Coordinated Aquatic Monitoring Program

CAMP Twelve Year Data Report (2008-2019)

Technical Document 3:

Saskatchewan River Region

Prepared by

Manitoba Hydro

And

North/South Consultants Inc.

2024

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83 Scurfield Blvd.
Winnipeg, MB R3Y 1G4

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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 Saskatchewan River Region. The Saskatchewan River Region includes the portion of the Saskatchewan River watershed from the Saskatchewan/Manitoba border extending into Lake Winnipeg downstream of the Grand Rapids Generating Station (GS). Waterbodies and sites monitored in this region over this period included four on-system and one off-system waterbodies or river reaches as follows:

- Cedar Lake - Southeast;
- the Saskatchewan River;
- South Moose Lake;
- Cedar Lake - West; and
- Cormorant 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 Saskatchewan River Region presented in this report include the physical environment (water regime and sedimentation), water quality, benthic macroinvertebrates, 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 OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHS

LIST OF APPENDICES

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
m	Metre
m^2	Metre squared
Max	Maximum
µg/L	Micrograms per litre
mg/L	Milligrams per litre
Min	Minimum
mm	Millimetre
MoU	Memorandum of Understanding
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
WI	Winter
Wr	Relative weight
°C	Degrees Celsius

WATERBODY ABBREVIATIONS

Abbreviation	Waterbody
CEDAR-SE	Cedar Lake - Southeast
GR GS	Grand Rapids Generating Station (GS)
LW-GR	Lake Winnipeg – Grand Rapids
SASK	Saskatchewan River
SMOOSE	South Moose Lake
CEDAR-W	Cedar Lake - West
CORM	Cormorant Lake

FISH SPECIES LIST

Abbreviation	Common Species Name	Species Name
BURB	Burbot	*Lota lota*
CISC	Cisco	*Coregonus artedi*
CMSH	Common Shiner	*Luxilus cornutus*
EMSH	Emerald Shiner	*Notropis atherinoides*
FRDR	Freshwater Drum	*Aplodinotus grunniens*
GOLD	Goldeye	*Hiodon alosoides*
LGPR	Logperch	*Percina caprodes*
LKCH	Lake Chub	*Couesius plumbeus*
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*
SLSC	Slimy Sculpin	*Cottus cognatus*
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 Saskatchewan River Region. The Saskatchewan River Region includes the portion of the Saskatchewan River watershed from the Saskatchewan/Manitoba border extending into Lake Winnipeg downstream of the Grand Rapids Generating Station (GS). Waterbodies and sites monitored in this region over this period included four on-system and one off-system waterbodies or river reaches as follows:

- Cedar Lake - Southeast;
- the Saskatchewan River;
- South Moose Lake;
- Cedar Lake - West; and
- Cormorant 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 Saskatchewan River Region presented in this report include the physical environment (water regime and sedimentation), water quality, benthic macroinvertebrates, 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. Saskatchewan 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
Cedar Lake - Southeast	CEDAR-SE	●		CONT		ANN	ANN	ANN	ROT
Grand Rapids Generating Station (GS)	GR GS	●		CONT	CONT				
Lake Winnipeg – Grand Rapids	LW-GR	●				ANN	ANN	ANN	
Saskatchewan River	SASK	●		CONT		ROT	ROT	ROT	
South Moose Lake	SMOOSE	●		CONT		ROT	ROT	ROT	OT
Cedar Lake - West	CEDAR-W	●		CONT		ROT	ROT	ROT	
Cormorant Lake	CORM		●	CONT		ANN	ANN	ANN	ROT

Notes:

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

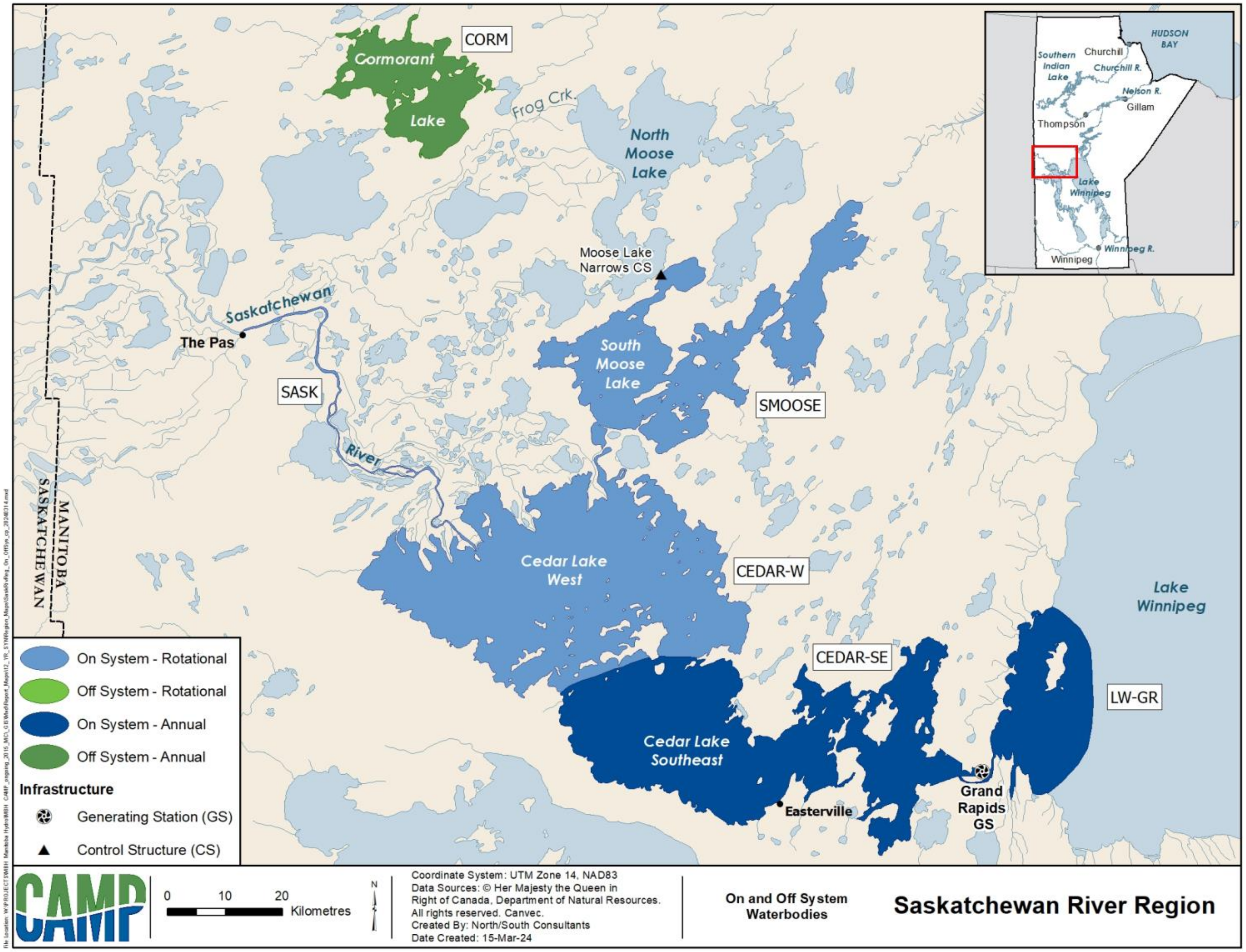


Figure 1-1. On-system and off-system waterbodies and river reaches sampled under CAMP in the Saskatchewan River Region: 2008-2019.

Photograph 1. Cedar Lake - Southeast.

Photograph 2. The Saskatchewan River.

Photograph 3. South Moose Lake.

Photograph 4. Cedar Lake - West.

Photograph 5. Cormorant 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 Saskatchewan River Region. Five waterbodies were monitored in the Saskatchewan River Region: four on-system sites (Cedar Lake; Saskatchewan River at The Pas; South Moose Lake; Grand Rapids GS) and one off system site (Cormorant Lake). In addition, a continuous water quality monitoring station is located at the Grand Rapids GS. 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 Saskatchewan River Region, meteorological conditions from ECCC's The Pas 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 Pas 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). Station data at The Pas is used herein to illustrate climate conditions in the Saskatchewan River Region.

Historical monthly average air temperature and total monthly precipitation during the monitoring period were calculated based on available 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: 5052880). 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 at The Pas 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, 2010 recorded considerably warmer 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 light blue, "near normal" are highlighted in grey, and “above normal” are highlighted in orange. Over the monitoring period, September generally experienced warmer than normal conditions (≥ 7 out of 13 months above normal), while the months of March and November generally experienced cooler than 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; 2016 had the warmest annual average temperature at 2.2ºC, while 2014 had the coolest annual average temperature at -0.8ºC. The maximum and minimum monthly average air temperatures during the monitoring period were 21.0ºC (July 2012) and -25.1ºC (December 2013), respectively. Grand Rapids station (located 150 km southeast of The Pas) was also considered to represent the Saskatchewan River Region; however, due to considerable missing data from the climate normals station (ID 5031111) and an identified temperature bias versus a nearby station with data (ID 5031A10), The Pas station was selected to represent climatic conditions for the region.

Table 2.2-1. The Pas 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	-19.6	-20.3	-11.9	-0.3	7.1	15.4	17.4	18.5	10.2	5.1	-6.0	-23.1	-0.6
2009	-20.2	-17.0	-12.1	0.3	5.7	14.1	15.7	16.2	16.6	2.2	-16.6	-18.8	-1.1
2010	-15.0	-14.5	-2.3	5.2	9.0	15.5	18.8	16.4	9.8	6.0	-6.8	-15.8	2.2
2011	-20.6	-16.6	-13.3	1.5	8.5	15.7	18.9	18.3	13.6	5.7	-6.5	-10.8	1.2
2012	-15.6	-12.1	-4.2	1.7	9.3	15.9	21.0	17.5	11.8	2.0	-8.8	-19.7	1.6
2013	-20.5	-15.6	-12.1	-2.7	9.6	15.5	17.8	17.7	13.7	3.0	-9.4	-25.1	-0.7
2014	-21.0	-21.4	-14.4	-2.3	8.3	14.2	18.4	18.1	11.3	4.2	-11.4	-13.5	-0.8
2015	-17.3	-21.5	-6.3	1.2	7.7	15.9	19.2	17.5	12.2	5.5	-3.5	-10.0	1.7
2016	-15.0	-14.5	-6.4	-0.7	11.1	16.5	18.7	16.7	12.3	2.8	1.0	-15.7	2.2
2017	-12.9	-12.6	-10.7	0.6	8.1	14.2	19.0	18.2	12.5	4.6	-11.0	-16.4	1.1
2018	-20.0	-18.9	-8.3	-3.3	11.2	16.8	18.7	16.0	6.4	0.0	-10.3	-12.5	-0.3
2019	-20.3	-22.1	-6.5	1.2	7.0	14.8	18.1	16.2	11.1	2.0	-7.7	-16.6	-0.2
2020	-14.6	-14.2	-10.4	-3.6	8.3	13.6	19.6	17.5	10.5	0.4	-9.2	-12.8	0.4
1981-2010 Normal	-19.1	-15.9	-8.6	1.3	8.5	14.9	18.1	16.9	10.6	3.1	-7.4	-16.4	0.5

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

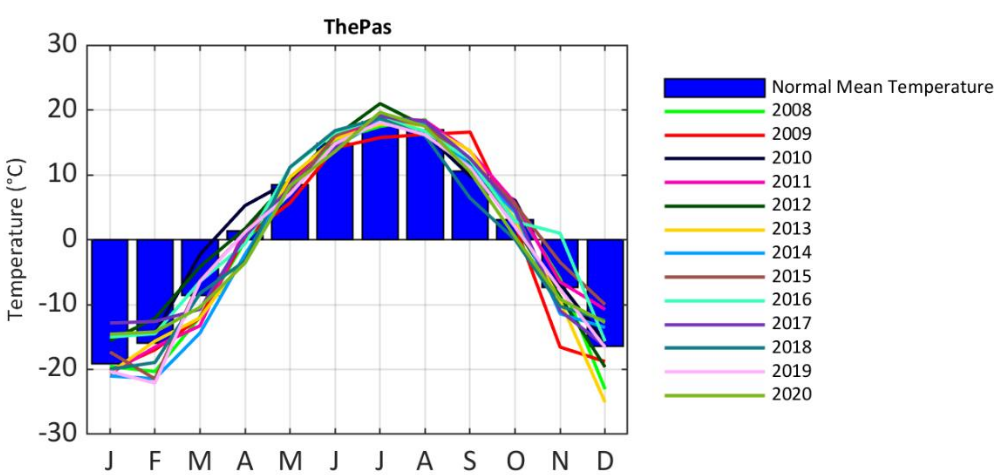


Figure 2.2-1. The Pas mean monthly air temperature (in ºC) compared to 1981-2010 normal.

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 The Pas follows a noticeable seasonal pattern, where generally the highest amounts of precipitation fall during the summer months (July and August) 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. Some deviations can be seen, such as 2016, where the recorded total precipitation for October was much higher than normal, and for 2017 (August) 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, January and July generally experienced more than normal precipitation (≥ 7 out of 13 months above normal), while the months of February, March, April, May, August, and October generally experienced less than normal precipitation (≥ 7 out of 13 months below normal). On an annual basis, no distinct patterns in the data were identified as most years in the monitoring period experienced near normal conditions, and there was nearly an equal number of years with above normal precipitation as there were below normal; 2016 had the highest annual total precipitation (695.0 mm), while 2019 had the lowest annual total precipitation (381.0 mm). The maximum and minimum monthly total precipitation recorded during the monitoring period were 206.2 mm (June 2013) and 1.3 mm (March 2019), respectively.

Table 2.2-2. The Pas 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	29.1	34.9	46.9	8.1	9.9	38.2	115.2	26.6	9.6	28.3	20.6	37.0	404.4
2009	32.2	20.0	39.0	37.4	37.0	46.0	72.9	63.9	7.7	40.7	6.6	24.1	427.5
2010	41.5	22.8	12.5	36.2	71.2	44.4	85.7	145.3	86.8	32.1	21.4	27.9	627.8
2011	69.2	19.8	3.0	1.9	26.9	60.0	133.8	80.8	19.8	32.9	24.0	19.4	491.5
2012	22.6	4.0	19.2	34.4	36.4	91.0	93.6	71.8	18.9	100.5	20.8	19.2	532.4
2013	30.2	8.2	8.8	5.8	18.9	206.2	109.9	88.9	70.7	53.0	41.0	14.8	656.4
2014	29.1	3.0	9.9	14.9	33.7	110.7	100.6	54.9	27.7	30.6	23.4	20.0	458.4
2015	10.0	15.5	9.6	16.5	13.1	51.1	39.3	95.4	78.9	33.7	19.7	14.8	397.5
2016	13.4	19.9	31.8	21.8	34.3	92.0	157.0	59.7	89.4	144.1	15.8	15.7	695.0
2017	7.4	4.3	38.9	27.4	66.8	90.6	36.8	6.8	96.2	56.0	41.1	22.5	494.8
2018	31.0	2.0	15.4	10.9	34.5	62.4	183.7	35.7	55.4	24.3	12.5	10.0	477.8
2019	17.8	8.4	1.3	10.9	30.3	68.2	75.8	28.8	71.6	43.6	12.9	12.3	381.9
2020	17.3	5.2	25.0	37.6	17.8	118.6	78.5	56.4	21.7	32.5	44.5	9.6	464.7
1981-2010 Normal	16.8	13.4	17.8	23.9	40.1	66.3	68.8	66.5	57.3	38.5	20.9	19.7	449.9

Below Normal	Near Normal	Above Normal

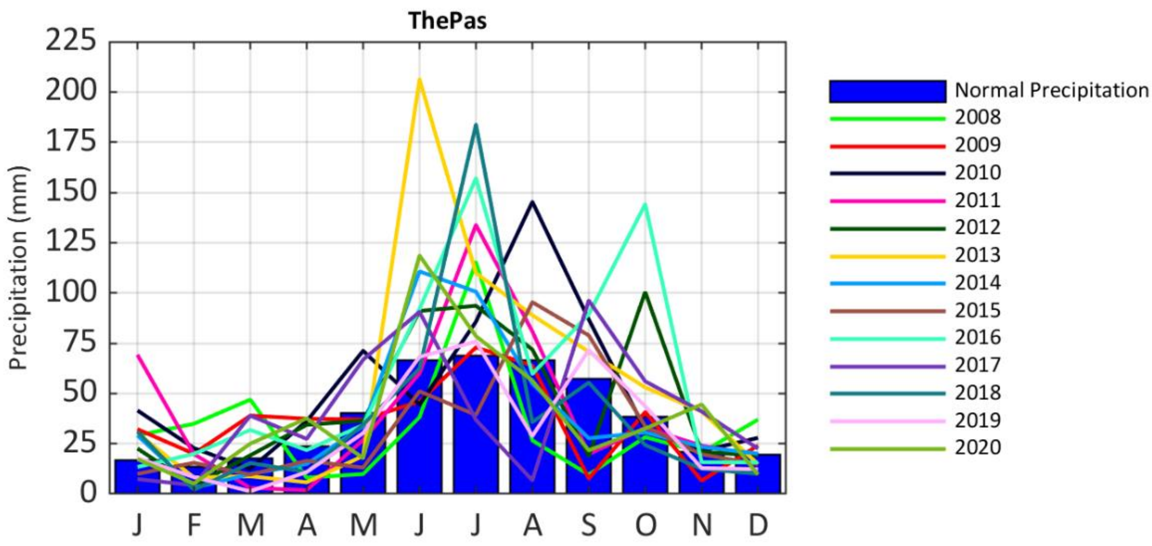


Figure 2.2-2. The Pas total monthly precipitation (in mm) compared to 1981-2010 normal.

2.3 WATER REGIME

The Saskatchewan River flows entering Manitoba are influenced by both precipitation and water use across the Saskatchewan River watershed. Flows originate from as far west as the foot of the Rocky Mountains and are affected by various operations along the way to Manitoba including municipal and recreational use, hydro-electric generation, irrigation, and flood control.

On-System Sites

On-system CAMP monitoring occurred along the Saskatchewan River and on Cedar Lake, which acts as a hydroelectric reservoir for the Grand Rapids GS (Figure 2.3-1). Monitoring also occurred on South Moose Lake, which is influenced by levels on Cedar Lake. Flows for this region are reported based on the Saskatchewan River at The Pas gauge and at the Grand Rapids GS.

Continuous water temperature is measured at the Grand Rapids GS continuous water quality monitoring site (Figure 2.3-1). Monitoring started in 2019 and consists of measuring water temperature every 5 minutes and monthly site visits to verify the data. For the water temperature indicator, the continuous water temperature and the duration, in days, that water is below 1 ^{o}C and five-degree increments is reported.

Off-System Sites

CAMP monitors Cormorant Lake as the off-system waterbody for this region (Figure 2.3-1). Water levels on Cormorant Lake are driven by precipitation in its drainage basin.

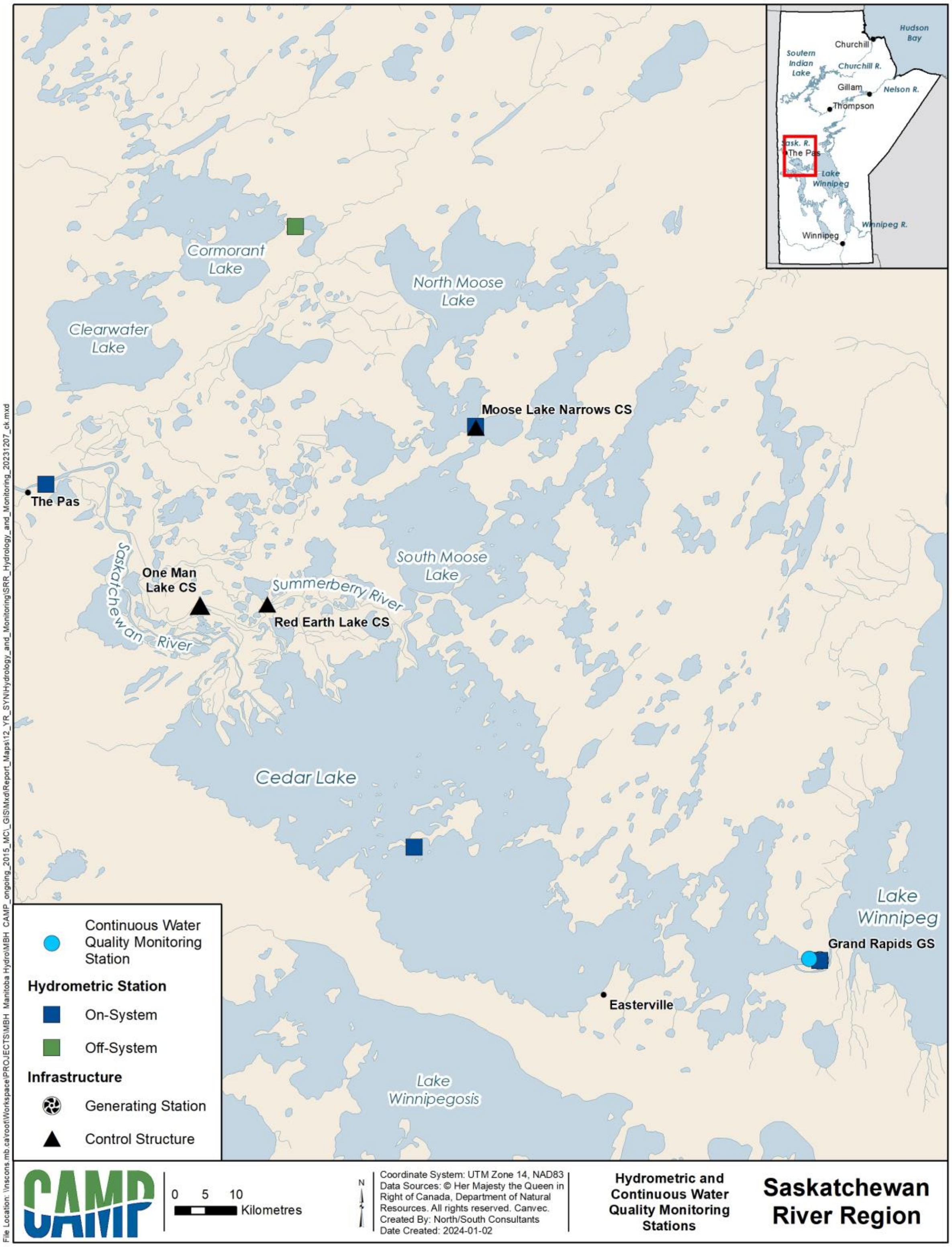


Figure 2.3-1. Hydrometric and continuous water quality monitoring stations in the Saskatchewan River Region.

2.3.1 FLOW

2.3.1.1 ON-SYSTEM SITES

Saskatchewan River at The Pas

The flow at the Saskatchewan River at the Pas is representative of the inflow to the region (Figure 2.3-1). From 2008 to 2020, flow conditions on the Saskatchewan River at the Pas 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 257 to 2,215 cms with the overall mean from 2008 to 2020 at 737 cms. Very dry flow conditions, defined as lower than 10th percentile, occurred in part of one year during the 2008-2020 CAMP monitoring period in December 2008 (Table 2.3-1). Flow conditions were very wet, defined as above the 90th percentile, in parts of ten years during CAMP, during the following months; July 2010, April to August 2011, June to August 2012, May to August 2013, May to August 2014, April 2015, November 2016, April to July 2017, May to June 2018, and May to August 2020 (Table 2.3-1).

Grand Rapids Generating Station

The Grand Rapids GS is at the downstream end of the Saskatchewan River Region. From 2008 to 2020, flows at the Grand Rapids GS 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 2.3-3 and Table 2.3-2). Monthly mean flow ranged from 128 to 2,099 cms with the overall mean from 2008 to 2020 at 745 cms. Very dry flow conditions, defined as lower than 10th percentile, occurred in part of one year during the 2008-2020 monitoring period in April 2009 (Table 2.3-2). Flow conditions were very wet, defined as above the 90th percentile, in parts of ten years over this period, during the following months; January to February 2008, July 2010, June to August 2011, July to August 2012, July to August 2013, June to August 2014, October to December 2016, March to April and June to July 2017, January to February 2019, and March and June to August 2020 (Table 2.3-2).

2.3.1.2 OFF-SYSTEM SITES

There are no off-system flows reported for this region.

Table 2.3-1. Saskatchewan River at The Pas (05KJ001) monthly average flow (cms).

Year	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	568	388	448	490	622	823	969	900	638	448	435	398	257
2009	444	331	478	372	670	565	414	431	460	445	381	441	347
2010	708	339	415	482	795	667	907	1206	888	797	816	676	487
2011	1040	416	375	523	1152	1610	1859	2215	1674	884	670	563	480
2012	763	437	410	498	894	886	996	1418	1310	741	592	547	404
2013	851	436	535	541	608	1385	1260	2053	1166	698	596	500	386
2014	885	445	453	465	656	1695	1702	1847	1194	731	626	402	360
2015	555	410	455	553	1183	834	545	426	462	450	485	481	381
2016	743	418	471	489	861	796	575	713	837	909	967	1145	736
2017	868	559	536	612	1340	1576	1778	1402	768	555	523	382	378
2018	639	363	400	403	571	1294	1049	754	697	604	613	459	440
2019	611	461	521	506	911	716	599	878	792	614	552	406	370
2020	929	459	500	570	576	1505	1587	1933	1597	826	631	530	406

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. Percentiles calculated using 1981-2010 as the reference period.

Table 2.3-2. Grand Rapids Generating Station monthly average flow (cms).

Year	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	579	1063	1198	648	324	370	472	660	513	430	300	342	647
2009	411	783	827	392	128	276	200	193	223	403	508	253	761
2010	658	790	796	557	281	152	339	1072	919	704	790	700	785
2011	1051	817	709	847	622	938	1712	2099	1721	815	809	690	785
2012	765	726	539	505	717	787	799	1136	1247	675	492	743	799
2013	861	850	854	867	645	490	992	1487	1169	555	720	742	948
2014	882	947	962	948	495	369	1375	1505	1192	684	360	903	855
2015	535	919	943	486	438	562	339	402	351	358	344	457	845
2016	772	831	799	670	288	411	405	704	774	1029	1073	1209	1063
2017	950	810	991	1135	1124	918	1920	1318	709	373	542	724	854
2018	622	1015	746	664	380	341	797	688	736	350	518	587	641
2019	691	1191	1327	945	294	258	297	561	722	555	693	757	722
2020	902	836	879	1126	416	257	1041	1935	1564	773	632	570	769

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. Percentiles calculated using 1981-2010 as the reference period.

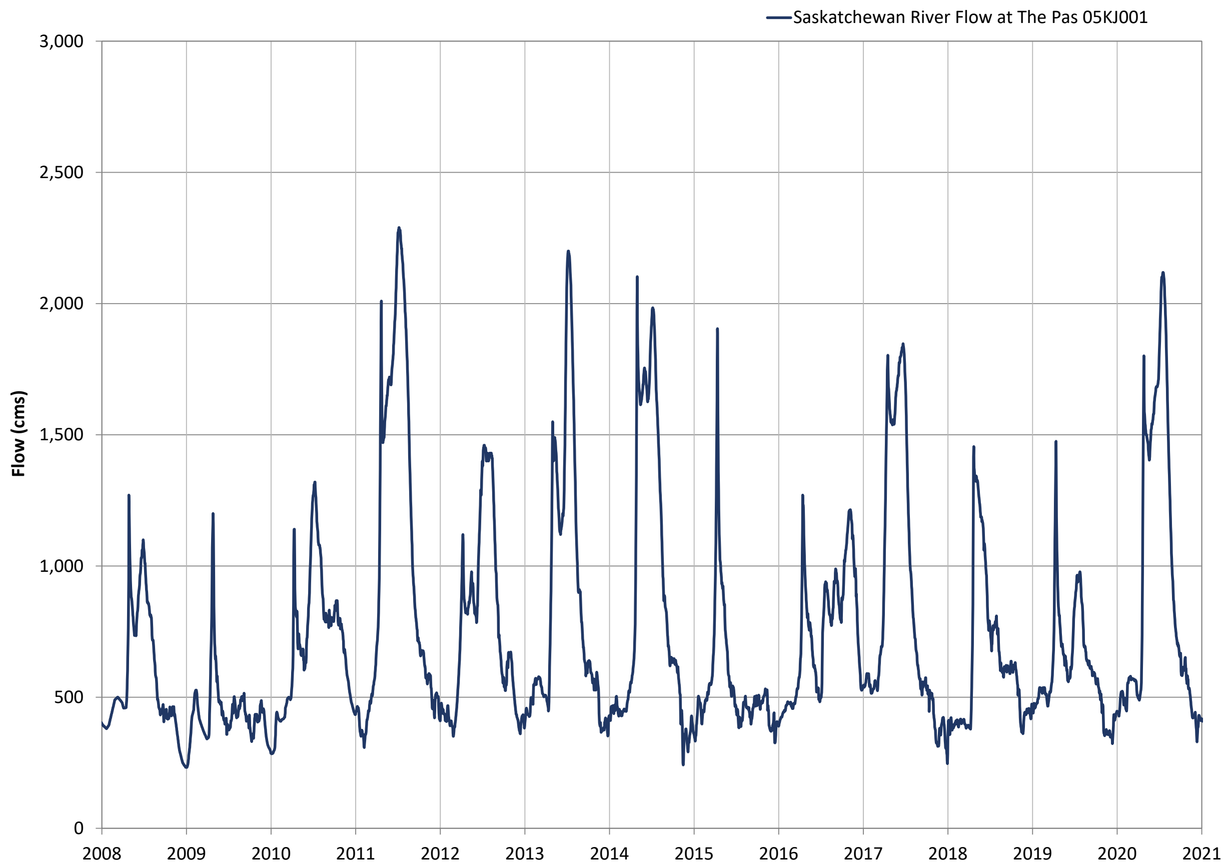


Figure 2.3-2. 2008-2020 Saskatchewan River at The Pas daily mean flow.

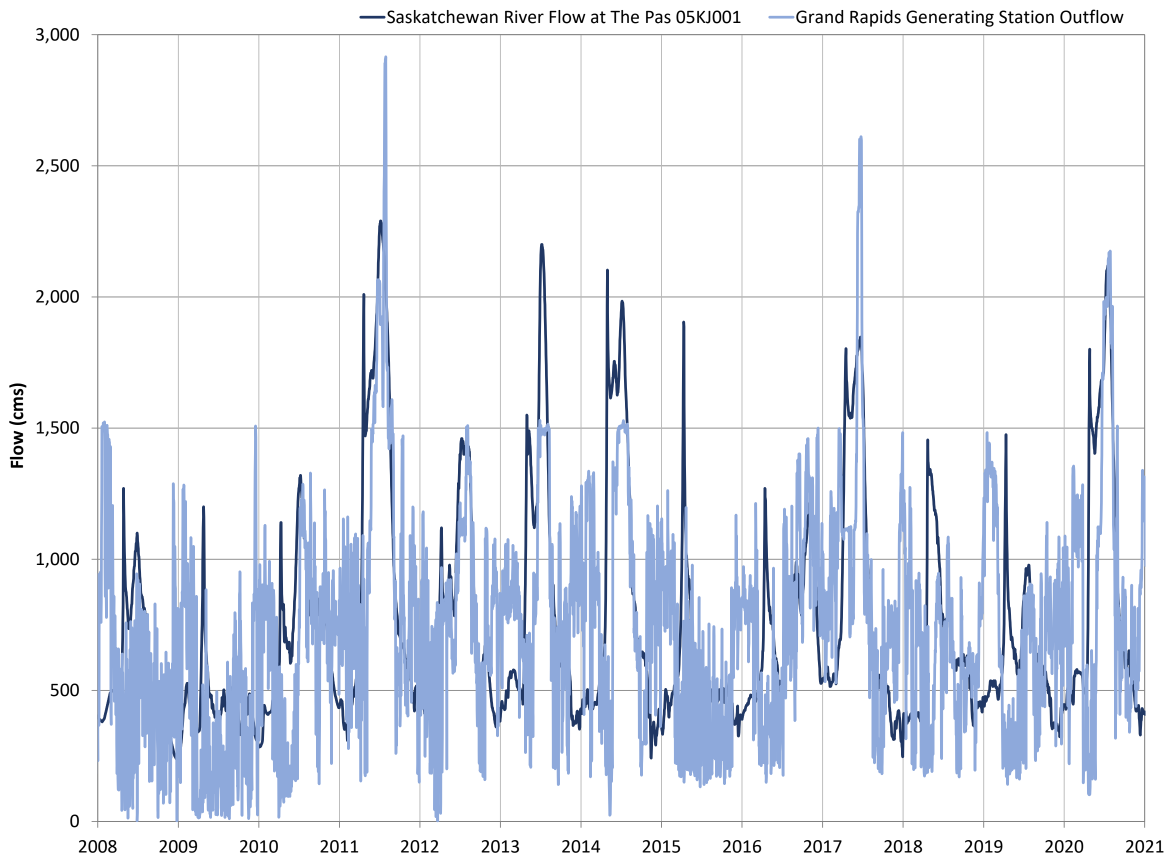


Figure 2.3-3. 2008-2020 Saskatchewan River at The Pas and Grand Rapids Generating Station daily mean flow.

2.3.2 WATER LEVEL AND VARIABILITY

2.3.2.1 ON-SYSTEM SITES

Cedar Lake

Cedar Lake is a controlled reservoir with water levels typically following a predictable pattern each year. In spring, water levels typically rise because of both increased inflows with the spring freshet and reduced outflows at Grand Rapids as energy demand is lower. Summer outflows from Cedar Lake are managed depending on precipitation conditions and inflows such that water levels peak in late summer/fall each year. Cedar Lake water levels then typically decline steadily through the winter as inflows drop off and Grand Rapids GS outflows are increased to meet Manitoba's higher winter energy requirements. Water levels on Cedar Lake generally followed the typical trend from 2008 to 2020 (Figure 2.3-4). During the period from 2008-2020, Cedar Lake monthly average water levels were more than 0.5 m above the 2008-2020 average in 48 months and were lower than 0.5 m below the 2008-2020 average in 31 months (Table 2.3-3). Cedar Lake monthly water level variability was lower (below 0.25 m) in 78 months, moderate (between 0.25 and 0.75 m) in 65 months, and higher (above 0.75 m) in 13 months (Table 2.3-4).

South Moose Lake

South Moose Lake water levels are influenced by inflows from the local drainage basin but driven mainly by water levels on downstream Cedar Lake which are regulated through outflows at the Grand Rapids GS (Figure 2.3-5). During the period from 2008-2020, South Moose Lake monthly average water levels remained within 0.5 m below and 0.5 m above the 2008-2020 average (Table 2.3-5). South Moose Lake monthly water level variability was lower (below 0.25 m) in 153 months and moderate (between 0.25 and 0.75 m) in 3 months. South Moose Lake monthly water level variability was never in the higher (above 0.75 m) category (Table 2.3-6).

2.3.2.2 OFF-SYSTEM SITES

Cormorant Lake

Water levels on Cormorant Lake vary with precipitation in its drainage basin (Figure 2.3-6). During the period from 2008-2020, Cormorant Lake monthly average water levels were more than 0.5 m above the 2008-2020 average in 15 months and lower than 0.5 m below the 2008-2020 average in 22 months (Table 2.3-7). Cormorant Lake monthly water level variability was lower (below 0.25 m) in 149 months and moderate (between 0.25 and 0.75 m) in 6 months. Cormorant Lake monthly water level variability was never in the higher (above 0.75 m) category (Table 2.3-8).

Table 2.3-3. Cedar Lake monthly average water level (m).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	255.39	254.40	253.64	253.82	254.94	255.49	255.85	255.96	255.93	255.93	255.95	255.74
2009	255.38	254.77	254.53	254.99	255.61	255.86	256.01	256.24	256.27	256.06	256.06	255.85
2010	255.43	254.99	254.65	254.99	255.66	256.09	256.37	256.33	256.33	256.43	256.35	256.18
2011	255.96	255.67	255.37	255.30	256.14	256.36	256.36	256.42	256.41	256.41	256.33	256.02
2012	255.90	255.78	255.88	256.04	256.19	256.34	256.40	256.40	256.35	256.42	256.33	256.08
2013	255.83	255.52	255.20	254.89	255.50	256.19	256.40	256.38	256.43	256.44	256.37	255.94
2014	255.45	254.81	254.14	253.87	255.23	256.30	256.46	256.30	256.26	256.40	256.30	255.92
2015	255.47	254.98	254.73	255.38	256.04	256.21	256.20	256.26	256.28	256.30	256.38	256.12
2016	255.76	255.44	255.14	255.43	256.12	256.33	256.39	256.42	256.42	256.45	256.46	256.29
2017	256.04	255.93	255.56	255.21	255.98	256.48	256.30	256.35	256.36	256.43	256.19	255.94
2018	255.26	254.71	254.55	254.44	255.49	256.19	256.36	256.28	256.33	256.43	256.43	256.34
2019	255.97	255.11	254.14	254.31	255.52	255.91	256.20	256.31	256.37	256.29	256.00	255.77
2020	255.45	255.24	254.56	254.13	255.36	256.36	256.50	256.38	256.48	256.44	256.43	256.33

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 2.3-4. Cedar Lake monthly water level range (m).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	0.72	0.99	0.35	0.63	0.99	0.47	0.22	0.07	0.15	0.15	0.06	0.34
2009	0.55	0.46	0.23	0.68	0.36	0.19	0.22	0.17	0.22	0.19	0.11	0.47
2010	0.39	0.41	0.18	0.76	0.47	0.38	0.10	0.16	0.13	0.15	0.08	0.23
2011	0.29	0.22	0.37	0.47	0.63	0.10	0.21	0.18	0.15	0.21	0.17	0.27
2012	0.18	0.10	0.09	0.21	0.15	0.14	0.10	0.13	0.11	0.21	0.18	0.26
2013	0.30	0.25	0.40	0.16	1.10	0.33	0.21	0.21	0.16	0.11	0.28	0.47
2014	0.47	0.56	0.78	0.32	1.98	0.31	0.18	0.15	0.06	0.25	0.38	0.35
2015	0.48	0.52	0.31	0.88	0.29	0.15	0.13	0.14	0.09	0.11	0.13	0.37
2016	0.34	0.28	0.25	0.71	0.40	0.13	0.14	0.10	0.20	0.19	0.06	0.37
2017	0.10	0.28	0.53	0.39	0.83	0.25	0.14	0.10	0.17	0.15	0.28	0.34
2018	0.67	0.42	0.37	0.33	1.25	0.31	0.15	0.14	0.22	0.13	0.14	0.14
2019	0.63	0.92	0.70	1.21	0.58	0.33	0.27	0.11	0.11	0.20	0.29	0.25
2020	0.33	0.41	0.80	0.35	1.66	0.47	0.13	0.16	0.12	0.11	0.09	0.21

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

Table 2.3-5. South Moose Lake monthly average water level (m).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	256.31	256.24	256.18	256.11	256.04	255.97	255.98	256.03	255.97	255.96	255.99	256.00
2009	255.92	255.87	255.83	255.80	255.83	255.88	255.93	256.04	256.12	256.10	256.11	256.10
2010	256.02	255.96	255.87	255.81	255.81	255.90	256.00	256.13	256.28	256.35	256.41	256.41
2011	256.35	256.28	256.20	256.12	256.20	256.32	256.41	256.52	256.52	256.50	256.49	256.45
2012	256.39	256.31	256.26	256.28	256.30	256.37	256.42	256.44	256.41	256.40	256.45	256.43
2013	256.36	256.29	256.19	256.09	256.11	256.25	256.43	256.46	256.47	256.54	256.61	256.56
2014	256.49	256.42	256.35	256.29	256.33	256.46	256.57	256.57	256.50	256.50	256.52	256.46
2015	256.35	256.27	256.20	256.19	256.21	256.23	256.23	256.29	256.32	256.33	256.39	256.39
2016	256.31	256.22	256.14	256.10	256.16	256.25	256.36	256.42	256.45	256.58	256.69	256.69
2017	256.62	256.54	256.48	256.43	256.48	256.64	256.69	256.61	256.54	256.57	256.56	256.50
2018	256.40	256.33	256.24	256.16	256.16	256.27	256.39	256.44	256.41	256.48	256.55	256.54
2019	256.50	256.42	256.32	256.24	256.22	256.21	256.28	256.34	256.37	256.36	256.35	256.28
2020	256.20	256.12	256.07	256.03	256.10	256.29	256.52	256.58	256.56	256.54	256.57	256.56

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 2.3-6. South Moose Lake monthly average water level (m).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	0.09	0.06	0.06	0.07	0.13	0.07	0.14	0.08	0.07	0.12	0.08	0.05
2009	0.08	0.04	0.03	0.03	0.11	0.12	0.11	0.13	0.07	0.05	0.05	0.06
2010	0.07	0.07	0.07	0.16	0.32	0.11	0.11	0.17	0.08	0.14	0.06	0.04
2011	0.05	0.08	0.09	0.05	0.12	0.13	0.14	0.06	0.09	0.07	0.10	0.07
2012	0.06	0.08	0.03	0.05	0.12	0.15	0.05	0.08	0.12	0.15	0.02	0.07
2013	0.06	0.08	0.09	0.09	0.14	0.19	0.10	0.04	0.12	0.14	0.04	0.08
2014	0.06	0.06	0.07	0.07	0.16	0.14	0.12	0.14	0.06	0.14	0.06	0.09
2015	0.10	0.07	0.07	0.05	0.09	0.05	0.10	0.08	0.05	0.08	0.09	0.06
2016	0.09	0.08	0.08	0.04	0.14	0.09	0.13	0.05	0.08	0.29	0.05	0.04
2017	0.08	0.08	0.07	0.02	0.13	0.16	0.08	0.12	0.08	0.08	0.04	0.09
2018	0.08	0.08	0.09	0.07	0.08	0.10	0.19	0.09	0.07	0.14	0.04	0.01
2019	0.07	0.09	0.11	0.04	0.06	0.06	0.14	0.06	0.08	0.12	0.06	0.08
2020	0.07	0.07	0.06	0.04	0.16	0.25	0.15	0.04	0.06	0.06	0.04	0.03

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

Table 2.3-7. Cormorant Lake monthly average water level (m).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	256.67	256.63	256.59	256.52	256.49	256.47	256.45	256.49	256.39	256.28	256.19	256.16
2009	256.13	256.11	256.08	256.07	256.08	256.13	256.19	256.23	256.19	256.09	256.06	256.05
2010	256.05	256.05	256.03	256.03	256.06	256.14	256.17	256.17	256.28	256.38	256.46	256.50
2011	256.51	256.51	256.49	256.47	256.50	256.53	256.61	256.76	256.82	256.81	256.79	256.79
2012	256.79	256.76	256.71	256.75	256.86	256.97	257.02	256.94	256.82	256.72	256.72	256.72
2013	256.70	256.67	256.63	256.56	256.55	256.66	257.15	257.25	257.23	257.28	257.30	257.28
2014	257.24	257.19	257.11	257.02	257.12	257.31	257.45	257.47	257.30	257.18	257.07	257.01
2015	256.94	256.87	256.80	256.75	256.74	256.74	256.72	256.69	256.62	256.56	256.53	256.53
2016	256.53	256.50	256.47	256.45	256.52	256.60	256.71	256.66	256.59		257.02	257.09
2017	257.05	256.99	256.92	256.91	257.08	257.34	257.44	257.34	257.17	257.10	257.03	256.98
2018	256.92	256.88	256.81	256.74	256.76	256.85	256.98	257.21	257.25	257.25	257.23	257.16
2019	257.08	257.01	256.91	256.83	256.84	256.87	256.92	256.91	256.82	256.72	256.68	256.63
2020	256.59	256.54	256.51	256.50	256.61	256.90	257.22	257.31	257.21	257.09	257.03	256.99

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 2.3-8. Cormorant Lake monthly water level range (m).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	0.04	0.05	0.05	0.07	0.02	0.04	0.06	0.08	0.13	0.10	0.06	0.03
2009	0.02	0.04	0.02	0.03	0.03	0.08	0.08	0.03	0.12	0.06	0.04	0.01
2010	0.03	0.02	0.02	0.04	0.07	0.06	0.04	0.11	0.14	0.07	0.07	0.02
2011	0.02	0.01	0.03	0.02	0.06	0.08	0.16	0.11	0.04	0.05	0.02	0.01
2012	0.02	0.04	0.04	0.12	0.07	0.17	0.06	0.10	0.15	0.05	0.02	0.03
2013	0.02	0.04	0.05	0.05	0.04	0.38	0.32	0.04	0.09	0.05	0.05	0.04
2014	0.03	0.07	0.09	0.07	0.26	0.16	0.10	0.15	0.16	0.14	0.10	0.06
2015	0.07	0.05	0.08	0.04	0.02	0.04	0.06	0.06	0.07	0.06	0.04	0.02
2016	0.02	0.04	0.02	0.01	0.12	0.07	0.13	0.16	0.05		0.16	0.02
2017	0.04	0.09	0.06	0.05	0.28	0.20	0.07	0.19	0.16	0.09	0.05	0.06
2018	0.04	0.06	0.07	0.06	0.06	0.10	0.28	0.11	0.08	0.05	0.05	0.08
2019	0.07	0.07	0.11	0.04	0.04	0.07	0.09	0.12	0.07	0.09	0.04	0.06
2020	0.04	0.05	0.04	0.04	0.23	0.33	0.25	0.08	0.11	0.14	0.04	0.05

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

Notes:

1. Blank cell indicates no data.

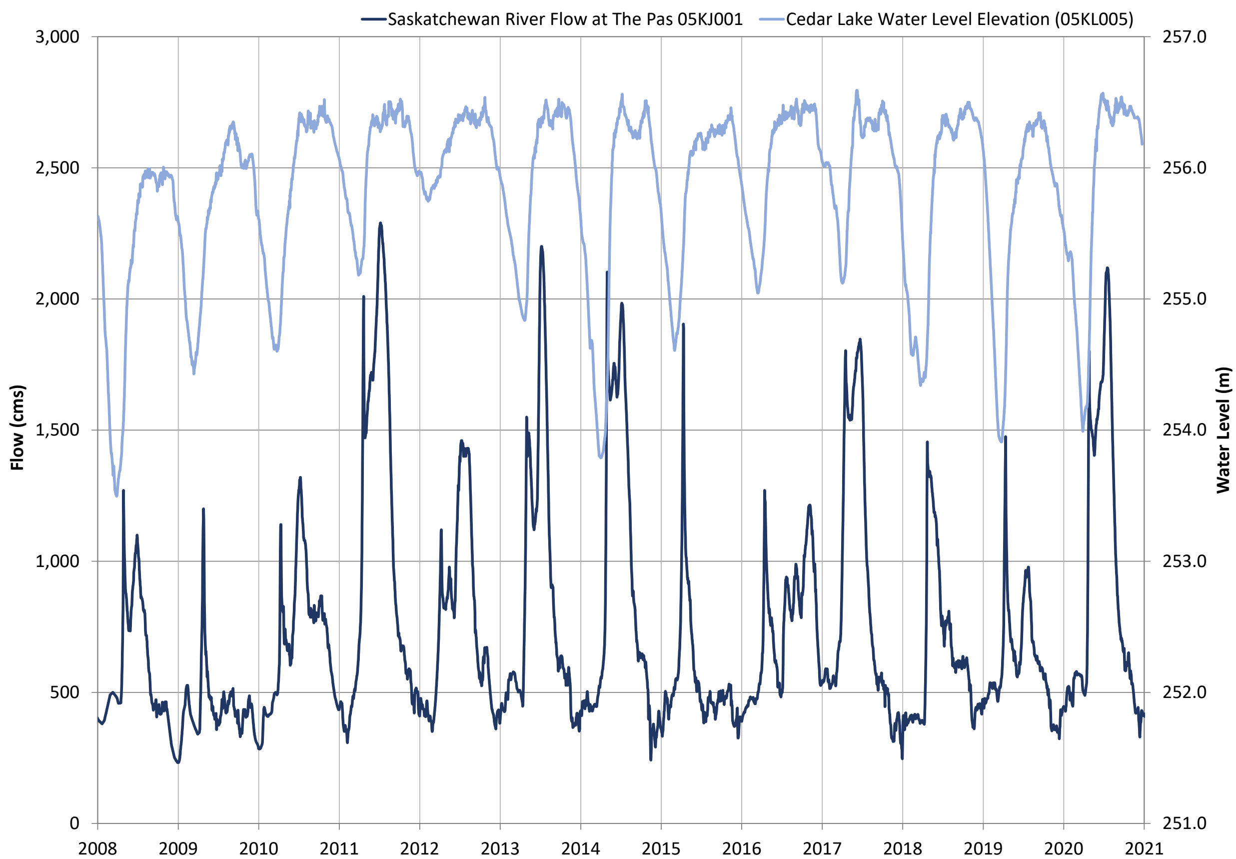


Figure 2.3-4. 2008-2020 Saskatchewan River daily mean flow and Cedar Lake daily mean water level.

