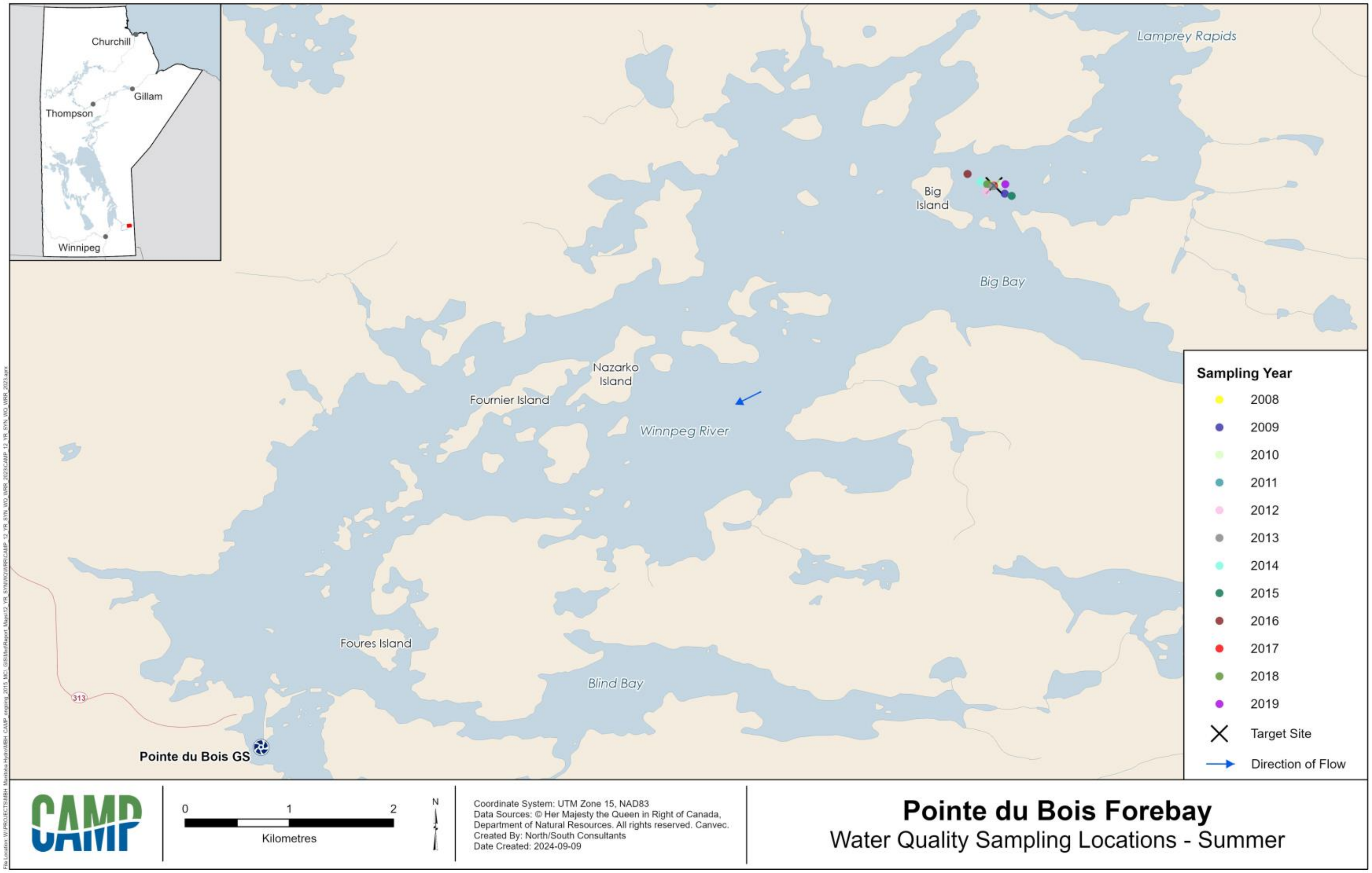


Figure A3-1-2. Summer water quality sampling locations: Pointe du Bois Forebay.

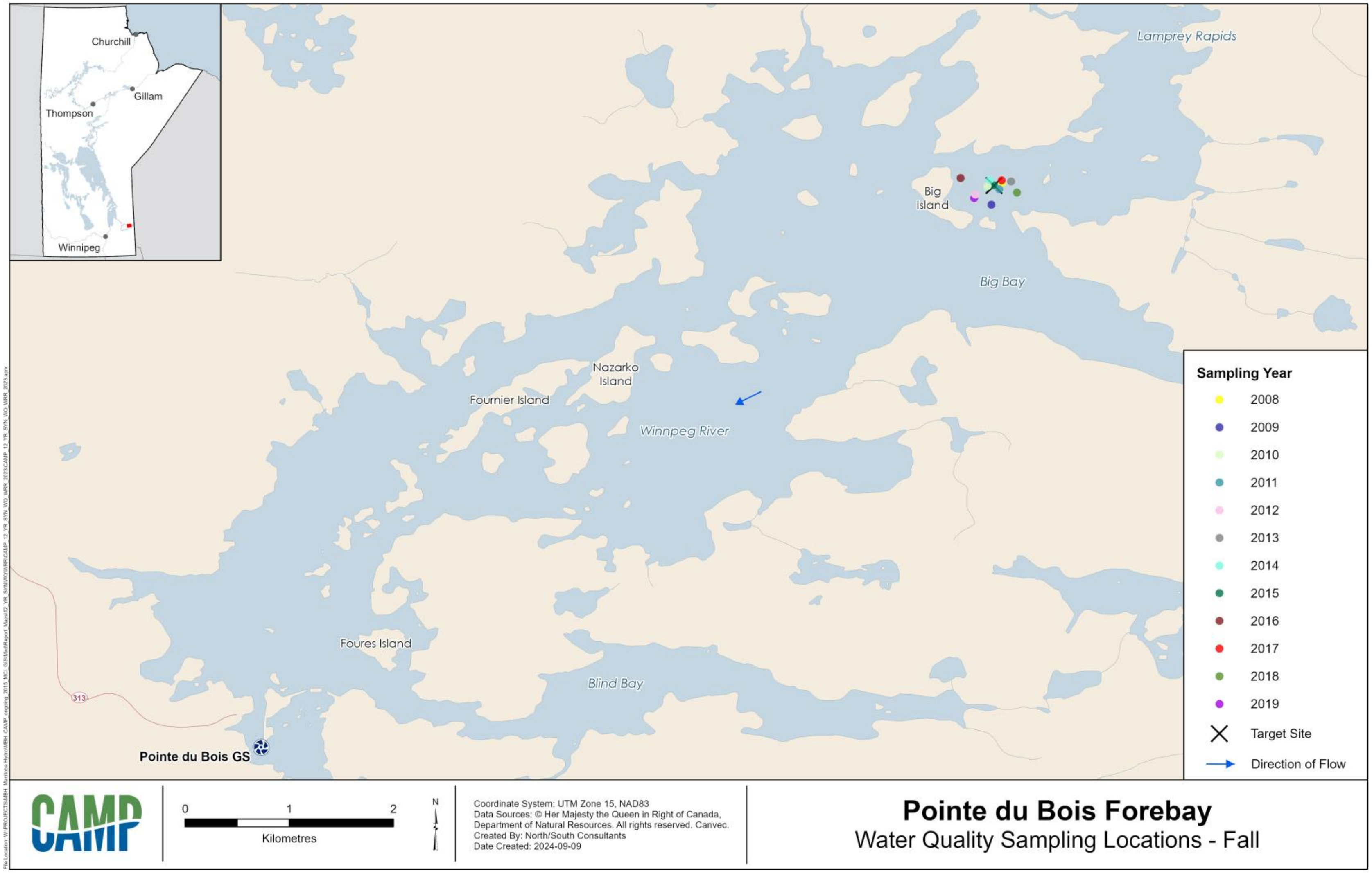


Figure A3-1-3. Fall water quality sampling locations: Pointe du Bois Forebay.

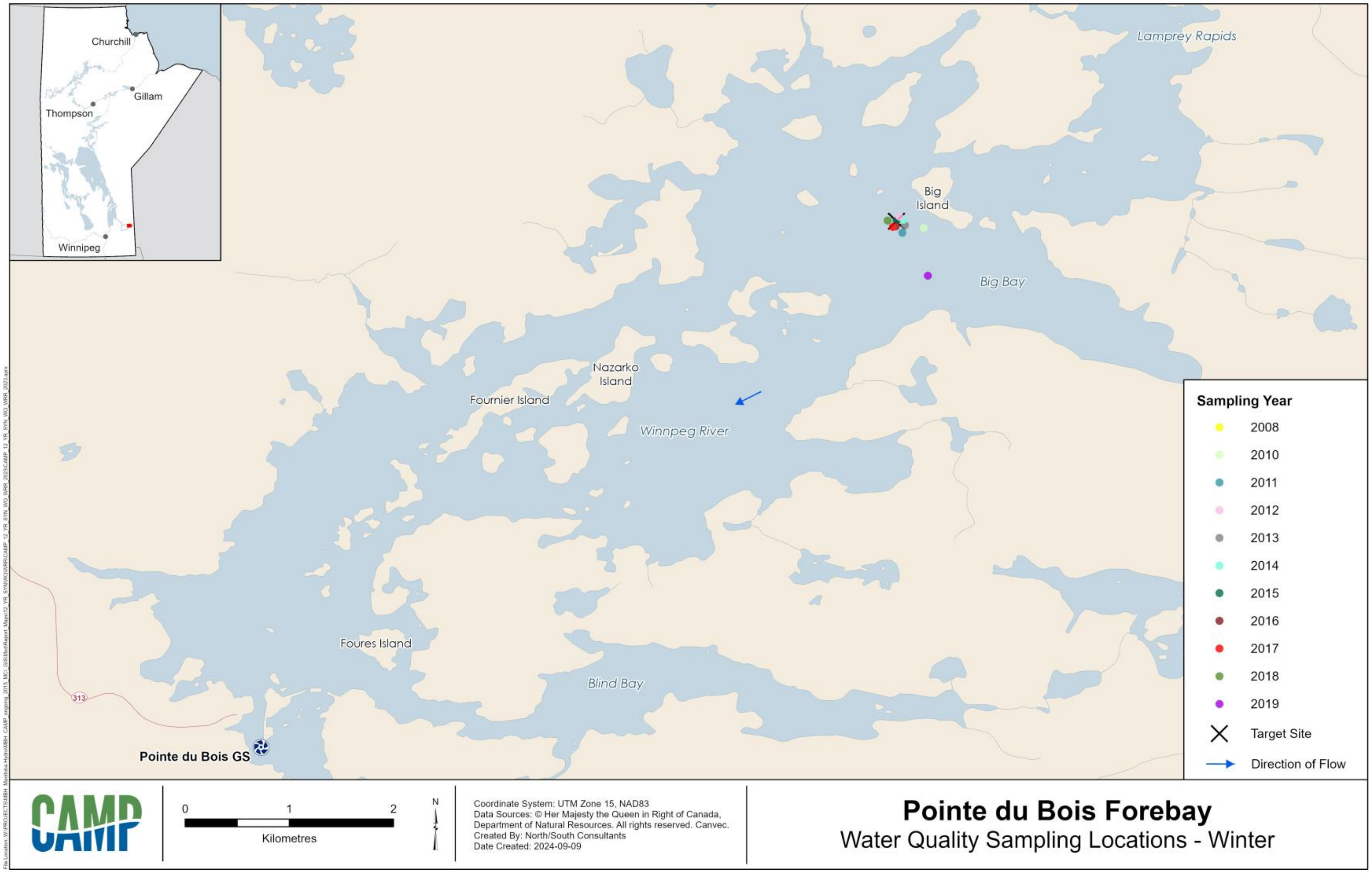


Figure A3-1-4. Winter water quality sampling locations: Pointe du Bois Forebay.

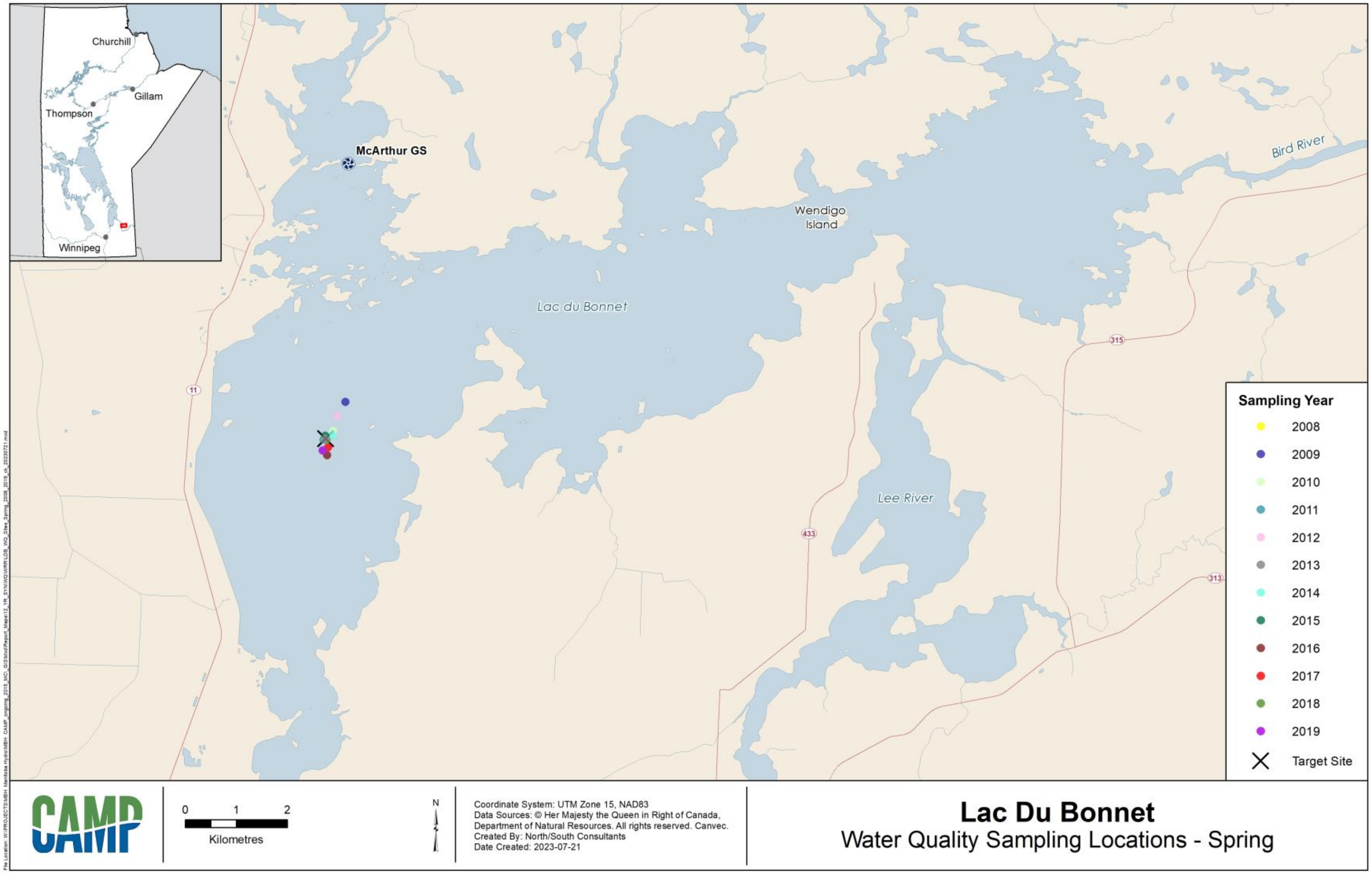


Figure A3-1-5. Spring water quality sampling locations: Lac du Bonnet.

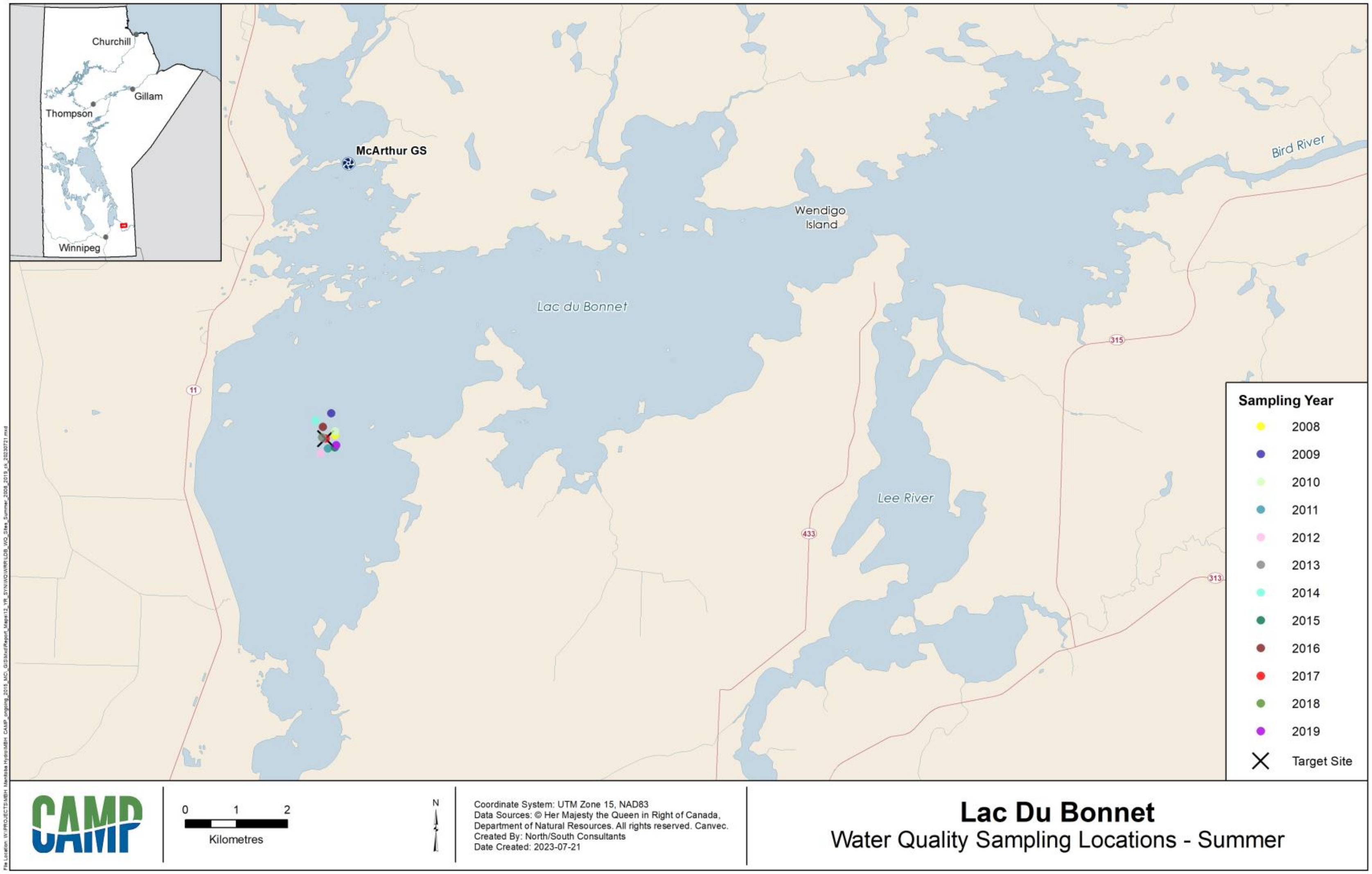


Figure A3-1-6. Summer water quality sampling locations: Lac du Bonnet.

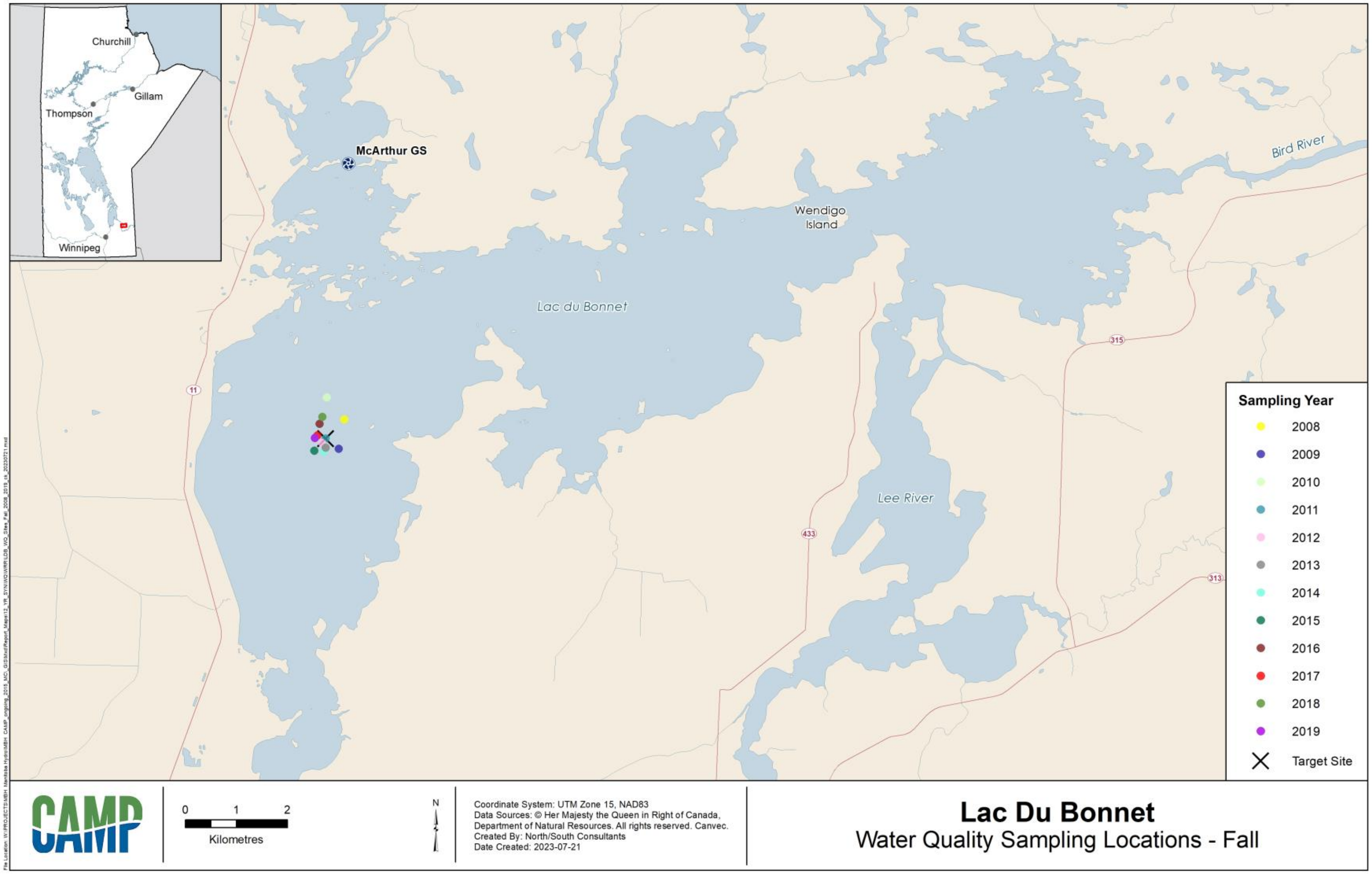


Figure A3-1-7. Fall water quality sampling locations: Lac du Bonnet.

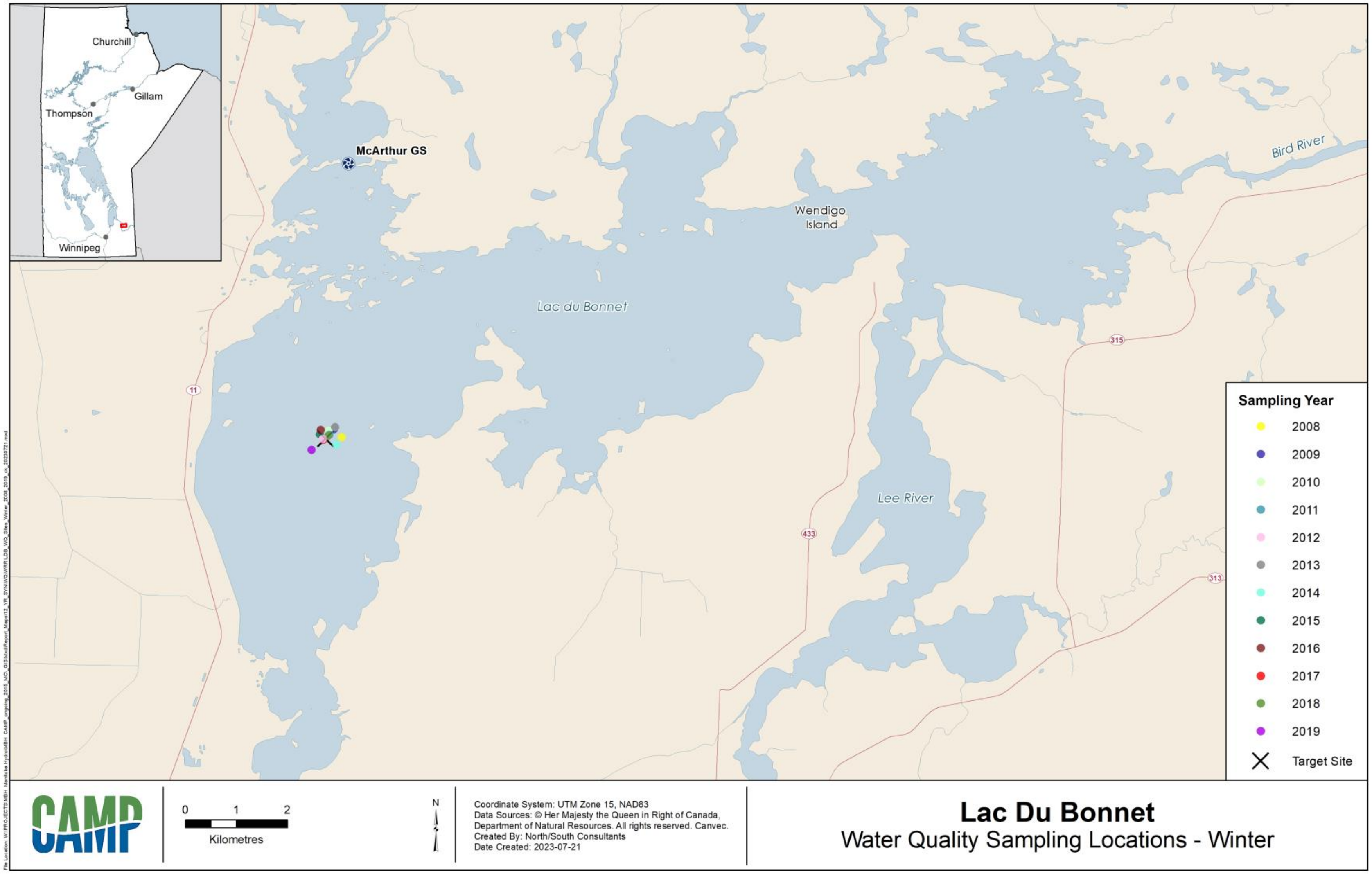


Figure A3-1-8. Winter water quality sampling locations: Lac du Bonnet.

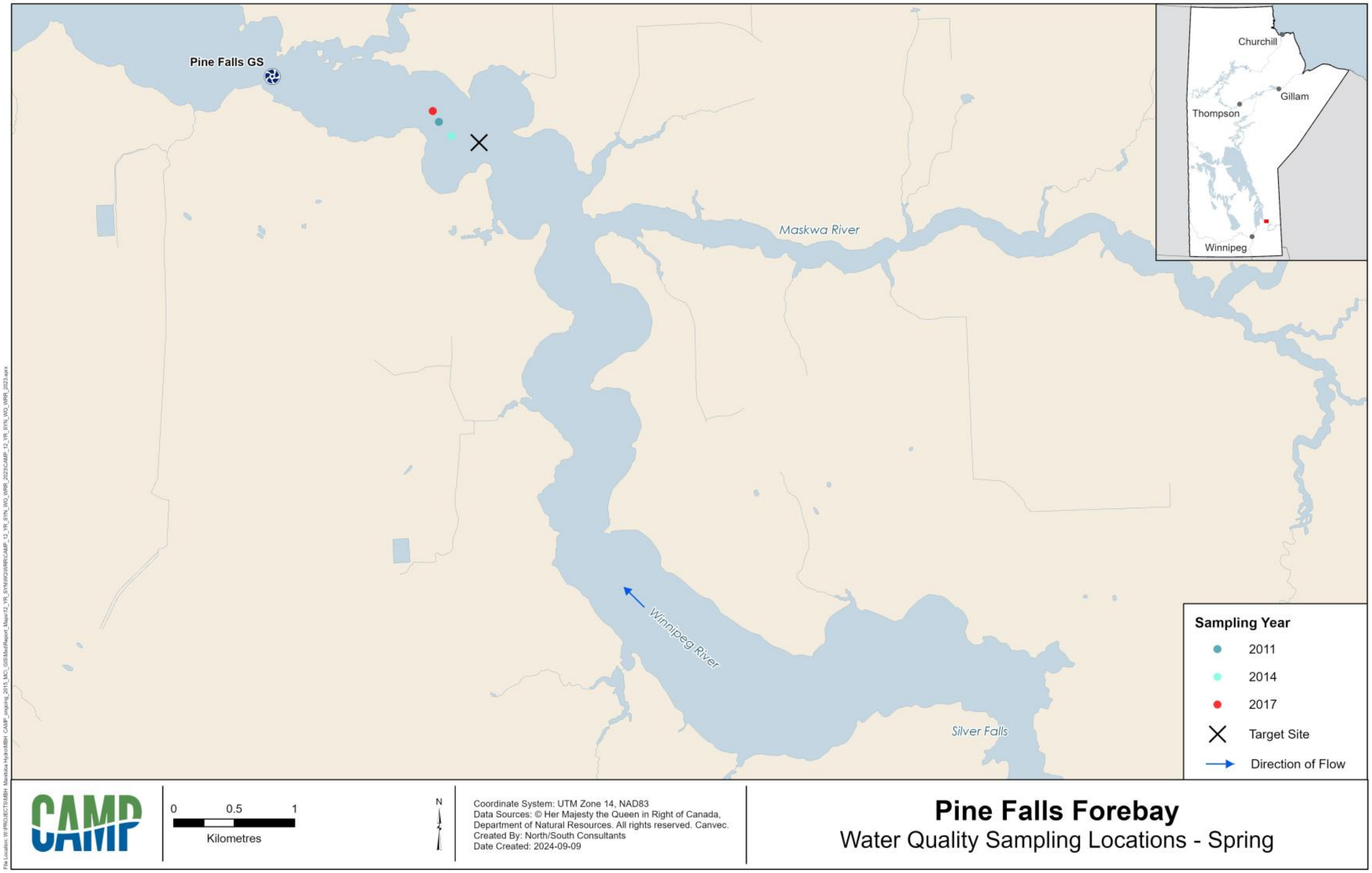


Figure A3-1-9. Spring water quality sampling locations: Pine Falls Forebay.

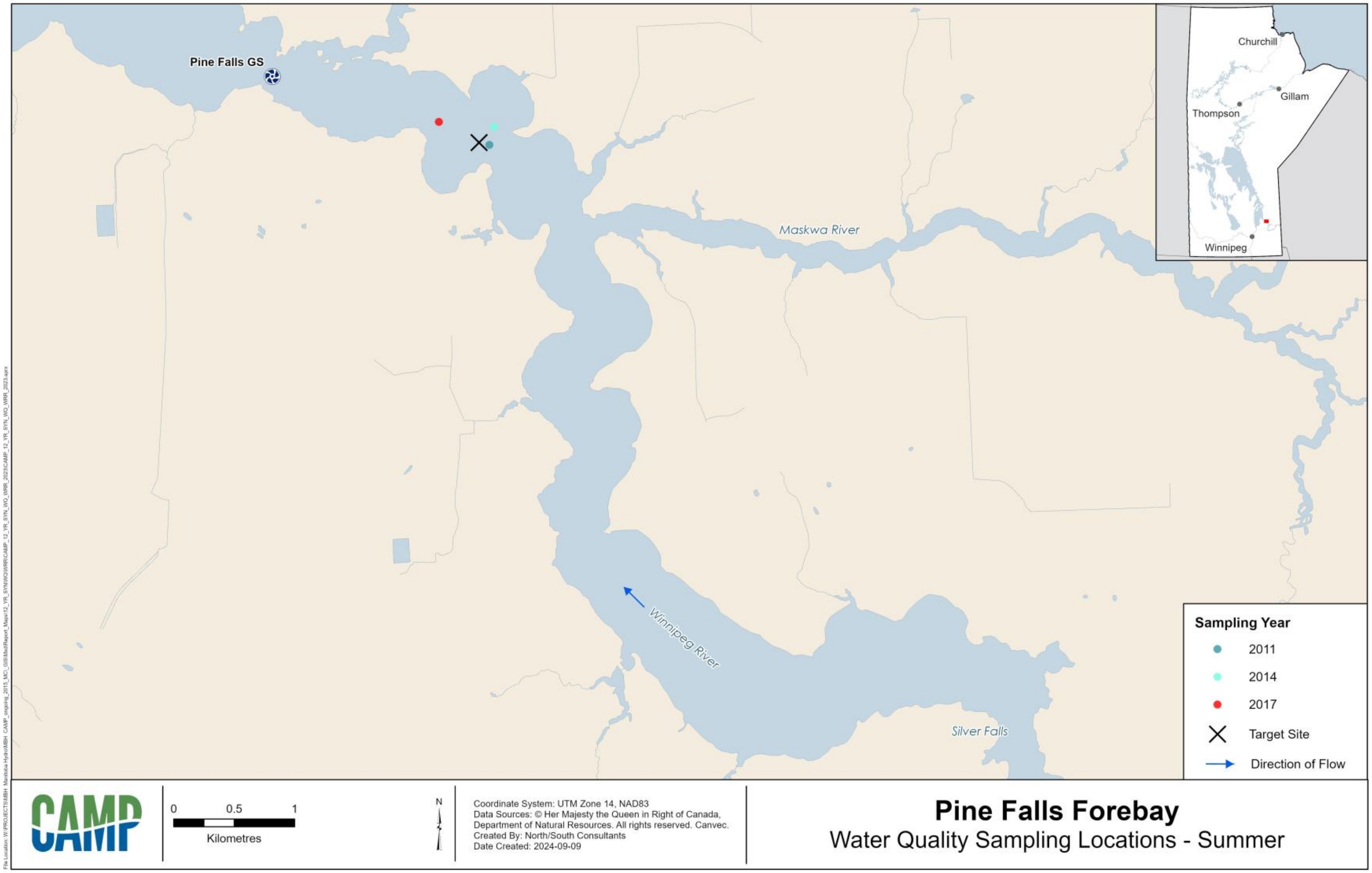


Figure A3-1-10. Summer water quality sampling locations: Pine Falls Forebay.

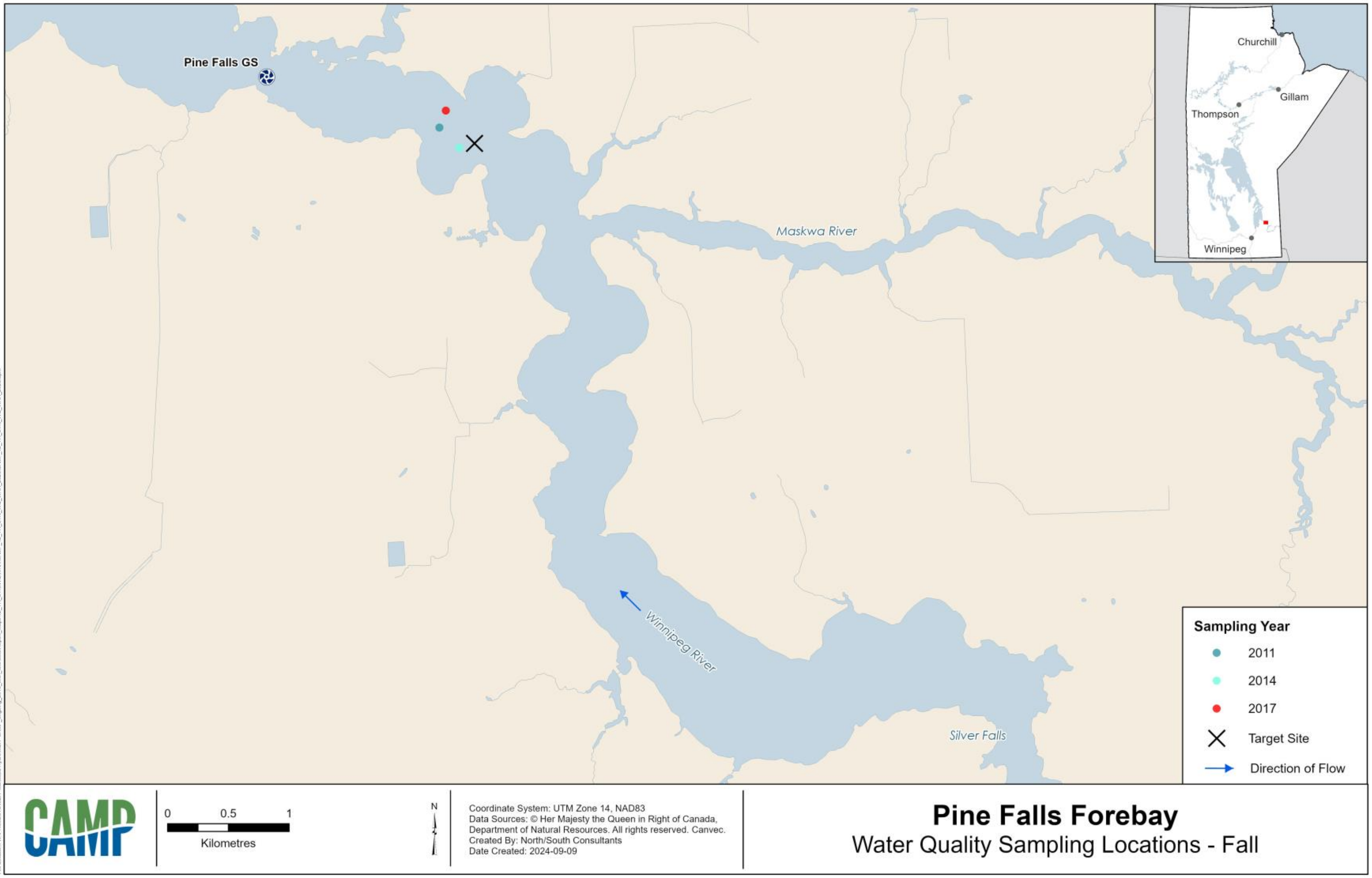


Figure A3-1-11. Fall water quality sampling locations: Pine Falls Forebay.

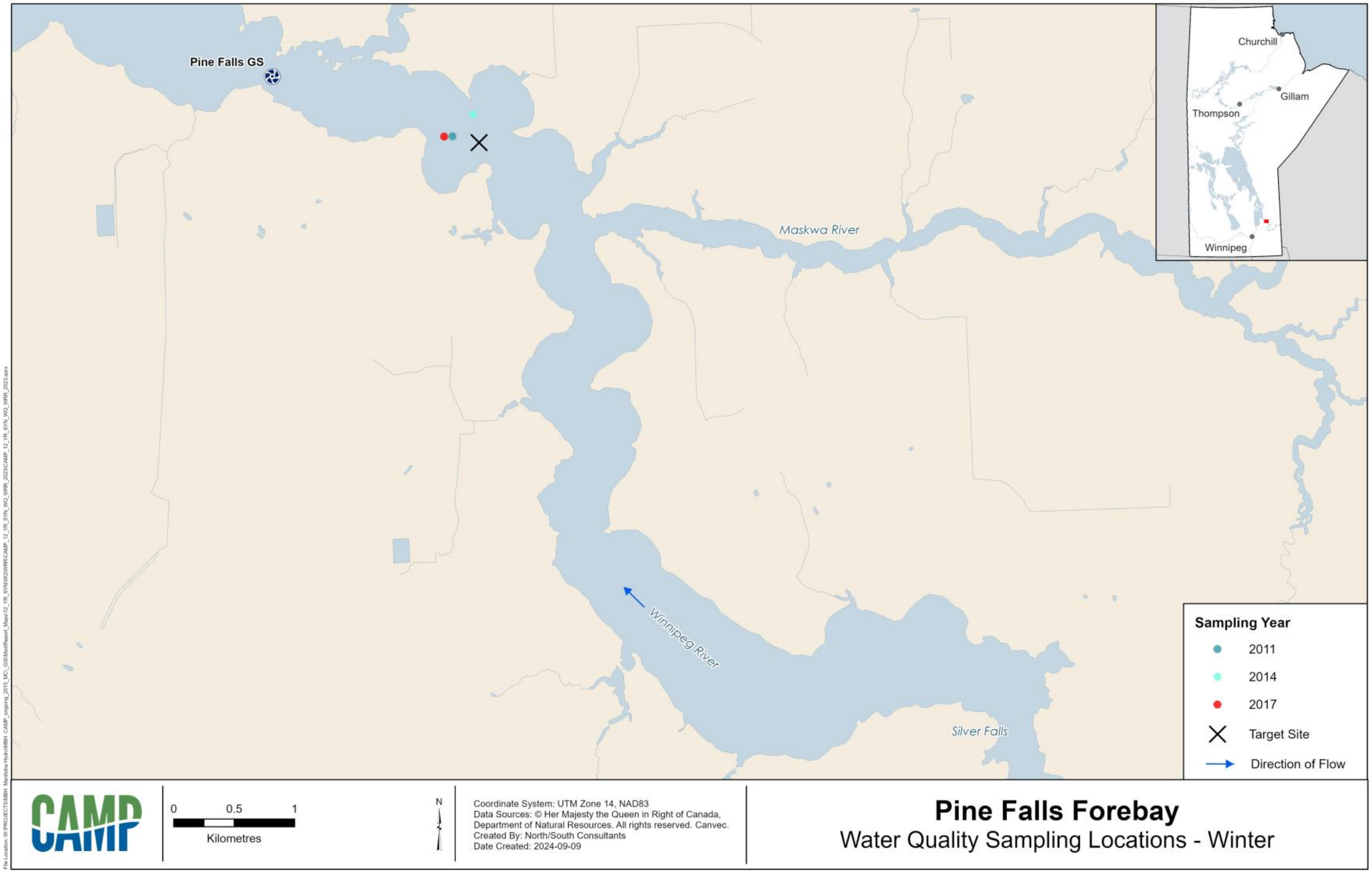


Figure A3-1-12. Winter water quality sampling locations: Pine Falls Forebay.

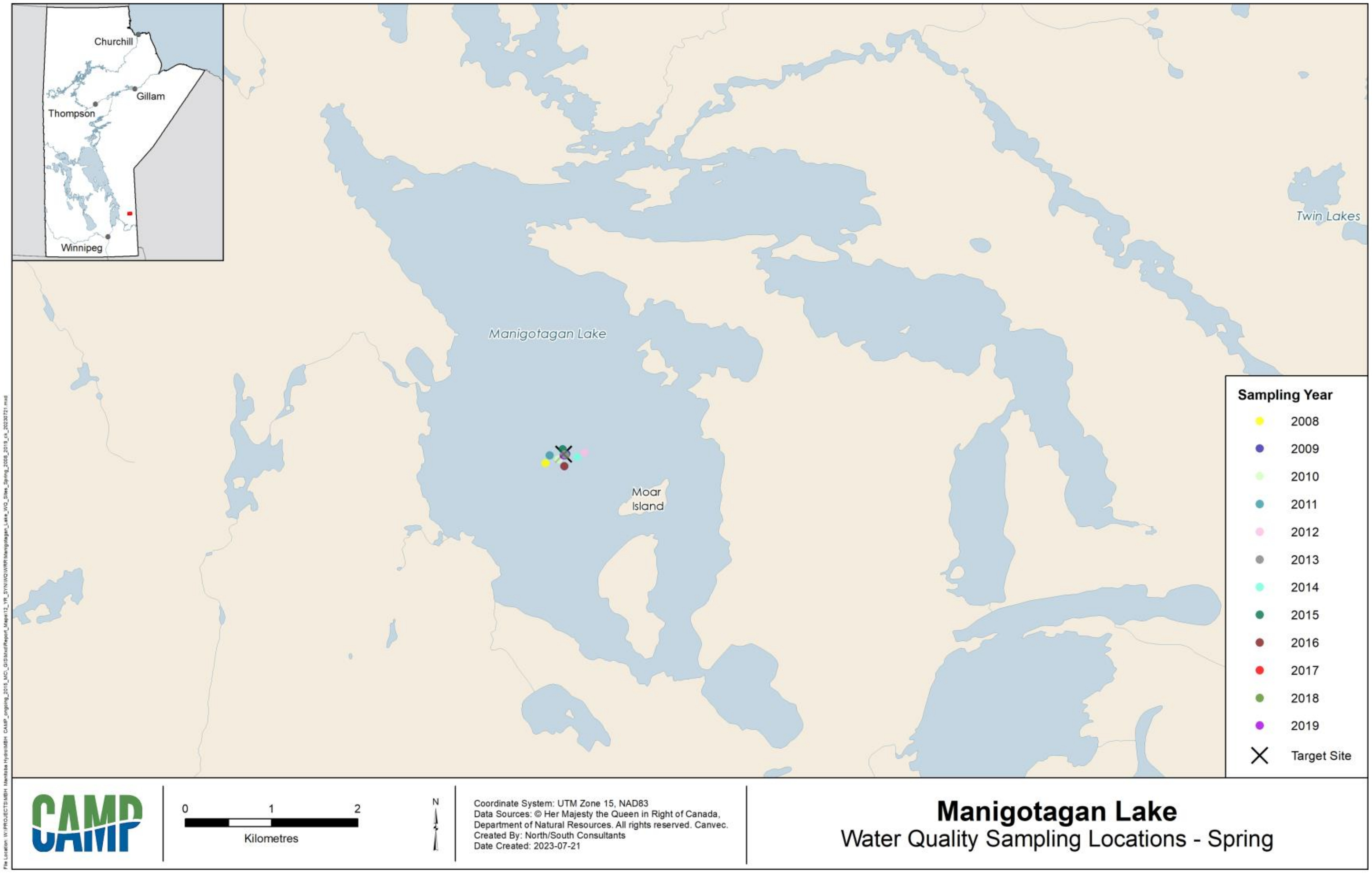


Figure A3-1-13. Spring water quality sampling locations: Manigotagan Lake.

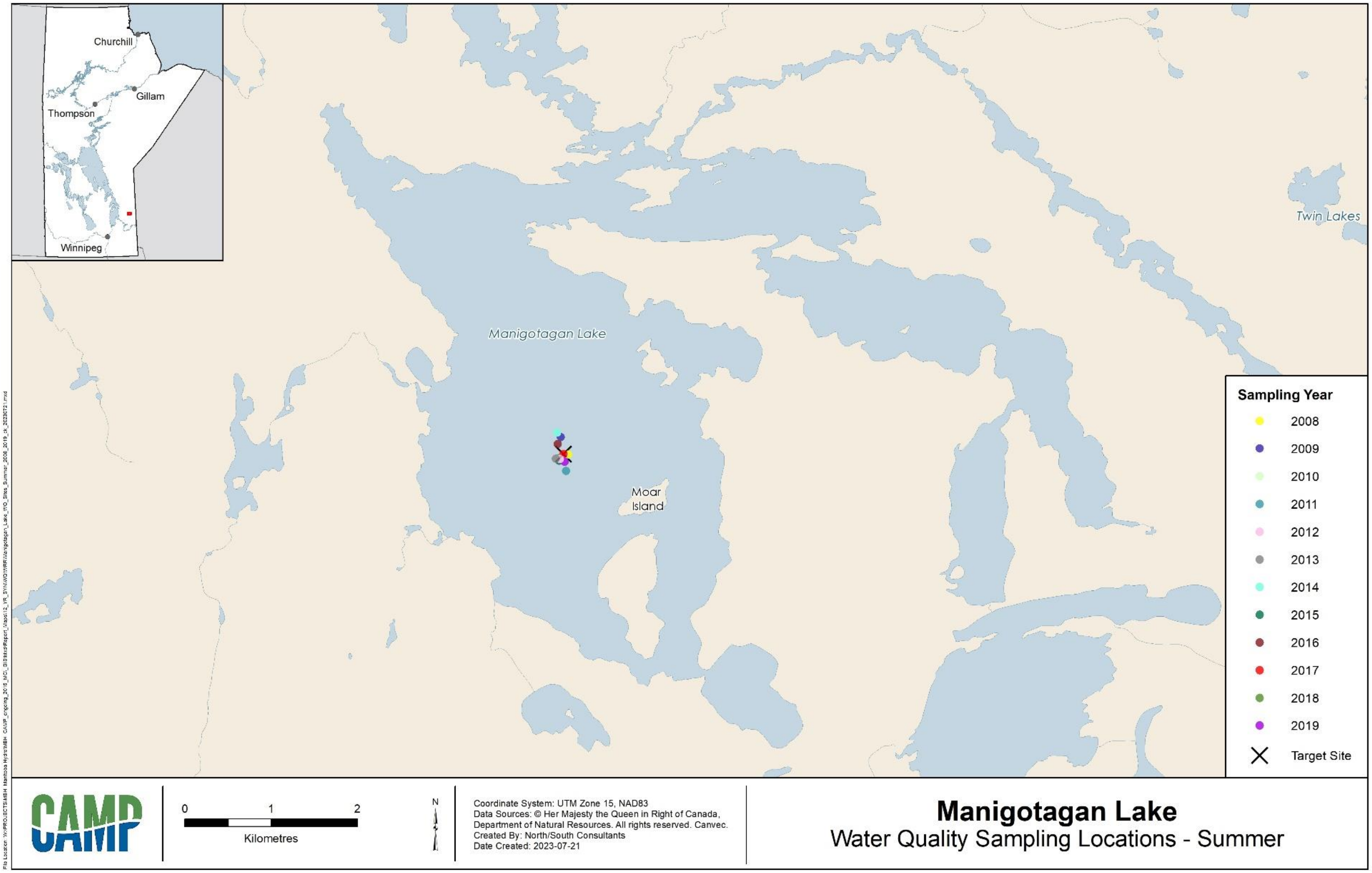


Figure A3-1-14. Summer water quality sampling locations: Manigotagan Lake.

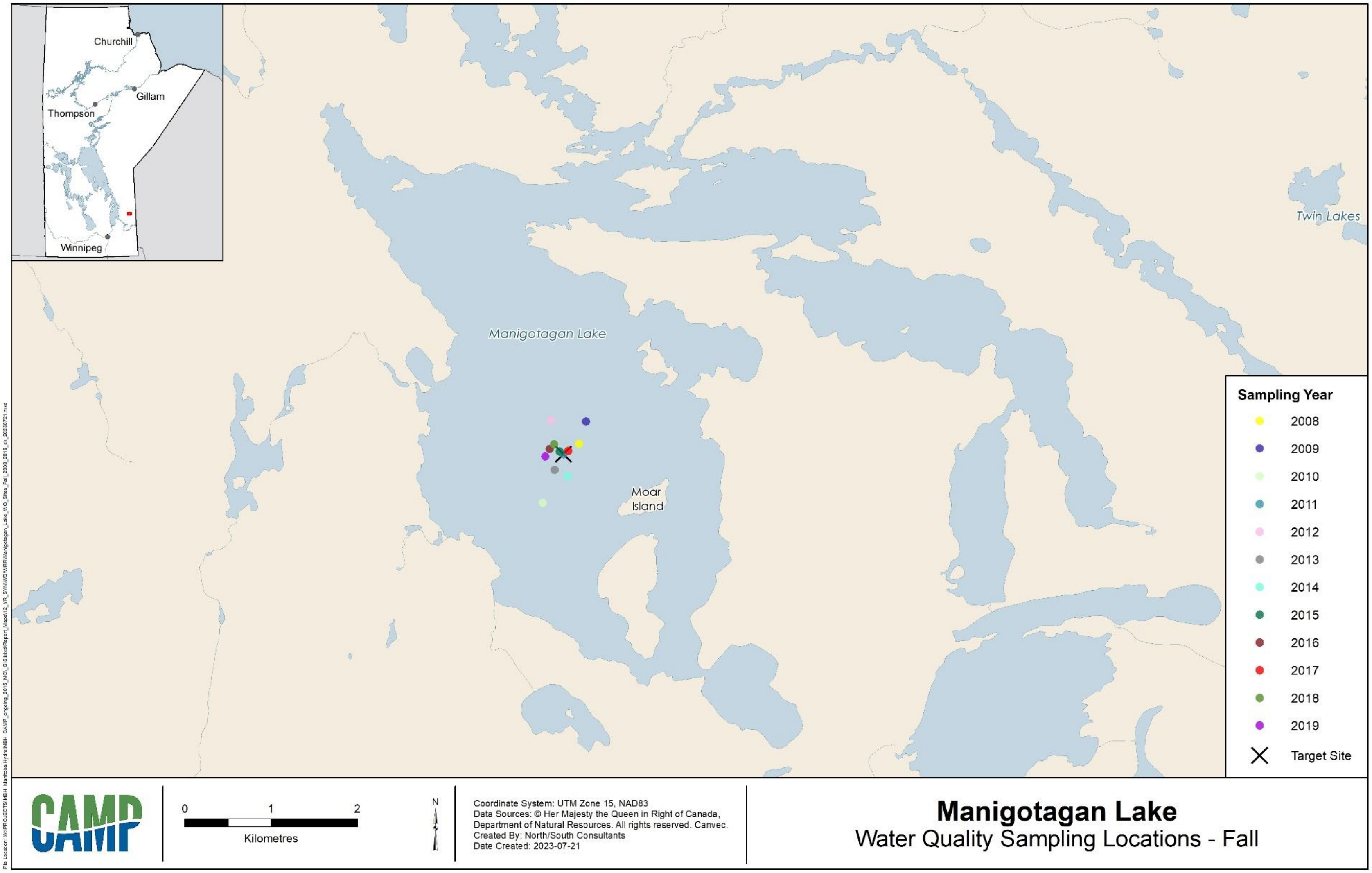


Figure A3-1-15. Fall water quality sampling locations: Manigotagan Lake.

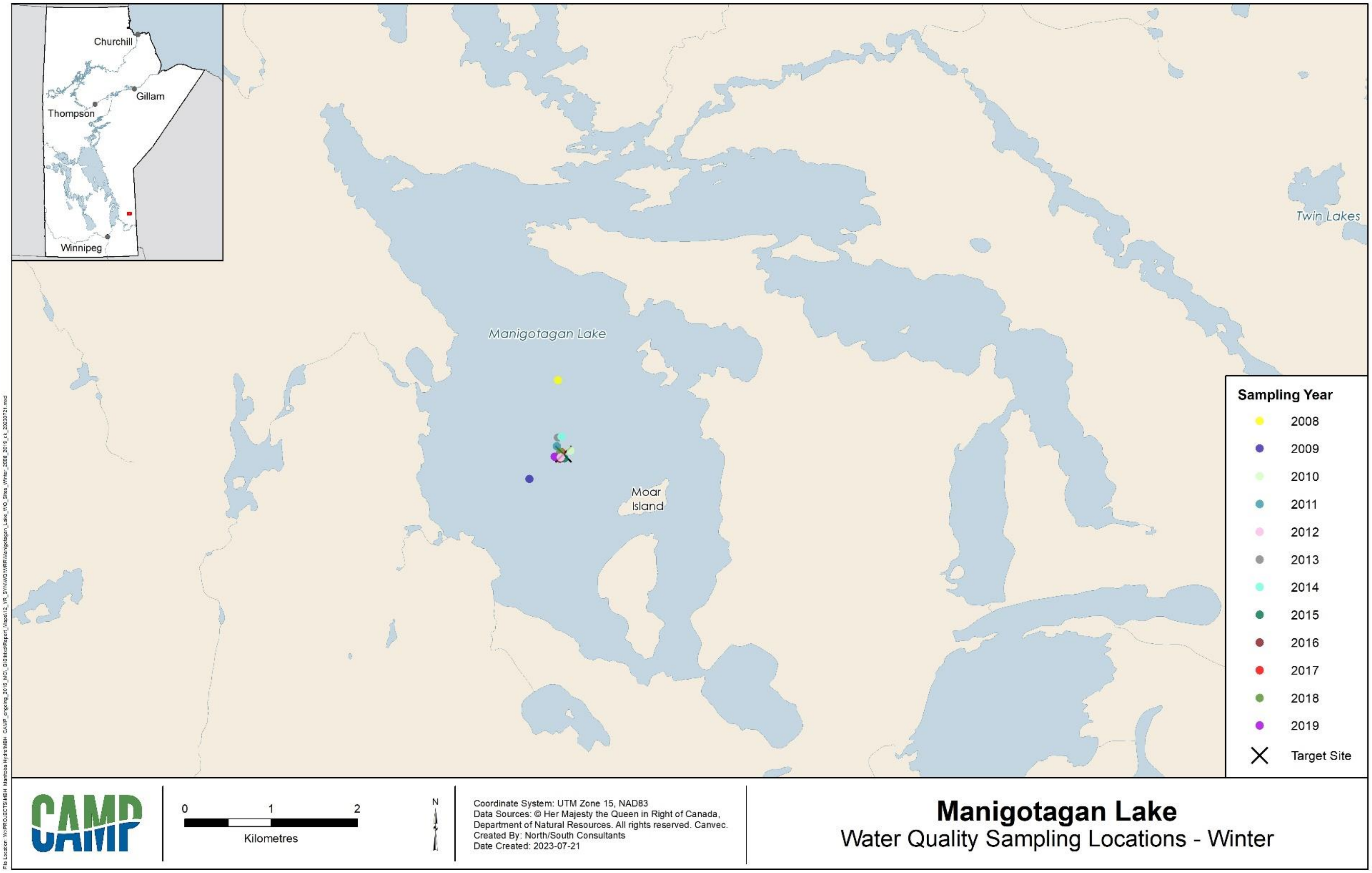


Figure A3-1-16. Winter water quality sampling locations: Manigotagan Lake.

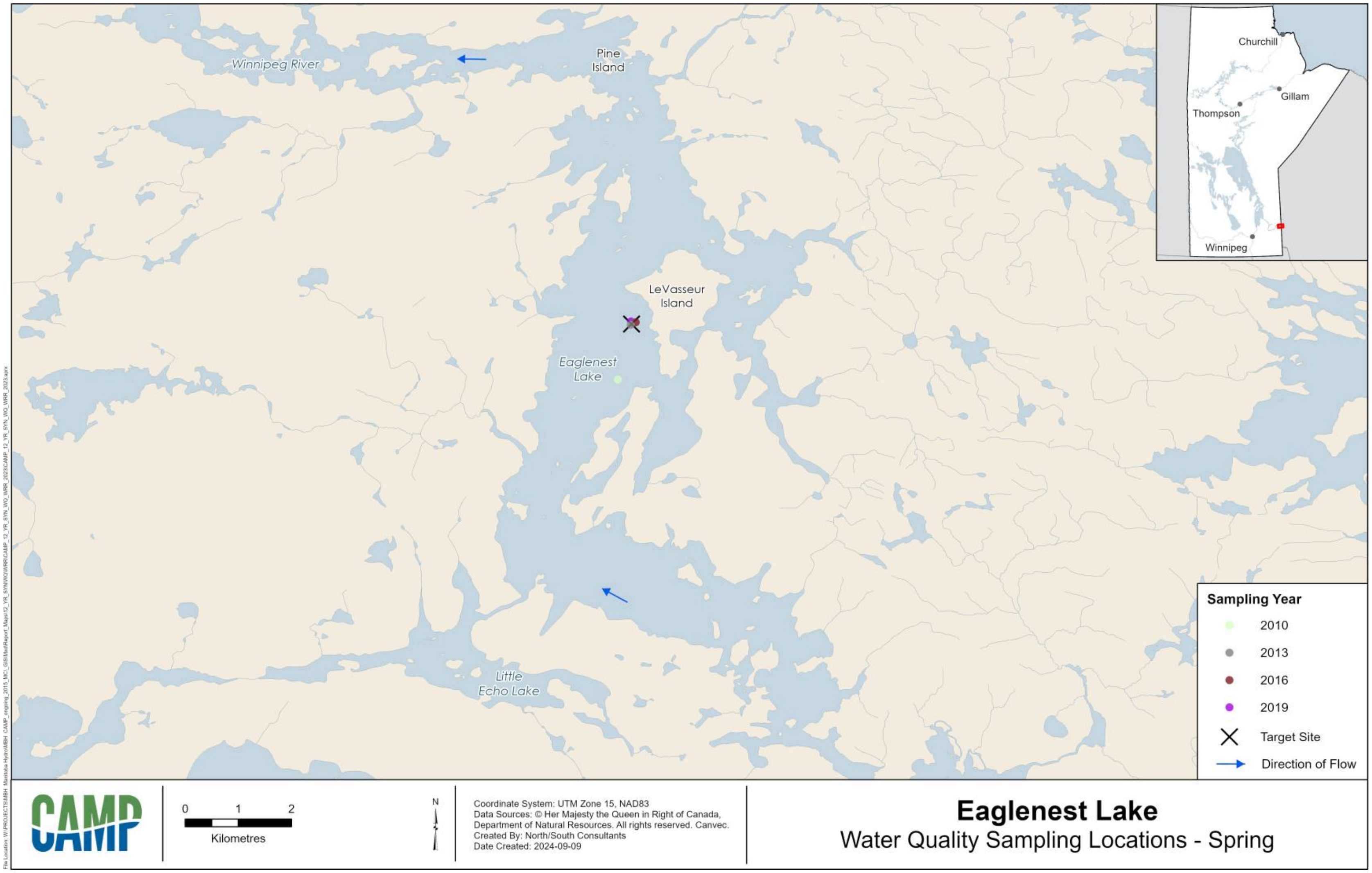


Figure A3-1-17. Spring water quality sampling locations: Eaglenest Lake.