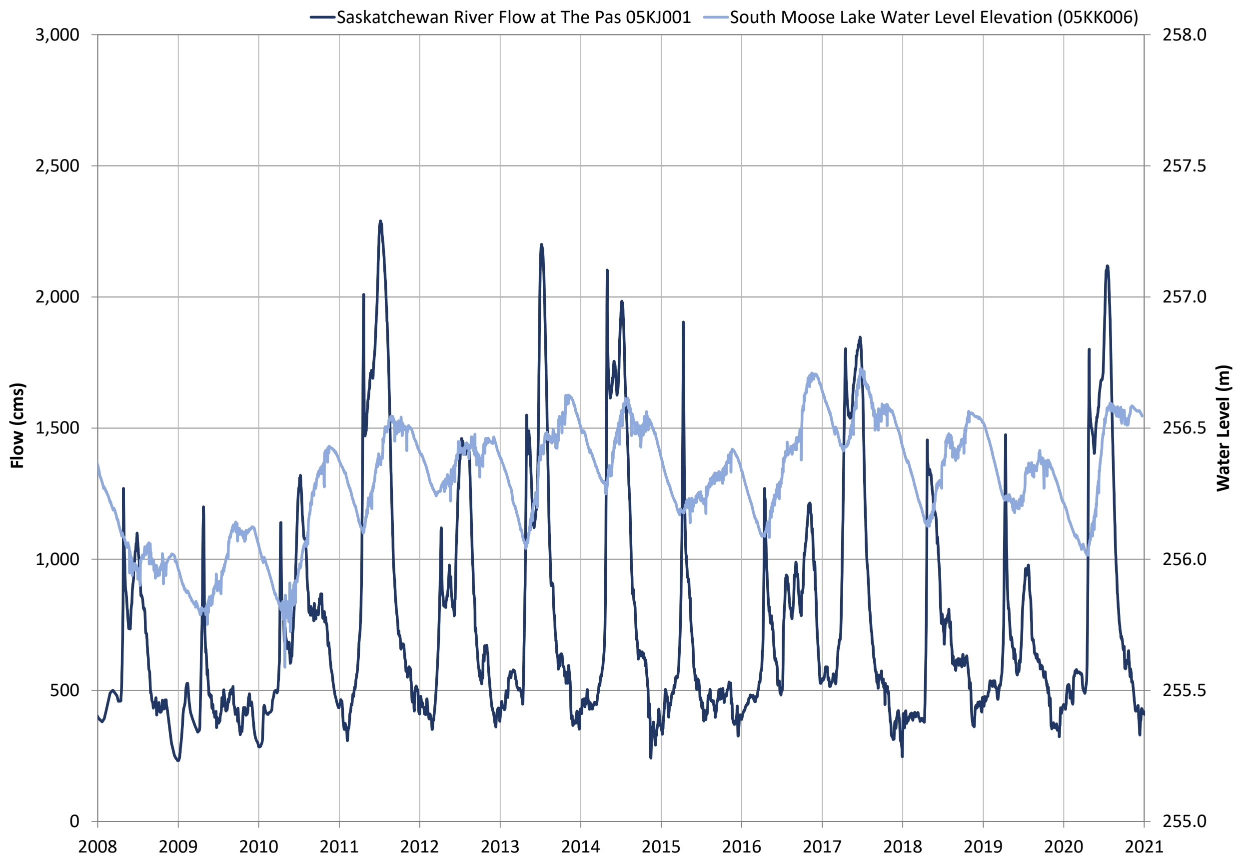


Figure 2.3-5. 2008-2020 Saskatchewan River daily mean flow and South Moose Lake daily mean water level.

Figure 2.3-6. 2008-2020 Cormorant Lake daily mean water level.

2.3.3 WATER TEMPERATURE

2.3.3.1 ON-SYSTEM SITES

Grand Rapids Generating Station

Water temperature in the Saskatchewan River Region is monitored at the continuous water quality monitoring station located at the Grand Rapids GS (Figure 2.3-1). With the short record of monitoring data, few conclusive observations can be made. The maximum temperature reached over 25°C in July and the minimum was at near 0°C in early November (Figure 2.3-7). Temperatures then started to increase in April.

The duration, in days, that water temperature is within different temperature ranges is used as a metric (Table 2.3-9). With less than one year of monitoring data there is insufficient data at this time to determine the duration of temperature ranges (Figure 2.3-7).

2.3.3.2 OFF-SYSTEM SITES

There are no continuous monitoring off-system sites in this region.

Table 2.3-9. 2017-19 Grand Rapids GS water temperature ranges.

Monitoring Year[1]	Number of Days in Temperature Range[2]					
	<1 °C	1-5 °C	5-10 °C	10-15 °C	15-20 °C	>20 °C
2017	Insufficient data					
2018						
2019						

Notes:

1. Period <1°C is for the entire winter period (e.g., 2017 monitoring year is from Nov 2017 to May 2018).
2. The duration has been estimated using data from nearby gauging stations to infill missing data when available.

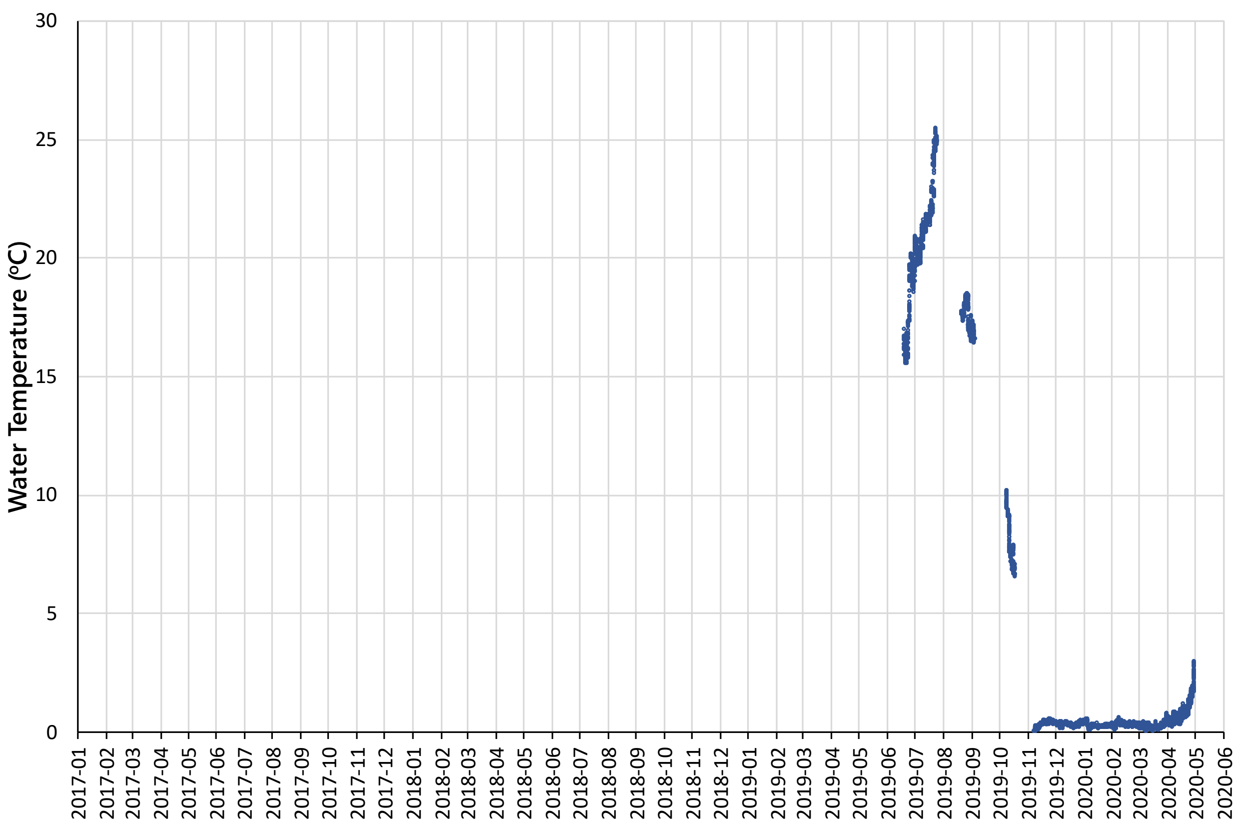


Figure 2.3-7. 2017-2019 Grand Rapids GS continuous water temperature.

2.4 SEDIMENTATION

The following presents the results of sedimentation monitoring conducted in the Saskatchewan River Region. Monitoring occurred on-system at the continuous water quality monitoring site located at the Grand Rapids GS (Figure 2.3-1). Monitoring started in 2019 (Table 2.4-1) and consists of measuring turbidity every 5 minutes and monthly site visits to verify the data and collect water samples for measuring total suspended solids (TSS) used in calculating the sediment load. For the sedimentation indicator, two metrics (continuous turbidity and suspended sediment load) were selected for detailed reporting (Table 2.4-2).

Table 2.4-1. 2008-2019 sedimentation sampling inventory.

Waterbody/ Area	Sampling Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Grand Rapids GS												●

Table 2.4-2. Sedimentation indicators and metrics.

Indicator	Metric	Units
Sedimentation	Continuous turbidity	FNU
	Suspended sediment load	Tonnes/day

2.4.1 CONTINUOUS TURBIDITY

2.4.1.1 ON-SYSTEM SITES

Grand Rapids Generating Station

Turbidity in the Saskatchewan River Region is monitored at the continuous water quality monitoring station located at the Grand Rapids GS (Figure 2.3-1). With the short record of monitoring data, few conclusive observations can be made. The average monthly turbidity ranged from 0.3 to 2.9 FNU (Table 2.4-3; Figure 2.4-1) with the hourly turbidity ranging from 0.3 to 6.5 FNU (Figure 2.4-2) over the entire monitoring period. The turbidity is observed decreasing during the ice-cover season from November to April.

2.4.1.2 OFF-SYSTEM SITES

There are no continuous monitoring off-system sites in this region.

Table 2.4-3. 2017-2019 Grand Rapids GS average monthly turbidity.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017												
2018												
2019							2.9				1.6	1.5
2020	1.1	0.9	0.5	0.3								

Notes:

1. Monthly data only shown for months with more than 15 days of data.

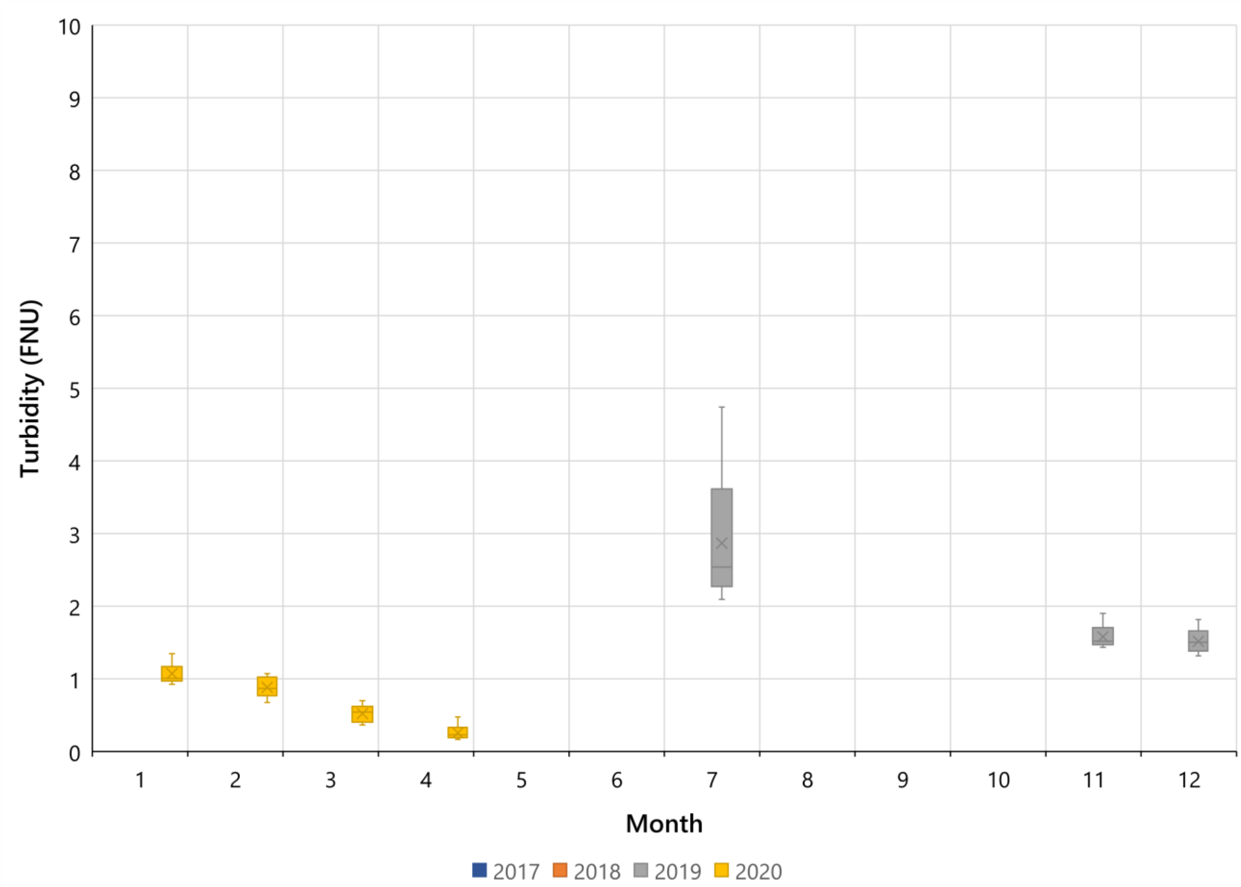


Figure 2.4-1. 2017-2019 Grand Rapids GS monthly turbidity.

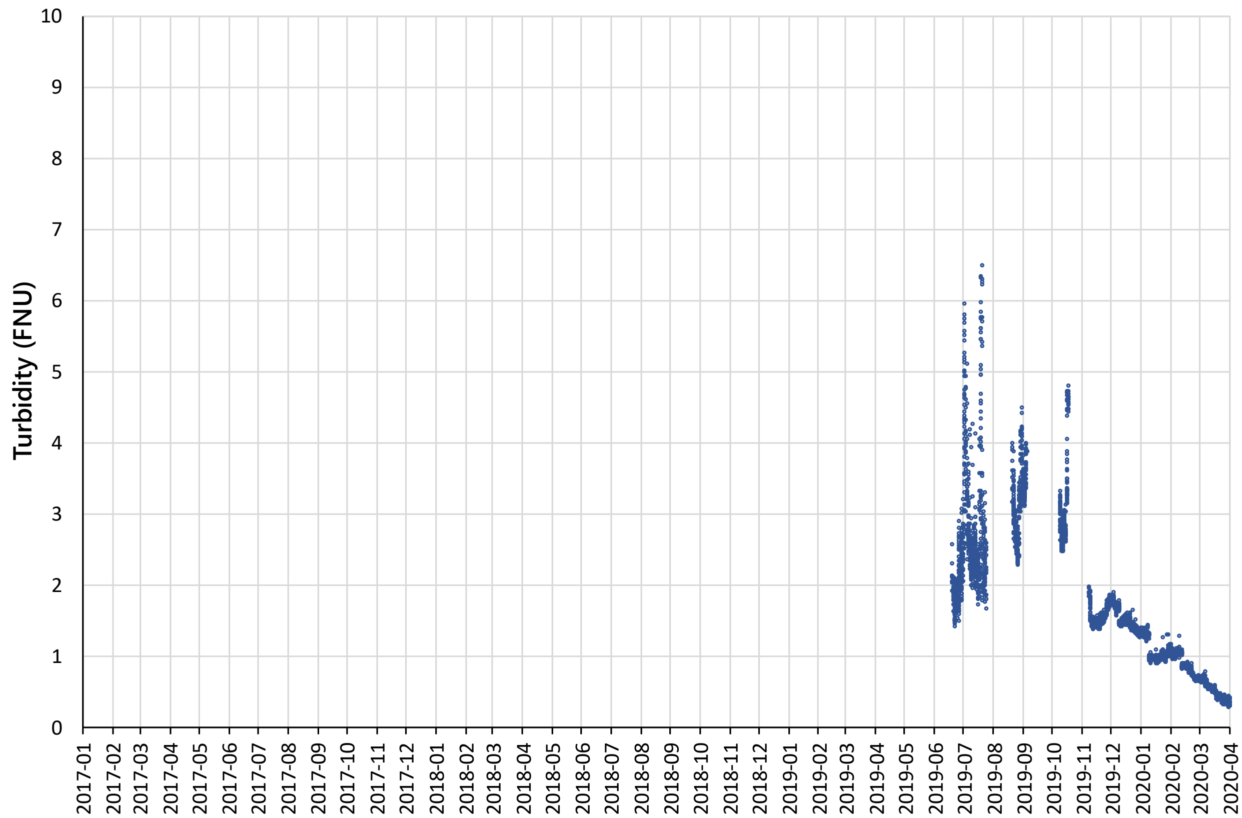


Figure 2.4-2. 2017-2019 Grand Rapids GS continuous turbidity.

2.4.2 SUSPENDED SEDIMENT LOAD

2.4.2.1 ON-SYSTEM SITES

Grand Rapids Generating Station

Sediment load is estimated using the discharge data, continuous turbidity data (Figure 2.4-2) and water samples collected to correlate the turbidity to TSS. With the short record of monitoring data, few conclusive observations can be made. The average monthly sediment load ranged from 7 to 133 T/day (Table 2.4-4; Figure 2.4-3) with the peak daily load reaching 450 T/day (Figure 2.4-4).

2.4.2.2 OFF-SYSTEM SITES

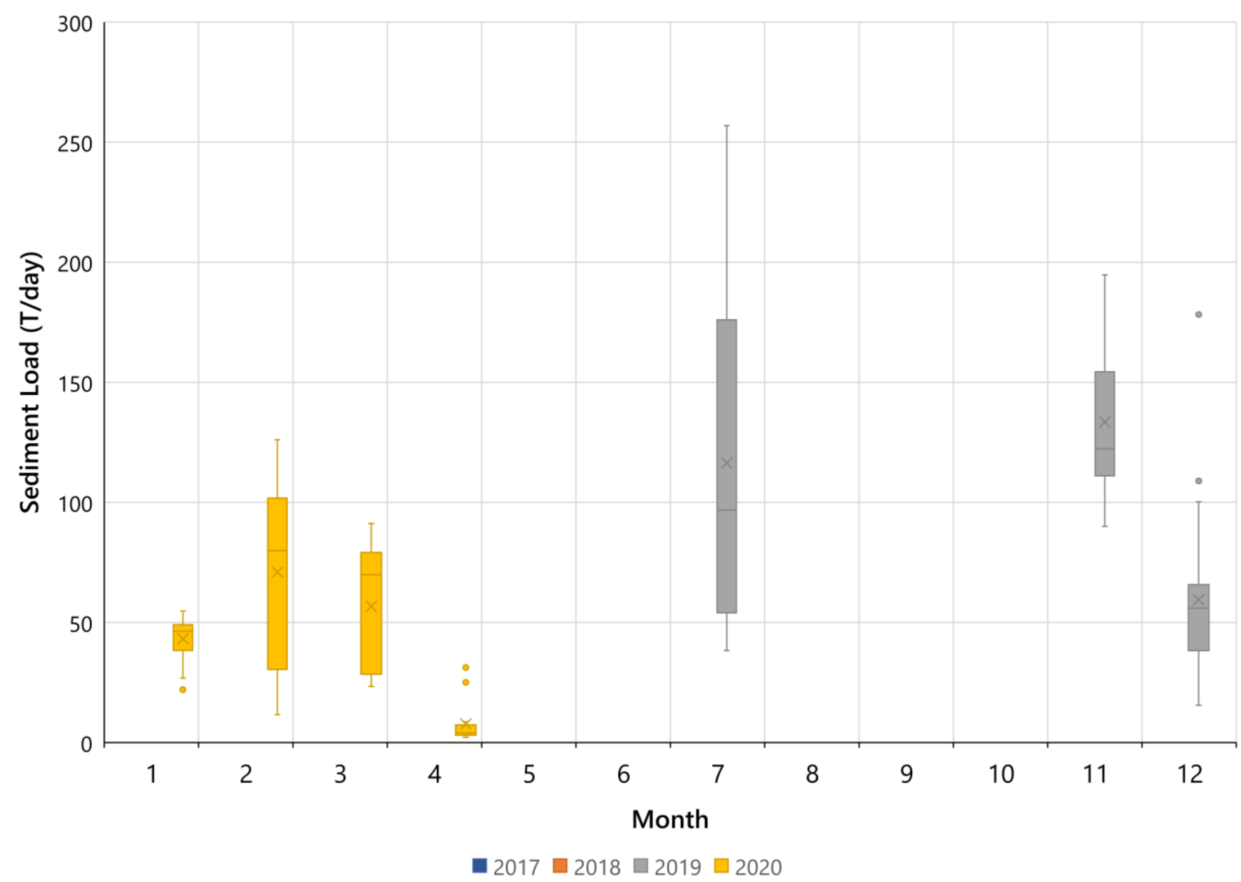
There are no continuous monitoring off-system sites in this region.

Table 2.4-4. 2017-19 Grand Rapids GS average monthly sediment load.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017												
2018												
2019							116				133	59
2020	43	71	55	7								

Notes:

1. Monthly average only shown for months with more than 15 days of data.
2. Some months are missing TSS measurements to estimate the load.



*Monthly data only shown for months with more than 15 days of data.

Figure 2.4-3. 2017-2019 Grand Rapids GS monthly sediment load.

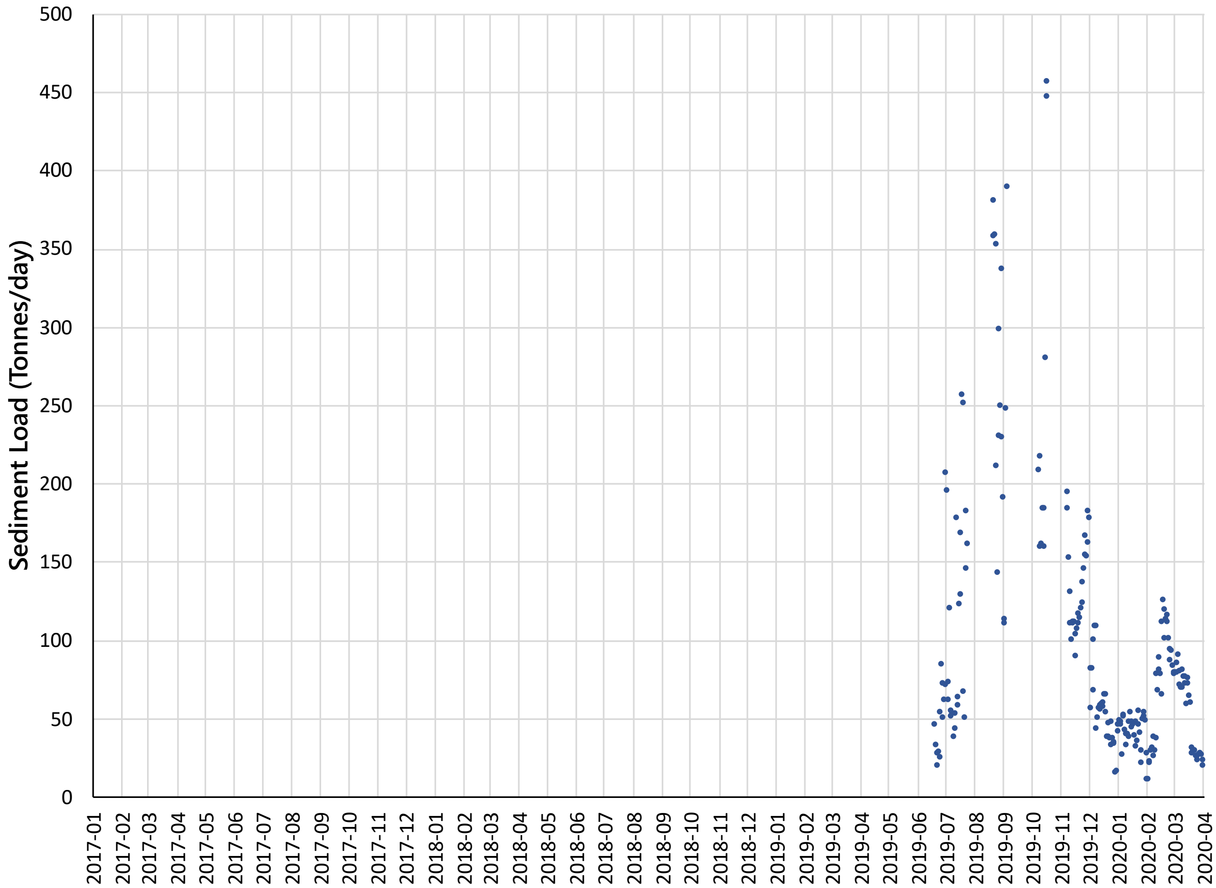
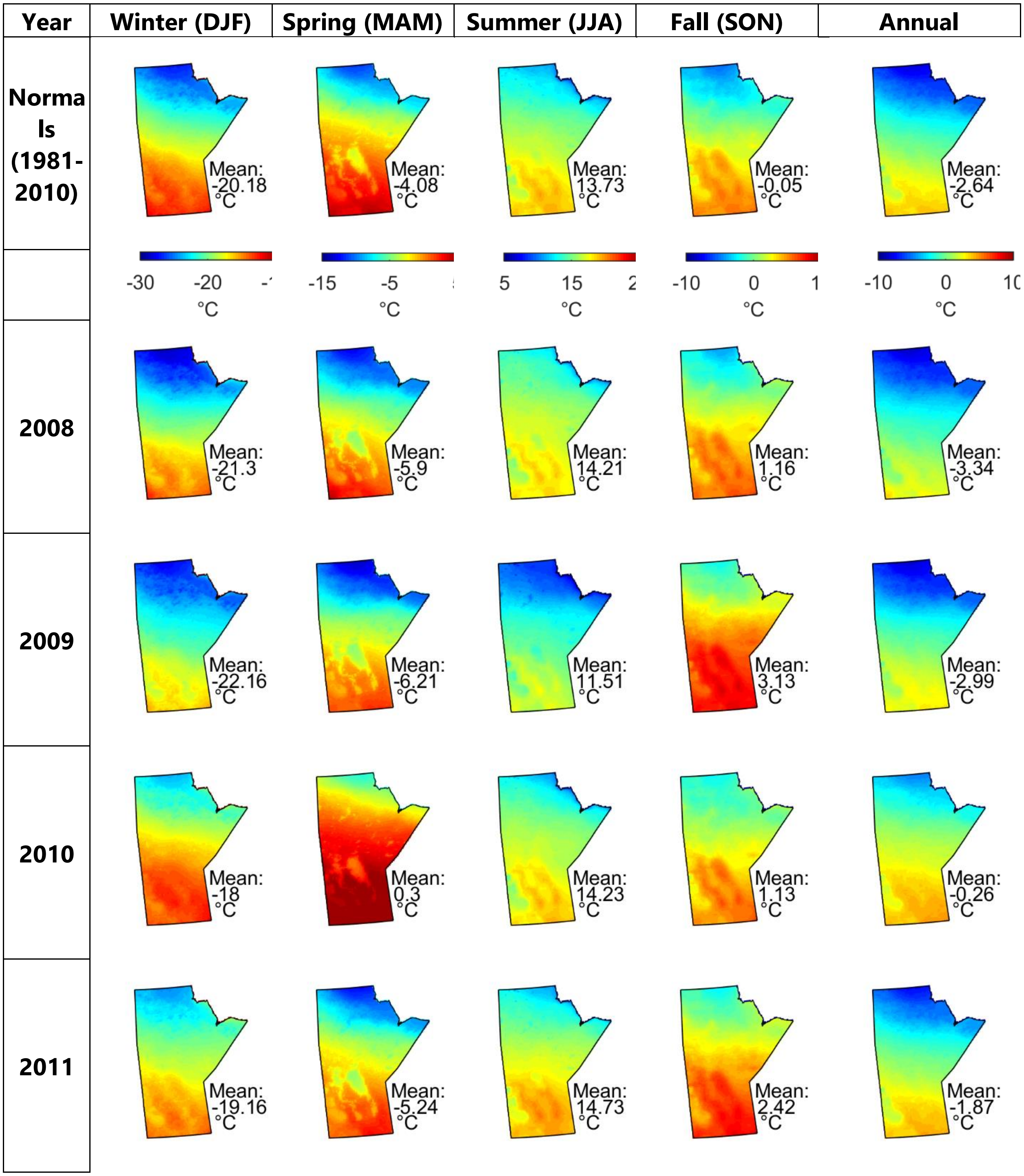
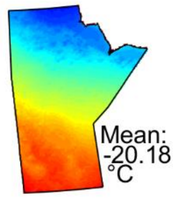
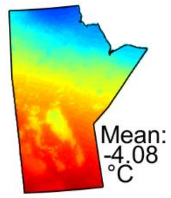
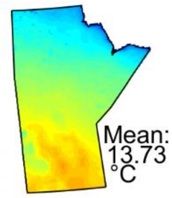
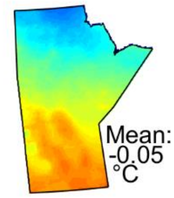
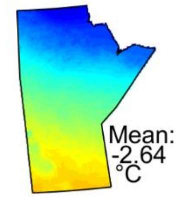
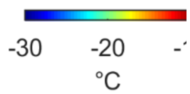
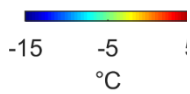
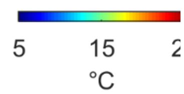
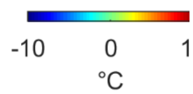
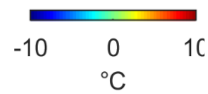
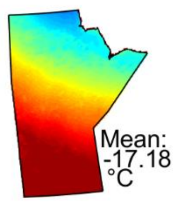
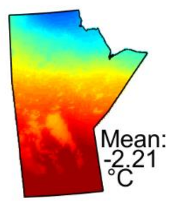
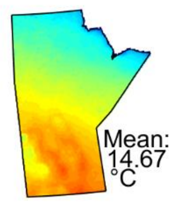
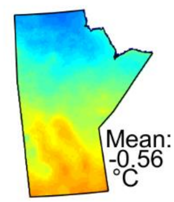
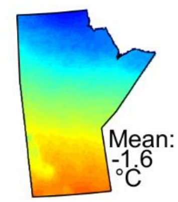
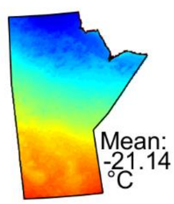
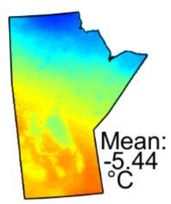
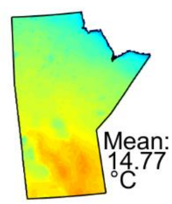
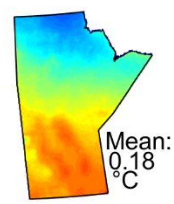
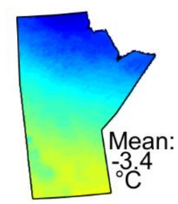
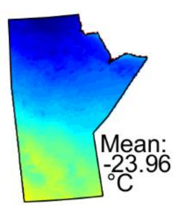
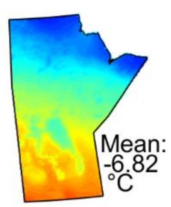
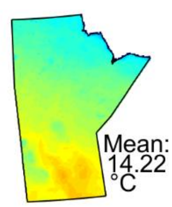
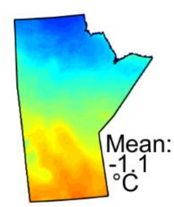
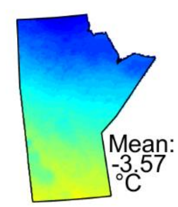
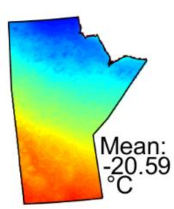
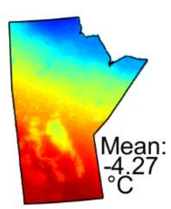
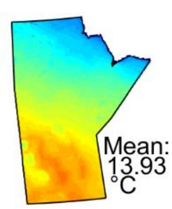
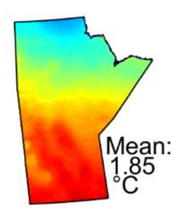
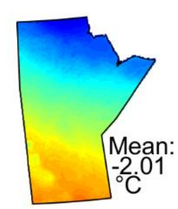
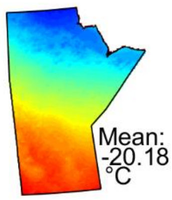
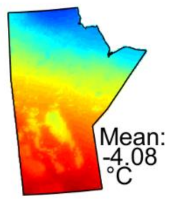
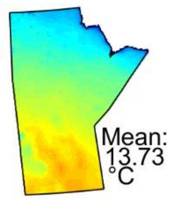
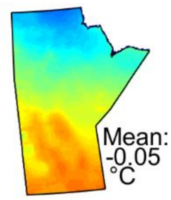
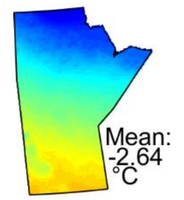
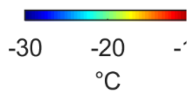
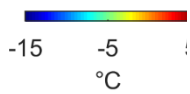
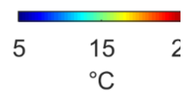
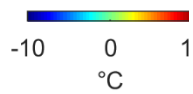
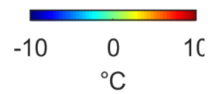
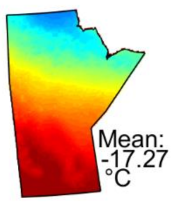
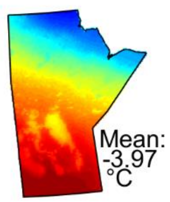
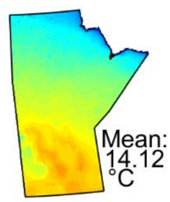
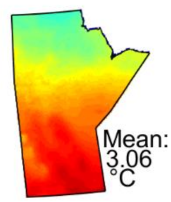
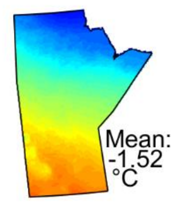
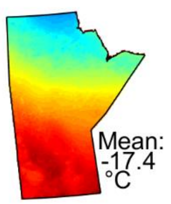
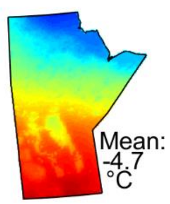
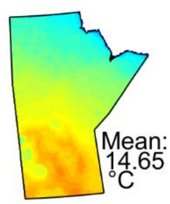
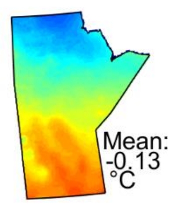
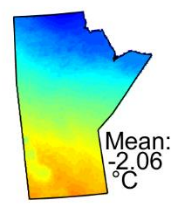
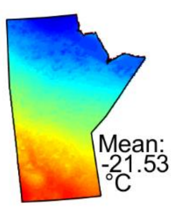
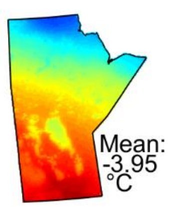
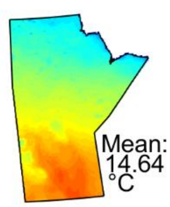
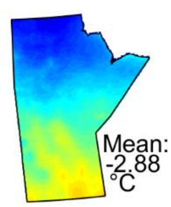
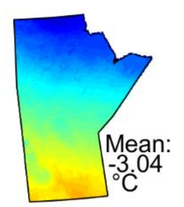
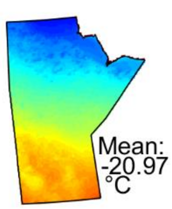
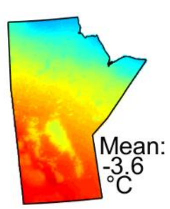
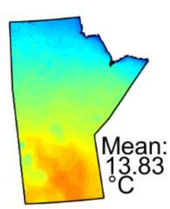
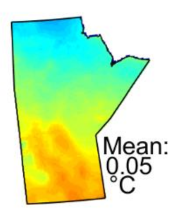
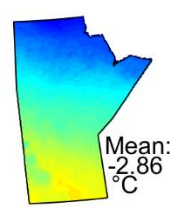
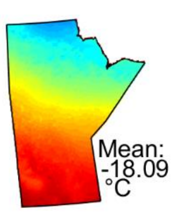
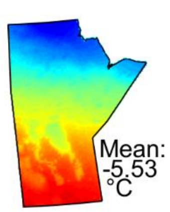
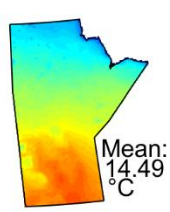
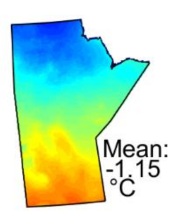
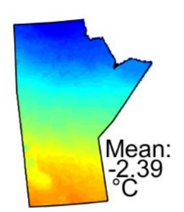


Figure 2.4-4. 2017-2019 Grand Rapids GS daily sediment load.

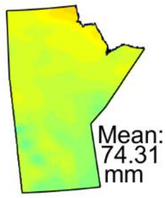
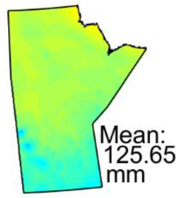
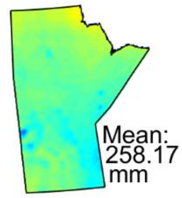
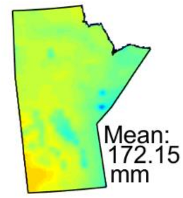
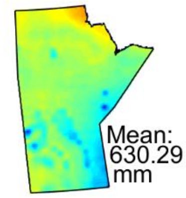
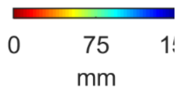
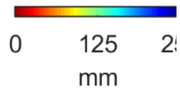
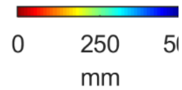
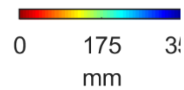
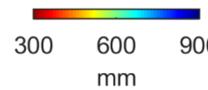
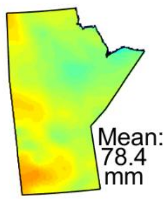
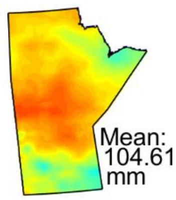
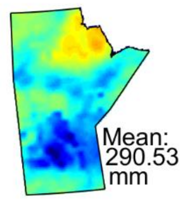
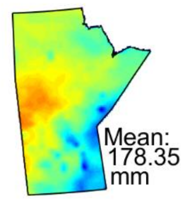
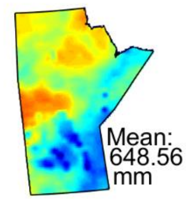
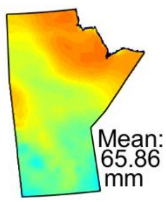
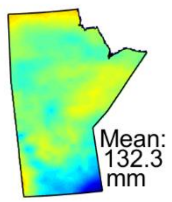
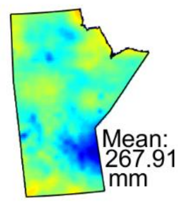
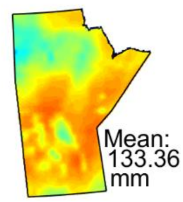
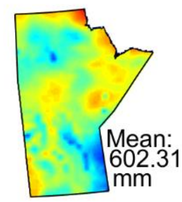
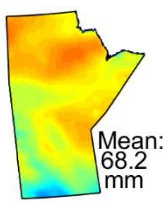
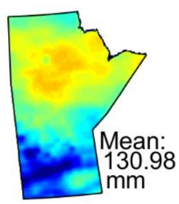
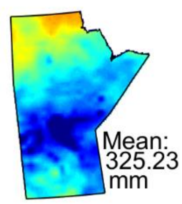
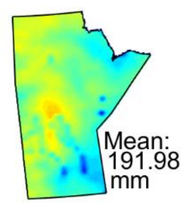
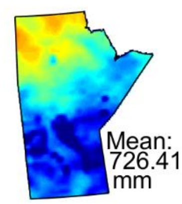
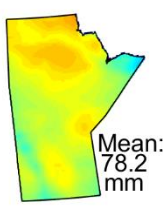
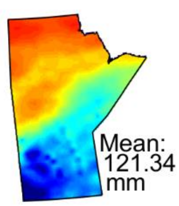
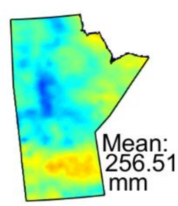
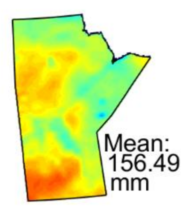
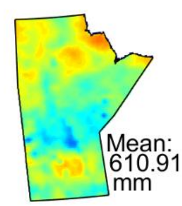
APPENDIX 2-1. SEASONAL AND ANNUAL TEMPERATURE NORMALS DERIVED FROM ERA5-LAND DATA

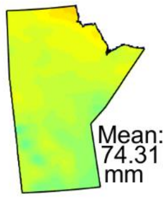
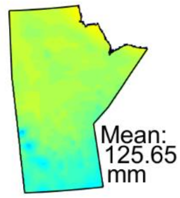
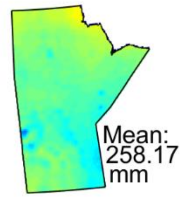
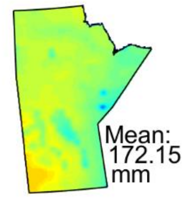
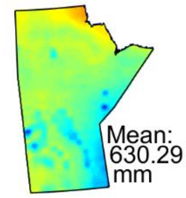
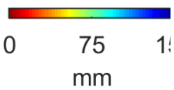
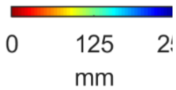
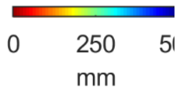
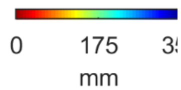
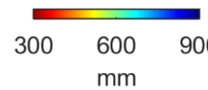
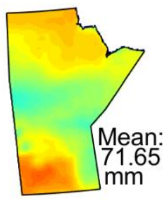
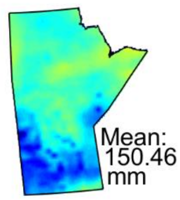
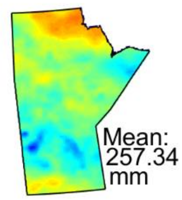
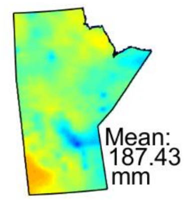
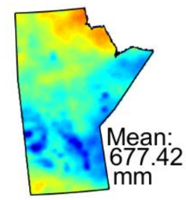
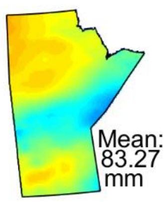
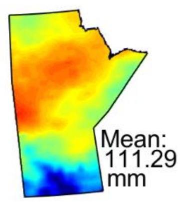
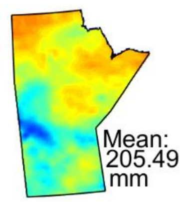
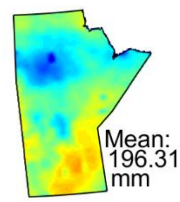
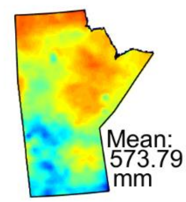
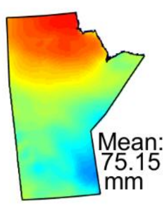
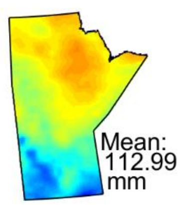
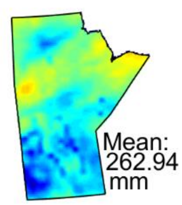
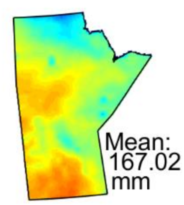
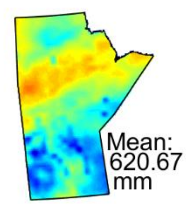
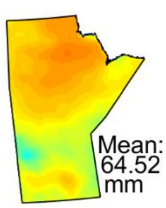
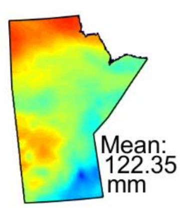
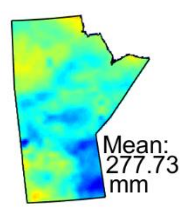
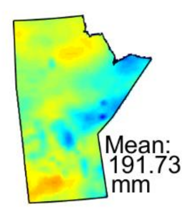
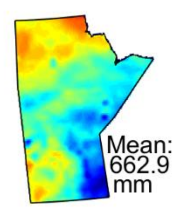

Year
Winter (DJF)
Spring (MAM)
Summer (JJA)
Fall (SON)
Annual
Normals (1981-2010)
Mean: -20.18 °C
Mean: -4.08 °C
Mean: 13.73 °C
Mean: -0.05 °C
Mean: -2.64 °C
-30 -20
°C
-15 -5
°C
5 15
°C
-10 0 1
°C
-10 0
°C
2008
Mean: -21.3 °C
Mean: -5.9 °C
Mean: 14.21 °C
Mean: 1.16 °C
Mean: -3.34 °C
2009
Mean: -22.16 °C
Mean: -6.21 °C
Mean: 11.51 °C
Mean: 3.13 °C
Mean: -2.99 °C
2010
Mean: -18 °C
Mean: 0.3 °C
Mean: 14.23 °C
Mean: 1.13 °C
Mean: -0.26 °C
2011
Mean: -19.16 °C
Mean: -5.24 °C
Mean: 14.73 °C
Mean: 2.42 °C
Mean: -1.87 °C

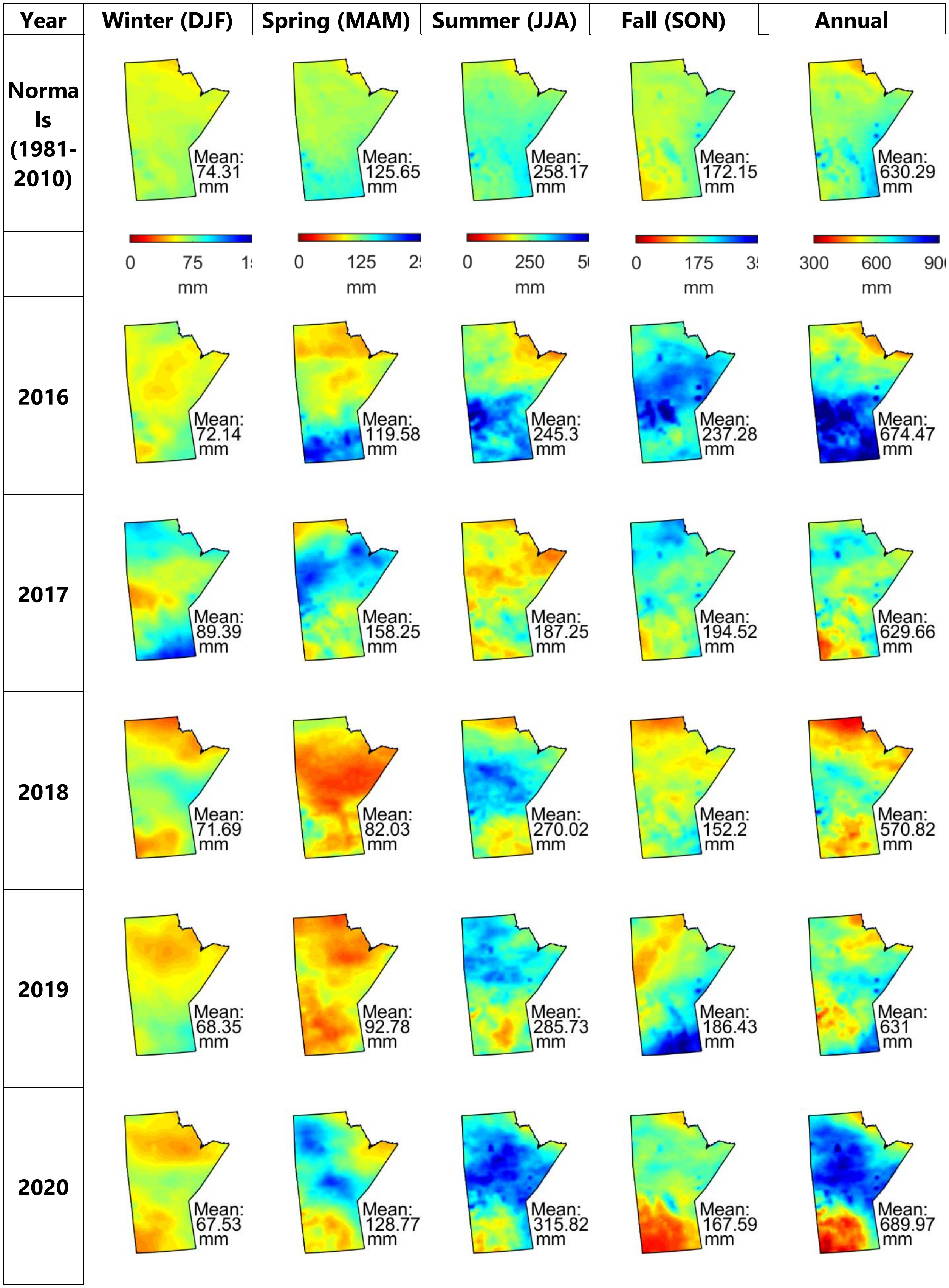
Year	Winter (DJF)	Spring (MAM)	Summer (JJA)	Fall (SON)	Annual
Normals (1981-2010)					
					
2012					
2013					
2014					
2015					

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					

Year	Winter (DJF)	Spring (MAM)	Summer (JJA)	Fall (SON)	Annual
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
mm
0 125
mm
0 250
mm
0 175
mm
300 600
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 Saskatchewan River Region. Six waterbodies were monitored in the Saskatchewan River Region: two on-system annual sites (Cedar Lake - Southeast and Lake Winnipeg - Grand Rapids); three on-system rotational sites (the Saskatchewan River, South Moose Lake, and Cedar Lake - West); and one off-system annual site (Cormorant 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.

The CAMP water quality program includes four sampling periods (referred to as spring, summer, fall, and winter) per monitoring year (i.e., April-March), typically 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):

- In 2008, Cedar Lake – Southeast was only sampled during the spring due a review of the sampling program. Therefore, there are only 11 years of monitoring in the summer, fall, and winter periods for this site over the 12-year period (i.e., n=45); and
- sampling was not completed at the Lake Winnipeg – Grand Rapids site in spring 2014 and 2018 due to repairs to the Namao boat used for Lake Winnipeg monitoring. Sampling was not completed in winter 2013 and 2016 logistical constraints. Therefore, only ten spring samples and ten winter samples were collected over the 12-year period at this site (i.e., n=44).

Deviations from the sampling protocols occurred as follows:

- sampling was completed at an alternate, more sheltered location at Cedar Lake - Southeast on several occasions for safety and logistical reasons (i.e., high wind conditions prevented landing at the target location; Appendix 3-1); and
- Secchi disk depths were not recorded at the Lake Winnipeg – Grand Rapids site in 2012, 2013, and 2014. Therefore, only nine years of monitoring data are available for this metric at this location.

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, 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
CEDAR-SE	● [2]	●	●	●	●	●	●	●	●	●	●	●
LW-GR	●	●	●	●	● [3]	● [3, 4]	● [3, 5]	●	● [4]	●	● [5]	●
SASK			●			●			●			●
SMOOSE		●			●			●			●	
CEDAR-W				●			●			●		
CORM	●	●	●	●	●	●	●	●	●	●	●	●

Notes:

1. Sampling year is from April-March.
2. Site was only sampled in spring.
3. Secchi disk depths were not recorded.
4. No winter sampling occurred due to logistical constraints.
5. No spring sampling due to repairs to the Namao boat used for Lake Winnipeg monitoring.

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.

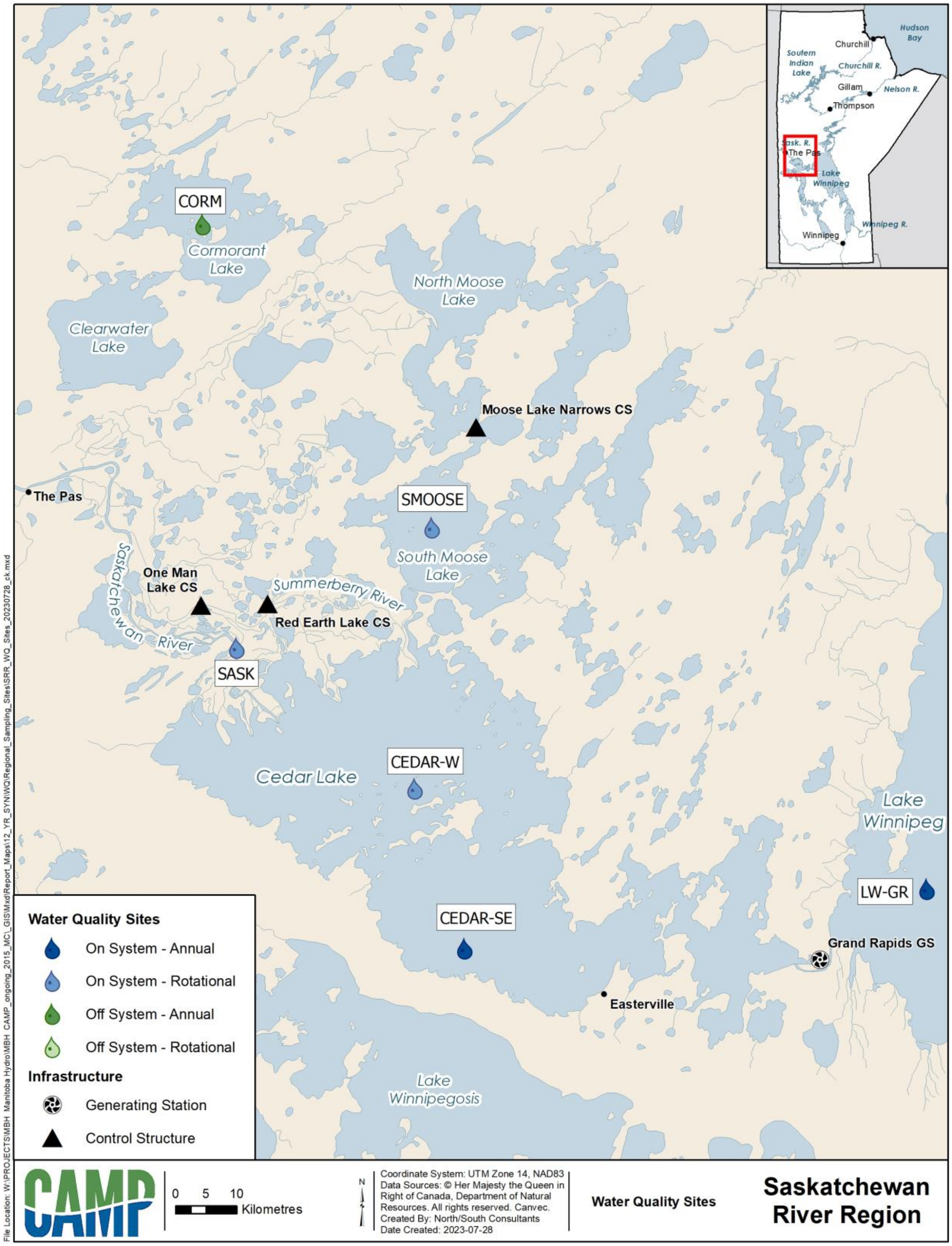


Figure 3.1-1. 2008-2019 Saskatchewan River Region water quality sites.

3.2 DISSOLVED OXYGEN

3.2.1 DISSOLVED OXYGEN

3.2.1.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

Cedar Lake - Southeast was well-oxygenated 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 season (Manitoba Water Stewardship (MWS) 2011). DO decreased with depth and fell below the MWQSOGs instantaneous minimum objective for cold-water aquatic life during two winter sampling events (2018 and 2019) over the 12 years of monitoring (Table 3.2-1).

Cedar Lake - Southeast was thermally stratified during seven open-water sampling events and during one ice-cover sampling event over the 12 years of monitoring. Thermal stratification was observed during four spring sampling events (2010, 2012, 2013 and 2015), three summer sampling events (2011, 2014, and 2016) and one winter sampling event (2013; Table 3.2-1 and Figure 3.2-1).

During the open-water season Cedar Lake – Southeast was well-oxygenated. Typically, DO concentrations were similar throughout the water column; however, DO concentrations decreased with water depth during one spring sampling event (2015), and increased with water depth during another spring sampling event (2013). DO concentrations at the surface and near the bottom were above the MWQSOGs instantaneous minimum objectives for cool- and cold-water aquatic life during all open-water sampling events over the 12 years of monitoring (Table 3.2-1 and Figure 3.2-2). During the open-water season, DO concentrations ranged from 8.09 to 12.35 mg/L at the surface and 7.77 to 10.55 mg/L near the bottom (maximum site water depth = 11.9 m; Table 3.2-2 and Figure 3.2-3).

During the ice-cover season, Cedar Lake – Southeast was well oxygenated near the surface. However, DO concentrations decreased with water depth during each winter sampling event and fell below the instantaneous minimum objective for cold-water aquatic life (8.0 mg/L) during the winters of 2018 and 2019 (Table 3.2-1 and Figure 3.2-2).

During the ice-cover season, DO concentrations ranged from 10.57 to 16.32 mg/L at the surface and 5.17 to 10.35 mg/L near the bottom (Table 3.2-2 and Figure 3.2-3).

DO concentrations near the surface varied between seasons, with seasonal mean DO concentrations being higher in winter when the water was cooler, and lower during the open-water season when the water was warmer. Despite colder water in winter, DO concentrations near the bottom were similar to those in the open-water season (Figure 3.2-4).

DO saturation was near 100% at the surface during each season sampled (Figure 3.2-5). During the open-water season, surface DO saturation ranged from 90.3 to 122.2%, with a mean of 101.1% and a median of 98.9% over the 12 years of monitoring. Mean surface DO saturation levels in the open-water season were similar from year to year ranging from 94.3 to 108.7% and were within or near the IQR (IQR) of 95.4 to 105.1% (Table 3.2-2 and Figure 3.2-6). On average, DO saturation was near 100% at the bottom during the open-water season (90.8, 95.8, and 93.4% in spring, summer, and fall, respectively). During the open-water season, bottom DO saturation ranged from 77.7 to 101.9% with a mean of 93.3% and a median of 94.3% over the 12 years of monitoring. Mean bottom DO saturation levels in the open-water season were similar from year to year ranging from 89.4 to 100.3% and were within or near the IQR of 89.8 to 96.1% (Table 3.2-2 and Figure 3.2-6).

During the ice-cover season, DO saturation at the surface ranged from 78.3 to 115.7% with a mean of 98.7% and a median of 99.1%. The IQR was 91.9 to 107.9% (Table 3.2-2 and Figure 3.2-7). During the ice-cover season, bottom DO saturation ranged from 38.3 to 80.1% with a mean of 63.3% and a median of 66.1%. The IQR was 61.4 to 71.3% (Table 3.2-2 and Figure 3.2-7).

Lake Winnipeg - Grand Rapids

The Lake Winnipeg - Grand Rapids site was generally well-oxygenated and DO concentrations throughout the water column typically met the MWQSOGs instantaneous minimum objectives for cool- and cold-water aquatic life. However, DO concentrations near the bottom fell below the MWQSOGs instantaneous minimum objectives for cold-water aquatic life during two summer sampling events (2012 and 2015; Table 3.2-1).

The Lake Winnipeg - Grand Rapids site was thermally stratified during the spring and/or summer sampling events in 10 open-water periods over the 12 years of monitoring. Stratification was observed in three spring sampling events (2009, 2010, and 2013) and eight summer sampling events (2008, 2012, 2013, 2014, 2015, 2016, 2017, and 2018). Thermal stratification was also observed in one winter sampling event (2019; Table 3.2-1 and Figure 3.2-1).

During most summer and winter sampling events, DO concentrations decreased down the water column. However, DO concentrations near the bottom remained above the MWQSOGs instantaneous minimum objectives for cool- and cold-water aquatic life with two exceptions. DO concentrations near the bottom were below both the MWQSOGs instantaneous minimum objectives for cool- and cold-water aquatic life (4.0 and 5.0 mg/L, respectively) in summer 2012 and were below the MWQSOGs instantaneous minimum objective for cool-water aquatic life (4.0 mg/L) in summer 2015. Although some variability was observed, DO concentrations were typically similar near the surface and bottom during most spring and fall sampling events (Figures 3.2-2 and 3.2-8).

During the open-water season, DO concentrations ranged from 6.83 to 11.34 mg/L at the surface and from 3.30 to 13.42 mg/L near the bottom (maximum site water depth = 14.7 m). During the ice-cover season, DO concentrations ranged from 10.99 to 14.70 mg/L at the surface and from 8.96 to 11.77 mg/L near the bottom (Table 3.2-2 and Figure 3.2-8).

DO concentrations at the surface varied between seasons, with mean surface DO concentrations being higher in winter and spring when the water was cooler, and lower in summer and fall when the water was warmer. Seasonal differences in mean bottom DO concentrations were less pronounced; however, bottom DO concentrations were lowest in summer and highest in spring (Figure 3.2-4).

On average, DO saturation was near 100% at the surface during each season sampled (Figure 3.2-5). During the open-water season, surface DO saturation ranged from 73.5 to 122.2%, with a mean of 91.5% and a median of 92.1% over the 12 years of monitoring. Mean surface DO saturation levels in the open-water season ranged from 82.7 to 104.2% and were within or near the IQR of 84.0 to 95.1% (Table 3.2-2 and Figure 3.2-6). During the ice-cover season, DO saturation at the surface ranged from 74.9 to 104.6% with a mean of 89.9% and a median of 87.4%. The IQR was 85.7 to 95.7% (Table 3.2-2 and Figure 3.2-7).

On average, DO saturation near the bottom was lower in summer and winter (62.6 and 72.6%, respectively) than in spring and fall (94.9 and 88.9%, respectively; Figure 3.2-5). During the open-water season, bottom DO saturation ranged from 30.1 to 113.9%, with a mean of 81.9% and a median of 89.4% over the 12 years of monitoring. Mean bottom DO saturation levels in the open-water season were similar from year to year ranging from 57.7 to 99.4% and were within or near the IQR of 74.6 to 93.9% in years except 2012 when it was below the IQR (Table 3.2-2 and Figure 3.2-6). During the ice-cover season, bottom DO saturation ranged from 64.9 to 87.7% with a mean of 72.6% and a median of 69.9%. The IQR was 65.7 to 77.3% (Table 3.2-2 and Figure 3.2-7).

ROTATIONAL SITES

Saskatchewan River

The Saskatchewan River was well-oxygenated year-round and DO concentrations at the surface 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). Only surface data are available for this site.

DO concentrations at the surface ranged from 6.85 to 10.01 mg/L during the open-water season, and from 10.20 to 13.72 mg/L during the ice-cover season (Table 3.2-2 and Figure 3.2-9).

During the open-water season, surface DO saturation ranged from 78.8 to 106.3% with a mean of 90.4% and a median of 90.6% over the four years of monitoring. Mean surface DO saturation levels in the open-water season were similar from year to year ranging from 86.3 to 93.6% and were within the IQR (85.8 to 95.2%) in all four years of monitoring (Table 3.2-2 and Figure 3.2-10). During the ice-cover season, DO saturation at the surface ranged from 71.3 to 96.1% with a mean of 82.9% (Table 3.2-2 and Figure 3.2-11).

South Moose Lake

South Moose Lake was well-oxygenated near the surface and DO concentrations near the surface met the MWQSOGs during all sampling periods. DO concentrations decreased with water depth and fell below the MWQSOGs instantaneous minimum objective for cold-water aquatic life near the bottom in the ice-cover seasons of 2009, 2012, and 2018.

South Moose Lake was thermally stratified during each winter sampling event over the four years of monitoring. The lake was typically isothermal during the open-water season; however, there were two occurrences of thermal stratification near the surface (thermocline at 0-1 m in spring and summer 2015; Table 3.2-1 and Figure 3.2-1).

South Moose Lake was well-oxygenated near the surface during all sampling periods. DO concentrations were similar throughout the water column during the open-water season. In winter

DO concentrations decreased with depth and fell below the MWQSOGs instantaneous minimum objective for cold-water aquatic life (8.0 mg/L) near the bottom in the winters of 2009, 2012, and 2018. The bottom DO concentration in winter 2018 was also below the MWQSOGs instantaneous minimum objective for cool-water aquatic life (3.0 mg/L; Table 3.2-1 and Figures 3.2-2 and 3.2-12).

During the open-water season, DO concentrations in South Moose Lake ranged from 8.31 to 10.56 mg/L at the surface and 7.83 to 10.58 mg/L near the bottom (maximum site water depth = 7.4 m). During the ice-cover season, DO concentration ranged from 14.46 mg/L and 16.18 mg/L at the surface and 2.48 and 11.85 mg/L near the bottom (Table 3.2-2 and Figure 3.2-12).

During the open-water season, surface DO saturation ranged from 90.8 to 110.5% with a mean of 100.0% and a median of 97.8% over the four years of monitoring. Mean surface DO saturation levels in the open-water season ranged from 93.9 to 103.1% and were within or near the IQR of 96.3 to 103.1%. Bottom DO saturation during the open-water season ranged from 87.2 to 108.5% with a mean of 97.7% and median of 97.4% over the four years of monitoring. Mean bottom DO saturation levels in the open-water season ranged from 90.7 to 102.2% and were within or near the IQR of 94.3 to 102.6% (Table 3.2-2 and Figure 3.2-10*)*.

During the ice-cover season, surface DO saturation ranged from 102.8% and 115.9% with a mean of 110.5%. Bottom DO saturation during the ice-cover season ranged from 20.1 to 90.3% with a mean of 46.3% (Table 3.2-2 and Figure 3.2-11).

Cedar Lake - West

Cedar Lake - West 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).

Cedar Lake - West was typically isothermal; however, one occurrence of thermal stratification (thermocline 1-2 m) was observed in summer 2011 (Table 3.2-1 and Figure 3.2-1). Cedar Lake – West was well-oxygenated near the surface and DO concentrations were similar across the water column during each sampling period (Figure 3.2-2).

During the open-water season, DO concentrations ranged from 8.15 to 10.34 mg/L at the surface and 7.59 to 10.23 mg/L near the bottom (maximum site water depth = 3.4 m). During the ice-cover season, the surface DO concentration was 10.32 mg/L in 2011 and 8.41 mg/L in 2017. The bottom DO concentration was 10.32 mg/L in 2011 (Table 3.2-2 and Figure 3.2-13).

During the open-water season, surface DO saturation ranged from 93.7 to 111.3% with a mean of 99.7% and a median of 99.1% over the three years of monitoring. Mean surface DO saturation levels in the open-water season were similar from year to year ranging from 95.3 to 105.5% and were within or near the IQR of 96.2 to 101.8%. Bottom DO saturation during the open-water season ranged from 88.4 to 107.6% with a mean of 96.1% and median of 93.9% over the three years of monitoring. Mean bottom DO saturation levels in the open-water season were similar from year to year ranging from 91.9 to 100.5% and were within or near the IQR of 93.1 to 98.6% (Table 3.2-2 and Figure 3.2-10*)*.

During the ice-cover season, DO saturation at the surface was 76.3% in 2011 and 59.9% in 2017 with a mean of 68.1%. Bottom DO saturation during the ice-cover season was 76.7% in 2011 (Table 3.2-2 and Figure 3.2-11).

3.2.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

Cormorant Lake was well-oxygenated near the surface and DO concentrations at the surface met the MWQSOGs during all open-water and ice-cover sampling events. However, DO concentrations decreased with water depth and fell below the MWQSOGs instantaneous minimum objectives for cool- and/or cold-water aquatic life during some sampling events (Table 3.2-3).

Cormorant Lake was thermally stratified during the spring and/or summer sampling events in nine of the 12 years of monitoring (Figure 3.2-1). Stratification was observed in four spring sampling events (2008, 2010, 2013, and 2015) and eight summer sampling events (2010, 2011, 2012, 2013, 2015, 2016, 2017, and 2019; Table 3.2-3).

During most summer and winter sampling events, DO concentrations decreased down the water column. However, DO concentrations near the bottom remained above the MWQSOGs instantaneous minimum objectives for cool- and cold-water aquatic life with six exceptions. During the open-water season, DO concentrations near the bottom fell below the MWQSOGs instantaneous minimum objective for cool-water aquatic life (5.0 mg/L) in three summers (2014, 2015, and 2017) and below the instantaneous minimum objectives for cool- and cold-water aquatic life (5.0 and 4.0 mg/L, respectively) in one summer (2010). During the ice-cover season, DO concentrations near the bottom fell below the MWQSOGs instantaneous minimum objective for cold-water aquatic life (8.0 mg/L) in two winters (2015 and 2018; Figures 3.2-2).

During the open-water season, DO concentrations ranged from 8.09 to 12.67 mg/L at the surface and from 3.27 to 11.99 mg/L near the bottom (maximum site water depth = 28.0 m). During the ice-cover season, DO concentrations ranged from 12.46 to 15.58 mg/L at the surface and from 5.63 to 10.12 mg/L near the bottom (Table 3.2-4 and Figure 3.2-14).

DO concentrations at the surface varied between seasons with mean surface 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. DO concentrations near the bottom were more similar in spring, fall, and winter but concentrations in summer were lower than the other seasons (Figure 3.2-15).

DO saturation in Cormorant Lake was near 100% at the surface during each season sampled (Figure 3.2-16). During the open-water season, surface DO saturation ranged from 88.5 to 119.4% with a mean of 101.2% and a median of 100.6% over the 12 years of monitoring. Mean surface DO saturation levels in the open-water season ranged from 93.2 to 106.9% and were within or near the IQR of 95.7 to 106.2%. During the ice-cover season, DO saturation at the surface ranged from 92.7 to 116.2% with a mean of 104.4% and a median of 105.3%. The IQR was 100.1 to 108.7% (Table 3.2-4 and Figure 3.2-17).

On average, DO saturation near the bottom was lower in summer and winter (59.9 and 66.5%, respectively) than in spring and fall (95.6 and 93.3%, respectively; Figure 3.2-16). During the open-water season, bottom DO saturation ranged from 32.4 to 100.0% with a mean of 81.5 and median of 92.3% over the 12 years of monitoring. Mean bottom DO saturation levels in the open-water season ranged from 70.2 to 92.2% and were within the IQR of 66.8 to 94.1%. Bottom DO saturation during the ice-cover season ranged from 42.2 to 77.3% with a mean of 66.5% and a median of 68.6%. The IQR was 63.7 to 71.4% (Table 3.2-4 and Figure 3.2-17).

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

Metric	Sampling Year	Surface or Bottom	CEDAR-SE				LW-GR				SASK				SMOOSE				CEDAR-W			
			Open-Water			Ice-Cover	Open-Water			Ice-Cover	Open-Water			Ice-Cover	Open-Water			Ice-Cover	Open-Water			Ice-Cover
			SP	SU	FA	WI	SP	SU	FA	WI	SP	SU	FA	WI	SP	SU	FA	WI	SP	SU	FA	WI
Thermal Stratification	2008		No	ND	ND	ND	No	2008	No	ND												
	2009		No	No	No	No	2009	No	No	ND					No	No	No	2009				
	2010		2010	No	No	No	2010	ND	No	ND												
	2011		No	2011	No	No	No	No	No	No									No	2011	No	No
	2012		2012	No	No	No	No	2012	No	No					No	No	No	2012				
	2013		2013	No	No	2013	2013	2013	No	ND	No Data											
	2014		No	2014	No	No	ND	2014	No	No									No	No	No	No
	2015		2015	No	No	No	No	2015	No	No					2015	2015	No	2015				
	2016		No	2016	No	No	No	2016	No	ND												
	2017		No	No	No	No	No	2017	No	No									No	No	No	No
	2018		No	No	No	No	ND	2018	No	No					No	No	No	2018				
	2019		No	No	No	No	No	ND	No	2019												
DO met MWQSOGs PAL objectives	2008	Surface	Yes	ND	ND	ND	Yes	Yes	Yes	ND												
		Bottom	Yes	ND	ND	ND	Yes	Yes	Yes	ND												
	2009	Surface	ND	ND	ND	Yes	ND	Yes	Yes	ND					ND	ND	ND	Yes				
		Bottom	ND	ND	ND	Yes	ND	Yes	Yes	ND					ND	ND	ND	2009				
	2010	Surface	Yes	Yes	Yes	ND	ND	ND	Yes	ND	Yes	Yes	Yes	ND								
		Bottom	Yes	Yes	Yes	ND	ND	ND	Yes	ND												
	2011	Surface	Yes	Yes	ND	Yes	Yes	Yes	Yes	Yes									Yes	Yes	Yes	Yes
		Bottom	Yes	Yes	ND	Yes	Yes	Yes	Yes	Yes									Yes	Yes	Yes	Yes
	2012	Surface	Yes	Yes	Yes	Yes	Yes	Yes	ND	Yes					Yes	Yes	Yes	Yes				
		Bottom	Yes	Yes	Yes	Yes	Yes	2012	ND	Yes					Yes	Yes	Yes	2012				
	2013	Surface	Yes	Yes	Yes	Yes	Yes	Yes	Yes	ND	Yes	Yes	Yes	Yes								
		Bottom	Yes	Yes	Yes	Yes	Yes	Yes	Yes	ND												
	2014	Surface	Yes	ND	Yes	Yes	ND	Yes	Yes	Yes									Yes	Yes	Yes	ND
		Bottom	Yes	ND	Yes	Yes	ND	ND	Yes	Yes									Yes	Yes	Yes	ND
	2015	Surface	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes					Yes	Yes	Yes	Yes				
		Bottom	Yes	Yes	Yes	Yes	Yes	2015	Yes	Yes					Yes	Yes	Yes	Yes				
	2016	Surface	Yes	Yes	Yes	Yes	Yes	Yes	Yes	ND	Yes	Yes	Yes	Yes								
		Bottom	Yes	Yes	Yes	Yes	Yes	ND	Yes	ND												
	2017	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	ND
	2018	Surface	Yes	Yes	Yes	Yes	ND	Yes	Yes	Yes					Yes	Yes	Yes	Yes				
		Bottom	Yes	Yes	Yes	2018	ND	Yes	Yes	Yes					Yes	Yes	Yes	2018				
	2019	Surface	Yes	Yes	Yes	Yes	Yes	ND	Yes	Yes	Yes	Yes	Yes	Yes								
		Bottom	Yes	Yes	Yes	2019	Yes	ND	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. As only surface data are available for riverine sites (i.e., SASK), assessment of thermal stratification and bottom dissolved oxygen concentrations are not provided for these locations.
7. [ ] = 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
CEDAR-SE	Mean	9.53	13.69	8.93	8.34	101.0	98.7	93.3	63.3	9.9	9.7	0.99
	Median	9.40	13.40	8.92	8.93	98.9	99.1	94.3	66.1	10.9	9.8	1.00
	Minimum	8.09	10.57	7.77	5.17	90.3	78.3	77.7	38.3	3.7	8.7	0.65
	Maximum	12.35	16.32	10.55	10.35	122.2	115.7	101.9	80.1	11.9	10.2	1.35
	SD	0.862	1.78	0.647	1.827	7.68	12.28	5.77	14.44	2.41	0.45	0.19
	SE	0.163	0.593	0.125	0.609	1.45	4.09	1.11	4.81	0.41	0.14	0.06
	Lower Quartile	9.02	12.60	8.57	8.09	95.4	91.9	89.8	61.4	10.4	9.5	0.88
	Upper Quartile	9.90	14.94	9.30	9.55	105.1	107.9	96.1	71.3	11.1	10.0	1.07
	n	28	9	27	9	28	9	27	9	34	11	11
	% Detections	100	100	100	100	100	300	100	100	-	-	-
LW-GR	Mean	9.35	12.88	8.80	10.10	91.5	89.9	81.9	72.6	13.3	12.9	0.93
	Median	9.25	12.65	9.17	9.73	92.1	87.4	89.4	69.9	13.3	12.9	0.87
	Minimum	6.83	10.99	3.30	8.96	73.5	74.9	30.1	64.9	12.3	12.4	0.67
	Maximum	11.34	14.70	13.42	11.77	122.2	104.6	113.9	87.7	14.7	13.5	1.40
	SD	1.31	1.21	2.36	1.09	10.6	9.99	18.9	8.52	0.64	0.31	0.25
	SE	0.243	0.456	0.431	0.412	1.97	3.78	3.45	3.22	0.11	0.10	0.10
	Lower Quartile	8.51	12.48	7.40	9.21	84.0	85.7	74.6	65.7	12.8	12.7	0.78
	Upper Quartile	10.61	13.43	10.24	10.91	95.1	95.7	93.9	77.3	13.8	13.0	1.03
	n	29	7	30	7	29	7	30	7	34	10	7
	% Detections	100	100	100	100	100	100	100	100	-	-	-
SASK	Mean	8.52	11.64	-	-	90.4	82.9	-	-	5.3	5.2	0.66
	Median	8.69	-	-	-	90.6	-	-	-	5.0	-	-
	Minimum	6.85	10.20	-	-	78.8	71.3	-	-	4.1	1.7	0.59
	Maximum	10.01	13.72	-	-	106.3	96.1	-	-	6.8	7.1	0.73
	SD	1.003	1.85	-	-	7.95	12.5	-	-	0.86	2.54	0.06
	SE	0.290	1.07	-	-	2.29	7.20	-	-	0.25	1.27	0.03
	Lower Quartile	8.06	-	-	-	85.8	-	-	-	4.8	-	-
	Upper Quartile	9.33	-	-	-	95.2	-	-	-	5.7	-	-
	n	12	3	-	-	12	3	-	-	12	4	4
	% Detections	100	100	-	-	100	100	-	-	-	-	-

Table 3.2-2. continued.

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
SMOOSE	Mean	9.63	15.20	9.54	5.93	100.0	110.5	97.7	46.3	6.6	6.2	0.92
	Median	9.52	-	9.34	-	97.8	-	97.4	-	6.7	-	-
	Minimum	8.31	14.46	7.83	2.48	90.8	102.8	87.2	20.1	6.1	5.8	0.73
	Maximum	10.56	16.18	10.58	11.85	110.0	115.9	108.5	90.3	7.4	6.4	1.20
	SD	0.818	0.842	1.02	4.11	6.67	6.46	7.23	30.7	0.33	0.28	0.204
	SE	0.273	0.421	0.339	2.056	2.22	3.23	2.41	15.3	0.09	0.14	0.10
	Lower Quartile	8.99	-	8.75	-	96.3	-	94.3	-	6.6	-	-
	Upper Quartile	10.39	-	10.50	-	103.1	-	102.6	-	6.7	-	-
	n	9	4	9	4	9	4	9	4	12	4	4
	% Detections	100	100	100	100	100	100	100	100	-	-	-
CEDAR-W	Mean	9.25	9.37	9.01	10.32	99.7	68.1	96.1	76.7	3.1	1.3	0.96
	Median	8.94	-	8.92	-	99.1	-	93.9	-	3.1	-	-
	Minimum	8.15	8.41	7.59	10.32	93.7	59.9	88.4	76.7	2.9	0.1	0.85
	Maximum	10.34	10.32	10.23	10.32	111.3	76.3	107.6	76.7	3.4	2.5	1.09
	SD	0.839	-	1.03	-	5.35	-	6.12	-	0.15	1.20	0.12
	SE	0.280	-	0.34	-	1.78	-	2.04	-	0.05	0.69	0.07
	Lower Quartile	8.63	-	8.15	-	96.2	-	93.1	-	3.0	-	-
	Upper Quartile	10.09	-	10.05	-	101.8	-	98.6	-	3.2	-	-
	n	9	2	9	1	9	2	9	1	9	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

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

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

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.
3. 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.
4. Cells with a year indicated denote instances of stratification or non-compliance with MWQSOGs instantaneous minimum objectives.
5. [ ] = 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
CORM	Mean	9.68	14.36	8.28	8.57	101.2	104.4	81.5	66.5	23.9	25.0	0.91
	Median	9.32	14.22	9.07	8.69	100.6	105.3	92.3	68.6	26.2	25.8	0.85
	Minimum	8.09	12.46	3.27	5.63	88.5	92.7	32.4	42.2	14.0	15.3	0.54
	Maximum	12.67	15.58	11.99	10.12	119.4	116.2	100.0	77.3	28.0	27.1	1.50
	SD	1.21	0.968	2.32	1.28	7.60	6.95	20.13	9.85	4.35	3.18	0.27
	SE	0.214	0.306	0.423	0.404	1.34	2.20	3.68	3.11	0.73	0.92	0.08
	Lower Quartile	8.81	13.94	6.55	8.13	95.7	100.1	66.8	63.7	21.9	25.3	0.76
	Upper Quartile	10.20	15.21	9.67	9.11	106.2	108.7	94.1	71.4	26.9	26.5	1.02
	n	32	10	30	10	32	10	30	10	36	12	12
	% 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.

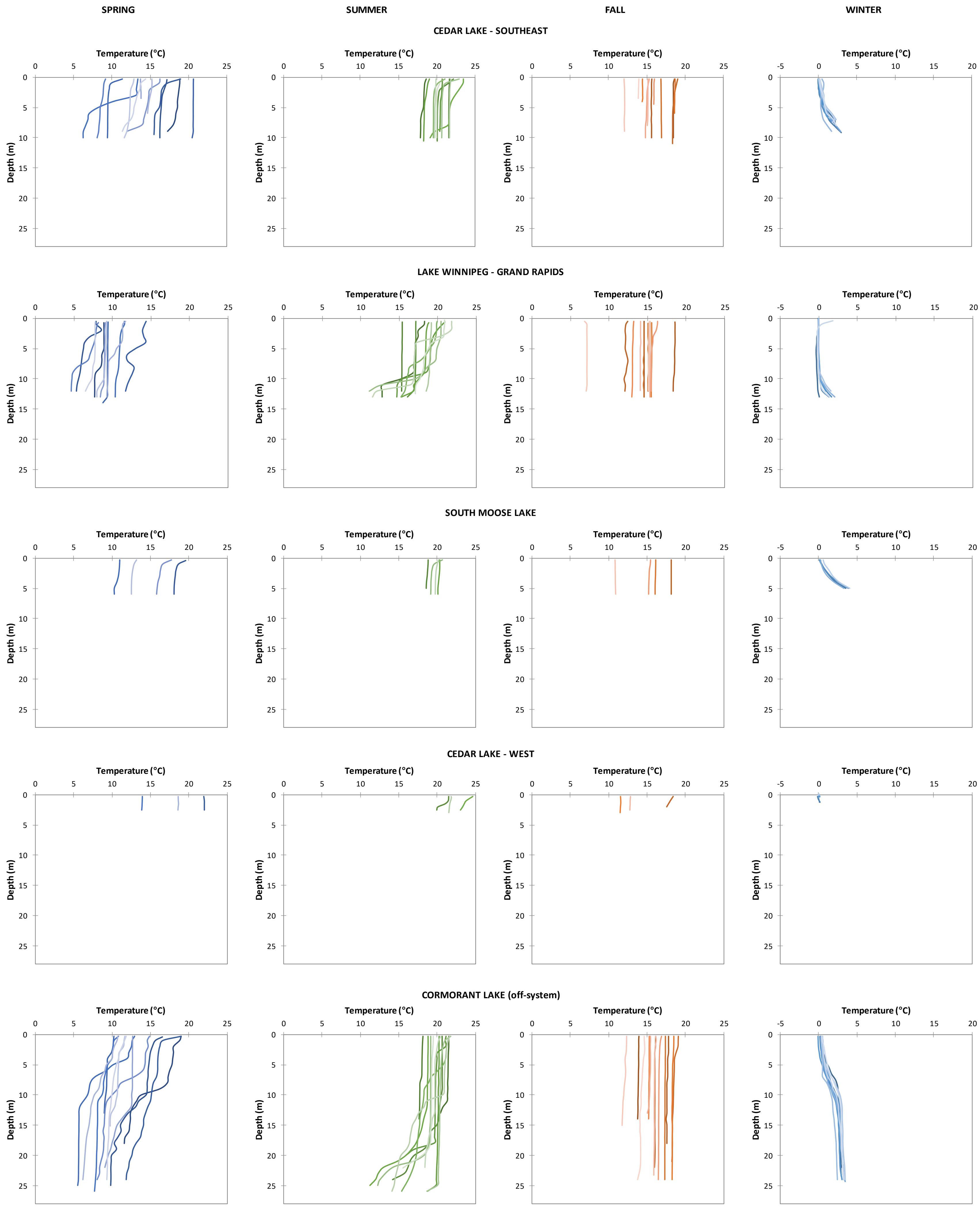


Figure 3.2-1. 2008-2019 On-system and off-system water temperature and depth profiles.

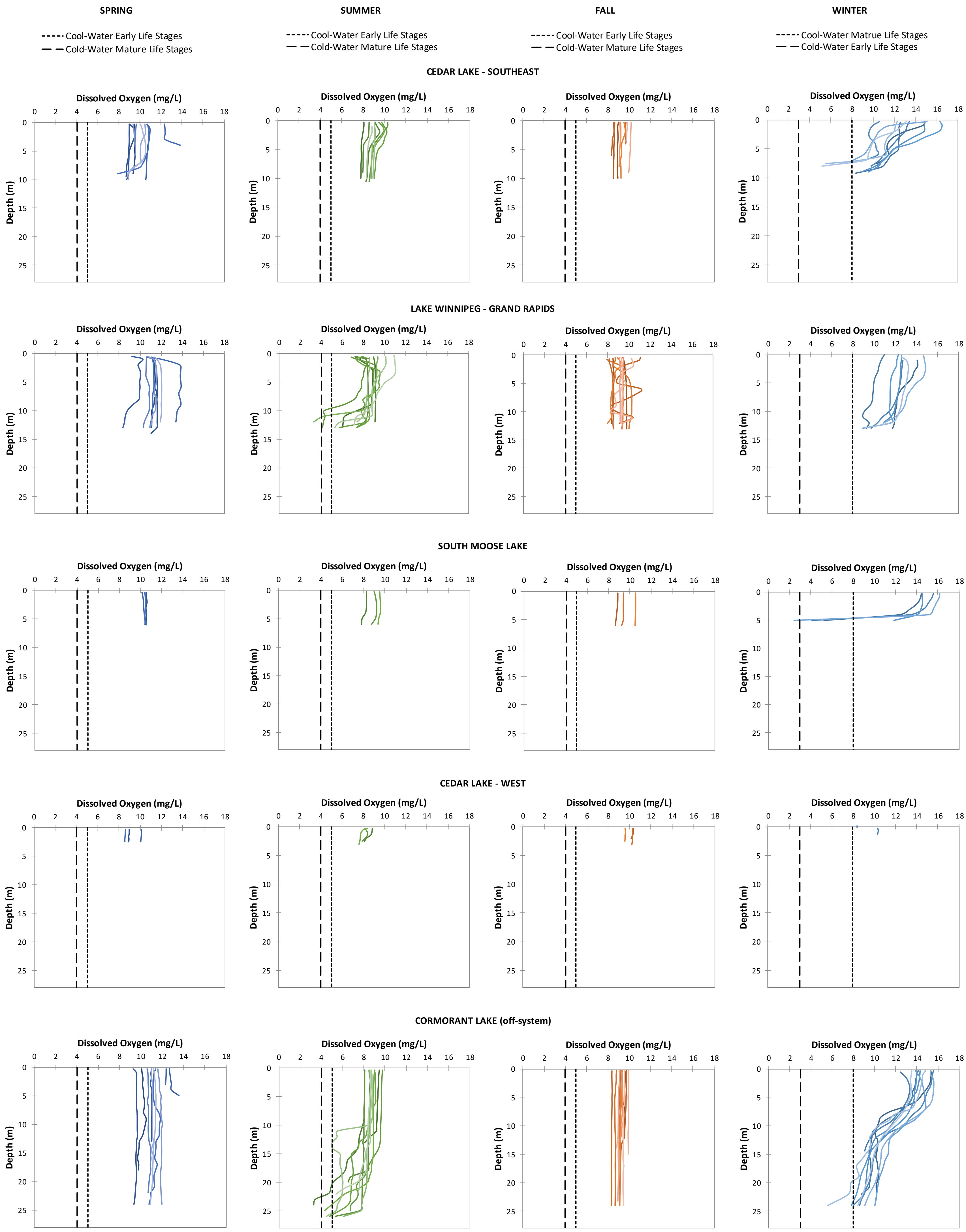


Figure 3.2-2. 2008-2019 On-system and off-system dissolved oxygen depth profiles and comparison to instantaneous minimum objectives for the protection of aquatic life.

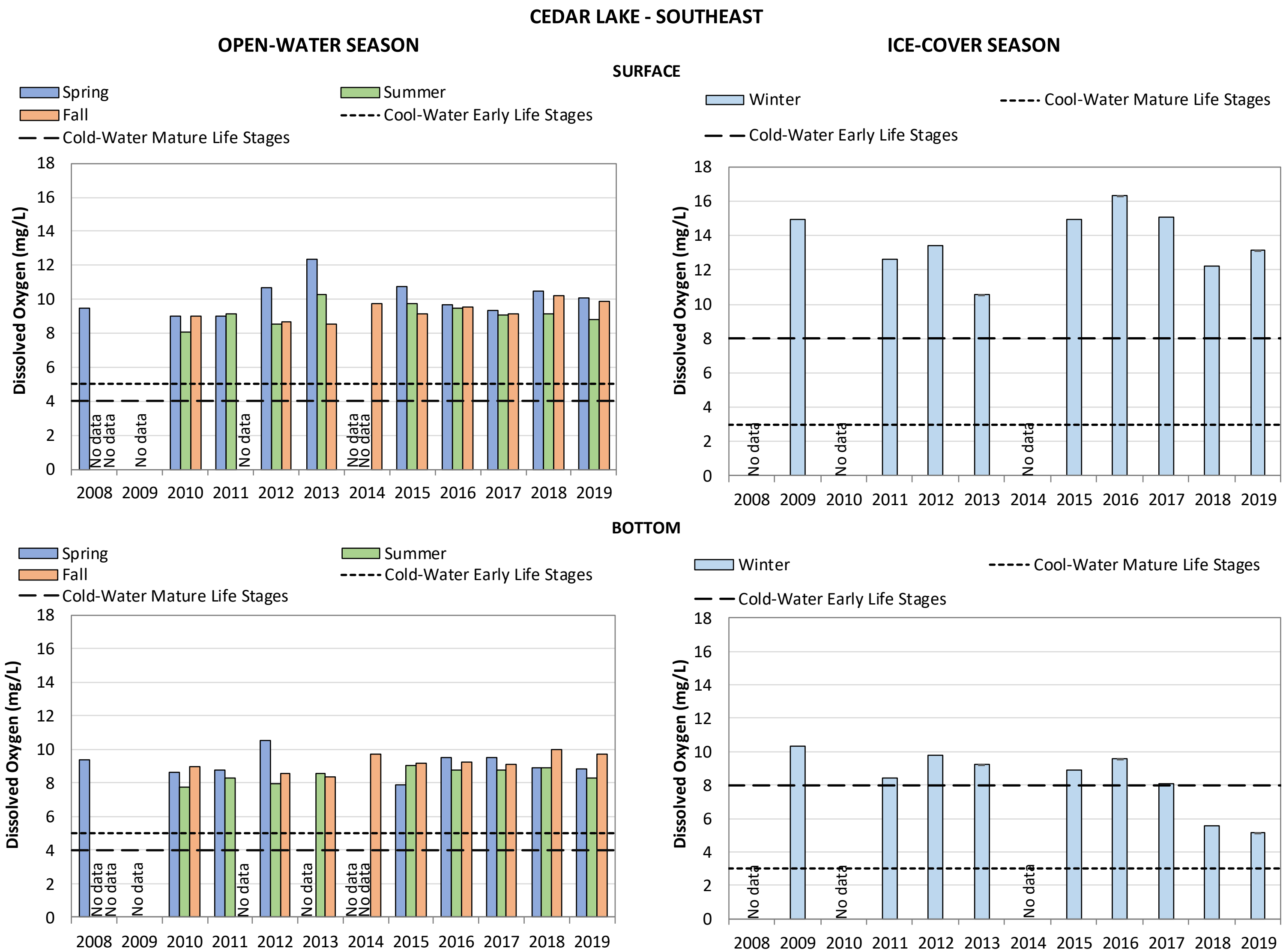


Figure 3.2-3. 2008-2019 Cedar Lake - Southeast surface and bottom dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

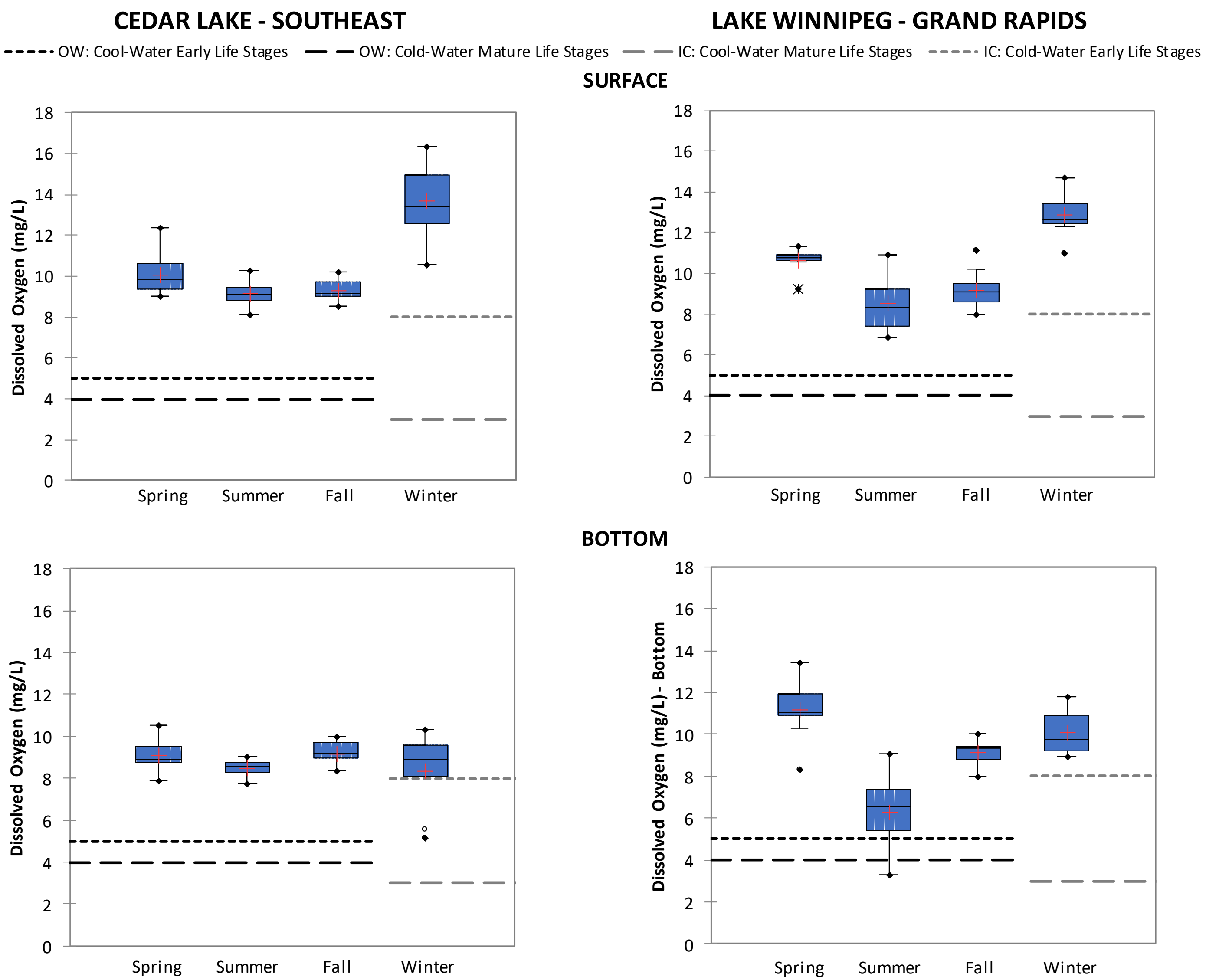


Figure 3.2-4 2008-2019 On-system seasonal surface and bottom dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

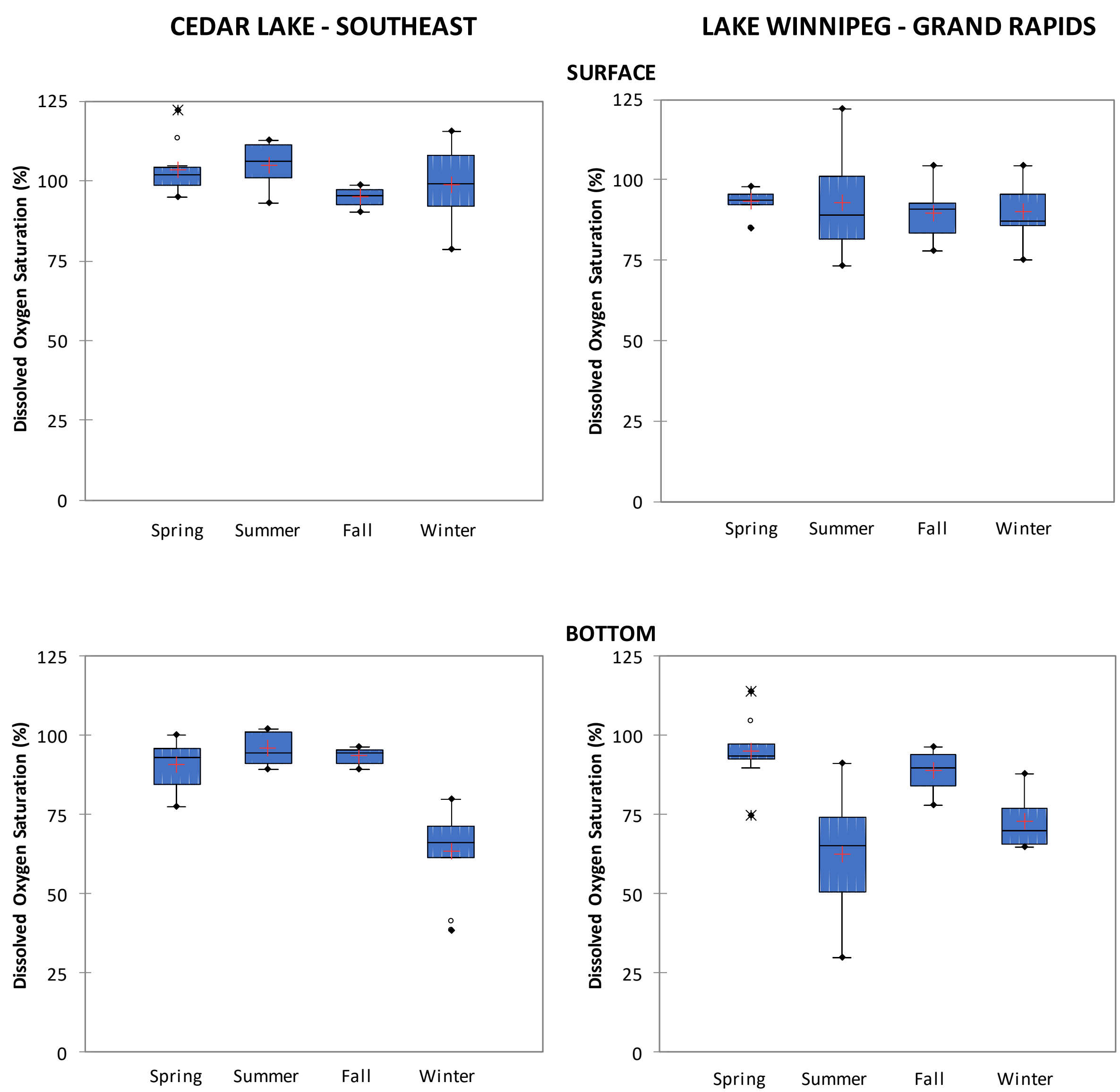


Figure 3.2-5. 2008-2019 On-system seasonal surface and bottom dissolved oxygen saturation.