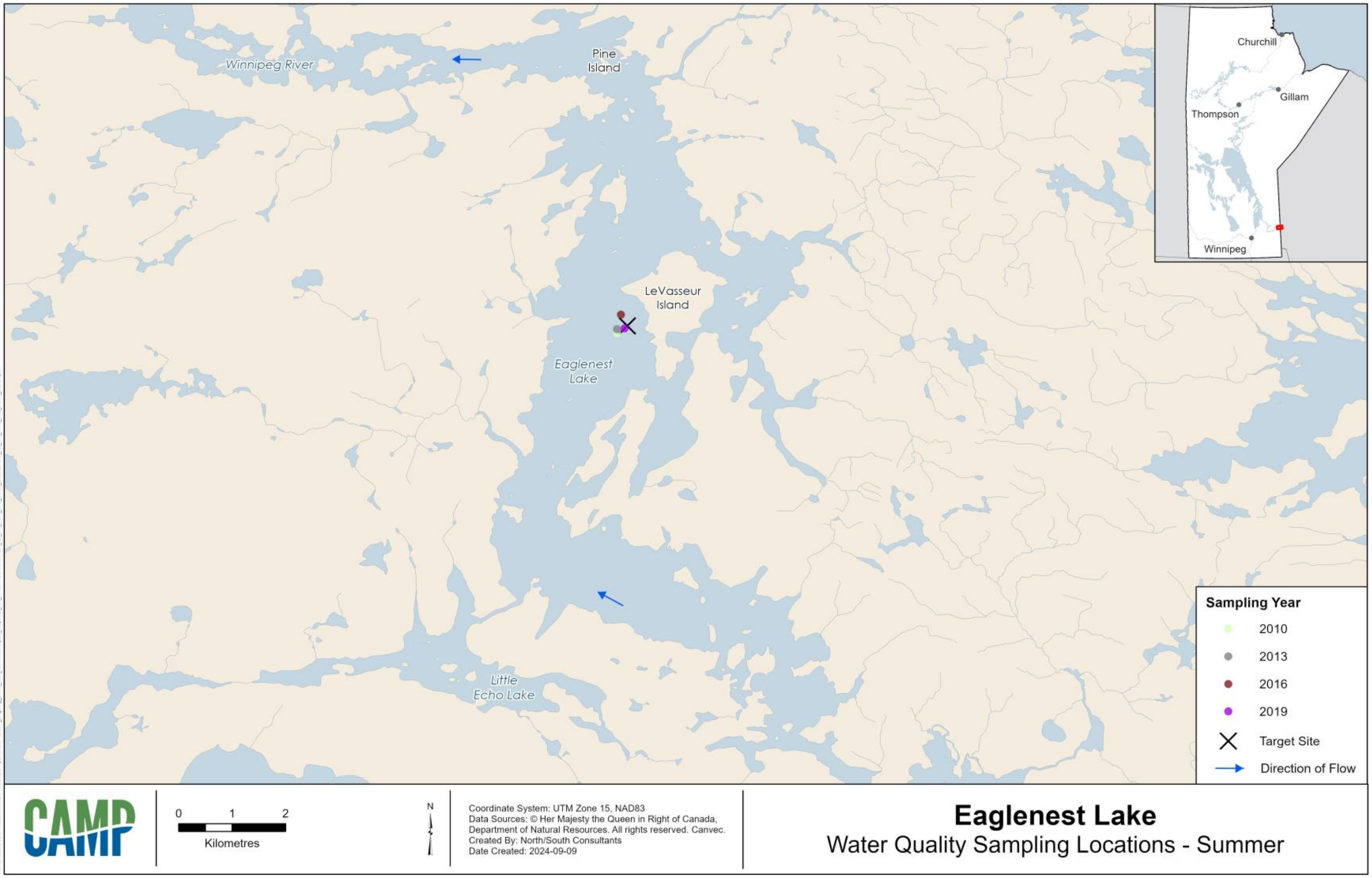


Figure A3-1-18. Summer water quality sampling locations: Eaglenest Lake.

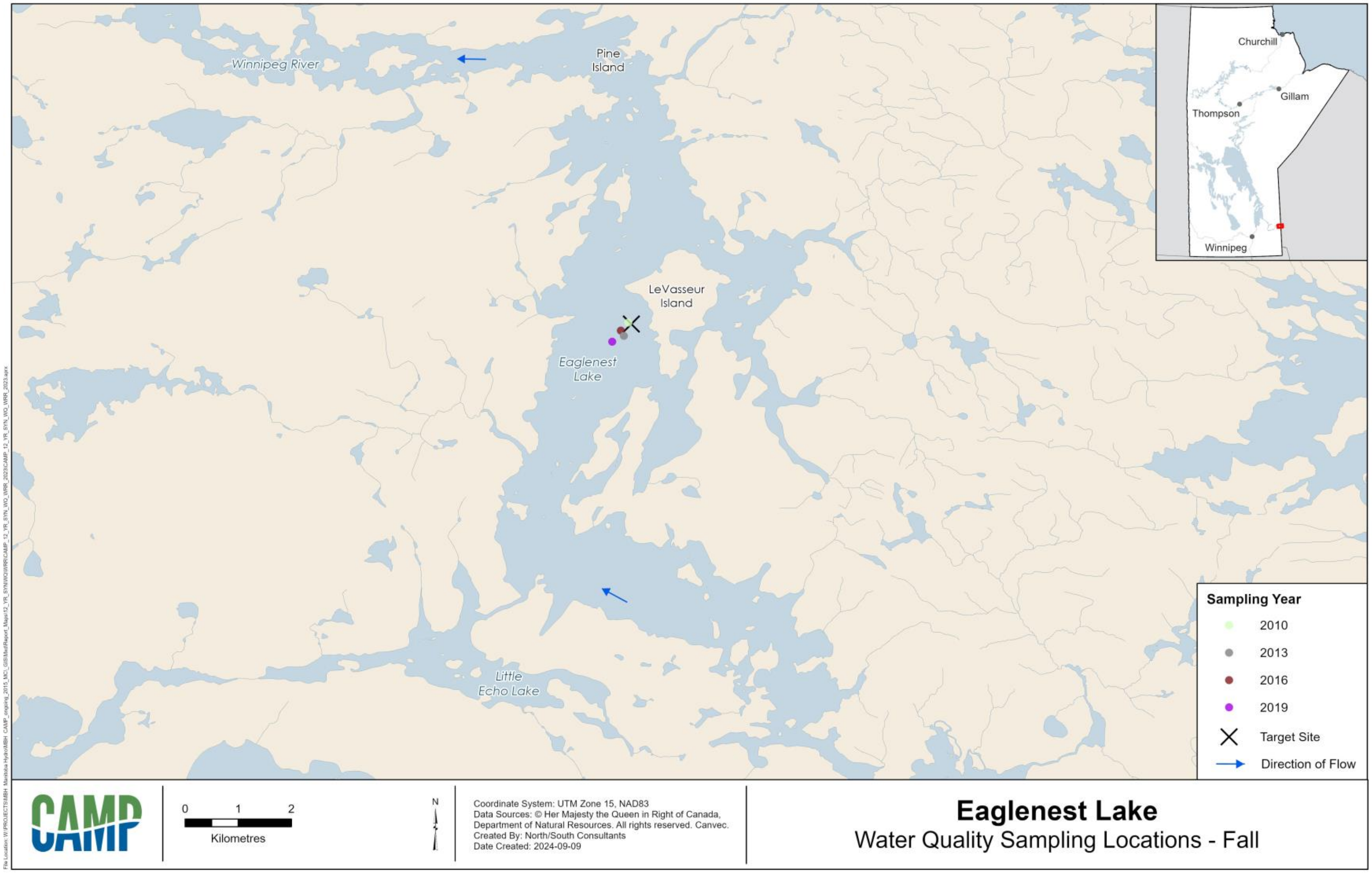


Figure A3-1-19. Fall water quality sampling locations: Eaglenest Lake.

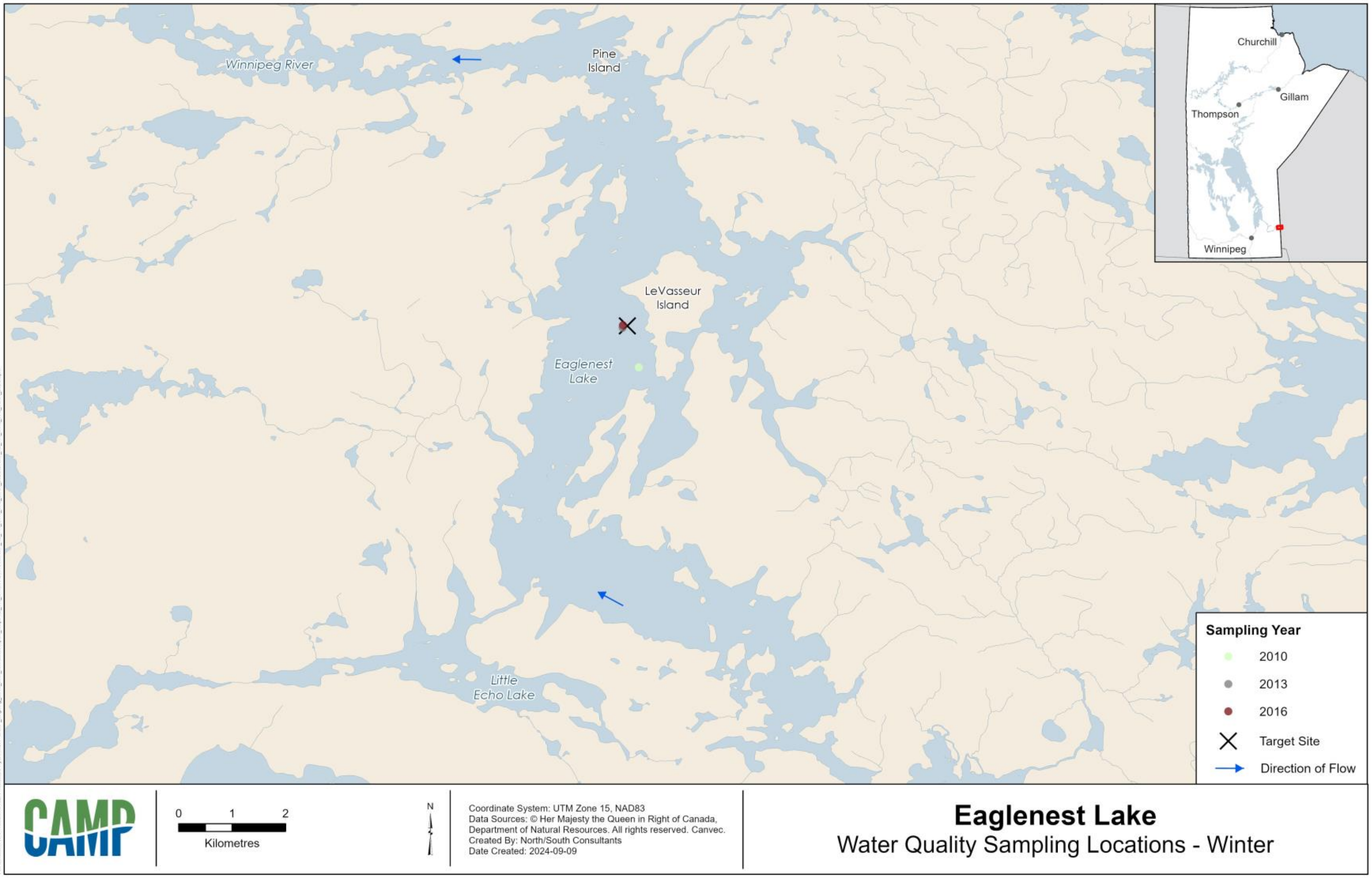


Figure A3-1-20. Winter water quality sampling locations: Eaglenest Lake.

4.0 BENTHIC INVERTEBRATES

4.1 INTRODUCTION

The following presents the results of the benthic invertebrate community monitoring conducted from 2010-2019 in the Winnipeg River Region. The 2008 and 2009 benthic invertebrate datasets were excluded due to a significant change in the sampling design in 2010.

Five waterbodies were monitored in the Winnipeg River Region: two on-system annual sites (the Pointe du Bois Forebay and Lac du Bonnet) and one on-system rotational site (the Pine Falls Forebay); and one off-system annual site (Manigotagan Lake) and one off-system rotational site (Eaglenest Lake; Table 4.1-1 and Figure 4.1-1). Eaglenest Lake is located on the Winnipeg River upstream of the Pointe du Bois Forebay and is not affected by MH's hydraulic operating system and is therefore considered an "off-system" site.

Two sampling polygons (nearshore [NS] and offshore [OS]) defined by water depth, flow, and substrate composition were sampled in each waterbody in late summer/fall per year (Appendix A4-1). Five benthic invertebrate samples were collected in each polygon for a total of ten invertebrate samples per waterbody per year. Five sediment samples were also collected in each polygon (where possible) to provide supporting information on substrate composition, total organic carbon (TOC), and texture. Dominant substrate type(s) and sediment analysis results are presented in Appendix 4-2. Sampling was completed at all sites as planned over the period of 2010-2019.

Four benthic invertebrate indicators (abundance, community composition, taxonomic richness, and diversity) were selected for detailed reporting (Table 4.1-2). Metrics for these indicators that are presented herein include: total invertebrate abundance or total invertebrate density; the Ephemeroptera, Plecoptera, and Trichoptera (EPT) Index; the Oligochaeta and Chironomidae (O+C) Index; total taxa richness; EPT taxa richness; and Hill's effective richness (Hill's Index). A detailed description of these indicators is provided in CAMP (2024).

A detailed description of the program design and sampling methods are provided Technical Document 1, Section 2.4.

Table 4.1-1. 2010 to 2019 Benthic invertebrate sampling inventory.

Waterbody/ Area	Sampling Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
PDB	-[1]	-[1]	●	●	●	●	●	●	●	●	●	●
LDB	-[1]	-[1]	●	●	●	●	●	●	●	●	●	●
PFF				●			●			●		
MANIG	-[1]	-[1]	●	●	●	●	●	●	●	●	●	●
EAGLE			●			●			●			●

Notes:

1. Dataset excluded from analysis and reporting due to change in sampling design in 2010.

Table 4.1-2. Benthic invertebrate indicators and metrics.

Indicator	Metric	Units
Abundance	• Total Invertebrate Abundance	Number (no.) per sample
	• Total Invertebrate Density	no. per square metre (m^2)
Community Composition	• Relative Proportions of Major Invertebrate Groups	%
	• EPT Index	%
	• O+C Index	%
Taxonomic Richness	• Total Taxa Richness	no. of families
	• EPT Taxa Richness	no. of families
Diversity	• Hill’s Effective Richness (Hill's Index)	value

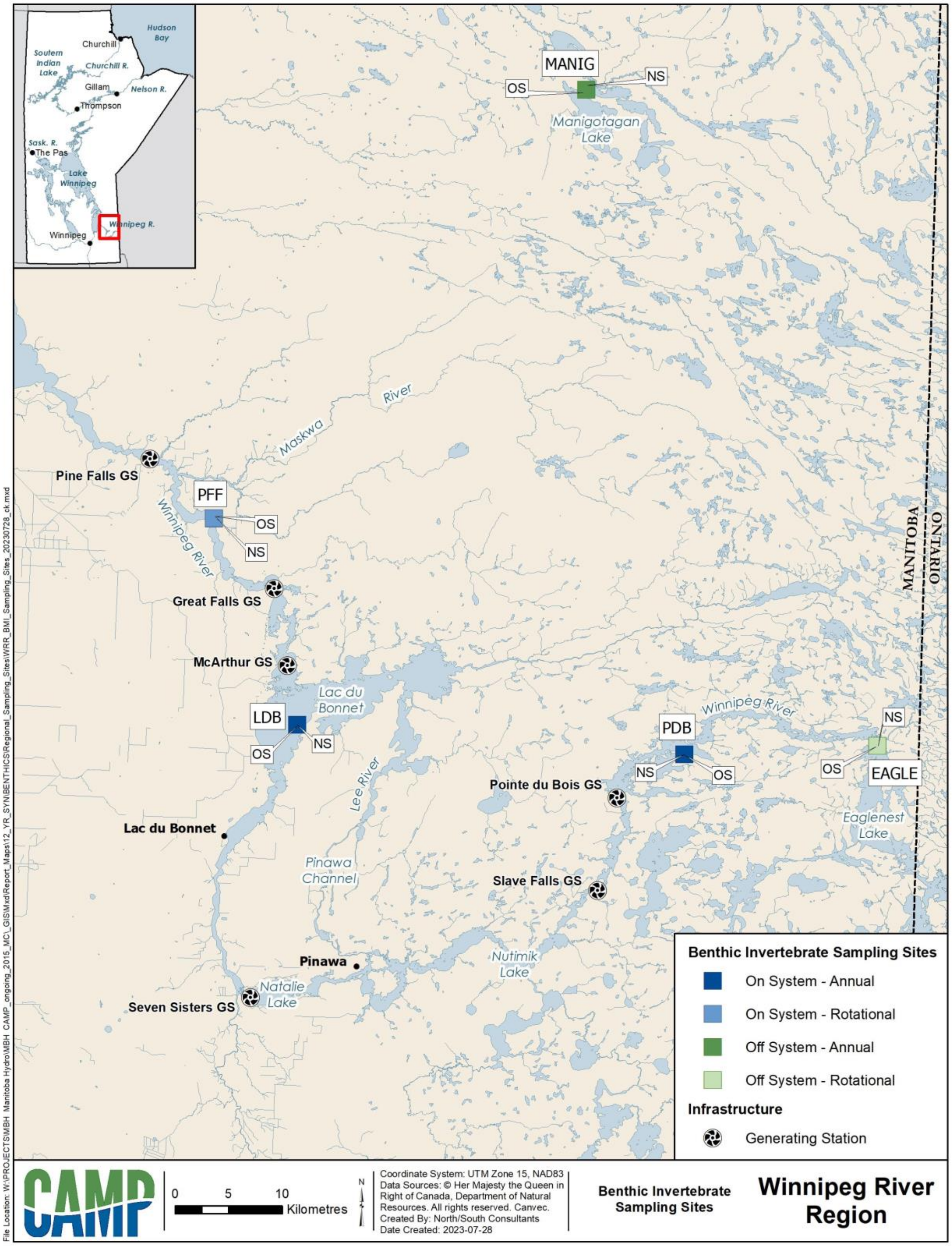


Figure 4.1-1. 2010 to 2019 Benthic invertebrate nearshore (NS) and offshore (OS) sampling sites.

4.2 ABUNDANCE

4.2.1 TOTAL INVERTEBRATE ABUNDANCE

4.2.1.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Nearshore Habitat

Annual mean abundance over the ten years of monitoring ranged from 517 invertebrates per sample (2010) to 16,506 invertebrates per sample (2014; Figure 4.2-1). The overall mean was 3,539 invertebrates per sample, the overall median was 1,724 invertebrates per sample, and the interquartile range was 971 to 2,829 invertebrates per sample. Annual means were below the IQR in 2010 and 2016, and above the IQR in 2012, 2014, 2015, and 2017.

Offshore Habitat

Annual mean abundance (density) over the ten years of monitoring ranged from 606 invertebrates per m^2 (2010) to 4,129 invertebrates per m^2 (2011; Figure 4.2-2). The overall mean was 1,972 invertebrates per m^2, the overall median was 1,565 invertebrates per m^2, and the IQR was 905 to 2,622 invertebrates per m^2. Annual means were below the IQR in 2010 and 2014, and above the IQR in 2011, 2013, 2017, and 2019.

Lac du Bonnet

Nearshore Habitat

Annual mean abundance over the ten years of monitoring ranged from 247 invertebrates per sample (2019) to 6,581 invertebrates per sample (2012; Figure 4.2-1). The overall mean was 1,965 invertebrates per sample, the overall median was 717 invertebrates per sample, and the IQR was 318 to 1,733 invertebrates per sample. Annual means were below the IQR in 2016 and 2019, and above the IQR in 2012, 2014, 2015, and 2017.

Offshore Habitat

Annual mean abundance (density) over the ten years of monitoring ranged from 929 invertebrates per m^2 (2019) to 10,047 invertebrates per m^2 (2016; Figure 4.2-2). The overall mean was 4,212 invertebrates per m^2, the overall median was 3,044 invertebrates per m^2, and the IQR was 1,666 to 5,955 invertebrates per m^2. Annual means were below the IQR in 2013, 2014, and 2019, and above the IQR in 2011 and 2016.

ROTATIONAL SITES

Pine Falls Forebay

Nearshore Habitat

Annual mean abundance over the three years of monitoring ranged from 1,791 (2017) to 8,189 invertebrates per sample (2014; Figure 4.2-1). The overall mean was 4,273 invertebrates per sample, the overall median was 2,691 invertebrates per sample, and the IQR was 1,422 to 5,829 invertebrates per sample. Annual means were within the IQR, except for in 2014 (above).

Offshore Habitat

Annual mean abundance (density) over the three years of monitoring ranged from 1,423 invertebrates per m^2 (2014) to 2,678 invertebrates per m^2 (2011; Figure 4.2-2). The overall mean was 2,176 invertebrates per m^2, the overall median was 2,121 invertebrates per m^2, and the IQR was 1,147 to 3,189 invertebrates per m^2. Annual means for all years fell within the IQR.

4.2.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Nearshore Habitat

Annual mean abundance over the ten years of monitoring ranged from 64 invertebrates per sample (2014) to 2,140 invertebrates per sample (2018; Figure 4.2-1). The overall mean was 536 invertebrates per sample, the overall median was 163 invertebrates per sample, and the IQR was 70 to 539 invertebrates per sample. Annual means were below the IQR in 2014, and above the IQR in 2012 and 2018.

Offshore Habitat

Annual mean abundance (density) over the ten years of monitoring ranged from 193 invertebrates per m^2 (2013) to 649 invertebrates per m^2 (2014; Figure 4.2-2). The overall mean was 380 invertebrates per m^2, the overall median was 310 invertebrates per m^2, and the IQR was 216 to

447 invertebrates per m^2. Annual means were below the IQR in 2013, and above the IQR in 2014, 2015, and 2019.

ROTATIONAL SITES

Eaglenest Lake

Nearshore Habitat

Annual mean abundance over the four years of monitoring ranged from 1,108 (2016) to 2,033 invertebrates per sample (2019; Figure 4.2-1). The overall mean was 1,466 invertebrates per sample, the overall median was 1,238 invertebrates per sample, and the IQR was 623 to 2,200 invertebrates per sample. Annual means for all years fell within the IQR.

Offshore Habitat

Annual mean abundance (density) over the four years of monitoring ranged from 718 invertebrates per m^2 (2010) to 2,753 invertebrates per m^2 (2013; Figure 4.2-2). The overall mean was 1,502 invertebrates per m^2, the overall median was 1,190 invertebrates per m^2, and the IQR was 700 to 1,490 invertebrates per m^2. Annual means were within the IQR, except for in 2013 (above).

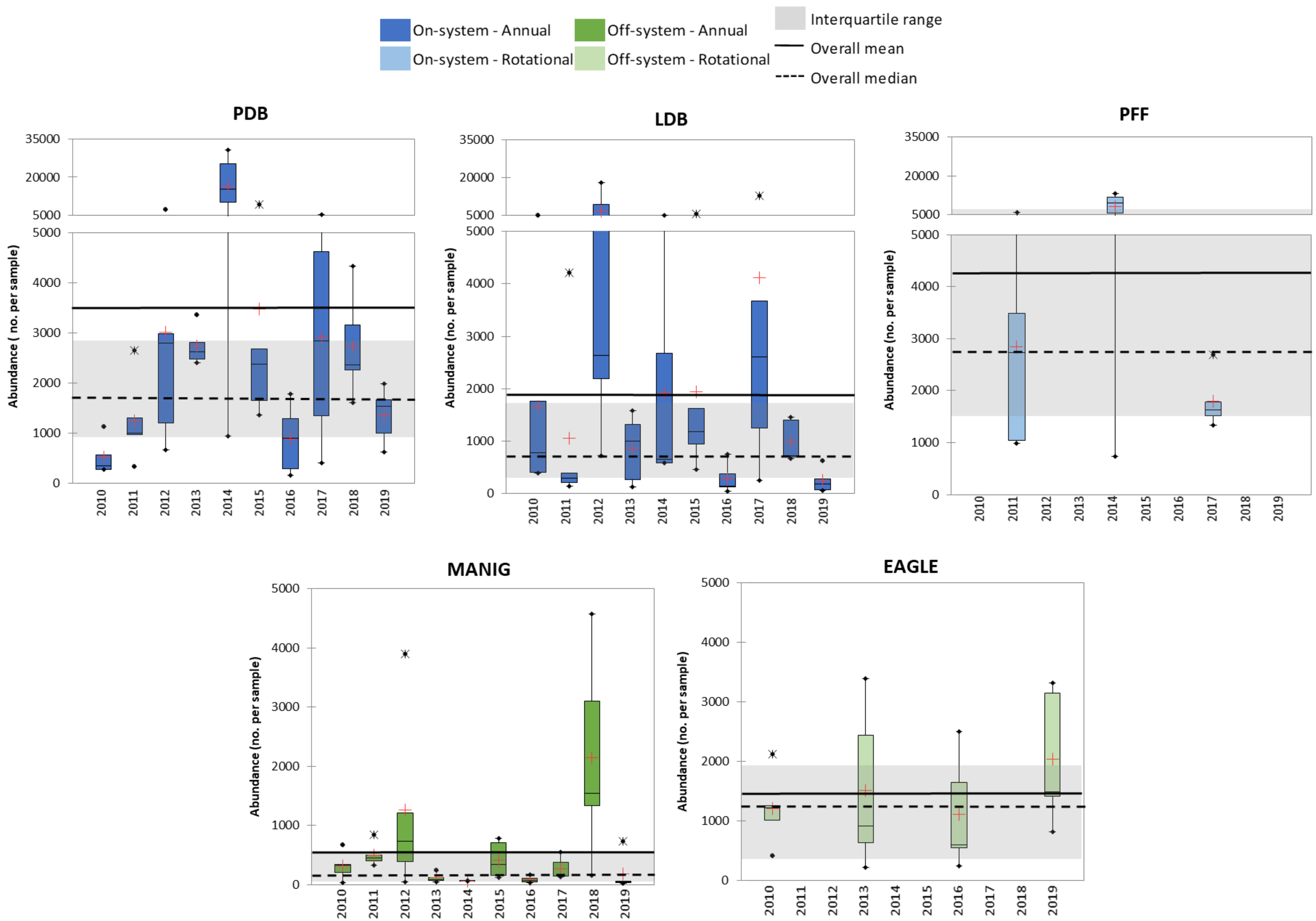


Figure 4.2-1. 2010 to 2019 Nearshore benthic invertebrate abundance (total no. per sample).

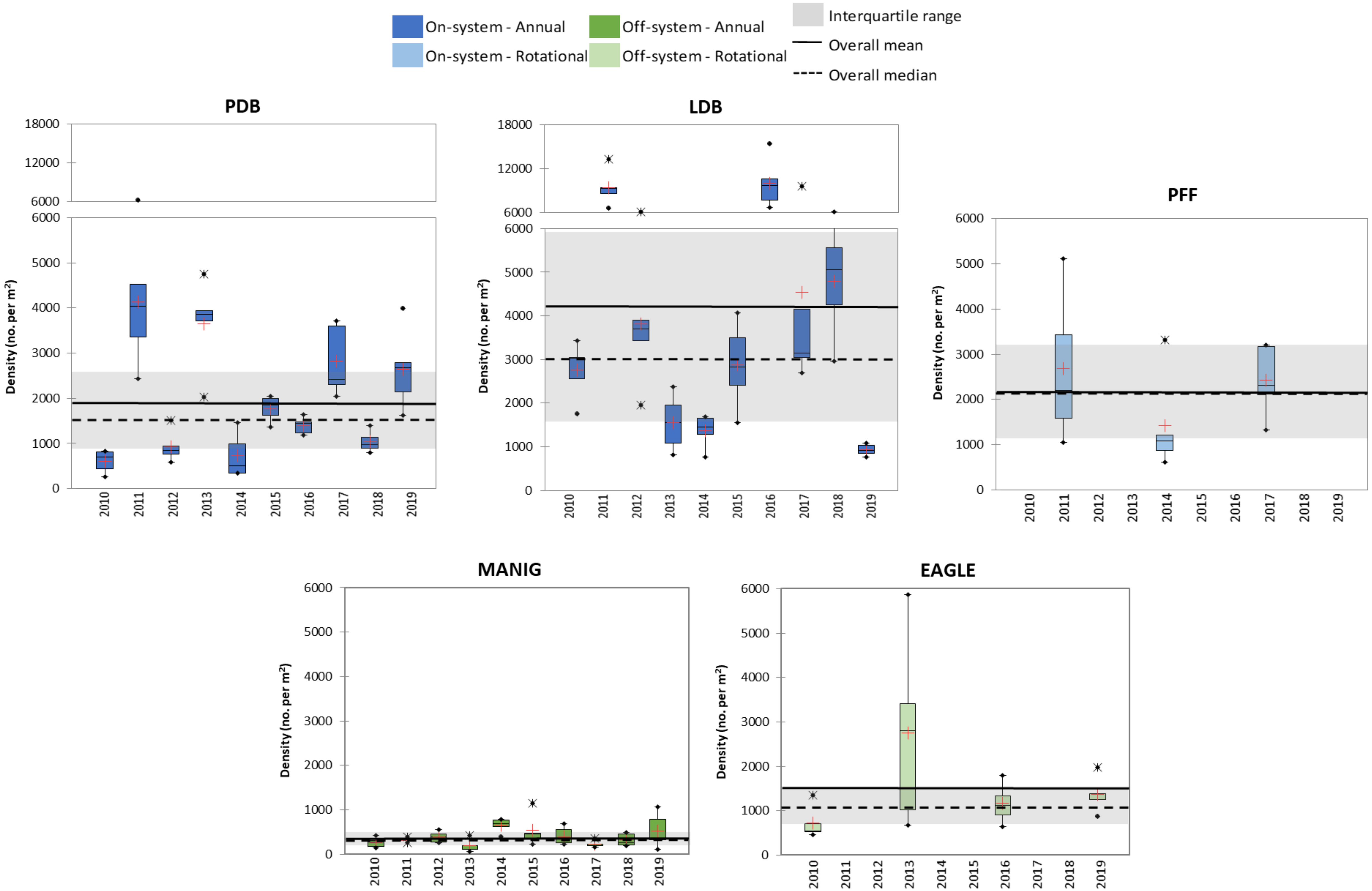


Figure 4.2-2. 2010 to 2019 Offshore benthic invertebrate abundance (density, total no. per m^2).

4.3 COMMUNITY COMPOSITION

4.3.1 RELATIVE ABUNDANCE

4.3.1.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Nearshore Habitat

Amphipoda (freshwater shrimps, mainly Hyalellidae) dominated the benthic invertebrate community in seven of the ten years of monitoring (2011 to 2017; Table 4.3-1). Among those years, mean annual relative abundances of Amphipoda ranged between 32% (2015) and 76% (2014). Amphipoda (28%, Hyalellidae) and Corixidae (water boatmen, 21%) were the dominant invertebrate taxa in 2010. Amphipoda (23%, mainly Hyalellidae), Gastropoda (snails, 24%, mainly Hydrobiidae, Planorbidae, and Lymnaeidae), and Ephemeroptera (22%, mainly Caenidae and Ephemeridae) were co-dominant in 2018. Gastropoda (31%) was the most abundant taxon in 2019.

Offshore Habitat

Ephemeroptera (mayflies, mainly Ephemeridae) dominated the benthic invertebrate community over the ten years of monitoring (2010 to 2019; Table 4.3-2). Excluding 2012, mean annual relative abundances of Ephemeroptera ranged between 50% (2010, 2015, and 2018) and 89% (2013). Ephemeroptera (37%), Oligochaeta (29%), and Chironomidae (29%) were dominant in 2012.

Lac du Bonnet

Nearshore Habitat

Amphipoda (freshwater shrimps, mainly Hyalellidae) dominated the benthic invertebrate community in nine of the ten years of monitoring (2010 to 2018; Table 4.3-3). Among those years, mean annual relative abundances of Amphipoda ranged between 38% (2015) and 78% (2010). Chironomidae (30%), Oligochaeta (22%) and Amphipoda (18%, Hyalellidae) were dominant in 2019.

Offshore Habitat

Benthic invertebrate community composition varied over the ten years of monitoring (2010 to 2019; Table 4.3-4). Oligochaeta (aquatic segmented worms) was the dominant taxon in 2010 (51%), 2012 (40%), and 2017 (37%). Ephemeroptera (mayflies, mainly Ephemeridae) was the dominant group in 2011 (46%) and 2018 (66%). Oligochaeta (39%) and Ephemeroptera (31%) dominated in 2013. Gastropoda (snails, 35%, mainly Hydrobiidae) dominated in 2014. Bivalvia (clams, 34%, mainly Sphaeriidae) and Gastropoda (30%) dominated in 2015. Bivalvia was dominant in 2016 (41%). Chironomidae (non-biting midges, 23%) and Ephemeroptera (24%) were co-dominant in 2019.

ROTATIONAL SITES

Pine Falls Forebay

Nearshore Habitat

Benthic invertebrate community composition varied over the over the three years of monitoring (2011, 2014, and 2017; Table 4.3-5). Amphipoda (freshwater shrimps, mainly Hyalellidae) was the dominant taxon in 2011 (44%). Oligochaeta (aquatic segmented worms, 24%) and Amphipoda (29%) were dominant in 2014. Amphipoda (29%) and Ephemeroptera (mayflies, 38%, mainly Caenidae and Ephemeridae) were the dominant invertebrate groups in 2017.

Offshore Habitat

Benthic invertebrate community composition varied over the over the three years of monitoring (2011, 2014, and 2017; Table 4.3-6). Chironomidae (non-biting midges) was the dominant taxon in 2011 (39%) and 2017 (39%). Oligochaeta (aquatic segmented worms, 19%) and Ephemeroptera (mayflies, Ephemeridae, 19%) were co-dominant in 2014.

4.3.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Nearshore Habitat

Benthic invertebrate community composition varied over the ten years of monitoring (2010 to 2019; Table 4.3-7). Amphipoda (freshwater shrimps, mainly Hyalellidae) was the dominant taxon in 2010 (50%). Oligochaeta (aquatic segmented worms) (23%), Amphipoda (24%), and

Chironomidae (21%) were dominant in 2011. Ephemeroptera (mayflies, mainly Caenidae) was the dominant group in 2012 (60%), 2013 (36%), and 2014 (41%). Oligochaeta was the dominant taxon in 2015 (49%). Oligochaeta (23%) and Ephemeroptera (24%) were co-dominant in 2016. Amphipoda (21%) and Chironomidae (23%) were dominant in 2017. Oligochaeta (24%) and Bivalvia (clams, 22%) were dominant in 2018. Oligochaeta (20%), Amphipoda (19%), Chironomidae (21%), and Ephemeroptera (23%) were the dominant groups in 2019.

Offshore Habitat

Benthic invertebrate community composition varied over the ten years of monitoring (2010 to 2019; Table 4.3-8). Chironomidae was the dominant taxon in 2010 (33%), 2014 (32%), 2015 (36%), and 2018 (51%). Oligochaeta (aquatic segmented worms) was the dominant group in 2011 (35%) and 2012 (31%). Oligochaeta (24%) and Bivalvia (clams, Sphaeriidae, 22%) were dominant in 2013. Bivalvia was dominant in 2016 (40%) and 2017 (31%). Oligochaeta (20%), Chironomidae (19%), and Ephemeroptera (mayflies, Ephemeridae, 23%) were dominant in 2019.

ROTATIONAL SITES

Eaglenest Lake

Nearshore Habitat

Benthic invertebrate community composition varied over the four years of monitoring (2010, 2013, 2016, and 2019; Table 4.3-9). Amphipoda (freshwater shrimps, 21%, mainly Hyalellidae), Gastropoda (snails, 19%, mainly Planorbidae and Lymnaeidae), Chironomidae (23%), and Ephemeroptera (mayflies, 15%, mainly Caenidae) were dominant in 2010. Oligochaeta (36%) and Chironomidae (32%) were the dominant groups in 2013. Gastropoda (36%) was the most dominant taxon in 2016. Oligochaeta (37%) and Chironomidae (41%) were the dominant invertebrate groups in 2019.

Offshore Habitat

Benthic invertebrate community composition varied over the four years of monitoring (2010, 2013, 2016, and 2019; Table 4.3-10). Bivalvia (clams, 27%, mainly Sphaeriidae), Chironomidae (33%) and Ephemeroptera (Ephemeridae, 31%) were the dominant invertebrate taxa in 2010. Ephemeroptera (mainly Ephemeridae) was the most dominant group in 2013 (68%), 2016 (54%), and 2019 (57%).

Table 4.3-1. 2010 to 2019 Pointe du Bois Forebay nearshore benthic invertebrate relative abundance.

0% | <1% to 15% | >15% to 25% | >25% to 50% | >50%

Invertebrate Taxa	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Oligochaeta	9%	7%	20%	12%	3%	9%	17%	9%	10%	15%
Amphipoda	28%	41%	39%	48%	76%	32%	29%	25%	23%	19%
Bivalvia	1%	1%	3%	2%	2%	3%	2%	9%	6%	3%
Gastropoda	10%	15%	13%	15%	6%	10%	8%	19%	24%	31%
Ceratopogonidae	1%	0%	<1%	1%	<1%	<1%	<1%	1%	1%	1%
Chironomidae	16%	5%	8%	7%	3%	24%	6%	6%	8%	14%
Other Diptera	<1%	<1%	<1%	<1%	<1%	0%	<1%	<1%	<1%	<1%
Ephemeroptera	5%	8%	10%	9%	5%	13%	27%	22%	22%	8%
Plecoptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Trichoptera	3%	3%	3%	4%	2%	5%	3%	4%	4%	5%
Corixidae	21%	17%	1%	1%	2%	1%	2%	1%	<1%	<1%
Coleoptera	3%	1%	1%	1%	1%	1%	3%	4%	2%	2%
All other taxa	2%	1%	1%	1%	<1%	1%	2%	1%	1%	2%

Table 4.3-2. 2010 to 2019 Pointe du Bois Forebay offshore benthic invertebrate relative abundance.

0% | <1% to 15% | >15% to 25% | >25% to 50% | >50%

Invertebrate Taxa	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Oligochaeta	9%	3%	29%	4%	15%	17%	14%	10%	12%	8%
Amphipoda	0%	<1%	<1%	<1%	2%	1%	0%	<1%	0%	<1%
Bivalvia	16%	4%	2%	1%	14%	8%	14%	4%	9%	13%
Gastropoda	<1%	<1%	1%	<1%	2%	1%	<1%	<1%	0%	1%
Ceratopogonidae	3%	<1%	1%	<1%	3%	1%	3%	1%	1%	1%
Chironomidae	18%	8%	29%	4%	7%	19%	15%	12%	20%	19%
Other Diptera	0%	<1%	0%	0%	0%	0%	<1%	0%	1%	1%
Ephemeroptera	50%	83%	37%	89%	53%	50%	52%	70%	50%	56%
Plecoptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Trichoptera	4%	2%	<1%	1%	1%	2%	2%	1%	3%	1%
Corixidae	0%	<1%	0%	0%	1%	0%	<1%	0%	<1%	<1%
Coleoptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
All other taxa	1%	<1%	<1%	<1%	2%	<1%	<1%	0%	2%	<1%

Table 4.3-3. 2010 to 2019 Lac du Bonnet nearshore benthic invertebrate relative abundance.

0% | <1% to 15% | >15% to 25% | >25% to 50% | >50%

Invertebrate Taxa	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Oligochaeta	6%	5%	4%	6%	12%	3%	13%	5%	18%	22%
Amphipoda	78%	62%	49%	76%	45%	38%	50%	63%	62%	18%
Bivalvia	0%	6%	7%	1%	2%	14%	2%	6%	1%	1%
Gastropoda	1%	10%	7%	3%	9%	16%	3%	6%	3%	4%
Ceratopogonidae	0%	<1%	<1%	<1%	<1%	<1%	0%	<1%	<1%	<1%
Chironomidae	5%	4%	1%	4%	4%	6%	5%	2%	6%	30%
Other Diptera	<1%	<1%	<1%	<1%	1%	<1%	<1%	1%	1%	1%
Ephemeroptera	6%	7%	23%	4%	18%	8%	9%	11%	3%	13%
Plecoptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Trichoptera	2%	4%	7%	4%	5%	8%	10%	4%	2%	2%
Corixidae	1%	2%	<1%	1%	2%	5%	8%	<1%	4%	<1%
Coleoptera	<1%	<1%	0%	<1%	<1%	0%	<1%	<1%	<1%	0%
All other taxa	<1%	1%	<1%	1%	1%	1%	1%	2%	1%	8%

Table 4.3-4. 2010 to 2019 Lac du Bonnet offshore benthic invertebrate relative abundance.

0% | <1% to 15% | >15% to 25% | >25% to 50% | >50%

Invertebrate Taxa	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Oligochaeta	51%	11%	40%	39%	14%	17%	21%	37%	5%	2%
Amphipoda	1%	1%	3%	5%	8%	5%	1%	3%	1%	7%
Bivalvia	31%	25%	15%	3%	26%	34%	41%	19%	7%	18%
Gastropoda	8%	7%	2%	9%	35%	30%	5%	7%	4%	12%
Ceratopogonidae	1%	1%	3%	1%	0%	<1%	1%	5%	<1%	2%
Chironomidae	4%	8%	16%	11%	3%	5%	8%	19%	11%	23%
Other Diptera	0%	<1%	0%	0%	0%	0%	3%	0%	2%	0%
Ephemeroptera	3%	46%	18%	31%	5%	5%	17%	7%	66%	24%
Plecoptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Trichoptera	1%	3%	3%	1%	7%	5%	2%	4%	3%	11%
Corixidae	0%	<1%	<1%	0%	0%	0%	0%	0%	<1%	<1%
Coleoptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
All other taxa	1%	0%	<1%	<1%	1%	1%	<1%	<1%	<1%	<1%

Table 4.3-5. 2010 to 2019 Pine Falls Forebay nearshore benthic invertebrate relative abundance.

0% | <1% to 15% | >15% to 25% | >25% to 50% | >50%

Invertebrate Taxa	2011	2014	2017
Oligochaeta	21%	24%	19%
Amphipoda	44%	29%	29%
Bivalvia	<1%	1%	1%
Gastropoda	4%	8%	2%
Ceratopogonidae	<1%	<1%	<1%
Chironomidae	5%	11%	6%
Other Diptera	<1%	<1%	<1%
Ephemeroptera	17%	19%	38%
Plecoptera	<1%	0%	0%
Trichoptera	5%	3%	2%
Corixidae	1%	1%	<1%
Coleoptera	2%	1%	2%
All other taxa	<1%	2%	2%

Table 4.3-6. 2010 to 2019 Pine Falls Forebay offshore benthic invertebrate relative abundance.

0% | <1% to 15% | >15% to 25% | >25% to 50% | >50%

Invertebrate Taxa	2011	2014	2017
Oligochaeta	26%	19%	25%
Amphipoda	0%	2%	<1%
Bivalvia	4%	16%	7%
Gastropoda	1%	6%	3%
Ceratopogonidae	<1%	<1%	0%
Chironomidae	39%	13%	39%
Other Diptera	1%	1%	2%
Ephemeroptera	23%	19%	19%
Plecoptera	0%	0%	0%
Trichoptera	2%	11%	<1%
Corixidae	0%	<1%	0%
Coleoptera	<1%	0%	0%
All other taxa	3%	13%	5%

Table 4.3-7. 2010 to 2019 Manigotagan Lake nearshore benthic invertebrate relative abundance.

0% <1% to 15% >15% to 25% >25% to 50% >50%

Invertebrate Taxa	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Oligochaeta	16%	23%	17%	13%	2%	49%	23%	7%	24%	20%
Amphipoda	50%	24%	15%	3%	4%	3%	9%	21%	8%	19%
Bivalvia	0%	3%	<1%	<1%	0%	0%	<1%	7%	22%	1%
Gastropoda	<1%	4%	<1%	3%	17%	2%	8%	13%	15%	4%
Ceratopogonidae	0%	<1%	1%	0%	0%	0%	0%	<1%	<1%	0%
Chironomidae	22%	21%	5%	20%	7%	11%	16%	23%	10%	21%
Other Diptera	1%	1%	1%	6%	0%	<1%	2%	<1%	<1%	<1%
Ephemeroptera	7%	15%	60%	36%	41%	19%	24%	16%	17%	23%
Plecoptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Trichoptera	3%	7%	2%	8%	11%	5%	12%	8%	3%	5%
Corixidae	1%	1%	<1%	<1%	1%	<1%	0%	<1%	0%	0%
Coleoptera	<1%	2%	1%	8%	11%	1%	3%	2%	1%	1%
All other taxa	<1%	<1%	<1%	2%	7%	9%	3%	3%	1%	5%

Table 4.3-8. 2010 to 2019 Manigotagan Lake offshore benthic invertebrate relative abundance.

0% <1% to 15% >15% to 25% >25% to 50% >50%

Invertebrate Taxa	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Oligochaeta	25%	35%	31%	24%	23%	9%	6%	8%	25%	20%
Amphipoda	5%	0%	2%	1%	8%	1%	7%	1%	3%	1%
Bivalvia	10%	21%	10%	22%	11%	23%	40%	31%	2%	13%
Gastropoda	2%	1%	2%	9%	<1%	5%	3%	3%	1%	4%
Ceratopogonidae	0%	0%	0%	0%	0%	1%	0%	1%	0%	1%
Chironomidae	33%	26%	20%	15%	32%	36%	26%	8%	51%	19%
Other Diptera	20%	12%	25%	1%	0%	5%	4%	24%	5%	7%
Ephemeroptera	3%	5%	8%	18%	24%	15%	10%	16%	13%	23%
Plecoptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Trichoptera	1%	1%	0%	0%	1%	0%	1%	1%	0%	1%
Corixidae	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
Coleoptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
All other taxa	0%	0%	2%	9%	1%	6%	3%	6%	1%	12%

Table 4.3-9. 2010 to 2019 Eaglenest Lake nearshore benthic invertebrate relative abundance.

0% <1% to 15% >15% to 25% >25% to 50% >50%

Invertebrate Taxa	2010	2013	2016	2019
Oligochaeta	5%	36%	24%	37%
Amphipoda	21%	5%	18%	3%
Bivalvia	<1%	0%	<1%	3%
Gastropoda	19%	15%	36%	9%
Ceratopogonidae	0%	0%	0%	<1%
Chironomidae	23%	32%	6%	41%
Other Diptera	<1%	0%	<1%	<1%
Ephemeroptera	15%	1%	2%	3%
Plecoptera	0%	0%	0%	0%
Trichoptera	8%	5%	3%	3%
Corixidae	7%	5%	8%	<1%
Coleoptera	2%	<1%	1%	1%
All other taxa	<1%	0%	1%	<1%

Table 4.3-10. 2010 to 2019 Eaglenest Lake offshore benthic invertebrate relative abundance.

0% <1% to 15% >15% to 25% >25% to 50% >50%

Invertebrate Taxa	2010	2013	2016	2019
Oligochaeta	1%	5%	10%	7%
Amphipoda	2%	1%	2%	1%
Bivalvia	27%	3%	5%	6%
Gastropoda	0%	<1%	2%	1%
Ceratopogonidae	<1%	<1%	<1%	<1%
Chironomidae	33%	21%	21%	25%
Other Diptera	<1%	<1%	<1%	1%
Ephemeroptera	31%	68%	54%	57%
Plecoptera	0%	0%	0%	0%
Trichoptera	4%	1%	1%	<1%
Corixidae	2%	0%	<1%	<1%
Coleoptera	0%	0%	0%	0%
All other taxa	<1%	<1%	3%	1%

4.3.2 EPT INDEX

4.3.2.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Nearshore Habitat

Annual mean EPT Index over the ten years of monitoring ranged from 7% (2010 and 2014) to 26% (2018; Figure 4.3-1). The overall mean was 15%, the overall median was 12%, and the IQR was 6% to 18%. Annual means were above the IQR in 2016, 2017, and 2018.

Offshore Habitat

Annual mean EPT Index over the ten years of monitoring ranged from 40% (2012) to 89% (2013; Figure 4.3-2). The overall mean and median were 60% and the IQR was 49% to 72%. Annual means were below the IQR in 2012 and 2014, and above the IQR in 2011, 2013, and 2017.

Lac du Bonnet

Nearshore Habitat

Annual mean EPT Index over the ten years of monitoring ranged from 5% (2018) to 33% 2012; Figure 4.3-1). The overall mean was 14%, the overall median was 10%, and the IQR was 6% to 22%. Annual means were below the IQR in 2018, and above the IQR in 2012.

Offshore Habitat

Annual mean EPT Index over the ten years of monitoring ranged from 4% (2010) to 68% (2018; Figure 4.3-2). The overall mean was 27%, the overall median was 22%, and the IQR was 11% to 38%. Annual means were below the IQR in 2010, and above the IQR in 2011 and 2018.

ROTATIONAL SITES

Pine Falls Forebay

Nearshore Habitat

Annual mean EPT Index over the three years of monitoring ranged from 21% (2011) to 35% (2017; Figure 4.3-1). The overall mean was 29%, the overall median was 25%, and the IQR was 17% to 32%. Annual means were within the IQR, except in 2017 (above).

Offshore Habitat

Annual mean EPT Index over the three years of monitoring ranged from 24% (2017) to 41% (2011; Figure 4.3-2). The overall mean was 31%, the overall median was 29%, and the IQR was 8% to 46%. Annual means for all years fell within the IQR.

4.3.2.2 OFF-SYSTEM SITES

ANNUAL SITES

<u>**Manigotagan Lake**</u>

Nearshore Habitat

Annual mean EPT Index over the ten years of monitoring ranged from 11% (2010) to 60% (2012; Figure 4.3-1). The overall mean was 32%., the overall median was 25%, and the IQR was 20% to 43%. Annual means were below the IQR in 2010 and 2018, and above the IQR in 2012 and 2014.

Offshore Habitat

Annual mean EPT Index over the ten years of monitoring ranged from 4% (2010) to 26% (2014; Figure 4.3-2). The overall mean was 15%, the overall median was 13%, and the IQR was 4% to 23%. Annual means were above the IQR in 2014 and 2019.

ROTATIONAL SITES

<u>**Eaglenest Lake**</u>

Nearshore Habitat

Annual mean EPT Index over the four years of monitoring ranged from 6% (2016 and 2019) to 21% (2010; Figure 4.3-1). The overall mean was 10%, the overall median was 8%, and the IQR was 5% to 13%. Annual means were within the IQR, except in 2010 (above).

Offshore Habitat

Annual mean EPT Index over the four years of monitoring ranged from 45% (2010) to 73% (2013; Figure 4.3-2). The overall mean EPT Index was 58%, the overall median EPT Index was 61%, and the IQR was 50% to 71%. Annual means were below the IQR in 2010, and above the IQR in 2013.

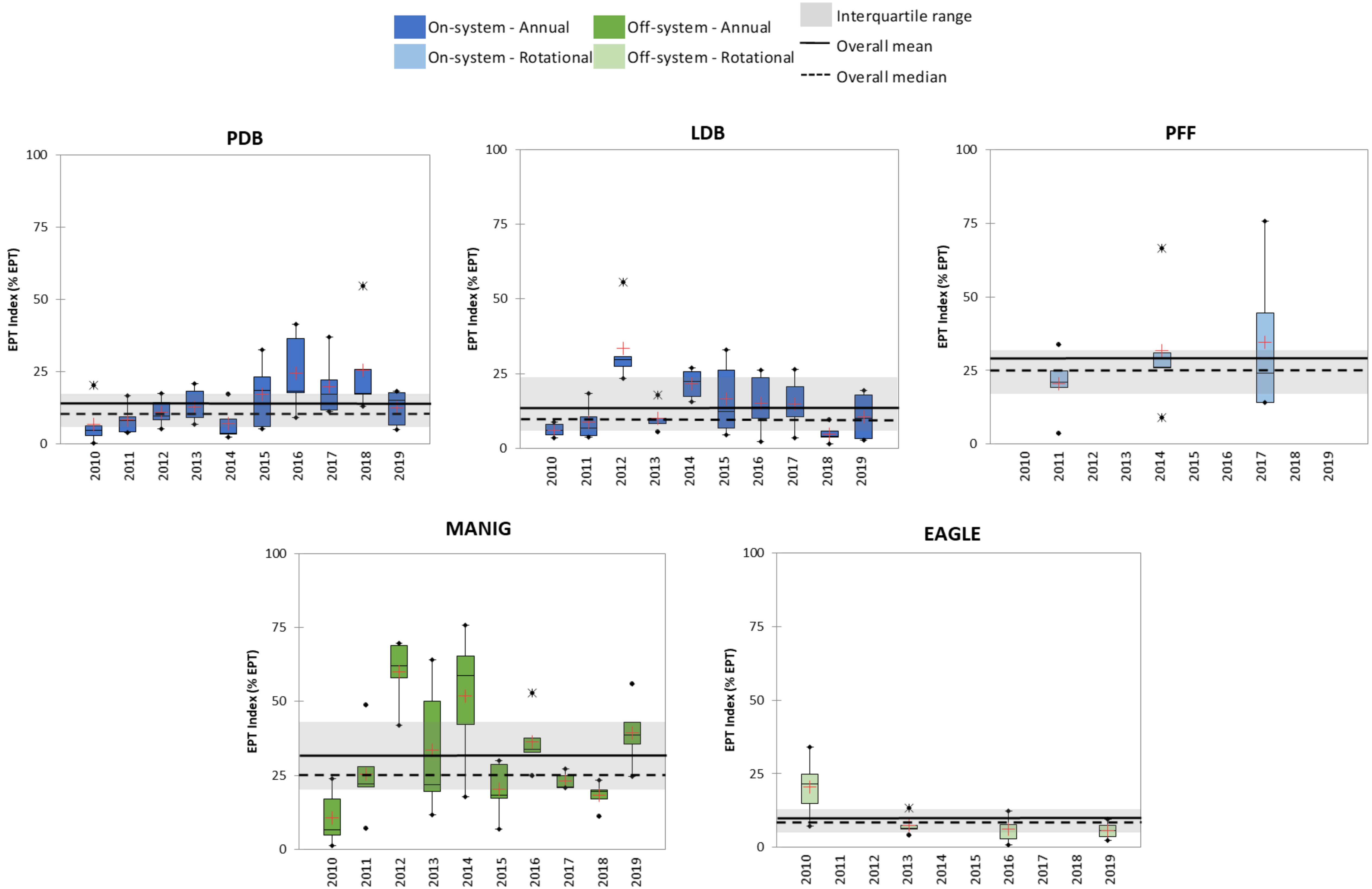


Figure 4.3-1. 2010 to 2019 Nearshore benthic invertebrate EPT Index.

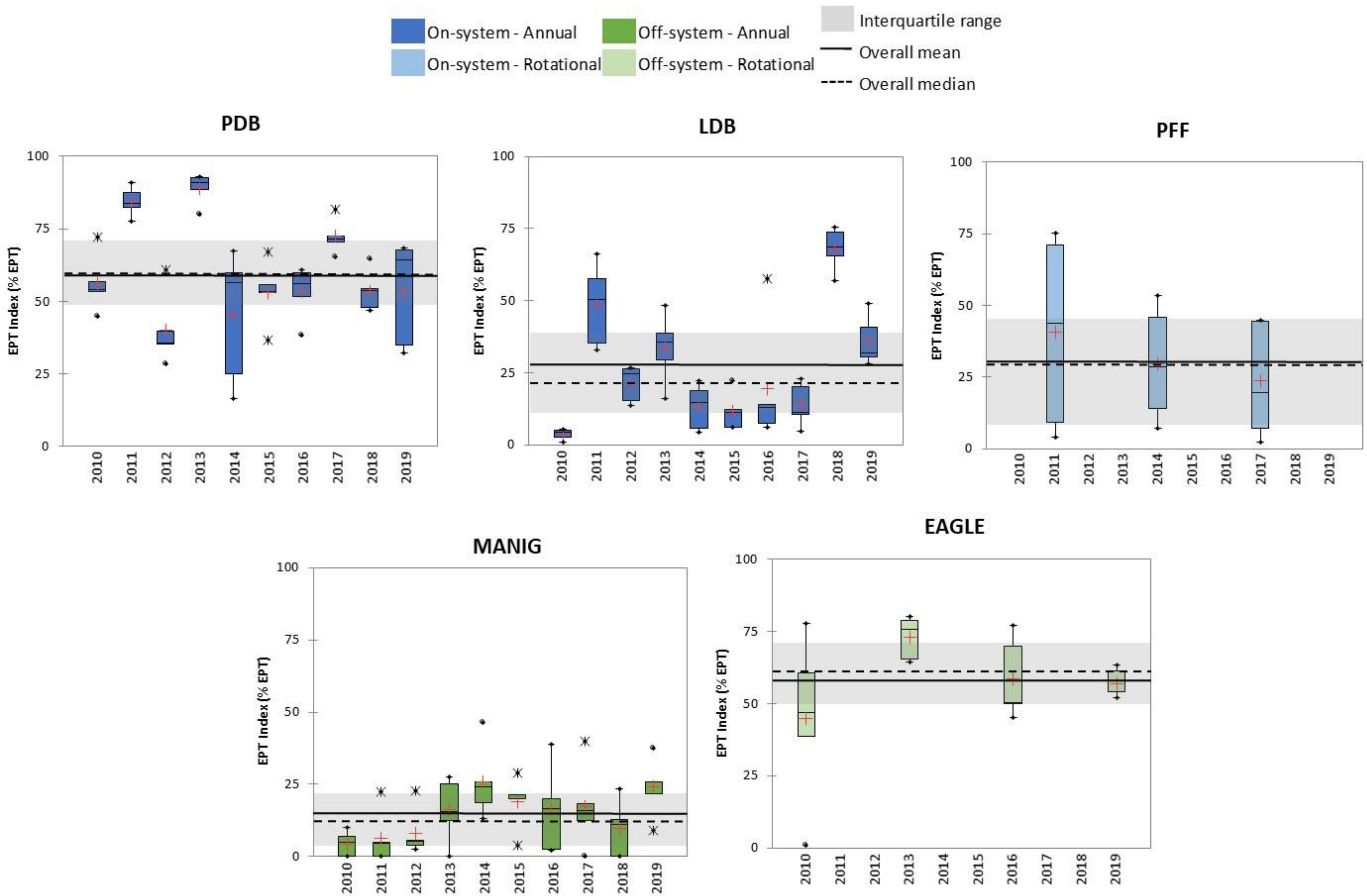


Figure 4.3-2. 2010 to 2019 Offshore benthic invertebrate EPT Index.

4.3.3 O+C INDEX

4.3.3.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Nearshore Habitat

Annual mean O+C Index over the ten years of monitoring ranged from 6% (2014) to 30% (2015 and 2019; Figure 4.3-3). The overall mean was 21%, the overall median was 20%, and the IQR was 13% to 29%. Annual means were below the IQR in 2011 and 2014, and above the IQR in 2015 and 2019.

Offshore Habitat

Annual mean O+C Index over the ten years of monitoring ranged from 9% (2013) to 55% (2012; Figure 4.3-4). The overall mean was 27%, the overall median was 26%, and the IQR was 19% to 35%. Annual means were below the IQR in 2011 and 2013, and above the IQR in 2012 and 2015.

Lac du Bonnet

Nearshore Habitat

Annual mean O+C Index over the ten years of monitoring ranged from 10% (2010) to 53% (2019; Figure 4.3-3). The overall mean was 20%, the overall median was 13%, and the IQR was 8% to 24%. Annual means were above the IQR in 2018 and 2019.

Offshore Habitat

Annual mean O+C Index over the ten years of monitoring ranged from 15% (2018) to 55% (2012; Figure 4.3-4). The overall mean was 33%, the overall median was 30%, and the IQR was 17% to 48%. Annual means were below the IQR in 2014 and 2018, and above the IQR in 2010, 2012, and 2017.

ROTATIONAL SITES

Pine Falls Forebay

Nearshore Habitat

Annual mean O+C Index over the three years of monitoring ranged from 26% (2017) to 31% (2011 and 2014; Figure 4.3-3). The overall mean was 29%, the overall median was 27%, and the IQR was 24% to 33%. Annual means for all years fell within the IQR.

Offshore Habitat

Annual mean O+C Index over the three years of monitoring ranged from 31% (2014) to 59% (2017; Figure 4.3-4). The overall mean was 46%, the overall median was 39%, and the IQR was 26% to 70%. Annual means for all years fell within the IQR.

4.3.3.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Nearshore Habitat

Annual mean O+C Index over the ten years of monitoring ranged from 9% (2014) to 54% (2015; Figure 4.3-3). The overall mean was 36%, the overall median was 35%, and the IQR was 24% to 47%. Annual means were below the IQR in 2014, and above the IQR in 2010 and 2015.

Offshore Habitat

Annual mean O+C Index over the ten years of monitoring ranged from 17% (2017) to 77% (2018; Figure 4.3-4). The overall mean was 47%, the overall median was 48%, and the IQR was 32% to 59%. Annual means were below the IQR in 2017, and above the IQR in 2018.

ROTATIONAL SITES

Eaglenest Lake

Nearshore Habitat

Annual mean O+C Index over the four years of monitoring ranged from 30% (2010) to 72% (2019; Figure 4.3-3). The overall mean was 48%, the overall median was 46%, and the IQR was 22% to 73%. Annual means for all years fell within the IQR.

Offshore Habitat

Annual mean O+C Index over the four years of monitoring ranged from 24% (2013) to 33% (2019; Figure 4.3-4). The overall mean was 30%, the overall median was 29%, and the IQR was 24% to 35%. Annual means were within the IQR, except in 2013 (below).

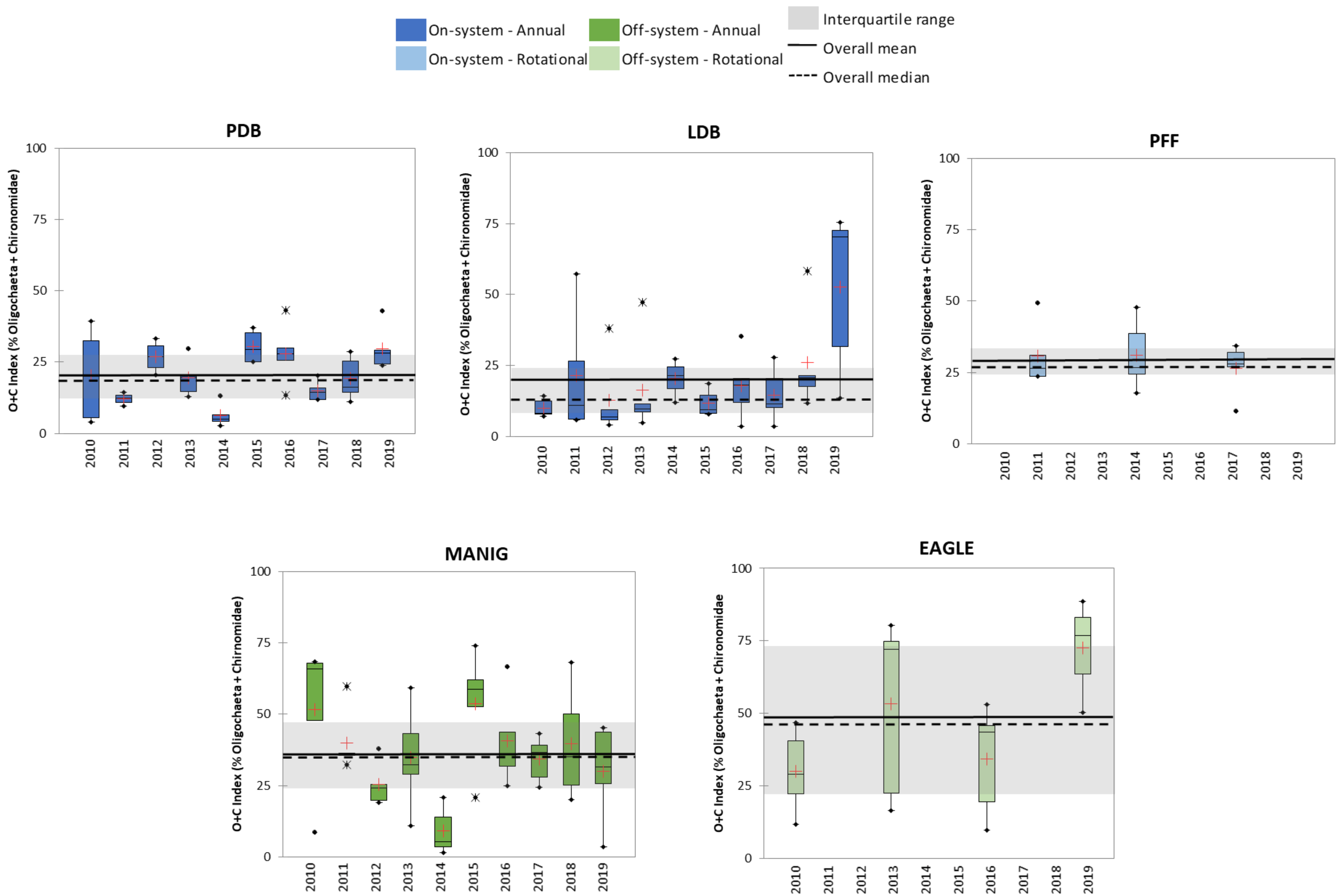


Figure 4.3-3. 2010 to 2019 Nearshore benthic invertebrate O+C Index.

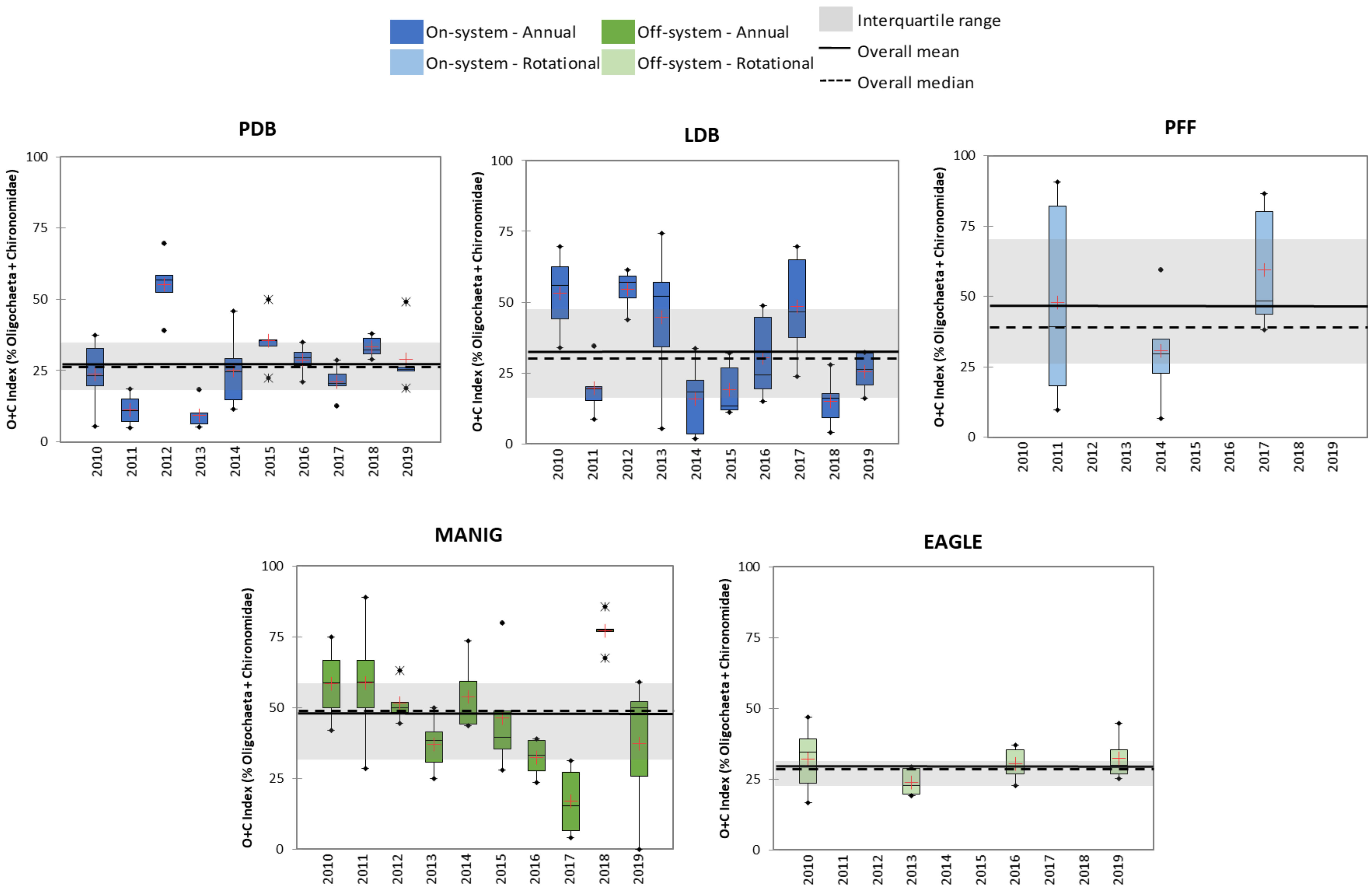


Figure 4.3-4. 2010 to 2019 Offshore benthic invertebrate O+C Index.

4.4 RICHNESS

4.4.1 TOTAL TAXA RICHNESS

4.4.1.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Nearshore Habitat

Annual mean total taxa richness over the ten years of monitoring ranged from 17 families (2010) to 26 families (2013 and 2018; Figure 4.4-1). The overall mean and median were 23 families, and the IQR was 21 to 25 families. Annual means were below the IQR in 2010, and above the IQR in 2013, 2017, and 2018.

Offshore Habitat

Annual mean total taxa richness over the ten years of monitoring ranged from five families (2012) to eight families (2011, 2014, 2015, and 2019; Figure 4.4-2). The overall mean and median were seven families, and the IQR was 6 to 8 families. Annual means were below the IQR in 2010 and 2012.

Lac du Bonnet

Nearshore Habitat

Annual mean total taxa richness over the ten years of monitoring ranged from 13 families (2019) to 22 families (2012, 2015, and 2017; Figure 4.4-1). The overall mean and median were 18 families, and the IQR was 14 to 21 families. Annual means were below the IQR in 2019, and above the IQR in 2012, 2015, and 2017.

Offshore Habitat

Annual mean total taxa richness over the ten years of monitoring ranged from seven families (2013) to 12 families (2014; Figure 4.4-2). The overall mean and median were nine families, and the IQR was 8 to 10 families. Annual means were below the IQR in 2013 and 2019, and above the IQR in 2014 and 2015.

ROTATIONAL SITES

Pine Falls Forebay

Nearshore Habitat

Annual mean total taxa richness over the three years of monitoring ranged from 24 families (2017) to 26 families (2014; Figure 4.4-1). The overall mean was 25 families, the overall median was 24 families, and the IQR was 23 to 28 families. Annual means for all years were within the IQR.

Offshore Habitat

Annual mean total taxa richness over the three years of monitoring ranged from eight families (2017) to ten families (2014; Figure 4.4-2). The overall mean and median were nine families, and the IQR was 8 to 10 families. Annual means for all years were within the IQR.

4.4.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Nearshore Habitat

Annual mean total taxa richness over the ten years of monitoring ranged from 11 families (2010) to 24 families (2011; Figure 4.4-1). The overall mean was 17 families, the overall median was 16 families, and the IQR was 14 to 21 families. Annual means were below the IQR in 2010 and 2014, and above the IQR in 2011.

Offshore Habitat

Annual mean total taxa richness over the ten years of monitoring ranged from five families (2011, 2012, 2013, 2014, and 2018) to seven families (2019; Figure 4.4-2). The overall mean was six families, the overall median was five families, and the IQR was 5 to 6 families. Annual means were below the IQR in 2011 and 2018, and above the IQR in 2016 and 2019.

ROTATIONAL SITES

Eaglenest Lake

Nearshore Habitat

Annual mean total taxa richness over the four years of monitoring ranged from 14 families (2014) to 17 families (2010, 2016, and 2019; Figure 4.4-1). The overall mean was 16 families, the overall median was 17 families, and the IQR was 15 to 18 families. Annual means were within the IQR, except in 2013 (below).

Offshore Habitat

Annual mean total taxa richness over the four years of monitoring ranged from six families (2010) to eight families (2016 and 2019; Figure 4.4-2). The overall mean and median were seven families, and the IQR was 5 to 9 families. Annual means for all years were within the IQR.

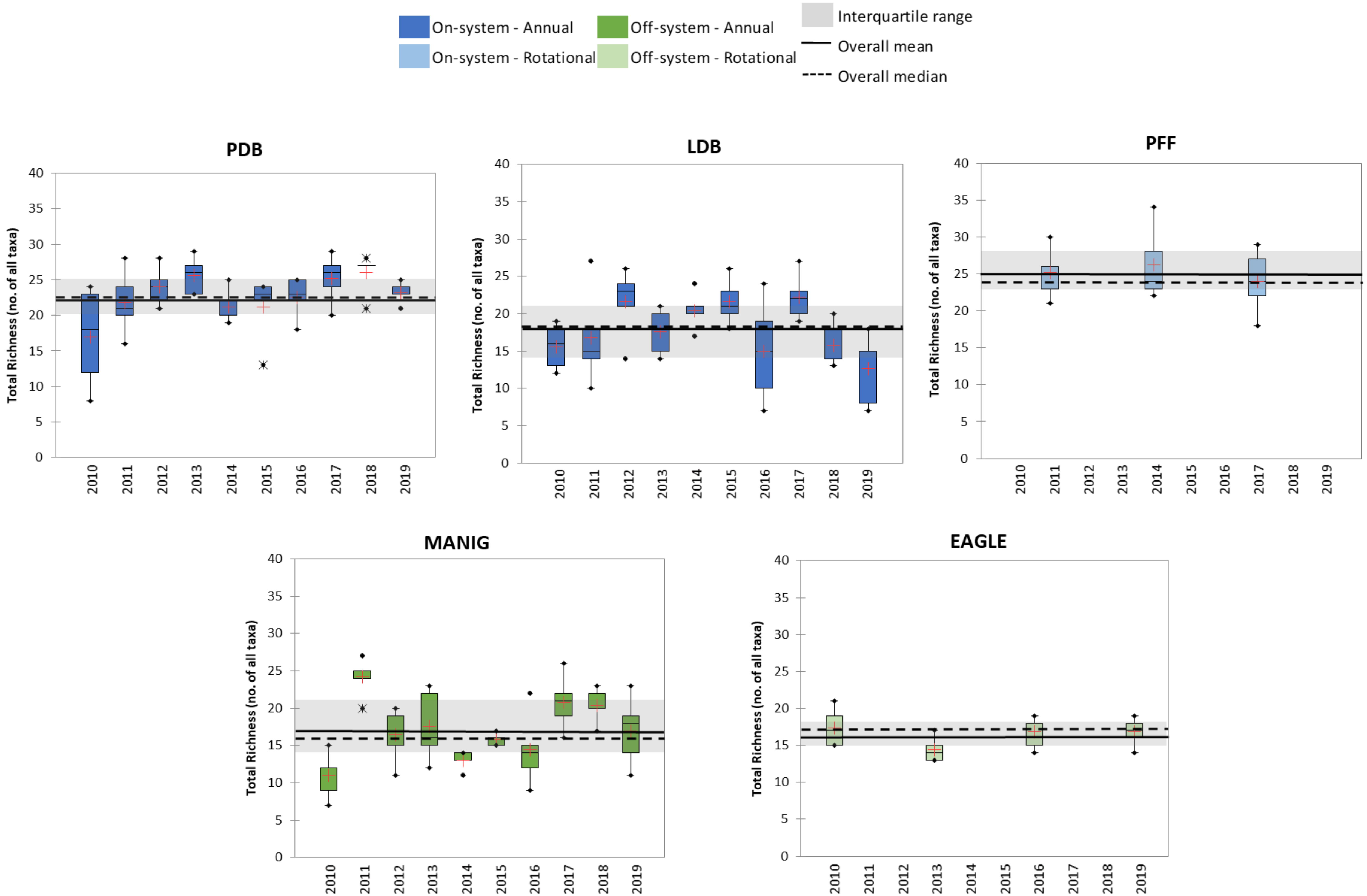


Figure 4.4-1. 2010 to 2019 Nearshore benthic invertebrate total richness (family-level).

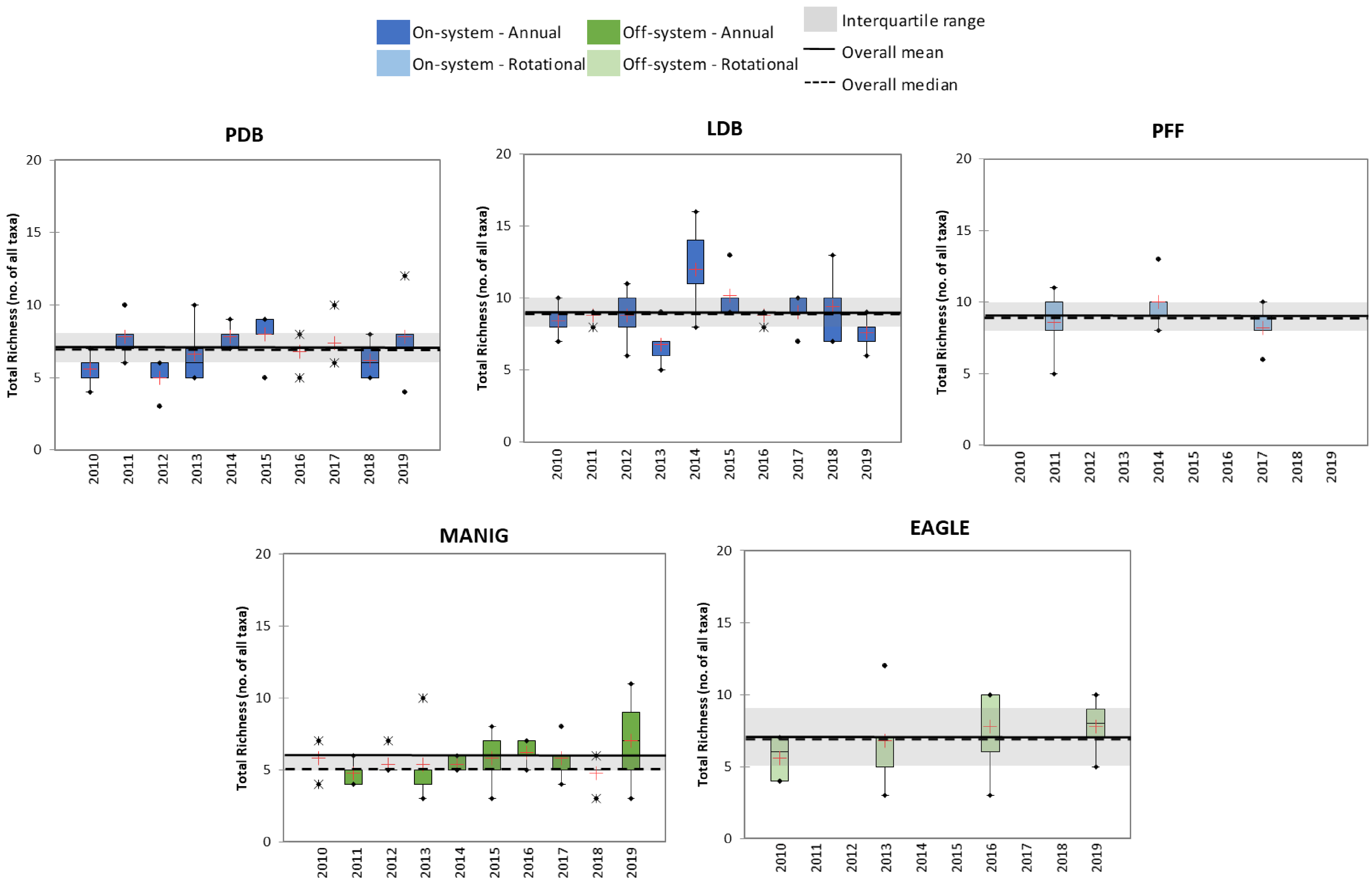


Figure 4.4-2. 2010 to 2019 Offshore benthic invertebrate total richness (family-level).

4.4.2 EPT TAXA RICHNESS

4.4.2.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Nearshore Habitat

Annual mean EPT taxa richness over the ten years of monitoring ranged from six families (2010) to nine families (2012, 2013, and 2018; Figure 4.4-3). The overall mean and median were eight families, the IQR was 6 to 9 families. Annual means were within the IQR, except in 2010 (below).

Offshore Habitat

Annual mean EPT taxa richness over the ten years of monitoring ranged from one family (2012 and 2014) to three families (2011 and 2017; Figure 4.4-4). The overall mean and median were two families, and the IQR was 1 to 2 families. Annual means were above the IQR in 2011, 2015, and 2017.

Lac du Bonnet

Nearshore Habitat

Annual mean EPT taxa richness over the ten years of monitoring ranged from four families (2018 and 2019) to eight families (2012, 2014, 2015, and 2017; Figure 4.4-3). The overall mean was seven families, the overall median was eight families, and the IQR was 5 to 9 families. Annual means were below the IQR in 2018 and 2019.

Offshore Habitat

Annual mean EPT taxa richness over the ten years of monitoring ranged from two families (2010 to 2013 and 2015 to 2019) to three families (2014; Figure 4.4-4). The overall mean, median, and IQR were two families. Annual means were below the IQR in 2013, and above the IQR in 2012, and 2014 to 2017.

ROTATIONAL SITES

Pine Falls Forebay

Nearshore Habitat

Annual mean EPT taxa richness over the three years of monitoring ranged from eight families (2017) to ten families (2011 and 2014; Figure 4.4-3). The overall mean and median were nine families, and the IQR was 8 to 11 families. Annual means for all years were within the IQR.

Offshore Habitat

Annual mean EPT taxa richness over the three years of monitoring ranged from two families (2017) to three families (2011 and 2014; Figure 4.4-4). The overall mean and median were three families, and the IQR was 2 to 3 families. Annual means for all years were within the IQR.

4.4.2.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Nearshore Habitat

Annual mean EPT taxa richness over the ten years of monitoring ranged from five families (2010 and 2014) to 11 families (2011; Figure 4.4-3). The overall mean was eight families, the overall median was seven families, and the IQR was 6 to 9 families. Annual means were below the IQR in 2010 and 2014, and above the IQR in 2011 and 2017.

Offshore Habitat

Annual mean EPT taxa richness over the ten years of monitoring was one family for all years (Figure 4.4-4). The overall mean, median, and IQR were also one family. Annual means were below the IQR in 2010, 2011, and 2018, and above the IQR in 2014, 2016, and 2019.

ROTATIONAL SITES

Eaglenest Lake

Nearshore Habitat

Annual mean EPT taxa richness over the four years of monitoring was five families for all years (Figure 4.4-3). The overall mean and median were five families, and the IQR was 4 to 6 families. Annual means for all years were within the IQR.

Offshore Habitat

Annual mean EPT taxa richness over the four years of monitoring ranged from one family (2010 and 2019) to two families (2013 and 2016; Figure 4.4-4). The overall mean and median were two families, and the IQR was 1 to 2 families. Annual means were within the IQR, except in 2013 (above).

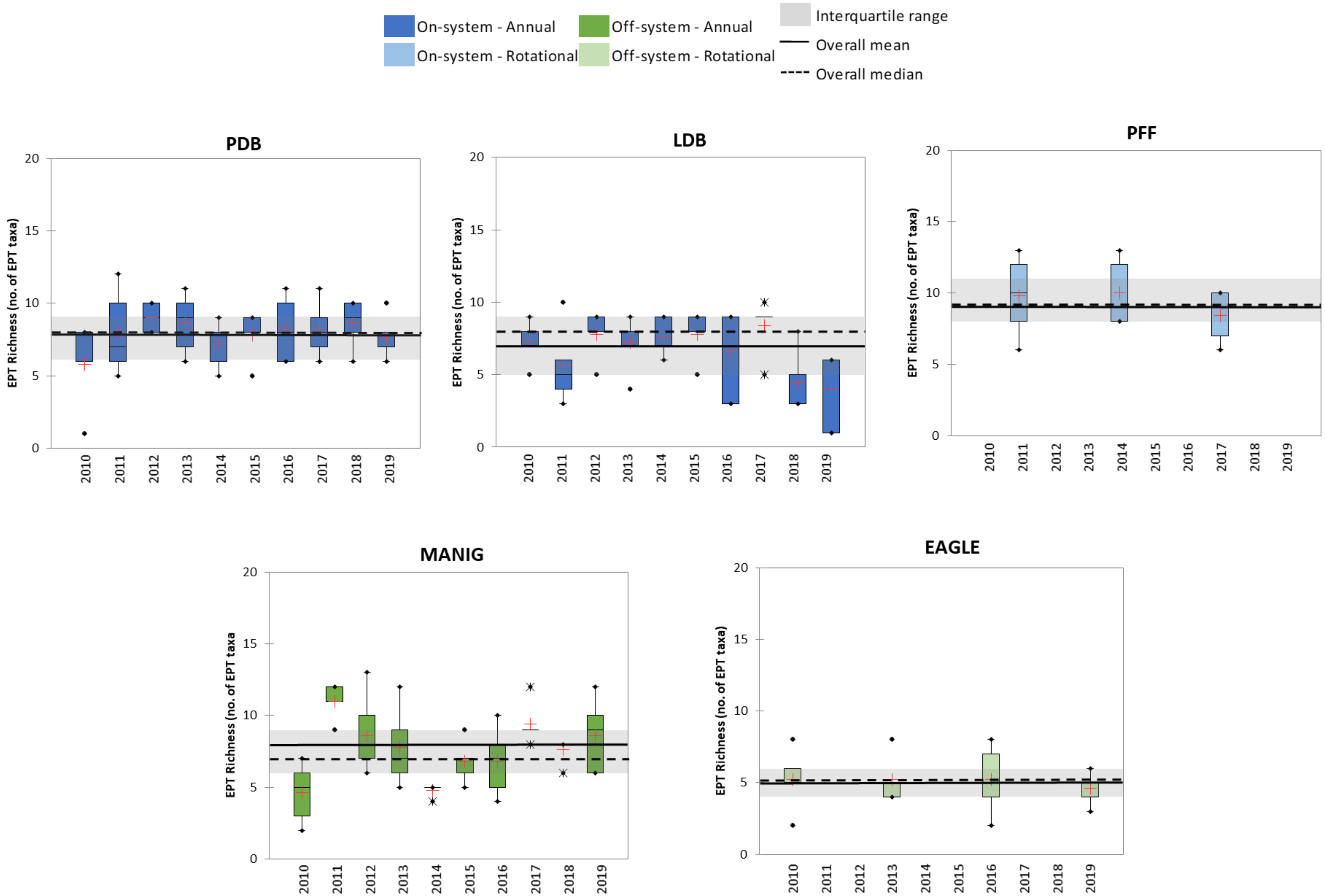


Figure 4.4-3. 2010 to 2019 Nearshore benthic invertebrate EPT richness (family-level).

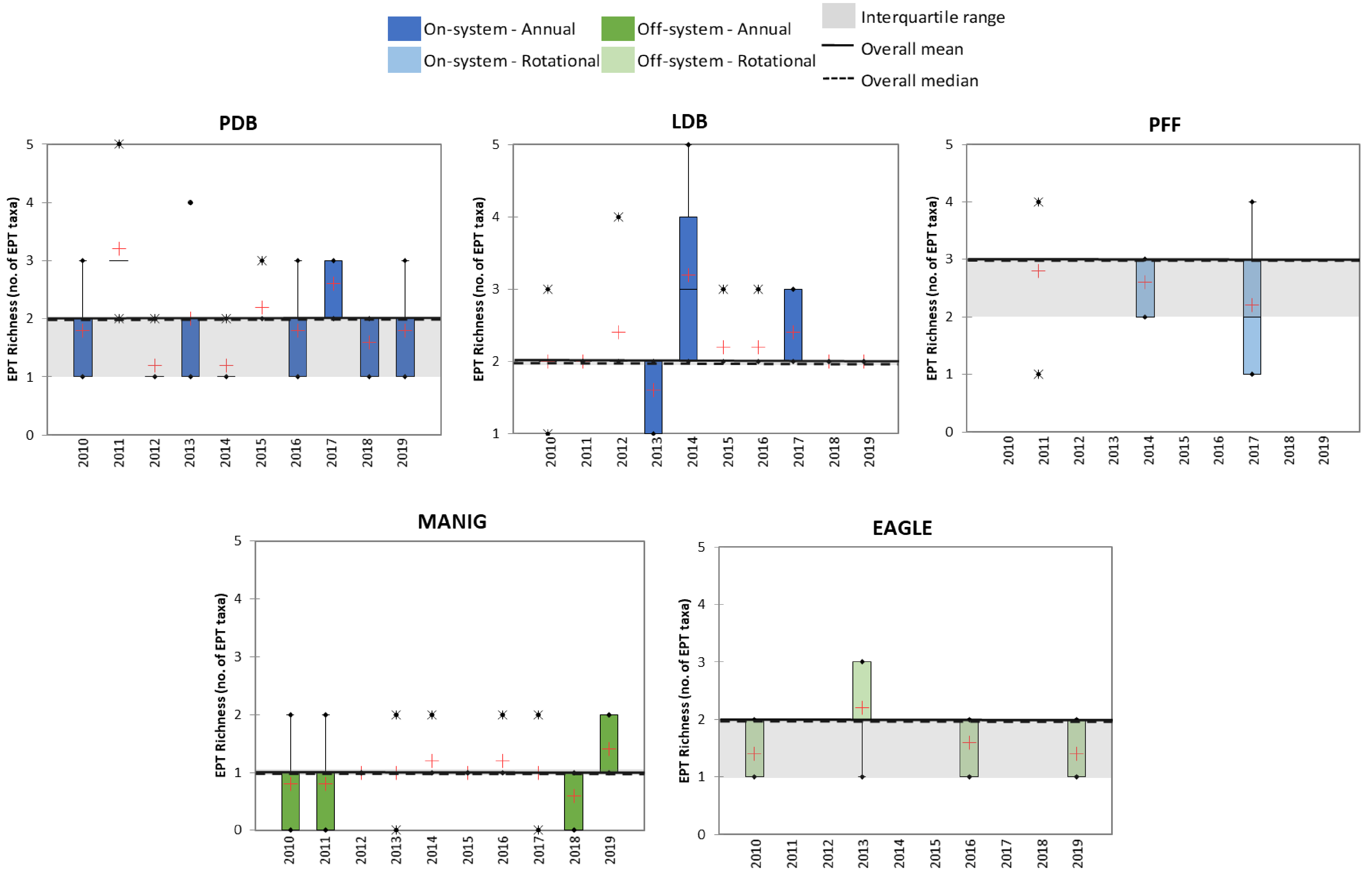


Figure 4.4-4. 2010 to 2019 Offshore benthic invertebrate EPT richness (family-level).

4.5 DIVERSITY

4.5.1 HILL'S EFFECTIVE RICHNESS

4.5.1.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Nearshore Habitat

Annual mean Hill's effective richness (Hill's index) over the ten years of monitoring ranged from three (2014) to nine (2016 to 2019; Figure 4.5-1). The overall mean and median were seven and the IQR was 5 to 10. Annual means were within the IQR, except for in 2014 (below).

Offshore Habitat

Annual mean Hill's index over the ten years of monitoring ranged from two (2011, 2013) to four (2010, 2014, 2015, 2016, 2018, and 2019; Figure 4.5-2). The overall mean and median were three and the IQR was 3 to 4. Annual means were below the IQR in 2011, 2013 and 2017, and above the IQR in 2014.

Lac du Bonnet

Nearshore Habitat

Annual mean Hill's index over the ten years of monitoring ranged from three (2010) to nine (2014; Figure 4.5-1). The overall mean and median were five and the IQR was 3 to 6. Annual means were below the IQR in 2010, and above the IQR in 2014 and 2015.

Offshore Habitat

Annual mean Hill's index over the ten years of monitoring ranged from three (2018) to six (2014 and 2017; Figure 4.5-2). The overall mean and median were five and the IQR was 4 to 5. Annual means were below the IQR in 2010, 2013 and 2018, and above the IQR in 2014, 2015, 2017 and 2019.

ROTATIONAL SITES

Pine Falls Forebay

Nearshore Habitat

Annual mean Hill's index over the three years of monitoring ranged from six (2011 and 2017) to ten (2014; Figure 4.5-1). The overall mean and median were seven and the IQR was 6 to 8. Annual means were within the IQR, except for in 2014 (above).

Offshore Habitat

Annual mean Hill's index over the three years of monitoring ranged from three (2011) to six (2014; Figure 4.5-2). The overall mean was five, the overall median was four, and the IQR was 4 to 5. Annual means were below the IQR in 2011, and above the IQR in 2014.

4.5.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Nearshore Habitat

Annual mean Hill's index over the ten years of monitoring ranged from four (2010) to 11 (2019; Figure 4.5-1). The overall mean was eight, the overall median was nine, and the IQR was 6 to 10. Annual means were below the IQR in 2010 and 2015, and above the IQR in 2017 and 2019.

Offshore Habitat

Annual mean Hill's index over the ten years of monitoring ranged from three (2018) to five (2015, 2017, and 2019; Figure 4.5-2). The overall mean and median were four and the IQR was 3 to 5. Annual means were within the IQR, except for in 2019 (above).

ROTATIONAL SITES

Eaglenest Lake

Nearshore Habitat

Annual mean Hill's index over the four years of monitoring ranged from five (2019) to eight (2010; Figure 4.5-1). The overall mean and median were six and the IQR was 5 to 7. Annual means were within the IQR, except for in 2010 (above).

Offshore Habitat

Annual mean Hill's index over the four years of monitoring ranged from two (2013) to four (2016; Figure 4.5-2). The overall mean and median were three and the IQR was 3 to 4. Annual means were within the IQR, except for in 2013 (below).

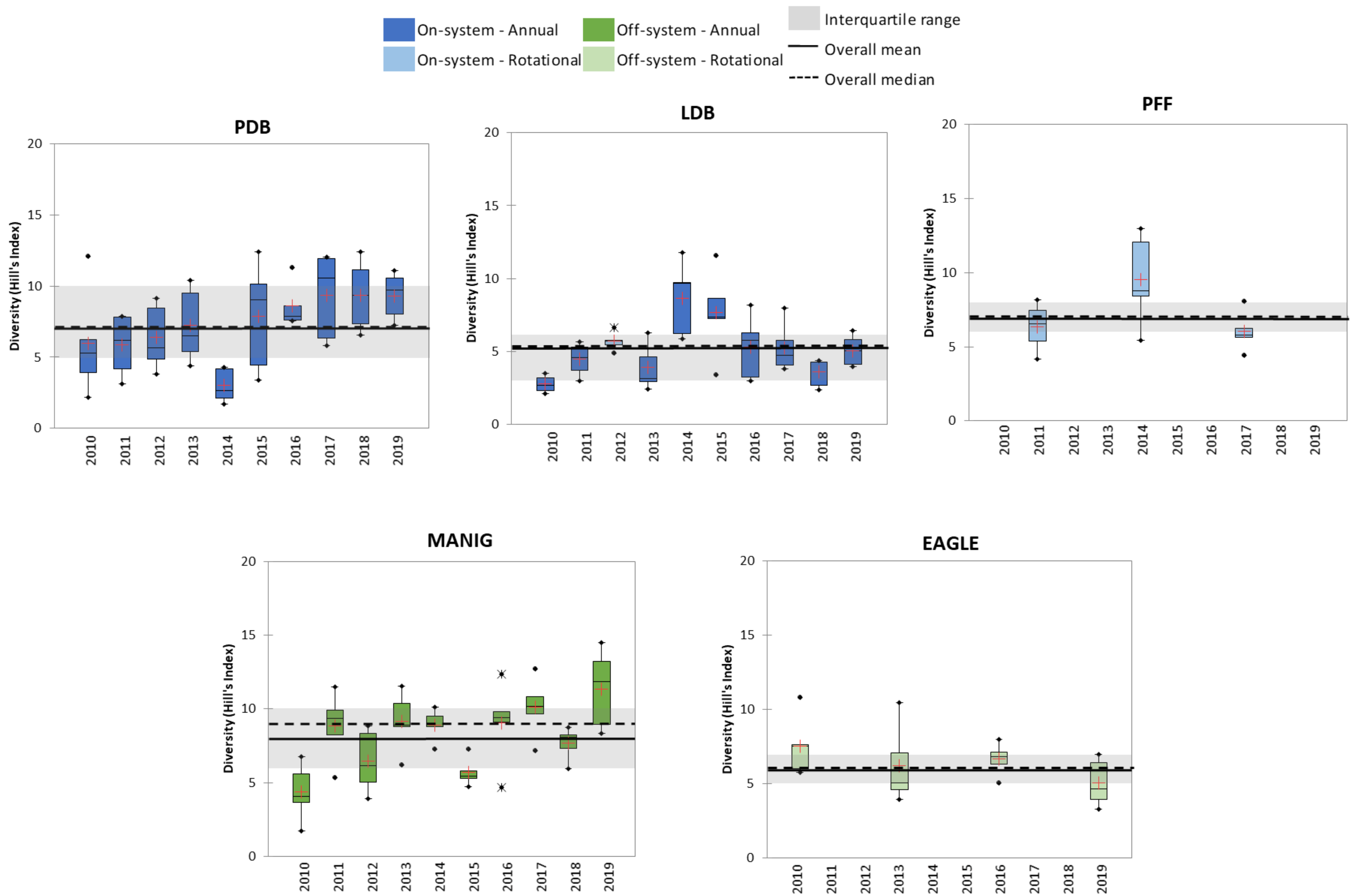


Figure 4.5-1. 2010 to 2019 Nearshore benthic invertebrate diversity (family-level).

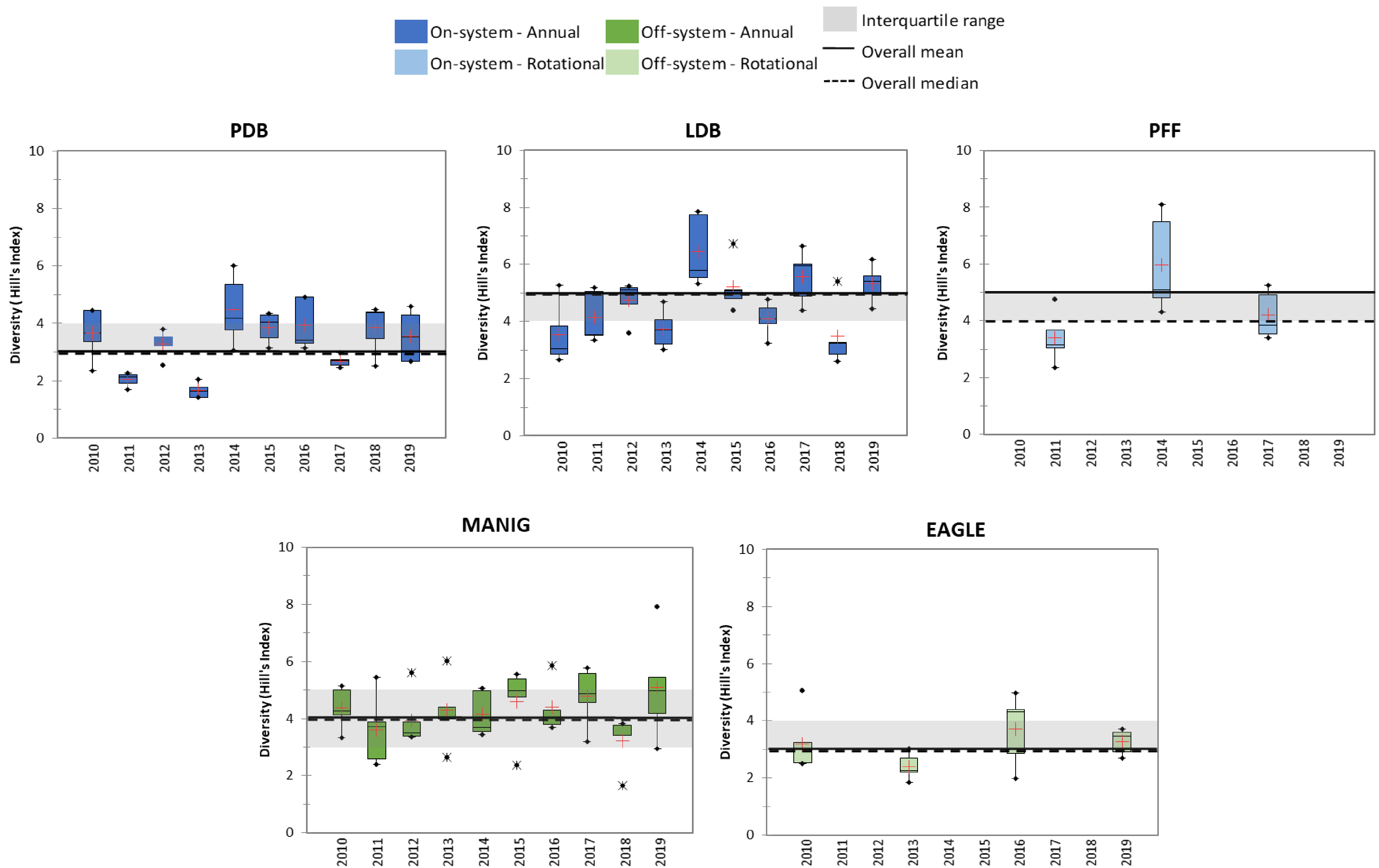


Figure 4.5-2. 2010 to 2019 Offshore benthic invertebrate diversity (family-level).

APPENDIX 4-1. BENTHIC INVERTEBRATE NEARSHORE AND OFFSHORE SAMPLING SITES: 2008-2019

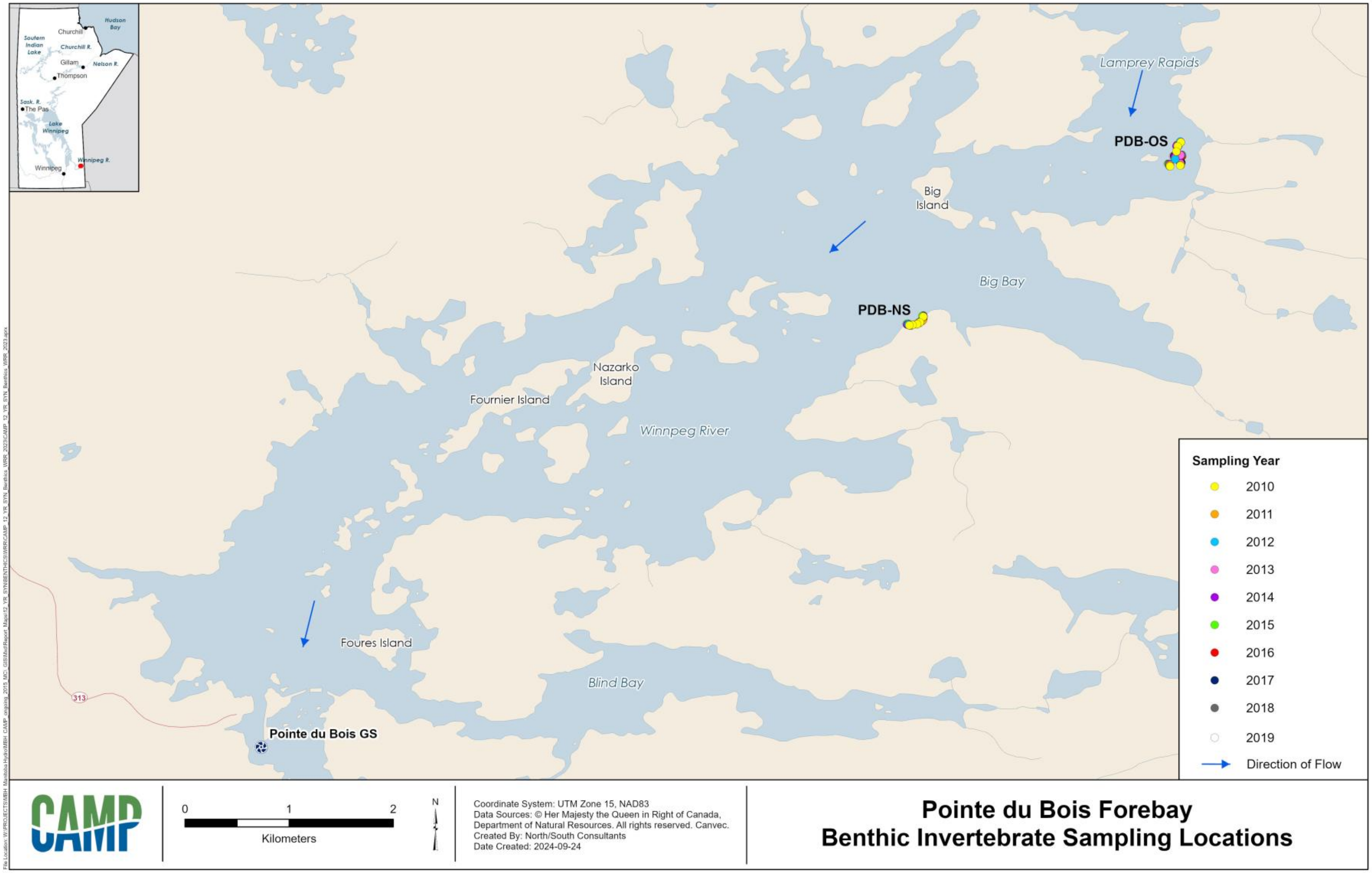


Figure A4-1-1. 2010 to 2019 Pointe du Bois Forebay nearshore (NS) and offshore (OS) benthic invertebrate sampling sites.

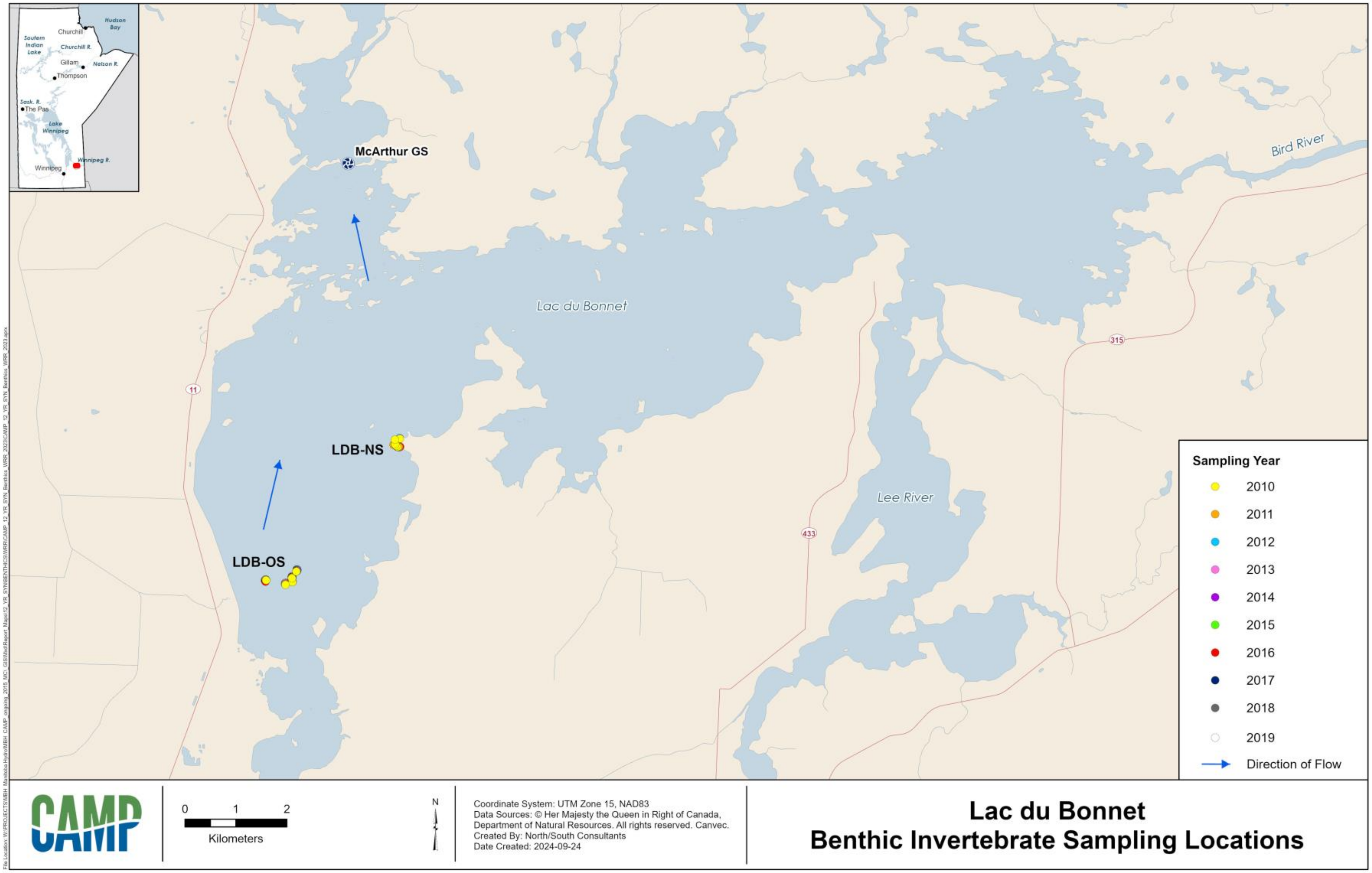


Figure A4-1-2. 2010 to 2019 Lac du Bonnet nearshore (NS) and offshore (OS) benthic invertebrate sampling sites.

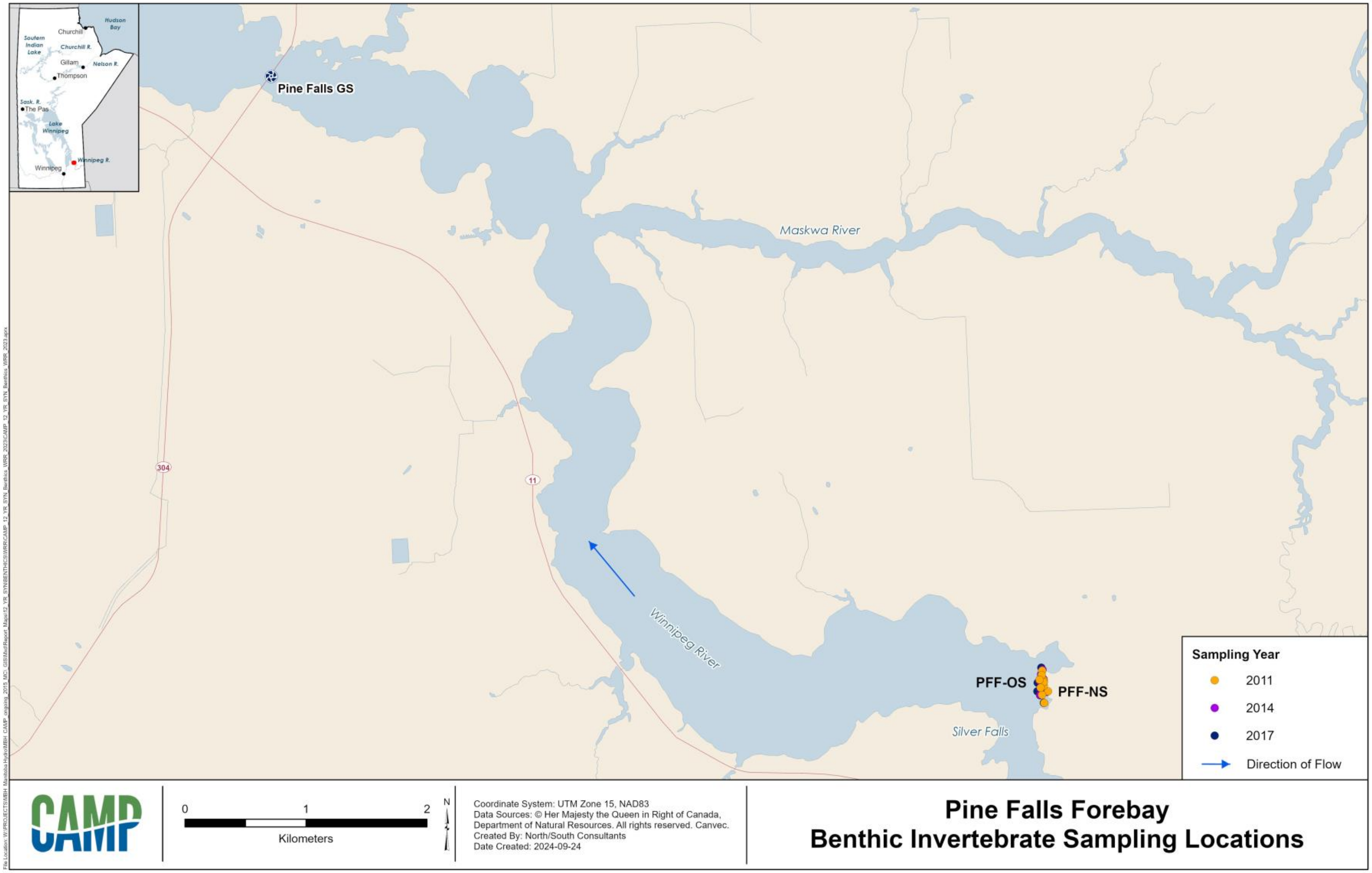


Figure A4-1-3. 2010 to 2019 Pine Falls Forebay nearshore (NS) and offshore (OS) benthic invertebrate sampling sites.

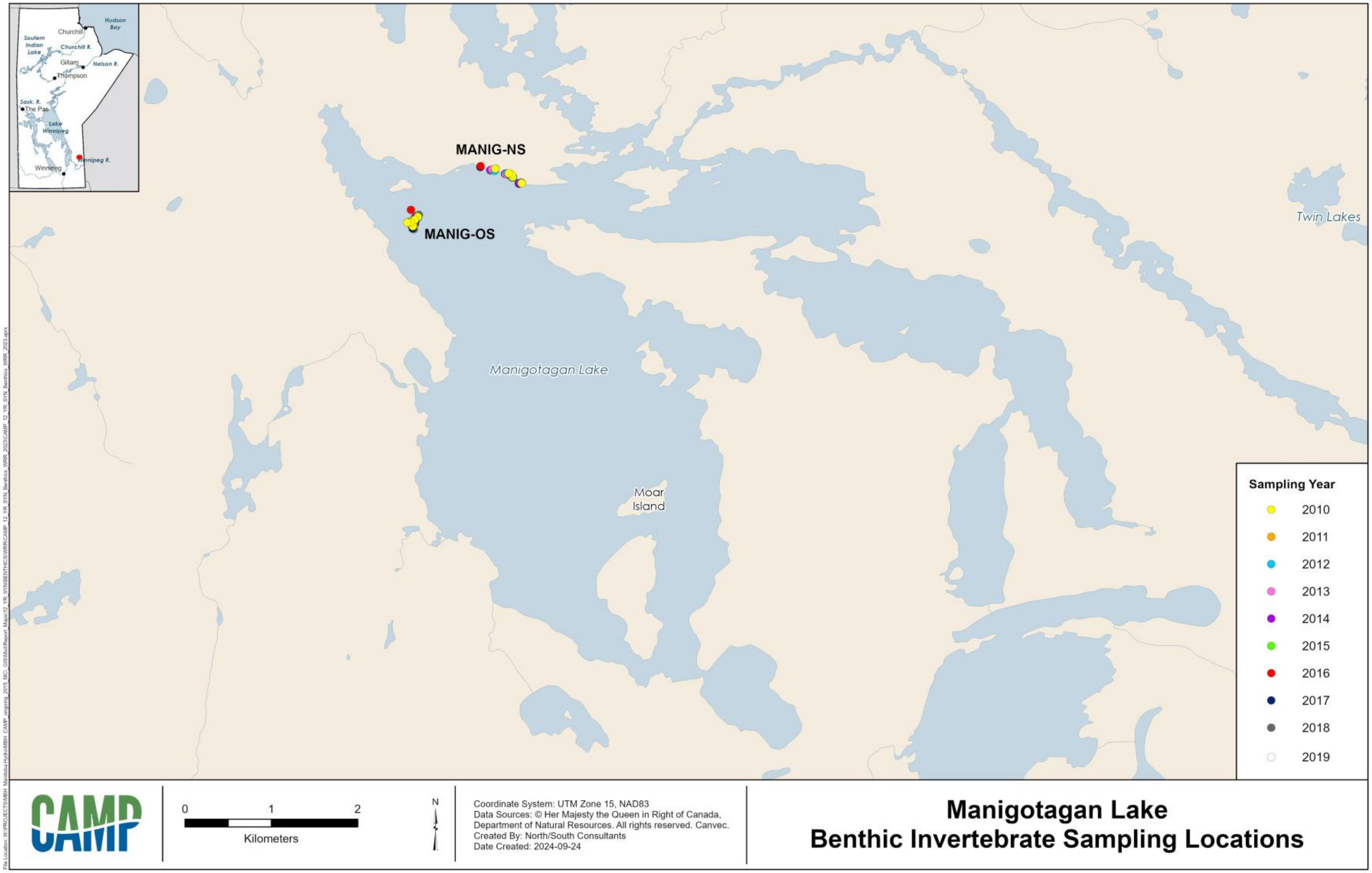


Figure A4-1-4. 2010 to 2019 Manigotagan Lake nearshore (NS) and offshore (OS) benthic invertebrate sampling sites.

Figure A4-1-5. 2010 to 2019 Eaglenest Lake nearshore (NS) and offshore (OS) benthic invertebrate sampling sites.

APPENDIX 4-2. BENTHIC INVERTEBRATE NEARSHORE AND OFFSHORE SUPPORTING SUBSTRATE DATA BY YEAR

Table A4-2-1. 2010 to 2019 Pointe du Bois Forebay nearshore supporting benthic substrate data.