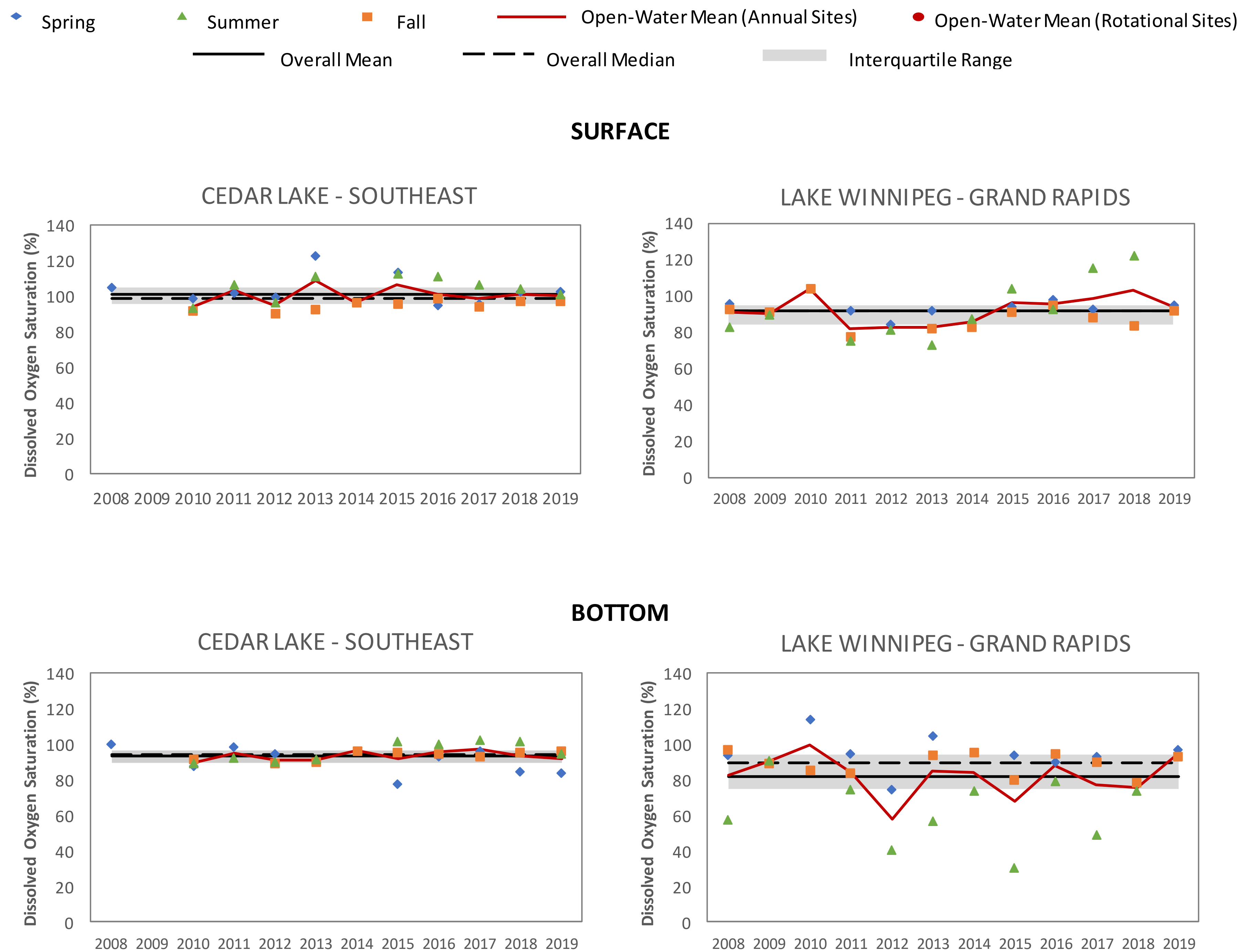


Figure 3.2-6. 2008-2019 On-system annual sites open water season surface and bottom dissolved oxygen saturation.

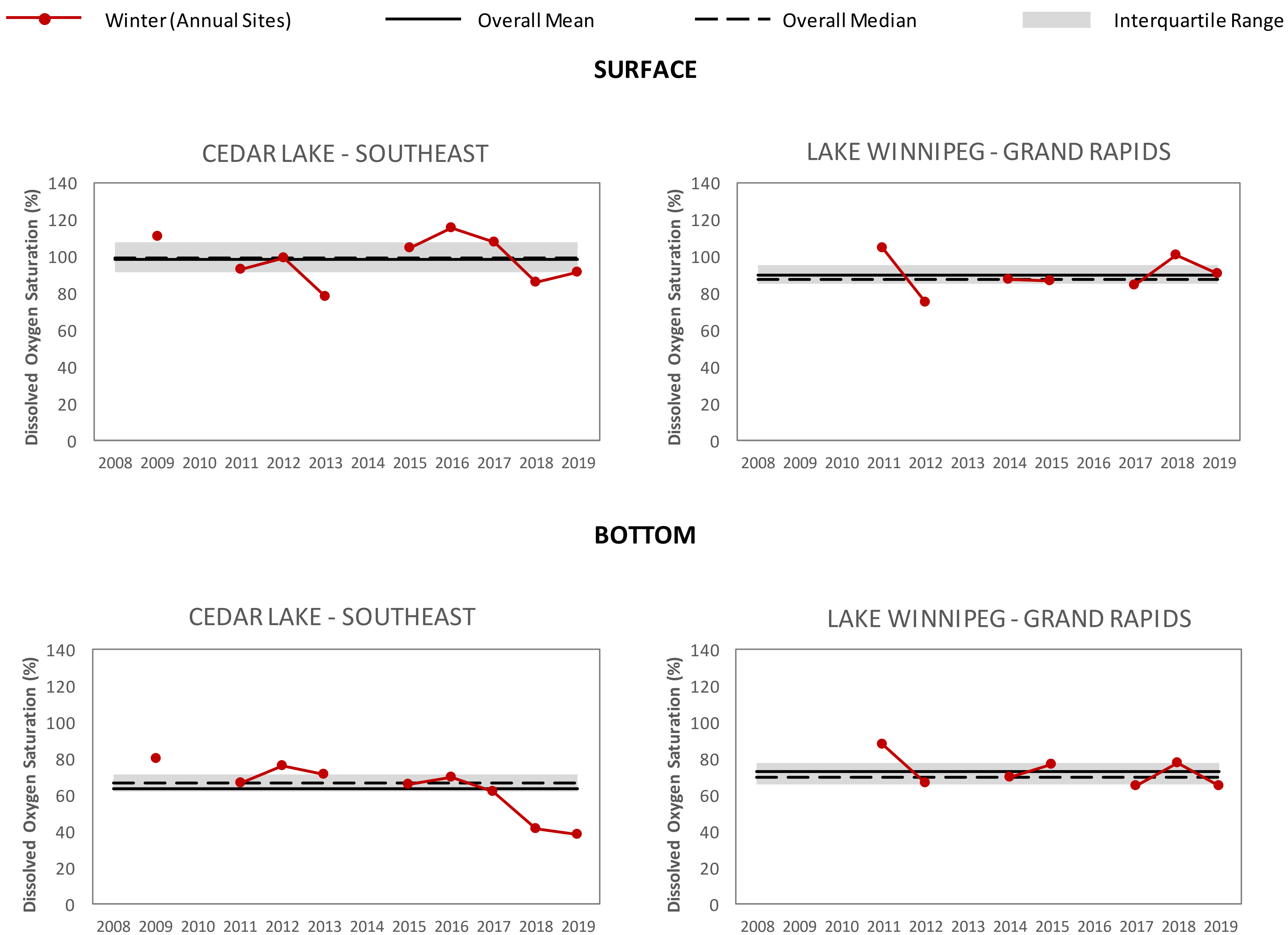


Figure 3.2-7. 2008-2019 On-system annual sites ice-cover season surface and bottom dissolved oxygen saturation.

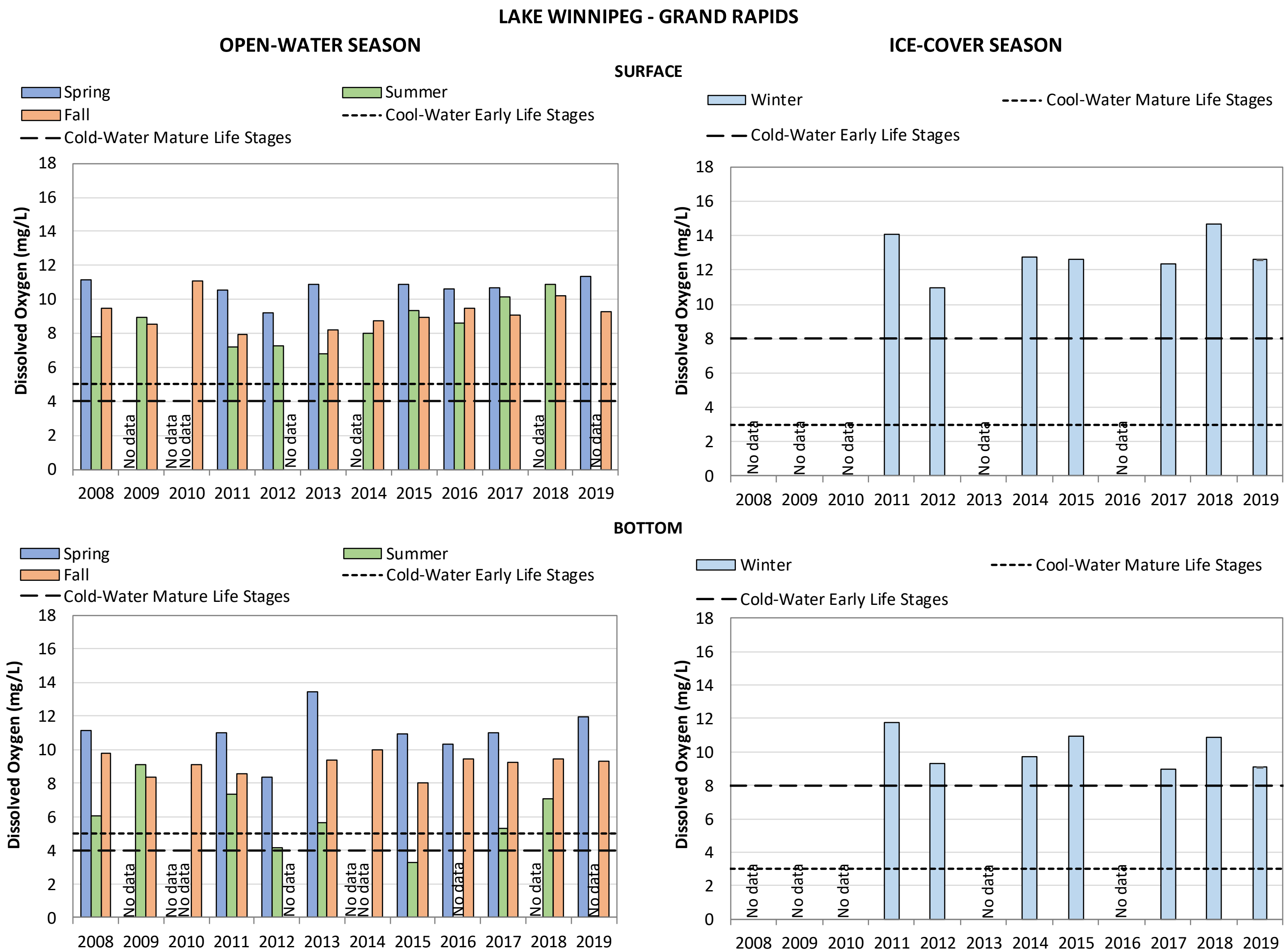


Figure 3.2-8 Lake Winnipeg - Grand Rapids surface and bottom dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

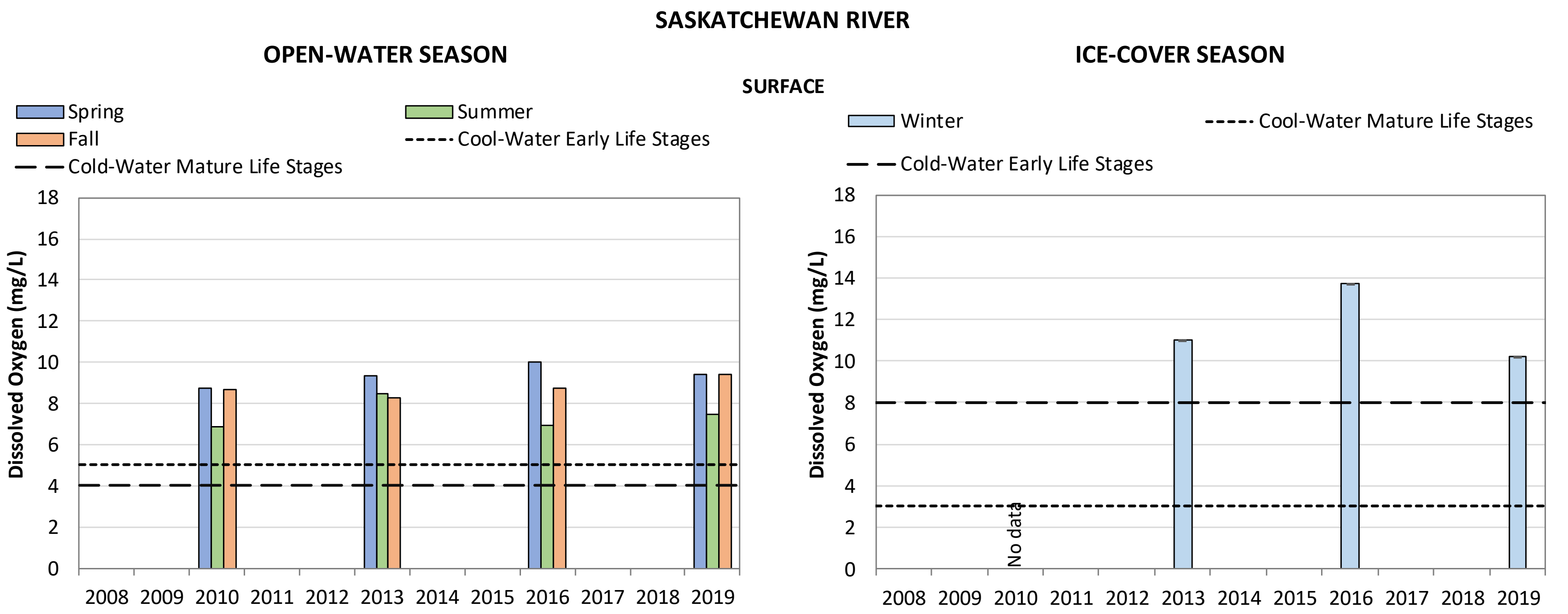


Figure 3.2-9. Saskatchewan River surface dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

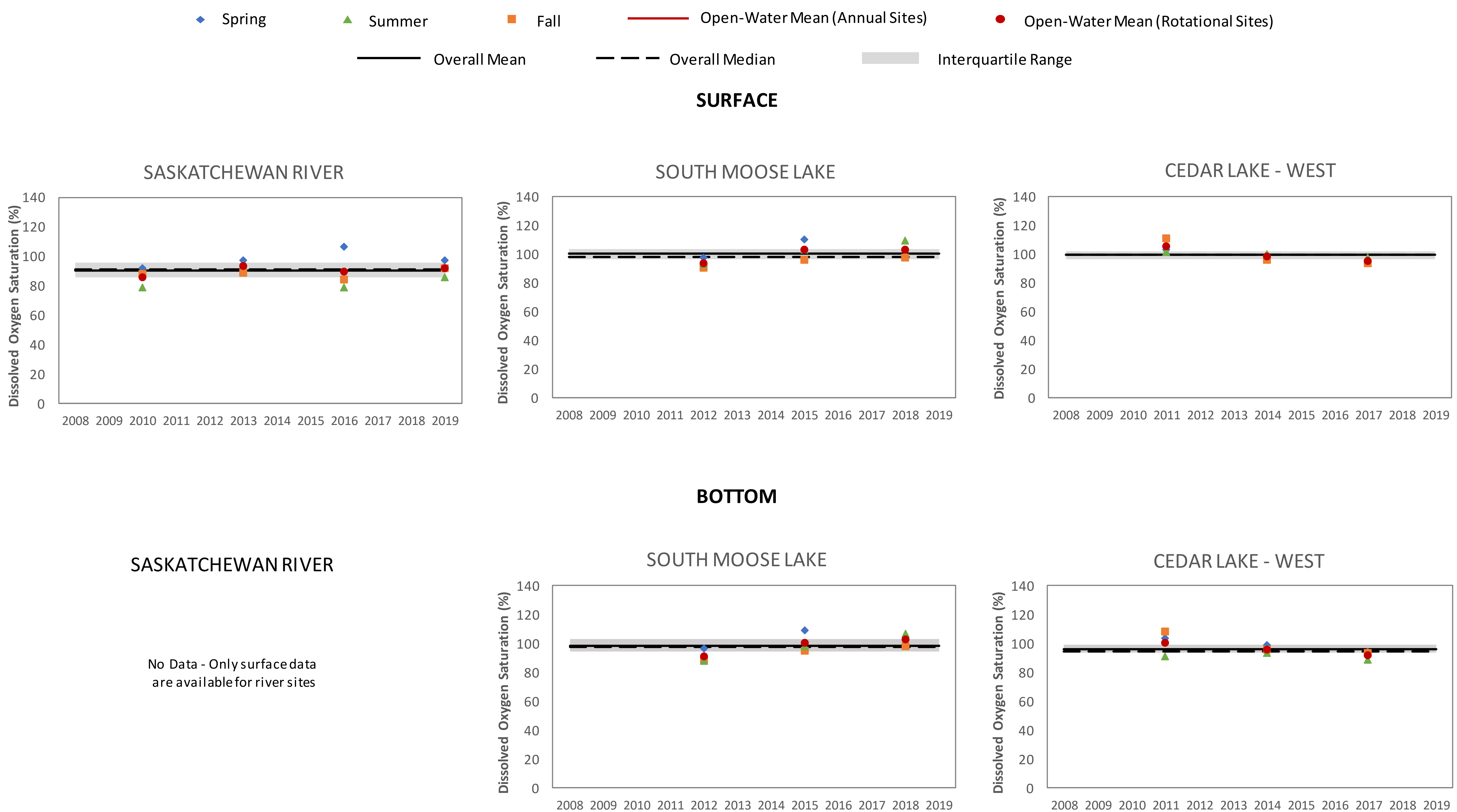


Figure 3.2-10. 2008-2019 On-system rotational sites open-water season surface and bottom dissolved oxygen saturation.

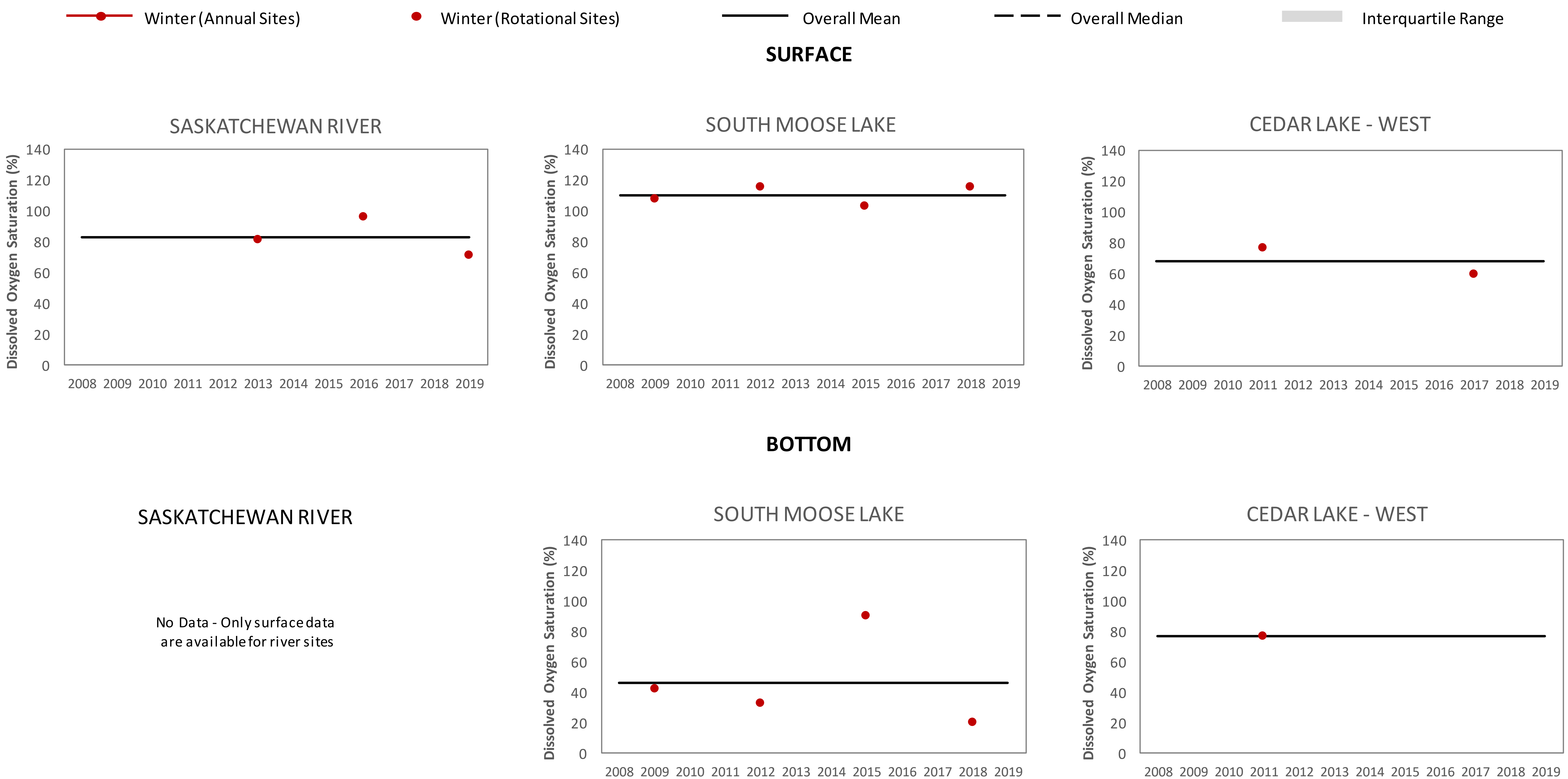


Figure 3.2-11. 2008-2019 On-system rotational sites ice-cover season surface and bottom dissolved oxygen saturation.

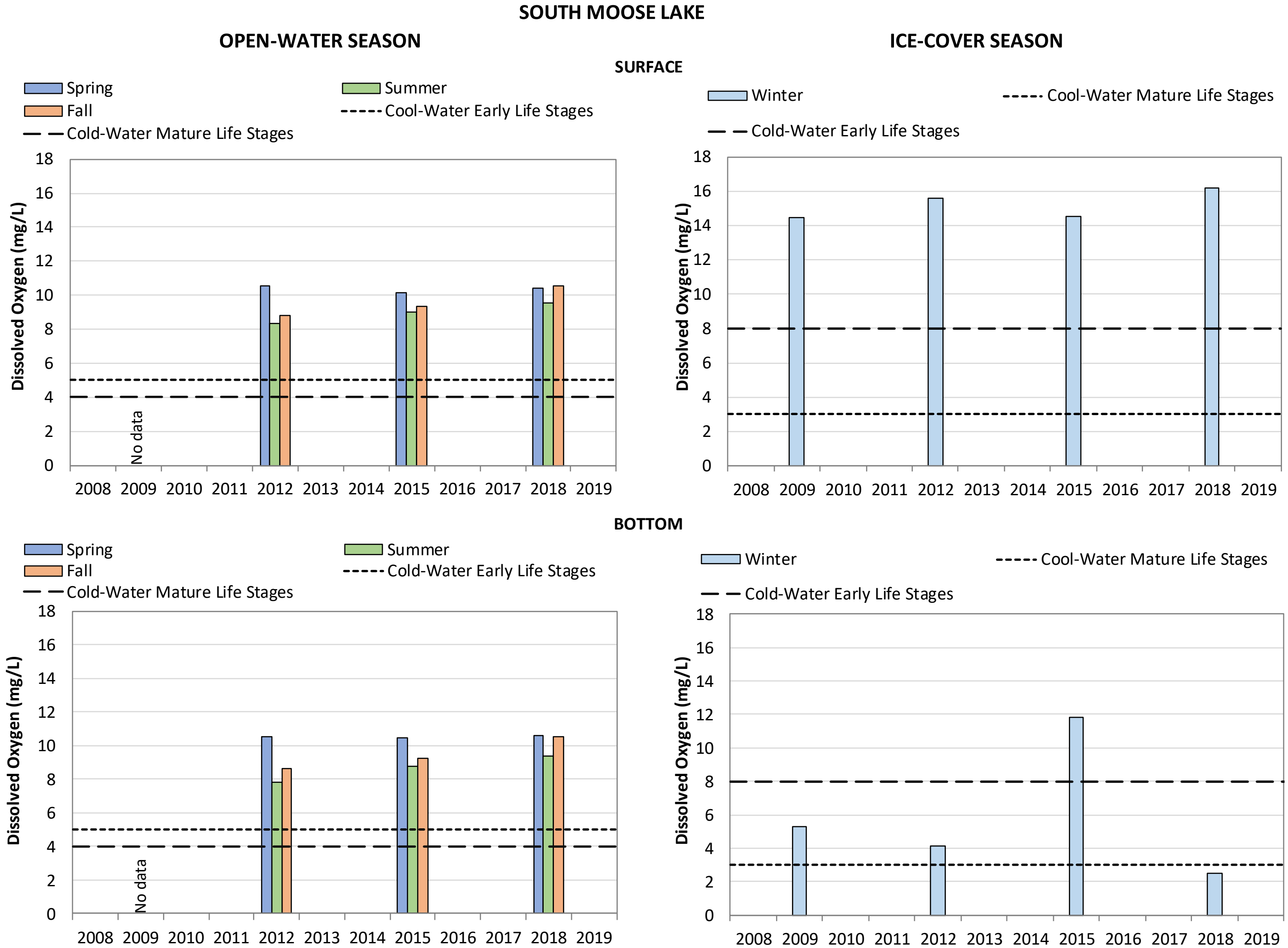


Figure 3.2-12. South Moose Lake surface and bottom dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

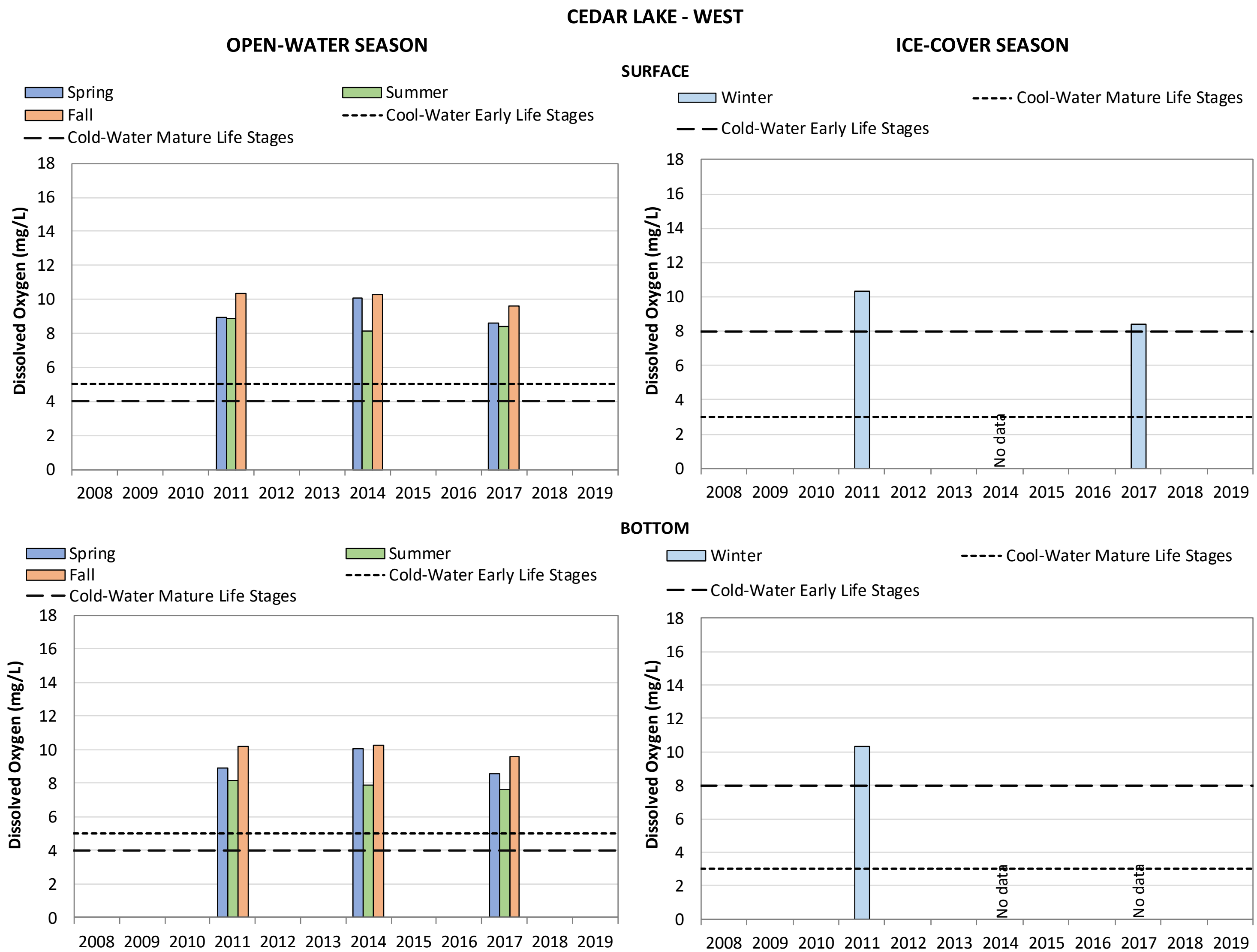


Figure 3.2-13. Cedar Lake - West surface and bottom dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

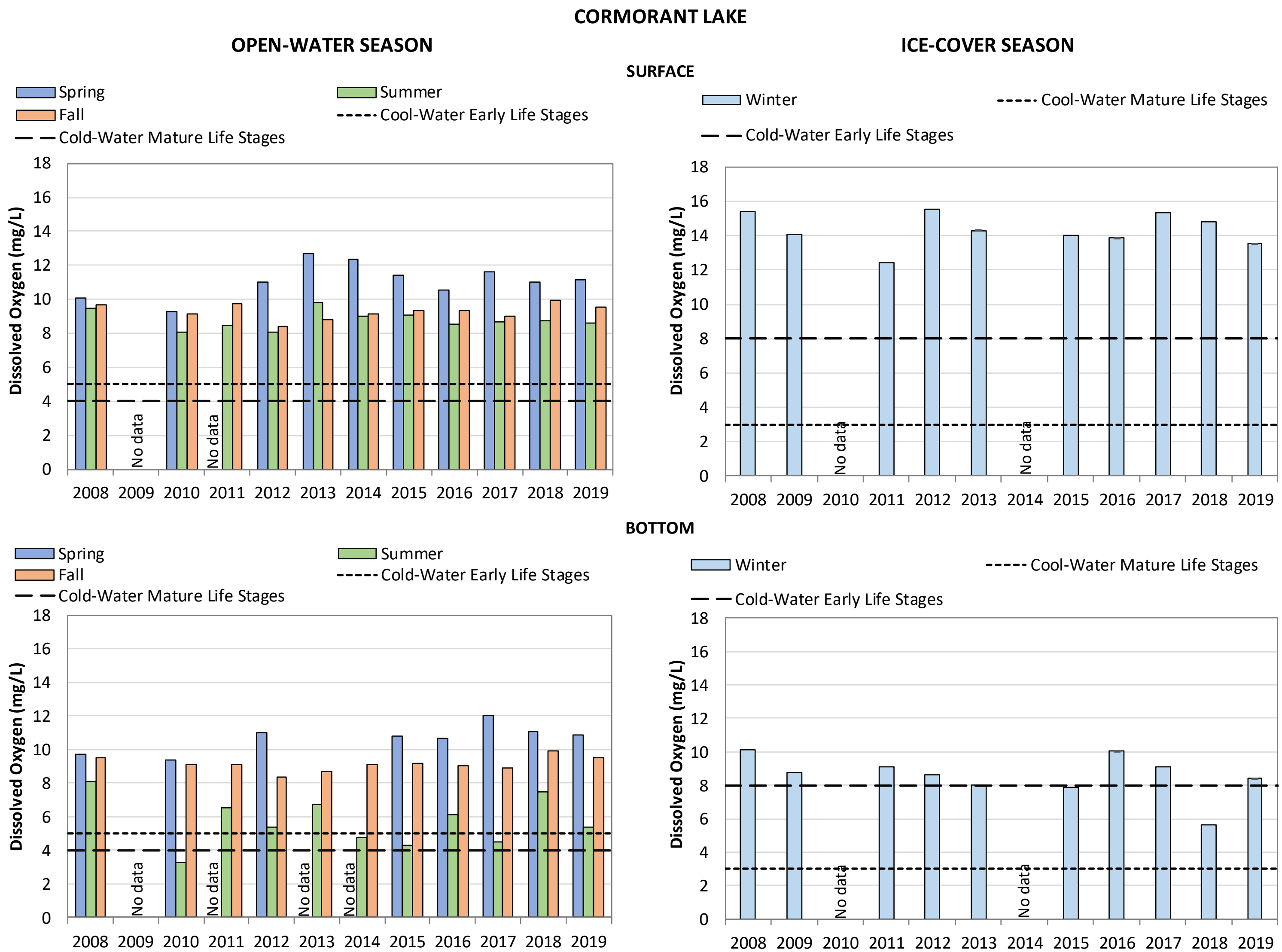


Figure 3.2-14. Cormorant Lake surface and bottom dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

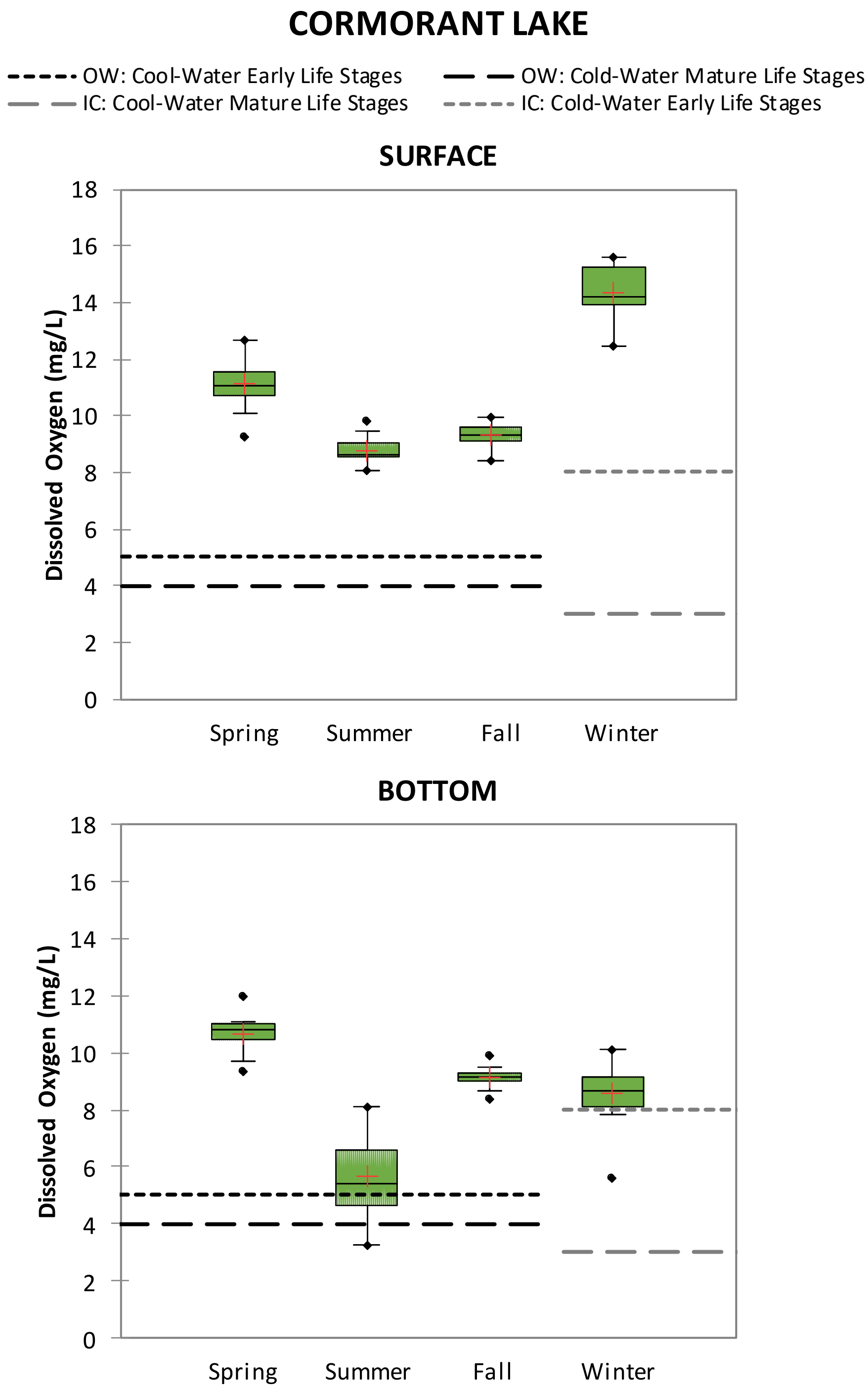


Figure 3.2-15. 2008-2019 Off-system seasonal surface and bottom dissolved oxygen concentrations with comparison to instantaneous minimum objectives for the protection of aquatic life.

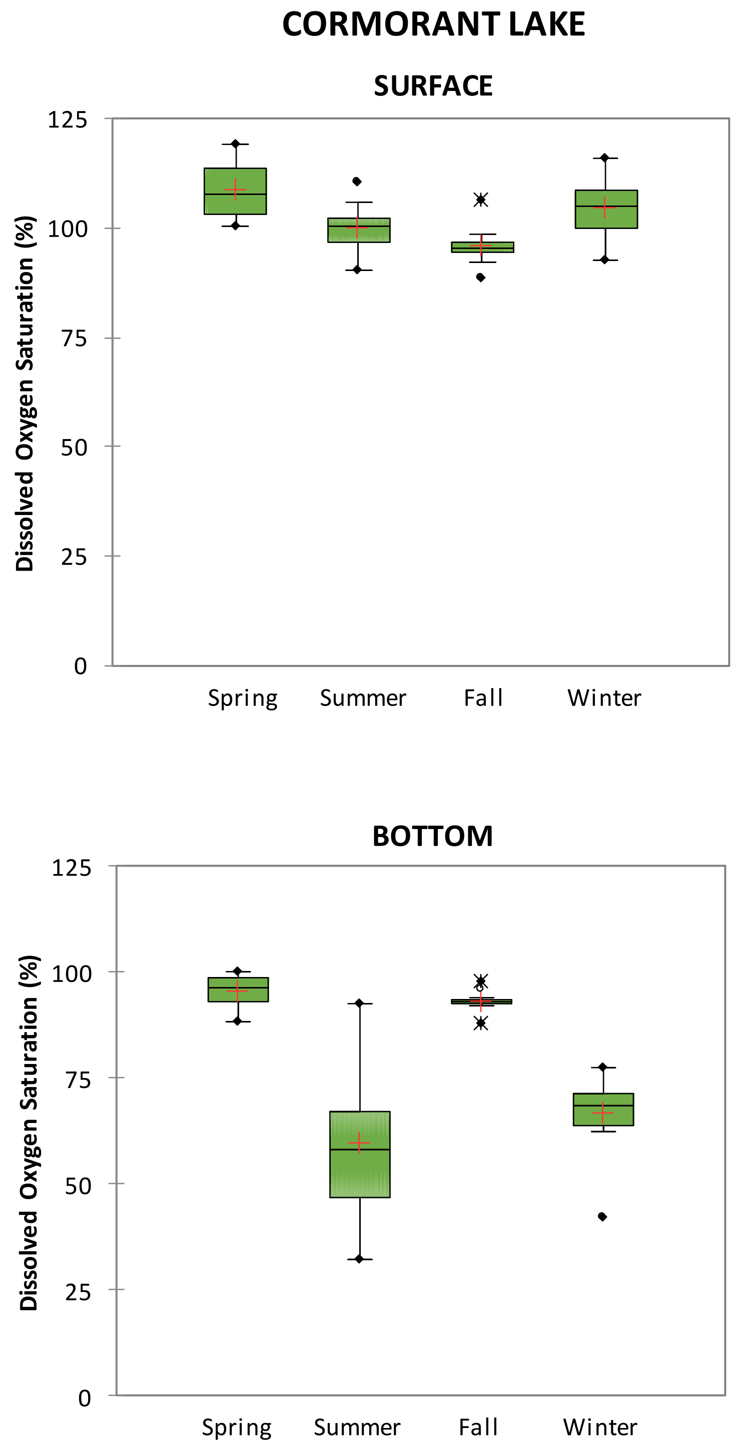


Figure 3.2-16. 2008-2019 Off-system seasonal surface and bottom dissolved oxygen saturation.

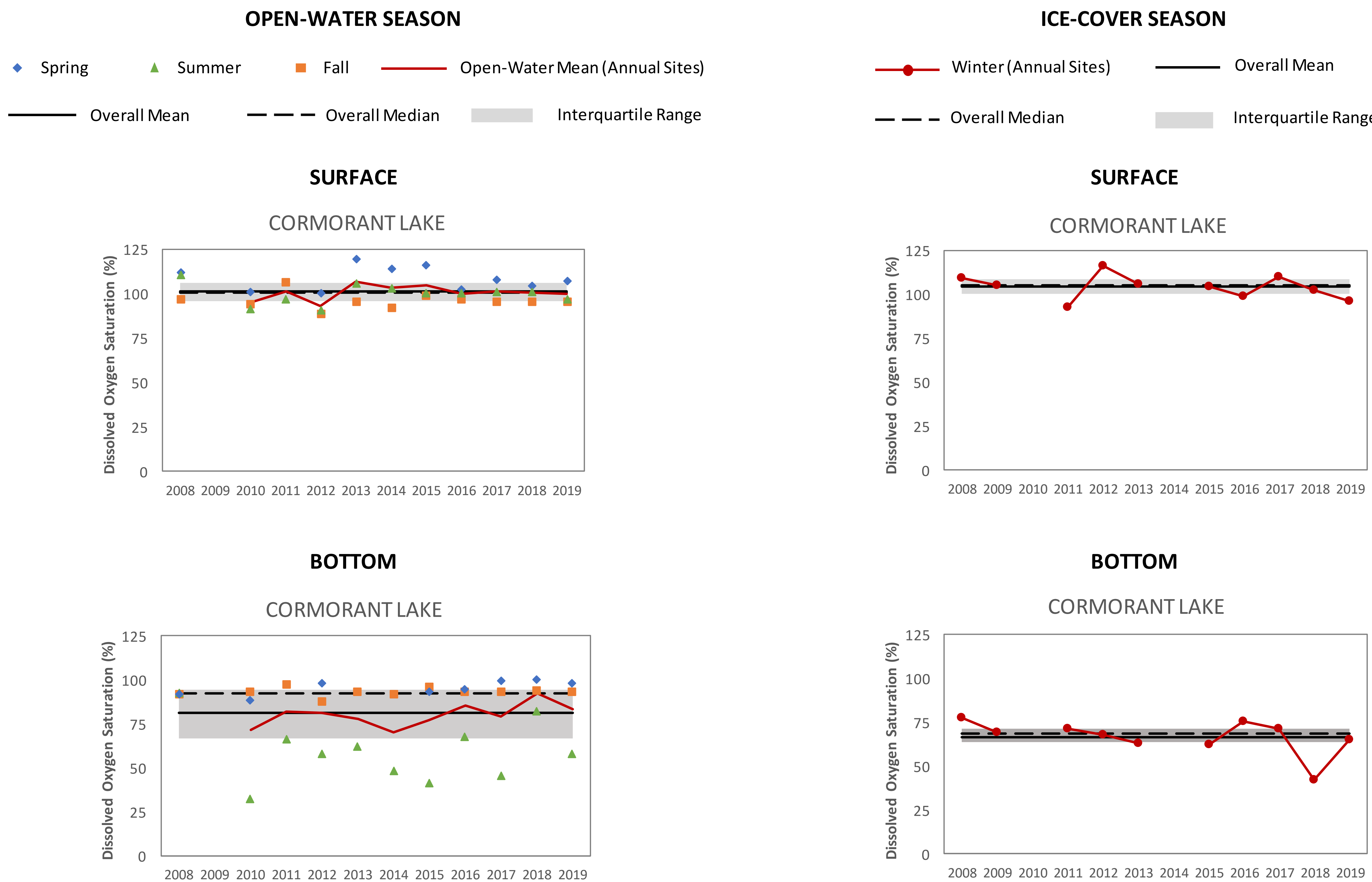


Figure 3.2-17. 2008-2019 Off-system open-water and ice-cover seasons surface and bottom dissolved oxygen saturation.

3.3 WATER CLARITY

3.3.1 SECCHI DISK DEPTH

3.3.1.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

Secchi disk depth at Cedar Lake - Southeast ranged from 0.70 to 3.55 m during the open-water season. The mean and median measurements for the 12 years of monitoring were 1.87 and 1.68 m, respectively. Mean annual Secchi disk depths ranged from 1.34 to 3.55 m and were within the IQR (1.46 to 2.23 m) in seven of the 12 years. Mean Secchi disk depth were below the IQR in 2012 and 2013 and above the IQR in 2008, 2011, and 2019 (Table 3.3-1 and Figure 3.3-1).

No clear seasonality was observed for Secchi disk depth at Cedar Lake - Southeast over the 12 years of monitoring. However, the mean Secchi disk depth was lowest in fall (1.58 m) and highest in spring (2.16 m; Figure 3.3-2).

Lake Winnipeg - Grand Rapids

Secchi disk depth in Lake Winnipeg near Grand Rapids ranged from 1.10 to 3.50 m during the open-water season. The mean and median measurements for the nine years of monitoring were 2.14 and 2.20 m, respectively. Mean annual Secchi disk depths ranged from 1.20 to 2.75 m and were within the IQR (1.53 to 2.48 m) in six of the nine years. Mean Secchi disk depth were below the IQR in 2011 and above the IQR in 2009 and 2019 (Table 3.3-1 and Figure 3.3-1).

On average, Secchi disk depth at the Lake Winnipeg - Grand Rapids site was lower in spring and fall (2.07 and 1.70 m, respectively) than in summer (2.65 m; Figure 3.3-2).

ROTATIONAL SITES

Saskatchewan River

Secchi disk depth data are not available for riverine sites therefore there are no data for this site.

South Moose Lake

Secchi disk depths in South Moose Lake ranged from 1.17 to 3.35 m during the open-water season. The mean was 1.97 m, the median was 1.68 m, and the IQR was 1.45 to 2.26 m for the four years of monitoring. Mean annual Secchi disk depths ranged from 1.33 to 2.20 m and were within the IQR in three of the four years. Mean Secchi disk depth was below the IQR in 2012 (Table 3.3-1 and Figure 3.3-3).

Cedar Lake - West

Secchi disk depths at Cedar Lake - West ranged from 0.25 to 0.95 m during the open-water season. The mean was 0.44 m, the median was 0.32 m, and the IQR was 0.30 to 0.50 m for the three years of monitoring. Mean annual Secchi disk depths ranged from 0.40 to 0.50 m and were within the IQR in all three years (Table 3.3-1 and Figure 3.3-3).

3.3.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

Secchi disk depths in Cormorant Lake ranged from 1.50 to 8.00 m during the open-water season. The mean and median for the 12 years of monitoring were 4.29 and 3.92 m, respectively. Mean annual Secchi disk depths ranged from 2.95 to 5.60 m and were within the IQR (3.20 to 4.99 m) in nine of the 12 years. Mean Secchi disk depths were below the IQR in 2015 and above the IQR in 2014 and 2017 (Table 3.3-2 and Figure 3.3-4).

Mean Secchi disk depth was lowest in fall (3.16 m) and highest in spring (5.37 m; Figure 3.3-5).