Year	Dominant Substrate	Sample Water Depth (m)	Supporting Substrate Analysis				
			Mean Particle Size (%)			Mean TOC (%)	Texture
			Sand	Silt	Clay		
2010	fines with coarse	0.5	49.1	36.2	14.7	0.3	Sandy loam
2011	coarse	0.9	85.5	10.5	4.0	5.6	Sandy loam
2012	coarse with fines	0.4	89.7	5.6	4.7	1.6	Sand / Loamy sand
2013	fines	0.4	77.4	10.2	12.4	0.9	Sandy clay loam
2014	fines with coarse	0.3	76.7	7.1	16.3	0.3	Sandy loam
2015	fines, coarse, hard	0.8	78.8	16.7	4.5	0.5	Sandy loam
2016	fines	0.5	75.4	15.4	8.9	0.6	Sandy loam
2017	coarse with fines	0.5	73.8	17.1	9.1	0.5	Sandy loam
2018	fines with coarse	0.7	63.6	15.7	20.7	0.9	Clay
2019	fines with coarse, hard, + organics	0.4	94.1	2.5	3.1	0.3	Sand

Notes:
1. TOC = Total organic carbon.

Table A4-2-2. 2010 to 2019 Pointe du Bois Forebay offshore supporting benthic substrate data.

Year	Dominant Substrate	Sample Water Depth (m)	Supporting Substrate Analysis				
			Mean Particle Size (%)			Mean TOC (%)	Texture
			Sand	Silt	Clay		
2010	fines with organics	7.0	84.8	13.3	1.8	0.7	Loamy sand
2011	fines	7.4	81.9	15.2	3.0	0.7	Sandy loam
2012	fines	6.6	76.0	16.8	7.3	0.9	Sandy loam
2013	fines	7.2	81.3	14.9	3.8	0.6	Loamy sand
2014	fines	7.3	80.3	15.6	4.0	0.6	Loamy sand
2015	fines with organics	7.2	73.4	22.7	3.9	0.7	Loamy sand
2016	fines	7.2	76.5	20.3	3.1	0.5	Loamy sand
2017	fines	7.2	82.1	15.0	2.9	0.6	Sandy loam / Loamy sand
2018	fines	7.1	80.6	17.1	2.3	0.5	Loamy sand
2019	fines with organics	7.5	77.6	19.2	3.1	0.6	Loamy sand

Notes:
1. TOC = Total organic carbon.

Table A4-2-3. 2010 to 2019 Lac du Bonnet nearshore supporting benthic substrate data.

Year	Dominant Substrate	Sample Water Depth (m)	Supporting Substrate Analysis				
			Mean Particle Size (%)			Mean TOC (%)	Texture
			Sand	Silt	Clay		
2010	hard, coarse, organics, + fines	0.4	92.8	2.4	4.7	0.4	Sand
2011	hard + coarse	0.9	83.9	6.2	9.9	0.4	Loamy sand
2012	fines + coarse	no sample	-	-	-	-	-
2013	coarse	0.6	63.9	7.8	28.3	0.6	Sand
2014	coarse + fines	0.3	81.3	8.6	10.1	0.5	Sandy loam / Loamy sand
2015	hard, coarse + fines	0.7	80.8	7.2	11.9	0.4	Sand
2016	coarse	0.5	74.5	10.3	15.0	1.1	Sand
2017	coarse	0.5	69.5	10.9	19.6	1.5	Sand
2018	coarse + fines	0.3	95.8	1.0	2.9	0.4	Sand
2019	coarse, fines + organics	0.4	81.1	4.6	14.0	0.6	Sand

Notes:

1. TOC = Total organic carbon.

Table A4-2-4. 2010 to 2019 Lac du Bonnet offshore supporting benthic substrate data.

Year	Dominant Substrate	Sample Water Depth (m)	Supporting Substrate Analysis				
			Mean Particle Size (%)			Mean TOC (%)	Texture
			Sand	Silt	Clay		
2010	fines	7.3	79.8	15.1	5.1	0.3	Loamy sand
2011	fines	7.0	74.0	16.4	9.7	0.4	Clay loam
2012	fines	7.0	74.4	18.4	7.2	0.9	Loamy sand
2013	fines	7.1	80.0	14.8	5.3	0.6	Loamy sand
2014	fines with coarse	7.1	82.9	11.0	6.1	0.6	Sandy loam
2015	fines	7.0	77.3	17.4	5.3	0.6	Loamy sand
2016	fines	7.5	79.4	15.6	5.0	0.6	Sandy loam
2017	fines	7.3	79.1	14.5	6.5	0.7	Sandy loam
2018	fines	7.3	85.1	10.9	4.0	0.4	Sand
2019	fines with coarse	7.4	81.6	12.6	5.9	0.5	Sandy loam

Notes:

1. TOC = Total organic carbon.

Table A4-2-5. 2010 to 2019 Pine Falls Forebay nearshore supporting benthic substrate data.

Year	Dominant Substrate	Sample Water Depth (m)	Supporting Substrate Analysis				
			Mean Particle Size (%)			Mean TOC (%)	Texture
			Sand	Silt	Clay		
2011	coarse	0.7	80.9	6.9	12.2	0.2	Sand
2014	coarse + fines	0.4	70.0	10.3	19.7	0.7	Loamy sand
2017	coarse	0.5	94.7	2.9	1.9	0.7	-

Notes:

1. TOC = Total organic carbon.

Table A4-2-6. 2010 to 2019 Pine Falls Forebay offshore supporting benthic substrate data.

Year	Dominant Substrate	Sample Water Depth (m)	Supporting Substrate Analysis				
			Mean Particle Size (%)			Mean TOC (%)	Texture
			Sand	Silt	Clay		
2011	fines	7.1	21.6	36.0	42.3	2.2	Clay
2014	fines, coarse, organics	6.6	18.0	34.5	47.6	2.5	Clay
2017	fines	8.1	28.6	40.5	30.9	2.7	Clay loam

Notes:

1. TOC = Total organic carbon.

Table A4-2-7. 2010 to 2019 Manigotagan Lake nearshore supporting benthic substrate data.

Year	Dominant Substrate	Sample Water Depth (m)	Supporting Substrate Analysis				
			Mean Particle Size (%)			Mean TOC (%)	Texture
			Sand	Silt	Clay		
2010	coarse + fines	no sample	-	-	-	-	-
2011	coarse	no sample	-	-	-	-	-
2012	coarse	no sample	-	-	-	-	-
2013	coarse	no sample	-	-	-	-	-
2014	coarse	no sample	-	-	-	-	-
2015	coarse + fines	no sample	-	-	-	-	-
2016	coarse	no sample	-	-	-	-	-
2017	coarse + fines	0.5	97.7	1.4	0.1	0.1	Sand
2018	coarse + fines	0.4	97.7	1.2	0.8	0.2	Sand
2019	coarse + fines	no sample	-	-	-	-	-

Notes:

1. TOC = Total organic carbon.

Table A4-2-8. 2010 to 2019 Manigotagan Lake offshore supporting benthic substrate data.

Year	Dominant Substrate	Sample Water Depth (m)	Supporting Substrate Analysis				
			Mean Particle Size (%)			Mean TOC (%)	Texture
			Sand	Silt	Clay		
2010	fines	7.9	92.5	6.1	1.5	0.5	Sand
2011	fines	6.7	93.2	4.1	2.6	0.5	Sand
2012	fines	7.2	88.3	8.6	3.1	0.6	Sand
2013	fines	6.6	89.3	7.8	3.0	0.5	Sand
2014	fines	7.7	89.9	8.1	2.0	0.5	Sand
2015	fines	7.9	87.1	9.7	3.2	0.8	Sand
2016	fines	7.9	78.4	16.2	5.4	0.9	Sand
2017	fines	7.0	89.0	8.3	2.7	0.7	Sand
2018	fines, gravel	7.5	86.0	10.3	3.6	0.7	Sand
2019	fines	8.6	81.3	14.5	4.2	1.0	Sand

Notes:

1. TOC = Total organic carbon.

Table A4-2-9. 2010 to 2019 Eaglenest Lake nearshore supporting benthic substrate data.

Year	Dominant Substrate	Sample Water Depth (m)	Supporting Substrate Analysis				
			Mean Particle Size (%)			Mean TOC (%)	Texture
			Sand	Silt	Clay		
2010	hard, fines, organics	0.8	46.3	30.8	22.9	7.3	Loam
2013	hard	no sample	-	-	-	-	-
2016	hard	no sample	-	-	-	-	-
2019	hard + coarse with fines	no sample	-	-	-	-	-

Notes:

1. TOC = Total organic carbon.

Table A4-2-10. 2010 to 2019 Eaglenest Lake offshore supporting benthic substrate data.

Year	Dominant Substrate	Sample Water Depth (m)	Supporting Substrate Analysis				
			Mean Particle Size (%)			Mean TOC (%)	Texture
			Sand	Silt	Clay		
2010	fines, organics	7.2	85.1	13.2	1.6	0.4	Loamy sand
2013	fines	6.9	78.2	18.1	3.7	0.5	Sandy loam / Loamy sand
2016	fines	7.0	78.4	18.4	3.1	0.5	Loamy sand
2019	fines, organics	6.4	73.3	24.4	2.2	0.6	Sandy loam

Notes:

1. TOC = Total organic carbon

5.0 FISH COMMUNITY

5.1 INTRODUCTION

The following presents the results of fish community monitoring conducted from 2008 to 2019 in the Winnipeg River Region. Five waterbodies were monitored in the Winnipeg River Region: two on-system annual sites (the Pointe du Bois Forebay and Lac du Bonnet); one on-system rotational site (the Pine Falls Forebay); one off-system annual site (Manigotagan Lake); and one off-system rotational site (Eaglenest Lake; Table 5.1-1 and Figure 5.1-1). Eaglenest Lake is located on the Winnipeg River upstream of the Pointe du Bois Forebay and is not affected by Manitoba Hydro's hydraulic operating system and is therefore identified as an "off-system" site. There were no departures from the planned field sampling during the 12-year period.

Monitoring targets both small-bodied fish species (i.e., forage fish) and large-bodied fish species (e.g., fish targeted in subsistence, commercial, and/or recreational fisheries). Within a given waterbody, sampling was conducted at approximately the same time of year during each year of monitoring. Standard gang index gill nets (GN; 51, 76, 95, 108, and 127 mm stretched mesh panels) were set at each site and a small mesh index gillnet gang (SN; 16, 20, and 25 mm bar measure panels) was attached to the end of the standard gang at approximately every third site (Appendix 5-1). Gill nets were set for approximately 24 hours. All fish captured at each site were counted by mesh size and species. Individual metrics (e.g., length, weight, deformities, erosion, lesions, and tumours [DELTs], sex and maturity, age) were collected for species of management interest (i.e., "target" species). These include: Walleye (*Sander vitreus*) and Northern Pike (*Esox lucius*) from all waterbodies in all years; Sauger (*S. canadensis*) from Lac du Bonnet and the Pointe du Bois Forebay in all years; Sauger from 2016-2019 in Eaglenest Lake and 2017-2019 in the Pine Falls Forebay; and White Sucker (*Catostomus commersonii*) from all waterbodies starting in 2010. All other species were bulk weighed.

Five fish community indicators (abundance, condition, growth, recruitment, and community diversity) were selected for detailed reporting (Table 5.1-2). Metrics for these indicators that are presented herein include: catch-per-unit-effort (CPUE); Fulton's condition factor (KF); relative weight (Wr); fork length-at-age (FLA); relative year-class strength (RYCS); Hill's effective species richness (Hill's index); and relative species abundance (RSA; Table 5.1-2).

A detailed description of the program design and sampling methods is provided in Technical Document 1, Section 2.5.

Table 5.1-1. 2008-2019 Inventory of fish community sampling.

Waterbody/Area	Sampling Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
PDB	●	●	●	●	●	●	●	●	●	●	●	●
LDB	●	●	●	●	●	●	●	●	●	●	●	●
PFF				●			●			●		
MANIG	●	●	●	●	●	●	●	●	●	●	●	●
EAGLE			●			●			●			●

Table 5.1-2. Fish community indicators and metrics.

Indicator	Metric	Units
Abundance	• Catch-Per-Unit-Effort (CPUE)	# fish/30 m/24 hour (h) # fish/100 m/24 h
Condition	• Fulton's Condition Factor (KF)	-
	• Relative Weight (Wr)	-
Growth	• Fork Length-At-Age (FLA)	mm
Recruitment	• Relative Year-Class Strength (RYCS)	-
Diversity	• Hill's Effective Species Richness	species
	• Relative Species Abundance (RSA)[1]	%

Notes:

1. Supporting metric.

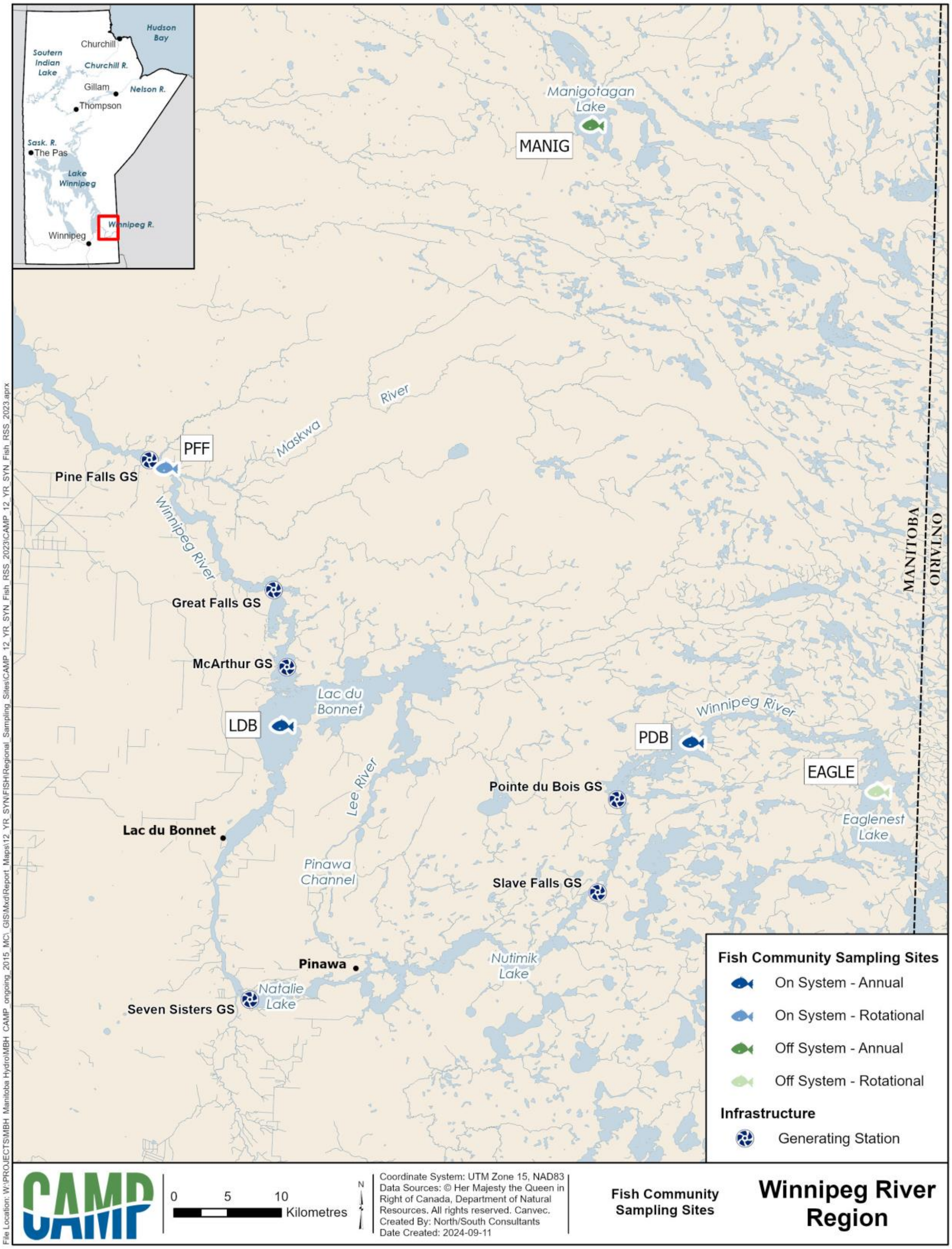


Figure 5.1-1. 2008-2019 Fish community sampling sites.

5.2 ABUNDANCE

5.2.1 CATCH-PER-UNIT-EFFORT

5.2.1.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Standard Gang Index Gill Nets

The annual mean CPUE varied over the 12 years of monitoring from a low of 21.2 in 2010 to a maximum of 52.1 fish/100 m/24 h in 2019 (Table 5.2-1; Figure 5.2-1).

The overall mean CPUE was 38.7, the median was 36.2, and the IQR was 33.6-49.2 fish/100 m/24 h (Figure 5.2-1). The annual mean CPUE fell within the overall IQR except in 2010 and 2014 when it was below the IQR and in 2011 and 2019 when it was above the IQR.

Small Mesh Index Gill Nets

The annual mean CPUE in the small mesh gangs over the 12 years of monitoring was more variable than in the standard gangs, with the mean ranging from a low of 10.6 in 2009 to a high of 144.6 fish/30 m/24 h in 2012 (Table 5.2-1; Figure 5.2-2).

The overall mean CPUE was 76.5, the median was 73.6, and the IQR was 45.2-114.3 fish/30 m/24 h (Figure 5.2-2). The annual mean CPUE fell within the overall IQR except in 2009, 2010, and 2016 when it was below the IQR and in 2011, 2012, and 2013 when it was above the IQR.

Lake Whitefish

Lake Whitefish (*Coregonus clupeaformis*) was not selected as a target species in any of the Winnipeg River Region waterbodies even though it is a target species in other CAMP regions.

Northern Pike

Catches of Northern Pike were relatively low in the Pointe du Bois Forebay over the 12 years of monitoring, with the annual mean CPUE ranging from a low of 0.7 in 2012 to a high of 3.3 fish/100 m/24 h in 2013 (Table 5.2-1; Figure 5.2-3).

The overall mean CPUE was 1.6, the median was 1.5, and the IQR was 1.3-1.8 fish/100 m/24 h (Figure 5.2-3). The annual mean CPUE fell within the overall IQR except in 2010 and 2012 when it was below the IQR and in 2008, 2013, and 2014 when it was above the IQR.

Sauger

The annual mean CPUE over the 12 years of monitoring varied up to about four-fold from year-to-year, ranging from a low of 2.8 in 2010 to a high of 10.4 fish/100 m/24 h in 2009 (Table 5.2-1; Figure 5.2-4).

The overall mean CPUE was 7.2, the median was 8.9, and the IQR was 5.1-8.9 fish/100 m/24 h (Figure 5.2-4). The annual mean CPUE fell within the overall IQR except in 2010 when it was below the IQR and in 2008 and 2009 when it was above the IQR.

Walleye

The annual mean CPUE over the 12 years of monitoring varied by up to about two-fold from year-to-year, ranging from a low of 2.6 in 2016 to a high of 6.7 fish/100 m/24 h in 2009 (Table 5.2-1; Figure 5.2-5).

The overall mean CPUE was 4.1, the median was 3.7, and the IQR was 3.1-5.0 fish/100 m/24 h (Figure 5.2-5). The annual mean CPUE fell within the overall IQR except in 2008, 2009, and 2019 when it was above the IQR.

White Sucker

The annual mean CPUE over the 12 years of monitoring varied up to about three-fold from year-to-year, with the mean ranging from a low of 5.6 in 2016 to a high of 19.3 fish/100 m/24 h in 2009 (Table 5.2-1; Figure 5.2-6).

The overall mean CPUE was 10.3, the median was 8.9, and the IQR was 8.0-11.7 fish/100 m/24 h (Figure 5.2-6). The annual mean CPUE fell within the overall IQR except in 2014 and 2016 when it was below the IQR and in 2008, 2009, and 2011 when it was above the IQR.

Lac du Bonnet

Standard Gang Index Gill Nets

The annual mean CPUE over the 12 years of monitoring varied up to about two-fold from year-to-year, with the mean ranging from a low of 32.4 in 2008 to a high of 51.1 fish/100 m/24 h in 2019 (Table 5.2-1; Figure 5.2-1).

The overall mean CPUE was 41.5, the median was 42.3, and the IQR was 37.2-45.3 fish/100 m/24 h (Figure 5.2-1). The annual mean CPUE fell within the overall IQR except in 2008, 2010, and 2015 when it was below the IQR and in 2012, 2013, and 2019 when it was above the IQR.

Small Mesh Index Gill Nets

The annual mean CPUE in the small mesh gangs over the 12 years of monitoring was more variable than in the standard gangs, with the mean ranging from a low of 25.4 in 2016 to a high of 424.6 fish/30 m/24 h in 2013 (Table 5.2-1; Figure 5.2-2).

The overall mean CPUE was 166.2, the median was 144.8, and the IQR was 51.8-216.8 fish/30 m/24 h (Figure 5.2-2). The annual mean CPUE fell within the overall IQR except in 2009, 2010, and 2016 when it was below the IQR and in 2011, 2013, and in 2015 when it was above the IQR.

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

Catches of Northern Pike were relatively low in Lac du Bonnet over the 12 years of monitoring, with the annual mean ranging from a low of 1.2 in 2009 to a high of 5.9 fish/100 m/24 in 2012 (Table 5.2-1; Figure 5.2-3).

The overall mean and median CPUE were 3.8 and the IQR was 3.4-4.5 fish/100 m/24 (Figure 5.2-3). The annual mean CPUE fell within the overall IQR except in 2008, 2009, and 2011 when it was below the IQR and in 2012, 2013, and 2014 when it was above the IQR.

Sauger

The annual mean CPUE over the 12 years of monitoring varied up to about two-fold from year-to-year, with the mean ranging from a low of 6.4 in 2010 to a high of 12.7 fish/100 m/24 h in 2009 (Table 5.2-1; Figure 5.2-4).

The overall mean CPUE was 8.8, the median was 8.6, and the IQR was 7.5-9.6 fish/100 m/24 h (Figure 5.2-4). The annual mean CPUE fell within the overall IQR except in 2010, 2015, and 2019 when it was below the IQR and in 2009 and 2016 when it was above the IQR.

Walleye

The annual mean CPUE over the 12 years of monitoring varied up to about two-fold from year-to-year, with the mean ranging from a low of 4.8 in 2008 to a high of 12.4 fish/100 m/24 h in 2012 (Table 5.2-1; Figure 5.2-5).

The overall mean CPUE was 7.0, the median was 6.3, and the IQR was 5.8-7.8 fish/100 m/24 h (Figure 5.2-5). The annual mean CPUE fell within the overall IQR except in 2008, 2010, and 2016 when it was below the IQR and in 2012 and 2014 when it was above the IQR.

White Sucker

The annual mean CPUE over the 12 years of monitoring varied up to about two-fold from year-to-year, with the mean ranging from a low of 3.1 in 2012 to a high of 6.7 fish/100 m/24 h in 2019 (Table 5.2-1; Figure 5.2-6).

The overall mean CPUE was 4.3, the median was 3.8, and the IQR was 3.7-5.0 fish/100 m/24 h (Figure 5.2-6). The annual mean CPUE fell within the overall IQR except in 2009, 2012, and 2015 when it was below the IQR and in 2008, 2013, and 2019 when it was above the IQR.

ROTATIONAL SITES

Pine Falls Forebay

Standard Gang Index Gill Nets

The annual mean CPUE over the three years of monitoring varied by up to about two-fold, with the mean ranging from a low of 18.4 in 2011 to a high of 35.3 fish/100 m/24 h in 2014 (Table 5.2-1; Figure 5.2-1).

The overall mean CPUE was 26.1, the median was 24.6, and the IQR was 21.5-29.9 fish/100 m/24 h (Figure 5.2-1). The annual mean CPUE was below the IQR in 2011 and was above the IQR in 2014.

Small Mesh Index Gill Nets

The annual mean CPUE over the three years of monitoring ranged from a low of 3.5 in 2011 to a high of 9.0 fish/30 m/24 h in 2017 (Table 5.2-1; Figure 5.2-2).

The overall mean CPUE was 6.9, the median was 8.3, and the IQR was 5.9-8.6 fish/30 m/24 h (Figure 5.2-2). The annual mean CPUE was below the IQR in 2011 and was above the IQR in 2014.

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

Catches of Northern Pike were relatively low in the Pine Falls Forebay over the three years of monitoring, with the annual mean ranging from a low of 0.5 in 2011 to a high of 1.1 fish/100 m/24 in 2017 (Table 5.2-1; Figure 5.2-3).

The overall mean and median CPUE were 0.7 and the IQR was 0.6-0.9 fish/100 m/24 h (Figure 5.2-3). The annual mean CPUE was below the IQR in 2011 and above the IQR in 2017.

Sauger

Catches of Sauger were relatively low in the Pine Falls Forebay over the three years of monitoring, with the annual mean ranging from a low of 0.9 in 2011 to a high of 2.5 fish/100 m/24 h in 2017 (Table 5.2-1; Figure 5.2-4).

The overall mean CPUE was 1.9, the median was 2.3, and the IQR was 1.6-2.4 fish/100 m/24 h (Figure 5.2-4). The annual mean CPUE was below the IQR in 2011 and was marginally above the IQR in 2017.

Walleye

The annual mean CPUE over the three years of monitoring varied by up to about three-fold, with the mean ranging from a low of 2.0 in 2011 to a high of 5.8 fish/100 m/24 h in 2014 (Table 5.2-1; Figure 5.2-5).

The overall mean CPUE was 3.5, the median was 2.7, and the IQR was 2.3-4.3 fish/100 m/24 h (Figure 5.2-5). The annual mean CPUE was above the IQR in 2014.

White Sucker

Catches of White Sucker were relatively low in the Pine Falls Forebay over the three years of monitoring, with the annual mean ranging from a low of 1.5 in 2011 to a high of 2.9 fish/100 m/24 h in 2014 (Table 5.2-1; Figure 5.2-6).

The overall mean CPUE was 2.3, the median was 2.7, and the IQR was 2.1-2.8 fish/100 m/24 h (Figure 5.2-6). The annual mean CPUE was below the IQR in 2011 and was marginally above the IQR in 2014.

5.2.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Standard Gang Index Gill Nets

The annual mean CPUE over the 12 years of monitoring varied by up to about two-fold, with the mean ranging from a low of 43.0 in 2013 to a high of 68.0 fish/100 m/24 h in 2008 (Table 5.2-1; Figure 5.2-1).

The overall mean CPUE was 55.6, the median was 53.6, and the IQR was 49.3-64.2 fish/100 m/24 h (Figure 5.2-1). The annual mean CPUE fell within the overall IQR except in in 2011, 2013, and 2019 when it was below the IQR and in 2008, 2015, and 2018 when it was above the IQR.

Small Mesh Index Gill Nets

The annual mean CPUE in the small mesh gangs over the 12 years of monitoring was more variable than in the standard gangs, with the mean ranging from a low of 2.6 in 2011 to a high of 71.4 fish/30 m/24 h in 2012 (Table 5.2-1; Figure 5.2-2).

The overall mean CPUE was 20.0, the median was 12.7, and the IQR was 7.2-25.2 fish/30 m/24 h (Figure 5.2-2). The annual mean CPUE fell within the overall IQR except in 2009, 2011, and 2017 when it was below the IQR and in 2012, 2013, and 2018 when it was above the IQR.

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

Catches of Northern Pike were relatively low in Manigotagan Lake over the 12 years of monitoring, with the annual mean CPUE ranging from a low of 2.0 in 2009 to a high of 4.4 fish/100 m/24 h in 2016 (Table 5.2-1; Figure 5.2-3).

The overall mean and median CPUE were 3.1 and the IQR was 2.3-3.8 fish/100 m/24 h (Figure 5.2-3). The annual mean CPUE fell within the overall IQR except in 2009, 2010, and 2019 when it was below the IQR and in 2014, 2016, and 2018 when it was above the IQR.

Sauger

Sauger were not captured in Manigotagan Lake over the 12 years of monitoring (Table 5.2-1).

Walleye

The annual mean CPUE over the 12 years of monitoring varied by up to about two-fold, with the mean ranging from a low of 11.0 in 2013 to a high of 23.5 fish/100 m/24 h in 2008 (Table 5.2-1; Figure 5.2-5).

The overall mean CPUE was 17.1, the median was 16.2, and the IQR was 15.5-18.7 fish/100 m/24 h (Figure 5.2-5). The annual mean CPUE fell within the overall IQR except in in 2013, 2014, and 2015 when it was below the IQR and in 2008, 2010, and 2018 when it was above the IQR.

White Sucker

The annual mean CPUE over the 12 years of monitoring varied by up to about five-fold, with the mean ranging from a low of 1.7 in 2011 to a high of 8.0 fish/100 m/24 h in 2018 (Table 5.2-1; Figure 5.2-6).

The overall mean CPUE was 4.2, the median was 3.8, and the IQR was 3.0-4.9 fish/100 m/24 h (Figure 5.2-6). The annual mean CPUE fell within the overall IQR except in in 2010 and 2011 when it was below the IQR and 2018 and 2019 when it was above the IQR.

ROTATIONAL SITES

Eaglenest Lake

Standard Gang Index Gill Nets

The annual mean CPUE over the four years of monitoring was generally similar among years, with the mean ranging from a low of 35.5 in 2010 to a high of 45.0 fish/100 m/24 h in 2019 (Table 5.2-1; Figure 5.2-1).

The overall mean CPUE was 42.0, the median was 43.7, and the IQR was 41.1-44.6 fish/100 m/24 h (Figure 5.2-1). The annual mean CPUE fell within the overall IQR except in 2010 when it was below the IQR and in 2019 when it was above the IQR.

Small Mesh Index Gill Nets

The annual mean CPUE over the four years of monitoring ranged from a low of 38.2 in 2016 to a high of 109.1 fish/30 m/24 h in 2019 (Table 5.2-1; Figure 5.2-2).

The overall mean CPUE was 71.0, the median was 68.3, and the IQR was 50.8-88.4 fish/30 m/24 h (Figure 5.2-2). The annual mean CPUE fell within the overall IQR except in 2016 when it was below the IQR and in 2019 when it was above the IQR.

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

Catches of Northern Pike were relatively low in Eaglenest Lake over the four years of monitoring, with the annual mean ranging from a low of 2.5 in 2010 to a high of 4.3 fish/100 m/24 in 2019 (Table 5.2-1; Figure 5.2-3).

The overall mean CPUE was 3.6, the median was 3.8, and the IQR was 3.3-4.1 fish/100 m/24 (Figure 5.2-3). The annual mean CPUE fell within the overall IQR except in 2010 when it was below the IQR and in 2019 when it was above the IQR.

Sauger

The annual mean CPUE over the four years of monitoring was generally similar among years, with the mean ranging from a low of 4.2 in 2016 to a high of 4.8 fish/100 m/24 h in 2010 (Table 5.2-1; Figure 5.2-4).

The overall mean CPUE was 4.5, the median was 4.6, and the IQR was 4.5-4.6 fish/100 m/24 h (Figure 5.2-4). The annual mean CPUE fell within the overall IQR except in 2016 when it was below the IQR and in 2010 when it was above the IQR.

Walleye

The annual mean CPUE over the 12 years of monitoring varied by up to about two-fold, with the mean ranging from a low of 4.7 in 2016 to a high of 8.0 fish/100 m/24 h in 2019 (Table 5.2-1; Figure 5.2-5).

The overall mean CPUE was 6.9, the median was 7.5, and the IQR was 6.7-7.7 fish/100 m/24 h (Figure 5.2-5). The annual mean CPUE fell within the overall IQR except in 2016 when it was below the IQR and in 2019 when it was above the IQR.

White Sucker

The annual mean CPUE over the four years of monitoring was generally similar among years, with the mean ranging from a low of 5.0 in 2013 to a high of 6.2 fish/100 m/24 h in 2010 (Table 5.2-1; Figure 5.2-6).

The overall mean CPUE was 5.7, the median was 5.8, and the IQR was 5.6-5.9 fish/100 m/24 h (Figure 5.2-6). The annual mean CPUE fell within the overall IQR except in 2013 when it was below the IQR and in 2010 when it was above the IQR.

Table 5.2-1. 2008-2019 Catch-per-unit-effort.

Waterbody	Year	Small Mesh Catch[1]				Total Catch[2]				NRPK			SAUG			WALL			WHSC		
		n_S[3]	n_F[4]	Mean	SE[5]	n_S	n_F	Mean	SE	n_F	Mean	SE	n_F	Mean	SE	n_F	Mean	SE	n_F	Mean	SE
PDB	2008	3	124	46.6	18.9	9	413	39.8	5.8	20	1.9	0.7	101	9.4	2.6	62	6.2	1.5	157	15.3	3.7
	2009	3	33	10.6	3.1	7	411	49.7	14.3	12	1.5	0.4	87	10.4	3.3	55	6.7	1.6	161	19.3	10.3
	2010	4	100	22.8	5.9	10	265	21.2	2.7	13	1.1	0.3	35	2.8	0.5	35	2.8	0.7	100	8.1	1.7
	2011	4	568	135.2	55.1	10	613	50.4	8.7	18	1.4	0.4	61	4.9	1.7	48	3.9	1.1	194	15.8	3.9
	2012	4	617	144.6	39.0	10	401	33.2	2.6	9	0.7	0.2	106	8.8	1.3	43	3.5	0.9	108	8.9	1.1
	2013	4	573	121.6	47.6	10	631	49.0	7.1	42	3.3	0.9	111	8.6	2.5	61	4.6	1.6	114	8.8	2.4
	2014	3	236	74.2	40.5	9	286	28.9	5.3	22	2.1	0.7	80	8.1	1.9	30	3.1	0.9	62	6.4	2.3
	2015	4	242	56.8	22.9	10	415	34.6	3.4	15	1.3	0.4	88	7.4	1.8	46	3.9	0.8	97	8.0	1.6
	2016	4	183	41.1	10.0	10	415	33.7	5.4	21	1.8	0.5	66	5.1	1.5	31	2.6	0.5	71	5.6	1.1
	2017	4	352	80.0	29.8	10	413	33.8	4.2	15	1.2	0.4	83	6.8	1.2	42	3.4	0.8	110	9.0	1.7
	2018	4	314	73.0	21.7	10	461	37.8	3.3	18	1.4	0.5	62	5.0	0.9	35	2.9	0.8	98	8.0	1.6
	2019	4	493	111.8	40.7	10	612	52.1	6.6	21	1.7	0.5	104	9.0	2.6	70	6.1	1.9	122	10.5	1.7
LDB	2008	3	133	54.3	24.4	10	305	32.4	6.4	22	2.3	0.5	71	7.6	1.7	45	4.8	1.3	49	5.2	1.4
	2009	3	102	40.6	14.7	10	349	37.4	4.8	11	1.2	0.2	116	12.7	1.8	55	5.9	0.9	34	3.6	0.8
	2010	3	110	44.5	25.0	10	311	32.7	5.8	38	3.9	0.6	65	6.4	1.1	52	5.3	1.2	35	3.8	1.2
	2011	3	1131	388.3	151.2	10	412	42.2	7.5	32	3.1	0.7	78	8.2	2.0	65	6.5	1.2	48	4.9	1.0
	2012	3	553	194.3	153.2	10	488	50.1	4.4	58	5.9	1.0	86	8.9	1.7	122	12.4	2.2	31	3.1	0.7
	2013	3	1235	424.6	314.0	10	477	48.2	5.0	50	4.9	0.9	95	9.6	1.5	59	6.1	1.2	54	5.4	1.2
	2014	3	187	65.0	37.6	10	418	43.2	4.9	52	5.3	1.1	73	7.6	1.7	96	9.7	2.4	36	3.8	0.8
	2015	3	744	284.3	170.1	10	361	36.7	4.4	37	3.7	0.8	72	7.3	1.1	77	7.8	2.7	31	3.2	0.8
	2016	3	68	25.4	3.8	10	413	42.4	5.7	35	3.5	0.6	113	11.4	2.3	57	5.7	1.1	36	3.7	0.7
	2017	3	311	110.9	68.5	8	320	37.7	3.5	36	4.2	0.8	80	9.4	2.1	54	6.4	2.0	32	3.8	0.6
	2018	3	497	178.8	61.5	10	443	44.4	8.1	35	3.5	0.6	96	9.6	2.5	64	6.3	1.2	45	4.7	1.2
	2019	3	525	183.9	113.8	10	531	51.1	7.4	45	4.3	0.6	72	6.9	1.3	81	7.8	2.2	69	6.7	1.9
PFF	2011	3	10	3.5	2.2	9	194	18.4	2.7	5	0.5	0.2	10	0.9	0.3	22	2.0	0.7	16	1.5	0.3
	2014	3	20	8.3	1.7	9	312	35.3	11.8	6	0.7	0.4	21	2.3	0.9	49	5.8	1.5	24	2.9	0.8
	2017	3	27	9.0	4.1	9	256	24.6	4.4	11	1.1	0.4	26	2.5	0.8	28	2.7	0.5	28	2.7	0.5

Table 5.2-1. continued.

Waterbody	Year	Small Mesh Catch[1]				Total Catch[2]				NRPK[2]			SAUG[2]			WALL[2]			WHSC[2]		
		n_S[3]	n_F[4]	Mean	SE[5]	n_S	n_F	Mean	SE	n_F	Mean	SE	n_F	Mean	SE	n_F	Mean	SE	n_F	Mean	SE
MANIG	2008	2	13	8.4	5.9	6	343	68.0	8.0	13	2.4	1.1	-	-	-	130	23.5	9.8	26	4.9	2.2
	2009	2	5	3.0	1.1	6	281	50.3	6.1	13	2.0	1.3	-	-	-	96	16.2	6.6	20	3.4	1.7
	2010	2	40	24.4	12.2	5	271	59.5	19.4	11	2.1	1.1	-	-	-	114	23.1	10.2	10	2.1	0.8
	2011	2	5	2.6	0.4	6	289	46.5	5.6	19	2.9	0.9	-	-	-	97	15.6	5.9	11	1.7	0.7
	2012	2	142	71.4	50.5	5	290	51.2	5.2	22	3.8	1.7	-	-	-	105	18.6	7.3	24	4.3	2.0
	2013	2	56	27.5	18.7	6	294	43.0	7.8	23	3.3	1.0	-	-	-	77	11.0	3.3	22	3.1	1.1
	2014	2	25	12.6	2.3	6	366	53.7	6.2	27	3.9	1.5	-	-	-	106	15.3	6.0	21	3.0	1.4
	2015	2	39	19.3	12.9	6	437	65.2	11.0	18	2.6	1.0	-	-	-	97	14.1	5.0	21	3.0	1.4
	2016	2	16	8.1	3.6	6	437	63.9	4.7	30	4.4	1.6	-	-	-	104	15.5	6.0	33	4.9	2.0
	2017	2	10	4.6	3.3	6	387	53.6	11.0	27	3.8	1.4	-	-	-	117	16.3	5.2	31	4.4	1.9
	2018	2	102	45.5	32.2	6	479	66.7	9.5	29	3.9	1.4	-	-	-	139	19.2	5.3	58	8.0	3.1
	2019	2	25	12.8	9.0	6	308	45.3	9.0	15	2.2	1.0	-	-	-	118	17.0	5.0	52	7.4	2.8
EAGLE	2010	3	185	55.0	22.8	11	483	35.5	3.9	34	2.5	0.4	65	4.8	0.9	102	7.6	1.8	84	6.2	1.3
	2013	4	331	81.6	3.5	11	579	44.4	3.3	52	4.0	0.5	60	4.6	1.0	95	7.3	1.2	65	5.0	1.3
	2016	4	156	38.2	15.4	12	593	43.0	5.0	51	3.6	0.7	58	4.2	1.1	64	4.7	0.6	79	5.9	1.7
	2019	4	450	109.1	35.1	12	640	45.0	4.2	61	4.3	0.9	65	4.6	1.2	114	8.0	1.6	83	5.8	0.9

Notes:

1. fish/30 m/24 h.
2. fish/100 m/24 h.
3. nS = number of sites fished (excludes sets > 36 h).
4. nF = number of fish caught.
5. SE = standard error.

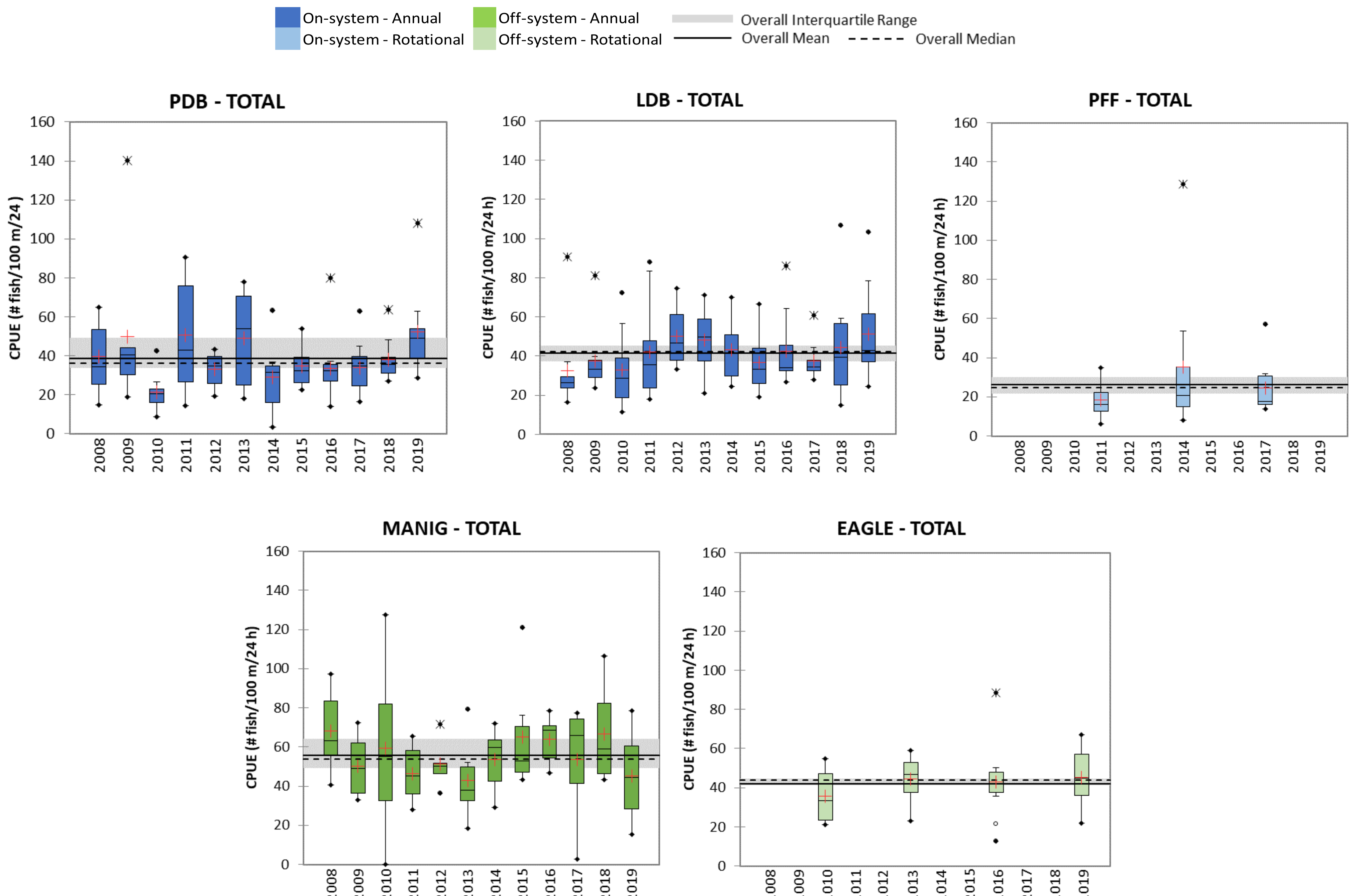


Figure 5.2-1. 2008-2019 Catch-per-unit-effort (CPUE) of standard gang index gill nets.

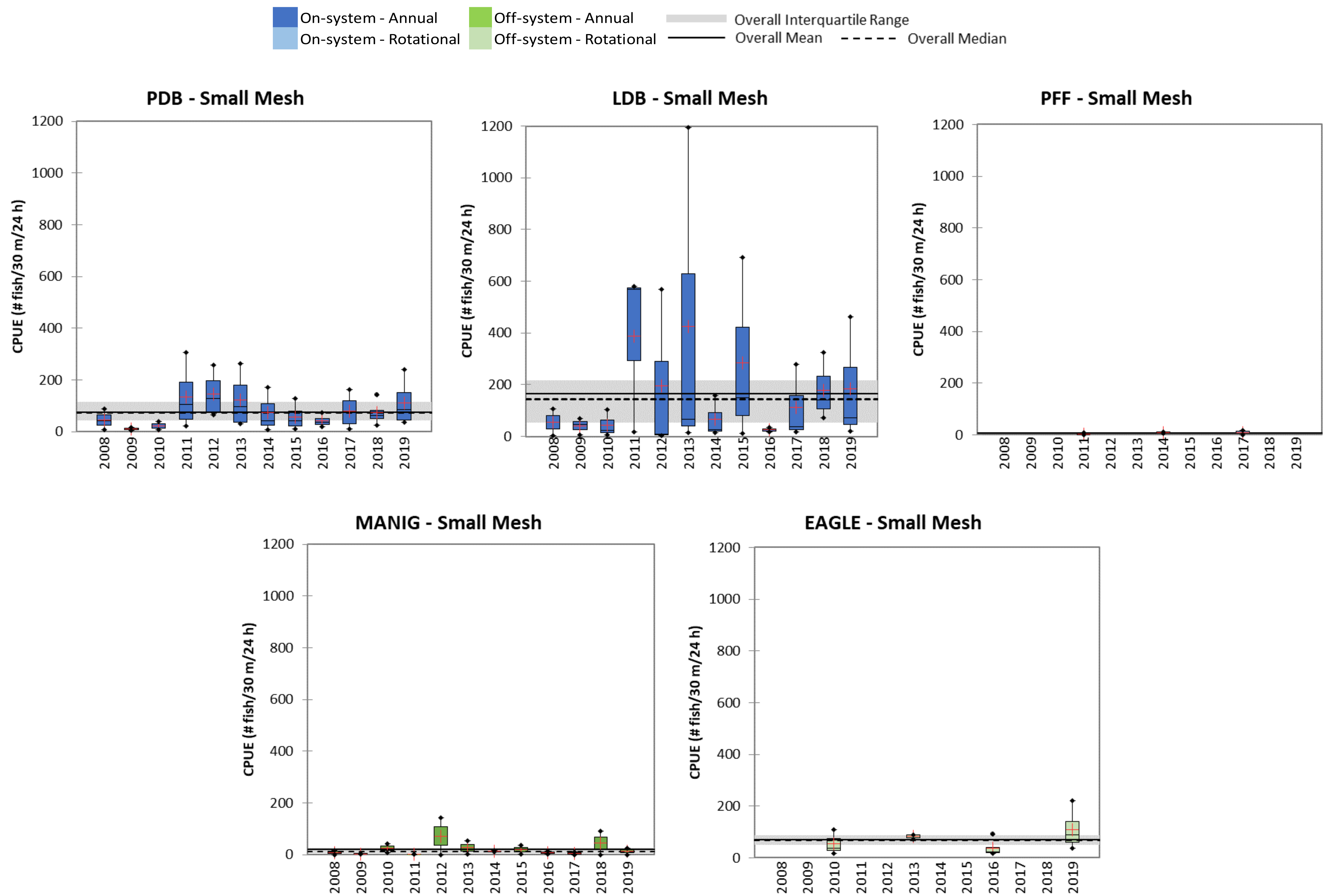


Figure 5.2-2. 2008-2019 Catch-per-unit-effort (CPUE) of small mesh index gill nets.

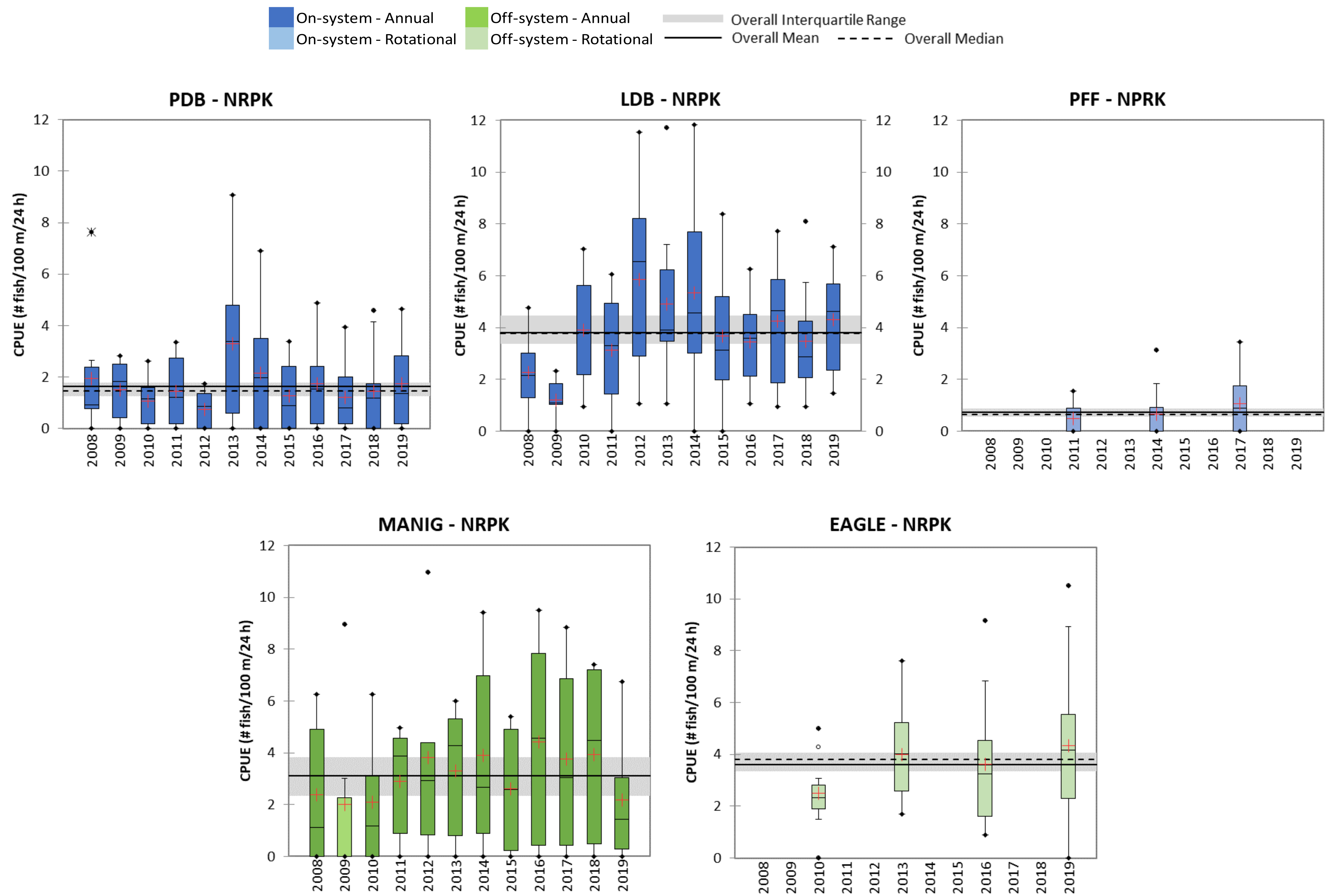


Figure 5.2-3. 2008-2019 Catch-per-unit-effort (CPUE) of Northern Pike.

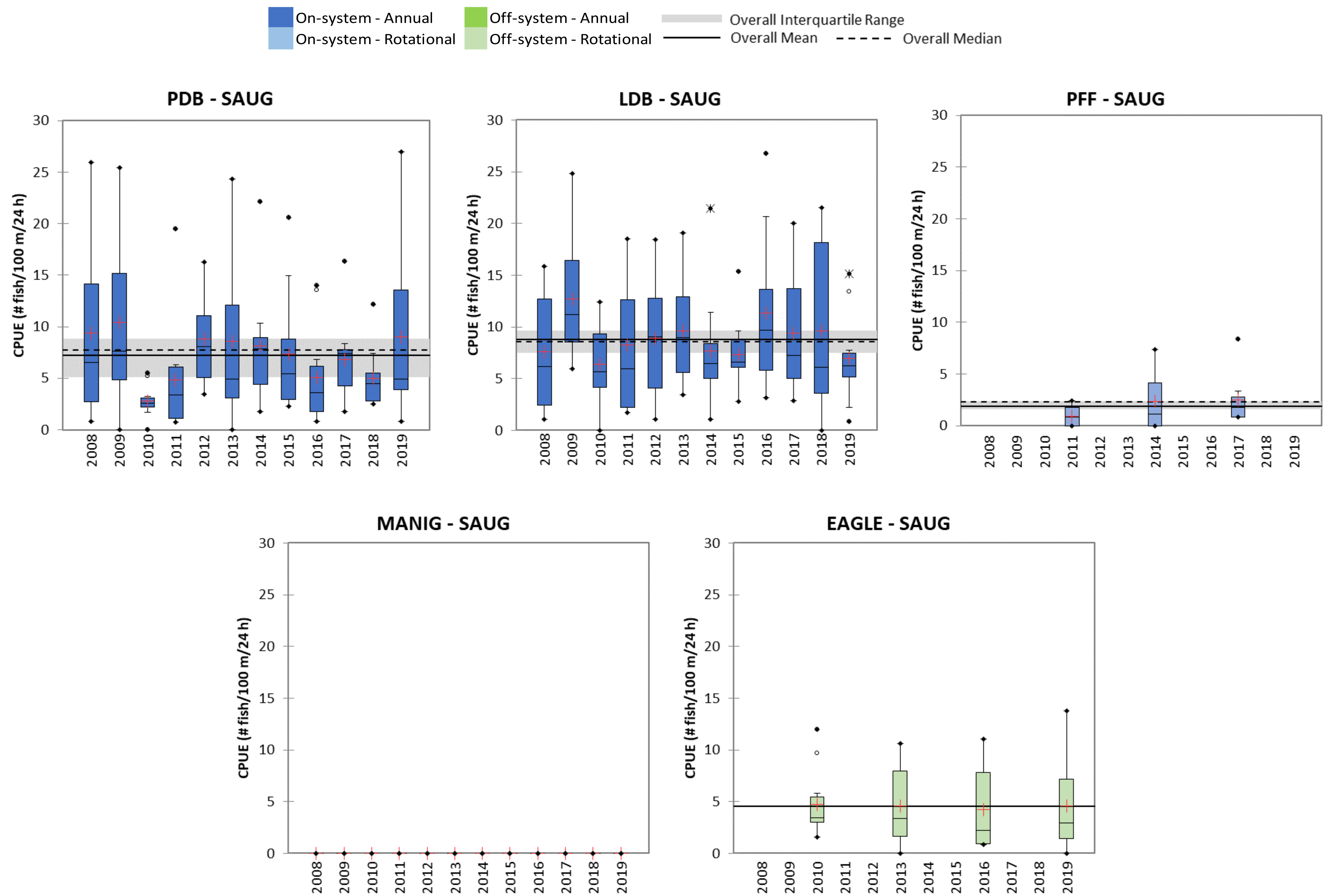


Figure 5.2-4. 2008-2019 Catch-per-unit-effort (CPUE) of Sauger.

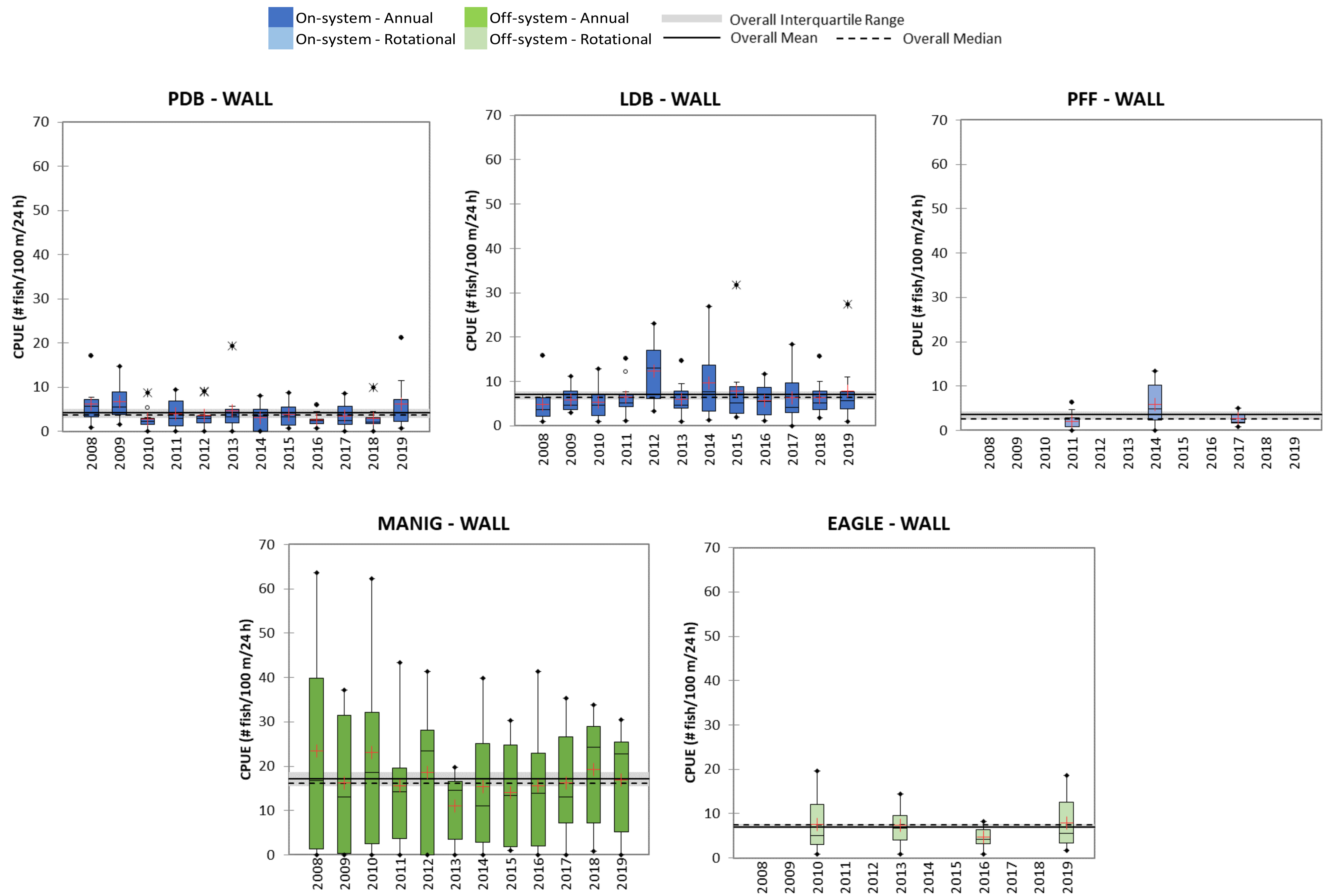


Figure 5.2-5. 2008-2019 Catch-per-unit-effort (CPUE) of Walleye.