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
CEDAR-SE	Mean	1.87	-	3.32	1.31	3.8	<2.0
	Median	1.68	-	3.17	1.11	3.6	<2.0
	Minimum	0.70	-	1.00	0.80	<2.0	<2.0
	Maximum	3.55	-	12.5	2.49	9.0	3.2
	SD	0.657	-	2.10	0.50	2.33	0.71
	SE	0.113	-	0.360	0.150	0.40	0.21
	Lower Quartile	1.46	-	2.14	1.07	2.1	<2.0
	Upper Quartile	2.23	-	4.17	1.37	5.4	<2.0
	n	34	-	34	11	34	11
	% Detections	100	-	100	100	76	18
LW-GR	Mean	2.14	-	3.27	2.30	5.5	<5.0
	Median	2.20	-	2.40	1.92	<5.0	<5.0
	Minimum	1.10	-	0.59	1.00	<5.0	<1.0
	Maximum	3.50	-	16.7	4.83	39.0	5.0
	SD	0.666	-	2.98	1.16	6.52	1.24
	SE	0.131	-	0.511	0.366	1.12	0.39
	Lower Quartile	1.53	-	1.70	1.66	<5.0	<5.0
	Upper Quartile	2.48	-	4.18	2.35	7.0	<5.0
	n	26	-	34	10	34	10
	% Detections	100	-	100	100	59	30
SASK	Mean	-	-	28.9	4.82	62.8	7.4
	Median	-	-	28.3	-	53.5	-
	Minimum	-	-	14.1	3.74	22.6	5.6
	Maximum	-	-	52.9	6.76	128	9.6
	SD	-	-	12.7	1.37	33.1	1.97
	SE	-	-	3.65	0.683	9.56	0.98
	Lower Quartile	-	-	17.1	-	39.9	-
	Upper Quartile	-	-	38.4	-	80.3	-
	n	-	-	12	4	12	4
	% Detections	-	-	100	100	100	100
SMOOSE	Mean	1.97	-	2.52	0.37	3.4	<2.0
	Median	1.68	-	2.32	-	2.8	-
	Minimum	1.17	-	1.00	0.26	<2.0	<2.0
	Maximum	3.35	-	5.15	0.54	7.6	<2.0
	SD	0.763	-	1.25	0.12	2.18	-
	SE	0.220	-	0.360	0.061	0.63	-
	Lower Quartile	1.45	-	1.64	-	<2.0	-
	Upper Quartile	2.26	-	3.21	-	5.0	-
	n	12	-	12	4	12	4
	% Detections	100	-	100	100	75	0
CEDAR-W	Mean	0.44	-	25.8	2.86	35.2	<2.0
	Median	0.32	-	22.9	-	33.4	-
	Minimum	0.25	-	7.50	1.88	6.0	<2.0
	Maximum	0.95	-	55.0	4.04	59.4	3.6
	SD	0.228	-	15.6	1.09	20.8	-
	SE	0.076	-	5.19	0.632	6.94	-
	Lower Quartile	0.30	-	15.5	-	21.2	-
	Upper Quartile	0.50	-	34.8	-	55.8	-
	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
CORM	Mean	4.29	-	1.18	0.48	<2.0	<2.0
	Median	3.92	-	1.02	0.50	<2.0	<2.0
	Minimum	1.50	-	0.10	0.23	<2.0	<2.0
	Maximum	8.00	-	4.50	0.75	4.0	4.0
	SD	1.48	-	0.77	0.16	0.92	-
	SE	0.246	-	0.13	0.05	0.15	-
	Lower Quartile	3.20	-	0.66	0.37	<2.0	<2.0
	Upper Quartile	4.99	-	1.56	0.54	2.2	<2.0
	n	36	-	36	12	36	12
	% Detections	100	-	100	100	31	8

Notes:

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

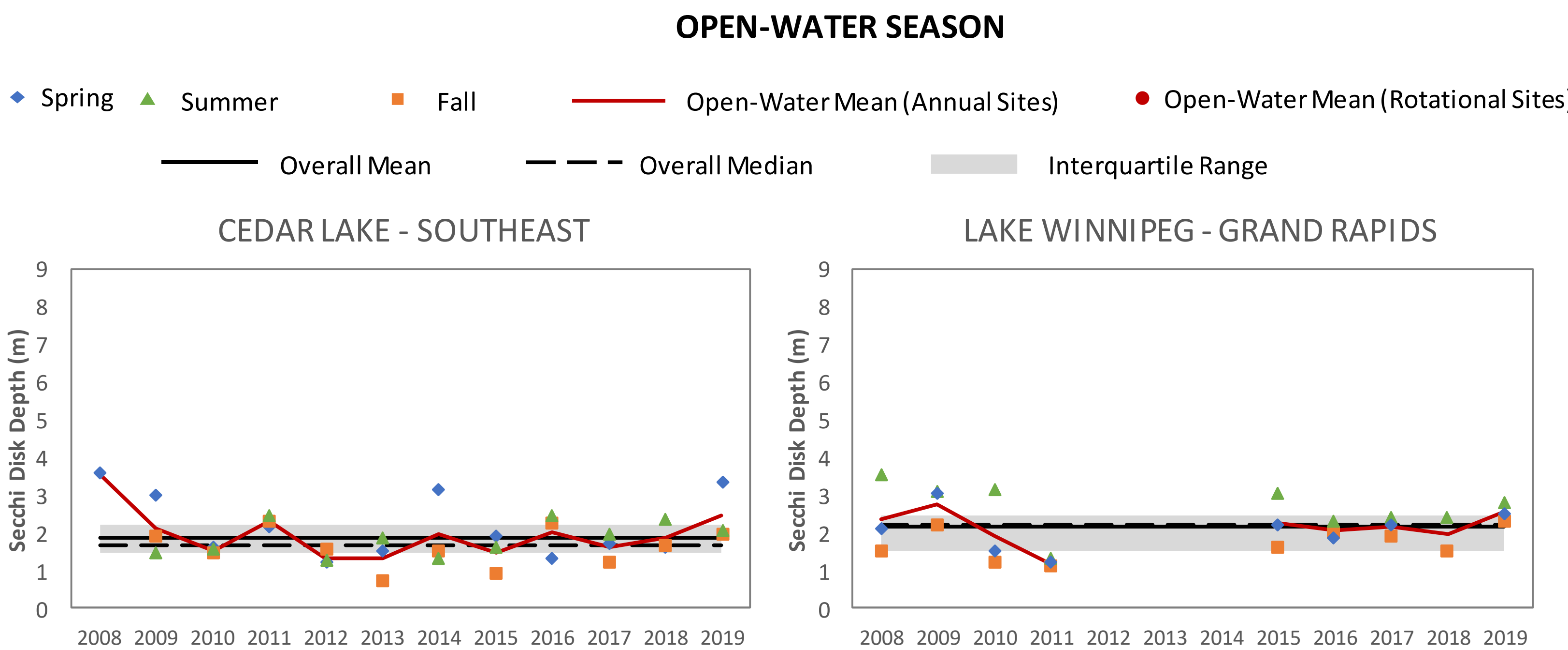


Figure 3.3-1. 2008-2019 On-system annual sites open-water season Secchi disk depths.

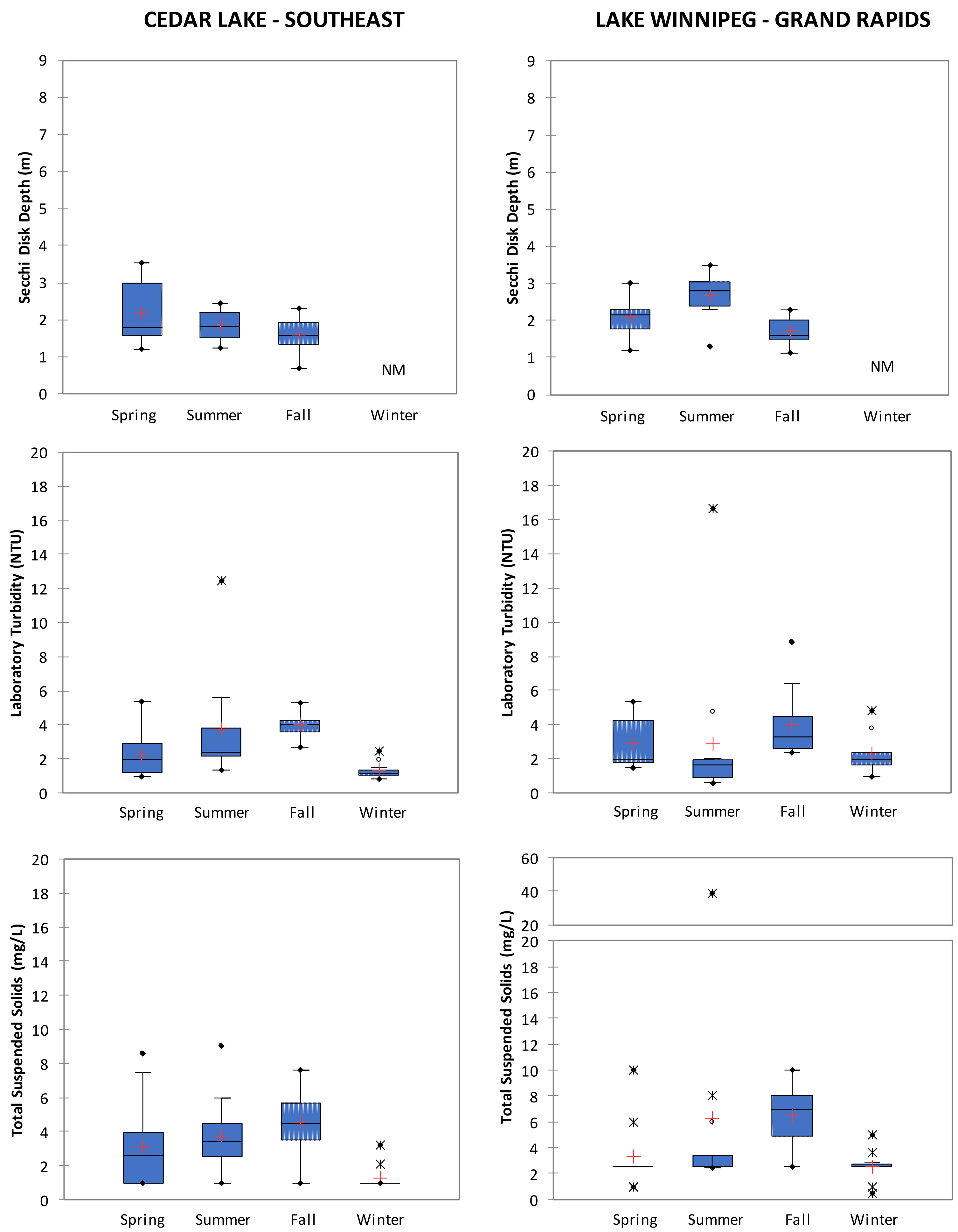


Figure 3.3-2. 2008-2019 On-system seasonal Secchi disk depths, turbidity, and TSS concentrations.

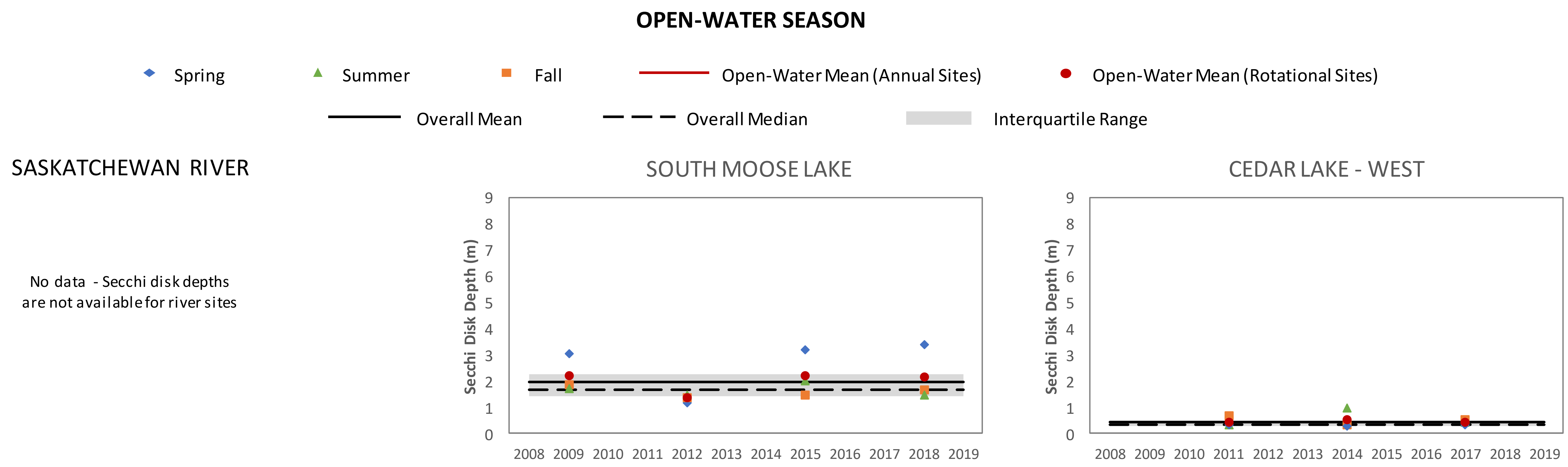


Figure 3.3-3. 2008-2019 On-system rotational sites open-water season Secchi disk depths.

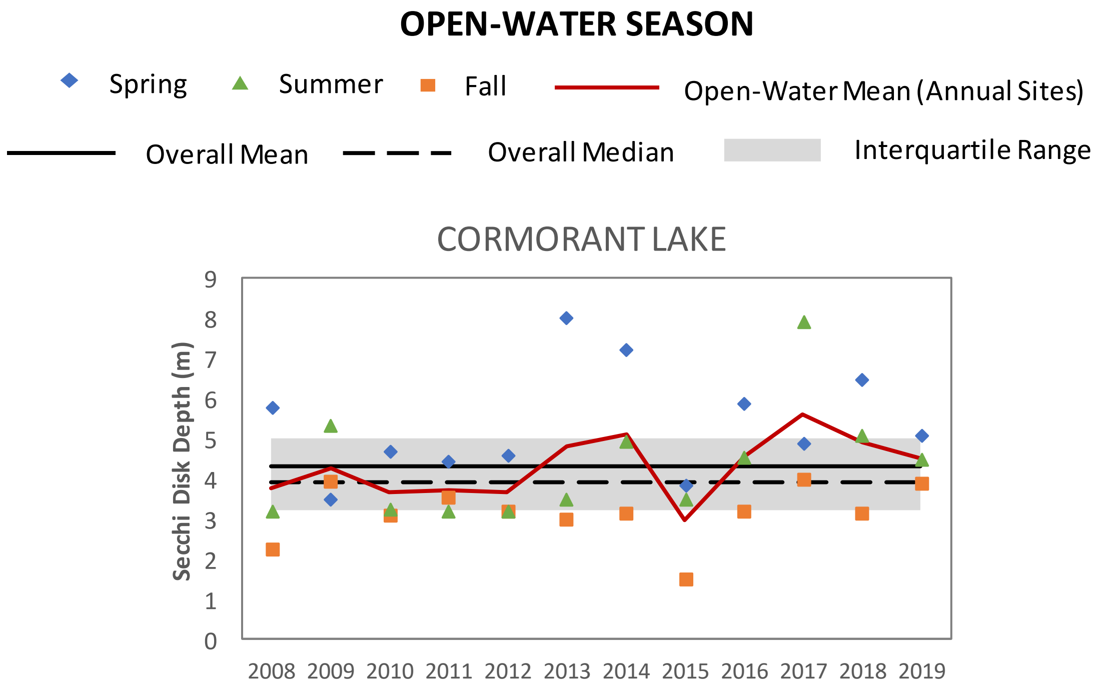


Figure 3.3-4. 2008-2019 Off-system open-water season Secchi disk depths.

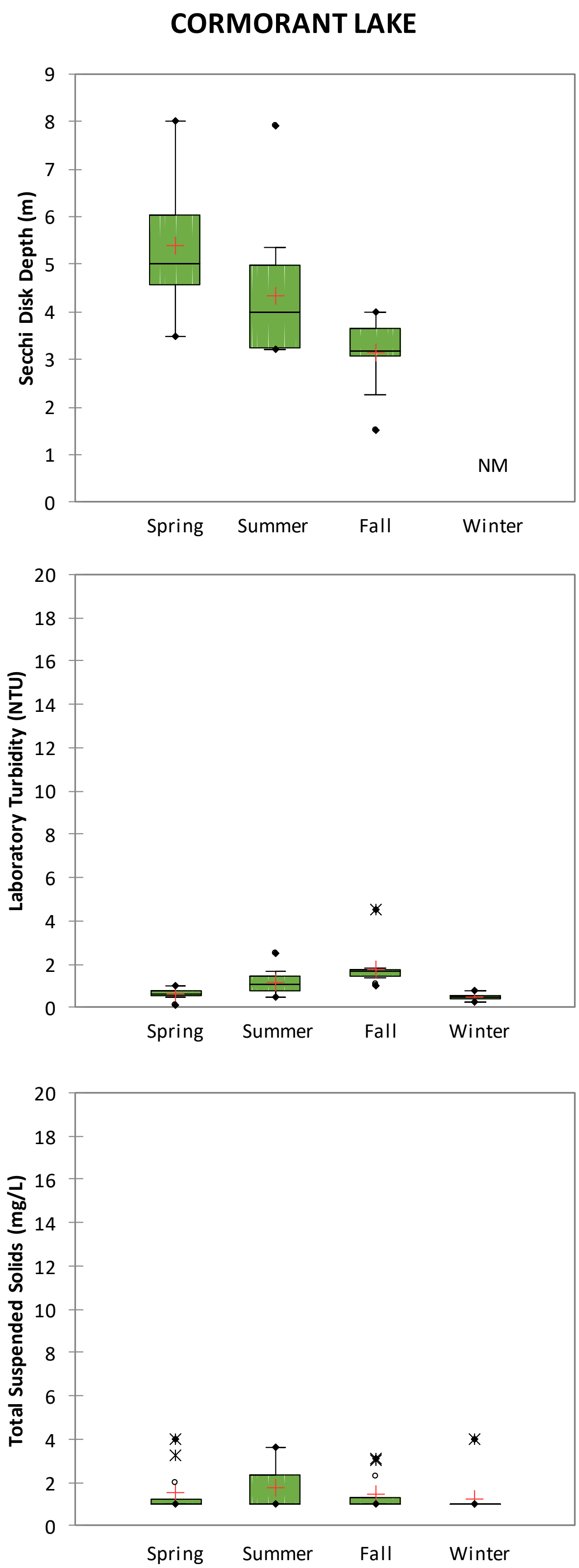


Figure 3.3-5. 2008-2019 Off-system seasonal Secchi disk depths, turbidity, and TSS concentrations.

3.3.2 TURBIDITY

3.3.2.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

Turbidity at Cedar Lake - Southeast ranged from 1.00 to 12.5 NTU during the open-water season. The mean and median turbidity for the 12 years of monitoring was 3.32 NTU and 3.17 NTU, respectively. Open-water season mean annual turbidity ranged from 1.10 to 6.78 NTU and was within the IQR (2.14 to 4.17 NTU) in 10 of the 12 years of monitoring. Mean turbidity was below the IQR in 2008 and 2011 and above the IQR in 2013 (Table 3.3-1 and Figure 3.3-6).

Turbidity in the ice-cover season ranged from 0.80 to 2.49 NTU, with a mean of 1.31 NTU and a median of 1.11 NTU for the 11 years of monitoring. The IQR was 1.07 to 1.37 NTU (Table 3.3-1 and Figure 3.3-6).

Turbidity at Cedar Lake - Southeast was lower in winter (mean = 1.31 NTU) than in the open-water season over the 12 years of monitoring. No clear seasonality was observed for turbidity in the open-water season; however, the lowest mean turbidity occurred in spring (2.27 NTU) and the highest in fall (4.03 NTU; Figure 3.3-2).

Lake Winnipeg - Grand Rapids

Turbidity in Lake Winnipeg near Grand Rapids ranged from 0.59 to 16.7 NTU during the open-water season. The mean and median turbidity for the 12 years of monitoring were 3.27 NTU and 2.40 NTU, respectively. Open-water season mean annual turbidity ranged from 1.61 to 6.97 NTU and was within the IQR (1.70 to 4.18 NTU) in nine of the 12 years of monitoring. Mean turbidity was below the IQR in 2014 and above the IQR in 2008 and 2011 (Table 3.3-1 and Figure 3.3-6).

Turbidity in the ice-cover season ranged from 1.00 to 4.83 NTU, with a mean of 2.3 NTU and a median of 1.92 NTU for the 10 years of monitoring. The IQR was 1.66 to 2.35 NTU (Table 3.3-1 and Figure 3.3-6).

No clear seasonality was observed for turbidity levels in Lake Winnipeg - Grand Rapids over the 12 years of monitoring. However, mean turbidity was lowest in winter (2.30 NTU) and highest in fall (3.99 NTU; Figure 3.3-2).

ROTATIONAL SITES

Saskatchewan River

Turbidity in the Saskatchewan River ranged from 14.1 to 52.9 NTU during the open-water season. The mean and median were 28.9 and 28.2 NTU, respectively. The IQR was 17.1 to 38.4 NTU for the four years of monitoring. Mean annual turbidity in the open-water season ranged from 23.1 to 37.2 NTU and was within the IQR in all four years of monitoring (Table 3.3-1 and Figure 3.3-7).

During the ice-cover season, turbidity ranged from 3.74 to 6.76 NTU with a mean of 4.82 NTU for the four years of monitoring (Table 3.3-1 and Figure 3.3-7).

South Moose Lake

Turbidity in South Moose Lake ranged from 1.00 to 5.15 NTU during the open-water season. The mean and median were 2.52 and 2.32 NTU, respectively. The IQR was 1.64 to 3.21 NTU for the four years of monitoring. Mean annual turbidity in the open-water season ranged from 1.63 to 3.38 NTU and was within the IQR in 2015 and 2018. Mean turbidity was below the IQR in 2009 and above the IQR in 2012 (Table 3.3-1 and Figure 3.3-7).

During the ice-cover season, turbidity ranged from 0.26 to 0.54 NTU with a mean of 0.37 NTU for the four years of monitoring (Table 3.3-1 and Figure 3.3-7).

Cedar Lake - West

Turbidity at Cedar Lake - West ranged from 7.50 to 55.0 NTU during the open-water season. The mean was 25.8 NTU, the median was 22.9 NTU and the IQR was 15.5 to 34.8 NTU for the three years of monitoring. Mean annual turbidity in the open-water season ranged from 20.7 to 35.2 NTU and was within the IQR in two of the three years of monitoring. Mean turbidity was above the IQR in 2014 (Table 3.3-1 and Figure 3.3-7).

During the ice-cover season, turbidity ranged from 1.88 to 4.04 NTU with a mean of 2.86 NTU for the three years of monitoring (Table 3.3-1 and Figure 3.3-7).

3.3.2.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

Turbidity in Cormorant Lake ranged from 0.10 to 4.50 NTU during the open-water season. The mean was 1.18 NTU and the median was 1.02 NTU for the 12 years of monitoring. Open-water season mean annual turbidity ranged from 0.73 to 2.60 NTU and was within the IQR (0.66 to 1.56 NTU) in 11 of the 12 years of monitoring. Mean turbidity was above the IQR in 2008 (Table 3.3-2 and Figure 3.3-8).

Turbidity in the ice-cover season ranged from 0.23 to 0.75 NTU, with a mean of 0.48 NTU and a median of 0.50 NTU for the 12 years of monitoring. The IQR was 0.37 to 0.54 NTU (Table 3.3-2 and Figure 3.3-8).

No clear seasonality was observed for turbidity levels in Cormorant Lake over the 12 years of monitoring. However, the lowest mean turbidity occurred in winter (0.48 NTU) and the highest in fall (1.77 NTU; Figure 3.3-5).

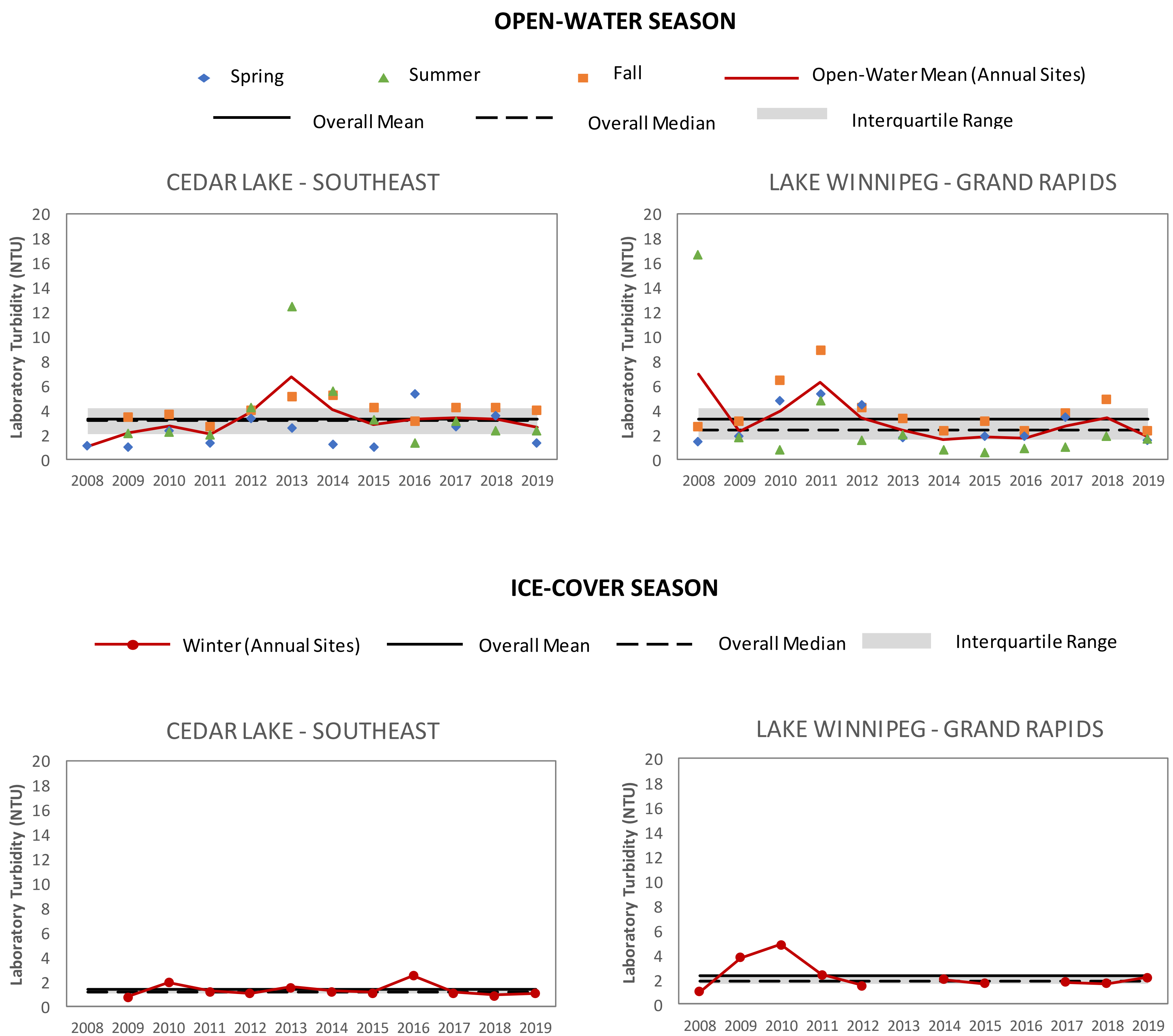


Figure 3.3-6. 2008-2019 On-system seasonal site open-water and ice-cover seasons turbidity levels.

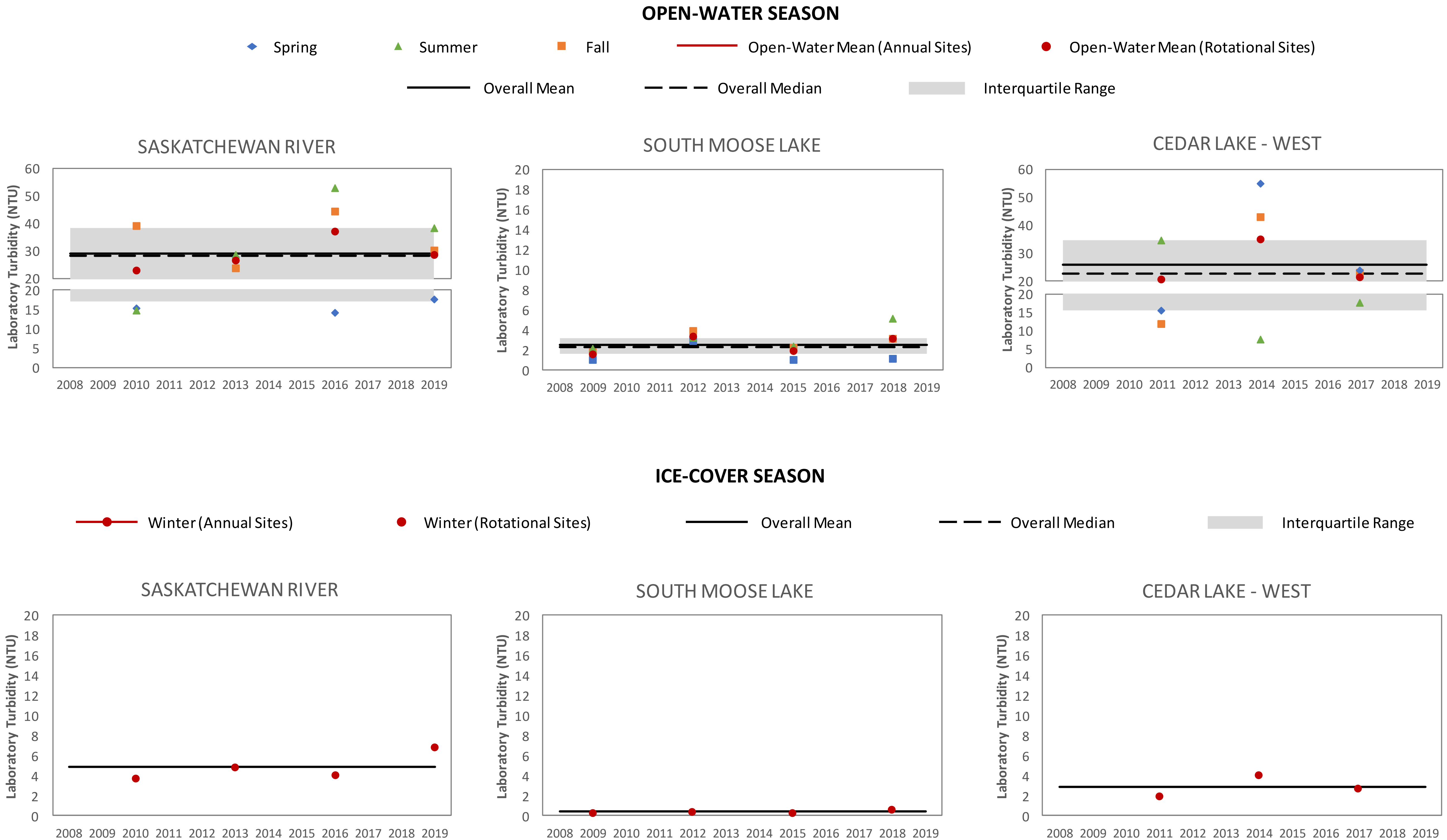
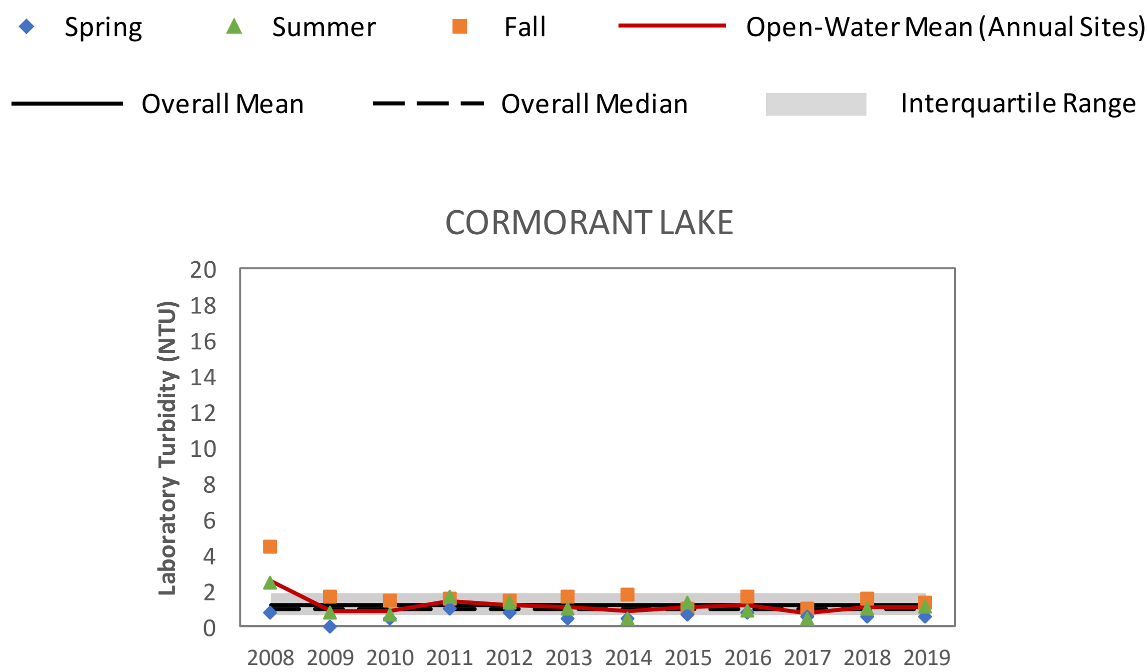


Figure 3.3-7. 2008-2019 On-system rotational site open-water and ice-cover seasons turbidity levels.

OPEN-WATER SEASON



ICE-COVER SEASON

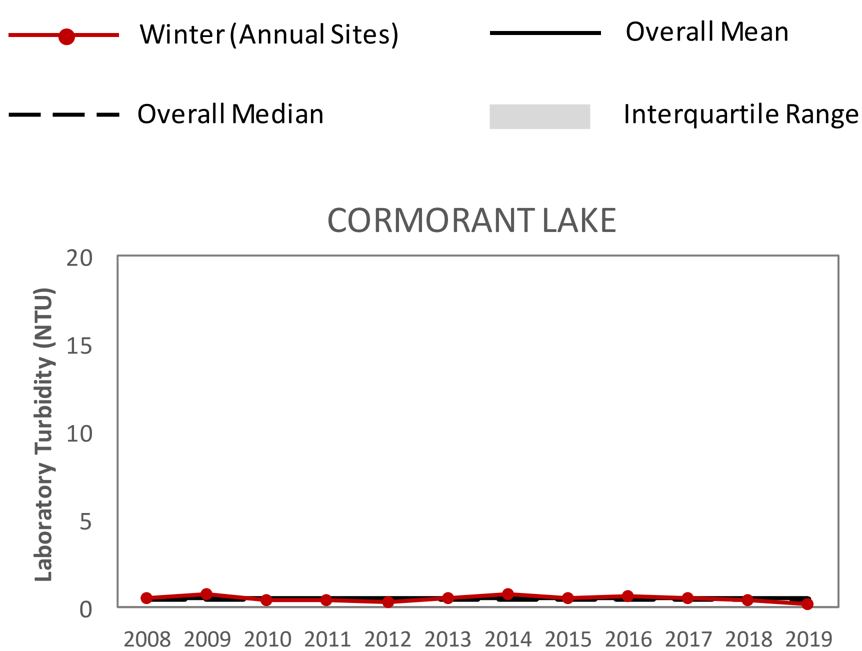


Figure 3.3-8. 2008-2019 Off-system open-water and ice-cover seasons turbidity levels.

3.3.3 TOTAL SUSPENDED SOLIDS

3.3.3.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

TSS concentrations at Cedar Lake -Southeast ranged from <2.0 to 9.0 mg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were 3.8 mg/L and 3.6 mg/L, respectively. Open-water season mean annual TSS concentrations ranged from <2.0 to 5.9 mg/L and were within the IQR (2.1 to 5.4 mg/L) in seven of the 12 years of monitoring. Mean TSS concentrations were below the IQR in 2008 and 2009 and above the IQR in 2012, 2013, and 2016. TSS concentrations were frequently above the analytical detection limit (DL; 2.0 mg/L) during the open-water season (percent detections = 76; Table 3.3-1 and Figure 3.3-9).

TSS concentrations in the ice-cover season ranged from <2.0 to 3.2 mg/L. The mean and median were both <2.0 mg/L and the IQR was below the analytical DL (2.0 mg/L) for the 11 years of monitoring. TSS concentrations were typically below the DL (2.0 mg/L) during the ice-cover season (percent detections = 18; Table 3.3-1 and Figure 3.3-9).

TSS concentrations at Cedar Lake – Southeast were lower in winter (mean = <2.0 mg/L) and more 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 (3.1 mg/L) and the highest in fall (4.6 mg/L; Figure 3.3-2).

Lake Winnipeg - Grand Rapids

TSS concentrations in Lake Winnipeg near Grand Rapids ranged from <5.0 to 39.0 mg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were 5.5 and <5.0 mg/L, respectively. Open-water season mean annual TSS concentrations ranged from <5.0 to 16.7 mg/L and were within the IQR (<5.0 to 7.0 mg/L) in 10 of the 12 years of monitoring. Mean TSS concentrations were above the IQR in 2008 and 2010. TSS concentrations were above the DL (2.0-5.0 mg/L) in a little more than half of the sampling events during the open-water season (percent detections = 59; Table 3.3-1 and Figure 3.3-9).

TSS concentrations in the ice-cover season ranged from <1.0 to 5.0 mg/L. Both the mean and median were <5.0 mg/L and the IQR was also below the highest DL (5.0 mg/L) for the 10 years of monitoring. TSS concentrations were typically below the DL (1.0-5.0 mg/L) during the ice-cover season (percent detections = 30; Table 3.3-1 and Figure 3.3-9).

The lowest mean TSS concentration occurred in winter (<5.0 mg/L) and the highest in fall (6.5 mg/L; Figure 3.3-2).

ROTATIONAL SITES

Saskatchewan River

TSS concentrations in the Saskatchewan River ranged from 22.6 to 128 mg/L during the open-water season. The mean was 62.8 mg/L, the median was 53.5 mg/L, and the IQR was 39.9 to 80.3 mg/L for the four years of monitoring. Mean annual TSS concentrations in the open-water season ranged from 44.1 to 82.5 mg/L and were within the IQR three of the four years of monitoring. The mean TSS concentration was above the IQR in 2016. TSS concentrations were consistently above the DL (2.0 mg/L) during the open-water season (percent detection = 100; Table 3.3-1 and Figure 3.3-10).

During the ice-cover season, TSS concentrations ranged from 5.6 to 9.6 mg/L, with a mean of 7.4 mg/L. TSS concentrations were consistently above the DL (2.0 mg/L) during the ice-cover season (percent detections = 100; Table 3.3-1 and Figure 3.3-10).

South Moose Lake

TSS concentrations in South Moose Lake ranged from <2.0 to 7.6 mg/L during the open-water season. The mean was 3.4 mg/L, the median was 2.8 mg/L, and the IQR was <2.0 to 5.0 mg/L for the four years of monitoring. Mean annual TSS concentrations in the open-water season ranged from <2.0 to 5.9 mg/L and were within the IQR in 2009 and 2018, below the IQR in 2015, and above the IQR in 2012. TSS concentrations were above the DL (2.0 mg/L) in three quarters of the samples collected in the open-water season (percent detections = 75; Table 3.3-1 and Figure 3.3-10).

TSS concentrations in the ice-cover season were consistently below the DL (2.0 mg/L) for the four years of monitoring (Table 3.3-1 and Figure 3.3-10).

Cedar Lake - West

TSS concentrations at Cedar Lake – West ranged from 6.0 to 59.4 mg/L during the open-water season. The mean was 35.2 mg/L, the median was 33.4 mg/L, and the IQR was 21.2 to 55.8 mg/L for the three years of monitoring. Mean annual TSS concentrations in the open-water season ranged from 25.5 to 42.4 mg/L and were within the IQR in all three years of monitoring. TSS concentrations were consistently above the DL (2.0 mg/L) during the open-water season (percent detections = 100; Table 3.3-1 and Figure 3.3-10).

During the ice-cover season, TSS concentrations ranged from <2.0 to 3.6 mg/L and the mean was <2.0 mg/L for the three years of monitoring. TSS concentrations were below the DL (2.0 mg/L) in two of the three samples collected during the ice-cover season (percent detections = 33; Table 3.3-1 and Figure 3.3-10).

3.3.3.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

TSS concentrations in Cormorant Lake ranged from <2.0 to 4.0 mg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were both <2.0 mg/L. Open-water season mean annual TSS concentrations ranged from <2.0 to 2.4 mg/L and were within the IQR (<2.0 to 2.2 mg/L) in 10 of the 12 years of monitoring. Mean TSS concentrations were above the IQR in 2008 and 2012. TSS concentrations were typically below the DL (2.0 mg/L) during the open-water season (percent detections = 31; Table 3.3-2 and Figure 3.3-11).

TSS concentrations in the ice-cover season ranged from <2.0 to 4.0 mg/L, with both a mean and median of <2.0 mg/L. The IQR was below the analytical DL of 2.0 mg/L. TSS concentrations were typically below the DL (2.0 mg/L) during the ice-cover season (percent detections = 8; Table 3.3-2 and Figure 3.3-11).

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 Cormorant 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 3.3-5).

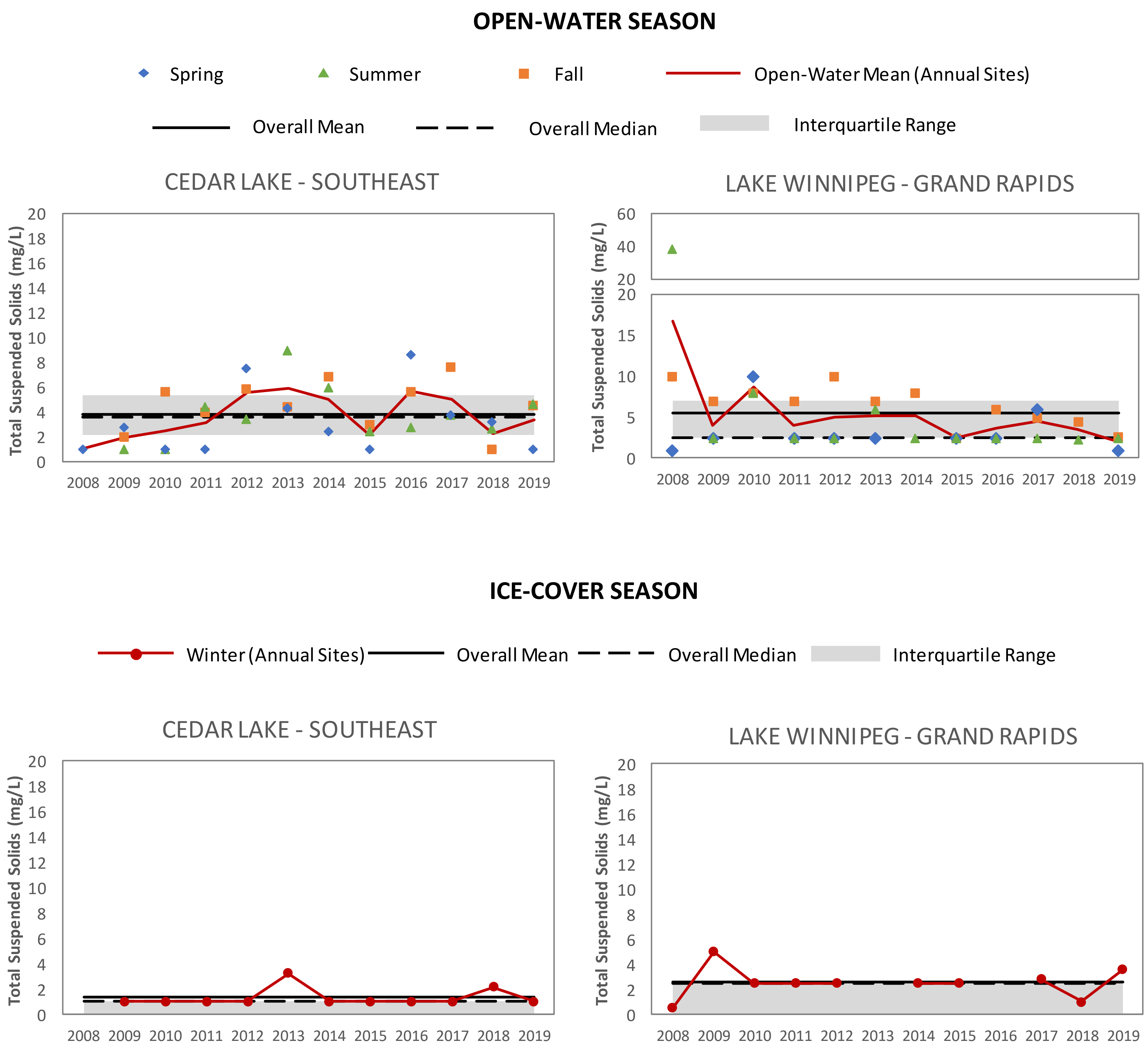


Figure 3.3-9. On-system annual sites open-water and ice-cover seasons TSS concentrations.

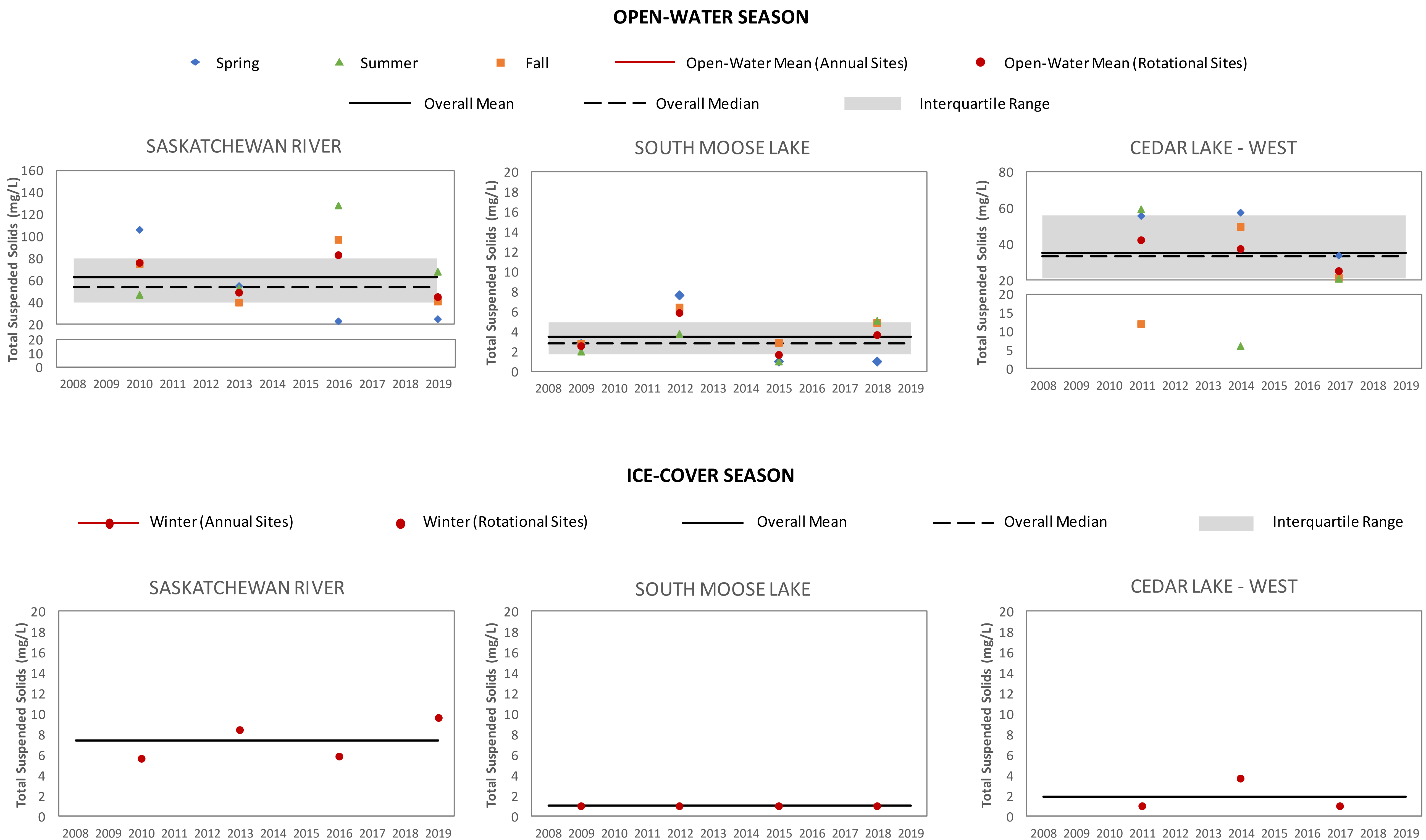
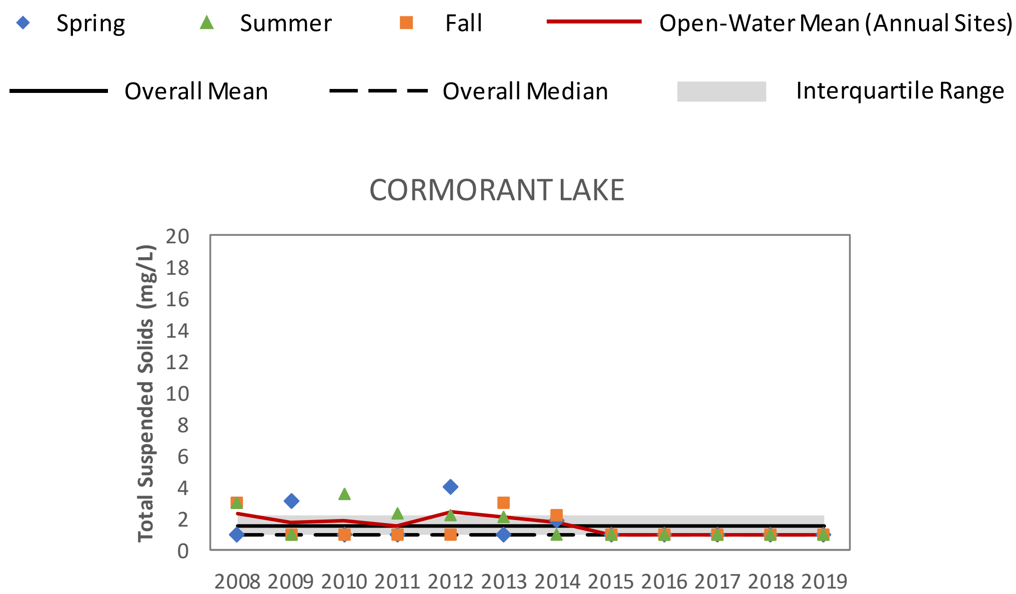


Figure 3.3-10. On-system rotational sites open-water and ice-cover seasons TSS concentrations.

OPEN-WATER SEASON



ICE-COVER SEASON

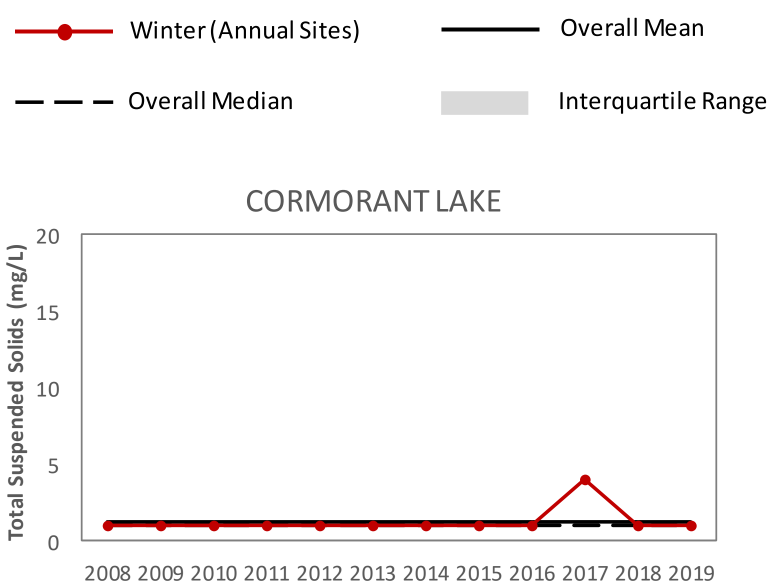


Figure 3.3-11. Off-system open-water and ice-cover seasons TSS concentrations.

3.4 NUTRIENTS AND TROPHIC STATUS

3.4.1 TOTAL PHOSPHORUS

3.4.1.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

TP concentrations at Cedar Lake - Southeast ranged from 0.006 to 0.063 mg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were 0.025 mg/Land 0.021 mg/L, respectively. Open-water season mean annual TP concentrations ranged from 0.011 to 0.039 mg/L and were within the IQR (0.015 to 0.031 mg/L) in nine of the 12 years of monitoring. Mean TP concentrations were below the IQR in 2008 and above the IQR in 2016 and 2019 (Table 3.4-1 and Figure 3.4-1).

TP concentrations in the ice-cover season ranged from 0.010 to 0.028 mg/L, with a mean of 0.015 mg/L and a median of 0.014 mg/L for the 11 years of monitoring. The IQR was 0.012 to 0.016 mg/L (Table 3.4-1 and Figure 3.4-1).

On average, TP concentrations were lower in spring and winter (both 0.015 mg/L) than in summer and fall (0.029 mg/L and 0.032 mg/L, respectively) over the 12 years of monitoring (Figure 3.4-2).

Cedar Lake - Southeast was meso-eutrophic (0.020 to 0.035 mg/L) based on the 2008-2019 mean open-water season TP concentration (0.025 mg/L). Mean annual TP concentrations (0.011 to 0.039 mg/L) in the open-water season were within the meso-eutrophic range (0.020 to 0.035 mg/L) seven of the 12 years of monitoring. Mean annual TP concentrations were within the mesotrophic range (0.010 to 0.020 mg/L) in 2008, 2009, 2011, and 2012 and in the eutrophic range (0.035-0.100 mg/L) in 2016 (Table 3.4-2).

Lake Winnipeg - Grand Rapids

TP concentrations at Lake Winnipeg – Grand Rapids ranged from 0.010 to 0.086 mg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were 0.028 and 0.023 mg/L, respectively. Open-water season mean annual TP concentrations ranged from 0.020 to 0.051 mg/L and were within the IQR (0.018 to 0.034 mg/L) in 10 of the 12 years of monitoring. Mean TP concentrations were above the IQR in 2008 and 2010 (Table 3.4-1 and Figure 3.4-1).

TP concentrations in the ice-cover season ranged from 0.013 to 0.063 mg/L, with a mean of 0.026 mg/L and a median of 0.023 mg/L for the 10 years of monitoring. The IQR was 0.015 to 0.026 mg/L (Table 3.4-1 and Figure 3.4-1).

No clear seasonality was observed for TP concentrations at Lake Winnipeg – Grand Rapids over the 12 years of monitoring. However, mean TP concentrations were lowest in summer (0.023 mg/L) and highest in fall (0.036 mg/L; Figure 3.4-2).

Lake Winnipeg – Grand Rapids was meso-eutrophic (0.020 to 0.035 mg/L) based on the 2008-2019 mean open-water season TP concentration (0.028 mg/L). Mean annual TP concentrations (0.020 to 0.051 mg/L) in the open-water season were within the meso-eutrophic (0.020 to 0.035 mg/L) in seven of the 12 years of monitoring. Mean annual TP concentrations were on the mesotrophic to meso-eutrophic boundary (i.e., 0.020 mg/L) in 2015, 2017 and 2019, and were within the eutrophic range (0.035 to 0.100 mg/L) in 2008 and 2010 (Table 3.4-2).

ROTATIONAL SITES

Saskatchewan River

TP concentrations in the Saskatchewan River ranged from 0.022 to 0.125 mg/L during the open-water season. The mean was 0.058 mg/L, the median was 0.052 mg/L, and the IQR was 0.038 to 0.068 mg/L for the four years of monitoring. Mean annual TP concentrations in the open-water season ranged from 0.043 to 0.082 mg/L and were within the IQR in three of the four years. The mean annual TP concentration was above the IQR in 2016 (Table 3.4-1 and Figure 3.4-3).

During the ice-cover season, TP concentrations ranged from 0.017 to 0.024 mg/L, with a mean of 0.019 mg/L (Table 3.4-1 and Figure 3.4-3).

The Saskatchewan River was eutrophic (0.035 to 0.100 mg/L) based on the mean of the open-water season TP concentrations for the four years of monitoring (0.058 mg/L). Open-water season mean annual TP concentrations (0.043 to 0.082 mg/L) were also within the eutrophic range in each year of monitoring (Table 3.4-3).

South Moose Lake

TP concentrations in the South Moose Lake ranged from 0.004 to 0.021 mg/L during the open-water season. The mean was 0.016 mg/L, the median was 0.017 mg/L, and the IQR was 0.015 to 0.019 mg/L for the four years of monitoring. Mean annual TP concentrations in the open-water season ranged from 0.015 to 0.018 mg/L and were within the IQR in all four years (Table 3.4-1 and Figure 3.4-3).

During the ice-cover season, TP concentrations ranged from 0.010 to 0.017 mg/L, with a mean of 0.014 mg/L (Table 3.4-1 and Figure 3.4-3).

South Moose Lake was mesotrophic (0.010 to 0.020 mg/L) based on the mean of the open-water season TP concentrations for the four years of monitoring (0.016 mg/L). Open-water season mean annual TP concentrations (0.015 to 0.018 mg/L) were also within the mesotrophic range in each year of monitoring (Table 3.4-2).

Cedar Lake - West

TP concentrations at Cedar Lake - West ranged from 0.025 to 0.066 mg/L during the open-water season. The mean was 0.042 mg/L, the median was 0.039 mg/L, and the IQR was 0.031 to 0.047 mg/L for the three years of monitoring. Mean annual TP concentrations in the open-water season ranged from 0.033 to 0.051 mg/L and were within the IQR in 2011 and 2017 and above the IQR in 2014 (Table 3.4-1 and Figure 3.4-3).

During the ice-cover season, TP concentrations ranged from 0.007 to 0.015 mg/L, with a mean of 0.010 mg/L (Table 3.4-1 and Figure 3.4-3).

Cedar Lake - West was eutrophic (0.035 to 0.100 mg/L) based on the mean of the open-water season TP concentrations for the three years of monitoring (0.042 mg/L). Open-water season mean annual TP concentrations (0.033 to 0.051 mg/L) were also within the eutrophic range in 2014 and 2016 but were within the meso-eutrophic range (0.020 to 0.035 mg/L) in 2011 (Table 3.4-2).

3.4.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

TP concentrations in Cormorant Lake ranged from <0.0010 to 0.016 mg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were 0.009 mg/L and 0.008 mg/L, respectively. Open-water season mean annual TP concentrations ranged from 0.005 to 0.014 mg/L and were within the IQR (0.006 to 0.011 mg/L) in eight of the 12 years of monitoring. Mean TP concentrations were below the IQR in 2013 and 2018 and above the IQR in 2009 and 2011 (Table 3.4-4 and Figure 3.4-4).

TP concentrations in the ice-cover season ranged from 0.005 to 0.012 mg/L, with a mean and median of 0.008 mg/L for the 12 years of monitoring. The IQR was 0.006 to 0.009 mg/L (Table 3.4-4 and Figure 3.4-4).

No clear seasonality was observed for TP concentrations in Cormorant Lake over the 12 years of monitoring. However, mean TP concentrations were lowest in spring (0.006 mg/L) and highest in fall (0.011 mg/L; Figure 3.4-5).

Cormorant Lake was oligotrophic (0.004 to 0.010 mg/L) based on the 2008-2019 mean open-water season TP concentration (0.009 mg/L). Mean annual TP concentrations (0.005 to 0.014 mg/L) in the open-water season were also within the oligotrophic range (0.004 to 0.010 mg/L) in eight of the 12 years of monitoring, but within the mesotrophic range (0.010 to 0.020 mg/L) in 2008, 2009, 2010, and 2011 (Table 3.4-5).

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
CEDAR-SE	Mean	0.025	0.015	0.47	0.66	11.5	2.71
	Median	0.021	0.014	0.44	0.60	12.0	1.16
	Minimum	0.006	0.010	<0.20	0.54	<1	<1.0
	Maximum	0.063	0.028	1.02	0.95	24.4	9.55
	SD	0.0131	0.0048	0.191	0.150	7.16	2.83
	SE	0.0022	0.0015	0.033	0.045	1.23	0.854
	Lower Quartile	0.015	0.012	0.39	0.56	5.45	<1.0
	Upper Quartile	0.031	0.016	0.56	0.66	16.8	3.39
	n	34	11	34	11	34	11
	% Detections	100	100	94	100	97	91
LW-GR	Mean	0.028	0.026	0.48	0.62	7.87	8.63
	Median	0.023	0.023	0.47	0.57	5.16	2.58
	Minimum	0.010	0.013	<0.20	0.44	<0.60	<0.60
	Maximum	0.086	0.063	1.00	1.14	30.9	46.8
	SD	0.0149	0.0156	0.146	0.200	7.46	14.9
	SE	0.0026	0.0049	0.025	0.063	1.28	4.71
	Lower Quartile	0.018	0.015	0.40	0.51	2.82	1.33
	Upper Quartile	0.034	0.026	0.55	0.63	9.69	5.25
	n	34	10	34	10	34	10
	% Detections	100	100	97	100	97	80
SASK	Mean	0.058	0.019	0.64	0.68	8.76	1.03
	Median	0.052	-	0.64	-	9.07	-
	Minimum	0.022	0.017	0.53	0.55	2.42	<0.60
	Maximum	0.125	0.024	0.89	0.87	15.3	1.91
	SD	0.0295	0.0033	0.098	0.136	4.35	0.68
	SE	0.0085	0.0016	0.028	0.068	1.26	0.341
	Lower Quartile	0.038	-	0.58	-	4.24	-
	Upper Quartile	0.068	-	0.69	-	11.5	-
	n	12	4	12	4	12	4
	% Detections	100	100	100	100	100	75
SMOOSE	Mean	0.016	0.014	0.43	0.52	6.51	1.45
	Median	0.017	-	0.46	-	5.26	-
	Minimum	0.004	0.010	<0.20	0.47	1.34	<1.0
	Maximum	0.021	0.017	0.67	0.55	20.7	3.51
	SD	0.0049	0.0033	0.156	0.036	5.41	1.39
	SE	0.0014	0.0016	0.045	0.018	1.56	0.696
	Lower Quartile	0.015	-	0.35	-	3.49	-
	Upper Quartile	0.019	-	0.51	-	7.51	-
	n	12	4	12	4	12	4
	% Detections	100	100	92	100	100	75
CEDAR-W	Mean	0.042	0.010	0.71	0.65	8.87	0.52
	Median	0.039	-	0.68	-	10.3	-
	Minimum	0.025	0.007	0.53	0.57	3.74	<0.60
	Maximum	0.066	0.015	0.87	0.71	15.8	0.95
	SD	0.0140	0.0039	0.128	0.071	3.97	0.38
	SE	0.0047	0.0023	0.043	0.041	1.32	0.217
	Lower Quartile	0.031	-	0.62	-	5.92	-
	Upper Quartile	0.047	-	0.84	-	10.7	-
	n	9	3	9	3	9	3
	% Detections	100	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 3.4-2 2008-2019 On-system trophic status for lakes and reservoirs 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	**CEDAR-SE**	**LW-GR**	**SMOOSE**	**CEDAR-W**	**CEDAR-SE**	**LW-GR**	**SMOOSE**	**CEDAR-W**	**CEDAR-SE**	**LW-GR**	**SMOOSE**	**CEDAR-W**
2008	0.011	0.051	-	-	0.43	0.48	-	-	<1	13.0	-	-
2009	0.019	0.027	0.018	-	0.28	0.65	0.49	-	9.20	3.48	4.57	-
2010	0.023	0.039	-	-	0.43	0.44	-	-	6.02	11.5	-	-
2011	0.016	0.032	-	0.033	0.51	0.69	-	0.82	6.58	8.46	-	9.53
2012	0.018	0.032	0.016	-	0.41	0.50	0.48	-	12.5	12.1	5.61	-
2013	0.030	0.023	-	-	0.62	0.36	-	-	12.5	8.15	-	-
2014	0.024	0.027	-	0.051	0.59	0.49	-	0.70	16.7	7.53	-	8.97
2015	0.028	0.020	0.015	-	0.39	0.45	0.33	-	10.2	4.22	4.04	-
2016	0.039	0.022	-	-	0.51	0.50	-	-	14.4	5.90	-	-
2017	0.027	0.020	-	0.043	0.65	0.37	-	0.60	13.0	3.70	-	8.11
2018	0.021	0.021	0.015	-	0.33	0.37	0.41	-	15.2	15.0	11.8	-
2019	0.032	0.020	-	-	0.50	0.41	-	-	13.5	4.95	-	-
Overall (2008-2019)	0.025	0.028	0.016	0.042	0.47	0.48	0.43	0.71	11.5	7.87	6.51	8.87

Notes:

1. CCME = Canadian Council of Ministers of the Environment.
2. OECD = Organization for Economic Cooperation and Development.
3. CEDAR-SE data for 2008 are limited to spring.

Table 3.4-3. 2008-2019 On-system trophic status for riverine sites 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	<0.7	<10
Mesotrophic	0.010-0.020	0.7-1.5	10-30
Meso-eutrophic	0.020-0.035		
Eutrophic	0.035-0.100	>1.5	>30
Hypereutrophic	> 0.100		
References	CCME (1999; updated to 2024)	Dodds et al. (1998)	Dodds et al. (1998)
Sampling Year	**SASK**	**SASK**	**SASK**
2008	-	-	-
2009	-	-	-
2010	0.050	0.57	3.63
2011	-	-	-
2012	-	-	-
2013	0.056	0.64	11.5
2014	-	-	-
2015	-	-	-
2016	0.082	0.76	7.23
2017	-	-	-
2018	-	-	-
2019	0.043	0.60	12.6
Overall (2008-2019)	0.058	0.64	8.76

Notes:
1. CCME = Canadian Council of Ministers of the Environment.

Table 3.4-4. 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
CORM	Mean	0.009	0.008	0.29	0.34	1.64	1.26
	Median	0.008	0.008	0.28	0.35	1.49	1.05
	Minimum	<0.0010	0.005	<0.20	<0.20	<1	<0.60
	Maximum	0.016	0.012	0.80	0.46	3.03	2.86
	SD	0.0039	0.0022	0.128	0.098	0.80	0.88
	SE	0.0007	0.0006	0.021	0.028	0.134	0.254
	Lower Quartile	0.006	0.006	0.24	0.31	<1	0.71
	Upper Quartile	0.011	0.009	0.34	0.41	2.35	1.59
	n	36	12	36	12	36	12
	% Detections	97	100	86	92	94	83

Notes:

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

Table 3.4-5. 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	**CORM**	**CORM**	**CORM**
2008	0.011	0.52	2.33
2009	0.014	0.35	1.37
2010	0.010	0.29	0.99
2011	0.012	0.40	1.24
2012	0.007	0.26	1.78
2013	0.005	0.26	1.31
2014	0.008	0.23	1.67
2015	0.007	0.21	1.87
2016	0.010	0.31	1.29
2017	0.007	0.27	1.25
2018	0.005	<0.20	2.16
2019	0.006	0.24	2.46
Overall (2008-2019)	0.009	0.29	1.64

Notes:

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

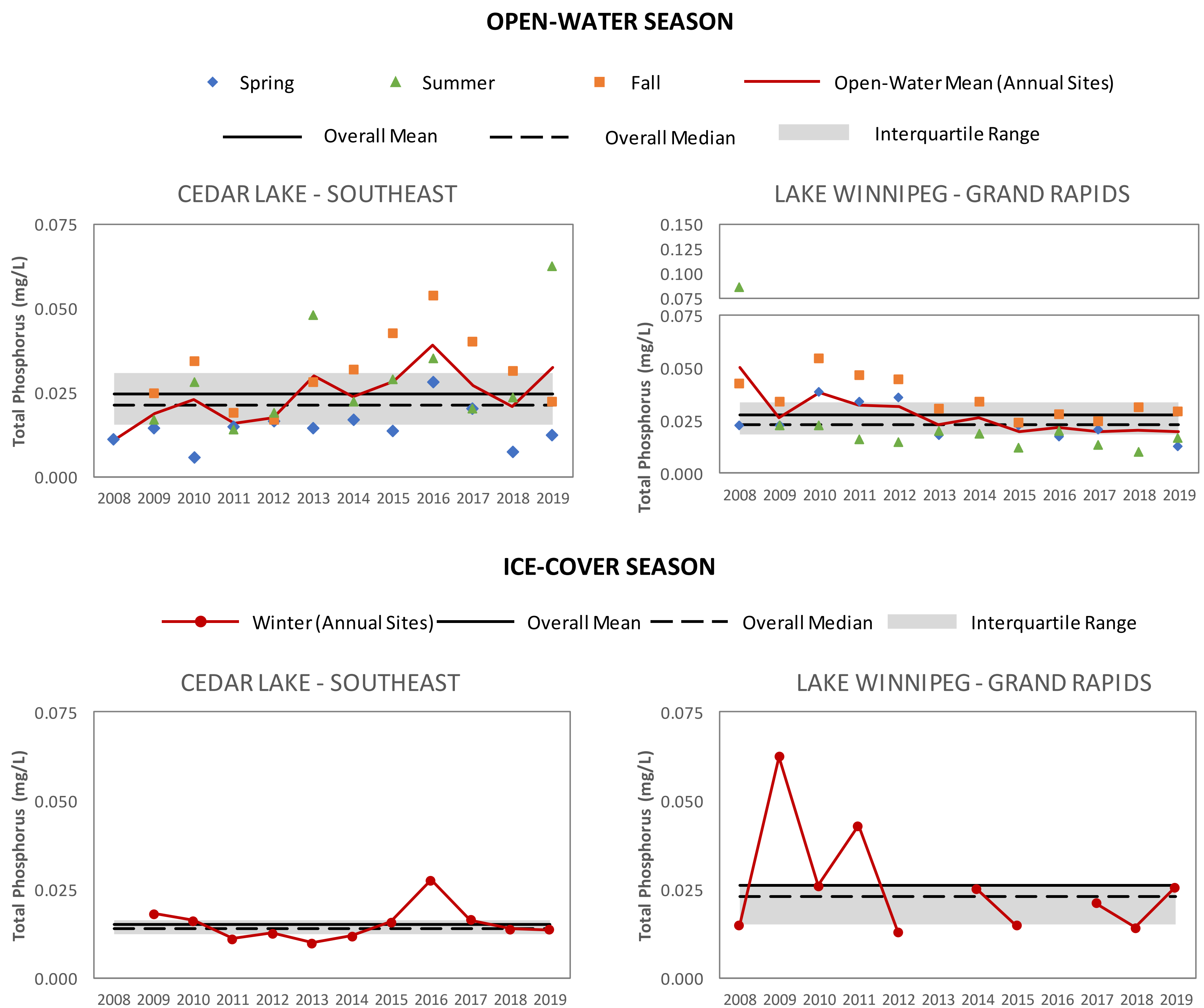


Figure 3.4-1. 2008-2019 On-system annual site open-water and ice-cover seasons TP concentrations.

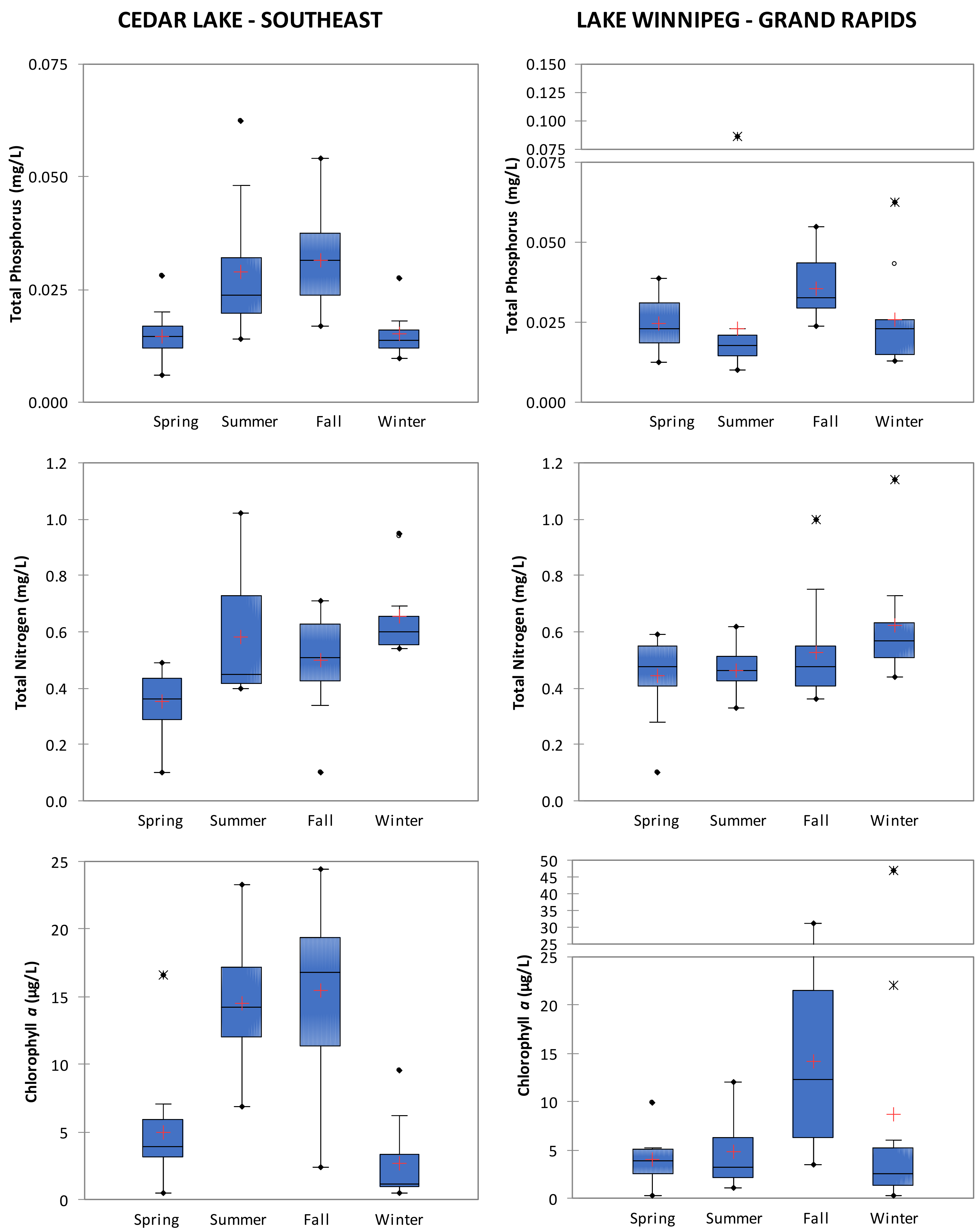


Figure 3.4-2. 2008-2019 On-system seasonal TP, TN, and chlorophyll *a* concentrations.

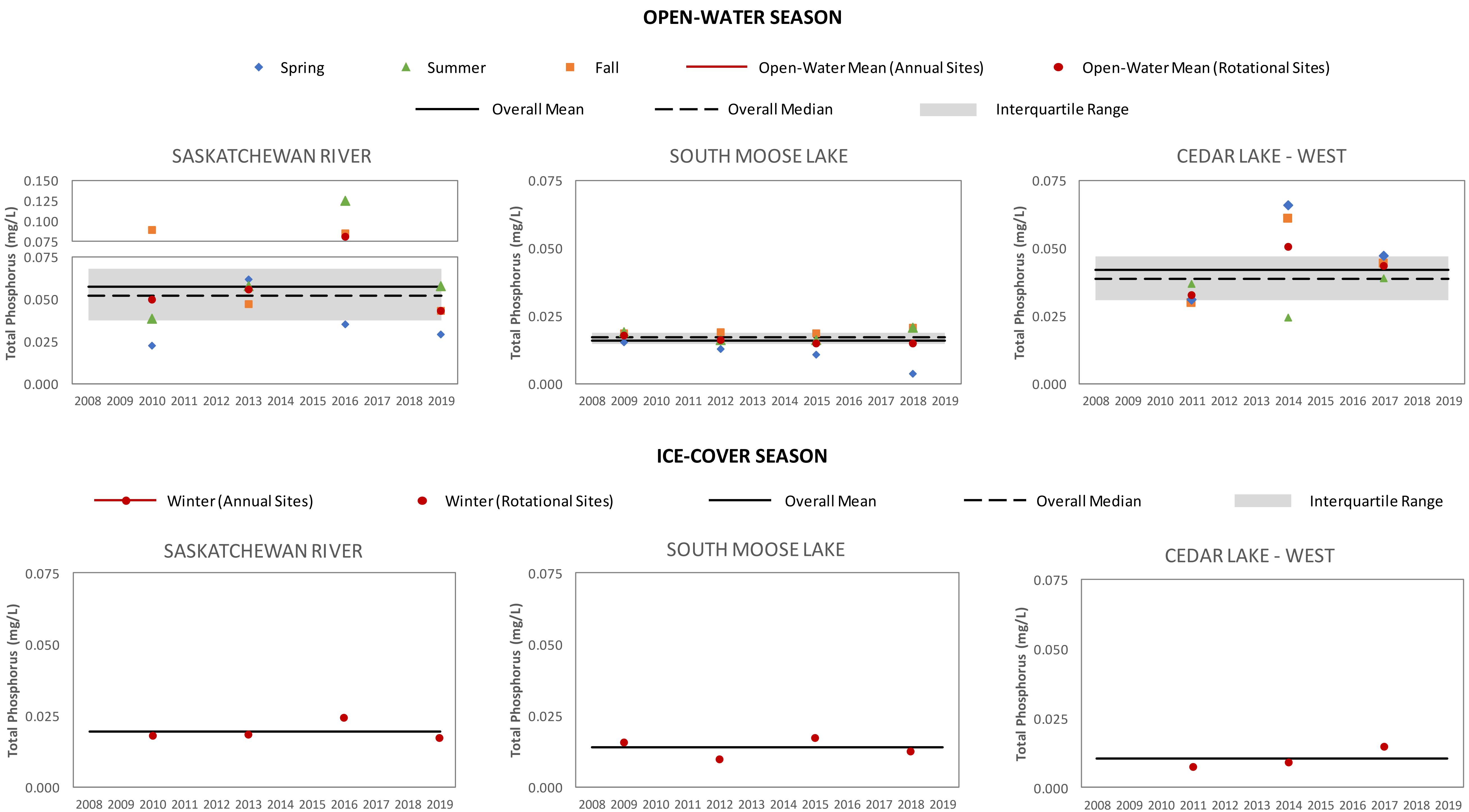


Figure 3.4-3. 2008-2019 On-system rotational site open-water and ice-cover seasons TP concentrations.

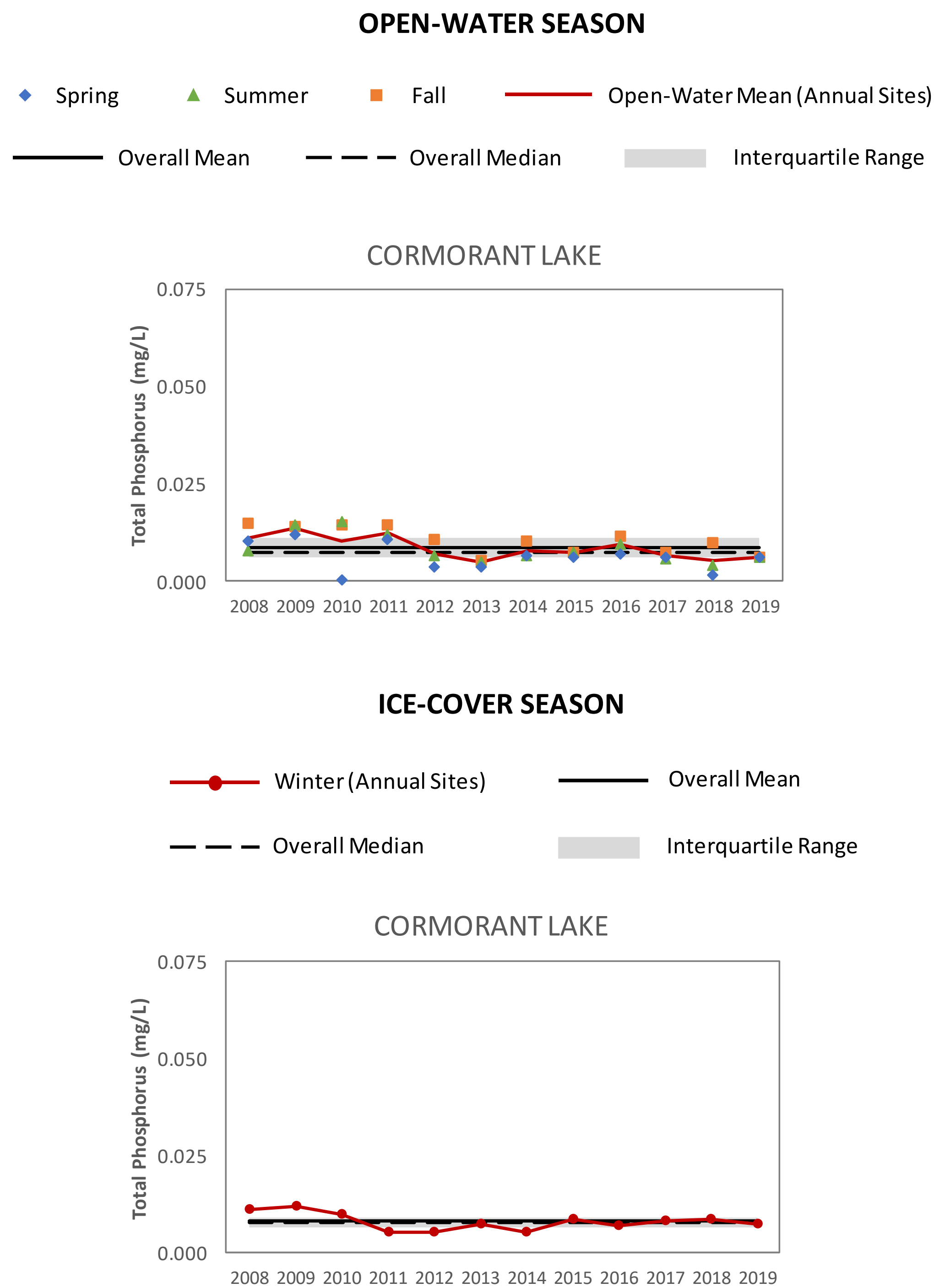


Figure 3.4-4. 2008-2019 Off-system open-water and ice-cover seasons TP concentrations.

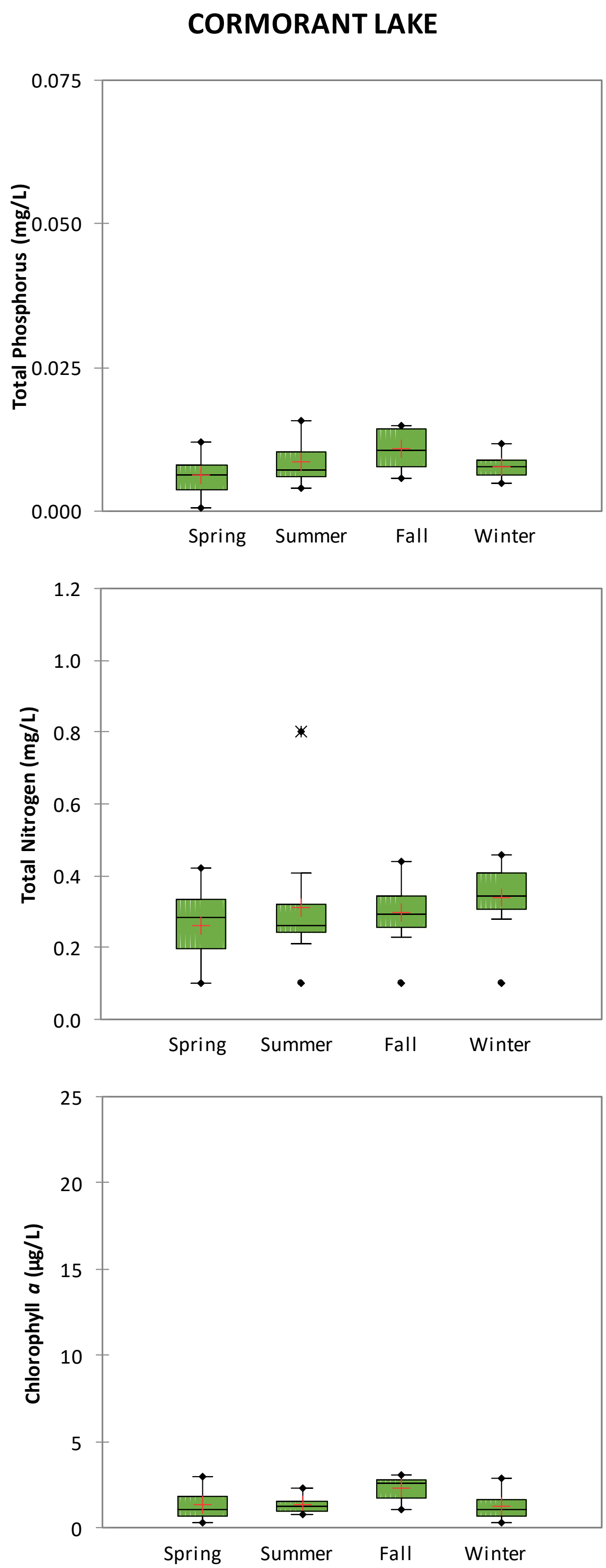


Figure 3.4-5. 2008-2019 Off-system seasonal TP, TN, chlorophyll *a* concentrations.

3.4.2 TOTAL NITROGEN

3.4.2.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

TN concentrations at Cedar Lake - Southeast ranged from <0.20 to 1.02 mg/L during the open-water season. The mean and median for the 12 years of monitoring were 0.47 mg/L and 0.44 mg/L, respectively. Open-water season mean annual TN concentrations ranged from 0.28 to 0.65 mg/L and were within the IQR (0.39 to 0.56 mg/L) in seven of the 12 years of monitoring. Mean TN concentrations were below the IQR in 2009 and 2018 and above the IQR in 2013, 2014, and 2017 (Table 3.4-1 and Figure 3.4-6).

TN concentrations in the ice-cover season ranged from 0.54 to 0.95 mg/L, with a mean of 0.66 mg/L and a median of 0.60 mg/L for the 11 years of monitoring. The IQR was 0.56 to 0.66 mg/L. TN concentrations were within or near the IQR except in 2012 and 2016 when they were above the IQR (Table 3.4-1 and Figure 3.4-6).

No clear seasonality was observed for TN concentrations at Cedar Lake - Southeast over the 12 years of monitoring. However, the lowest mean TN concentration occurred in spring (0.36 mg/L) and the highest in winter (0.66 mg/L; Figure 3.4-2).

Cedar Lake - Southeast was mesotrophic (0.350 to 0.650 mg/L) based on the 2008-2019 mean open-water season TN concentration (0.47 mg/L). Mean annual TN concentrations (0.28 to 0.65 mg/L) in the open-water season were also within the mesotrophic range (0.350 to 0.650 mg/L) in 10 of the 12 years of monitoring. Mean TN concentrations were in the oligotrophic range (i.e., <0.350 mg/L) in 2009 and 2018 (Table 3.4-2).

Lake Winnipeg - Grand Rapids

TN concentrations in Lake Winnipeg near Grand Rapids ranged from <0.20 to 1.00 mg/L during the open-water season. The mean and median for the 12 years of monitoring were 0.48 mg/L and 0.47 mg/L, respectively. Open-water season mean annual TN concentrations ranged from 0.36 to 0.69 mg/L and were within the IQR (0.40 to 0.55 mg/L) in six of the 12 years of monitoring. Mean

TN concentrations were below the IQR in 2013, 2017, 2018, and 2019 and above the IQR in 2009 and 2011 (Table 3.4-1 and Figure 3.4-6).

TN concentrations in the ice-cover season ranged from 0.44 to 1.14 mg/L, with a mean of 0.62 mg/L and a median of 0.57 mg/L for the 10 years of monitoring. TN concentrations were within or near the IQR (0.51 to 0.63 mg/L) except in 2009 and 2019 when concentrations were above the IQR (Table 3.4-1 and Figure 3.4-6).

No clear seasonality was observed for TN at Lake Winnipeg - Grand Rapids over the 12 years of monitoring. However, the lowest mean TN concentration occurred in spring (0.45 mg/L) and the highest in winter (0.62 mg/L; Figure 3.4-2).

The Lake Winnipeg - Grand Rapids site was mesotrophic (0.350 to 0.650 mg/L) based on the 2008-2019 mean open-water season TN concentration (0.48 mg/L). Mean annual TN concentrations (0.36 to 0.69 mg/L) in the open-water season were also within the mesotrophic range (0.350 to 0.650 mg/L) in 11 of the 12 years of monitoring. The exception was 2011 when the mean TN concentration was in the eutrophic range (i.e., 0.651 to 1.20 mg/L; Table 3.4-2).

ROTATIONAL SITES

Saskatchewan River

TN concentrations in the Saskatchewan River ranged from 0.53 to 0.89 mg/L during the open-water season. The mean and median were both 0.64 mg/L, and the IQR was 0.58 to 0.69 mg/L for the four years of monitoring. Mean annual TN concentrations in the open-water season ranged from 0.57 to 0.76 mg/L and were within the IQR in 2013 and 2019 but were below the IQR in 2010 and above the IQR in 2016 (Table 3.4-1 and Figure 3.4-7).

During the ice-cover season, TN concentrations ranged from 0.55 and 0.87 mg/L, with a mean of 0.68 mg/L (Table 3.4-1 and Figure 3.4-7).

The Saskatchewan River was oligotrophic (<0.7 mg/L) based on the mean of the open-water season TN concentrations for the four years of monitoring (0.64 mg/L). Open-water season mean annual TN concentrations (0.57 to 0.76 mg/L) were also within the oligotrophic range in three of the four years but were within the mesotrophic range (0.7 to 1.5 mg/L) in 2016 (Table 3.4-3).

South Moose Lake

TN concentrations in South Moose Lake ranged from <0.20 to 0.67 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 0.35 to 0.51 mg/L for the four 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 three of the four years of monitoring. The exception was 2015 when the mean TN concentration was below the IQR (Table 3.4-1 and Figure 3.4-7).

During the ice-cover season, TN concentrations ranged from 0.47 and 0.55 mg/L, with a mean of 0.52 mg/L (Table 3.4-1 and Figure 3.4-7).

South Moose Lake was mesotrophic (i.e., 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 (0.33 to 0.49 mg/L) were also within the mesotrophic range in three of the four years but were within the oligotrophic range (<0.350 mg/L) in 2015 (Table 3.4-2).

Cedar Lake - West

TN concentrations at Cedar Lake - West ranged from 0.53 to 0.87 mg/L during the open-water season. The mean was 0.71 mg/L, the median was 0.68 mg/L, and the IQR was 0.62 to 0.84 mg/L for the three years of monitoring. Mean annual TN concentrations in the open-water season ranged from 0.60 to 0.82 mg/L and were within the IQR in 2011 and 2014 but were below the IQR in 2017 (Table 3.4-1 and Figure 3.4-7).

During the ice-cover season, TN concentrations ranged from 0.57 to 0.71 mg/L, with a mean of 0.65 mg/L (Table 3.4-1 and Figure 3.4-7).

Cedar Lake - West was eutrophic (0.651 to 1.20 mg/L) based on the mean of the open-water season TN concentrations for the three years of monitoring (0.71 mg/L). Open-water season mean annual TN concentrations (0.60 to 0.82 mg/L) were also within the eutrophic range in 2011 and 2014 but were within the mesotrophic range (0.350 to 0.650 mg/L) in 2017 (Table 3.4-2).

3.4.2.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

TN concentrations in Cormorant Lake ranged from <0.20 to 0.80 mg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were 0.29 mg/L and 0.28 mg/L, respectively. Open-water season mean annual TN concentrations ranged from <0.20 to 0.52 mg/L and were within the IQR (0.24 to 0.34 mg/L) in six of the 12 years. Mean TN concentrations were below the IQR in 2014, 2015, and 2018 and above the IQR in 2008, 2009, and 2011 (Table 3.4-4 and Figure 3.4-8).

TN concentrations in the ice-cover season ranged from <0.20 to 0.46 mg/L, with a mean of 0.34 mg/L and a median of 0.35 mg/L for the 12 years of monitoring. The IQR was 0.31 to 0.41 mg/L (Table 3.4-4 and Figure 3.4-8).

No clear seasonality was observed for TN concentrations in Cormorant Lake over the 12 years of monitoring. However, the lowest mean TN concentration occurred in spring (0.26 mg/L) and the highest in winter (0.34 mg/L; Figure 3.4-5).

Cormorant Lake was oligotrophic (<0.350 mg/L) based on the 2008-2019 mean open-water season TN concentration (0.29 mg/L). Mean annual TN concentrations (<0.20 to 0.52 mg/L) in the open-water season were also within the oligotrophic range in 10 of the 12 years of monitoring. Mean annual TN concentrations were within the mesotrophic range (0.350 to 0.650 mg/L) in 2008 and 2011 (Table 3.4-5).

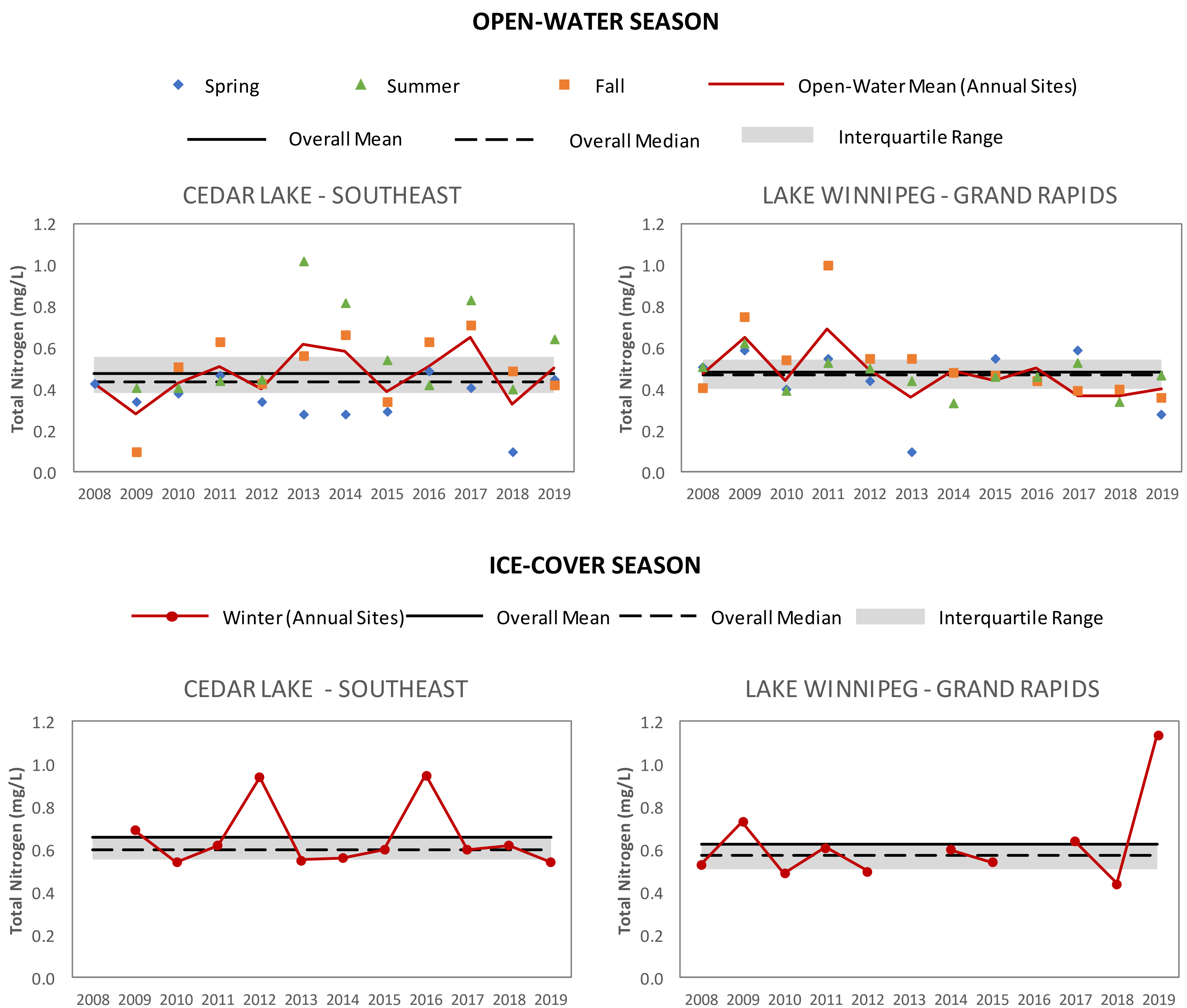


Figure 3.4-6. 2008-2019 On-system annual site open-water and ice-cover seasons TN concentrations.

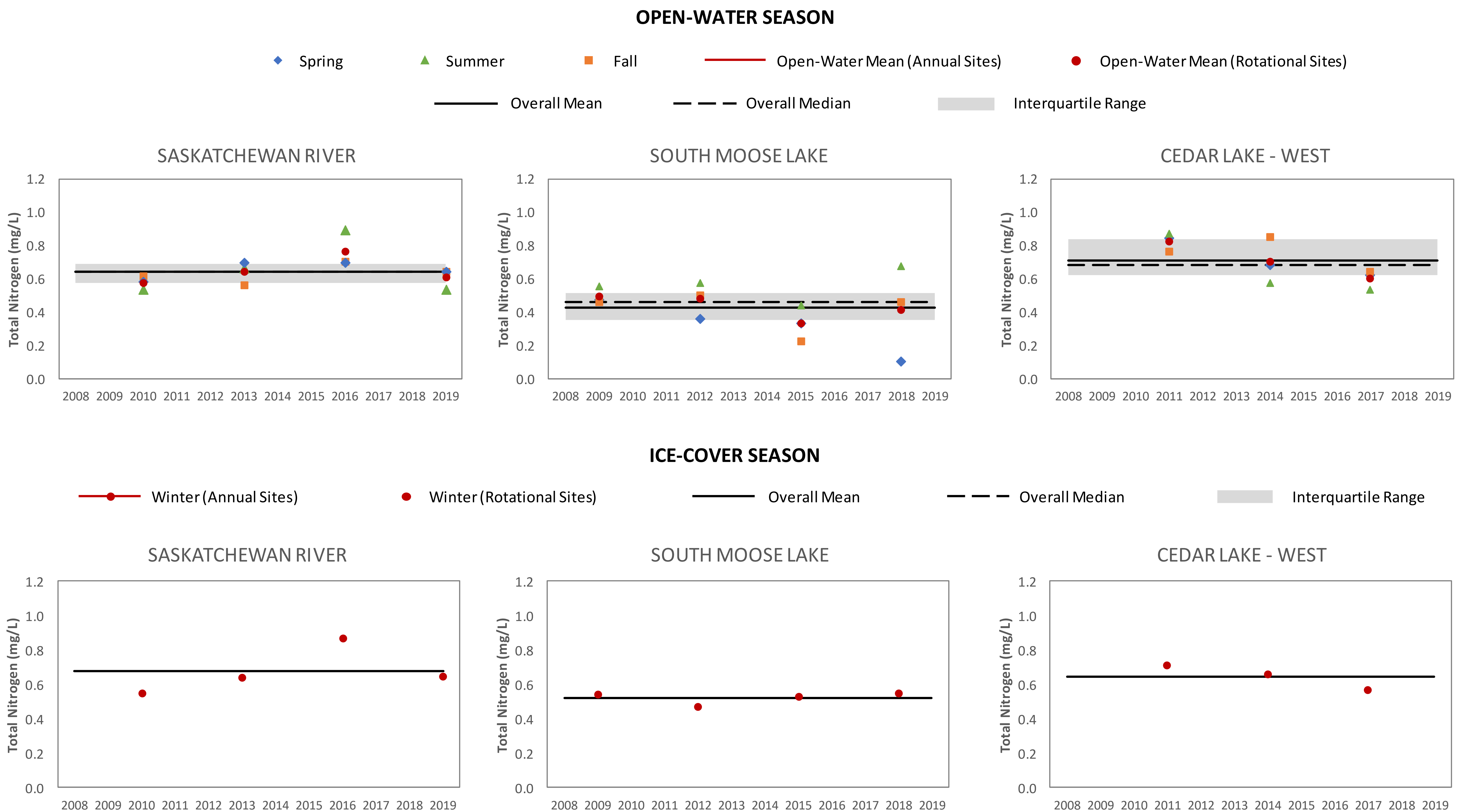
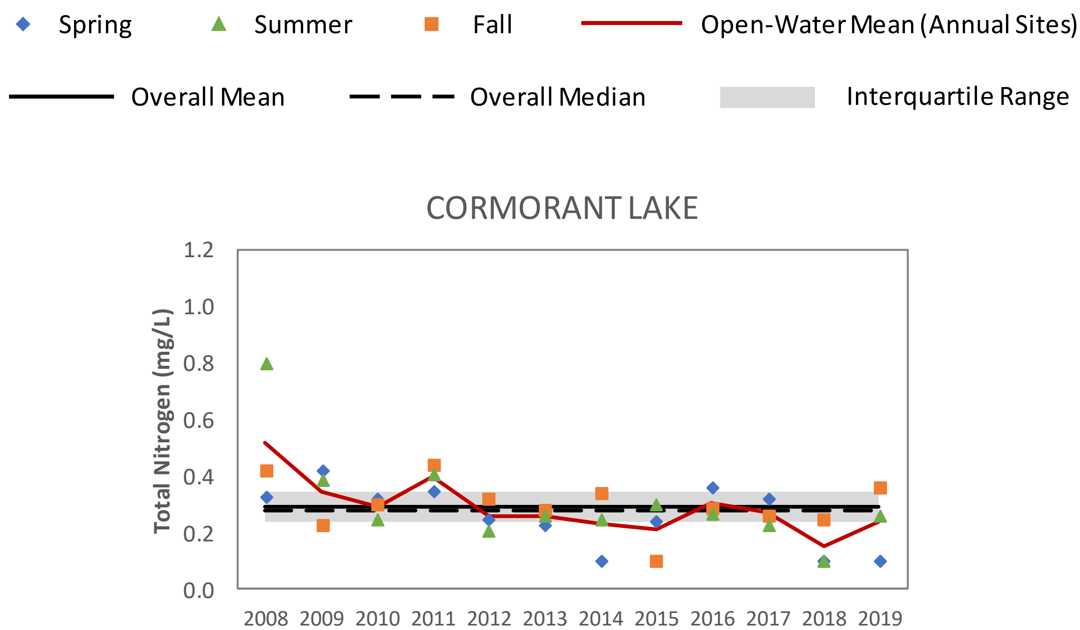


Figure 3.4-7. 2008-2019 On-system rotational site open-water and ice-cover seasons TN concentrations.