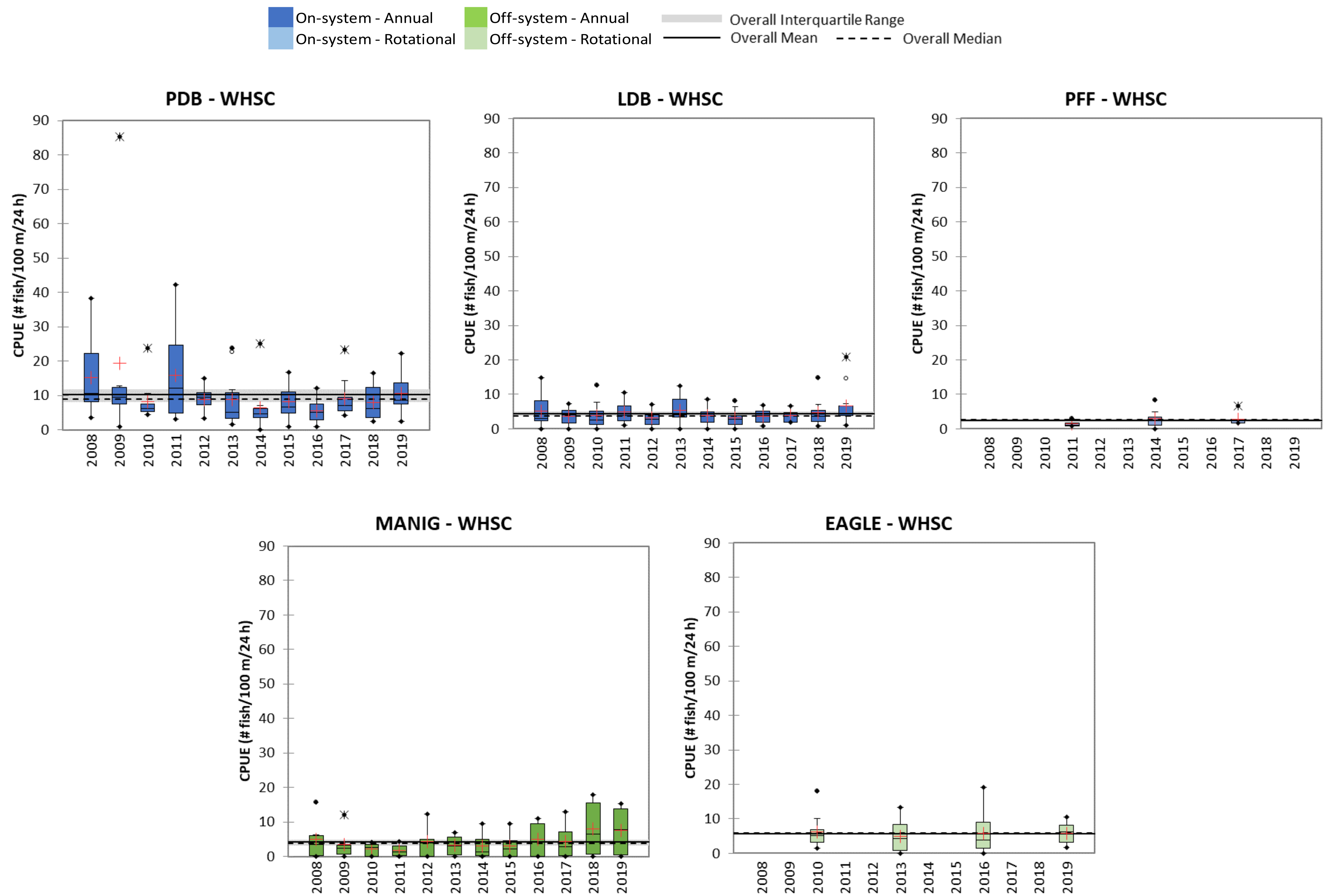


Figure 5.2-6. 2008-2019 Catch-per-unit-effort (CPUE) of White Sucker.

5.3 CONDITION

5.3.1 FULTON'S CONDITION FACTOR

5.3.1.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean KF of Northern Pike between 400 and 699 mm in fork length over the 12 years of monitoring ranged from a low of 0.60 in 2010 to a high of 0.71 in 2016 (Table 5.3-1; Figure 5.3-1).

The overall mean KF was 0.67, the median was 0.68, and the IQR was 0.65-0.69 (Figure 5.3-1). The annual mean KF fell within the overall IQR except in 2009, 2010, and 2011 when it was below the IQR and in 2016 when it was above the IQR.

Sauger

The annual mean KF of Sauger between 200 and 349 mm in fork length over the 12 years of monitoring ranged from a low of 0.87 in 2009 to a high of 1.05 in 2011 (Table 5.3-1; Figure 5.3-2).

The overall mean and median KF were 0.95 and the IQR was 0.89-0.99 (Figure 5.3-2). The annual mean KF fell within the overall IQR except in 2009 and 2018 when it was below the IQR and in 2008, 2011, and 2012 when it was above the IQR.

Walleye

The annual mean KF of Walleye between 300 and 499 mm in fork length over the 12 years of monitoring ranged from a low of 1.09 in 2010 to a high of 1.20 in 2008 (Table 5.3-1; Figure 5.3-3).

The overall mean and median KF were 1.14 and the IQR was 1.11-1.16 (Figure 5.3-3). The annual mean KF fell within the overall IQR except in 2009, 2010, and 2018 when it was below the IQR and in 2008, 2011, and 2016 when it was above the IQR.

White Sucker

The annual mean KF of White Sucker between 300 and 499 mm in fork length over the 10 years of monitoring that it was a target species ranged from a low of 1.46 in 2010 to a high of 1.63 in 2011 and 2012 (Table 5.3-1; Figure 5.3-4).

The overall mean KF was 1.59, the median was 1.60, and the IQR was 1.59-1.63 (Figure 5.3-4). The annual mean KF fell within the overall IQR except in 2010 and 2018 when it was below the IQR.

Lac du Bonnet

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean KF of Northern Pike between 400 and 699 mm in fork length over the 12 years of monitoring ranged from a low of 0.64 in 2009 to a high of 0.75 in 2011 (Table 5.3-1; Figure 5.3-1).

The overall mean and median KF were 0.70 and the IQR was 0.67-0.73 (Figure 5.3-1). The annual mean KF fell within the overall IQR except in 2008, 2009, and 2017 when it was below the IQR and in 2011 and 2012 when it was above the IQR.

Sauger

The annual mean KF of Sauger between 200 and 349 mm in fork length over the 12 years of monitoring ranged from a low of 0.90 in 2015 to a high of 1.00 in 2012 (Table 5.3-1; Figure 5.3-2).

The overall mean KF was 0.94, the median was 0.93, and the IQR was 0.91-0.94 (Figure 5.3-2). The annual mean KF fell within the overall IQR except in 2015 when it was below the IQR and in 2012 and 2014 when it was above the IQR.

Walleye

The annual mean KF of Walleye between 300 and 499 mm in fork length over the 12 years of monitoring ranged from a low of 1.10 in 2016 to a high of 1.17 in 2013 (Table 5.3-1; Figure 5.3-3).

The overall mean and median KF were 1.14 and the IQR was 1.12-1.16 (Figure 5.3-3). The annual mean KF fell within the overall IQR except in 2008, 2015, and 2016 when it was below the IQR and in 2013 when it was above the IQR.

White Sucker

Individual White Sucker were only measured for length and weight sporadically at Lac du Bonnet and KF is only available for 2010, 2016, 2018, and 2019 (Table 5.3-1). The annual mean KF of White Sucker between 300 and 499 mm in fork length ranged from a low of 1.59 in 2010 and 2018 to a high of 1.65 in 2019 (Table 5.3-1; Figure 5.3-4).

The overall mean KF was 1.62, the median was 1.63, and the IQR was 1.59-1.65 (Figure 5.3-4). The annual mean KF fell within the overall IQR except in 2008 when it was above the IQR.

ROTATIONAL SITES

Pine Falls Forebay

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean KF of Northern Pike between 400 and 699 mm in fork length over the three years of monitoring ranged from a low of 0.64 in 2014 to a high of 0.66 in 2017 (Table 5.3-1; Figure 5.3-1).

The overall mean and median KF were 0.65 and the IQR was 0.64-0.66 (Figure 5.3-1). The annual mean KF was equal to or fell within the overall IQR in all three years.

Sauger

Sauger between 200 and 349 mm in fork length had an annual mean KF of 0.97 in 2017 (Table 5.3-1; Figure 5.3-2). Sauger was not a target species in the Pine Falls forebay prior to 2017.

Walleye

The annual mean KF of Walleye between 300 and 499 mm in fork length over the three years of monitoring ranged from a low of 1.01 in 2014 to a high of 1.13 in 2017 (Table 5.3-1; Figure 5.3-3).

The overall mean KF was 1.07, the median was 1.12, and the IQR was 1.01-1.12 (Figure 5.3-3). The annual mean KF fell within or was equal to the overall IQR except in 2017 when it was above the IQR.

White Sucker

The annual mean KF of White Sucker between 300 and 499 mm in fork length over the three years of monitoring was 1.48 in 2011 and 2014 and 1.59 in 2017 (Table 5.3-1; Figure 5.3-4).

The overall mean KF was 1.52, the median was 1.48, and the IQR was 1.48-1.59 (Figure 5.3-4). The annual mean KF was equal to or fell within the overall IQR in all three years.

5.3.1.2 OFF-SYSTEM SITES

ANNUAL SITES

<u>Manigotagan Lake</u>

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean KF of Northern Pike between 400 and 699 mm in fork length over the 12 years of monitoring ranged from a low of 0.55 in 2010 to a high of 0.72 in 2019 (Table 5.3-1; Figure 5.3-1).

The overall mean KF was 0.67, the median was 0.68, and the IQR was 0.66-0.69 (Figure 5.3-1). The annual mean KF fell within the overall IQR except in 2008, 2010, and 2011 when it was below the IQR and in 2017 and 2019 when it was above the IQR.

Sauger

Sauger were not captured in Manigotagan Lake over the 12 years of monitoring (Table 5.3-1).

Walleye

The annual mean KF of Walleye between 300 and 499 mm in fork length over the 12 years of monitoring ranged from a low of 1.02 in 2014 to a high of 1.10 in 2012 (Table 5.3-1; Figure 5.3-3).

The overall mean and median KF were 1.07 and the IQR was 1.07-1.08 (Figure 5.3-3). The annual mean KF fell within the overall IQR except in 2011, 2013, and 2014 when it was below the IQR and in 2012 when it was above the IQR.

White Sucker

The annual mean KF of White Sucker between 300 and 499 mm in fork length over the 10 years of monitoring that it was a target species ranged from a low of 1.47 in 2010 to a high of 1.65 in 2015 (Table 5.3-1; Figure 5.3-4).

The overall mean and median KF were 1.57 and the IQR was 1.57-1.62 (Figure 5.3-4). The annual mean KF fell within the overall IQR except in 2010, 2011, 2013, and 2014 when it was below the IQR and in 2015 when it was above the IQR.

ROTATIONAL SITES

Eaglenest Lake

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean KF of Northern Pike between 400 and 699 mm in fork length over the four years of monitoring ranged from a low of 0.68 in 2019 to a high of 0.70 in 2013 (Table 5.3-1; Figure 5.3-1).

The overall mean and median KF were 0.69 and the IQR was 0.68-0.70 (Figure 5.3-1). The annual mean KF was equal to or fell within the overall IQR in all three years.

Sauger

The annual mean KF of Sauger between 200 and 349 mm in fork length was 0.97 in 2016 and 0.90 in 2019 (Table 5.3-1; Figure 5.3-2). Sauger was not a target species in Eaglenest Lake prior to 2016.

Walleye

The annual mean KF of Walleye between 300 and 499 mm in fork length over the four years of monitoring ranged from a low of 1.10 in 2010 to a high of 1.17 in 2013 (Table 5.3-1; Figure 5.3-3).

The overall mean KF was 1.13, the median was 1.12, and the IQR was 1.10-1.17 (Figure 5.3-3). The annual mean KF was equal to or fell within the overall IQR in all four years.

White Sucker

The annual mean KF of White Sucker between 300 and 499 mm in fork length over the four years of monitoring ranged from a low of 1.48 in 2010 to a high of 1.72 in 2016 (Table 5.3-1; Figure 5.3-4).

The overall mean KF was 1.61, the median was 1.63, and the IQR was 1.48-1.72 (Figure 5.3-4). The annual mean KF was equal to or fell within the overall IQR in all four years.

Table 5.3-1. 2008-2019 Fulton's condition factor of target species.

Waterbody	Year	NRPK			SAUG			WALL			WHSC		
		n_F[1]	Mean	SE[2]	n_F	Mean	SE	n_F	Mean	SE	n_F	Mean	SE
PDB	2008	12	0.66	0.03	78	1.05	0.01	27	1.20	0.02			
	2009	20	0.63	0.02	110	0.87	0.01	40	1.10	0.02			
	2010	10	0.60	0.03	33	0.92	0.01	19	1.09	0.02	95	1.46	0.01
	2011	14	0.63	0.03	57	1.05	0.02	23	1.17	0.02	183	1.63	0.01
	2012	5	0.68	0.05	120	1.02	0.01	21	1.16	0.02	95	1.63	0.01
	2013	39	0.69	0.01	115	0.99	0.01	33	1.14	0	93	1.59	0.01
	2014	19	0.69	0.02	90	0.90	0.01	16	1.11	0	58	1.59	0.02
	2015	14	0.68	0.01	117	0.89	0.01	25	1.14	0	87	1.60	0.01
	2016	16	0.71	0.02	80	0.94	0.01	22	1.18	0	62	1.60	0.02
	2017	9	0.65	0.02	87	0.97	0.01	22	1.16	0	89	1.60	0.01
	2018	9	0.68	0.03	77	0.88	0.01	16	1.09	0.02	78	1.55	0.02
	2019	14	0.66	0.01	109	0.95	0.01	43	1.13	0.02	110	1.61	0.01
LDB	2008	10	0.66	0.02	84	0.91	0.02	17	1.11	0.02			
	2009	9	0.64	0.02	133	0.93	0.01	18	1.12	0.01			
	2010	27	0.73	0.01	72	0.92	0.01	23	1.15	0.02	32	1.59	0.02
	2011	18	0.75	0.02	81	0.91	0.01	24	1.14	0.02			
	2012	35	0.74	0.01	90	1.00	0.01	83	1.16	0.01			
	2013	32	0.72	0.01	102	0.94	0.01	31	1.17	0.02			
	2014	33	0.73	0.02	74	1.00	0.01	48	1.15	0.01			
	2015	27	0.68	0.02	76	0.90	0.02	43	1.11	0.02			
	2016	28	0.67	0.01	64	0.91	0.01	35	1.10	0.01	32	1.63	0.02
	2017	29	0.66	0.01	80	0.93	0.01	40	1.13	0.01			
	2018	23	0.68	0.01	106	0.94	0.01	40	1.12	0.01	36	1.59	0.03
	2019	32	0.70	0.01	82	0.94	0.01	47	1.14	0.01	59	1.65	0.02
PFF	2011	5	0.65	0.03				16	1.12	0.02	15	1.48	0.04
	2014	7	0.64	0.03				21	1.01	0.03	18	1.48	0.04
	2017	7	0.66	0.01	26	0.97	0.02	10	1.13	0.03	16	1.59	0.04
MANIG	2008	11	0.59	0.02	-	-	-	46	1.07	0.01			
	2009	12	0.66	0.03	-	-	-	31	1.08	0.02			
	2010	9	0.55	0.04	-	-	-	95	1.07	0.01	11	1.47	0.02
	2011	16	0.62	0.02	-	-	-	63	1.05	0.01	11	1.50	0.03
	2012	22	0.68	0.01	-	-	-	79	1.10	0.01	26	1.57	0.02
	2013	28	0.69	0.01	-	-	-	38	1.03	0.01	21	1.53	0.01
	2014	28	0.69	0.01	-	-	-	50	1.02	0.01	20	1.54	0.02
	2015	19	0.66	0.02	-	-	-	58	1.07	0.01	19	1.65	0.08
	2016	27	0.68	0.01	-	-	-	62	1.07	0.01	31	1.57	0.03
	2017	25	0.70	0.02	-	-	-	65	1.08	0.01	28	1.60	0.02
	2018	26	0.68	0.01	-	-	-	74	1.07	0.01	51	1.57	0.02
	2019	12	0.72	0.02	-	-	-	71	1.10	0.01	48	1.62	0.02
EAGLE	2010	17	0.70	0.02				64	1.10	0.01	80	1.48	0.01
	2013	35	0.70	0.01				62	1.17	0.01	51	1.62	0.02
	2016	29	0.69	0.02	62	0.97	0.03	35	1.15	0.03	71	1.72	0.02
	2019	33	0.68	0.01	82	0.90	0.01	43	1.12	0.01	72	1.63	0.01

Notes:

1. n_F = number of fish measured for length and weight.
2. SE = standard error.
3. Grey shading indicates a species was not a target species in that year.

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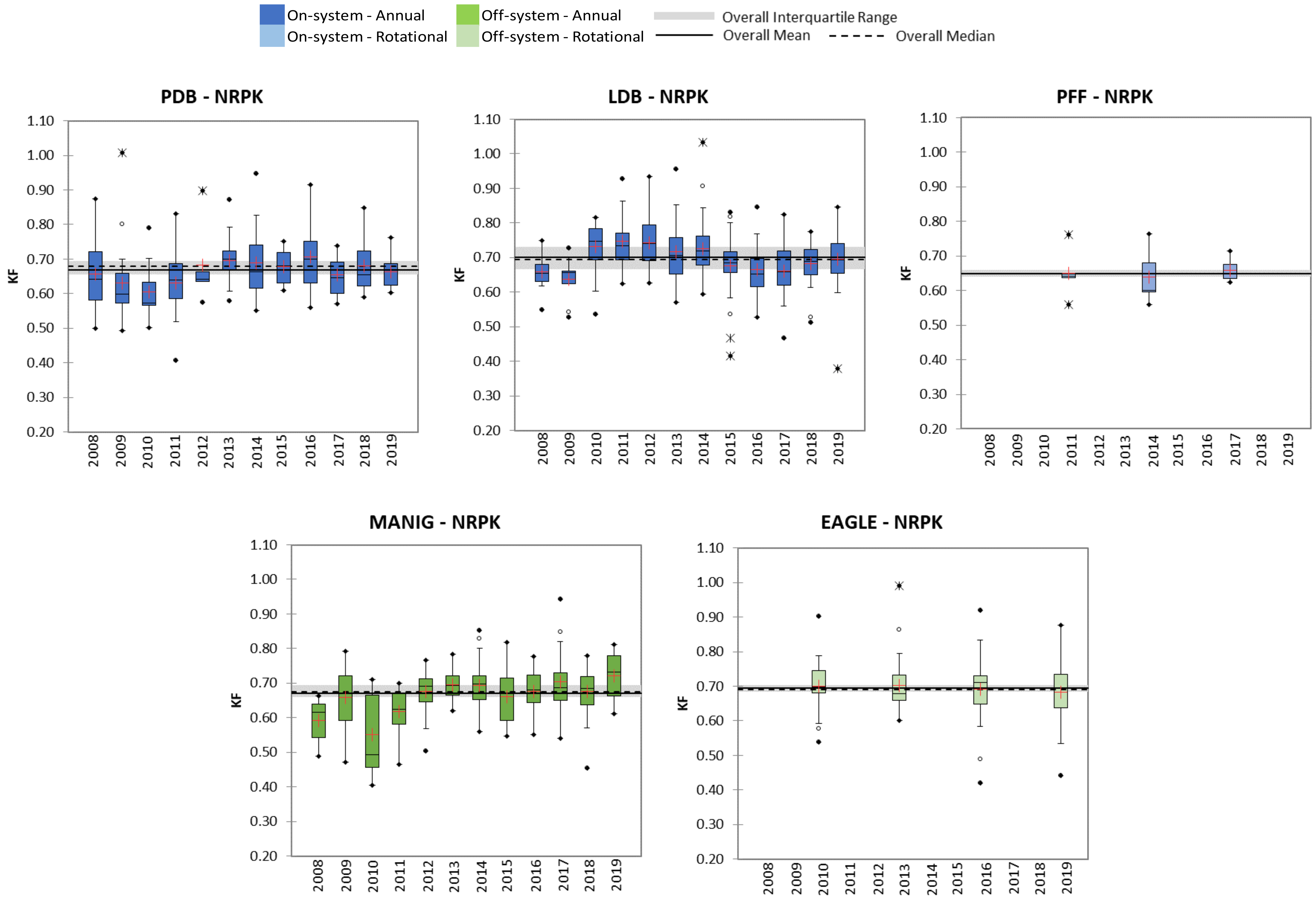


Figure 5.3-1. 2008-2019 Fulton's condition factor (KF) of Northern Pike.

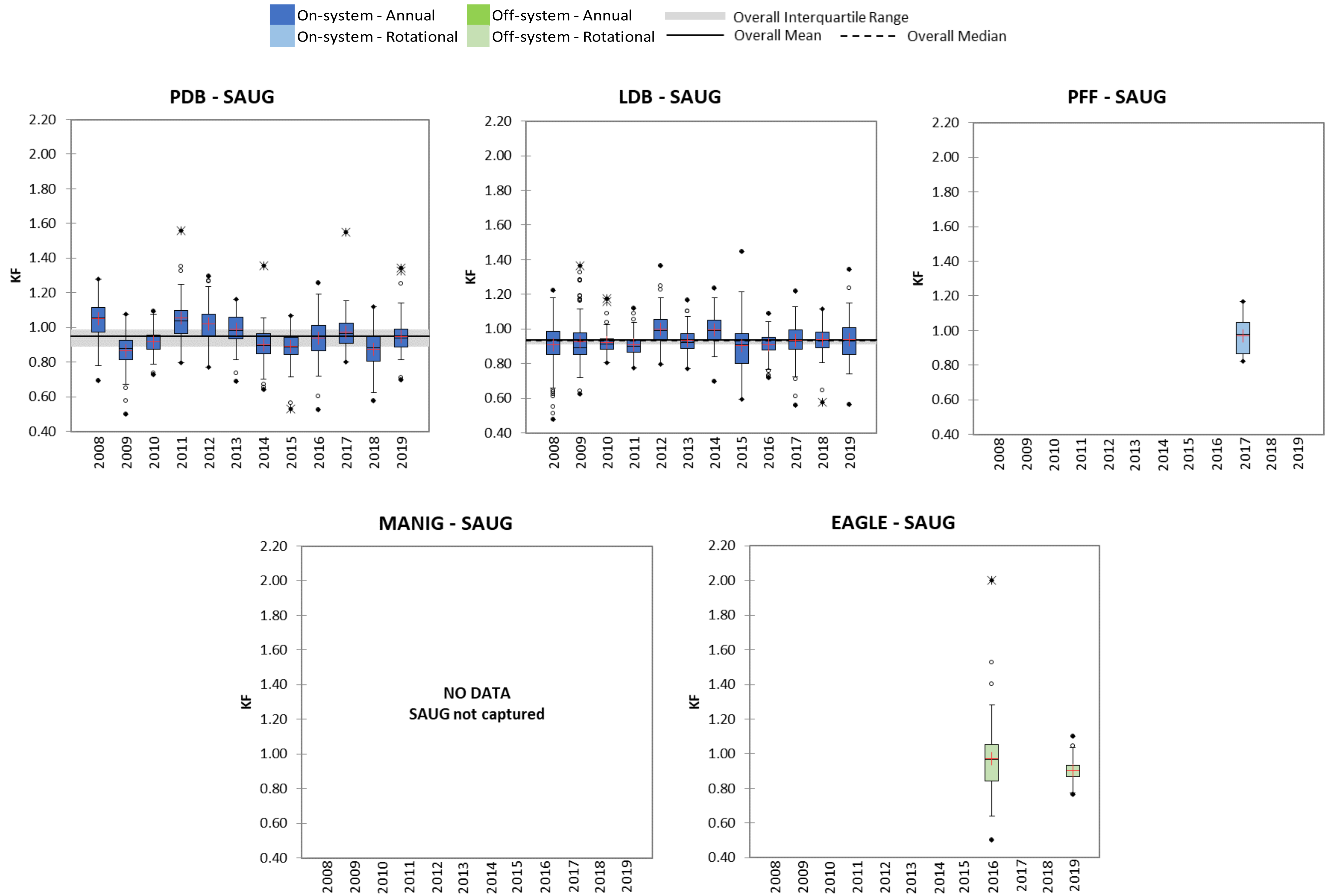


Figure 5.3-2. 2008-2019 Fulton's condition factor (KF) of Sauger.

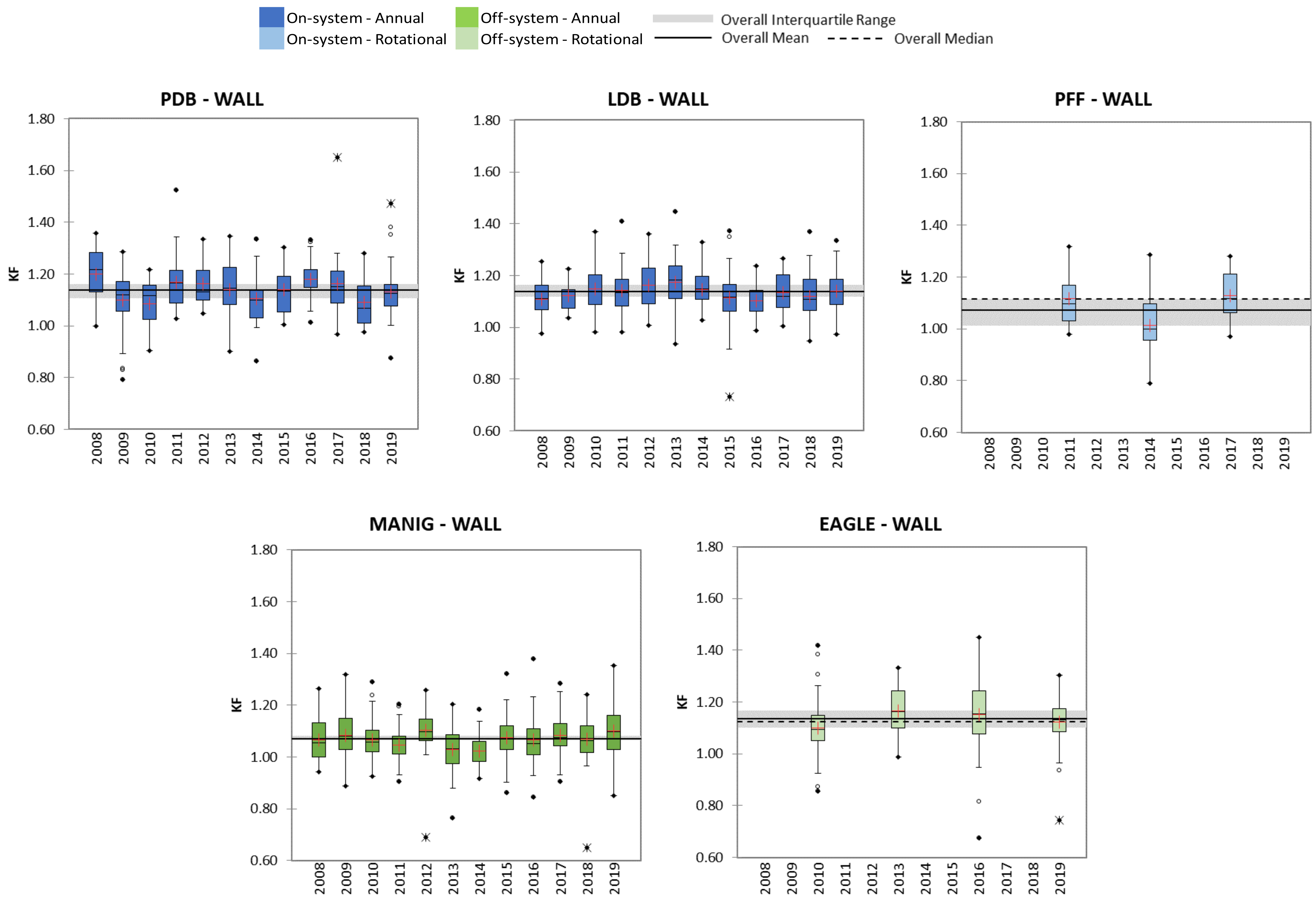


Figure 5.3-3. 2008-2019 Fulton's condition factor (KF) of Walleye.

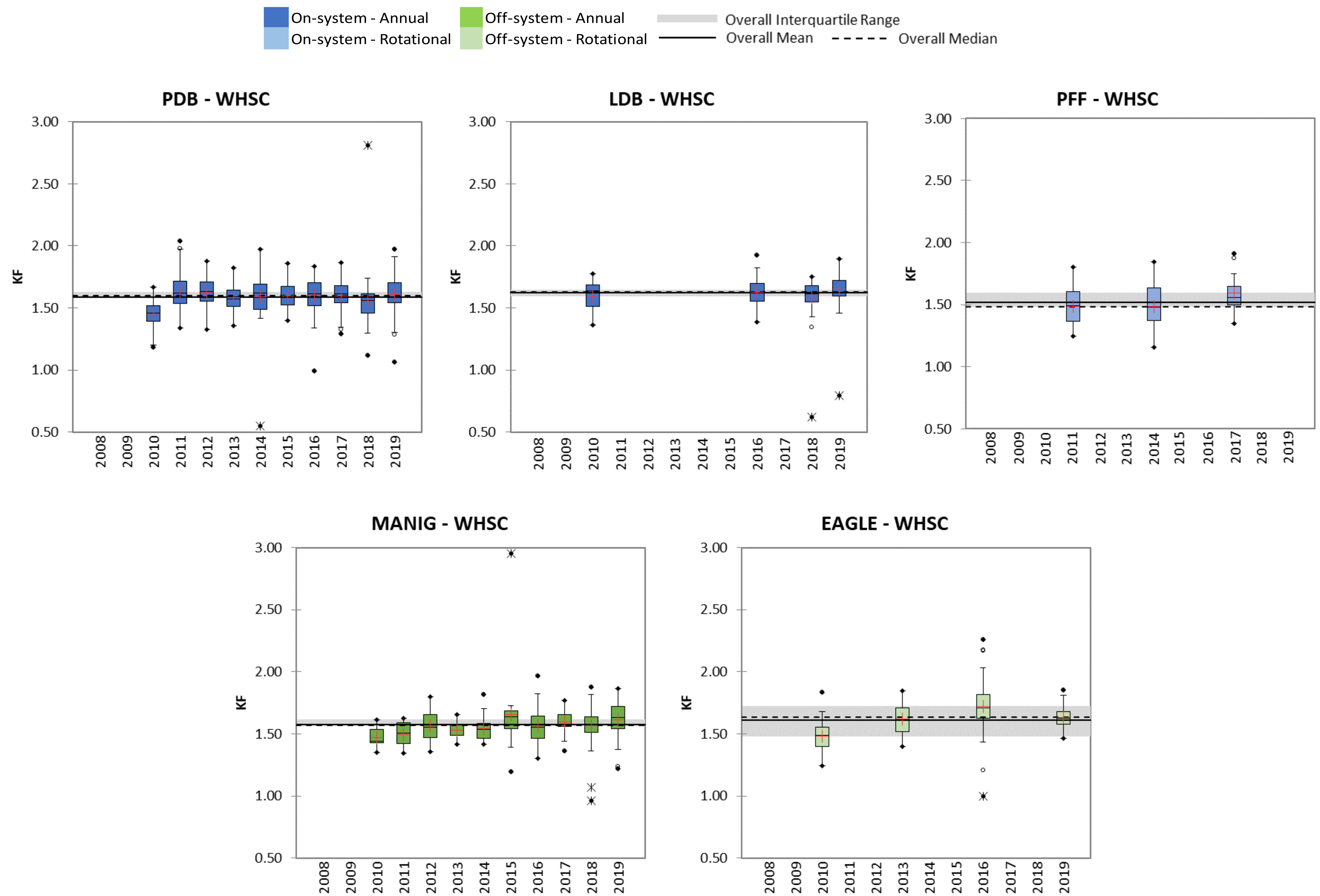


Figure 5.3-4. 2008-2019 Fulton's condition factor (KF) of White Sucker.

5.3.2 RELATIVE WEIGHT

5.3.2.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean Wr of Northern Pike greater than 99 mm in total length over the 12 years of monitoring ranged from a low of 77 in 2010 to a high of 89 in 2016 (Table 5.3-2; Figure 5.3-5).

The overall mean Wr was 85, the median was 86, and the IQR was 83-87 (Figure 5.3-5). The annual mean Wr fell within the overall IQR except in 2010 and 2011 when it was below the IQR and in 2016 when it was above the IQR.

Sauger

The annual mean Wr of Sauger greater than 69 mm in total length over the 12 years of monitoring ranged from a low of 81 in 2009 to a high of 104 in 2008 (Table 5.3-2; Figure 5.3-6).

The overall mean Wr was 90, the median was 91, and the IQR was 84-92 (Figure 5.3-6). The annual mean Wr fell within the overall IQR except in 2009 when it was below the IQR and in 2008, 2011, and 2012 when it was above the IQR.

Walleye

The annual mean Wr of Walleye greater than 29 mm in total length over the 12 years of monitoring ranged from a low of 84 in 2010 to a high of 98 in 2008 (Table 5.3-2; Figure 5.3-7).

The overall mean and median Wr were 90 and the IQR was 89-92 (Figure 5.3-7). The annual mean Wr fell within the overall IQR except in 2009, 2010, and 2018 when it was below the IQR and in 2008 and 2016 when it was above the IQR.

White Sucker

The annual mean Wr of White Sucker greater than 99 mm in total length over the 10 years of monitoring that it was a target species ranged from a low of 94 in 2010 to a high of 105 in 2011 (Table 5.3-2; Figure 5.3-8).

The overall mean and median Wr were 102 and the IQR was 101-104 (Figure 5.3-8). The annual mean Wr fell within the overall IQR except in 2010 and 2018 when it was below the IQR and in 2011 when it was above the IQR.

Lac du Bonnet

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean Wr of Northern Pike greater than 99 mm in total length over the 12 years of monitoring ranged from a low of 80 in 2017 to a high of 91 in 2011 (Table 5.3-2; Figure 5.3-5).

The overall mean Wr was 87, the median was 88, and the IQR was 83-89 (Figure 5.3-5). The annual mean Wr fell within the overall IQR except in 2009, 2016, and 2017 when it was below the IQR and in 2011 and 2012 when it was above the IQR.

Sauger

The annual mean Wr of Sauger greater than 69 mm in total length over the 12 years of monitoring ranged from a low of 86 in 2011 to a high of 95 in 2014 (Table 5.3-2; Figure 5.3-6).

The overall mean Wr was 89, the median was 88, and the IQR was 88-89 (Figure 5.3-6). The annual mean Wr fell within the overall IQR except in 2008, 2011, and 2015 when it was below the IQR and in 2012, 2014, and 2019 when it was above the IQR.

Walleye

The annual mean Wr of Walleye greater than 29 mm in total length over the 12 years of monitoring ranged from a low of 84 in 2018 to a high of 95 in 2019 (Table 5.3-2; Figure 5.3-7).

The overall mean Wr was 90, the median was 92, and the IQR was 88-93 (Figure 5.3-7). The annual mean Wr fell within the overall IQR except in 2013 and 2018 when it was below the IQR and in 2012 and 2019 when it was above the IQR.

White Sucker

Individual White Sucker were only measured for length and weight sporadically at Lac du Bonnet and Wr is only available for 2010, 2016, 2018, and 2019 (Table 5.3-2). The annual mean Wr of White Sucker greater than 99 mm in total length ranged from a low of 102 in 2018 to a high of 109 in 2016 and 2019 (Table 5.3-2; Figure 5.3-8).

The overall mean Wr was 104, the median was 105, and the IQR was 103-105 (Figure 5.3-8). The annual mean Wr fell within the overall IQR except in 2018 when it was below the IQR.

ROTATIONAL SITES

<u>Pine Falls Forebay</u>

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean Wr of Northern Pike greater than 99 mm in total length over the three years of monitoring ranged from a low of 79 in 2014 to a high of 84 in 2017 (Table 5.3-2; Figure 5.3-5).

The overall mean Wr was 82, the median was 80, and the IQR was 79-84 (Figure 5.3-5). The annual mean Wr was equal to or fell within the overall IQR in all three years.

Sauger

Sauger greater than 69 mm in total length had an annual mean Wr of 92 in 2017 (Table 5.3-2; Figure 5.3-6). Sauger was not a target species in the Pine Falls Forebay prior to 2017.

Walleye

The annual mean Wr of Walleye greater than 29 mm in total length over the three years of monitoring ranged from a low of 80 in 2014 to a high of 93 in 2017 (Table 5.3-2; Figure 5.3-7).

The overall mean Wr was 87, the median was 93, and the IQR was 80-93 (Figure 5.3-7). The annual mean Wr was equal to or fell within the overall IQR in all three years.

White Sucker

The annual mean Wr of White Sucker greater than 99 mm in total length over the three years of monitoring ranged from a low of 94 in 2014 to a high of 104 in 2017 (Table 5.3-2; Figure 5.3-8).

The overall mean Wr was 99, the median was 96, and the IQR was 94-104 (Figure 5.3-8). The annual mean Wr was equal to or fell within the overall IQR in all three years.

5.3.2.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean Wr of Northern Pike greater than 99 mm in total length over the 12 years of monitoring ranged from a low of 71 in 2010 to a high of 88 in 2019 (Table 5.3-2; Figure 5.3-5).

The overall mean and median Wr were 83 and the IQR was 81-86 (Figure 5.3-5). The annual mean Wr fell within the overall IQR except in 2008, 2010, and 2011 when it was below the IQR and in 2017 and 2019 when it was above the IQR.

Sauger

Sauger were not captured in Manigotagan Lake over the 12 years of monitoring (Table 5.3-2).

Walleye

The annual mean Wr of Walleye greater than 29 mm in total length over the 12 years of monitoring ranged from a low of 80 in 2008 to a high of 87 in 2019 (Table 5.3-2; Figure 5.3-7).

The overall mean Wr was 84, the median was 83, and the IQR was 82-86 (Figure 5.3-7). The annual mean Wr fell within the overall IQR except in 2008 and 2013 when it was below the IQR and in 2019 when it was above the IQR.

White Sucker

The annual mean Wr of White Sucker greater than 99 mm in total length over the 10 years of monitoring that it was a target species ranged from a low of 95 in 2010 to a high of 106 in 2015 (Table 5.3-2; Figure 5.3-8).

The overall mean Wr was 102, the median was 101, and the IQR was 101-105 (Figure 5.3-8). The annual mean Wr fell within the overall IQR except in 2010, 2011, 2013, and 2014 when it was below the IQR and in 2015 when it was above the IQR.

ROTATIONAL SITES

Eaglenest Lake

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean Wr of Northern Pike greater than 99 mm in total length over the four years of monitoring ranged from a low of 85 in 2019 to a high of 89 in 2010 (Table 5.3-2; Figure 5.3-5).

The overall mean and median Wr were 86 and the IQR was 85-87 (Figure 5.3-5). The annual mean Wr fell within the overall IQR except in 2010 when it was above the IQR.

Sauger

The annual mean Wr of Sauger greater than 69 mm in total length was 96 in 2016 and 86 in 2019 (Table 5.3-2; Figure 5.3-6). Sauger was not a target species in Eaglenest Lake prior to 2016.

Walleye

The annual mean Wr of Walleye greater than 29 mm in total length over the four years of monitoring ranged from a low of 87 in 2010 to a high of 92 in 2016 (Table 5.3-2; Figure 5.3-7).

The overall mean Wr was 90, the median was 89, and the IQR was 87-90 (Figure 5.3-7). The annual mean Wr was equal to or fell within the overall IQR except in 2016 when it was above the IQR.

White Sucker

The annual mean Wr of White Sucker greater than 99 mm in total length over the four years of monitoring ranged from a low of 96 in 2010 to a high of 110 in 2016 (Table 5.3-2; Figure 5.3-8).

The overall mean Wr was 103, the median was 104, and the IQR was 96-104 (Figure 5.3-8). The annual mean Wr fell within the overall IQR in all years except 2016 when it was above the IQR.

Table 5.3-2. 2008-2019 Relative weight of target species.

Waterbody	Year	NRPK			SAUG			WALL			WHSC		
		n_F[1]	Mean	SE[2]	n_F	Mean	SE	n_F	Mean	SE	n_F	Mean	SE
PDB	2008	20	84	3	91	104	2	71	98	2			
	2009	30	83	3	120	81	1	80	88	1			
	2010	13	77	3	35	85	2	47	84	1	100	94	1
	2011	18	78	3	61	99	2	48	92	2	191	105	1
	2012	12	86	4	150	94	1	61	89	1	108	104	1
	2013	52	87	1	160	91	1	72	89	1	114	101	1
	2014	25	86	3	126	85	1	33	89	2	62	103	1
	2015	17	84	2	146	84	1	56	89	1	98	102	1
	2016	22	89	3	145	90	1	38	93	1	71	104	1
	2017	16	87	3	145	91	1	44	89	1	112	102	1
	2018	19	85	2	127	84	1	38	87	1	99	98	1
	2019	23	83	1	132	89	1	86	90	1	124	102	1
LDB	2008	23	89	4	90	86	1	57	93	3			
	2009	12	80	2	167	88	1	66	88	1			
	2010	40	89	1	77	88	1	62	88	1	34	103	1
	2011	35	91	2	90	86	1	76	88	2			
	2012	56	91	1	92	94	1	123	94	1			
	2013	51	88	2	116	88	1	81	87	1			
	2014	52	89	2	76	95	1	101	92	1			
	2015	39	83	2	77	86	2	76	88	1			
	2016	35	82	1	69	88	2	69	92	2	36	105	1
	2017	36	80	2	90	88	1	70	93	2			
	2018	36	88	3	129	89	1	88	84	1	45	102	2
	2019	43	86	1	112	95	2	85	95	2	67	105	1
PFF	2011	5	80	3				22	93	2	16	96	2
	2014	7	79	3				50	80	1	24	94	3
	2017	11	84	2	33	92	2	31	93	3	27	104	2
MANIG	2008	12	74	3	-	-	-	134	80	1			
	2009	13	81	3	-	-	-	97	82	1			
	2010	11	71	4	-	-	-	155	86	1	11	95	2
	2011	18	77	2	-	-	-	97	82	1	11	97	2
	2012	24	83	2	-	-	-	191	85	1	28	101	1
	2013	28	86	1	-	-	-	100	81	1	22	98	1
	2014	30	86	2	-	-	-	112	82	1	21	100	1
	2015	19	81	2	-	-	-	113	85	1	21	106	5
	2016	31	83	1	-	-	-	109	83	1	32	101	2
	2017	27	87	2	-	-	-	120	86	1	31	103	1
	2018	29	83	2	-	-	-	151	82	1	58	101	1
	2019	15	88	2	-	-	-	123	87	1	52	105	1
EAGLE	2010	34	89	2				103	87	1	89	96	1
	2013	54	86	1				108	90	1	66	103	1
	2016	52	87	2	88	96	3	68	92	2	79	110	1
	2019	64	85	1	132	85	1	129	89	2	83	104	1

Notes:

1. n_F = number of fish measured for length and weight.
2. SE = standard error.
3. Grey shading indicates a species was not a target species in that year.

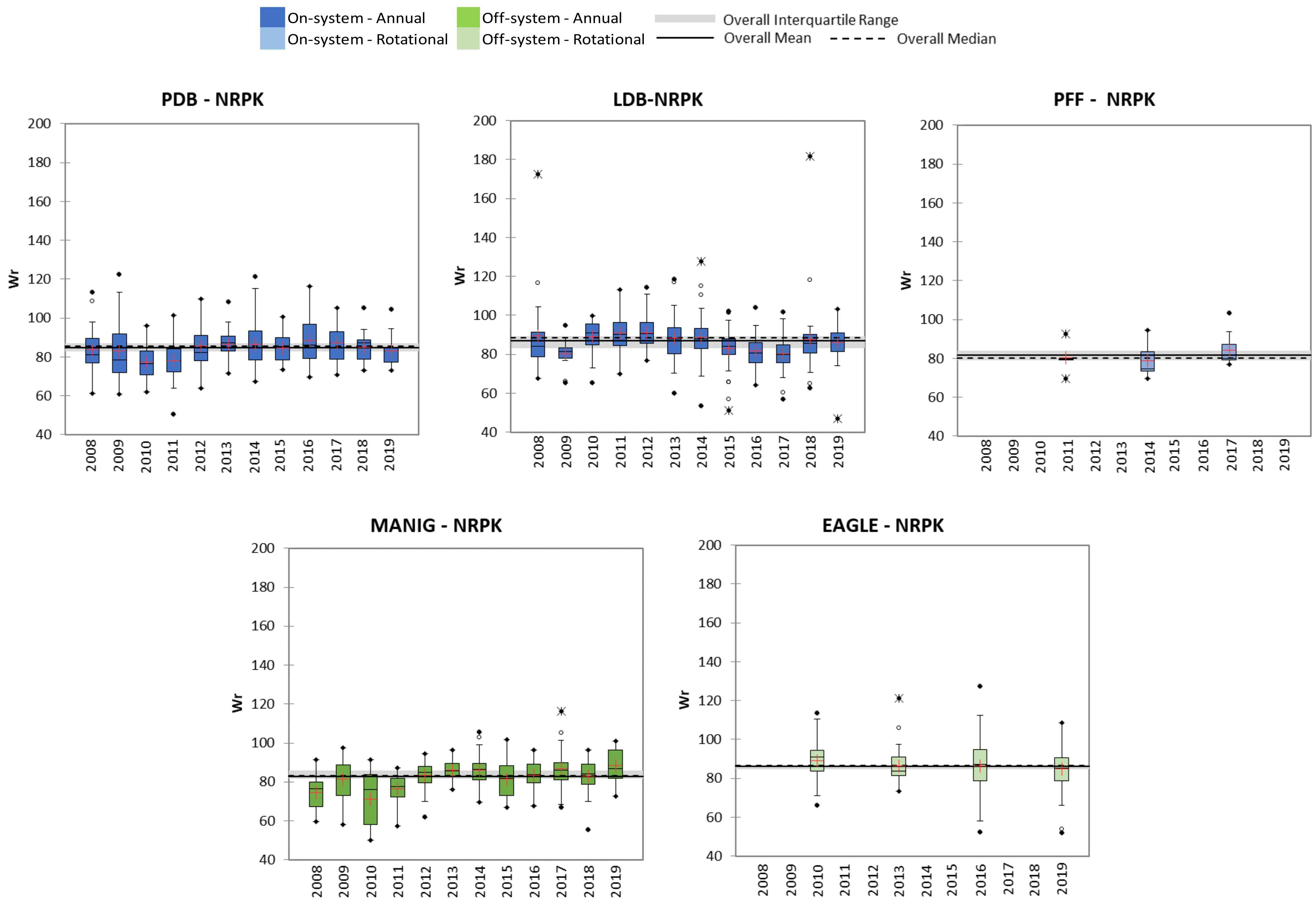


Figure 5.3-5. 2008-2019 Relative weight (Wr) of Northern Pike.

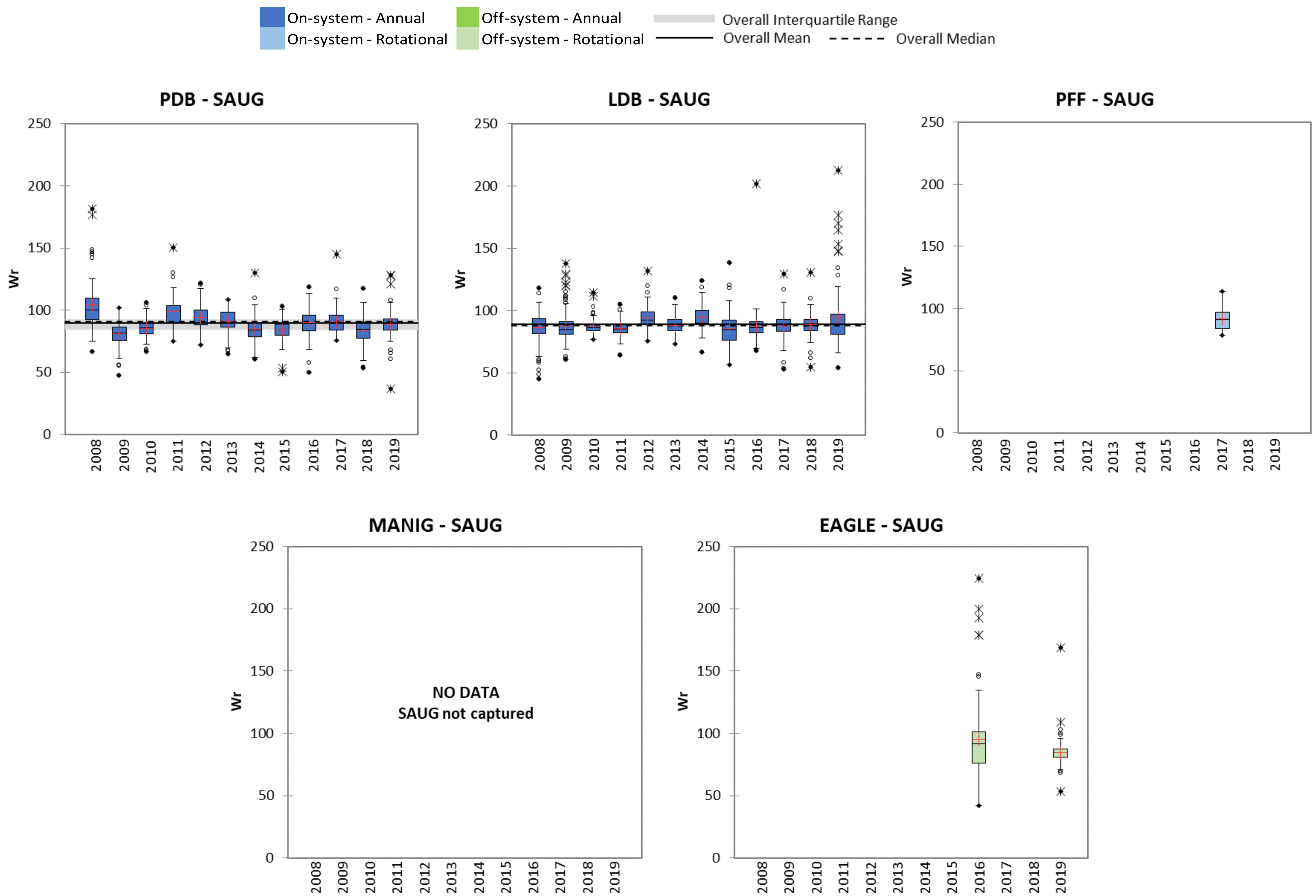


Figure 5.3-6. 2008-2019 Relative weight (Wr) of Sauger.

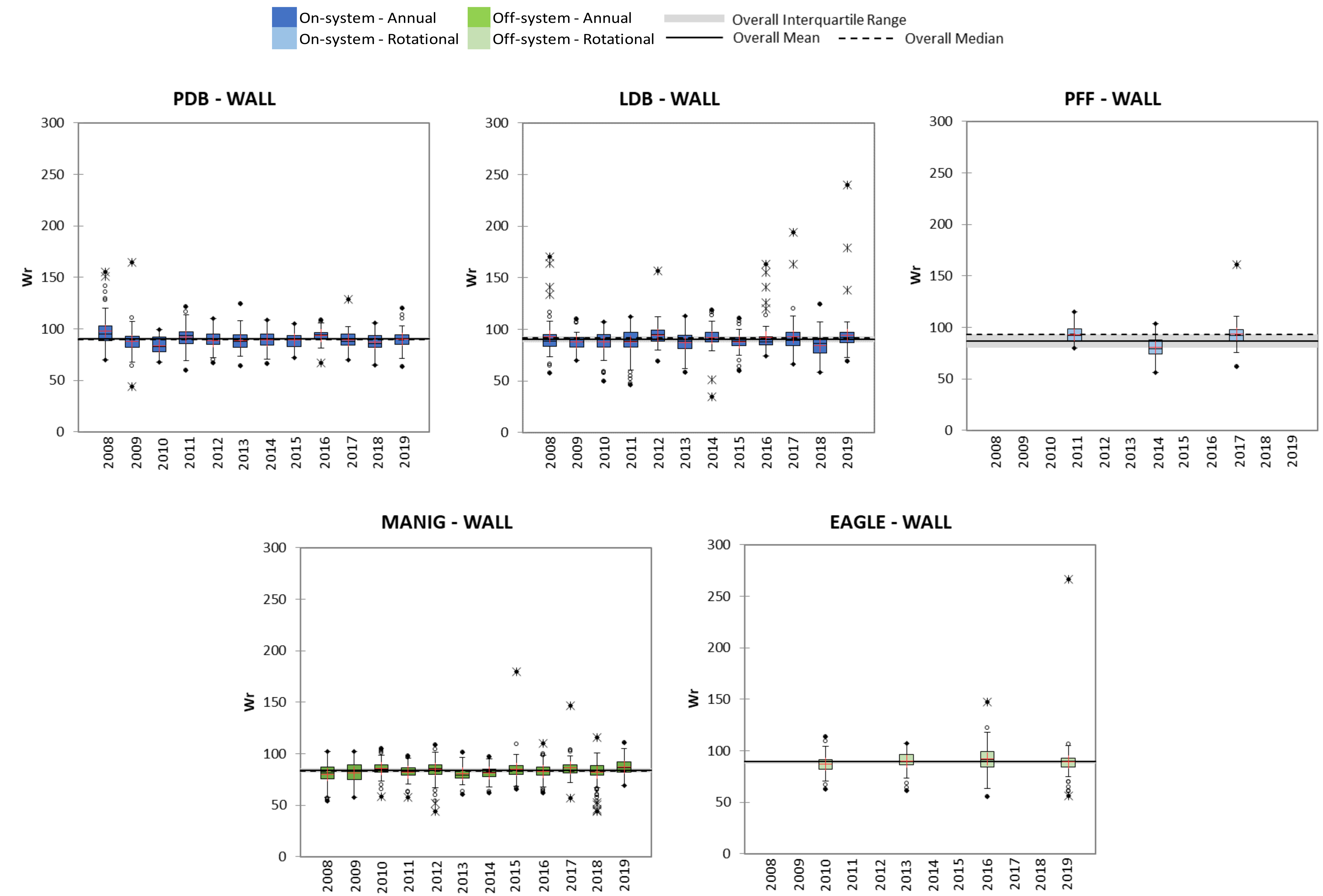


Figure 5.3-7. 2008-2019 Relative weight (Wr) of Walleye.

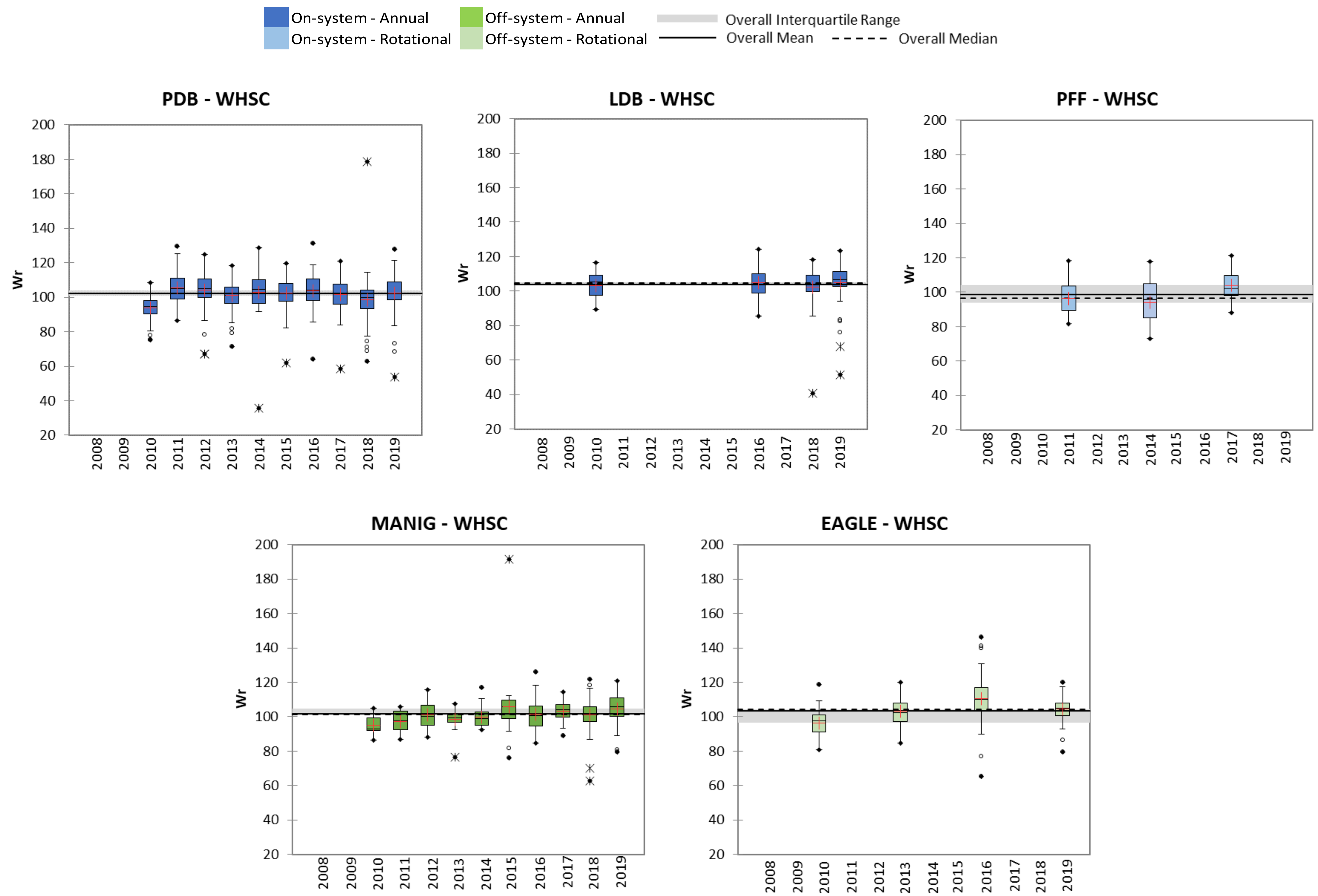


Figure 5.3-8. 2008-2019 Relative weight (Wr) of White Sucker.

5.4 GROWTH

5.4.1 LENGTH-AT-AGE

5.4.1.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean FLA of 4-year-old Northern Pike over the 12 years of monitoring ranged from a low of 390 in 2011 to a high of 545 mm in 2014 (Table 5.4-1; Figure 5.4-1).

The overall mean FLA was 452, the median was 435, and the IQR was 421-470 mm (Figure 5.4-1). The annual mean FLA fell within the overall IQR except in 2009 and 2011 when it was below the IQR and in 2008, 2014, and 2016 when it was above the IQR.

Sauger

The annual mean FLA of 3-year-old Sauger over the 12 years of monitoring ranged from a low of 217 in 2008 to a high of 250 mm in 2017 (Table 5.4-1; Figure 5.4-2).

The overall mean and median FLA were 230 and the IQR was 226-230 mm (Figure 5.4-2). The annual mean FLA fell within the overall IQR except in 2008, 2010, and 2012 when it was below the IQR and in 2009, 2017, and 2018 when it was above the IQR.

Walleye

The annual mean FLA of 3-year-old Walleye over the 12 years of monitoring ranged from a low of 234 in 2009 to a high of 263 mm in 2012 (Table 5.4-1; Figure 5.4-3).

The overall mean FLA was 249, the median was 250, and the IQR was 247-259 mm (Figure 5.4-3). The annual mean FLA fell within the overall IQR except in 2008, 2009, and 2011 when it was below the IQR and in 2012, 2015, and 2017 when it was above the IQR.

White Sucker

White Sucker are not aged as part of CAMP.

Lac du Bonnet

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean FLA of 4-year-old Northern Pike over the 12 years of monitoring ranged from a low of 509 in 2009 to a high of 707 mm in 2014 (Table 5.4-1; Figure 5.4-1).

The overall mean FLA was 601, the median was 604, and the IQR was 590-622 mm (Figure 5.4-1). The annual mean FLA fell within the overall IQR except in 2009, 2012, and 2015 when it was below the IQR and in 2014 when it was above the IQR.

Sauger

The annual mean FLA of 3-year-old Sauger over the 12 years of monitoring ranged from a low of 222 in 2010 to a high of 261 mm in 2019 (Table 5.4-1; Figure 5.4-2).

The overall mean FLA was 230, the median was 247, and the IQR was 233-253 mm (Figure 5.4-2). The annual mean FLA fell within the overall IQR except in 2010 when it was below the IQR and in 2012, 2017, and 2019 when it was above the IQR.

Walleye

The annual mean FLA of 3-year-old Walleye over the 12 years of monitoring ranged from a low of 282 in 2010 to a high of 347 mm in 2013 (Table 5.4-1; Figure 5.4-3).

The overall mean FLA was 309, the median was 304, and the IQR was 304-320 mm (Figure 5.4-3). The annual mean FLA fell within the overall IQR except in 2009, 2010, and 2011 when it was below the IQR and in 2012, 2013, and 2019 when it was above the IQR.

White Sucker

White Sucker are not aged as part of CAMP.