OPEN-WATER SEASON



ICE-COVER SEASON

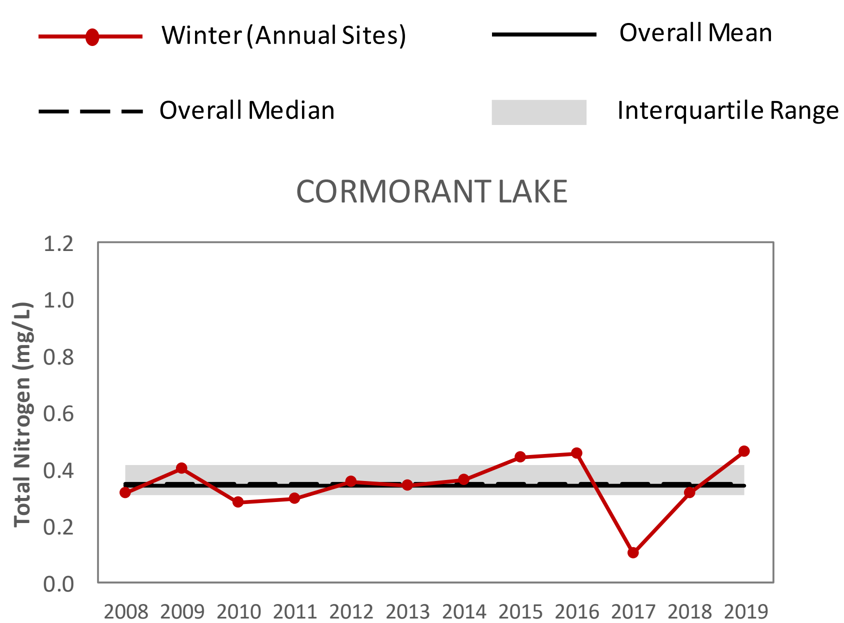


Figure 3.4-8. 2008-2019 Off-system open-water and ice-cover seasons TN concentrations.

3.4.3 CHLOROPHYLL *A*

3.4.3.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake-Southeast

Chlorophyll *a* concentrations at Cedar Lake - Southeast ranged from <1 to 24.4 µg/L during the open-water season. The mean and median for the 12 years of monitoring were 11.5 µg/L and 12.0 µg/L, respectively. Open-water season mean annual chlorophyll *a* concentrations ranged from <1 to 16.7 µg/L and were within the IQR (5.45 to 16.8 µg/L) in 11 of the 12 years of monitoring. Mean chlorophyll *a* concentrations were below the IQR in 2008 when monitoring was limited to the spring. Chlorophyll *a* concentrations were typically above the DL (0.010-1 µg/L) in the open-water season (percent detection = 97; Table 3.4-1 and Figure 3.4-9).

Chlorophyll *a* concentrations in the ice-cover season ranged from <1.0 to 9.55 µg/L, with a mean of 2.71 µg/L and a median of 1.16 µg/L for the 11 years of monitoring. The IQR was <1.0 to 3.39 µg/L. Chlorophyll *a* concentrations were typically above the DL (0.010-1.0 µg/L) in the ice-cover season (percent detection =91; Table 3.4-1 and Figure 3.4-9).

On average, chlorophyll *a* concentrations were lower in spring and winter (5.01 µg/L and 2.72 µg/L, respectively) than in summer and fall (14.5 µg/L and 15.4 µg/L, respectively) over the 12-year period (Figure 3.4-2).

Cedar Lake - Southeast was eutrophic (8 to 25 µg/L) based on the 2008-2019 mean open-water season chlorophyll *a* concentration (11.5 µg/L). Mean annual chlorophyll *a* concentrations (<1 to 16.71 µg/L) in the open-water season were also within the eutrophic range (8 to 25 µg/L) in nine of the 12 years on monitoring. The exceptions were: 2008, when monitoring was limited to the spring sampling event and the chlorophyll *a* concentration was within the oligotrophic range (<2.5 µg/L); and 2010 and 2011, when the mean chlorophyll *a* concentrations were within the mesotrophic range (2.5-8 µg/L; Table 3.4-3).

Lake Winnipeg - Grand Rapids

Chlorophyll *a* concentrations in Lake Winnipeg near Grand Rapids ranged from <0.60 to 30.9 µg/L during the open-water season. The mean was 7.87 µg/L and median was 5.16 µg/L for the 12 years of monitoring. Open-water season mean annual chlorophyll *a* concentrations ranged from 3.48 to 15.0 µg/L and were within the IQR (2.82 to 9.69 µg/L) in eight of the 12 years of monitoring. Mean chlorophyll *a* concentrations were above the IQR in 2008, 2010, 2012, and 2018. Chlorophyll *a* concentrations were typically above the DL (0.10-1.2 µg/L) in the open-water season (percent detection = 97; Table 3.4-1 and Figure 3.4-9).

Chlorophyll *a* concentrations in the ice-cover season ranged from <0.60 to 46.8 µg/L, with a mean of 8.63 µg/L and a median of 2.58 µg/L for the 10 years of monitoring. The IQR was 1.33 to 5.25 µg/L. Chlorophyll *a* concentrations were typically above the DL (0.10-0.60 µg/L) in the ice-cover season (percent detection =80; Table 3.4-1 and Figure 3.4-9).

On average, chlorophyll *a* concentrations were lower in spring (4.05 µg/L), summer (4.36 µg/L), and winter (8.63 µg/L) than in fall (14.2 µg/L) over the 12 years of monitoring (Figure 3.4-2).

Lake Winnipeg - Grand Rapids was eutrophic (8 to 25 µg/L) based on the 2008-2019 mean open-water season chlorophyll *a* concentration (7.83 µg/L). Mean annual chlorophyll *a* concentrations (3.48 to 15.0 µg/L) in the open-water season were within the eutrophic range (8 to 25 µg/L) in six of the 12 years of monitoring. Mean annual chlorophyll *a* concentrations were within the mesotrophic range (2.5-8 µg/L) in 2009, 2014, 2015, 2016, 2017 and 2019 (Table 3.4-3).

ROTATIONAL SITES

Saskatchewan River

Chlorophyll *a* concentrations in the Saskatchewan River ranged from 2.42 to 15.3 µg/L during the open-water season. The mean was 8.76 µg/L, the median was 9.07 µg/L, and the IQR was 4.24 to 11.5 µg/L for the four years of monitoring. Mean annual chlorophyll *a* concentrations in the open-water season ranged from 3.63 to 12.6 µg/L and were within the IQR in 2013 and 2016, below the IQR in 2010, and above the IQR in 2019 (Table 3.4-1 and Figure 3.4-10).

During the ice-cover season, chlorophyll *a* concentrations ranged from <0.60 to 1.91 µg/L, with a mean of 1.03 µg/L (Table 3.4-1 and Figure 3.4-10).

The Saskatchewan River was oligotrophic (<10 µg/L) based on the mean of the open-water season chlorophyll *a* concentrations for the four years of monitoring (8.76 µg/L). Open-water season mean annual chlorophyll *a* concentrations (3.63 to 12.6 µg/L) were also within the oligotrophic range in 2010 and 2016 but were within the mesotrophic range (10-30 µg/L) in 2013 and 2019 (Table 3.4-3).

South Moose Lake

Chlorophyll *a* concentrations in South Moose Lake ranged from 1.34 to 20.7 µg/L during the open-water season. The mean was 6.51 µg/L, the median was 5.26 µg/L, and the IQR was 3.49 to 7.51 µg/L for the four years of monitoring. Mean annual chlorophyll *a* concentrations in the open-water season ranged from 4.04 to 11.8 µg/L and were within the IQR in three of the four years of monitoring. Mean annual chlorophyll *a* concentrations were above the IQR in 2018 (Table 3.4-1 and Figure 3.4-10).

During the ice-cover season, chlorophyll *a* concentrations ranged from <1.0 and 3.51 µg/L, with a mean of 1.45 µg/L (Table 3.4-1 and Figure 3.4-10).

South Moose 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 (6.51 µg/L). Open-water season mean annual chlorophyll *a* concentrations (4.04 to 11.8 µg/L) were also within the mesotrophic range in three of the four years of monitoring. The exception was 2018, when the mean chlorophyll *a* concentration was within the eutrophic range (8-25 µg/L; Table 3.4-2).

Cedar Lake-West

Chlorophyll *a* concentrations at Cedar Lake - West ranged from 3.74 to 15.8 µg/L during the open-water season. The mean was 8.87 µg/L, the median was 10.3 µg/L, and the IQR was 5.92 to 10.7 µg/L for the three years of monitoring. Mean annual chlorophyll *a* concentrations in the open-water season ranged from 8.11 to 9.53 µg/L and were within the IQR in all three years of monitoring (Table 3.4-1 and Figure 3.4-10).

Chlorophyll *a* concentrations in the ice-cover season ranged from <0.60 and 0.95 µg/L, with a mean of 0.52 µg/L for the three years of monitoring (Table 3.4-1 and Figure 3.4-10).

Cedar Lake - West was eutrophic (8 to 25 µg/L) based on the mean of the open-water season chlorophyll *a* concentrations for the three years of monitoring (8.87 µg/L). Open-water season mean annual chlorophyll *a* concentrations (8.11 to 9.53 µg/L) were also within the eutrophic range in each year of monitoring (Table 3.4-2).

3.4.3.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

Chlorophyll *a* concentrations in Cormorant Lake ranged from <1 to 3.03 μg/L during the open-water season. The mean and median concentrations for the 12 years of monitoring were 1.64 μg/L and 1.49 μg/L, respectively. Open-water season mean annual chlorophyll *a* concentrations ranged from 0.99 to 2.46 μg/L and were within the IQR (<1 to 2.35 μg/L) in 11 of the 12 years of monitoring. Mean chlorophyll *a* concentrations were above the IQR in 2019 (Table 3.4-4 and Figure 3.4-11). Chlorophyll *a* concentrations were typically above the DL (0.010-1 μg/L) in the open-water season (percent detection = 94; Table 3.4-1 and Figure 3.4-11).

Chlorophyll *a* concentrations in the ice-cover season ranged from <0.60 to 2.86 μg/L, with a mean of 1.26 μg/L and a median of 1.05 μg/L for the 12 years of monitoring. The IQR was 0.71 to 1.59 μg/L. Chlorophyll *a* concentrations were typically above the DL (0.010-1 μg/L) in the ice-cover season (percent detection = 83; Table 3.4-4 and Figure 3.4-11).

No clear seasonality was observed for chlorophyll *a* concentrations in Cormorant Lake over the 12 years of monitoring. However, mean chlorophyll *a* concentrations were lowest in winter (1.26 μg/L) and highest in fall (2.30 μg/L; Figure 3.4-5).

Cormorant Lake was oligotrophic (<2.5 μg/L) based on the 2008-2019 mean open-water season chlorophyll *a* concentration (1.64 μg/L). Mean annual chlorophyll *a* concentrations (0.99 to 2.46 μg/L) in the open-water season were also within the oligotrophic range in each year of monitoring (Table 3.4-5).

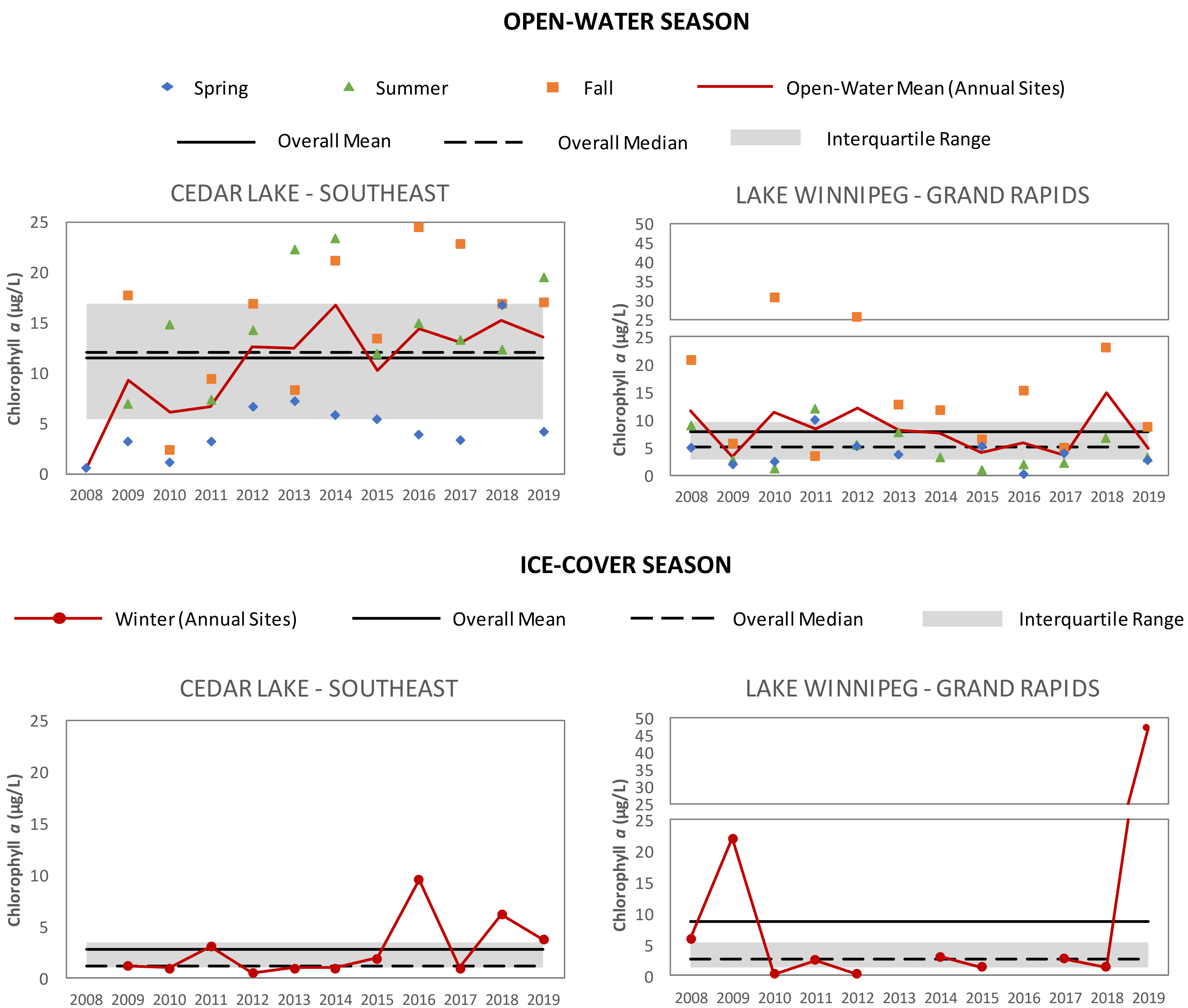


Figure 3.4-9. 2008-2019 On-system annual site open-water and ice-cover seasons chlorophyll *a* concentrations.

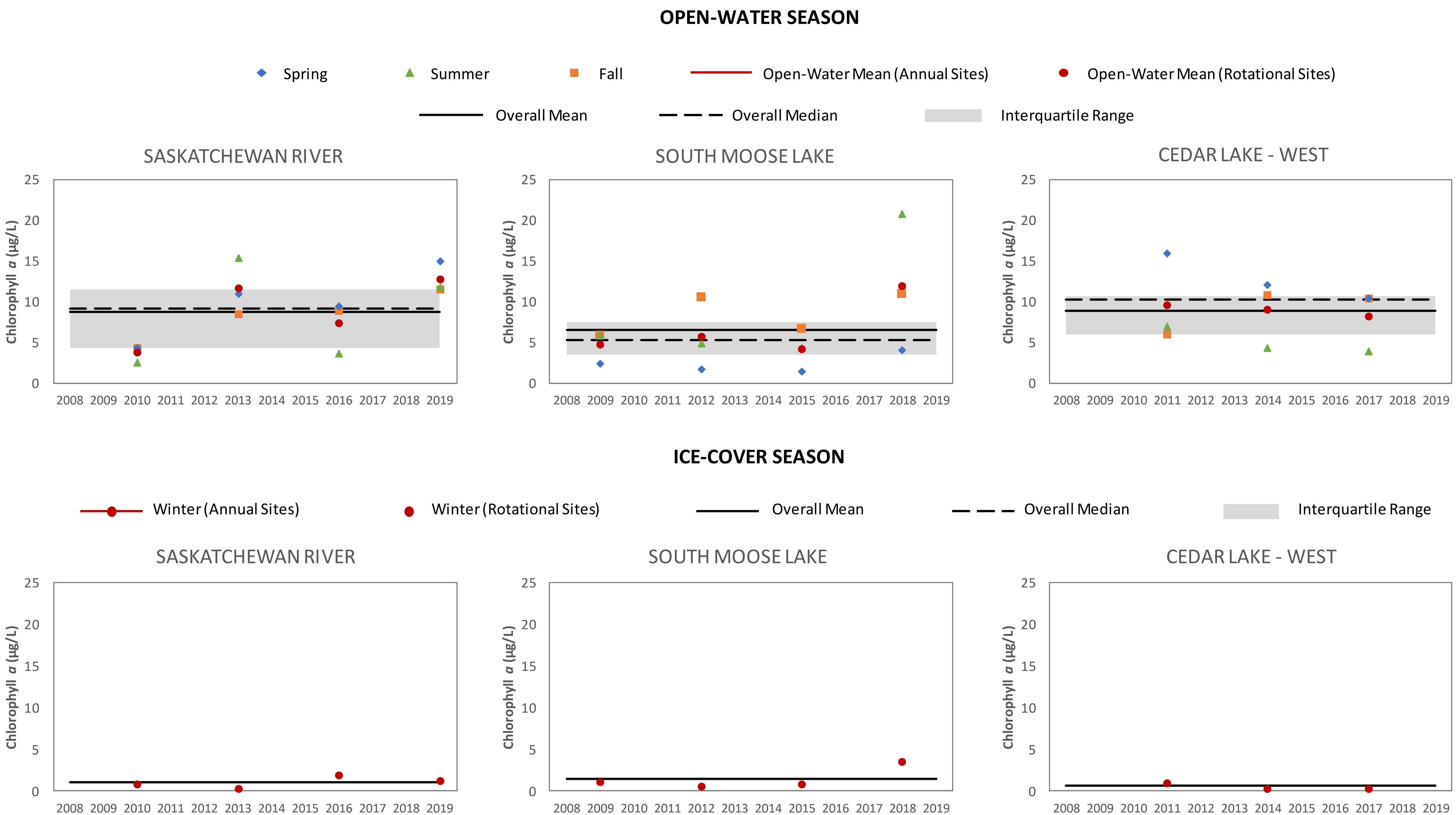


Figure 3.4-10. 2008-2019 On-system rotational site open-water and ice-cover seasons chlorophyll *a* concentrations.

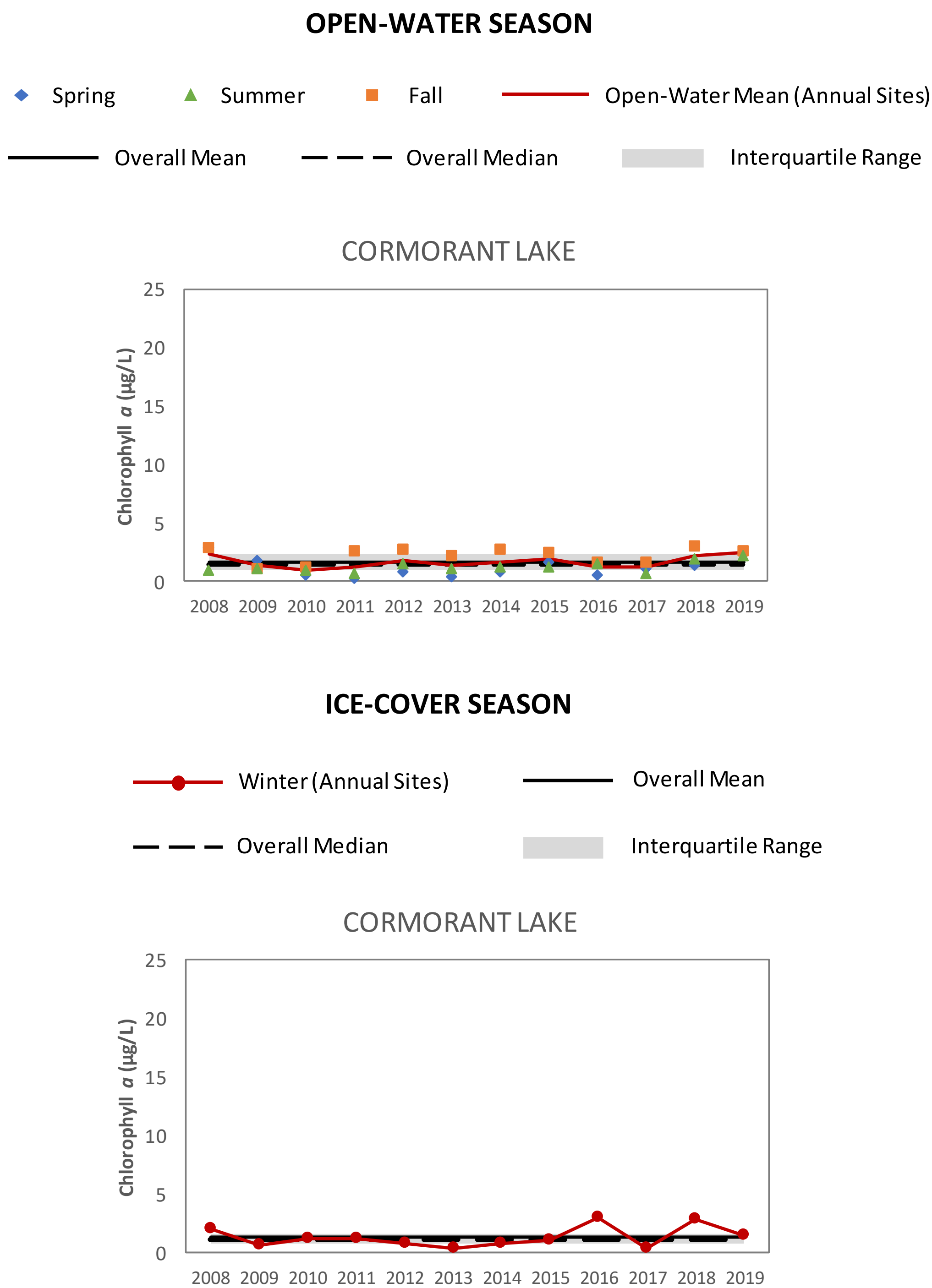


Figure 3.4-11. 2008-2019 Off-system open-water and ice-cover seasons chlorophyll *a* concentrations.

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

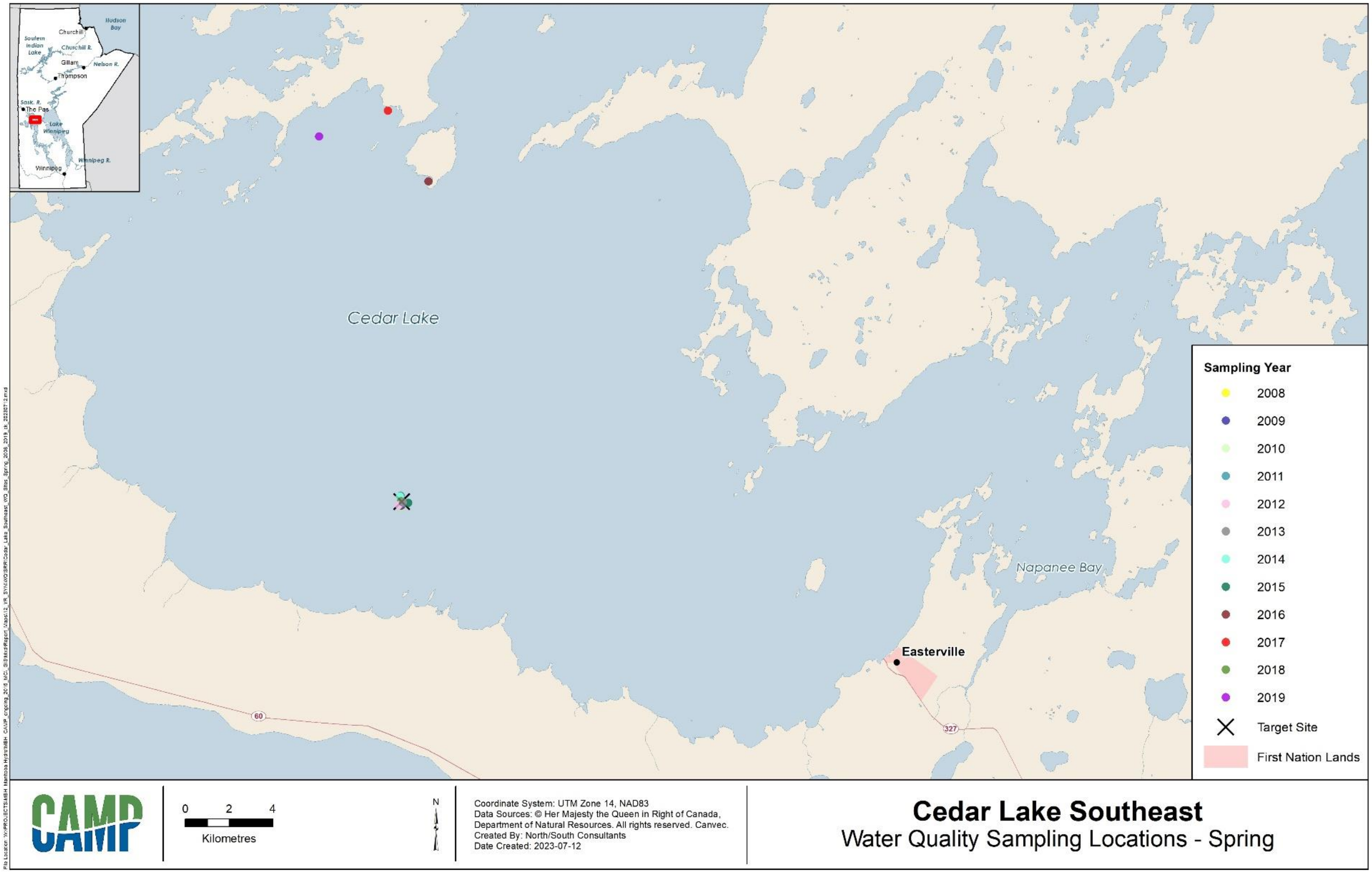


Figure A3-1-1. Spring water quality sampling locations: Cedar Lake - Southeast.

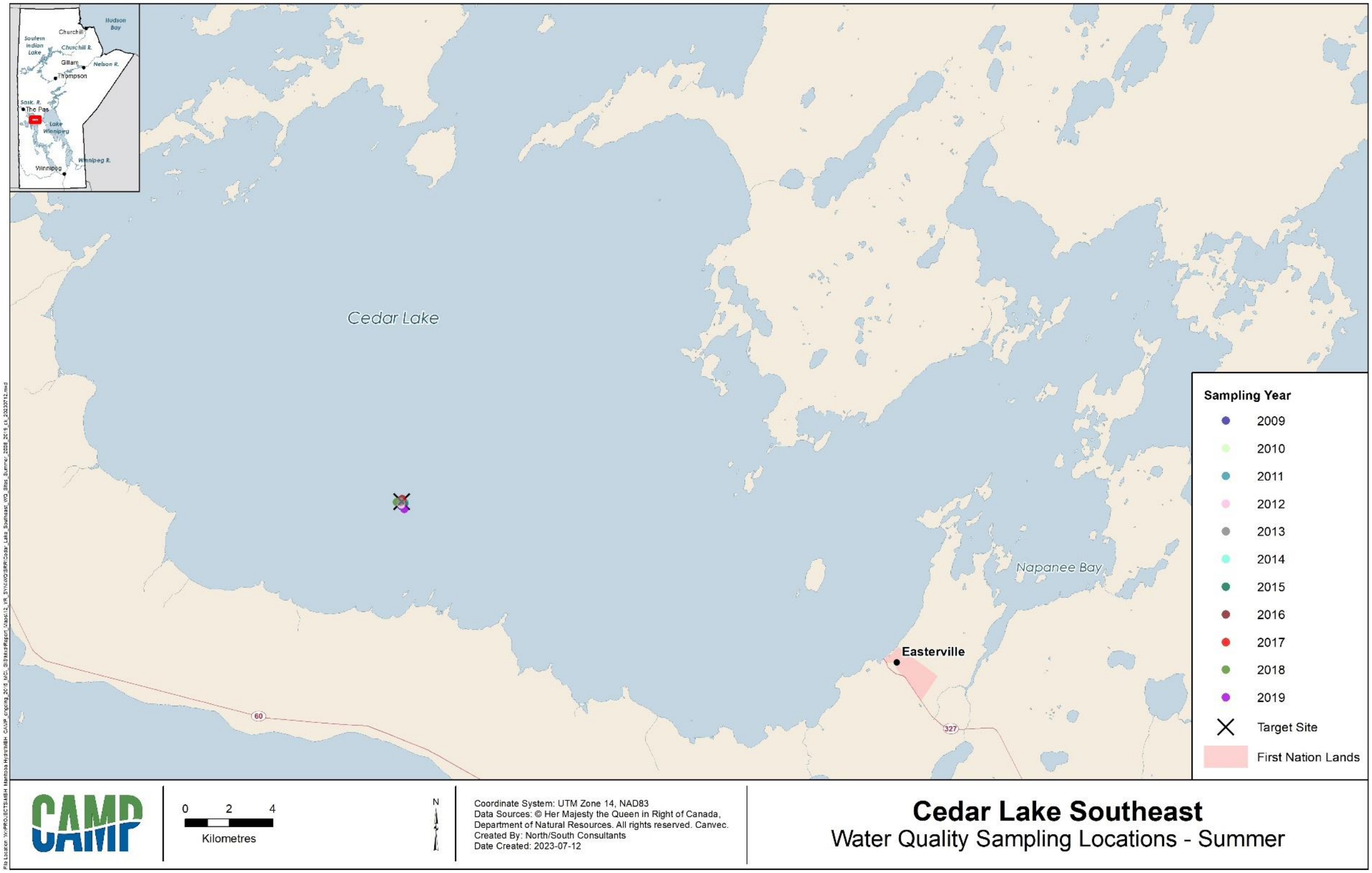


Figure A3-1-2. Summer water quality sampling locations: Cedar Lake - Southeast.

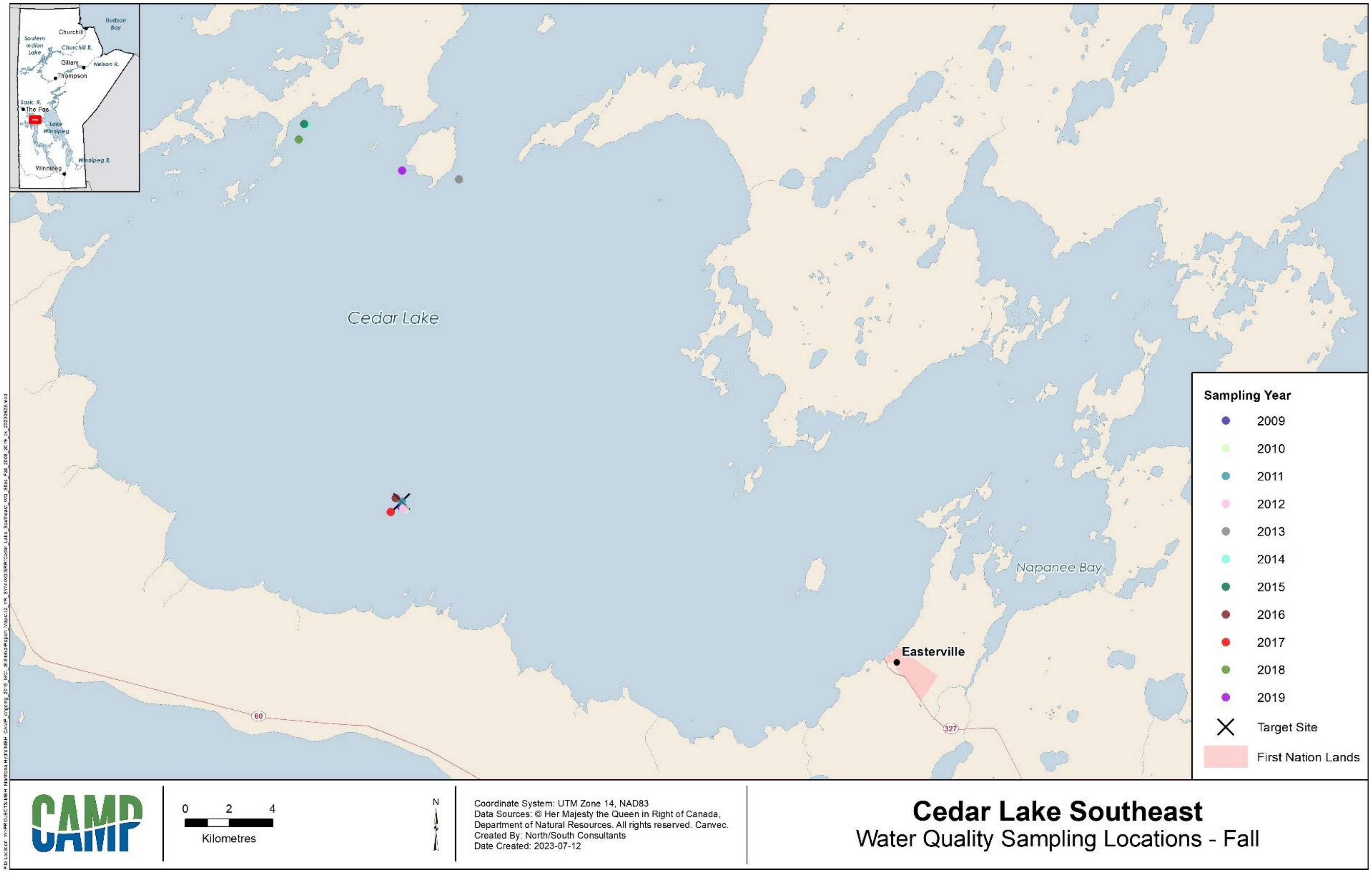


Figure A3-1-3. Fall water quality sampling locations: Cedar Lake - Southeast.

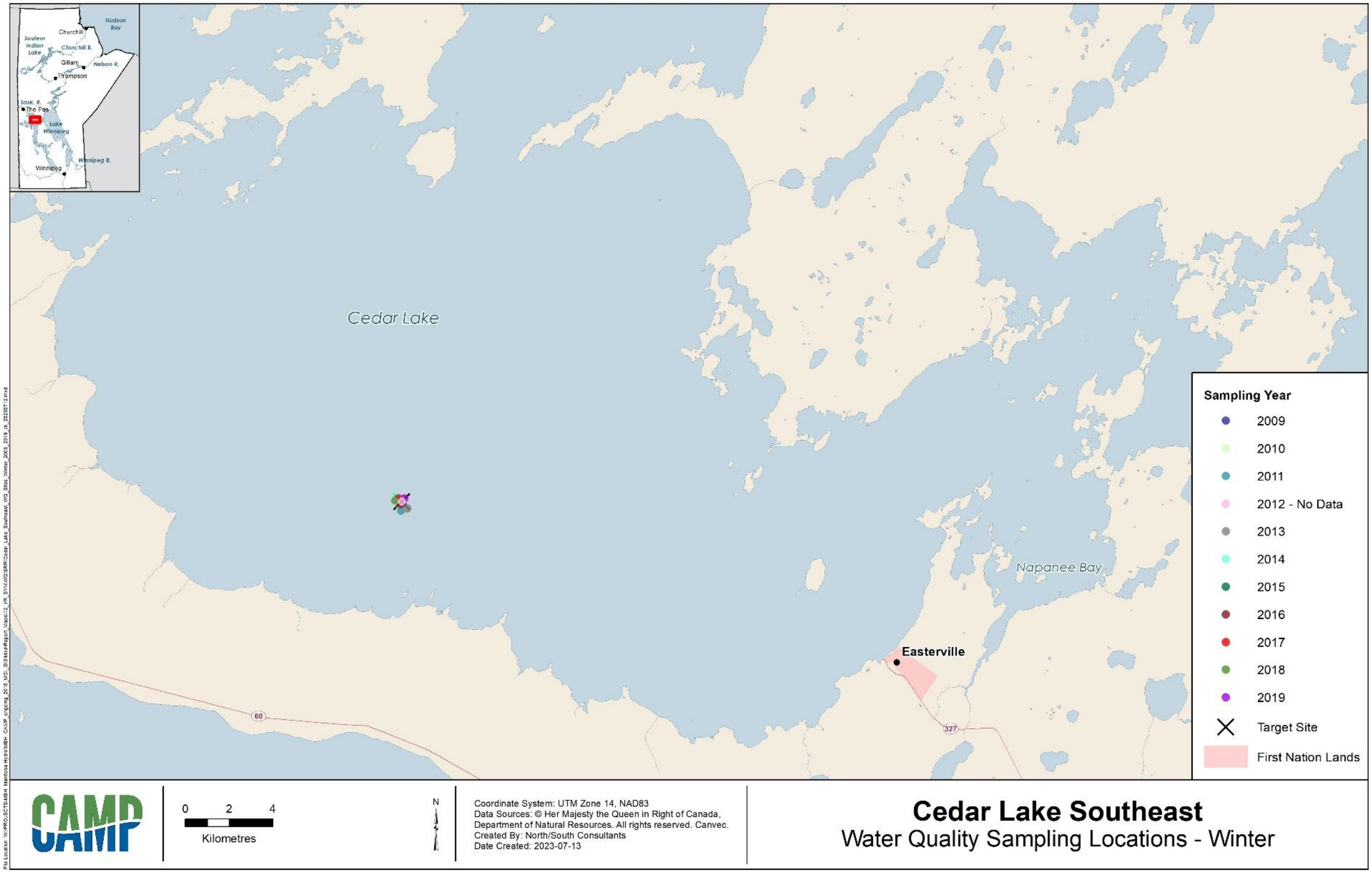


Figure A3-1-4. Winter water quality sampling locations: Cedar Lake - Southeast.

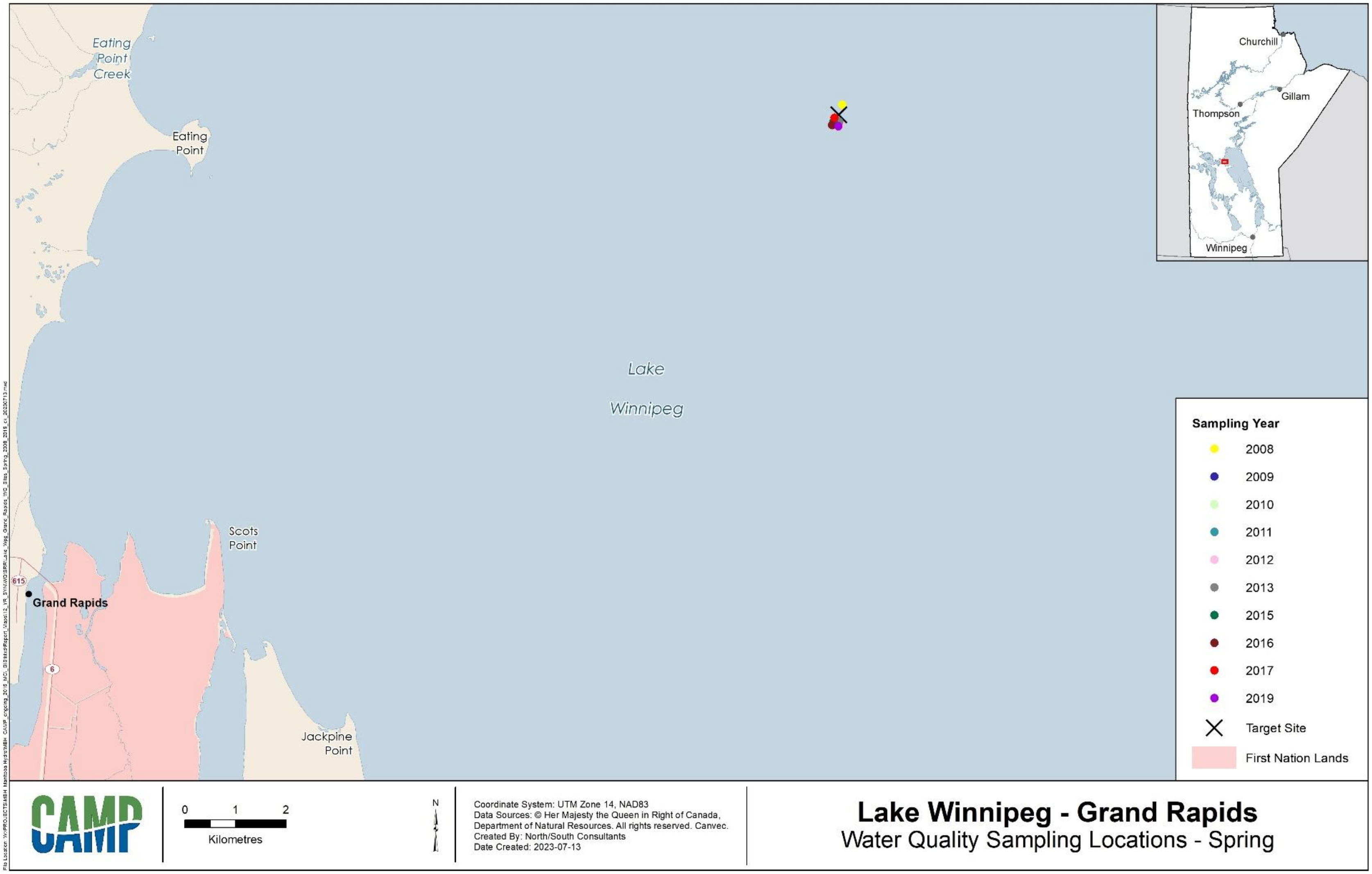


Figure A3-1-5. Spring water quality sampling locations: Lake Winnipeg – Grand Rapids.

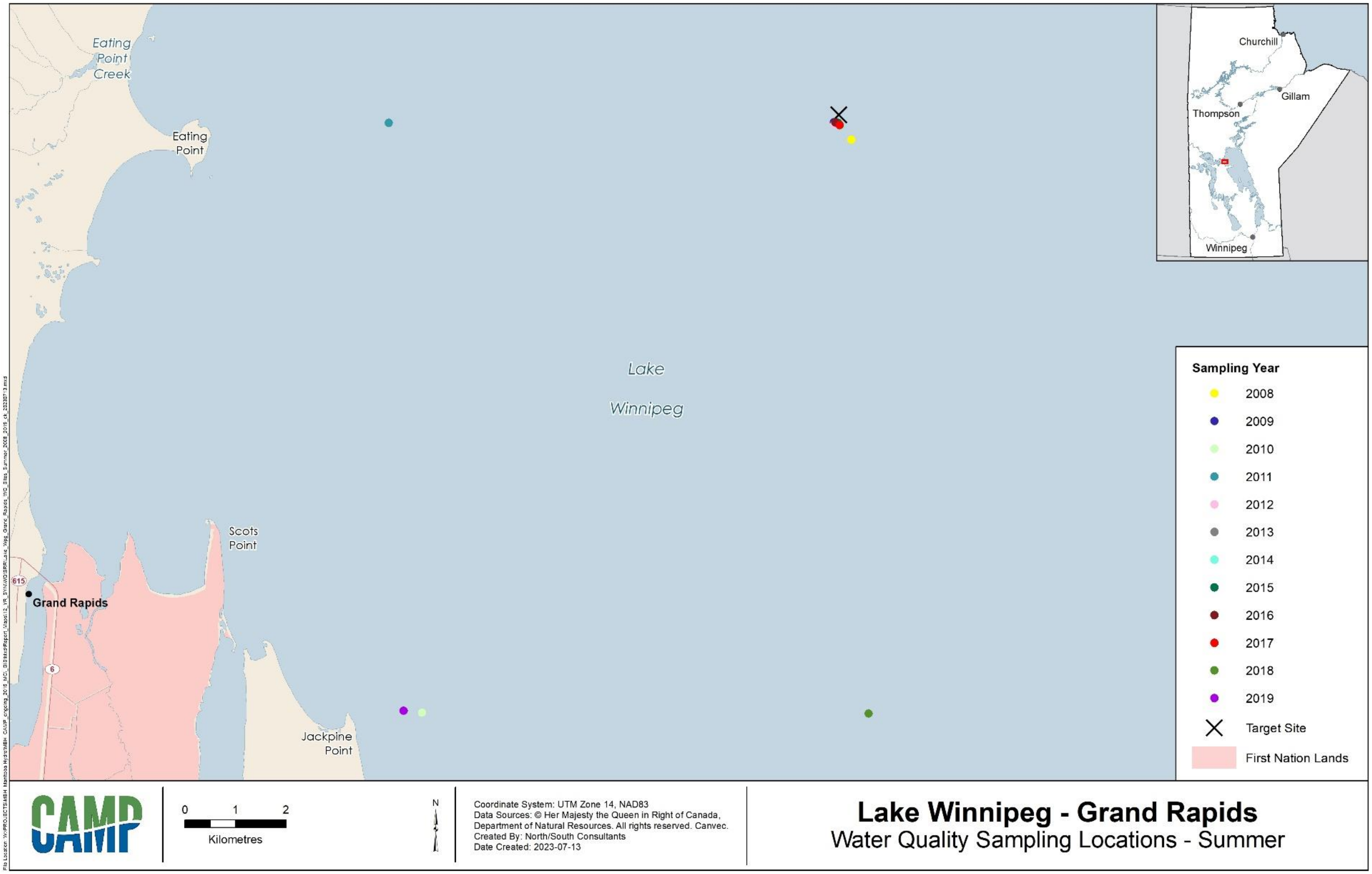


Figure A3-1-6. Summer water quality sampling locations: Lake Winnipeg – Grand Rapids.

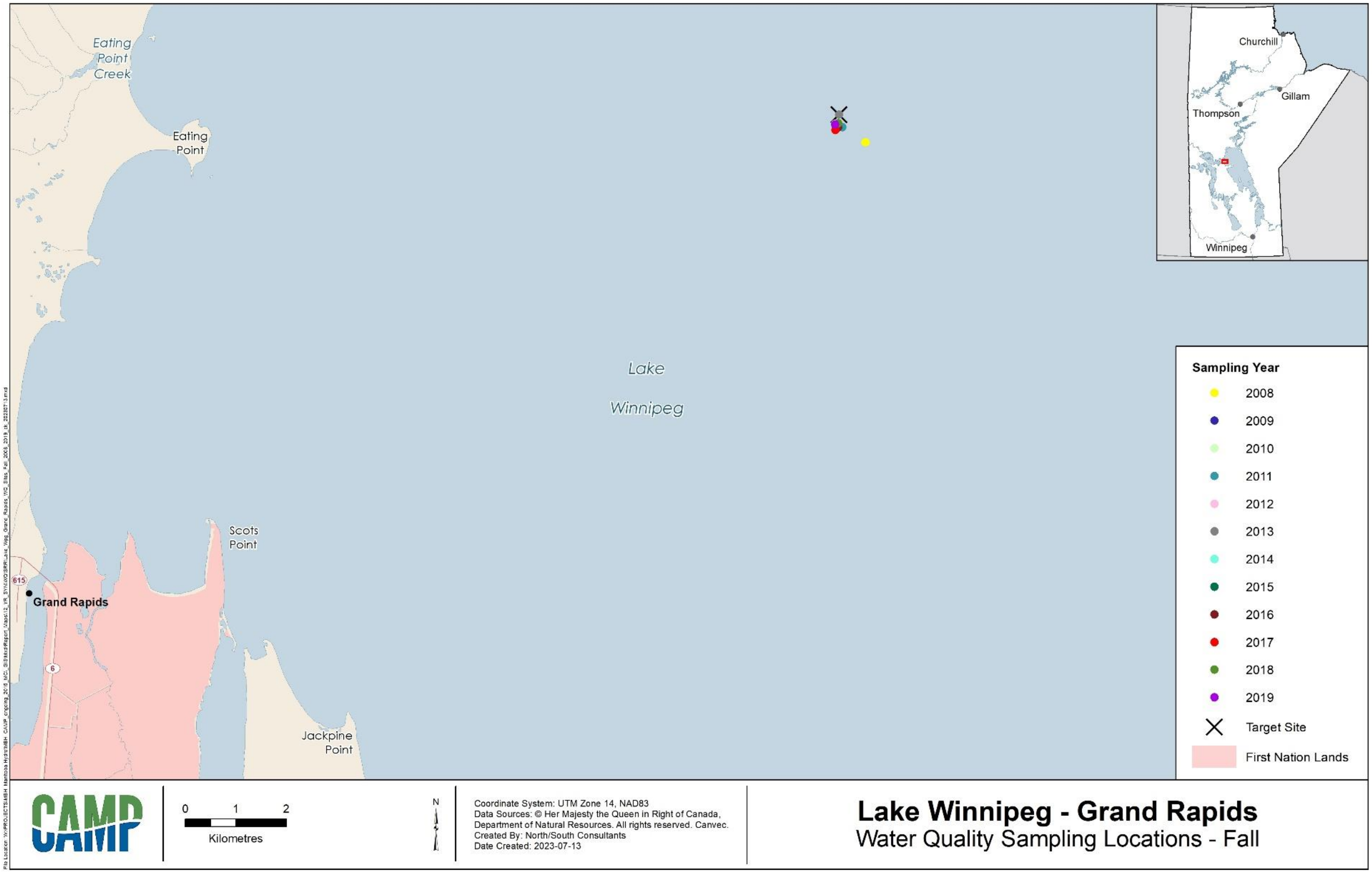


Figure A3-1-7. Fall water quality sampling locations: Lake Winnipeg – Grand Rapids.