ROTATIONAL SITES

Pine Falls Forebay

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean FLA of 4-year-old Northern Pike over the three years of monitoring ranged from a low of 428 in 2011 to a high of 464 mm in 2014 (Table 5.4-1; Figure 5.4-1).

There were too few 4-year-old Northern Pike captured in the Pine Falls Forebay to calculate the overall metrics.

Sauger

The annual mean FLA of 3-year-old Sauger was 247 mm in 2017 (Table 5.4-1; Figure 5.4-2). Sauger was not a target species in the Pine Falls Forebay prior to 2017.

Walleye

The annual mean FLA of 3-year-old Walleye over the three years of monitoring ranged from a low of 189 in 2011 to a high of 278 mm in 2014 (Table 5.4-1; Figure 5.4-3).

There were too few 3-year-old Walleye captured in the Pine Falls Forebay to calculate the overall metrics.

White Sucker

White Sucker are not aged as part of CAMP.

5.4.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean FLA of 4-year-old Northern Pike over the 12 years of monitoring ranged from a low of 380 in 2011 to a high of 539 mm in 2018 (Table 5.4-1; Figure 5.4-1).

The overall mean FLA was 494, the median was 487, and the IQR was 484-521 mm (Figure 5.4-1). The annual mean FLA fell within the overall IQR except in 2011, 2012, and 2019 when it was below the IQR and in 2017 and 2018 when it was above the IQR.

Sauger

Sauger were not captured in Manigotagan Lake over the 12 years of monitoring (Table 5.4-1).

Walleye

The annual mean FLA of 3-year-old Walleye over the 12 years of monitoring ranged from a low of 267 in 2010 to a high of 341 mm in 2008 (Table 5.4-1; Figure 5.4-3).

The overall mean FLA was 297, the median was 295, and the IQR was 288-312 mm (Figure 5.4-3). The annual mean FLA fell within the overall IQR except in 2010, 2013, and 2014 when it was below the IQR and in 2008, 2012, and 2016 when it was above the IQR.

White Sucker

White Sucker are not aged as part of CAMP.

ROTATIONAL SITES

<u>Eaglenest Lake</u>

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The annual mean FLA of 4-year-old Northern Pike over the four years of monitoring was 373 in 2010 to a high of 549 mm in 2016 (Table 5.4-1; Figure 5.4-1).

The overall mean FLA was 467, the median was 425, and the IQR was 425-510 mm (Figure 5.4-1). The annual mean FLA fell within the overall IQR except in 2010 when it was below the IQR and 2016 was above the IQR.

Sauger

The annual mean FLA of 3-year-old Sauger was 215 in 2016 and 223 mm in 2019 (Table 5.4-1; Figure 5.4-2). Sauger was not a target species in Eaglenest Lake prior to 2016.

Walleye

The annual mean FLA of 3-year-old Walleye over the four years of monitoring ranged from a low of 229 in 2010 to a high of 271 mm in 2013 (Table 5.4-1; Figure 5.4-3).

The overall mean FLA was 259, the median was 263, and the IQR was 263-271 mm (Figure 5.4-3). The annual mean FLA fell within the overall IQR except in 2010 and 2016 when it was below the IQR.

White Sucker

White Sucker are not aged as part of CAMP.

Table 5.4-1. 2008-2019 Fork length-at-age of target species.

Waterbody	Year	NRPK			SAUG			WALL		
		n_F[1]	Mean	SE[2]	n_F	Mean	SE	n_F	Mean	SE
PDB	2008	2	474	22	5	217	14	4	234	9
	2009	8	415	10	5	242	2	12	234	6
	2010	6	463	10	5	225	6	-	-	-
	2011	1	390	-	-	-	-	4	239	8
	2012	1	440	-	5	220	11	2	263	10
	2013	17	421	11	27	226	5	16	251	6
	2014	3	545	19	21	230	4	7	247	7
	2015	5	459	17	30	230	4	11	262	10
	2016	8	512	30	14	230	5	5	259	12
	2017	2	435	2	3	250	2	5	260	7
	2018	2	424	25	11	242	4	3	248	9
	2019	4	470	14	18	229	4	15	250	6
LDB	2008	-	-	-	15	243	4	7	309	9
	2009	4	509	19	52	233	2	11	291	9
	2010	7	595	20	5	222	5	8	282	6
	2011	2	604	16	10	242	3	4	301	20
	2012	2	571	39	4	258	11	20	332	6
	2013	7	605	17	16	245	4	2	347	12
	2014	3	707	19	21	247	3	35	304	4
	2015	6	579	16	22	249	4	8	307	9
	2016	6	606	25	8	251	6	6	308	13
	2017	12	590	13	5	258	6	6	304	15
	2018	7	622	33	26	253	4	4	320	8
	2019	8	622	16	19	261	4	6	328	9
PFF	2011	1	428	-				1	189	-
	2014	1	464	-				11	278	10
	2017	4	439	6	5	247	5	4	248	5
MANIG	2008	3	521	9	-	-	-	11	341	9
	2009	3	506	15	-	-	-	45	295	5
	2010	-	-	-	-	-	-	16	267	9
	2011	1	380	-	-	-	-	6	294	9
	2012	3	459	9	-	-	-	7	328	10
	2013	11	484	8	-	-	-	7	280	14
	2014	7	485	11	-	-	-	21	272	9
	2015	9	487	11	-	-	-	22	288	7
	2016	6	506	14	-	-	-	10	319	10
	2017	5	525	11	-	-	-	8	295	3
	2018	10	539	16	-	-	-	13	323	6
	2019	7	445	8	-	-	-	16	312	7
EAGLE	2010	3	373	16				8	229	11
	2013	13	425	18				14	271	10
	2016	6	549	34	1	215	-	3	244	6
	2019	8	510	22	14	223	7	30	263	3

Notes:

1. n_F = number of fish measured for length and weight.
2. SE = standard error.
3. Grey shading indicates that a species was not a target species in that year.

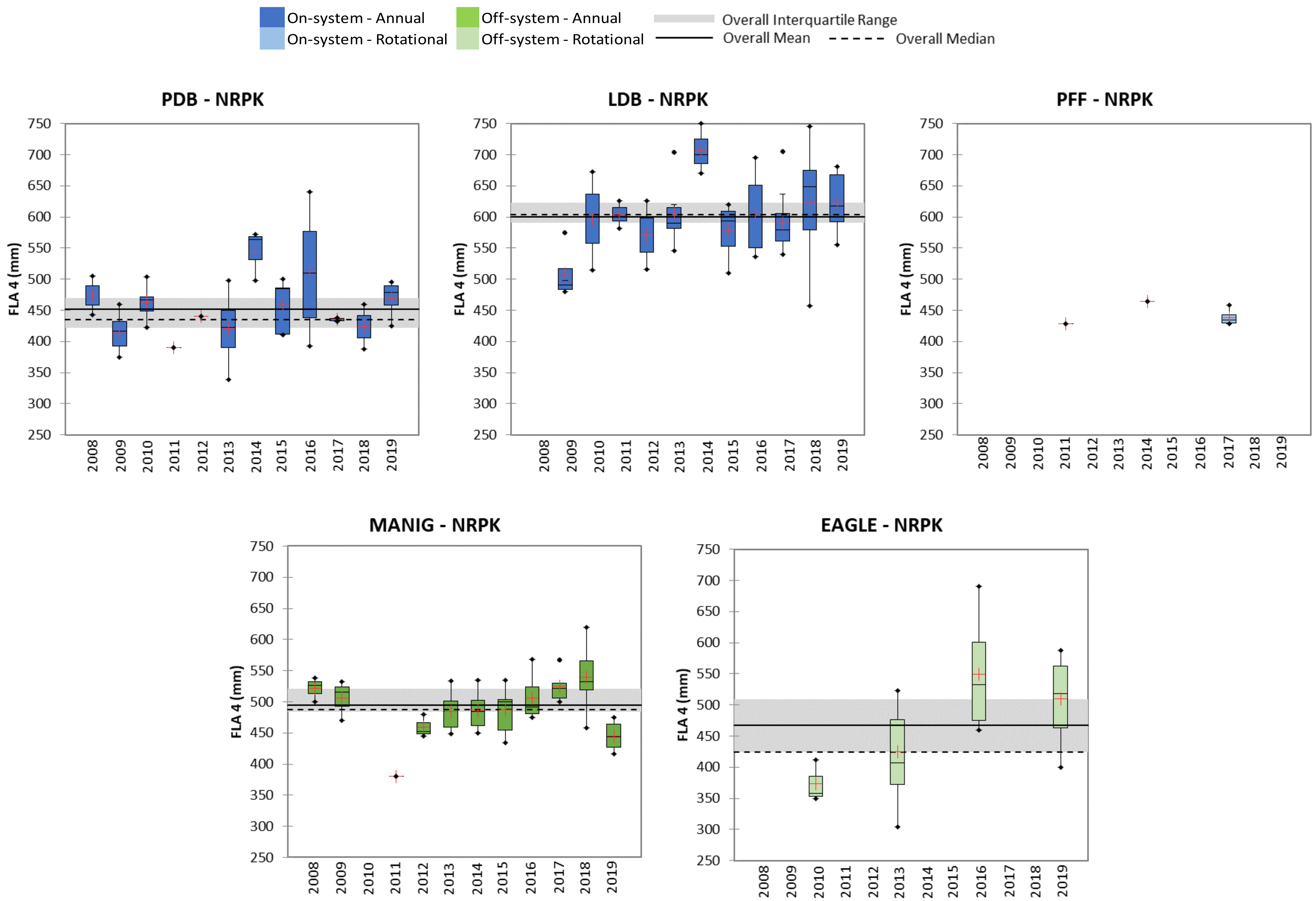


Figure 5.4-1. 2008-2019 Fork length-at-age (FLA) 4 of Northern Pike.

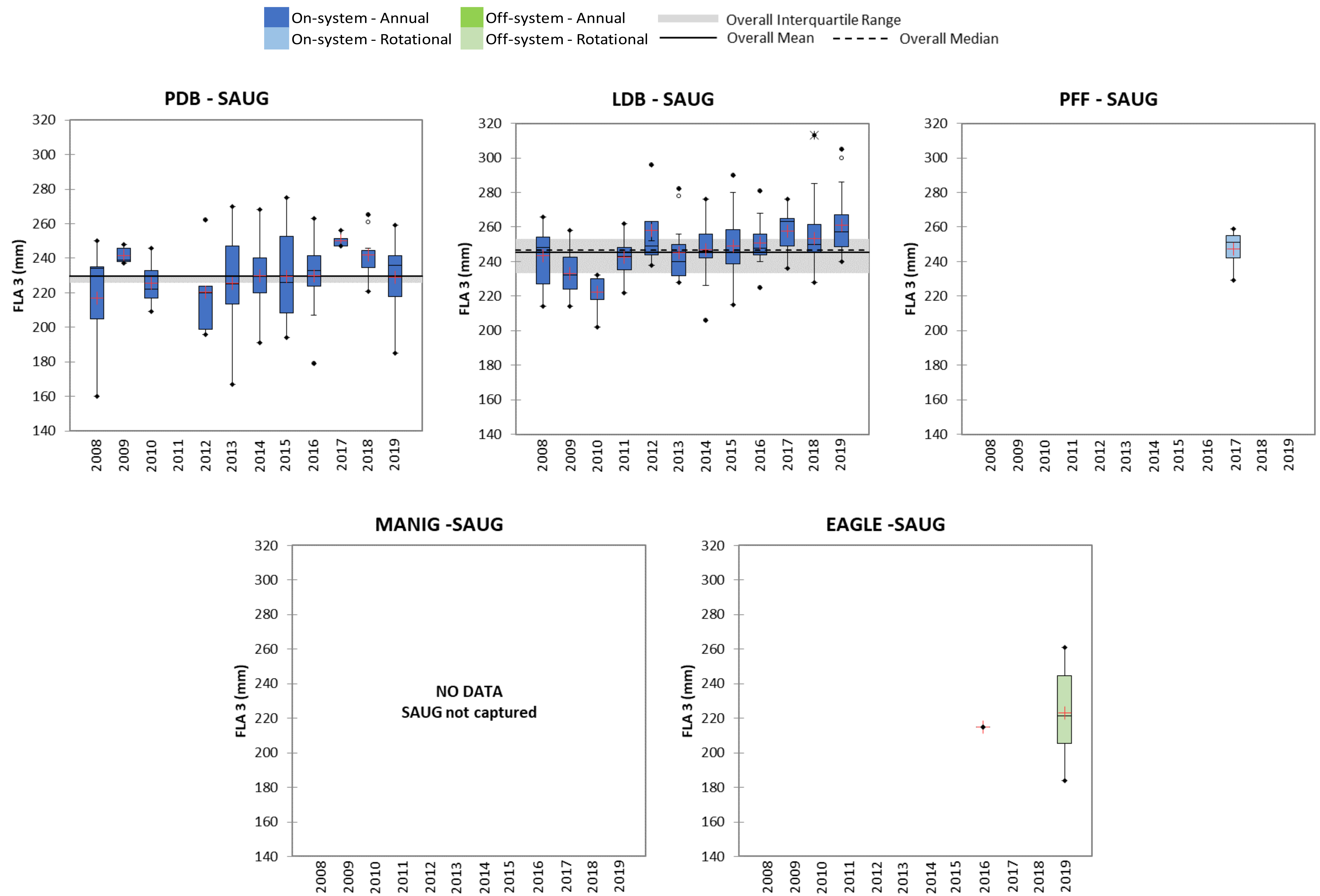


Figure 5.4-2. 2008-2019 Fork length-at-age (FLA) 3 of Sauger.

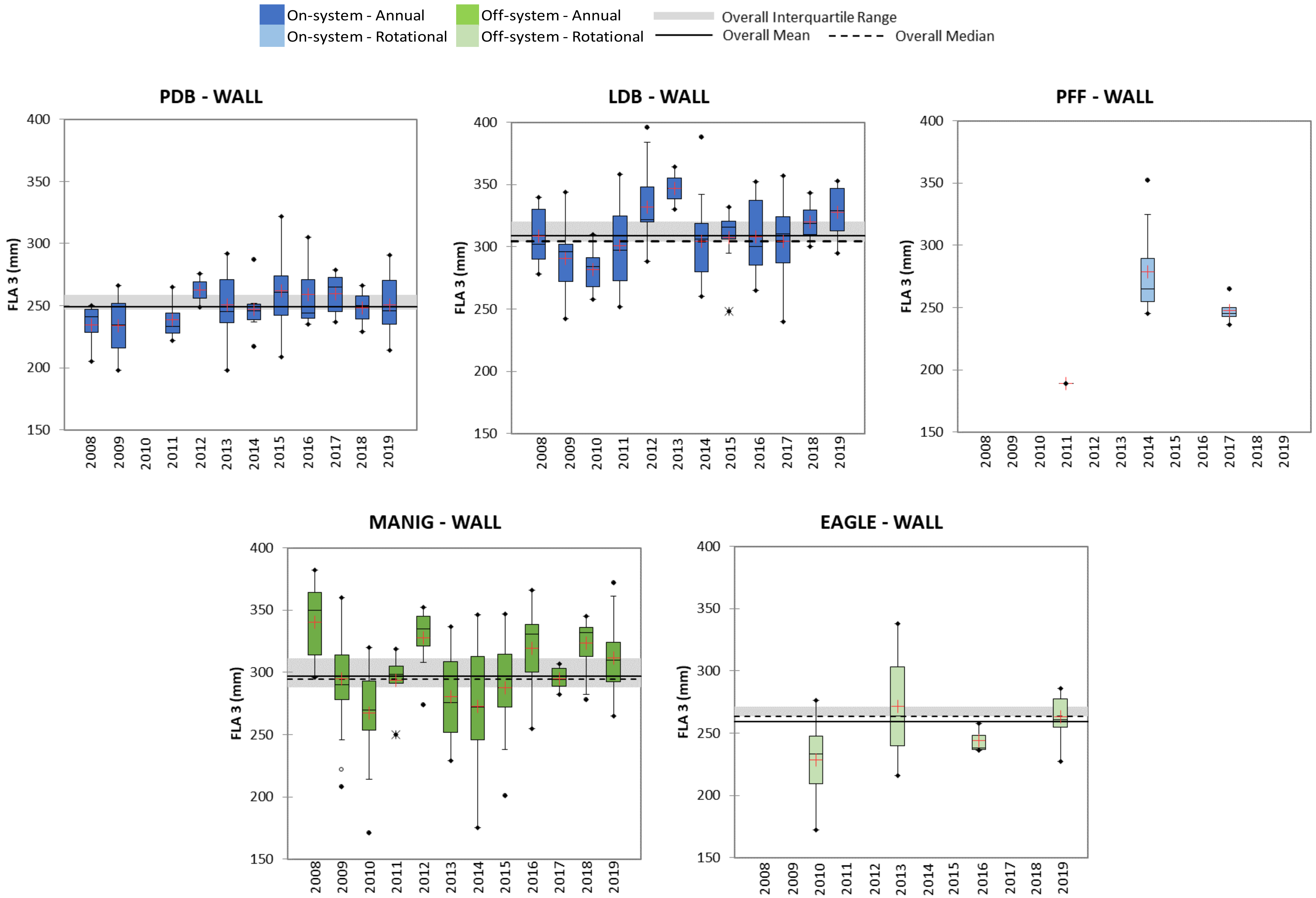


Figure 5.4-3. 2008-2019 Fork length-at-age (FLA) 3 of Walleye.

5.5 RECRUITMENT

5.5.1 RELATIVE YEAR-CLASS STRENGTH

5.5.1.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The RYCS of Northern Pike over the 12 years of monitoring ranged from a low of 22 for the 2002 cohort to a high of 171 for the 2010 cohort (Figure 5.5-1). There were no missing cohorts from 2002-2014. Particularly weak cohorts (<50) occurred in 2002, 2007, and 2012.

Sauger

The RYCS of Sauger over the 12 years of monitoring ranged from a low of 30 for the 2008 cohort to a high of 233 for the 2006 cohort (Figure 5.5-2). There were no missing cohorts from 2002-2013. A series of weak cohorts (<50) were produced over a three-year period from 2008-2010. Strong cohorts (>100) were produced in 2002, 2003, 2006, 2007, 2011, and 2012.

Walleye

The RYCS of Walleye over the 12 years of monitoring ranged from a low of 46 for the 2008 cohort to a high of 211 for the 2011 cohort (Figure 5.5-3). There were no missing cohorts from 2002-2014. A particularly weak cohort (<50) only occurred in 2008 and strong cohorts (>100) were produced in 2002, 2003, 2006, 2010, and 2011.

White Sucker

White Sucker are not aged as part of CAMP.

Lac du Bonnet

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The RYCS of Northern Pike over the 12 years of monitoring ranged from a low of 43 for the 2002 cohort to a high of 135 for the 2005 cohort (Figure 5.5-1). There were no missing cohorts from 2002-2014. Particularly strong cohorts (>100) were produced in about half of the years (2003, 2005, 2006, 2011, 2013, and 2014), and only the 2002 cohort was particularly weak (<50).

Sauger

RYCS analysis was not conducted for Sauger from Lac du Bonnet because only a subsample of the catch was aged in some years which is not appropriate for the analysis.

Walleye

The RYCS of Walleye over the 12 years of monitoring ranged from a low of 12 for the 2004 cohort to a high of 281 for the 2011 cohort (Figure 5.5-3). There were no missing cohorts from 2002-2014. Particularly weak cohorts (<50) were produced in 2004, 2010, and 2013. Strong cohorts (>100) were produced in 2003, 2006, 2007, 2011, and 2014.

White Sucker

White Sucker are not aged as part of CAMP.

ROTATIONAL SITES

RYCS analysis requires data be collected in at least three consecutive years and therefore cannot be conducted for rotational waterbodies.

5.5.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

Lake Whitefish

Lake Whitefish was not selected as a target species in any of the Winnipeg River waterbodies even though it is a target species in other CAMP regions.

Northern Pike

The RYCS of Northern Pike over the 12 years of monitoring ranged from a low of 40 for the 2006 cohort to a high of 199 for the 2004 cohort (Figure 5.5-1). There were no missing cohorts from 2002-2014. Strong cohorts (>100) were produced in five years (2003, 2004, 2008, 2011, and 2014) and particularly weak cohorts (<50) produced in two years (2002 and 2006).

Sauger

Sauger were not captured in Manigotagan Lake over the 12 years of monitoring.

Walleye

The RYCS of Walleye over the 12 years of monitoring ranged from a low of 36 for the 2009 cohort to a high of 253 for the 2006 cohort (Figure 5.5-3). There were no missing cohorts from 2002-2014. A series of strong cohorts (>100) were produced from 2005-2007 and again from 2011-2012. A series of weak cohorts (<50) were produced over a three-year period from 2008-2010.

White Sucker

White Sucker are not aged as part of CAMP.

ROTATIONAL SITES

RYCS analysis requires data be collected in at least three consecutive years and therefore cannot be conducted for rotational waterbodies.

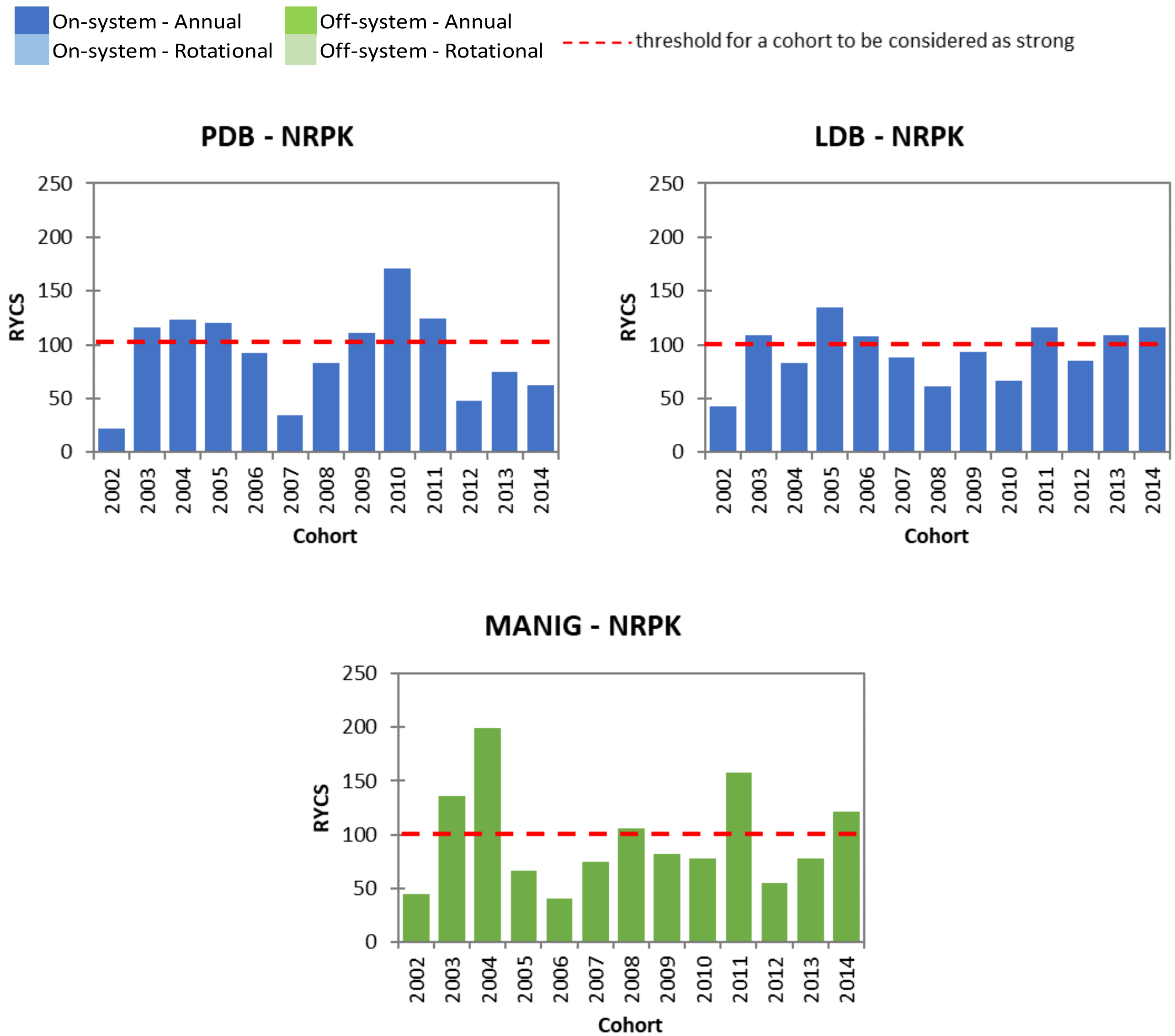


Figure 5.5-1. Relative year-class strength (RYCS) of Northern Pike.

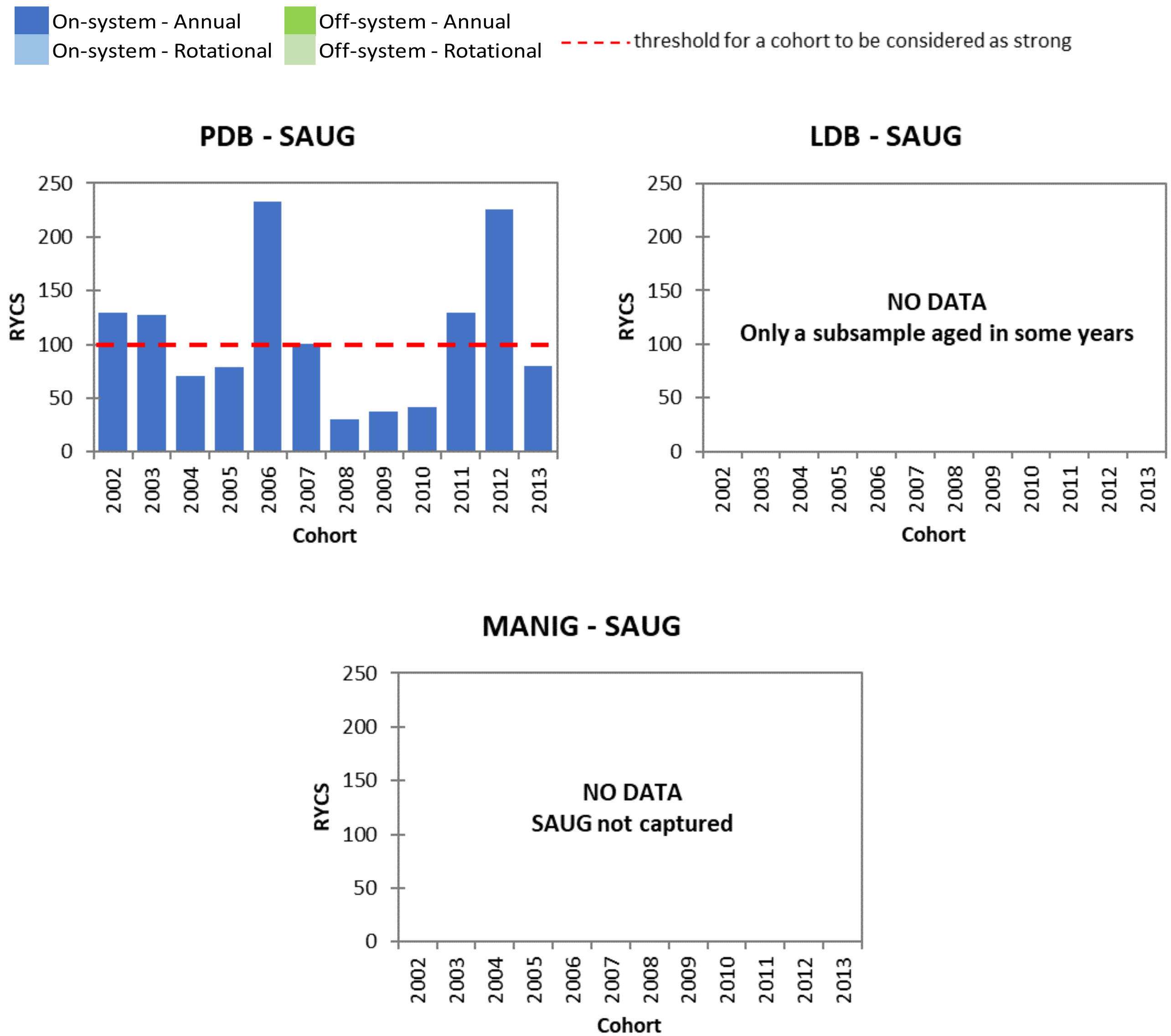


Figure 5.5-2. Relative year-class strength (RYCS) of Sauger.

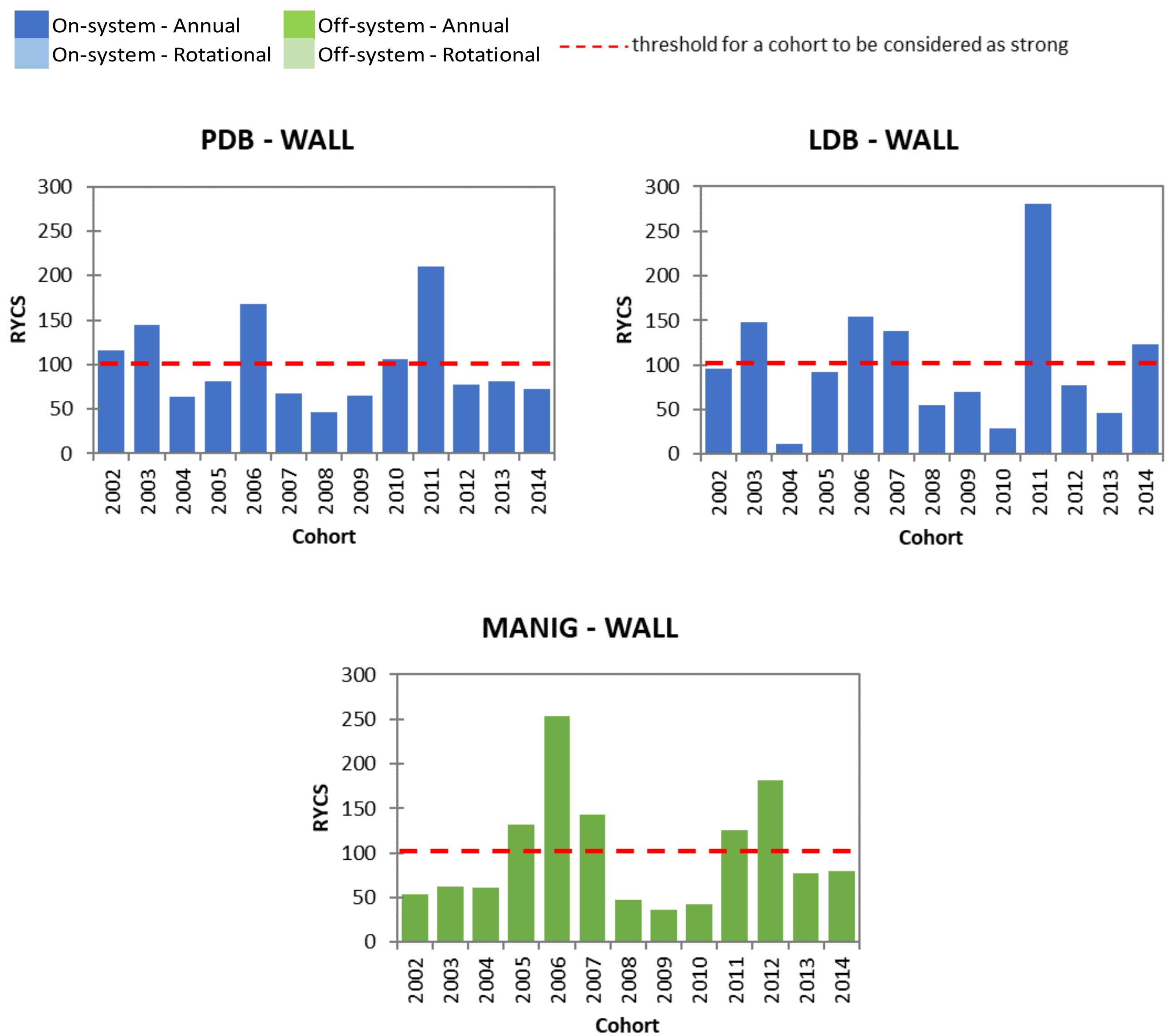


Figure 5.5-3. Relative year-class strength (RYCS) of Walleye.

5.6 DIVERSITY

5.6.1 RELATIVE SPECIES ABUNDANCE

5.6.1.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

A total of 22 fish species were captured in the combined standard and small mesh gangs at the Pointe du Bois Forebay over the 12 years of monitoring (Table 5.6-1) with the number of species caught each year ranging from 16-19 (Tables 5.6-2 and 5.6-3). In one case, a sculpin was not identified to species (unidentified [unid.] sculpin species [*spp.*]).

Standard Gang Index Gill Nets

White Sucker and Yellow Perch (*Perca flavescens*) were the most frequently captured species at the Pointe du Bois Forebay over the 12 years of monitoring, accounting for an average of >25% of the catch (Table 5.6-2). The annual RSA for White Sucker ranged from a low of 17% in 2016 to a high of 39% in 2009. The annual RSA for Yellow Perch ranged from a low of 11% in 2008 to a high of 47% in 2016. Sauger accounted for >25% in two years (2012 and 2014).

Small Mesh Index Gill Nets

The most common species captured in the Pointe du Bois Forebay over the 12 years of monitoring was Spottail Shiner (*Notropis hudsonius*), which accounted for an average of >25% of the catch (Table 5.6-3). The annual RSA for Spottail Shiner ranged from a low of 0% in 2009 to a high of 52% in 2014. Three other species accounted for >25% of the catch in some years: Sauger in 2008, 2009, 2010, and 2016; Yellow Perch in 2011, 2013, 2017, and 2019; and Trout-perch (*Percopsis omiscomaycus*) in 2010 and 2012.

Lac du Bonnet

A total of 23 fish species were captured in the combined standard and small mesh gangs at Lac du Bonnet over the 12 years of monitoring (Table 5.6-1), with the number of species caught each year ranging from 16-18 (Tables 5.6-4 and 5.6-5). In one case, a sculpin was not identified to species. Rainbow Smelt (*Osmerus mordax*) were not captured in Lac du Bonnet.

Standard Gang Index Gill Nets

The catch in standard gangs set in Lac du Bonnet over the 12 years of monitoring were not dominated by any one species, with none of the species accounting for an average of >25% of the catch (Table 5.6-4). Two species accounted for >25% of the catch in some years, Sauger in 2009, 2016, and 2017 and Walleye in 2012.

Small Mesh Index Gill Nets

The most common species captured in Lac du Bonnet over the 12 years of monitoring was Yellow Perch, which accounted for an average of >25% of the catch (Table 5.6-5). The annual RSA for Yellow Perch ranged from a low of 3% in 2016 to a high of 68% in 2015. Four other species accounted for >25% of the catch in some years, Spottail Shiner in 2012, 2013, 2014, 2017, and 2019, Trout-perch in 2016, Black Crappie (*Pomoxis nigromaculatus*) in 2015 and 2017, and Sauger in 2009 and 2016.

ROTATIONAL SITES

Pine Falls Forebay

A total of 17 fish species were captured in the combined standard and small mesh gangs at the Pine Falls Forebay over the three years of monitoring (Table 5.6-1), with the number of species caught each year ranging from 13-14 species (Tables 5.6-6 and 5.6-7).

Standard Gang Index Gill Nets

The catch in standard gangs set in the Pine Falls Forebay over the three years of monitoring was dominated by Channel Catfish, which accounted for an average of ≥50% of the catch (Table 5.6-6). The annual RSA of Channel Catfish (*Ictalurus punctatus*) ranged from a low of 50% in 2017 to a high of 63% in 2014.

Small Mesh Index Gill Nets

The most common species captured in the Pine Falls Forebay over the three years of monitoring was Trout-perch, which accounted for an average of >25% of the catch (Table 5.6-7). The annual RSA for Trout-perch ranged from a low of 20% in 2011 to a high of 70% in 2014. Two other species accounted for >25% of the catch in some years, Sauger in 2017 and Walleye in 2011.

5.6.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

A total of 13 fish species were captured in the combined standard and small mesh gangs at Manigotagan Lake over the 12 years of monitoring (Table 5.6-1), with the number of species caught each year ranging from 7-13 species (Tables 5.6-8 and 5.6-9). Sauger, Rainbow Smelt, and Lake Sturgeon (*Acipenser fulvescens*) were not captured at Manigotagan Lake.

Standard Gang Index Gill Nets

Cisco (*Coregonus artedi*) and Walleye were the most frequently captured species at Manigotagan Lake over the 12 years of monitoring, accounting for an average of >25% of the catch (Table 5.6-2). The annual RSA for Cisco ranged from a low of 27% in 2008 to a high of 50% in 2015. The annual RSA for Walleye ranged from a low of 22% in 2015 to a high of 42% in 2010.

Small Mesh Index Gill Nets

The most common species captured in Manigotagan Lake over the 12 years of monitoring was Walleye, which accounted for an average of >25% of the catch (Table 5.6-3). The annual RSA for Walleye ranged from a low of 12% in 2018 to a high of 100% in 2008. Four other species accounted for >25% of the catch in some years, Emerald Shiner (*Notropis atherinoides*) in 2015, 2016, 2017, and 2018, Cisco in 2011 and 2014, Trout-perch in 2013, and Yellow Perch in 2012.

ROTATIONAL SITES

Eaglenest Lake

A total of 23 fish species were captured in the combined standard and small mesh gangs at Eaglenest Lake over the four years of monitoring (Table 5.6-1), with the number of species caught each year ranging from 16-19 species (Tables 5.6-10 and 5.6-11). Lake Sturgeon were not captured at Eaglenest Lake.

Standard Gang Index Gill Nets

Yellow Perch was the most frequently captured species at Eaglenest Lake over the four years of monitoring, accounting for an average of >25% of the catch (Table 5.6-10). The annual RSA for Yellow Perch ranged from a low of 25% in 2010 to a high of 37% in 2013.

Small Mesh Index Gill Nets

The most common species captured in Eaglenest Lake over the four years of monitoring was Yellow Perch, which accounted for an average of >25% of the catch (Table 5.6-11). The annual RSA for Yellow Perch ranged from a low of 12% in 2010 to a high of 51% in 2019. Three other species accounted for >25% of the catch in some years, Spottail Shiner in 2016, Trout-perch in 2010, and Sauger in 2013.

Table 5.6-1. 2008-2019 Inventory of fish species.

Family	Species	Abbreviation	Status[1]	Target	PDB	LDB	PFF	MANIG	EAGLE
Petromyzontidae	Silver Lamprey	SLLM	Native		●	●			●
Acipenseridae	Lake Sturgeon[2]	LKST	Native		●	●	●		
Hiodontidae	Mooneye	MOON	Native		●	●	●		●
	Goldeye	GOLD	Native				●		●
Cyprinidae	Emerald Shiner	EMSH	Native		●	●		●	●
	Spottail Shiner	SPSH	Native		●	●	●	●	●
Catostomidae	Longnose Sucker	LNSC	Native		●	●			●
	White Sucker	WHSC	Native	●	●	●	●	●	●
	Shorthead Redhorse	SHRD	Native		●	●	●		●
	Silver Redhorse	SLRD	Native		●	●			●
Ictaluridae	Black Bullhead	BLBL	Native			●			●
	Brown Bullhead	BRBL	Native						●
	Channel Catfish	CHCT	Native			●	●		
Esocidae	Northern Pike	NRPK	Native	●	●	●	●	●	●
Osmeridae	Rainbow Smelt	RNSM	Introduced		●		●		●
Salmonidae	Cisco	CISC	Native		●	●		●	●
	Lake Whitefish	LKWH	Native		●	●	●	●	●
Percopsidae	Trout-perch	TRPR	Native		●	●	●	●	●
Gadidae	Burbot	BURB	Native		●	●	●	●	
Cottidae	Mottled Sculpin	MTSC	Native					●	
	Slimy Sculpin	SLSC	Native					●	
	Unid. Sculpin Spp.	-	Native		●	●			
Centrarchidae	Rock Bass	RCBS	Native		●	●	●		●
	Smallmouth Bass	SMBS	Introduced		●	●	●	●	●
	Black Crappie	BLCR	Native		●	●			●
Percidae	Yellow Perch	YLPR	Native		●	●	●	●	●
	Logperch	LGPR	Native						●
	Sauger	SAUG	Native	●	●	●	●		●
	Walleye	WALL	Native	●	●	●	●	●	●

Notes:

1. Assigned from Stewart and Watkinson (2004).
2. Status under review by Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Table 5.6-2. 2008-2019 Relative species abundance in standard gang index gill nets in the Pointe du Bois Forebay.

0%	>0-5%	>5-10%	>10-25%	>25-50%	>50%

Group	Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
Target	LKWH	0.5%	1%	2%	1%	0.5%	0%	0.3%	2%	0.2%	0.5%	2%	1%	1%
	NRPK	5%	3%	5%	3%	2%	7%	8%	4%	5%	4%	4%	3%	4%
	SAUG	24%	21%	13%	10%	26%	18%	28%	21%	16%	20%	13%	17%	19%
	WALL	15%	13%	13%	8%	11%	10%	10%	11%	7%	10%	8%	11%	11%
	WHSC	38%	39%	38%	32%	27%	18%	22%	23%	17%	27%	21%	20%	27%
Lampreys	SLLM	0.5%	3%	5%	0%	1%	0.2%	2%	1%	4%	2%	1%	0.5%	2%
Sturgeon	LKST	0.2%	0.2%	2%	0.2%	0%	0.2%	0%	0%	0%	0%	0%	0%	0.2%
Mooneyes	MOON	0.5%	0.7%	3%	1%	11%	1%	0.3%	0%	0.5%	2%	7%	5%	3%
	GOLD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Suckers	LNSC	0.2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.02%
	SHRD	4%	1%	2%	0.2%	0.5%	0.3%	0%	0.2%	0%	1%	1%	0.5%	0.9%
	SLRD	0%	0.2%	1%	2%	0%	0.5%	2%	1%	0.2%	1%	5%	3%	1%
Catfishes	BLBL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	BRBL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	CHCT	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Smelts	RNSM	0%	0%	0%	0%	0%	0.2%	0%	0.2%	0%	0%	0%	0%	0.0%
Coregonids	CISC	0%	0.5%	0.4%	1%	2%	0.2%	1%	1%	0%	0%	2%	1%	1%
Trout-perch	TRPR	0%	0%	0%	0%	0%	0.2%	0%	0.2%	0%	0%	0.2%	0%	0.1%
Codfishes	BURB	0.5%	0.5%	0.4%	0.3%	1%	0.3%	1%	1%	1%	0%	1%	0%	1%
Sunfishes	RCBS	0%	2%	0%	1%	0.2%	1%	2%	0.5%	0.2%	1%	0.4%	2%	1%
	SMBS	0.2%	0.2%	1%	1%	1%	0.6%	1%	2%	1%	2%	4%	2%	1%
	BLCR	0%	0%	0%	0%	0%	0%	0.7%	0%	1%	1%	0.4%	0.5%	0.3%
Perch	YLPR	11%	14%	16%	40%	15%	43%	22%	31%	47%	27%	30%	32%	27%

Table 5.6-3. 2008-2019 Relative species abundance in small mesh index gill nets in the Pointe du Bois Forebay.

0%	>0-5%	>5-10%	>10-25%	>25-50%	>50%

Group	Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
Sturgeon	LKST	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mooneyes	MOON	0%	0%	2%	0%	0.3%	0.2%	0%	0%	0%	0.3%	2%	0.2%	0.4%
Minnows	EMSH	15%	0%	1%	0%	0%	0%	3%	0.4%	1%	0%	1%	0%	2%
	SPSH	9%	0%	14%	37%	13%	26%	52%	39%	16%	30%	36%	46%	26%
Suckers	WHSC	0%	0%	1%	1%	1%	1%	0%	1%	0%	1%	1%	1%	1%
Catfishes	BLBL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	BRBL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pikes	NRPK	1%	0%	0%	1%	0.5%	2%	1%	1%	1%	0.3%	0.3%	0.4%	0.7%
Smelts	RNSM	0%	0%	2%	0.4%	0.5%	0%	0.4%	1%	0%	0%	0.3%	0.2%	0.4%
Coregonids	CISC	0%	0%	0%	0.2%	0.2%	0%	1%	2%	0%	0.3%	0%	0%	0.3%
	LKWH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Trout-perch	TRPR	18%	15%	28%	11%	54%	13%	10%	7%	17%	25%	16%	13%	19%
Codfishes	BURB	0%	0%	0%	0%	0%	0%	0%	0.4%	0%	0%	0%	0%	0.03%
Sculpins	MTSC	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	SLSC	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Sculpin spp.	0%	0%	0%	0.2%	0%	0%	0%	0%	0%	0%	0%	0%	0.01%
Sunfishes	RCBS	0%	0%	0%	0%	0%	1%	0.4%	0%	1%	0%	1%	0%	0.2%
	SMBS	0%	0%	0%	0.2%	0%	0%	0%	0%	0%	0%	0%	0%	0.01%
	BLCR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Perch	YLPR	20%	0%	7%	38%	14%	44%	12%	19%	17%	26%	23%	30%	21%
	LGPR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	SAUG	26%	67%	29%	5%	12%	11%	19%	24%	43%	18%	21%	6%	23%
	WALL	11%	18%	15%	7%	4%	2%	1%	4%	4%	1%	1%	3%	6%

Table 5.6-4. 2008-2019 Relative species abundance in standard gang index gill nets in Lac du Bonnet.

0%	>0-5%	>5-10%	>10-25%	>25-50%	>50%

Group	Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
Target	LKWH	5%	4%	5%	10%	9%	12%	7%	10%	4%	6%	3%	3%	7%
	NRPK	7%	3%	12%	8%	12%	10%	12%	10%	8%	11%	8%	8%	9%
	SAUG	23%	33%	21%	19%	18%	20%	17%	20%	27%	25%	22%	14%	22%
	WALL	15%	16%	17%	16%	25%	12%	23%	21%	14%	17%	14%	15%	17%
	WHSC	16%	10%	11%	12%	6%	11%	9%	9%	9%	10%	10%	13%	10%
Lampreys	SLLM	0%	0%	0%	0%	0%	0.2%	0%	0%	0%	0%	0%	0.0%	0.02%
Sturgeon	LKST	2%	1%	0.3%	0.5%	0.4%	1%	0%	3%	1%	0%	3%	4%	1%
Mooneyes	MOON	3%	1%	9%	5%	0%	2%	8%	1%	1%	7%	1%	1%	3%
	GOLD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Suckers	LNSC	0.3%	0%	0%	0%	6%	0%	0%	0%	0%	0%	0%	0%	1%
	SHRD	3%	2%	7%	4%	5%	7%	3%	4%	3%	1%	4%	4%	4%
	SLRD	3%	5%	6%	5%	1%	0%	4%	3%	2%	2%	4%	3%	3%
Catfishes	BLBL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	BRBL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	CHCT	0.3%	2%	0%	0%	0%	0.2%	0%	1%	2%	0%	0.2%	1%	0.5%
Smelts	RNSM	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Coregonids	CISC	7%	7%	3%	12%	9%	8%	5%	2%	7%	3%	2%	5%	6%
Trout-perch	TRPR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.3%	0%	0%	0.03%
Codfishes	BURB	0%	0%	1%	0%	0%	0.2%	0%	0%	0%	0.3%	0%	0%	0.1%
Sunfishes	RCBS	2%	1%	1%	1%	1%	2%	2%	3%	3%	1%	1%	1%	2%
	SMBS	1%	1%	0.3%	1%	0.4%	1%	1%	2%	0%	1%	1%	1%	1%
	BLCR	0%	0%	0%	0.2%	0.2%	1%	2%	0%	5%	7%	6%	11%	3%
Perch	YLPR	11%	15%	6%	6%	7%	11%	6%	11%	14%	9%	20%	15%	11%

Table 5.6-5. 2008-2019 Relative species abundance in small mesh index gill nets in Lac du Bonnet.

0%	>0-5%	>5-10%	>10-25%	>25-50%	>50%

Group	Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
Sturgeon	LKST	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mooneyes	MOON	1%	0%	1%	0%	0%	0%	1%	0%	0%	0%	0.2%	0%	0.2%
Minnows	EMSH	7%	1%	5%	19%	0%	0%	14%	0%	0%	9%	1%	6%	5%
	SPSH	22%	1%	17%	16%	41%	49%	52%	2%	3%	29%	3%	53%	24%
Suckers	WHSC	0%	0%	0%	0.4%	0.2%	0.1%	0%	0.4%	0%	0%	0%	0%	0.1%
Catfishes	BLBL	0%	0%	0%	0%	0.2%	0%	0%	0%	0%	0%	0%	0%	0.02%
	BRBL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pikes	NRPK	1%	1%	2%	0.3%	0%	0.2%	1%	0.3%	0%	0%	0.2%	0%	0.4%
Smelts	RNSM	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Coregonids	CISC	0%	2%	2%	0%	0%	0%	2%	0%	7%	0%	4%	1%	1%
	LKWH	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.1%
Trout-perch	TRPR	8%	7%	19%	0.3%	0%	0.5%	5%	1%	32%	9%	12%	1%	8%
Codfishes	BURB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sculpins	MTSC	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	SLSC	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Sculpin spp.	0%	0%	0%	0.1%	0%	0%	0%	0%	0%	0%	0%	0%	0.01%
Sunfishes	RCBS	0%	0%	0%	0%	0%	0.5%	0%	0.3%	0%	0%	0.2%	0%	0.1%
	SMBS	0%	0%	0%	0%	0%	0%	0%	0.1%	0%	0%	0.4%	0%	0.04%
	BLCR	0%	0%	0%	0%	0.2%	0.1%	4%	26%	9%	37%	10%	11%	8%
Perch	YLPR	37%	25%	34%	61%	57%	47%	17%	68%	3%	4%	58%	21%	36%
	LGPR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	SAUG	16%	52%	11%	2%	1%	2%	2%	1%	28%	8%	7%	8%	11%
	WALL	10%	12%	9%	1%	1%	2%	3%	1%	18%	5%	5%	1%	6%

Table 5.6-6. 2008-2019 Relative species abundance in standard gang index gill nets in the Pine Falls Forebay.

0%	>0-5%	>5-10%	>10-25%	>25-50%	>50%

Group	Species	2011	2014	2017	Mean
Target	LKWH	0%	1%	1%	1%
	NRPK	3%	2%	4%	3%
	SAUG	5%	7%	10%	7%
	WALL	11%	16%	11%	13%
	WHSC	8%	8%	11%	9%
Lampreys	SLLM	0%	0%	0%	0%
Sturgeon	LKST	0%	1%	0.4%	0.3%
Mooneyes	MOON	6%	0%	9%	5%
	GOLD	0%	1%	0%	0.2%
Suckers	LNSC	0%	0%	0%	0%
	SHRD	1%	0.3%	1%	1%
	SLRD	0%	0%	0%	0%
Catfishes	BLBL	0%	0%	0%	0%
	BRBL	0%	0%	0%	0%
	CHCT	60%	63%	50%	57%
Smelts	RNSM	0%	0%	0%	0%
Coregonids	CISC	0%	0%	0%	0%
Trout-perch	TRPR	0%	0%	0%	0%
Codfishes	BURB	1%	0.3%	0%	0.3%
Sunfishes	RCBS	1%	0%	0.4%	0.5%
	SMBS	0%	1%	0%	0.2%
	BLCR	0%	0%	0%	0%
Perch	YLPR	4%	2%	2%	3%

Table 5.6-7. 2008-2019 Relative species abundance in small mesh index gill nets in the Pine Falls Forebay.

0%	>0-5%	>5-10%	>10-25%	>25-50%	>50%

Group	Species	2011	2014	2017	Mean
Sturgeon	LKST	10%	0%	0%	3%
Mooneyes	MOON	0%	0%	7%	2%
Minnows	EMSH	0%	0%	0%	0%
	SPSH	20%	0%	11%	10%
Suckers	WHSC	0%	0%	0%	0%
Catfishes	BLBL	0%	0%	0%	0%
	BRBL	0%	0%	0%	0%
Pikes	NRPK	0%	5%	0%	2%
Smelts	RNSM	0%	5%	0%	2%
Coregonids	CISC	0%	0%	0%	0%
	LKWH	0%	0%	0%	0%
Trout-perch	TRPR	20%	70%	44%	45%
Codfishes	BURB	0%	0%	0%	0%
Sculpins	MTSC	0%	0%	0%	0%
	SLSC	0%	0%	0%	0%
	Sculpin spp.	0%	0%	0%	0%
Sunfishes	RCBS	0%	0%	0%	0%
	SMBS	0%	0%	0%	0%
	BLCR	0%	0%	0%	0%
Perch	YLPR	10%	0%	0%	3%
	LGPR	0%	0%	0%	0%
	SAUG	0%	15%	26%	14%
	WALL	40%	5%	11%	19%

Table 5.6-8. 2008-2019 Relative species abundance in standard gang index gill nets in Manigotagan Lake.

0%	>0-5%	>5-10%	>10-25%	>25-50%	>50%

Group	Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
Target	LKWH	10%	15%	2%	5%	6%	2%	10%	10%	7%	6%	6%	4%	7%
	NRPK	4%	5%	4%	7%	8%	8%	7%	4%	7%	7%	6%	5%	6%
	SAUG	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	WALL	38%	34%	42%	34%	36%	26%	29%	22%	24%	30%	29%	38%	32%
	WHSC	8%	7%	4%	4%	8%	7%	6%	5%	8%	8%	12%	17%	8%
Lampreys	SLLM	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sturgeon	LKST	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mooneyes	MOON	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	GOLD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Suckers	LNSC	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	SHRD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	SLRD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Catfishes	BLBL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	BRBL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	CHCT	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Smelts	RNSM	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Coregonids	CISC	27%	30%	41%	36%	39%	36%	34%	50%	47%	36%	33%	28%	36%
Trout-perch	TRPR	0%	0%	0.4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.03%
Codfishes	BURB	8%	6%	1%	12%	0.3%	10%	9%	4%	2%	5%	4%	1%	5%
Sunfishes	RCBS	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	SMBS	1%	0.4%	1%	0%	0%	4%	1%	1%	1%	4%	4%	5%	2%
	BLCR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Perch	YLPR	5%	3%	5%	4%	3%	7%	4%	4%	4%	3%	6%	2%	4%

Table 5.6-9. 2008-2019 Relative species abundance in small mesh index gill nets in Manigotagan Lake.

0%	>0-5%	>5-10%	>10-25%	>25-50%	>50%

Group	Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
Sturgeon	LKST	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mooneyes	MOON	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Minnows	EMSH	0%	0%	0%	0%	4%	0%	0%	26%	50%	50%	67%	24%	18%
	SPSH	0%	0%	0%	0%	1%	0%	4%	5%	0%	0%	9%	20%	3%
Suckers	WHSC	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0.1%
Catfishes	BLBL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	BRBL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pikes	NRPK	0%	0%	0%	0%	1%	9%	12%	3%	6%	0%	0%	0%	3%
Smelts	RNSM	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Coregonids	CISC	0%	20%	15%	60%	8%	11%	36%	3%	0%	10%	1%	0%	14%
	LKWH	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.2%
Trout-perch	TRPR	0%	0%	8%	0%	8%	36%	16%	13%	13%	0%	7%	16%	10%
Codfishes	BURB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sculpins	MTSC	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0.1%
	SLSC	0%	0%	0%	0%	1%	0%	0%	3%	0%	0%	0%	0%	0.3%
	Sculpin spp.	0%	0%	0%	0%	0%	0%	0%	0%	0%	10%	0%	0%	1%
Sunfishes	RCBS	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	SMBS	0%	20%	0%	0%	3%	0%	0%	0%	0%	0%	2%	12%	3%
	BLCR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Perch	YLPR	0%	0%	0%	0%	31%	4%	0%	0%	0%	0%	2%	8%	4%
	LGPR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	SAUG	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	WALL	100%	60%	75%	40%	43%	41%	32%	49%	31%	30%	12%	20%	44%

Table 5.6-10. 2008-2019 Relative species abundance in standard gang index gill nets in Eaglenest Lake.

0%	>0-5%	>5-10%	>10-25%	>25-50%	>50%

Group	Species	2010	2013	2016	2019	Mean
Target	LKWH	2%	2%	5%	1%	2%
	NRPK	7%	9%	9%	10%	9%
	SAUG	13%	10%	10%	10%	11%
	WALL	21%	16%	11%	18%	17%
	WHSC	17%	11%	13%	13%	14%
Lampreys	SLLM	3%	0%	0%	0.3%	0.8%
Sturgeon	LKST	0%	0%	0%	0%	0%
Mooneyes	MOON	7%	6%	2%	9%	6%
	GOLD	0%	0%	1%	0%	0.2%
Suckers	LNSC	0%	0%	3%	0%	1%
	SHRD	0.4%	0.2%	0%	0.2%	0.2%
	SLRD	1%	1%	1%	2%	1%
Catfishes	BLBL	0%	2%	0%	0%	1%
	BRBL	0%	0%	17%	3%	5%
	CHCT	0%	0%	0%	0%	0%
Smelts	RNSM	0.2%	0%	0%	0%	0.1%
Coregonids	CISC	0.2%	3%	1%	0.5%	1.1%
Trout-perch	TRPR	0%	0%	0%	0%	0%
Codfishes	BURB	0%	0%	0%	0%	0%
Sunfishes	RCBS	1%	1%	1%	1%	1%
	SMBS	1%	2%	1%	3%	2%
	BLCR	0.2%	0.2%	0%	0.2%	0.1%
Perch	YLPR	25%	37%	26%	29%	29%

Table 5.6-11. 2008-2019 Relative species abundance in small mesh index gill nets in Eaglenest Lake.

0%	>0-5%	>5-10%	>10-25%	>25-50%	>50%

Group	Species	2010	2013	2016	2019	Mean
Sturgeon	LKST	0%	0%	0%	0%	0%
Mooneyes	MOON	1%	0.3%	1%	0.2%	0.4%
Minnows	EMSH	0%	0%	0%	0.2%	0.1%
	SPSH	7%	8%	26%	24%	16%
Suckers	WHSC	1%	0.3%	0%	0.2%	0.3%
Catfishes	BLBL	0%	0%	0%	0%	0%
	BRBL	0%	0%	1%	0%	0.3%
Pikes	NRPK	3%	1%	1%	1%	1%
Smelts	RNSM	0%	0%	0%	0%	0%
Coregonids	CISC	0%	0%	1%	0%	0.2%
	LKWH	0%	0%	0%	0%	0%
Trout-perch	TRPR	46%	18%	18%	5%	22%
Codfishes	BURB	0%	0%	0%	0%	0%
Sculpins	MTSC	0%	0%	0%	0%	0%
	SLSC	0%	0%	0%	0%	0%
	Sculpin spp.	0%	0%	0%	0%	0%
Sunfishes	RCBS	0%	0%	0%	0.2%	0.1%
	SMBS	0%	0%	0%	0%	0%
	BLCR	0%	0%	0%	0%	0%
Perch	YLPR	12%	44%	31%	51%	34%
	LGPR	0%	0%	0%	0.2%	0.1%
	SAUG	18%	25%	19%	15%	19%
	WALL	12%	4%	3%	3%	6%

5.6.2 HILL'S EFFECTIVE RICHNESS

5.6.2.1 ON-SYSTEM SITES

ANNUAL SITES

Pointe du Bois Forebay

The Hill's effective species richness over the 12 years of monitoring ranged from a low of 5.8 in 2013 to a high of 9.9 species in 2017 (Table 5.6-12; Figure 5.6-1).

The overall mean Hill's index value was 7.4, the median was 7.2, and the IQR was 6.3-8.1 species (Figure 5.6-1). The annual mean Hill's index value fell within the overall IQR except in 2009, 2011, and 2013 when it was below the IQR and in 2010, 2017, and 2018 when it was above the IQR.

Lac du Bonnet

The Hill's effective species richness over the 12 years of monitoring ranged from a low of 5.5 in 2013 to a high of 11.8 species in 2014 (Table 5.6-12; Figure 5.6-1).

The overall mean Hill's index value was 8.7, the median was 8.8, and the IQR was 7.1-10.3 species (Figure 5.6-1). The annual mean Hill's index value fell within the overall IQR except in 2011, 2013, and 2015 when it was below the IQR and in 2008, 2010, and 2014 when it was above the IQR.

ROTATIONAL SITES

Pine Falls Forebay

The Hill's effective species richness over the three years of monitoring ranged from a low of 4.3 in 2014 to a high of 6.2 species in 2017 (Table 5.6-12; Figure 5.6-1).

The overall mean Hill's index value was 5.1, the median was 4.8, and the IQR was 4.5-5.5 species (Figure 5.6-1). The annual mean Hill's index value was below the IQR in 2014 and was above the IQR in 2017.

5.6.2.2 OFF-SYSTEM SITES

ANNUAL SITES

Manigotagan Lake

The Hill's effective species richness over the 12 years of monitoring ranged from a low of 3.7 in 2010 to a high of 7.3 species in 2018 (Table 5.6-12; Figure 5.6-1).

The overall mean Hill's index value was 5.4, the median was 5.3, and the IQR was 5.1-5.7 species (Figure 5.6-1). The annual mean Hill's index value fell within the overall IQR except in 2010, 2011, and 2016 when it was below the IQR and in 2013 and 2018 when it was above the IQR.

ROTATIONAL SITES

Eaglenest Lake

The Hill's effective species richness over the four years of monitoring ranged from a low of 7.2 in 2013 to a high of 9.7 species in 2016 (Table 5.6-12; Figure 5.6-1).

The overall mean Hill's index value was 8.3, the median was 8.0, and the IQR was 7.4-8.9 species (Figure 5.6-1). The annual mean Hill's index value fell within the overall IQR except in 2013 when it was below the IQR and in 2016 when it was above the IQR.

Table 5.6-12. 2008-2019 Hill's effective species richness.

Waterbody	Year	n_F[1]	n_{spp}[2]	Value
PDB	2008	537	16	6.9
	2009	444	16	5.9
	2010	364	18	8.6
	2011	1181	18	6.2
	2012	1018	16	7.0
	2013	1204	17	5.8
	2014	522	18	7.9
	2015	656	17	7.4
	2016	598	16	6.3
	2017	765	16	9.9
	2018	775	19	9.0
	2019	1105	17	7.6
LDB	2008	438	18	10.7
	2009	451	17	7.4
	2010	421	17	11.4
	2011	1543	18	6.4
	2012	1041	16	7.3
	2013	1712	18	5.5
	2014	605	16	11.8
	2015	1105	17	5.9
	2016	481	16	10.0
	2017	631	17	10.2
	2018	940	18	8.0
	2019	1056	18	9.7
PFF	2011	204	13	4.8
	2014	332	14	4.3
	2017	283	13	6.2

Table 5.6-12. continued.

Waterbody	Year	n_F[1]	n_{spp}[2]	Value
MANIG	2008	356	8	5.1
	2009	286	8	5.2
	2010	311	9	3.7
	2011	294	7	4.7
	2012	432	13	5.4
	2013	350	9	6.1
	2014	391	10	5.7
	2015	476	12	5.1
	2016	453	10	5.0
	2017	397	10	5.7
	2018	581	11	7.3
	2019	333	11	5.7
EAGLE	2010	668	17	8.6
	2013	910	16	7.2
	2016	749	16	9.7
	2019	1090	19	7.5

Notes:

1. nF = number of fish caught in standard and small mesh gill nets.
2. nspp = number of species caught in standard and small mesh gill nets.

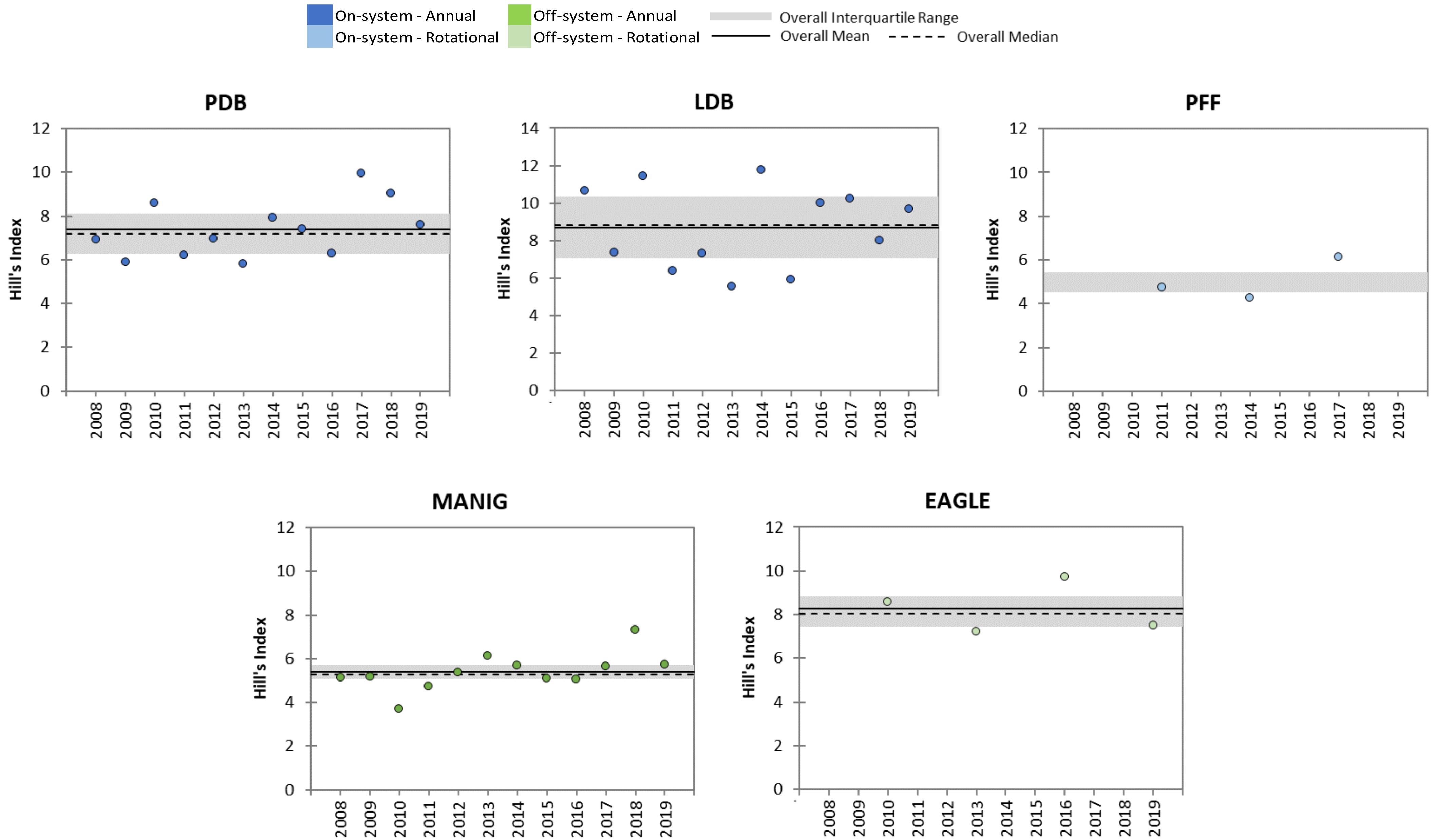


Figure 5.6-1. 2008-2019 Hill's effective species richness.

APPENDIX 5-1. GILLNETTING SITE INFORMATION AND LOCATIONS

The following is a summary of sampling locations over the 12 years of monitoring in the Winnipeg River Region:

<u>Pointe du Bois Forebay</u>

- Gill nets were set at the target locations in all 12 years at all but three locations:
  - GN-04 was not set in 2009 and GN/SN-12 was not set in 2014 due to a combination of high water velocities and inconsistent depths at these sites.
  - GN/SN-16 was added as a target location in 2009.

<u>Lac du Bonnet</u>

- Gill nets were set at the target locations in all 12 years except in 2017 when fishing could not be completed at GN-09 and GN-10 because of a boat malfunction.

<u>Pine Falls Forebay</u>

- Gill nets were set at the target locations in all four years.

<u>Manigotagan Lake</u>

- Gill nets were set at the target locations in all 12 years.

<u>Eaglenest Lake</u>

- Gill nets were set at the target locations in all four years at all but two locations:
  - Site GN-07 was not set in 2013 as gill nets were set at an alternative location to try and increase the amount of deep-water habitat covered.
  - GN/SN-14 was added as a target location after the Pilot Program starting in 2013.

Table A5-1-1. 2008-2019 Set information for gillnetting sites.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
PDB	GN-01	15	326434	5579359	14-Jul-08	22.0	7.3	7.9	18.0
	GN-03	15	324982	5580785	14-Jul-08	26.7	11.5	6.2	19.0
	GN-04	15	323895	5579878	14-Jul-08	27.5	18.0	6.9	18.0
	GN-05	15	323540	5577759	15-Jul-08	24.7	14.9	14.7	20.0
	GN-07	15	322553	5578660	16-Jul-08	23.8	5.5	6.1	18.0
	GN-10	15	322201	5577408	17-Jul-08	22.4	12.8	13.5	18.0
	GN-11	15	320098	5578585	17-Jul-08	26.2	4.5	5.6	20.0
	GN-12	15	319766	5577488	17-Jul-08	20.4	11.4	16.6	19.0
	GN-15	15	319474	5575530	19-Jul-08	23.3	10.1	7.5	19.0
	SN-01	15	326409	5579338	14-Jul-08	20.9	5.8	7.3	18.0
	SN-05	15	323569	5577793	15-Jul-08	25.6	10.8	14.9	20.0
	SN-12	15	319788	5577462	17-Jul-08	21.2	-	-	19.0
	GN-01	15	326366	5579325	14-Jul-09	46.3	7.2	7.9	17.0
	GN-03	15	324972	5580891	17-Jul-09	25.6	6.0	5.0	16.0
	GN-05	15	323487	5577708	17-Jul-09	24.8	15.4	15.2	16.0
	GN-07	15	322561	5578643	13-Jul-09	22.3	6.6	5.1	20.5
	GN-10	15	322191	5577415	18-Jul-09	25.6	12.5	12.6	16.5
	GN-11	15	320112	5578578	15-Jul-09	48.8	5.1	4.5	17.0
	GN-12	15	319738	5577533	18-Jul-09	24.7	11.0	12.5	16.0
	GN-15	15	319493	5575532	19-Jul-09	22.8	6.9	7.4	16.5
	GN-16	15	323786	5581047	20-Jul-09	26.9	4.8	4.6	16.5
	SN-01	15	326386	5579343	14-Jul-09	46.3	7.1	7.2	17.0
	SN-05	15	323529	5577737	17-Jul-09	24.8	14.2	15.4	16.0
	SN-12	15	319755	5577493	18-Jul-09	24.7	11.4	11.0	16.0
	SN-16	15	323839	5581029	20-Jul-09	26.9	4.5	4.8	16.5

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
PDB	GN-01	15	326330	5579312	13-Jul-10	25.1	7.6	6.5	19.0
	GN-03	15	324805	5580920	15-Jul-10	27.3	5.6	6.9	19.0
	GN-04	15	324032	5579877	13-Jul-10	24.4	19.6	15.8	19.0
	GN-05	15	323449	5577738	14-Jul-10	29.8	15.8	16.0	19.0
	GN-07	15	322557	5578674	16-Jul-10	26.2	6.5	6.2	19.0
	GN-10	15	322233	5577384	16-Jul-10	26.6	12.3	13.6	19.0
	GN-11	15	320126	5578551	17-Jul-10	24.0	4.7	6.0	19.0
	GN-12	15	319643	5577488	17-Jul-10	24.1	13.0	9.7	19.0
	GN-15	15	319538	5575533	17-Jul-10	24.0	6.9	5.9	19.0
	GN-16	15	324027	5581109	15-Jul-10	28.6	5.4	4.9	19.0
	SN-01	15	326300	5579283	13-Jul-10	25.1	7.9	7.6	19.0
	SN-05	15	323495	5577776	14-Jul-10	29.8	12.8	15.8	19.0
	SN-12	15	319610	5577472	17-Jul-10	24.1	12.1	13.0	19.0
	SN-16	15	324067	5581119	15-Jul-10	28.6	5.2	5.4	19.0
	GN-01	15	326500	5579322	8-Jul-11	21.6	6.4	7.4	22.0
	GN-03	15	324935	5580917	8-Jul-11	23.3	6.2	4.3	22.5
	GN-04	15	323902	5579858	9-Jul-11	26.3	22.5	10.2	20.0
	GN-05	15	323450	5577817	12-Jul-11	28.8	8.8	21.5	21.0
	GN-07	15	322595	5578555	9-Jul-11	29.0	6.6	6.4	20.0
	GN-10	15	322220	5577494	13-Jul-11	26.8	11.1	10.8	21.0
	GN-11	15	320114	5578570	12-Jul-11	26.7	3.8	5.5	21.0
	GN-12	15	319733	5577542	13-Jul-11	26.7	9.1	10.3	21.0
	GN-15	15	319513	5575527	13-Jul-11	25.0	6.5	3.7	21.0
	GN-16	15	323983	5581088	10-Jul-11	26.5	5.0	5.4	20.5
	SN-01	15	326333	5579342	8-Jul-11	21.6	4.9	6.4	22.0
	SN-05	15	323486	5577827	12-Jul-11	28.8	9.1	8.8	21.0

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
PDB	SN-12	15	319766	5577565	13-Jul-11	26.7	8.8	9.1	21.0
	SN-16	15	323955	5581096	10-Jul-11	26.5	4.9	5.0	20.5
	GN-01	15	326386	5579353	15-Jul-12	25.2	6.9	8.0	22.0
	GN-03	15	324862	5580941	17-Jul-12	25.0	6.2	4.5	21.0
	GN-04	15	323975	5579923	21-Jul-12	24.8	19.6	22.2	22.5
	GN-05	15	323378	5577702	22-Jul-12	24.5	17.4	14.1	22.5
	GN-07	15	322530	5578696	17-Jul-12	24.1	4.7	5.3	22.0
	GN-10	15	322142	5577503	21-Jul-12	25.9	13.1	12.5	23.0
	GN-11	15	320170	5578508	15-Jul-12	24.3	5.0	5.6	21.5
	GN-12	15	319627	5577501	20-Jul-12	26.3	14.2	10.1	22.0
	GN-15	15	319609	5575621	20-Jul-12	27.8	6.8	6.8	22.0
	GN-16	15	324065	5581123	16-Jul-12	24.3	5.2	5.0	21.0
	SN-01	15	326418	5579376	15-Jul-12	26.3	5.3	6.9	22.0
	SN-05	15	323354	5577686	22-Jul-12	24.0	16.4	17.4	22.5
	SN-12	15	319627	5577501	20-Jul-12	26.6	13.1	14.2	22.0
	SN-16	15	324104	5581139	16-Jul-12	24.8	5.1	5.2	21.0
	GN-01	15	326306	5579301	19-Jul-13	24.8	7.5	6.8	21.5
	GN-03	15	324850	5580959	16-Jul-13	27.8	5.5	7.5	22.5
	GN-04	15	324005	5579797	20-Jul-13	24.3	21.0	21.8	21.5
	GN-05	15	323480	5577771	17-Jul-13	29.3	14.1	16.7	21.5
	GN-07	15	322629	5578571	15-Jul-13	24.7	6.9	5.2	23.0
	GN-10	15	322220	5577404	19-Jul-13	25.8	12.1	13.5	22.0
	GN-11	15	320115	5578559	18-Jul-13	27.9	4.1	5.6	21.0
	GN-12	15	319624	5577502	18-Jul-13	28.9	14.2	9.0	21.5
	GN-15	15	319669	5575457	20-Jul-13	24.0	4.9	6.1	21.0

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
PDB	GN-16	15	324012	5581115	16-Jul-13	30.1	5.0	4.6	21.5
	SN-01	15	326290	5579280	19-Jul-13	24.8	7.9	7.5	21.5
	SN-05	15	323503	5577789	17-Jul-13	29.3	10.3	14.1	21.5
	SN-12	15	319598	5577482	18-Jul-13	28.9	12.5	14.2	21.5
	SN-16	15	324045	5581119	16-Jul-13	30.1	5.0	5.0	21.5
	GN-01	15	326413	5579364	24-Jul-14	23.2	8.8	6.9	19.5
	GN-03	15	324981	5580853	21-Jul-14	24.3	5.8	5.9	20.0
	GN-04	15	323956	5579893	20-Jul-14	24.0	23.2	20.2	18.5
	GN-05	15	323328	5577731	22-Jul-14	24.0	15.2	17.4	19.0
	GN-07	15	322624	5578570	17-Jul-14	21.2	5.6	7.3	18.0
	GN-10	15	322131	5577475	15-Jul-14	20.8	12.1	13.2	18.5
	GN-11	15	320207	5578469	18-Jul-14	23.6	6.0	5.4	18.5
	GN-15	15	319651	5575446	25-Jul-14	23.9	6.6	4.9	21.0
	GN-16	15	323880	5581093	19-Jul-14	26.1	5.3	4.8	18.0
	SN-01	15	326258	5579292	24-Jul-14	23.2	9.8	8.8	19.5
	SN-05	15	323458	5577783	22-Jul-14	24.0	12.1	15.2	19.0
	SN-16	15	324024	5581115	19-Jul-14	26.1	5.2	5.3	18.0
	GN-01	15	326320	5579283	15-Jul-15	24.7	7.6	6.5	19.5
	GN-03	15	324861	5580951	15-Jul-15	25.4	5.8	5.5	20.0
	GN-04	15	323904	5579813	14-Jul-15	23.8	22.8	18.6	19.5
	GN-05	15	323465	5577769	14-Jul-15	26.4	15.1	18.6	20.0
	GN-07	15	322555	5578678	17-Jul-15	27.3	6.3	6.0	20.0
	GN-10	15	322215	5577402	18-Jul-15	24.0	12.6	13.8	20.0
	GN-11	15	320200	5578474	13-Jul-15	22.5	5.8	4.6	22.5
	GN-12	15	319641	5577498	16-Jul-15	26.2	13.5	9.8	20.0

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
PDB	GN-15	15	319663	5575572	13-Jul-15	23.5	5.8	4.4	22.5
	GN-16	15	324024	5581097	17-Jul-15	25.8	5.1	5.0	19.5
	SN-01	15	326297	5579266	15-Jul-15	24.7	7.9	7.6	19.5
	SN-05	15	323505	5577770	14-Jul-15	26.4	13.1	15.1	20.0
	SN-12	15	319615	5577478	16-Jul-15	26.2	12.1	13.5	20.0
	SN-16	15	324056	5581108	17-Jul-15	25.8	5.4	5.1	19.5
	GN-01	15	326304	5579288	12-Jul-16	25.8	7.5	6.1	20.0
	GN-03	15	324846	5580961	11-Jul-16	23.8	3.1	5.5	21.0
	GN-04	15	323839	5579798	12-Jul-16	24.5	20.0	22.1	20.0
	GN-05	15	323464	5577764	14-Jul-16	27.8	14.9	16.0	21.0
	GN-07	15	322538	5578694	14-Jul-16	26.4	4.6	6.2	20.5
	GN-10	15	322197	5577382	15-Jul-16	29.9	12.4	12.1	21.5
	GN-11	15	320130	5578531	11-Jul-16	23.7	4.9	6.1	21.0
	GN-12	15	319638	5577503	15-Jul-16	25.8	14.1	11.4	21.0
	GN-15	15	319604	5575451	15-Jul-16	24.4	4.2	6.0	21.0
	GN-16	15	324003	5581091	13-Jul-16	27.0	4.8	4.7	19.5
	SN-01	15	326275	5579276	12-Jul-16	25.8	8.3	7.5	20.0
	SN-05	15	323499	5577775	14-Jul-16	28.2	12.8	14.9	21.0
	SN-12	15	319613	5577473	15-Jul-16	26.2	11.7	14.1	21.0
	SN-16	15	324031	5581108	13-Jul-16	27.3	5.3	4.8	19.5
	GN-01	15	326403	5579378	19-Jul-17	26.3	7.5	6.2	20.5
	GN-03	15	324860	5580946	19-Jul-17	26.7	5.7	5.6	21.0
	GN-04	15	323857	5579821	18-Jul-17	27.6	19.8	21.6	20.5
	GN-05	15	323342	5577714	21-Jul-17	27.9	12.7	16.8	21.5
	GN-07	15	322547	5578690	21-Jul-17	25.3	4.8	6.0	21.5

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
PDB	GN-10	15	322218	5577383	17-Jul-17	24.3	12.4	12.7	21.0
	GN-11	15	320103	5578574	17-Jul-17	23.9	5.6	5.9	21.5
	GN-12	15	319718	5577578	20-Jul-17	25.0	12.4	10.8	20.5
	GN-15	15	319666	5575569	21-Jul-17	24.9	6.0	4.0	20.5
	GN-16	15	323878	5581063	18-Jul-17	26.8	4.8	4.6	20.5
	SN-01	15	326269	5579274	19-Jul-17	26.3	7.5	8.5	20.5
	SN-05	15	323511	5577760	21-Jul-17	27.9	12.7	12.8	21.5
	SN-12	15	319601	5577467	20-Jul-17	25.0	12.4	11.3	20.5
	SN-16	15	324037	5581111	18-Jul-17	26.8	4.8	5.2	20.5
	GN-01	15	326407	5579377	17-Jul-18	28.3	6.3	7.5	21.0
	GN-03	15	324847	5580943	18-Jul-18	27.4	6.4	3.8	21.5
	GN-04	15	323890	5579782	16-Jul-18	25.8	20.4	20.6	21.0
	GN-05	15	323453	5577770	18-Jul-18	26.3	15.4	17.9	22.0
	GN-07	15	322553	5578681	18-Jul-18	25.5	6.2	8.7	21.5
	GN-10	15	322146	5577500	19-Jul-18	23.1	12.1	13.2	22.0
	GN-11	15	320124	5578562	19-Jul-18	23.8	3.3	6.3	23.0
	GN-12	15	319721	5577562	16-Jul-18	26.8	9.4	11.0	21.0
	GN-15	15	319673	5575618	15-Jul-18	25.3	5.8	3.8	23.0
	GN-16	15	323948	5581073	15-Jul-18	24.3	4.7	5.7	22.5
	SN-01	15	326301	5579289	17-Jul-18	28.3	7.5	8.7	21.0
	SN-05	15	323490	5577776	18-Jul-18	26.3	12.9	15.4	22.0
	SN-12	15	319623	5577474	16-Jul-18	26.8	11.0	9.3	21.0
	SN-16	15	324092	5581132	15-Jul-18	24.3	5.1	5.7	22.5
	GN-01	15	326327	5579332	17-Jul-19	27.0	7.7	3.9	21.5
	GN-03	15	324825	5580957	17-Jul-19	26.3	5.5	5.5	21.5

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
PDB	GN-04	15	323880	5579820	20-Jul-19	24.8	20.5	21.2	21.0
	GN-05	15	323494	5577771	19-Jul-19	25.4	12.8	17.2	21.5
	GN-07	15	322556	5578667	16-Jul-19	22.4	6.5	6.7	22.0
	GN-10	15	322138	5577498	16-Jul-19	21.8	12.0	13.0	22.0
	GN-11	15	320111	5578568	19-Jul-19	26.8	3.8	6.3	21.5
	GN-12	15	319614	5577488	20-Jul-19	24.2	12.6	9.4	21.0
	GN-15	15	319633	5575472	20-Jul-19	23.8	5.3	6.8	21.0
	GN-16	15	324039	5581128	18-Jul-19	25.6	5.4	4.9	21.5
	SN-01	15	326298	5579318	17-Jul-19	27.9	7.7	7.7	21.5
	SN-05	15	323534	5577779	19-Jul-19	25.4	11.0	12.8	21.5
	SN-12	15	319591	5577471	20-Jul-19	23.6	11.8	12.6	21.0
	SN-16	15	324068	5581146	18-Jul-19	25.0	5.3	5.4	21.5
LDB	GN-01	15	300757	5586695	21-Sep-08	18.4	13.2	13.3	17.1
	GN-02	15	301067	5588844	21-Sep-08	19.9	3.9	7.9	17.3
	GN-03	15	297646	5586239	21-Sep-08	21.0	8.0	7.9	16.6
	GN-04	15	298543	5583161	22-Sep-08	20.8	5.0	6.1	16.4
	GN-05	15	294154	5584383	22-Sep-08	20.0	7.5	7.7	16.1
	GN-06	15	293387	5587195	22-Sep-08	22.0	5.2	5.2	16.1
	GN-07	15	291311	5583254	23-Sep-08	19.0	4.5	5.9	16.3
	GN-08	15	288429	5586292	23-Sep-08	19.0	2.0	11.4	17.0
	GN-09	15	288004	5582048	24-Sep-08	18.5	8.0	3.0	17.0
	GN-10	15	286599	5579621	24-Sep-08	21.0	5.0	3.9	17.0
	SN-01	15	300612	5586709	21-Sep-08	18.4	13.2	13.2	17.1
	SN-04	15	298654	5583047	22-Sep-08	20.8	5.0	5.0	16.4
	SN-08	15	288592	5586328	23-Sep-08	19.0	2.0	2.0	17.0
	GN-01	15	300801	5586766	20-Sep-09	17.8	17.0	17.0	20.4

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
LDB	GN-02	15	301078	5588621	20-Sep-09	18.1	6.5	3.5	21.3
	GN-03	15	297768	5586211	21-Sep-09	20.5	7.9	7.9	20.3
	GN-04	15	298678	5583062	21-Sep-09	20.1	1.7	5.8	20.0
	GN-05	15	294285	5584308	22-Sep-09	18.4	7.8	7.6	19.9
	GN-06	15	293285	5587369	22-Sep-09	18.6	4.5	-	19.9
	GN-07	15	291360	5583363	23-Sep-09	19.9	4.4	5.1	19.6
	GN-08	15	288602	5586327	23-Sep-09	20.5	1.6	11.5	19.3
	GN-09	15	288150	5582048	24-Sep-09	20.2	3.5	8.0	20.3
	GN-10	15	286655	5579739	24-Sep-09	21.1	5.3	5.0	19.9
	SN-01	15	300801	5586766	20-Sep-09	17.8	17.0	17.0	20.4
	SN-04	15	298678	5583062	21-Sep-09	20.1	1.7	1.7	20.0
	SN-08	15	288602	5586327	23-Sep-09	20.5	4.4	4.4	19.3
	GN-01	15	300801	5586766	21-Sep-10	21.8	15.6	15.1	13.8
	GN-02	15	301078	5588621	21-Sep-10	20.5	6.5	7.8	13.5
	GN-03	15	297768	5586211	21-Sep-10	22.0	9.2	8.8	13.3
	GN-04	15	298678	5583062	22-Sep-10	21.8	7.3	3.7	12.4
	GN-05	15	294285	5584308	22-Sep-10	21.3	9.0	8.7	12.9
	GN-06	15	293285	5587369	22-Sep-10	24.3	6.5	6.0	12.9
	GN-07	15	291360	5583363	23-Sep-10	17.9	6.1	7.3	12.8
	GN-08	15	288602	5586327	23-Sep-10	19.3	2.5	7.8	13.7
	GN-09	15	288150	5582048	20-Sep-10	19.8	1.5	9.1	14.4
	GN-10	15	286655	5579739	20-Sep-10	16.3	5.5	5.8	14.5
	SN-01	15	300801	5586766	21-Sep-10	21.8	15.6	15.1	13.8
	SN-04	15	298678	5583062	22-Sep-10	21.8	7.3	7.3	12.4
	SN-08	15	288602	5586327	23-Sep-10	19.3	2.5	2.5	13.7

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
LDB	GN-01	15	300801	5586766	26-Sep-11	20.0	13.1	13.1	15.9
	GN-02	15	301078	5588621	26-Sep-11	19.0	2.7	6.7	16.4
	GN-03	15	297768	5586211	26-Sep-11	23.6	7.6	6.4	15.3
	GN-04	15	298678	5583062	26-Sep-11	22.0	1.0	5.9	14.8
	GN-05	15	294285	5584308	27-Sep-11	18.2	7.6	7.6	16.5
	GN-06	15	293285	5587369	27-Sep-11	17.5	5.2	5.5	15.3
	GN-07	15	291360	5583363	27-Sep-11	20.3	6.1	5.8	16.4
	GN-08	15	288602	5586327	28-Sep-11	24.7	1.8	13.1	15.8
	GN-09	15	288150	5582048	28-Sep-11	20.8	7.6	1.8	15.9
	GN-10	15	286655	5579739	28-Sep-11	18.1	5.2	4.3	15.8
	SN-01	15	300801	5586766	26-Sep-11	20.0	13.1	13.1	15.9
	SN-04	15	298678	5583062	26-Sep-11	22.0	1.0	1.0	14.8
	SN-08	15	288602	5586327	28-Sep-11	24.7	1.8	1.8	15.8
	GN-01	15	300801	5586766	23-Sep-12	22.2	13.1	12.8	14.4
	GN-02	15	301078	5588621	23-Sep-12	20.0	8.2	5.6	14.3
	GN-03	15	297768	5586211	24-Sep-12	18.3	8.4	7.6	12.9
	GN-04	15	298678	5583062	23-Sep-12	22.8	1.8	5.5	12.8
	GN-05	15	294285	5584308	24-Sep-12	19.5	7.6	7.6	12.9
	GN-06	15	293285	5587369	24-Sep-12	20.3	5.5	5.2	12.9
	GN-07	15	291360	5583363	24-Sep-12	21.3	3.1	5.6	13.3
	GN-08	15	288602	5586327	25-Sep-12	23.8	1.9	12.8	13.4
	GN-09	15	288150	5582048	25-Sep-12	20.5	7.9	2.7	13.8
	GN-10	15	286655	5579739	25-Sep-12	18.2	5.5	4.1	14.0
	SN-01	15	300801	5586766	23-Sep-12	22.2	13.1	13.1	14.4
	SN-04	15	298678	5583062	23-Sep-12	22.8	1.8	1.8	12.8

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
LDB	SN-08	15	288602	5586327	25-Sep-12	23.8	1.9	1.9	13.4
	GN-01	15	300612	5586709	23-Sep-13	21.5	12.8	12.8	17.2
	GN-02	15	301067	5588844	23-Sep-13	20.3	5.5	6.4	17.2
	GN-03	15	297646	5586239	23-Sep-13	25.5	7.7	7.6	17.1
	GN-04	15	298654	5583047	23-Sep-13	23.3	1.7	5.9	16.3
	GN-05	15	294154	5584383	24-Sep-13	17.6	7.6	7.6	16.9
	GN-06	15	293387	5587195	24-Sep-13	16.1	5.5	5.3	16.9
	GN-07	15	291311	5583254	24-Sep-13	18.3	4.4	5.5	17.1
	GN-08	15	288592	5586328	25-Sep-13	24.0	1.8	13.7	17.4
	GN-09	15	288131	5582036	25-Sep-13	21.5	7.9	1.5	17.7
	GN-10	15	286604	5579676	25-Sep-13	19.8	6.1	4.9	17.7
	SN-01	15	300612	5586709	23-Sep-13	21.5	12.8	12.9	17.2
	SN-04	15	298654	5583047	23-Sep-13	23.3	1.7	1.7	16.3
	SN-08	15	288592	5586328	25-Sep-13	24.0	1.8	1.8	17.4
	GN-01	15	300612	5586709	22-Sep-14	21.8	12.8	12.8	13.0
	GN-02	15	301067	5588844	21-Sep-14	21.0	5.5	6.4	13.5
	GN-03	15	297646	5586239	21-Sep-14	19.5	7.7	7.6	12.8
	GN-04	15	298654	5583047	21-Sep-14	23.4	1.7	5.9	12.8
	GN-05	15	294154	5584383	22-Sep-14	20.2	7.6	7.6	13.5
	GN-06	15	293387	5587195	22-Sep-14	19.5	5.5	5.3	13.4
	GN-07	15	291311	5583254	22-Sep-14	21.1	4.4	5.5	13.8
	GN-08	15	288592	5586328	23-Sep-14	21.0	1.8	13.7	13.8
	GN-09	15	288131	5582036	23-Sep-14	18.6	7.9	1.5	13.4
	GN-10	15	286604	5579676	23-Sep-14	17.2	6.1	4.9	14.0
	SN-01	15	300612	5586709	22-Sep-14	21.8	12.8	12.9	13.0
	SN-04	15	298654	5583047	21-Sep-14	23.4	1.7	1.7	12.8

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
LDB	SN-08	15	288592	5586328	23-Sep-14	21.0	1.8	1.8	13.8
	GN-01	15	300612	5586709	20-Sep-15	20.5	13.0	12.5	17.4
	GN-02	15	301067	5588844	20-Sep-15	19.3	6.3	4.7	17.2
	GN-03	15	297646	5586239	20-Sep-15	22.5	8.0	7.3	17.2
	GN-04	15	298654	5583047	21-Sep-15	20.5	1.8	5.6	17.1
	GN-05	15	294154	5584383	21-Sep-15	19.7	7.5	7.3	16.9
	GN-06	15	293387	5587195	21-Sep-15	20.8	4.3	5.2	17.1
	GN-07	15	291311	5583254	21-Sep-15	21.5	3.9	5.0	17.5
	GN-08	15	288592	5586328	22-Sep-15	23.0	10.0	3.0	17.0
	GN-09	15	288131	5582036	22-Sep-15	20.5	8.9	4.0	17.0
	GN-10	15	286604	5579676	22-Sep-15	18.5	4.6	3.9	17.1
	SN-01	15	300612	5586709	20-Sep-15	20.5	1.8	1.8	17.4
	SN-04	15	298654	5583047	21-Sep-15	20.5	13.0	13.0	17.1
	SN-08	15	288592	5586328	22-Sep-15	23.0	10.0	10.0	17.0
	GN-01	15	300612	5586709	20-Sep-16	23.5	13.4	13.4	16.9
	GN-02	15	301067	5588844	19-Sep-16	23.3	6.3	5.3	17.2
	GN-03	15	297646	5586239	19-Sep-16	23.5	7.7	7.7	17.0
	GN-04	15	298654	5583047	19-Sep-16	21.5	5.5	6.0	16.4
	GN-05	15	294154	5584383	20-Sep-16	19.3	7.5	7.6	16.4
	GN-06	15	293387	5587195	20-Sep-16	19.5	5.3	5.5	16.4
	GN-07	15	291311	5583254	21-Sep-16	19.6	6.0	5.7	17.0
	GN-08	15	288592	5586328	21-Sep-16	20.0	10.2	1.8	16.6
	GN-09	15	288131	5582036	21-Sep-16	18.3	4.0	8.0	17.2
	GN-10	15	286604	5579676	22-Sep-16	19.6	5.8	5.5	16.9
	SN-01	15	300612	5586709	20-Sep-16	23.5	13.4	13.4	16.9

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
LDB	SN-04	15	298654	5583047	19-Sep-16	21.5	5.5	5.5	16.4
	SN-08	15	288592	5586328	21-Sep-16	20.0	10.2	10.2	16.6
	GN-01	15	300801	5586766	18-Sep-17	22.6	-	13.2	16.2
	GN-02	15	301078	5588621	18-Sep-17	23.0	9.7	9.2	16.2
	GN-03	15	297768	5586211	19-Sep-17	22.0	7.9	7.8	15.7
	GN-04	15	298678	5583062	18-Sep-17	22.5	-	5.6	14.8
	GN-05	15	294285	5584308	19-Sep-17	21.8	7.3	7.5	14.9
	GN-06	15	293285	5587369	19-Sep-17	22.6	4.4	4.5	15.8
	GN-07	15	291360	5583363	20-Sep-17	22.2	-	-	15.2
	GN-08	15	288602	5586327	20-Sep-17	21.8	-	-	15.8
	SN-01	15	300801	5586766	18-Sep-17	22.6	13.0	-	16.2
	SN-04	15	298678	5583062	18-Sep-17	22.5	4.7	-	14.8
	SN-08	15	288602	5586327	20-Sep-17	21.8	-	-	15.8
	GN-01	15	300718	5586678	17-Sep-18	24.2	13.2	13.1	18.0
	GN-02	15	301127	5588669	18-Sep-18	18.3	9.8	9.8	18.5
	GN-03	15	297889	5586283	18-Sep-18	18.7	8.0	7.9	18.5
	GN-04	15	298573	5583134	18-Sep-18	18.8	5.9	5.2	18.5
	GN-05	15	294161	5584269	17-Sep-18	22.4	7.6	7.6	17.4
	GN-06	15	293462	5587348	17-Sep-18	22.6	5.6	4.9	17.2
	GN-07	15	291425	5583354	19-Sep-18	22.7	3.4	4.7	17.0
	GN-08	15	288535	5586306	19-Sep-18	23.3	2.9	7.6	17.2
	GN-09	15	288137	5582074	20-Sep-18	20.8	5.8	8.2	17.3
	GN-10	15	286633	5579760	20-Sep-18	21.0	5.3	5.3	17.3
	SN-01	15	300694	5586658	17-Sep-18	24.2	13.1		18.0
	SN-04	15	298555	5583136	18-Sep-18	18.8	5.9		18.5

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
LDB	SN-08	15	288535	5586306	19-Sep-18	23.3	2.6		17.2
	GN-01	15	300716	5586910	16-Sep-19	22.9	-	-	17.2
	GN-02	15	301074	5588706	16-Sep-19	23.6	-	-	17.5
	GN-03	15	297692	5586320	17-Sep-19	21.6	-	-	17.7
	GN-04	15	298617	5583087	16-Sep-19	21.9	-	-	17.4
	GN-05	15	294178	5584309	17-Sep-19	20.8	-	-	18.0
	GN-06	15	293306	5587454	17-Sep-19	21.8	-	-	18.8
	GN-07	15	291409	5583417	18-Sep-19	18.9	-	-	18.2
	GN-08	15	288559	5586301	19-Sep-19	28.8	-	-	18.1
	GN-09	15	288099	5582006	18-Sep-19	19.0	-	-	18.2
	GN-10	15	286482	5579738	19-Sep-19	21.7	5.3	5.3	18.2
	SN-01	15	300584	5586893	16-Sep-19	22.9	-	-	17.2
	SN-04	15	298665	5583077	16-Sep-19	21.9	-	-	17.4
	SN-08	15	288590	5586317	19-Sep-19	28.8	-	-	18.1
PFF	GN-01	14	701309	5604645	15-Jul-11	22.1	7.7	5.0	21.5
	GN-02	14	701396	5604838	15-Jul-11	22.8	15.0	15.5	21.5
	GN-03	14	702466	5603192	16-Jul-11	24.8	11.4	8.6	21.5
	GN-05	14	702878	5601645	17-Jul-11	23.8	7.1	7.2	22.0
	GN-07	14	706060	5600416	17-Jul-11	26.9	14.8	10.5	23.0
	GN-09	14	701645	5605432	18-Jul-11	26.3	15.2	15.2	23.0
	GN-10	14	706297	5600715	19-Jul-11	23.6	7.1	2.4	23.0
	GN-11	14	701806	5604275	19-Jul-11	24.0	3.8	2.6	24.0
	GN-13	14	704600	5600217	20-Jul-11	27.2	7.9	6.9	23.0
	SN-01	14	701341	5604635	15-Jul-11	22.1	5.6	7.7	21.5
	SN-03	14	702484	5603222	16-Jul-11	24.3	11.7	11.4	21.5

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
PFF	SN-07	14	706079	5600308	17-Jul-11	25.3	15.5	14.8	22.0
	GN-01	14	701293	5604672	16-Jul-14	18.6	-	-	18.0
	GN-02	14	701556	5604852	16-Jul-14	19.4	-	-	18.0
	GN-03	14	702670	5603400	15-Jul-14	18.8	17.0	8.5	17.0
	GN-05	14	702871	5601580	15-Jul-14	17.3	10.0	7.7	17.0
	GN-07	14	706167	5600389	17-Jul-14	21.3	4.1	10.5	18.0
	GN-09	14	701658	5605403	16-Jul-14	18.0	-	-	18.0
	GN-10	14	706332	5600706	17-Jul-14	22.7	5.4	7.3	18.0
	GN-11	14	701911	5604235	15-Jul-14	20.2	5.5	8.5	17.0
	GN-13	14	704588	5600180	14-Jul-14	22.7	5.5	8.5	16.0
	SN-01	14	701316	5604659	16-Jul-14	18.6	-	-	18.0
	SN-03	14	702675	5603425	15-Jul-14	18.8	17.0	17.0	17.0
	SN-07	14	706170	5600351	17-Jul-14	21.3	4.1	4.1	18.0
	GN-01	14	701176	5604727	24-Jul-17	23.8	9.2	8.8	22.0
	GN-02	14	701565	5604854	24-Jul-17	24.8	13.4	22.4	22.0
	GN-03	14	702675	5603433	25-Jul-17	23.7	15.7	7.7	22.0
	GN-05	14	702868	5601580	25-Jul-17	24.9	10.2	7.3	22.0
	GN-07	14	706145	5600404	26-Jul-17	25.0	11.1	10.1	22.0
	GN-09	14	701654	5605413	23-Jul-17	24.8	14.6	8.6	21.5
	GN-10	14	706271	5600728	25-Jul-17	22.4	7.3	3.8	23.0
	GN-11	14	702025	5604270	23-Jul-17	24.4	6.6	4.8	23.0
	GN-13	14	704603	5600212	26-Jul-17	24.0	7.7	6.8	22.0
	SN-01	14	701312	5604671	24-Jul-17	23.8	9.2	8.7	22.0
	SN-03	14	702675	5603460	25-Jul-17	23.7	15.7	14.3	22.0
	SN-07	14	706160	5600378	26-Jul-17	25.0	11.1	8.2	22.0

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
MANIG	GN-01	15	318961	5640604	7-Sep-08	15.8	18.2	17.5	17.0
	GN-02	15	320044	5639418	7-Sep-08	16.8	6.7	3.7	17.0
	GN-03	15	317163	5639414	8-Sep-08	18.6	5.7	13.0	17.0
	GN-04	15	317424	5636260	8-Sep-08	21.7	3.5	1.4	16.0
	GN-05	15	316202	5637849	9-Sep-08	15.5	20.5	20.3	16.5
	GN-06	15	314841	5640180	9-Sep-08	16.2	15.0	14.0	16.5
	SN-01	15	318961	5640604	7-Sep-08	15.8	18.2	18.2	17.0
	SN-03	15	317163	5639414	8-Sep-08	18.6	3.3	5.7	17.0
	GN-01	15	318955	5640676	1-Sep-09	17.4	19.0	19.0	18.2
	GN-02	15	320137	5639470	1-Sep-09	18.7	7.6	4.7	18.0
	GN-03	15	317135	5639444	2-Sep-09	20.9	1.0	13.0	19.7
	GN-04	15	317454	5636318	2-Sep-09	23.4	4.5	1.5	18.5
	GN-05	15	316224	5637833	3-Sep-09	17.6	21.7	21.5	22.7
	GN-06	15	314846	5640208	3-Sep-09	18.4	16.0	14.8	22.0
	SN-01	15	318955	5640676	1-Sep-09	17.4	19.0	19.0	18.2
	SN-03	15	317135	5639444	2-Sep-09	20.9	1.0	1.0	19.7
	GN-01	15	318918	5640658	7-Sep-10	16.8	19.0	19.0	16.0
	GN-02	15	320077	5639435	7-Sep-10	18.0	7.3	5.2	16.0
	GN-03	15	317176	5639330	8-Sep-10	20.2	11.0	3.9	16.0
	GN-04	15	317422	5636276	8-Sep-10	23.5	4.3	1.9	16.0
	GN-05	15	315996	5637930	9-Sep-10	41.5	22.0	21.0	16.0
	GN-06	15	314778	5640225	9-Sep-10	39.4	16.0	13.0	16.0
	SN-01	15	318950	5640638	7-Sep-10	16.8	19.0	19.0	16.0
	SN-03	15	317138	5639436	8-Sep-10	20.2	11.0	3.9	16.0
	GN-01	15	319087	5640536	8-Sep-11	22.4	16.0	17.0	18.5

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
MANIG	GN-02	15	320163	5639343	8-Sep-11	22.4	3.9	4.3	18.5
	GN-03	15	317108	5639251	7-Sep-11	23.8	13.0	8.4	19.0
	GN-04	15	317408	5636217	6-Sep-11	19.9	9.3	2.0	21.0
	GN-05	15	316021	5637932	6-Sep-11	18.3	20.0	20.0	21.0
	GN-06	15	314711	5640265	7-Sep-11	25.4	14.0	13.0	19.0
	SN-01	15	319094	5640464	8-Sep-11	22.4	16.0	16.0	18.5
	SN-03	15	317250	5639192	7-Sep-11	23.8	4.1	8.4	19.0
	GN-01	15	318877	5640698	10-Sep-12	22.1	18.7	18.7	17.0
	GN-02	15	320078	5639433	10-Sep-12	21.4	6.9	6.8	17.0
	GN-03	15	317194	5639432	11-Sep-12	23.9	6.2	12.3	17.0
	GN-04	15	317418	5636273	12-Sep-12	24.9	3.5	4.1	16.0
	GN-05	15	316047	5637936	12-Sep-12	25.4	20.5	20.4	16.0
	GN-06	15	314777	5640223	11-Sep-12	46.2	14.9	12.8	17.0
	SN-01	15	318901	5640679	10-Sep-12	22.0	18.7	18.3	17.0
	SN-03	15	317161	5639448	11-Sep-12	23.9	3.1	6.2	16.0
	GN-01	15	318933	5640672	9-Sep-13	22.5	17.6	17.4	19.0
	GN-02	15	320083	5639437	9-Sep-13	23.7	6.0	6.3	19.0
	GN-03	15	317166	5639338	10-Sep-13	24.5	10.0	6.6	19.5
	GN-04	15	317423	5636278	11-Sep-13	25.8	2.9	3.5	19.0
	GN-05	15	316015	5637938	10-Sep-13	26.1	20.1	19.9	19.5
	GN-06	15	314779	5640223	11-Sep-13	23.7	13.1	12.1	19.0
	SN-01	15	318957	5640646	9-Sep-13	22.5	17.7	17.6	19.0
	SN-03	15	317201	5639292	10-Sep-13	24.5	12.1	10.0	19.5
	GN-01	15	318933	5640697	8-Sep-14	23.2	18.0	17.8	17.0
	GN-02	15	320046	5639431	8-Sep-14	23.6	7.0	4.0	17.0

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
MANIG	GN-03	15	317198	5639412	9-Sep-14	24.2	8.0	15.0	16.0
	GN-04	15	317431	5636234	10-Sep-14	24.5	3.5	2.6	16.0
	GN-05	15	315982	5637938	9-Sep-14	23.8	20.7	20.8	16.0
	GN-06	15	314836	5640208	10-Sep-14	23.6	15.6	12.3	16.0
	SN-01	15	318980	5640642	8-Sep-14	23.2	18.0	18.0	17.0
	SN-03	15	317157	5639443	9-Sep-14	24.2	6.0	8.0	16.0
	GN-01	15	318849	5640694	14-Sep-15	22.6	18.4	37.9	17.0
	GN-02	15	320088	5639461	14-Sep-15	23.3	7.1	5.8	16.0
	GN-03	15	317156	5639399	15-Sep-15	24.3	6.8	13.2	16.0
	GN-04	15	317440	5636255	16-Sep-15	24.6	4.0	3.6	15.0
	GN-05	15	315992	5637967	15-Sep-15	22.8	25.9	34.0	15.0
	GN-06	15	314862	5640180	16-Sep-15	24.3	17.9	17.6	16.0
	SN-01	15	318939	5640650	14-Sep-15	22.6	18.5	18.4	17.0
	SN-03	15	317151	5639442	15-Sep-15	24.3	3.8	6.8	16.0
	GN-01	15	318917	5640683	12-Sep-16	24.7	38.6	29.3	18.0
	GN-02	15	320074	5639445	12-Sep-16	24.3	6.6	4.2	18.0
	GN-03	15	317174	5639419	13-Sep-16	23.6	6.0	12.4	16.0
	GN-04	15	317423	5636258	14-Sep-16	22.8	3.4	2.3	16.0
	GN-05	15	315989	5637931	13-Sep-16	24.0	20.7	20.2	16.5
	GN-06	15	314698	5640135	14-Sep-16	24.0	14.9	14.9	16.0
	SN-01	15	318939	5640652	12-Sep-16	24.7	18.1	38.6	18.0
	SN-03	15	317150	5639443	13-Sep-16	23.6	5.1	6.0	16.0
	GN-01	15	318907	5640656	13-Sep-17	24.8	17.4	17.4	17.5
	GN-02	15	320055	5639466	13-Sep-17	24.4	6.0	4.9	17.5
	GN-03	15	317179	5639422	12-Sep-17	26.1	5.5	12.0	17.0

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
MANIG	GN-04	15	317456	5636271	11-Sep-17	24.5	2.9	1.9	18.0
	GN-05	15	315983	5637959	12-Sep-17	27.1	18.5	20.1	16.5
	GN-06	15	314869	5640137	11-Sep-17	23.8	14.9	14.6	17.0
	SN-01	15	318934	5640632	13-Sep-17	24.8	17.4	17.4	17.5
	SN-03	15	317158	5639443	12-Sep-17	26.1	5.5	4.1	17.0
	GN-01	15	318913	5640663	10-Sep-18	23.6	17.1	19.7	18.0
	GN-02	15	320065	5639413	10-Sep-18	21.8	5.6	5.1	17.5
	GN-03	15	317172	5639398	11-Sep-18	26.9	5.6	12.3	17.0
	GN-04	15	317431	5636267	12-Sep-18	25.5	2.4	2.9	15.5
	GN-05	15	316010	5637920	12-Sep-18	24.3	19.7	19.8	16.5
	GN-06	15	314767	5640228	11-Sep-18	26.0	13.9	10.5	17.0
	SN-01	15	318945	5640644	10-Sep-18	23.6	17.0	17.1	18.0
	SN-03	15	317155	5639429	11-Sep-18	26.9	4.2	5.6	17.0
	SN-04	15	317402	5636261	12-Sep-18	25.5	2.3	2.4	15.5
	GN-01	15	318927	5640658	9-Sep-19	19.1	16.4	17.5	16.5
	GN-02	15	320113	5639339	9-Sep-19	23.9	6.4	2.0	15.0
	GN-03	15	317164	5639420	12-Sep-19	24.1	5.7	11.6	16.0
	GN-04	15	317331	5636331	11-Sep-19	24.8	3.3	1.9	15.0
	GN-05	15	316028	5637939	11-Sep-19	21.3	20.3	19.8	15.5
	GN-06	15	314783	5640218	12-Sep-19	24.3	15.2	11.8	15.0
	SN-01	15	318946	5640643	9-Sep-19	18.9	16.2	16.4	16.5
	SN-03	15	317144	5639437	12-Sep-19	23.5	3.2	5.7	16.0
	SN-04	15	317438	5636296	11-Sep-19	24.6	3.4	3.3	15.0
EAGLE	GN-02	15	342972	5578980	20-Jul-10	25.2	3.2	3.3	19.0
	GN-03	15	341990	5576703	19-Jul-10	24.4	7.8	8.1	19.5

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
EAGLE	GN-04	15	343679	5577547	20-Jul-10	28.3	12.9	14.2	20.0
	GN-05	15	341358	5573610	21-Jul-10	28.6	7.8	10.9	20.0
	GN-06	15	341263	5576055	21-Jul-10	26.9	2.4	5.5	20.0
	GN-07	15	345398	5569004	22-Jul-10	27.8	4.2	3.9	19.5
	GN-08	15	346310	5569611	22-Jul-10	25.0	12.3	16.2	19.5
	GN-09	15	342276	5571804	23-Jul-10	26.3	4.8	3.8	19.5
	GN-10	15	342879	5571475	23-Jul-10	24.5	7.4	14.5	19.5
	GN-11	15	340695	5570949	24-Jul-10	27.3	3.0	3.1	21.0
	GN-12	15	340769	5571569	24-Jul-10	24.5	8.9	10.3	21.0
	SN-04	15	343718	5577472	20-Jul-10	28.3	12.6	12.9	20.0
	SN-08	15	346239	5569587	22-Jul-10	25.0	11.7	12.3	19.5
	SN-11	15	340623	5570926	24-Jul-10	27.3	2.9	3.0	21.0
	GN-02	15	342035	5578932	22-Jul-13	23.6	3.9	3.7	20.5
	GN-03	15	341951	5576658	26-Jul-13	26.0	8.1	8.4	20.0
	GN-04	15	343691	5577527	26-Jul-13	23.6	12.8	13.9	20.0
	GN-05	15	341335	5573649	26-Jul-13	24.0	7.6	11.5	20.0
	GN-06	15	341284	5576116	22-Jul-13	24.8	5.3	4.9	21.0
	GN-08	15	346274	5569642	23-Jul-13	24.6	13.5	11.8	21.0
	GN-09	15	342220	5571764	23-Jul-13	26.3	5.3	4.2	21.0
	GN-10	15	342873	5571537	24-Jul-13	25.7	7.7	13.2	20.5
	GN-11	15	340667	5570941	24-Jul-13	24.5	3.1	3.3	21.0
	GN-12	15	340725	5571532	25-Jul-13	25.5	8.3	9.4	20.5
	GN-14	15	341362	5574269	25-Jul-13	24.8	5.1	4.3	20.5
	SN-04	15	343613	5577611	26-Jul-13	23.6	12.8	12.8	20.0
	SN-08	15	346245	5569659	23-Jul-13	24.6	12.9	13.5	21.0
	SN-11	15	340639	5570924	24-Jul-13	24.5	3.0	3.1	21.0

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
EAGLE	SN-14	15	341395	5574276	25-Jul-13	24.8	4.8	5.1	20.5
	GN-02	15	342007	5578923	19-Jul-16	24.4	3.3	3.4	20.0
	GN-03	15	341963	5576649	23-Jul-16	24.6	8.1	8.3	20.5
	GN-04	15	343670	5577534	19-Jul-16	22.5	12.6	13.2	21.0
	GN-05	15	341427	5573682	22-Jul-16	23.4	7.8	11.6	20.5
	GN-06	15	341301	5576111	23-Jul-16	22.7	5.6	5.4	20.5
	GN-07	15	345368	5569037	20-Jul-16	26.6	4.3	2.8	20.0
	GN-08	15	346381	5569686	20-Jul-16	25.5	14.2	15.1	20.0
	GN-09	15	342316	5571775	21-Jul-16	22.4	3.3	6.6	20.5
	GN-10	15	342855	5571526	20-Jul-16	22.8	10.6	13.7	20.0
	GN-11	15	340707	5570941	21-Jul-16	25.2	2.8	3.1	19.0
	GN-12	15	340688	5571517	21-Jul-16	25.9	7.9	8.9	19.0
	GN-14	15	341338	5574271	22-Jul-16	21.8	5.1	4.3	21.0
	SN-04	15	343705	5577529	19-Jul-16	22.5	12.5	12.6	21.0
	SN-08	15	346376	5569719	20-Jul-16	25.5	13.7	14.2	20.0
	SN-11	15	340667	5570933	21-Jul-16	25.2	2.3	2.8	19.0
	SN-14	15	341347	5574282	22-Jul-16	21.8	5.0	5.1	21.0
	GN-02	15	341999	5578938	27-Jul-19	23.5	2.7	2.6	20.5
	GN-03	15	341948	5576656	27-Jul-19	23.9	7.5	7.4	20.5
	GN-04	15	343705	5577495	22-Jul-19	24.3	11.4	13.0	22.0
	GN-05	15	341348	5573666	26-Jul-19	25.0	7.1	9.9	20.5
	GN-06	15	341234	5576100	22-Jul-19	24.8	2.1	4.9	21.5
	GN-07	15	345436	5568966	23-Jul-19	26.5	3.4	3.7	21.0
	GN-08	15	346280	5569632	23-Jul-19	25.9	11.9	9.7	21.0
	GN-09	15	342328	5571778	24-Jul-19	25.3	5.9	3.4	21.0

Table A5-1-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h) [1]	Water Depth (m)		Set Water Temperature (°C)
		Zone	Easting	Northing			Start	End	
EAGLE	GN-10	15	342869	5571520	25-Jul-19	24.3	9.3	13.0	22.0
	GN-11	15	340672	5571047	25-Jul-19	24.5	2.9	2.7	22.0
	GN-12	15	340724	5571587	24-Jul-19	24.9	7.8	8.6	22.0
	GN-14	15	341255	5574291	26-Jul-19	24.8	4.5	3.5	20.5
	SN-04	15	343727	5577470	22-Jul-19	23.8	11.3	11.4	22.0
	SN-08	15	346256	5569643	23-Jul-19	25.2	11.1	11.9	21.0
	SN-11	15	340644	5571050	25-Jul-19	25.0	3.0	2.9	22.0
	SN-14	15	341366	5574279	26-Jul-19	24.6	4.0	4.5	20.5

Notes:

1. Gill nets that were set for >36 h (red font) were excluded from the data analysis for abundance and diversity metrics.

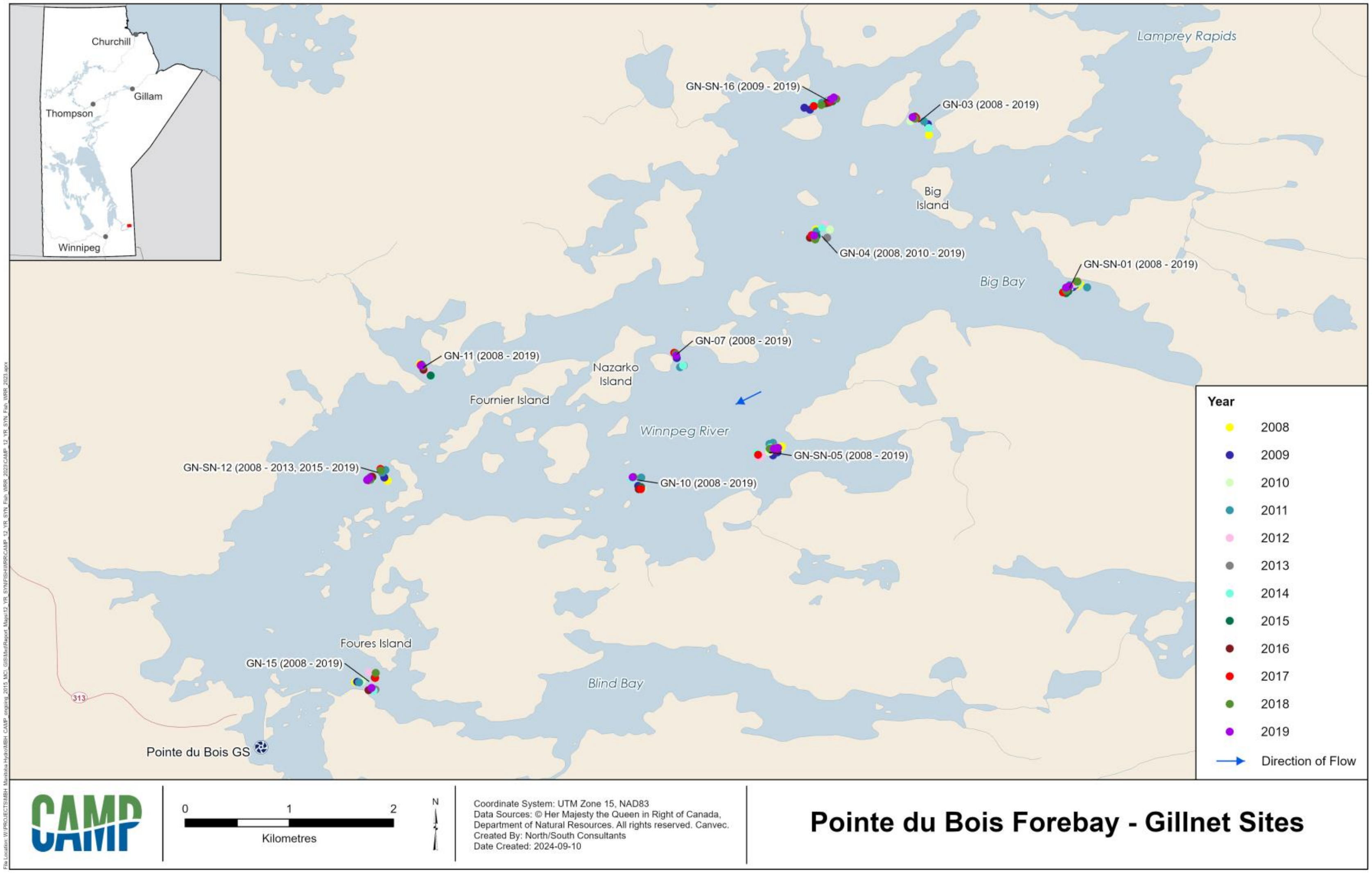


Figure A5-1-1. 2008-2019 Gillnetting sites in the Pointe du Bois Forebay.

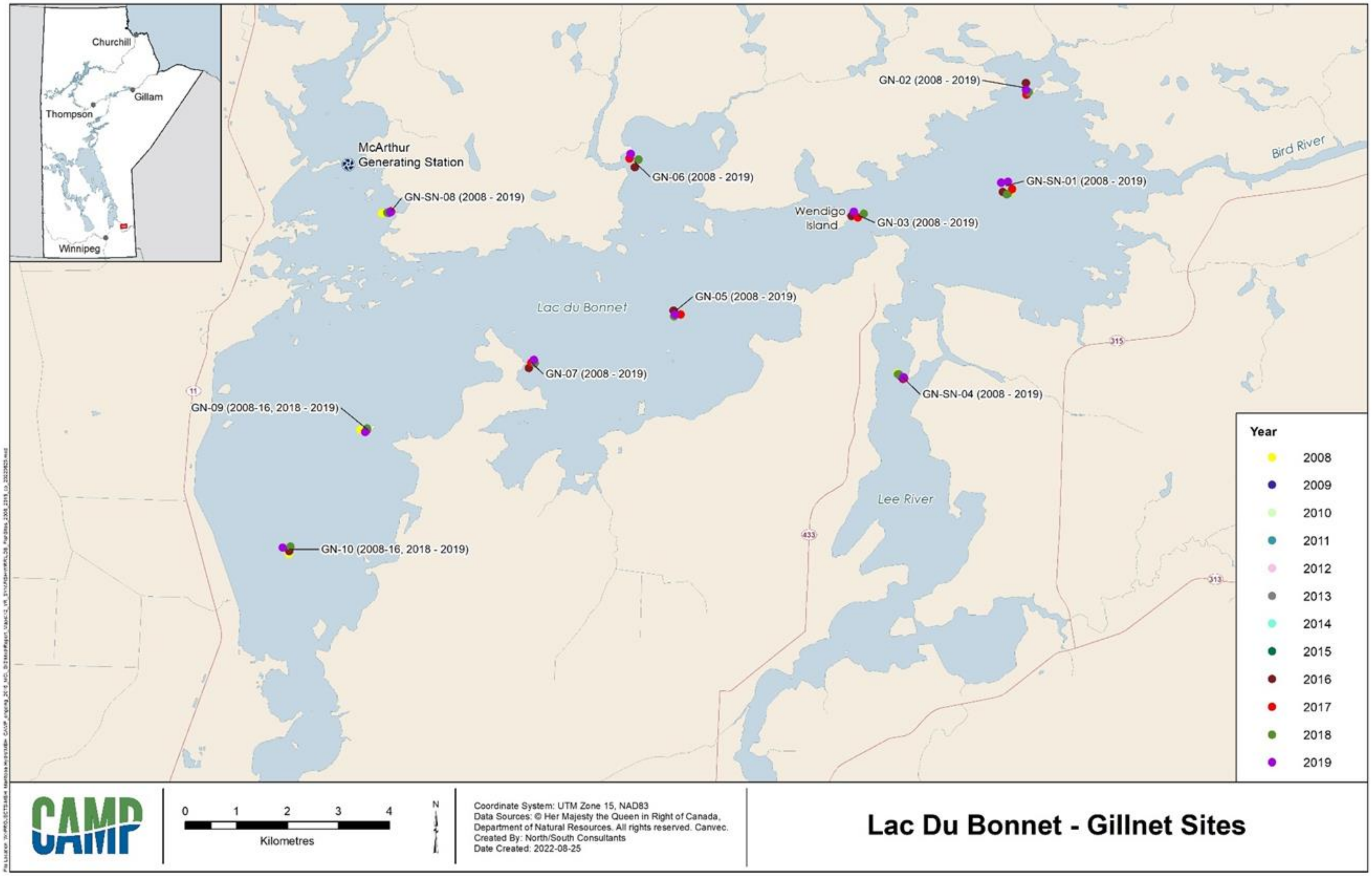


Figure A5-1-2. 2008-2019 Gillnetting sites in Lac du Bonnet.

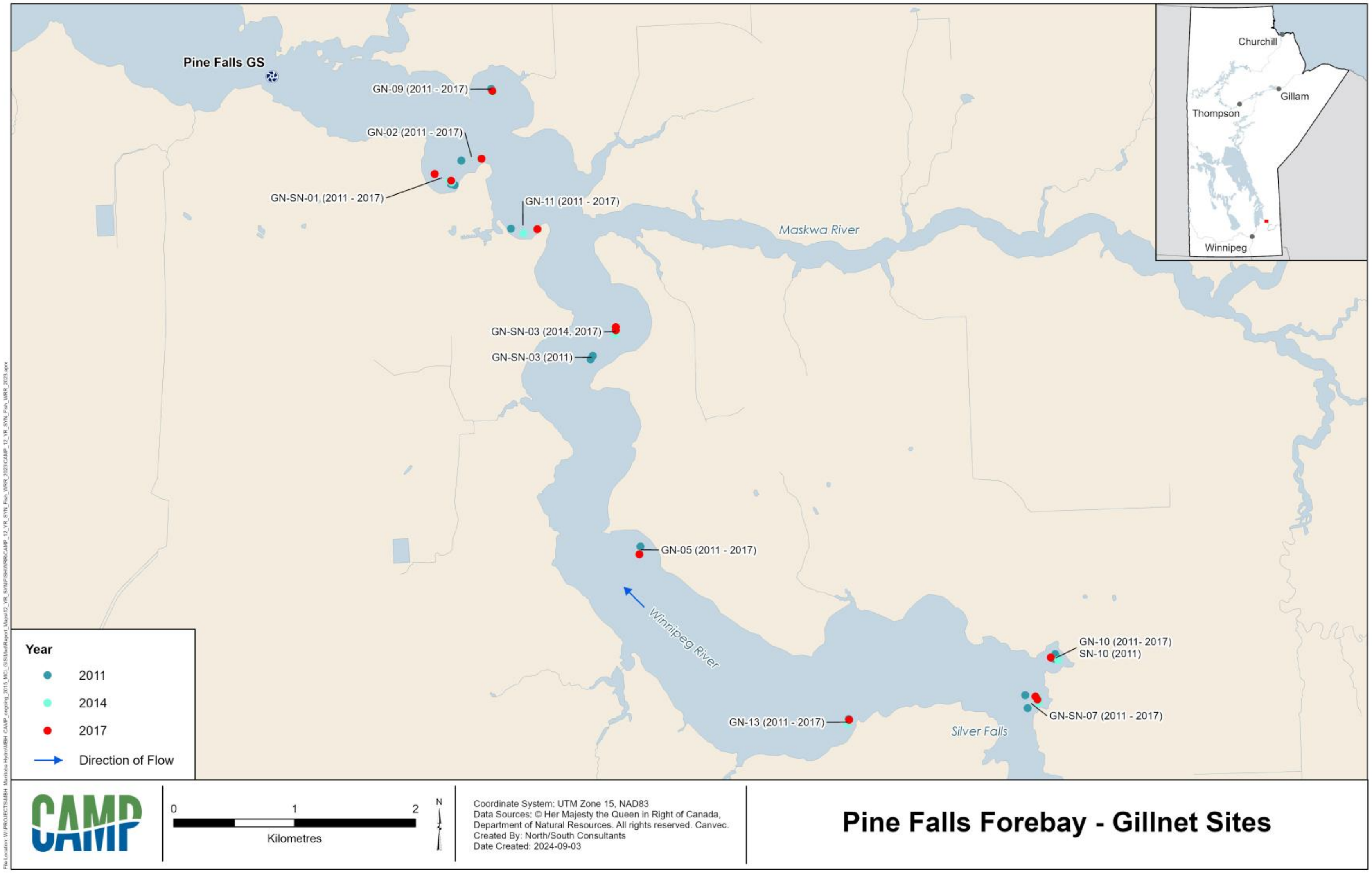


Figure A5-1-3. 2011-2017 Gillnetting sites in the Pine Falls Forebay.

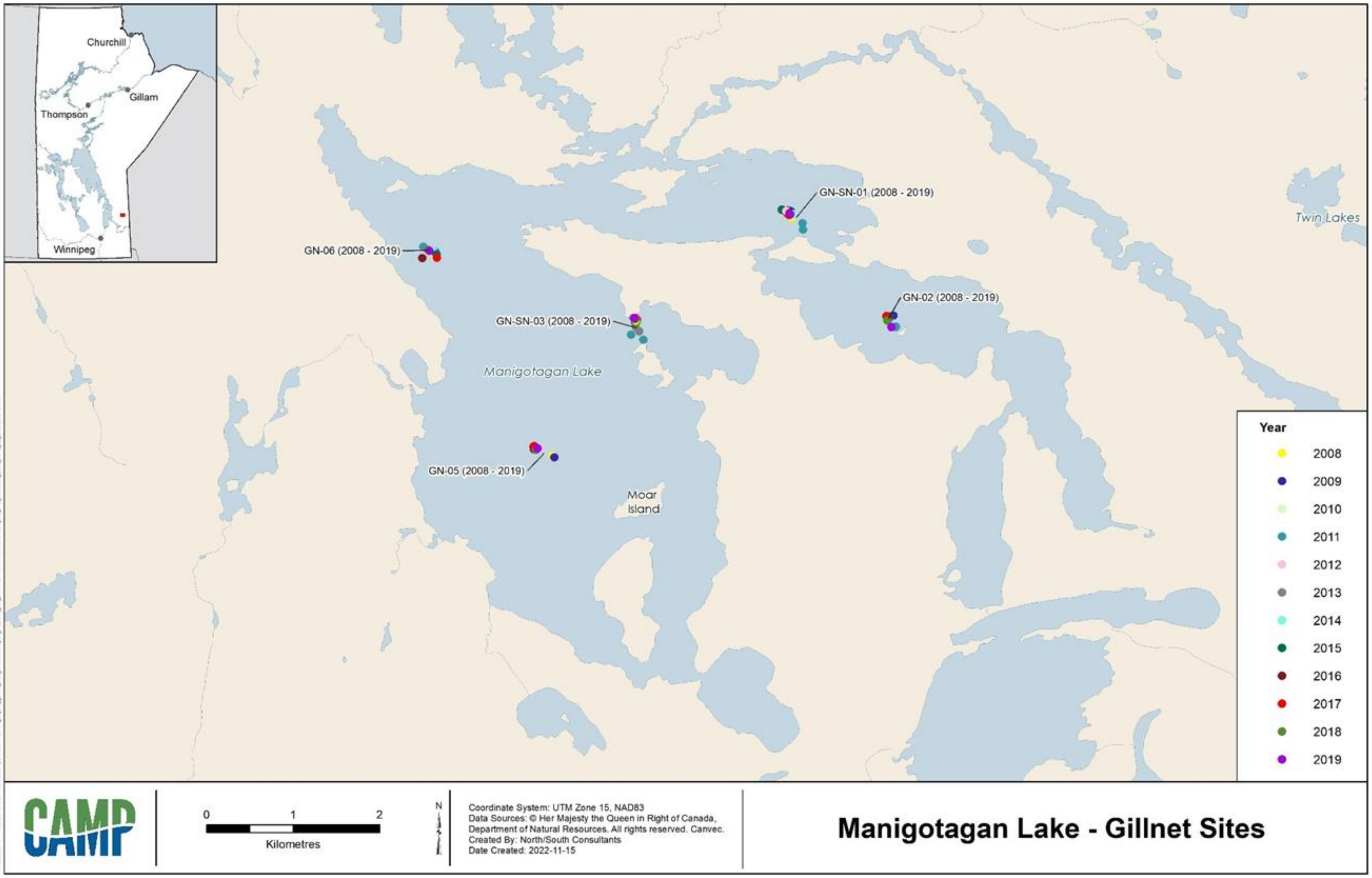


Figure A5-1-4. 2008-2019 Gillnetting sites in Manigotagan Lake.

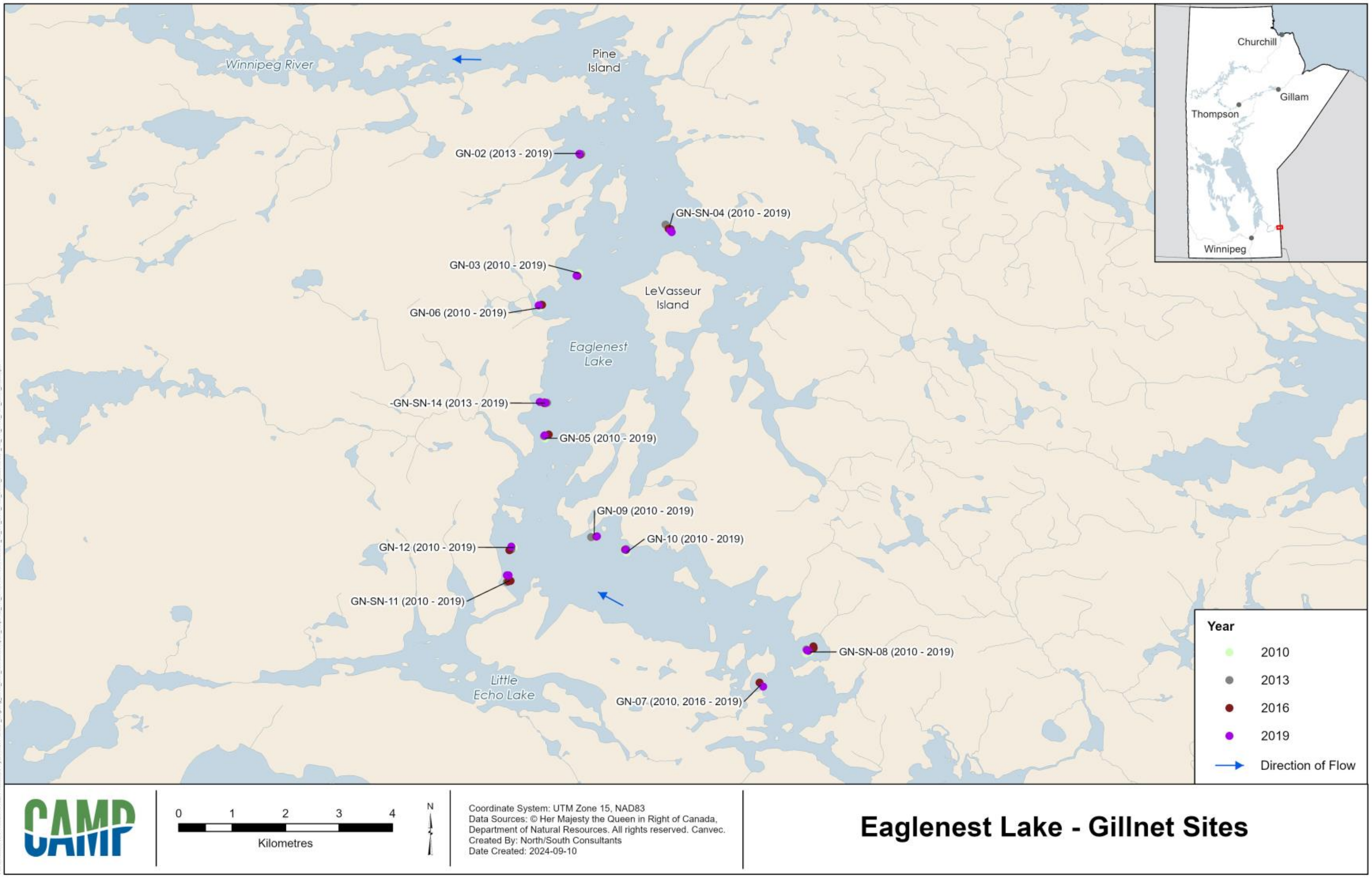


Figure A5-1-5. 2010-2019 Gillnetting sites in Eaglenest Lake.

6.0 MERCURY IN FISH

6.1 INTRODUCTION

The following presents the results of fish mercury monitoring conducted from 2008-2019 in the Winnipeg River Region. Fish mercury sampling was conducted on a three-year rotation beginning in 2010 at the on-system Pointe du Bois Forebay and the off-system Manigotagan Lake (Table 6.1-1; Figure 6.1-1).

Mercury concentrations are measured in muscle tissue of commercially important fish species – Northern Pike, Walleye, and Lake Whitefish. Monitoring of mercury in 1-year-old Yellow Perch is also conducted as a potential early indicator of changes in mercury in the food web. Samples of fish muscle are collected during the conduct of fish community monitoring. Mercury is analysed in the trunk muscle of Northern Pike, Lake Whitefish, and Walleye selected over a range of fork lengths. Yearling Yellow Perch are analyzed for mercury as carcass with the head, pelvic and pectoral girdles, caudal fin, and digestive tract removed.

There were two departures from the planned field sampling schedule during the 12-year period:

- Lake Whitefish were sampled for mercury analysis from Manigotagan Lake in 2011 because of low catches in 2010; and
- Lake Whitefish were not sampled for mercury analysis from the Pointe du Bois Forebay as scheduled in 2019.

Two metrics were selected for detailed reporting: arithmetic mean mercury concentrations; and, length-standardized mean mercury concentrations (also referred to as "standard mean(s)"; Table 6.1-2). Standard lengths varied by species as follows: Lake Whitefish (350 mm); Northern Pike (550 mm); and Walleye (400 mm). As CAMP targets a specific age class of Yellow Perch, fish captured for this component are inherently of a limited size range; therefore, length-standardization for this species was not undertaken.

A detailed description of the program design and sampling methods is provided in Technical Document 1, Section 2.6.

Table 6.1-1. 2008-2019 Inventory of fish mercury sampling.

Waterbody/Area	Sampling Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
PDB			●			●			●			● [2]
MANIG			●	● [1]		●			●			●

Notes:

1. Lake Whitefish only; samples collected in 2011 due to low catches in 2010.
2. Lake Whitefish were not collected for mercury analysis.

Table 6.1-2. Mercury in fish indicators and metrics.

Indicator	Metric	Units
Mercury in Fish	• Arithmetic mean mercury concentration	Parts per million (ppm)
	• Length-standardized mean mercury concentration of large-bodied species	ppm

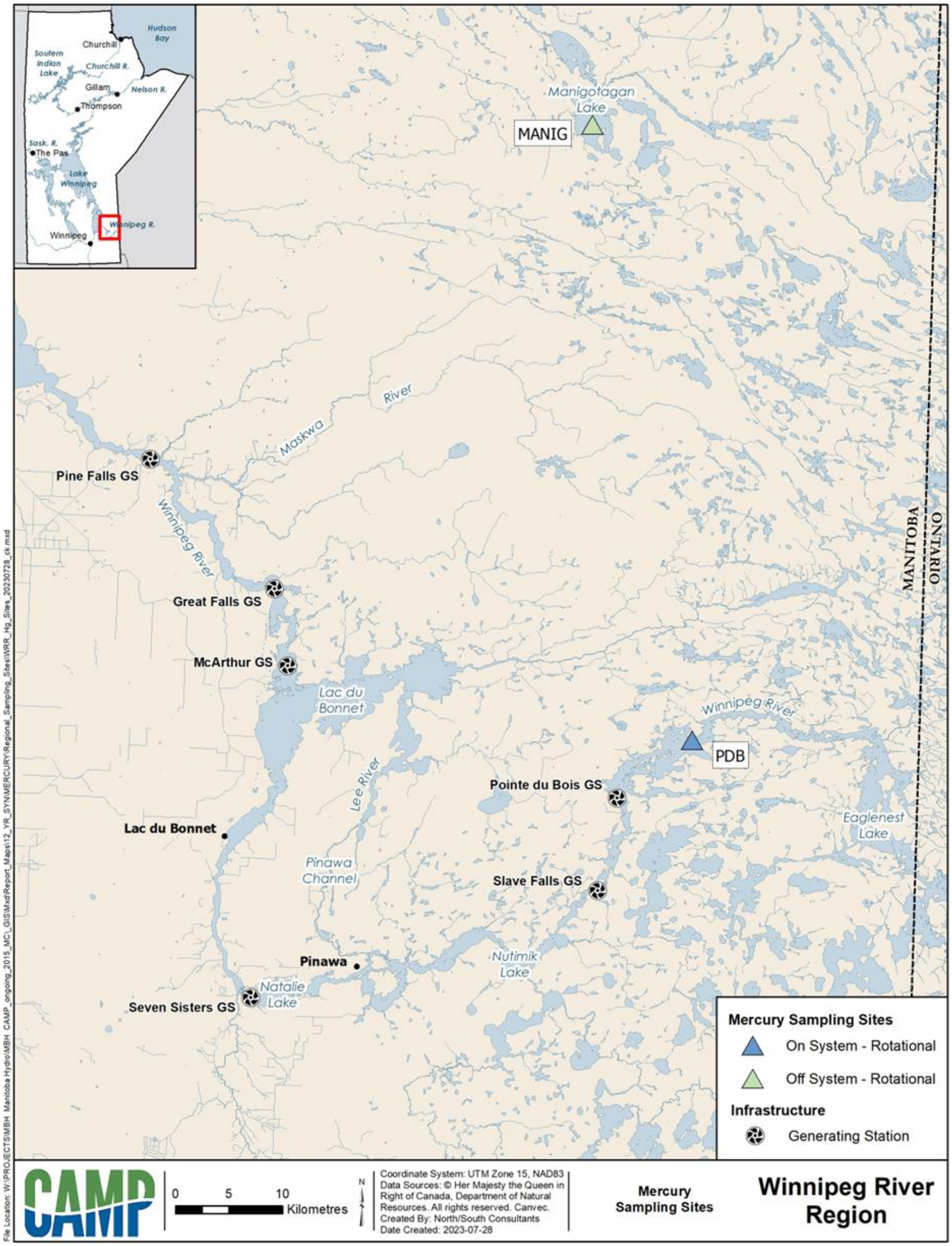


Figure 6.1-1. 2008-2019 Fish mercury sampling sites.

6.2 MERCURY IN FISH

6.2.1 MERCURY CONCENTRATIONS IN FISH

6.2.1.1 ON-SYSTEM SITES

ANNUAL SITES

There are no waterbodies in the Winnipeg River Region that are monitored for fish mercury annually.

ROTATIONAL SITES

<u>Pointe du Bois Forebay</u>

Lake Whitefish

The arithmetic mean mercury concentration of Lake Whitefish over the four years of monitoring ranged from a low of 0.045 parts per million (ppm) in 2013 to a high of 0.096 ppm in 2010 (Table 6.2-1). Lake Whitefish were not sampled for mercury in 2019 (Figure 6.2-1).

Northern Pike

The arithmetic mean mercury concentration of Northern Pike over the four years of monitoring ranged from a low of 0.313 ppm in 2013 to a high of 0.508 ppm in 2010 (Table 6.2-1). The mercury concentration typically increased with fork length, although there was variation in the mercury concentration of Northern Pike of the same length (Figure 6.2-2).

Walleye

The arithmetic mean mercury concentration of Walleye over the four years of monitoring ranged from a low of 0.283 ppm in 2019 to a high of 0.652 ppm in 2010 (Table 6.2-1). The mercury concentration typically increased with fork length, although there was variation in the mercury concentration of Walleye of the same length (Figure 6.2-3).

Yellow Perch

The arithmetic mean mercury concentration of 1-year-old Yellow Perch over the three years of monitoring was 0.017 ppm in 2013, 0.030 ppm in 2016, and 0.023 ppm in 2019 (Figure 6.2-4).

6.2.1.2 OFF-SYSTEM SITES

ANNUAL SITES

There are no waterbodies in the Winnipeg River Region that are monitored for fish mercury annually.

ROTATIONAL SITES

Manigotagan Lake

Lake Whitefish

The arithmetic mean mercury concentration of Lake Whitefish over the four years of monitoring ranged from a low of 0.044 ppm in 2019 to a high of 0.126 ppm in 2013 (Table 6.2-1). There was variation in the mercury concentration of Lake Whitefish of the same length (Figure 6.2-1).

Northern Pike

The arithmetic mean mercury concentration in Northern Pike over the four years of monitoring ranged from a low of 0.419 ppm in 2013 to a high of 1.18 ppm in 2010 (Table 6.2-1). The mercury concentration typically increased with fork length, although there was variation in the mercury concentration of Northern Pike of the same length (Figure 6.2-2).

Walleye

The arithmetic mean mercury concentration in Walleye over the four years of monitoring ranged from a low of 0.291 ppm in 2016 to a high of 0.530 ppm in 2013 (Table 6.2-1). The mercury concentration typically increased with fork length, although there was variation in the mercury concentration of Walleye of the same length (Figure 6.2-3).

Yellow Perch

The arithmetic mean mercury concentration of 1-year-old Yellow Perch over the three years of monitoring was 0.059 ppm in 2013 and 0.025 ppm in 2016 (Figure 6.2-4). None of the Yellow Perch collected for mercury analysis in 2019 were one-year-old.

Table 6.2-1. 2010-2019 Fork length, age, and mercury concentrations of Lake Whitefish, Northern Pike, and Walleye.

Species	Waterbody	Year	Fork Length (mm)					Age (years)					Mercury (ppm)						
			n[1]	Mean	Min[2]	Max[2]	SE[3]	n	Mean	Min	Max	SE	n	Mean	Min	Max	SE	Standard Mean[4]	95% CL[5]
LKWH	PDB	2010	4	403	320	560	54	4	7	3	15	3	4	0.096	0.046	0.230	0.045	0.053	0.028-0.101
		2013	3	363	297	431	39	0	-	-	-	-	3	0.045	0.037	0.055	0.005	not significant	
		2016	4	430	334	470	32	4	6	4	6	1	4	0.062	0.055	0.071	0.003	not significant	
		2019	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	MANIG	2011	13	371	254	508	18	12	13	5	30	2	13	0.096	0.073	0.135	0.006	not significant	
		2013	5	383	216	450	43	5	13	2	20	3	5	0.126	0.060	0.210	0.026	not significant	
		2016	32	406	248	482	12	31	12	1	27	1	32	0.100	0.040	0.325	0.009	0.076	0.065-0.089
		2019	12	354	238	482	22	11	9	4	26	2	12	0.044	0.026	0.091	0.006	0.041	0.034-0.050
NRPK	PDB	2010	17	490	235	897	34	17	5	2	10	0	17	0.508	0.110	1.23	0.078	0.558	0.435-0.716
		2013	35	495	339	782	21	34	5	3	9	0	35	0.313	0.086	1.05	0.042	0.341	0.298-0.390
		2016	32	550	231	883	25	32	4	1	7	0	32	0.461	0.114	0.980	0.037	0.440	0.409-0.473
		2019	28	474	286	927	28	28	4	2	8	0	28	0.330	0.079	1.22	0.053	0.389	0.335-0.451
	MANIG	2010	11	583	520	770	24	11	6	5	10	1	11	1.18	0.584	1.69	0.121	not significant	
		2013	28	509	411	640	10	28	5	3	6	0	28	0.419	0.144	0.840	0.036	0.494	0.420-0.581
		2016	31	554	365	725	16	31	5	2	12	0	31	0.437	0.101	1.13	0.044	0.376	0.327-0.431
		2019	14	537	416	781	35	14	5	3	8	0	14	0.422	0.158	1.21	0.086	0.385	0.317-0.466
WALL	PDB	2010	36	375	128	710	27	28	11	2	27	1	36	0.652	0.098	1.92	0.076	0.649	0.585-0.719
		2013	37	405	156	662	22	37	8	2	18	1	37	0.419	0.124	1.12	0.048	0.365	0.323-0.414
		2016	36	393	183	574	20	36	7	2	17	1	36	0.467	0.145	1.66	0.055	0.425	0.369-0.488
		2019	36	336	123	551	21	36	6	1	16	1	36	0.283	0.052	0.792	0.033	0.324	0.280-0.376
	MANIG	2010	53	351	116	596	15	53	5	0	14	0	53	0.396	0.095	1.36	0.038	0.429	0.386-0.477
		2013	36	368	131	657	26	36	7	1	18	1	36	0.530	0.107	1.89	0.070	0.522	0.465-0.585
		2016	38	372	121	570	18	36	5	1	14	0	38	0.291	0.063	0.954	0.034	0.283	0.246-0.326
		2019	36	410	219	665	21	34	7	2	17	1	36	0.325	0.068	1.22	0.053	0.226	0.192-0.266

Notes:

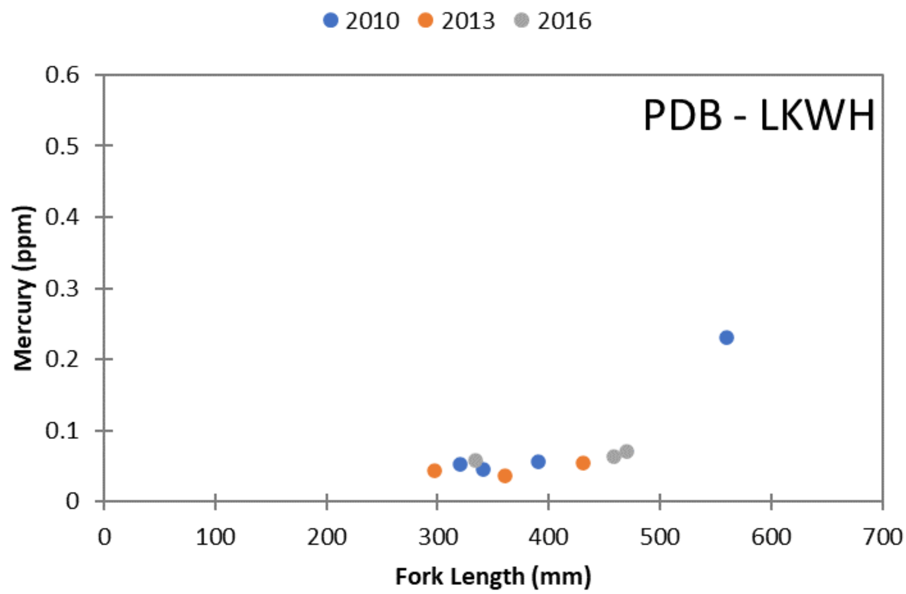
1. n = sample size.
2. Min = minimum; Max = maximum.
3. SE = standard error.
4. For standard lengths of 350 mm for LKWH, 550 mm for NRPK, and 400 mm for WALL.
5. CL = confidence limits.

Table 6.2-2. 2013-2019 Fork length and mercury concentrations of 1-year-old Yellow Perch.

Species	Waterbody	Year	n[1]	Fork Length (mm)				Mercury (ppm)			
				Mean	Min[2]	Max[2]	SE[3]	Mean	Min	Max	SE
YLPR	PDB	2013	19	78	70	83	1	0.017	<0.010	0.029	0.002
		2016	8	81	70	90	1	0.030	0.018	0.044	0.003
		2019	9	82	78	88	1	0.023	0.0195	0.0289	0.001
	MANIG	2013	2	90	88	92	0	0.059	0.055	0.062	0.002
		2016	9	65	60	68	0	0.025	0.017	0.031	0.002
		2019	0	-	-	-	-	-	-	-	-

Notes:

1. n = sample size.
2. Min = minimum; Max = maximum.
3. SE = standard error.



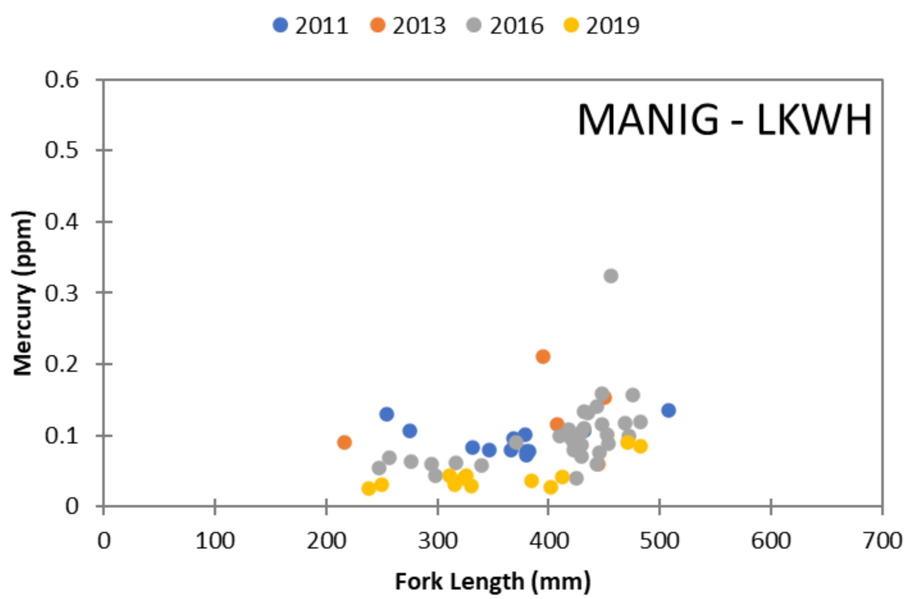


Figure 6.2-1. 2010-2019 Mercury concentration versus fork length of Lake Whitefish.

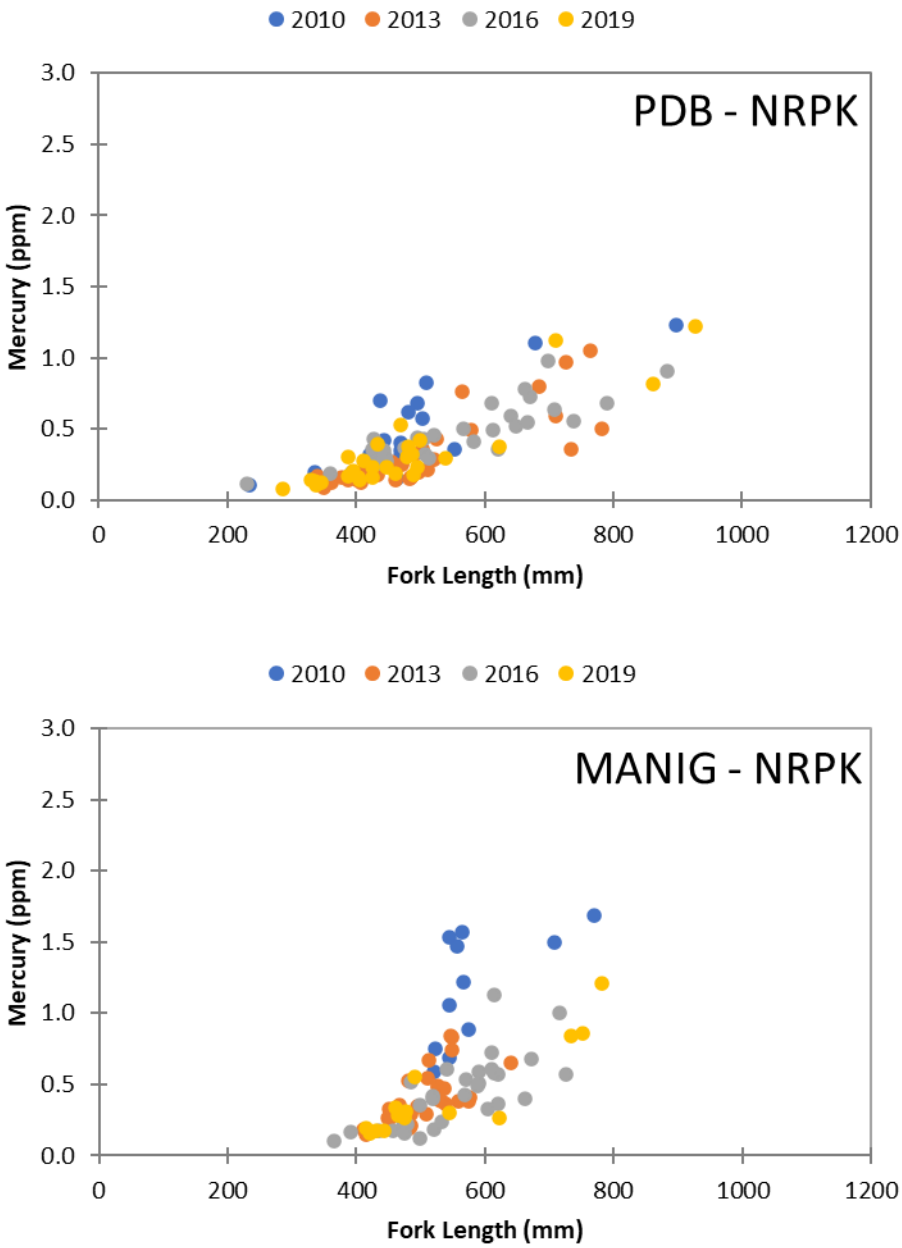
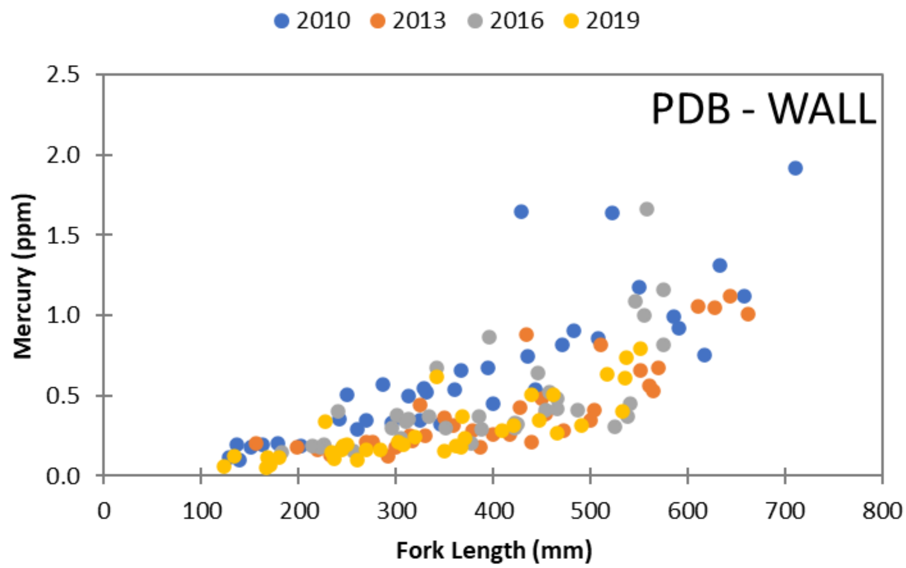


Figure 6.2-2. 2010-2019 Mercury concentration versus fork length of Northern Pike.



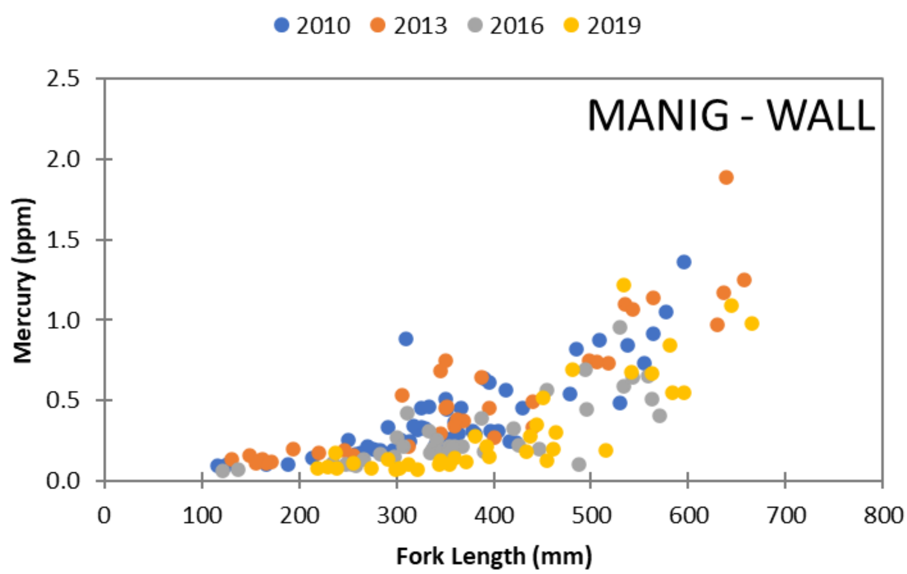


Figure 6.2-3. 2010-2019 Mercury concentration versus fork length of Walleye.

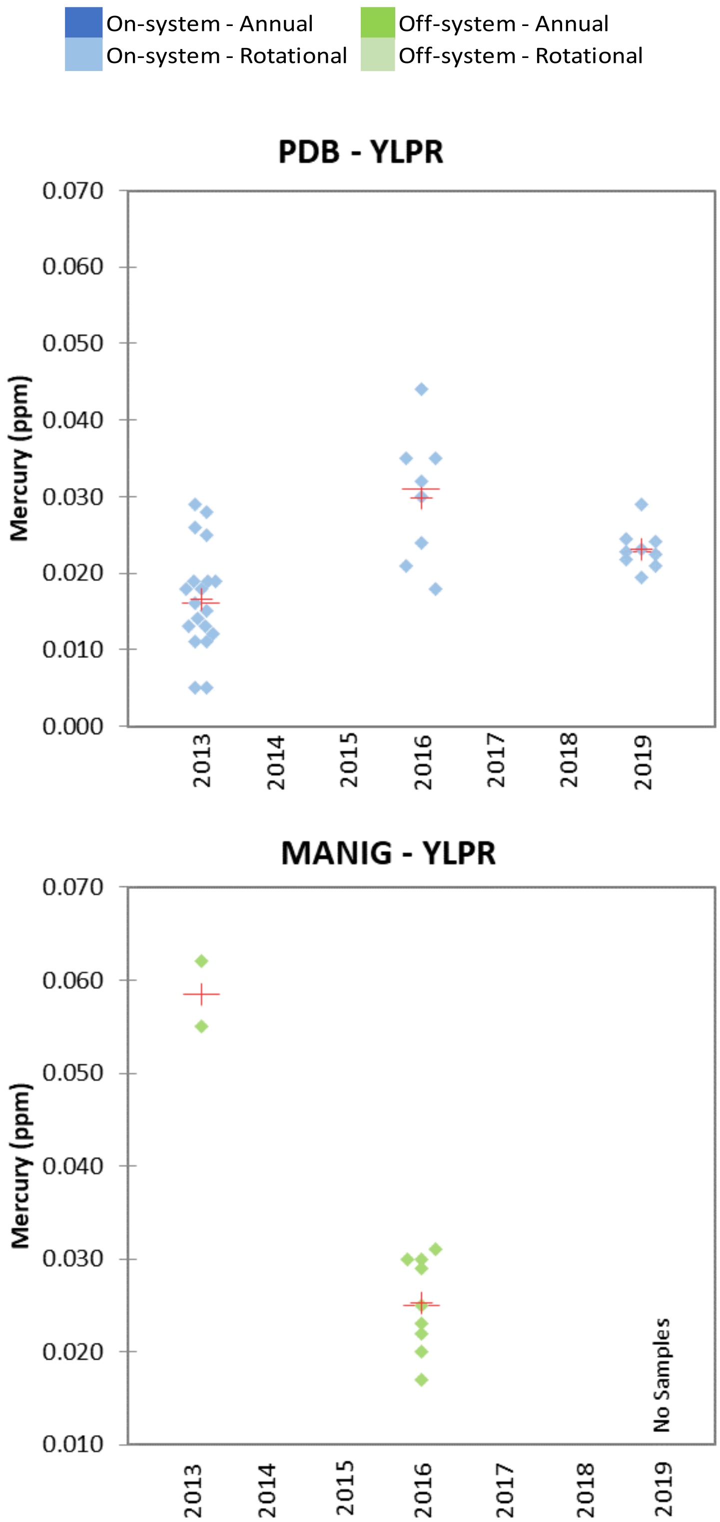


Figure 6.2-4. 2013-2019 Mercury concentrations of one-year-old Yellow Perch.

6.2.2 LENGTH-STANDARDIZED MEAN CONCENTRATION

6.2.2.1 ON-SYSTEM SITES

ANNUAL SITES

There are no waterbodies in the Winnipeg River Region that are monitored for fish mercury annually.

ROTATIONAL SITES

<u>**Pointe du Bois Forebay**</u>

Lake Whitefish

The length-standardized mean mercury concentration of a 350 mm Lake Whitefish was 0.053 ppm in 2010 (Figure 6.2-5). A standard mean could not be calculated for the other years because there was not a significant relationship between mercury concentration and fork length for the few Lake Whitefish analyzed for mercury in 2013 and 2016, and no Lake Whitefish were analyzed for mercury in 2019 (Table 6.2-1).

Northern Pike

The length-standardized mean mercury concentration of a 550 mm Northern Pike over the four years of monitoring ranged from a low of 0.341 ppm in 2013 to a high of 0.558 ppm in 2010 (Figure 6.2-6).

The overall mean concentration was 0.432 ppm, the median concentration was 0.414 ppm, and the interquartile range (IQR) was 0.377–0.470 ppm (Figure 6.2-6). The annual mean mercury concentration fell within the IQR except in 2013 when it was below and in 2010 when it was above.

Walleye

The length-standardized mean mercury concentration of a 400 mm Walleye over the four years of monitoring ranged from a low of 0.324 ppm in 2019 to a high of 0.649 ppm in 2010 (Figure 6.2-7).

The overall mean concentration was 0.441 ppm, the median concentration was 0.395 ppm, and the IQR was 0.355–0.481 ppm (Figure 6.2-7). The annual mean mercury concentration fell within the IQR except in 2019 when it was below and in 2010 when it was above.

6.2.2.2 OFF-SYSTEM SITES

ANNUAL SITES

There are no waterbodies in the Winnipeg River Region that are monitored for fish mercury annually.

ROTATIONAL SITES

Manigotagan Lake

Lake Whitefish

The length-standardized mean mercury concentration of a 350 mm Lake Whitefish was 0.041 ppm in 2019 and 0.076 ppm in 2016 (Figure 6.2-5). A standard mean could not be calculated for the other years because there was not a significant relationship between mercury concentration and fork length for the few Lake Whitefish analyzed for mercury (Table 6.2-1).

Northern Pike

The length-standardized mean mercury concentration of a 550 mm Northern Pike over the four years of monitoring ranged from a low of 0.376 ppm in 2016 to a high of 0.494 ppm in 2013 (Figure 6.2-6). A standard mean could not be calculated for 2010 because there was not a significant relationship between mercury concentration and fork length for the few Northern Pike analyzed for mercury (Table 6.2-1).

The overall mean concentration was 0.418 ppm, the median concentration was 0.385 ppm, and the IQR was 0.380–0.439 ppm (Figure 6.2-6). The annual mean mercury concentration fell within the IQR except in 2016 when it was below and in 2013 when it was above.

Walleye

The length-standardized mean mercury concentration of a 400 mm Walleye over the four years of monitoring ranged from a low of 0.226 ppm in 2019 to a high of 0.522 ppm in 2013 (Figure 6.2-7).

The overall mean concentration was 0.365 ppm, the median concentration was 0.356 ppm, and the IQR was 0.269–0.452 ppm (Figure 6.2-7). The annual mean mercury concentration fell within the IQR except in 2019 when it was below and in 2013 when it was above.

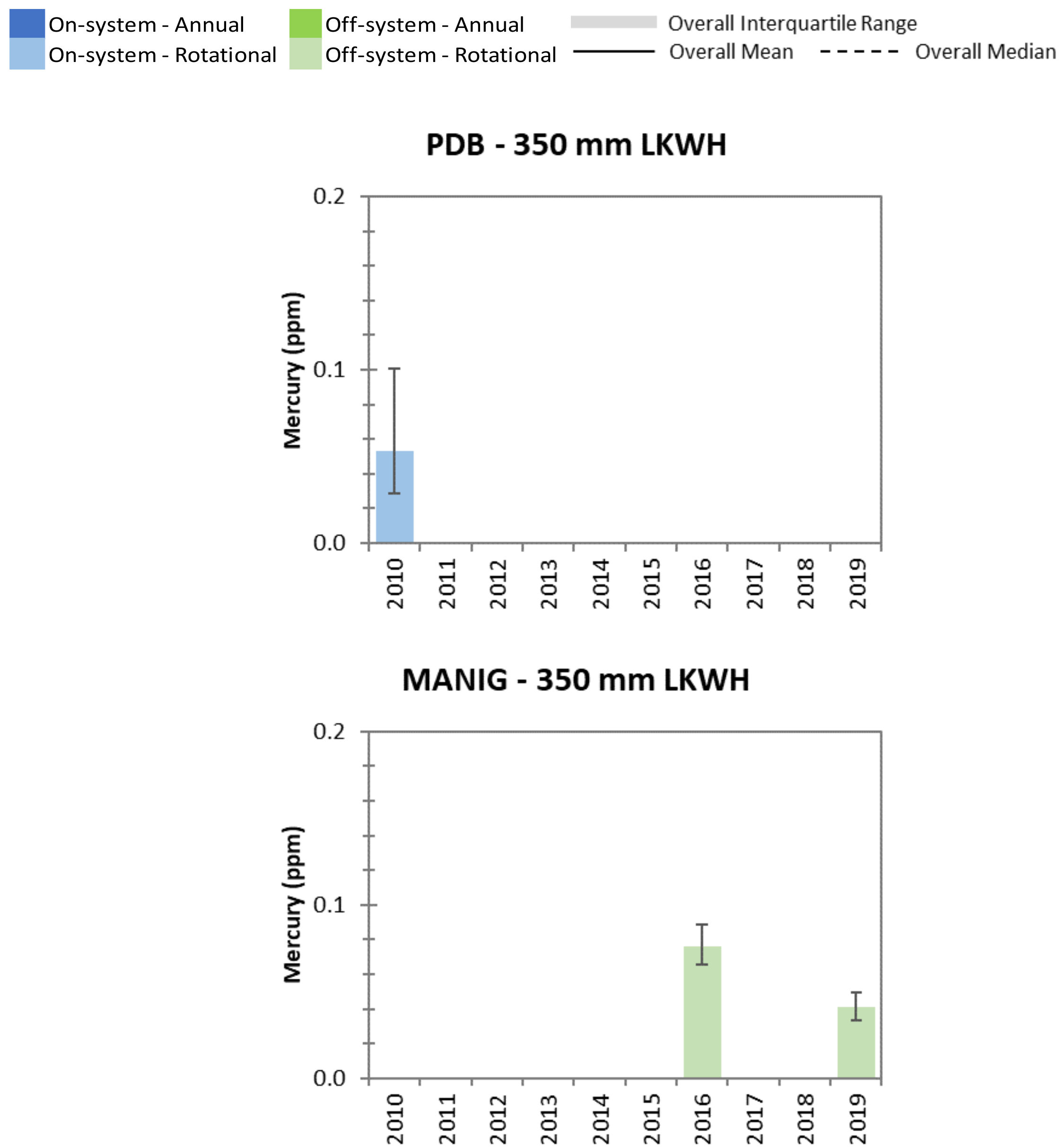


Figure 6.2-5. 2010-2019 Length-standardized mean mercury concentrations (±95% confidence interval) of Lake Whitefish.

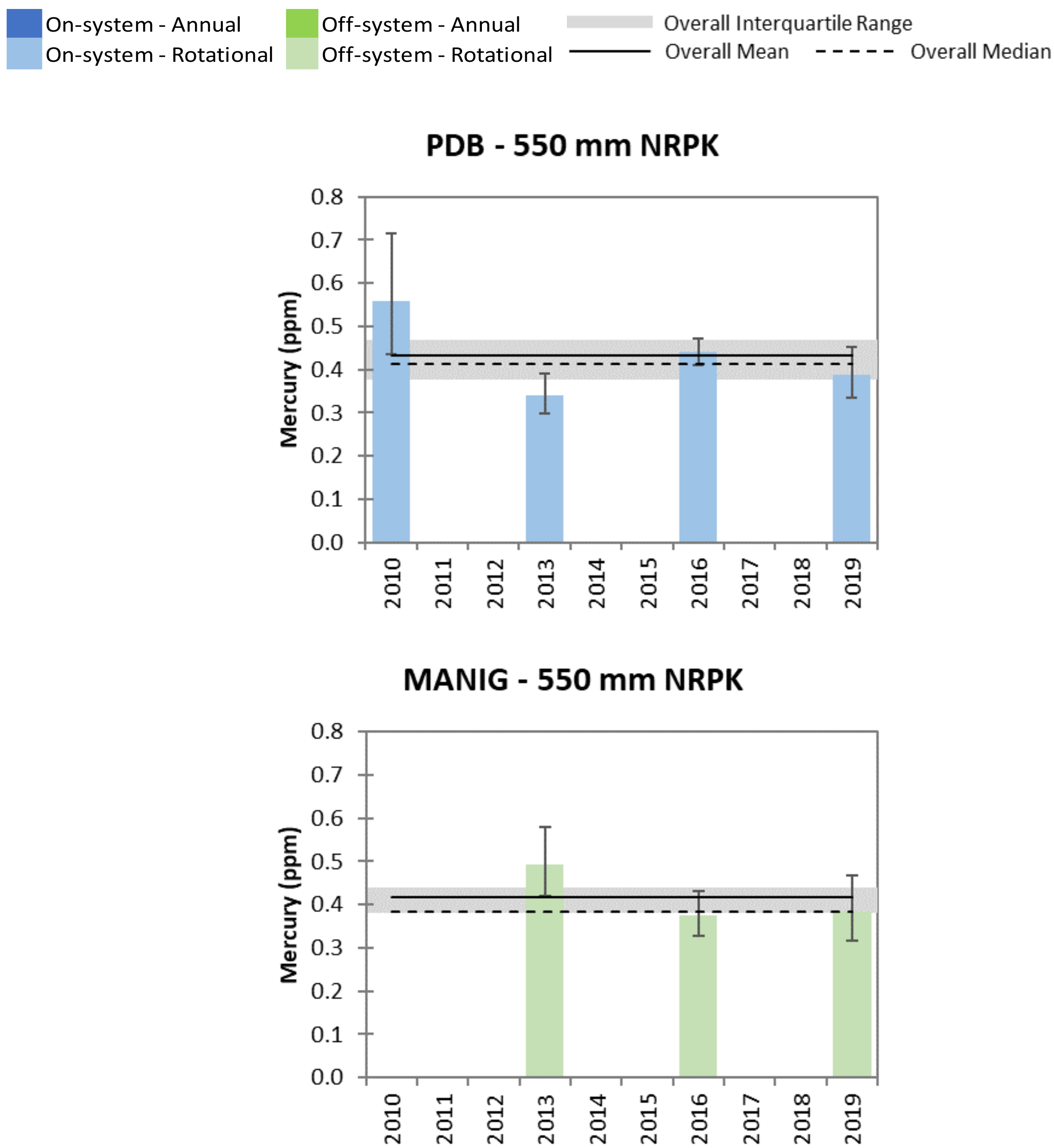


Figure 6.2-6. 2010-2019 Length-standardized mean mercury concentrations (±95% confidence interval) of Northern Pike.

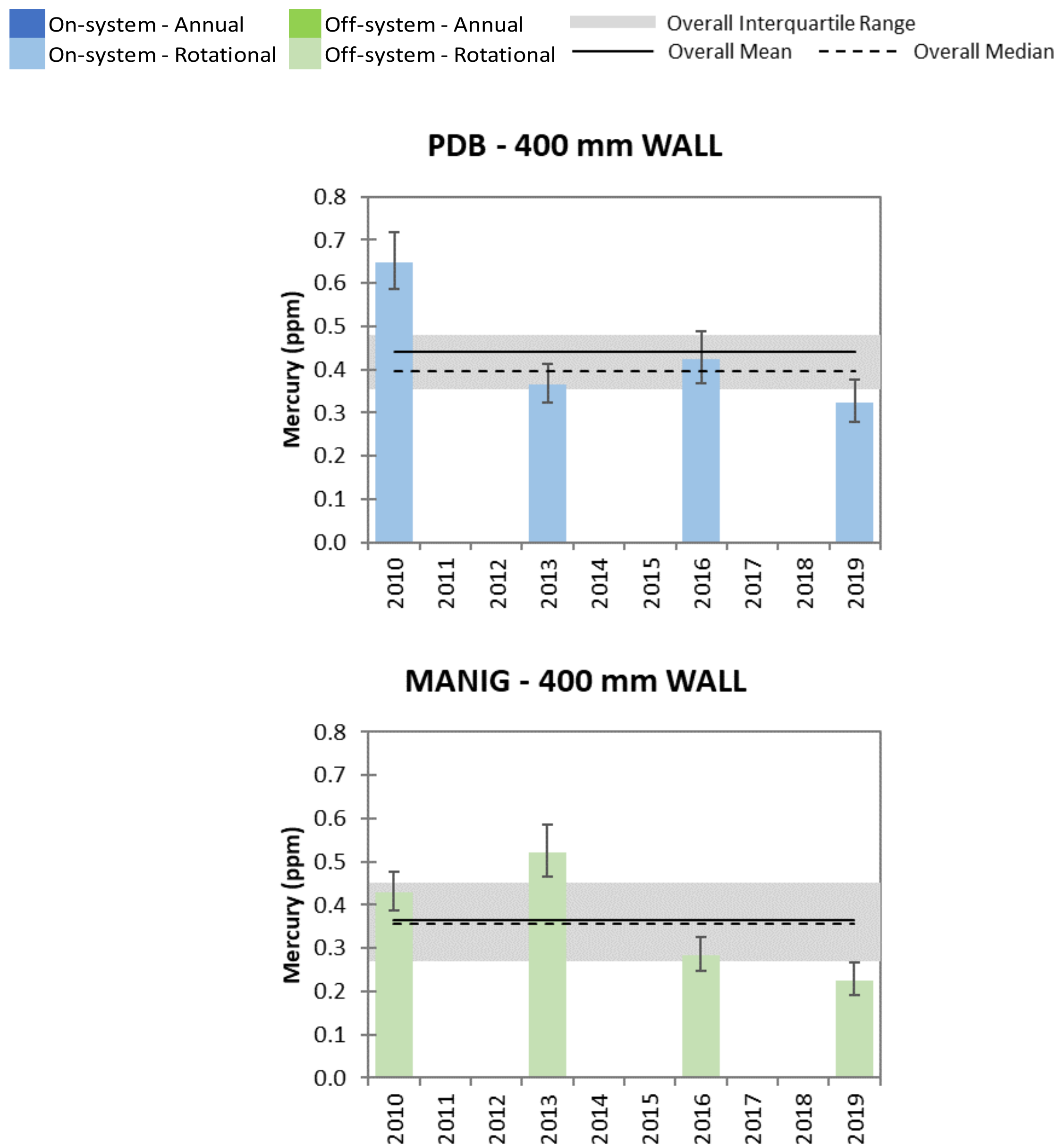


Figure 6.2-7. 2010-2019 Length-standardized mean mercury concentrations (±95% confidence interval) of Walleye.

7.0 LITERATURE CITED

Canadian Council of Ministers of the Environment (CCME). 1999. Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg, MB. Updated to 2024.

Coordinated Aquatic Monitoring Program (CAMP). 2024. CAMP Indicator Report. Prepared for Manitoba/Manitoba Hydro Steering Committee by Manitoba Hydro, Winnipeg, MB.

Manitoba Water Stewardship (MWS). 2011. Manitoba Water Quality Standards, Objectives, and Guidelines. Water Science and Management Branch, MWS. MWS Report 2011-01, November 28, 2011. 67 pp.

Muñoz Sabater, J. 2019. ERA5-Land monthly averaged data from 1950 to present. Copernicus Climate Change Service (C3S) Climate Data Store (CDS). DOI: 10.24381/cds.68d2bb30.

Nürnberg, G.K. 1996. Trophic state in clear and colored, soft- and hardwater lakes with special consideration of nutrients, anoxia, phytoplankton and fish. Lake Reservoir Management. 12: 432-447.

Organization for Economic Cooperation and Development (OECD). 1982. Eutrophication of waters: monitoring, assessment and control. Final Report. OECD cooperative programme on monitoring of inland waters (eutrophication control). Environment Directorate, OECD, Paris, France. 154 pp.

Stewart, K.W. and D.A. Watkinson. 2004. The freshwater fishes of Manitoba. University of Manitoba Press, Winnipeg, MB. 276 p.