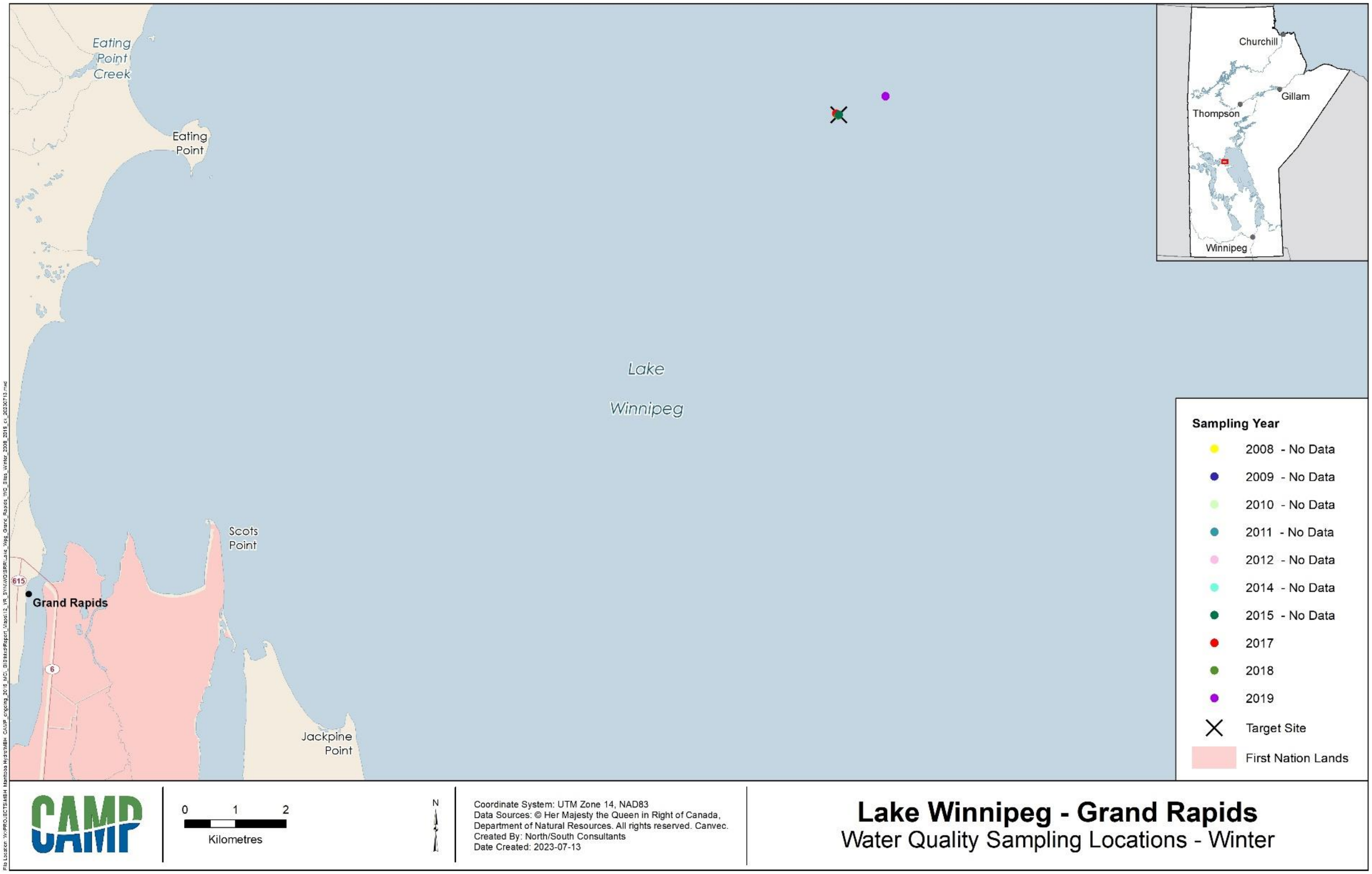


Figure A3-1-8. Winter water quality sampling locations: Lake Winnipeg – Grand Rapids.

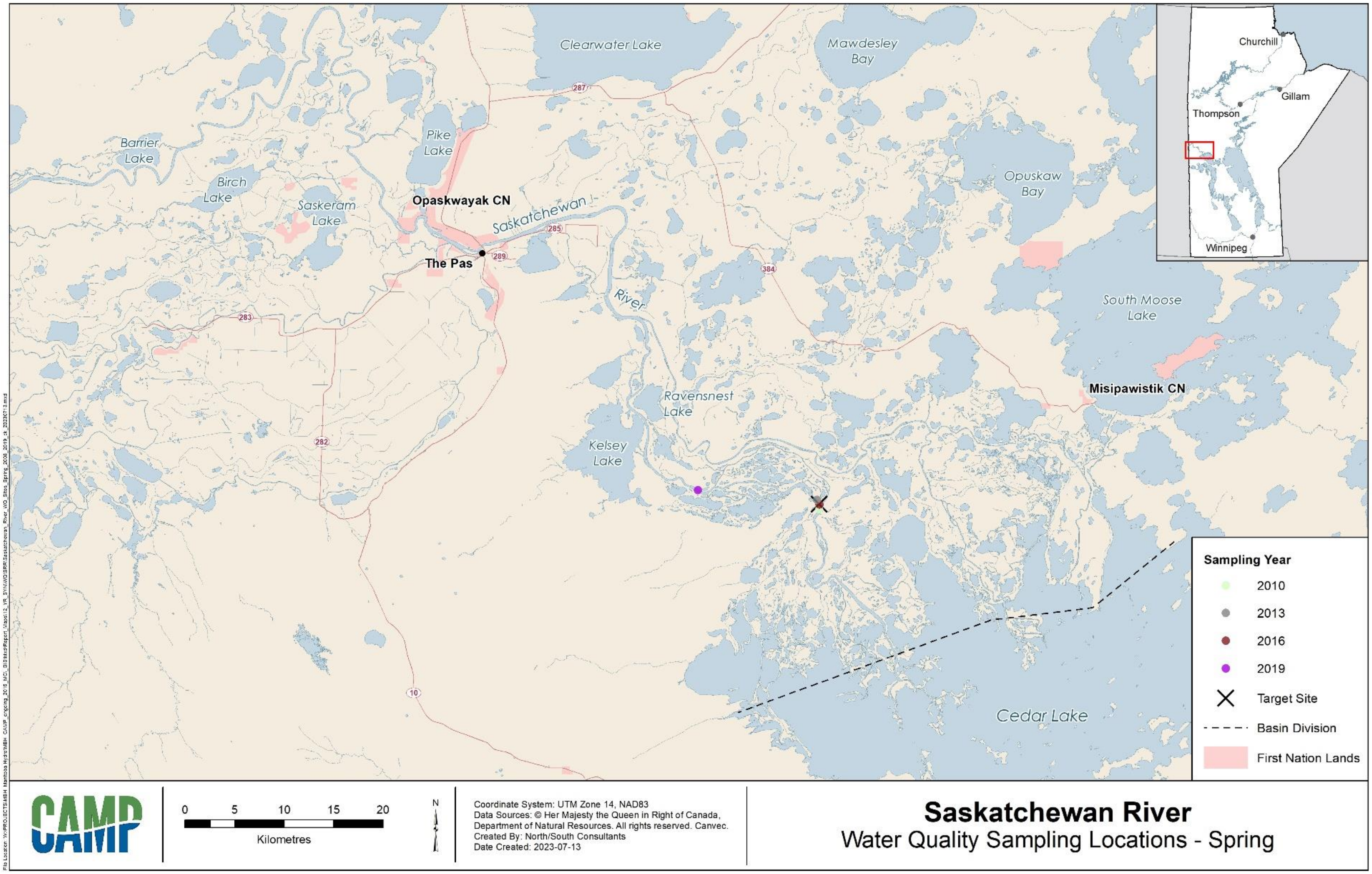


Figure A3-1-9. Spring water quality sampling locations: the Saskatchewan River.

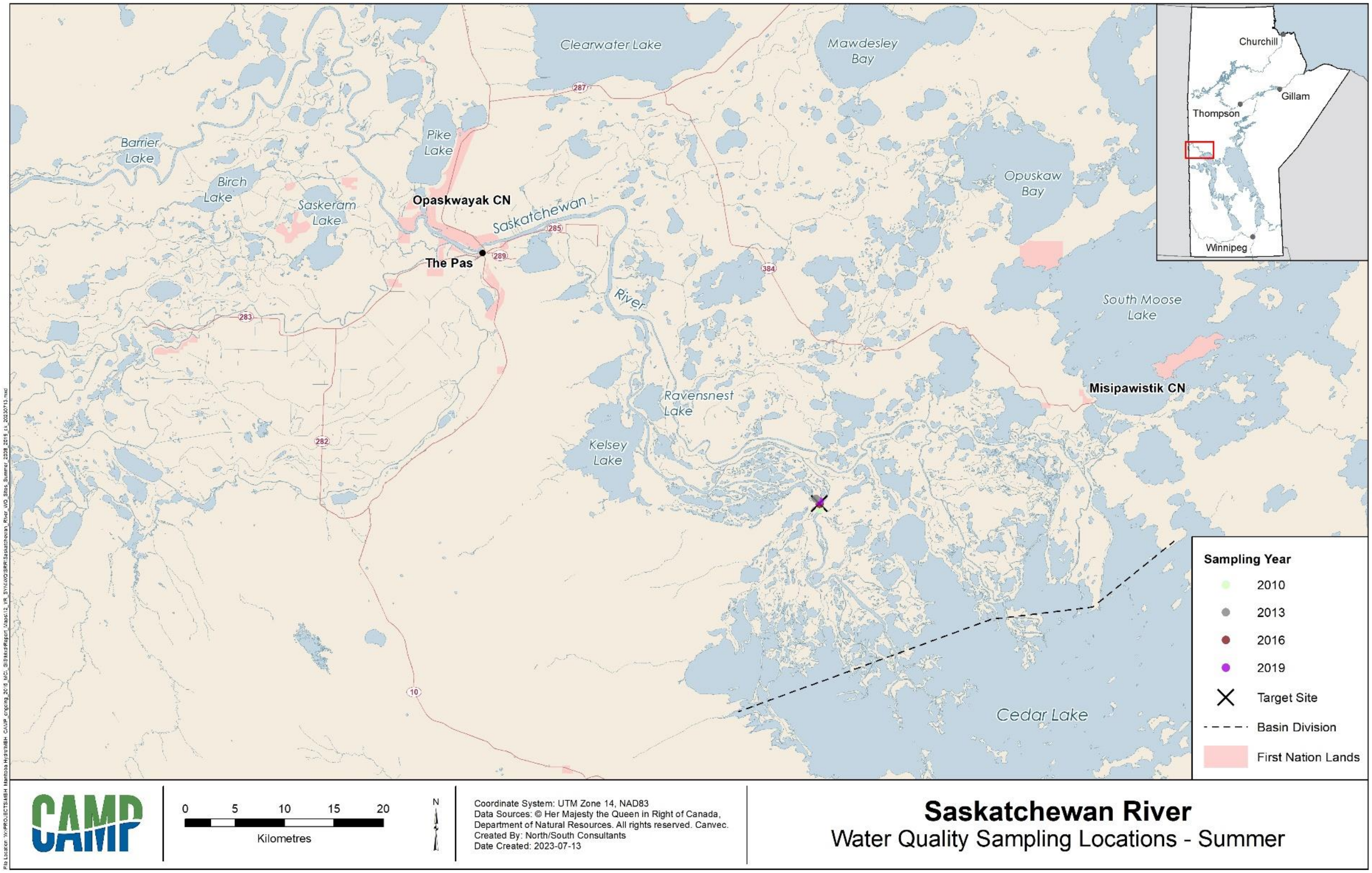


Figure A3-1-10. Summer water quality sampling locations: the Saskatchewan River.

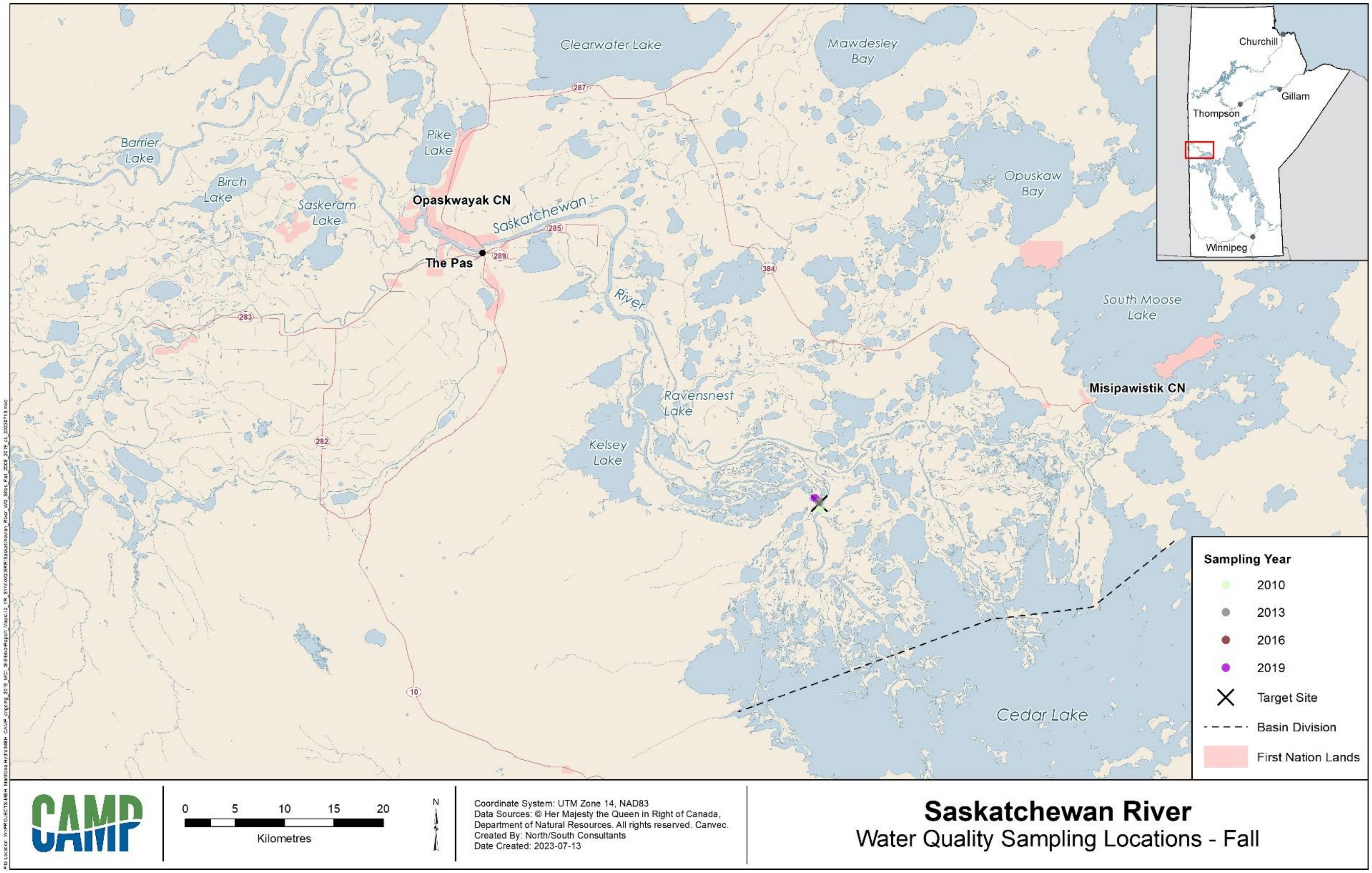


Figure A3-1-11. Fall water quality sampling locations: the Saskatchewan River.

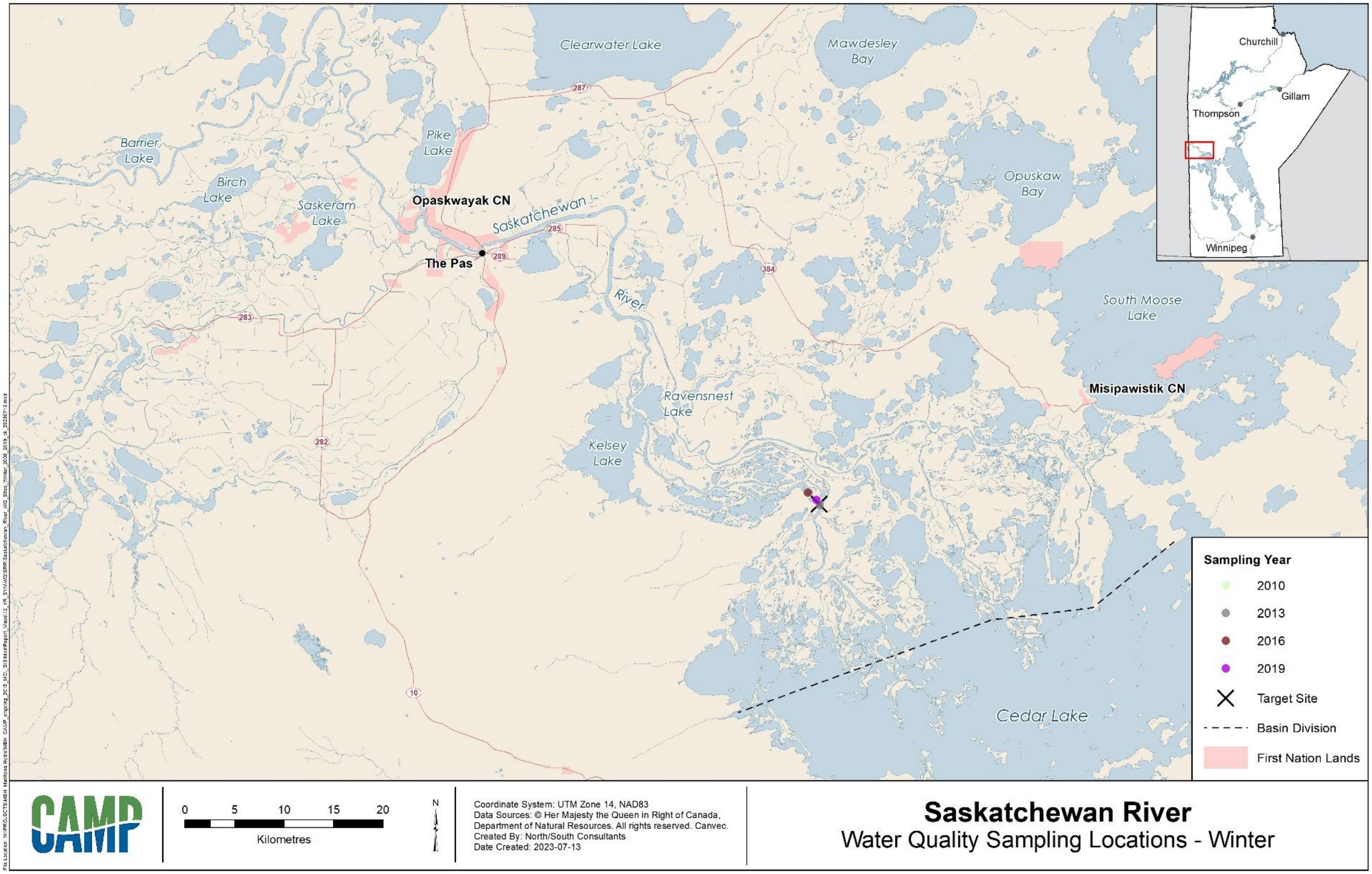


Figure A3-1-12. Winter water quality sampling locations: the Saskatchewan River.

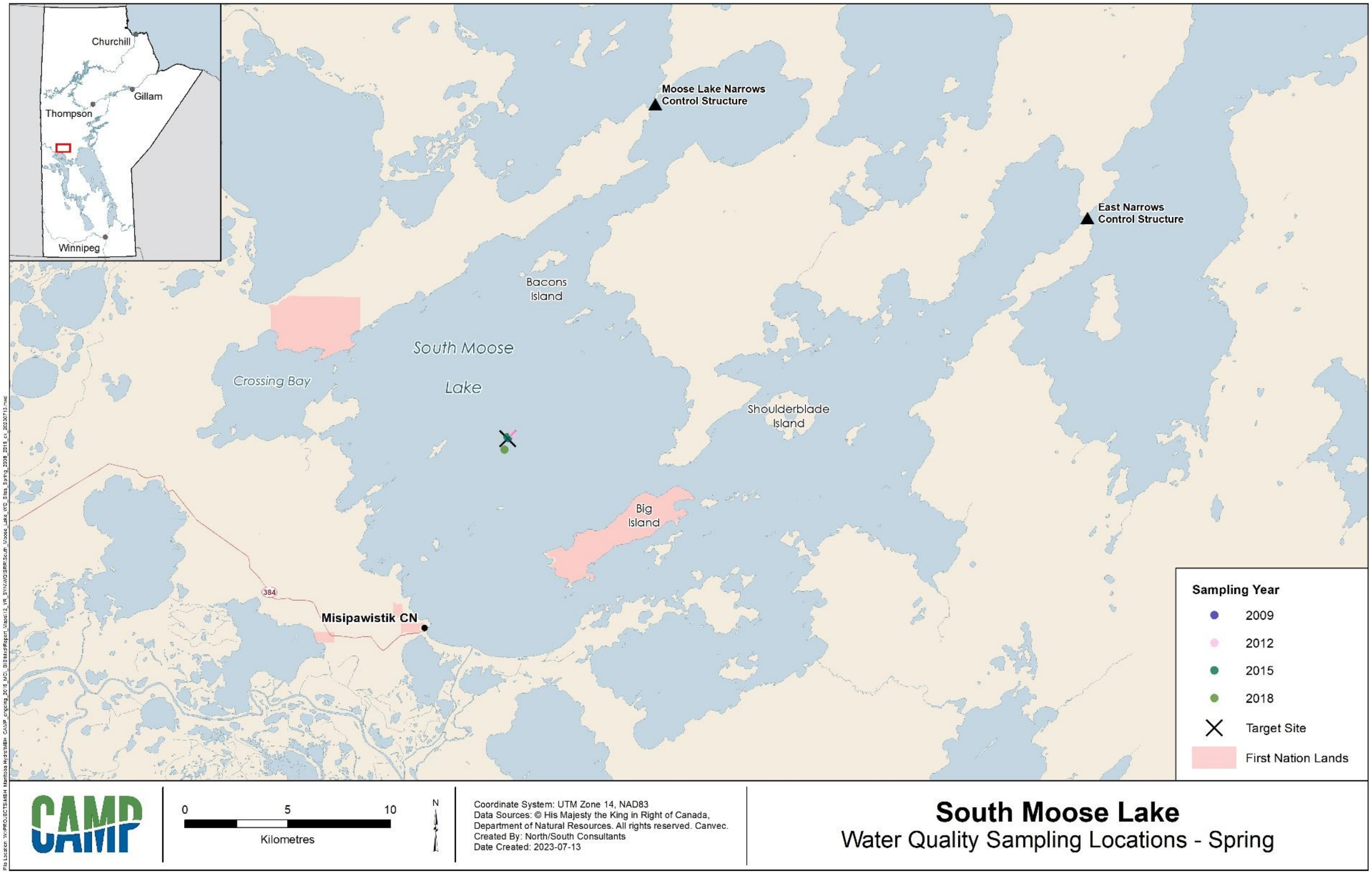


Figure A3-1-13. Spring water quality sampling locations: South Moose Lake.

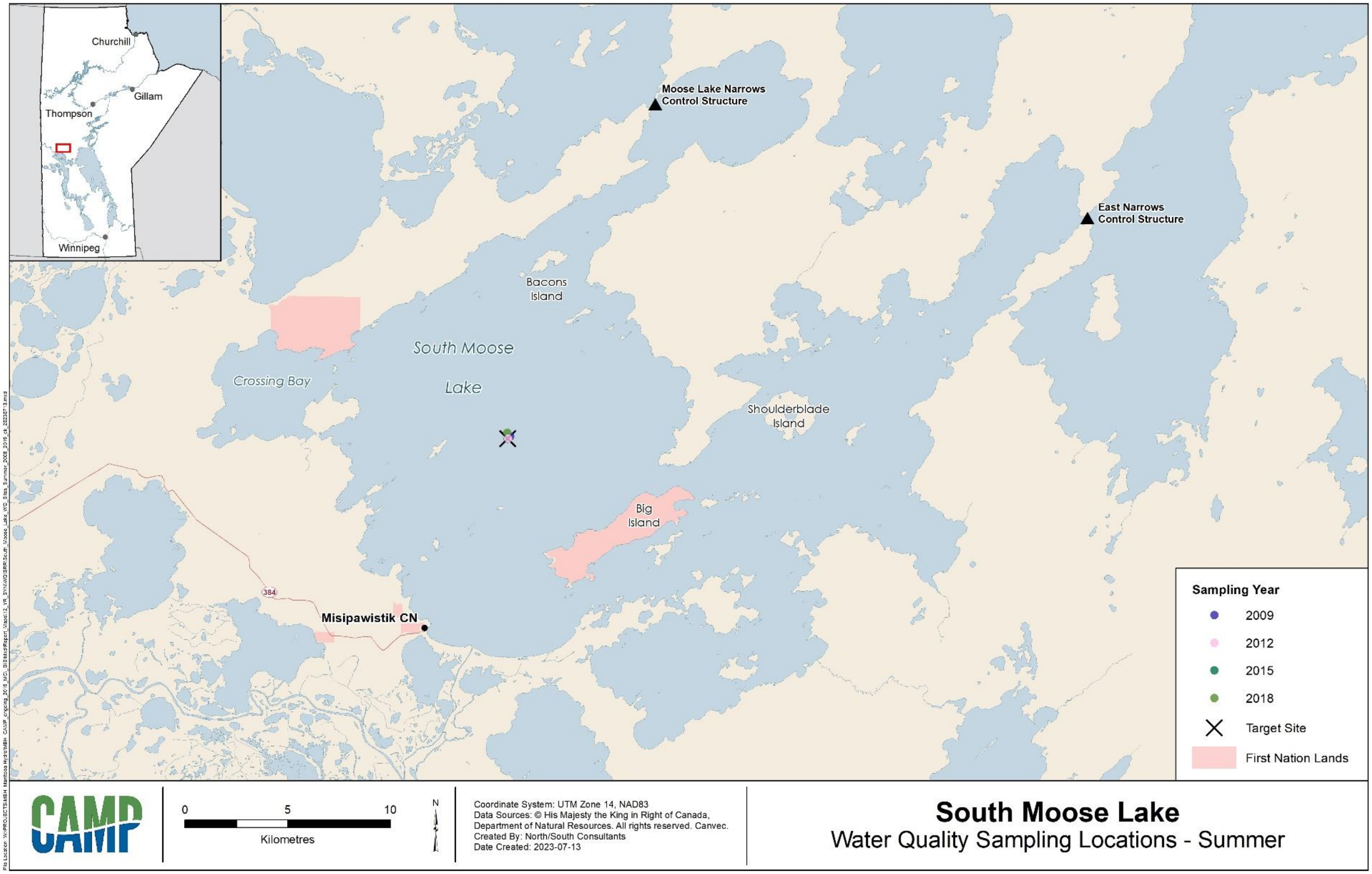


Figure A3-1-14. Summer water quality sampling locations: South Moose Lake.

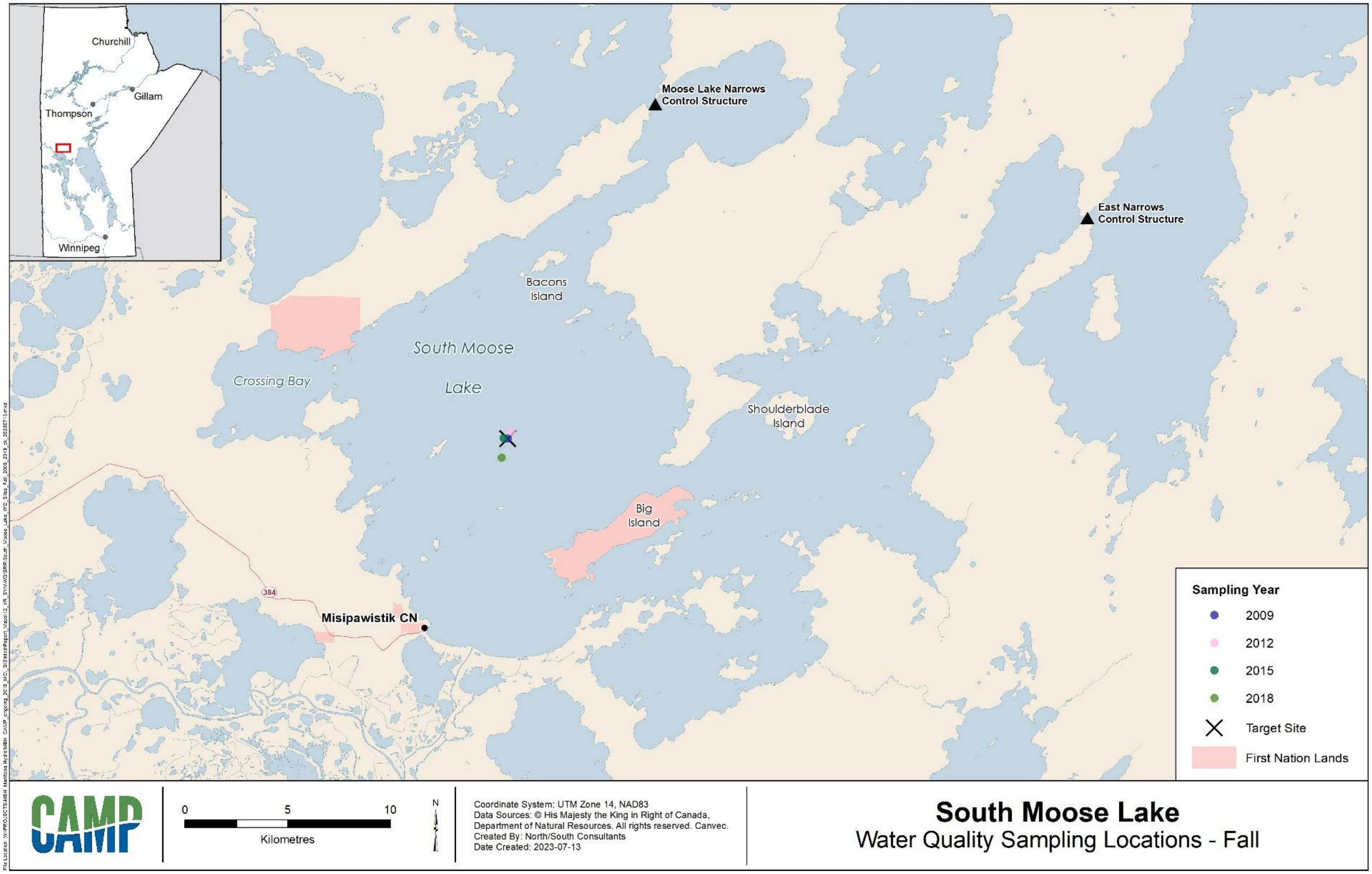


Figure A3-1-15. Fall water quality sampling locations: South Moose Lake.

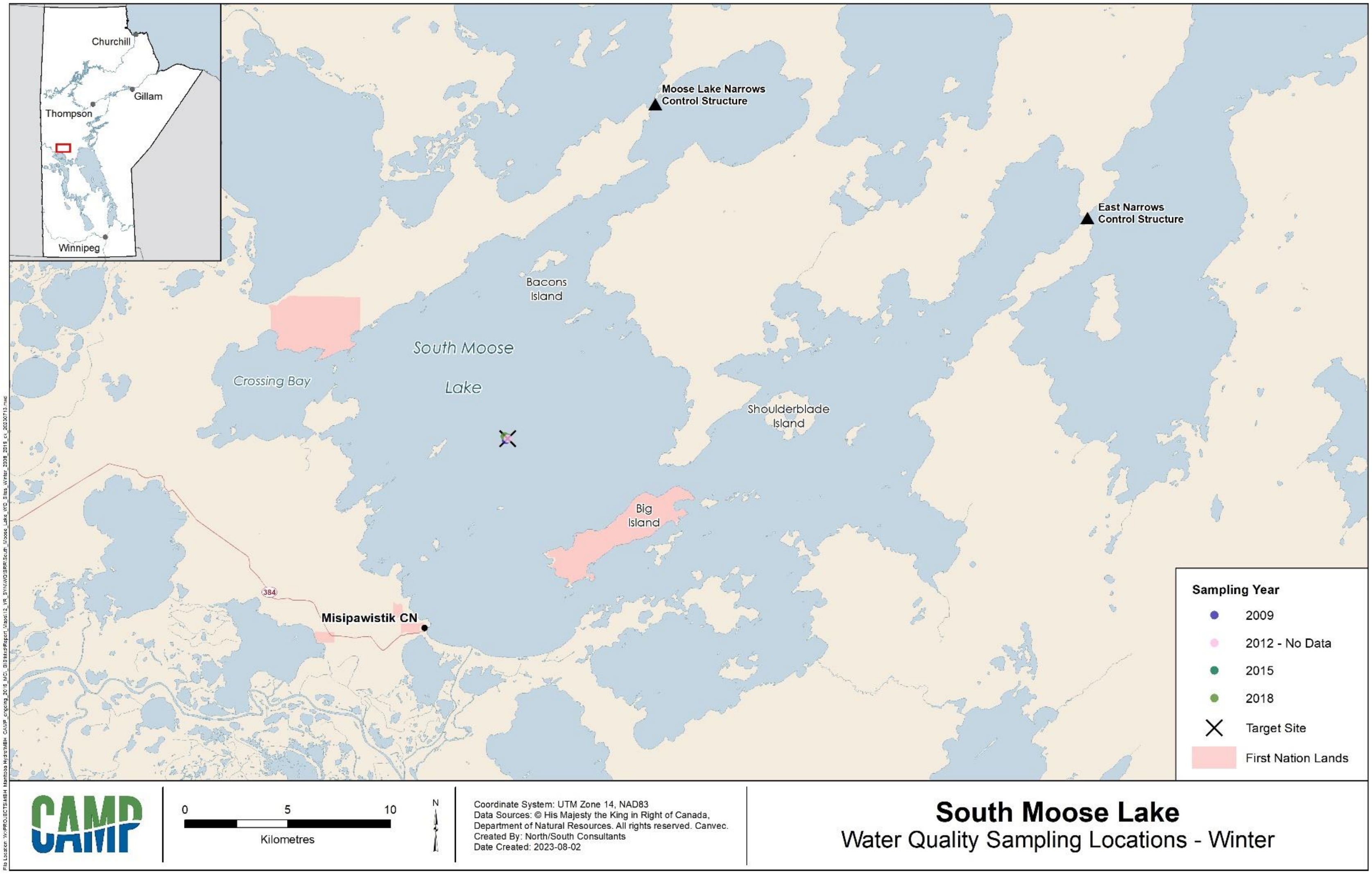


Figure A3-1-16. Winter water quality sampling locations: South Moose Lake.

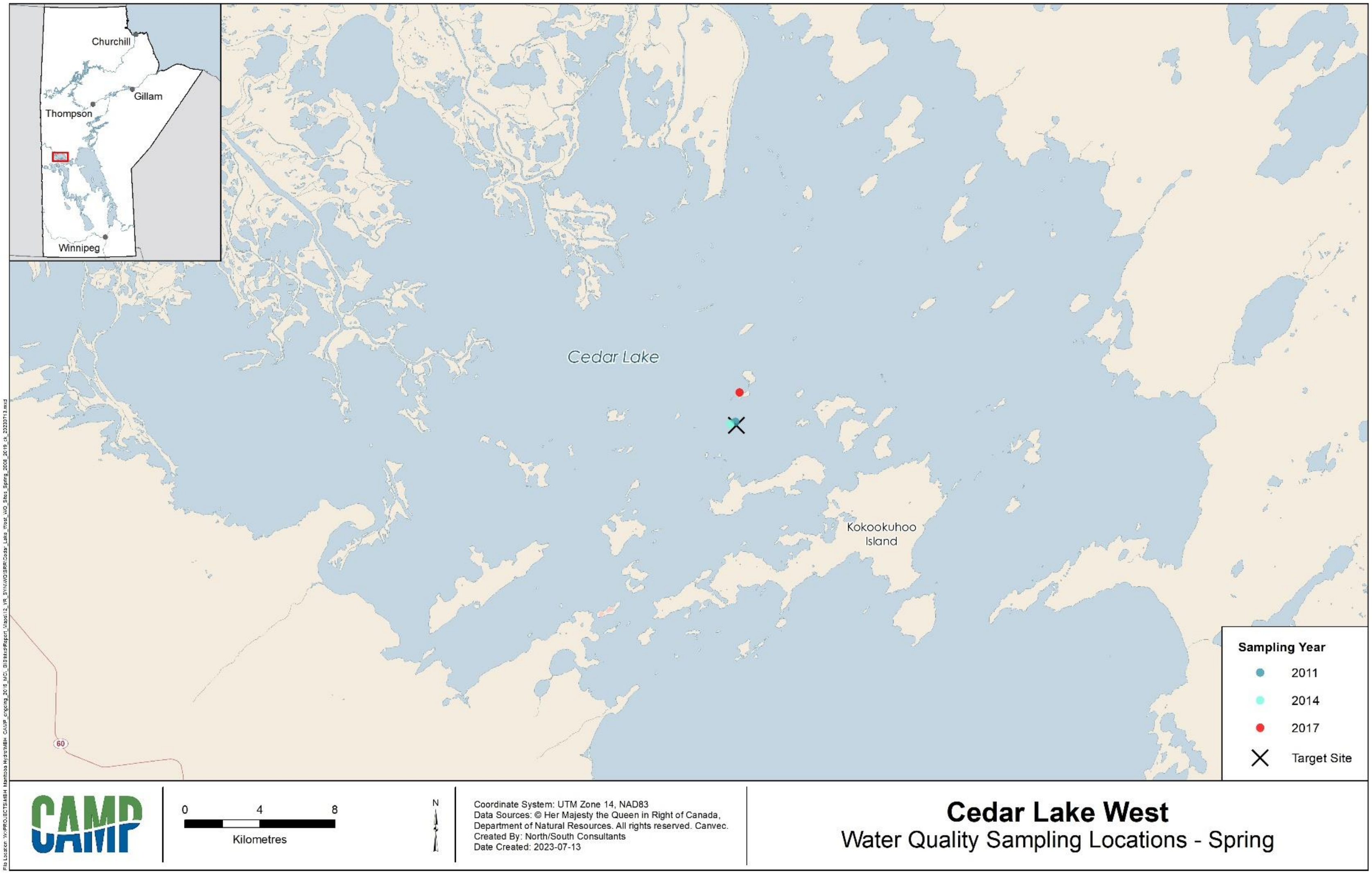


Figure A3-1-17. Spring water quality sampling locations: Cedar Lake - West.

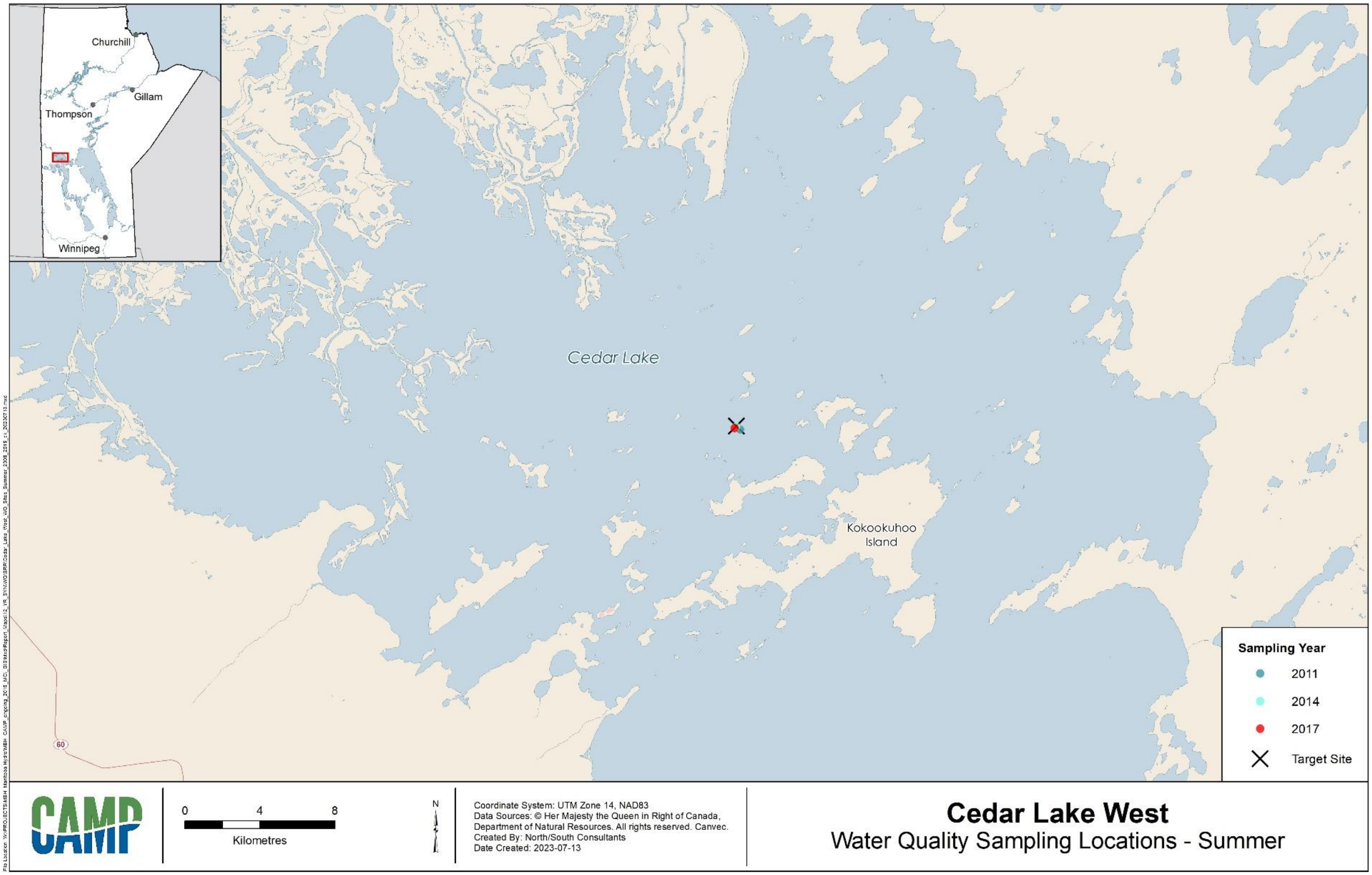


Figure A3-1-18. Summer water quality sampling locations: Cedar Lake - West.

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

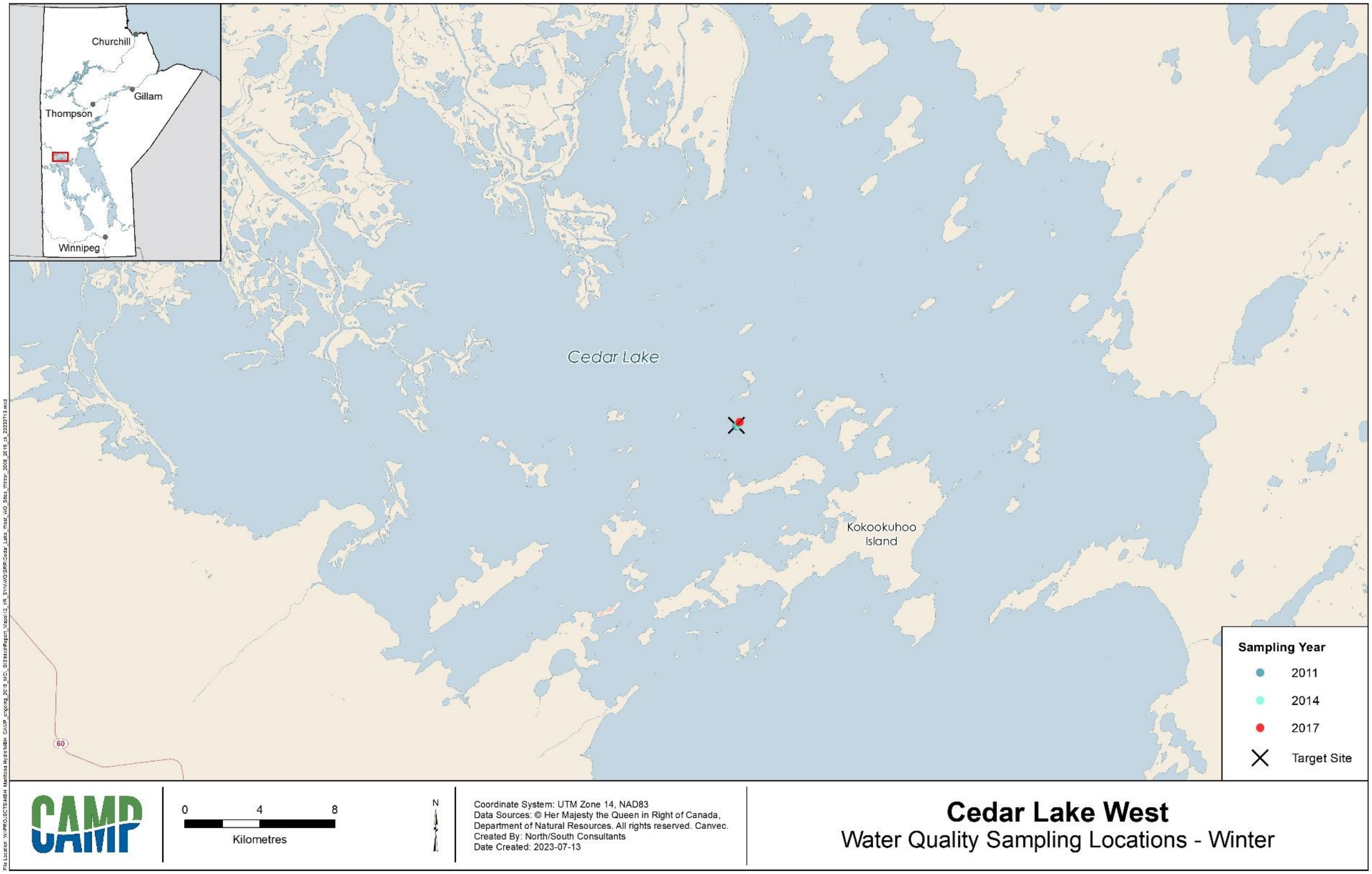


Figure A3-1-20. Winter water quality sampling locations: Cedar Lake - West.

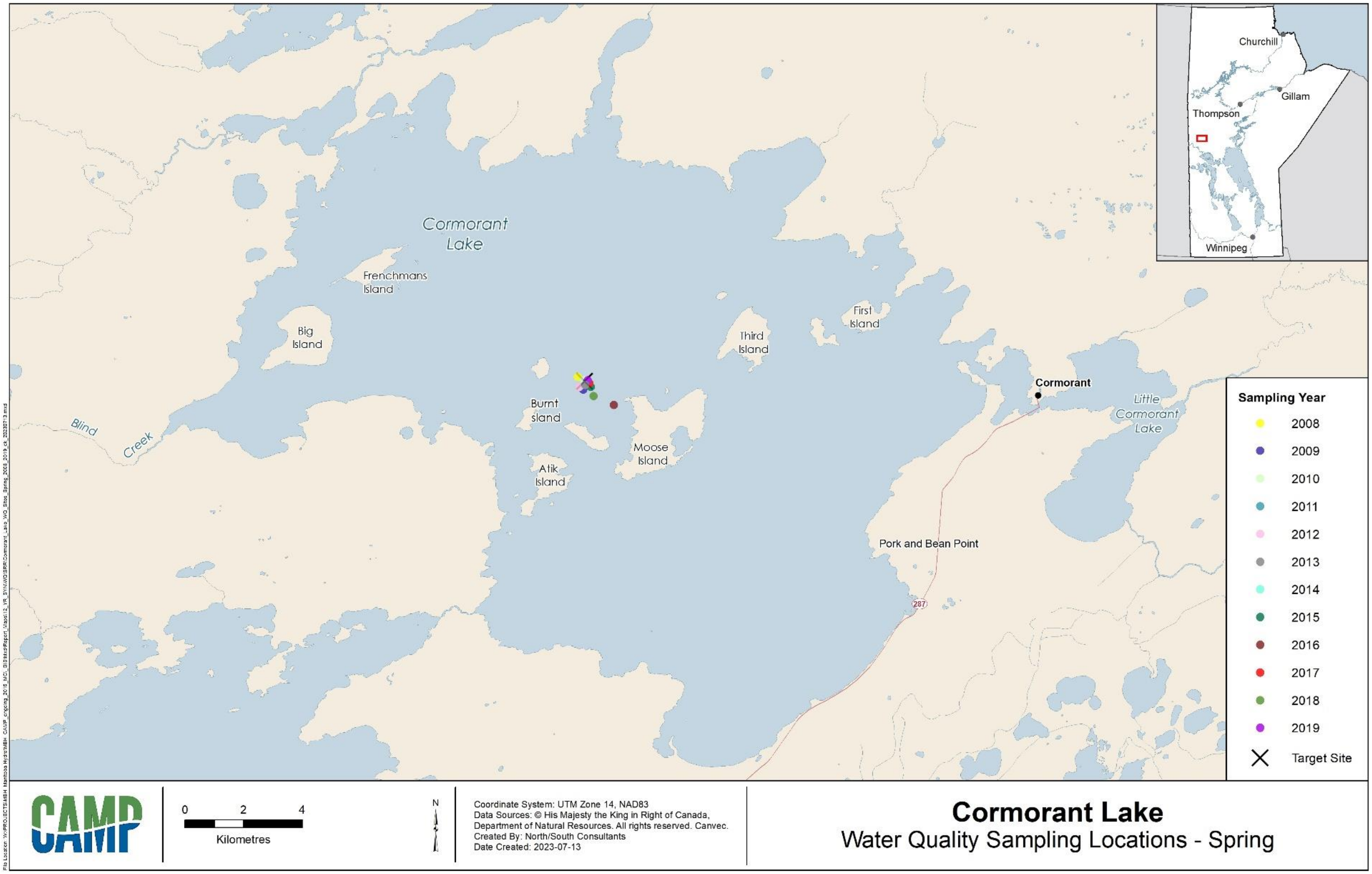


Figure A3-1-21. Spring water quality sampling locations: Cormorant Lake.

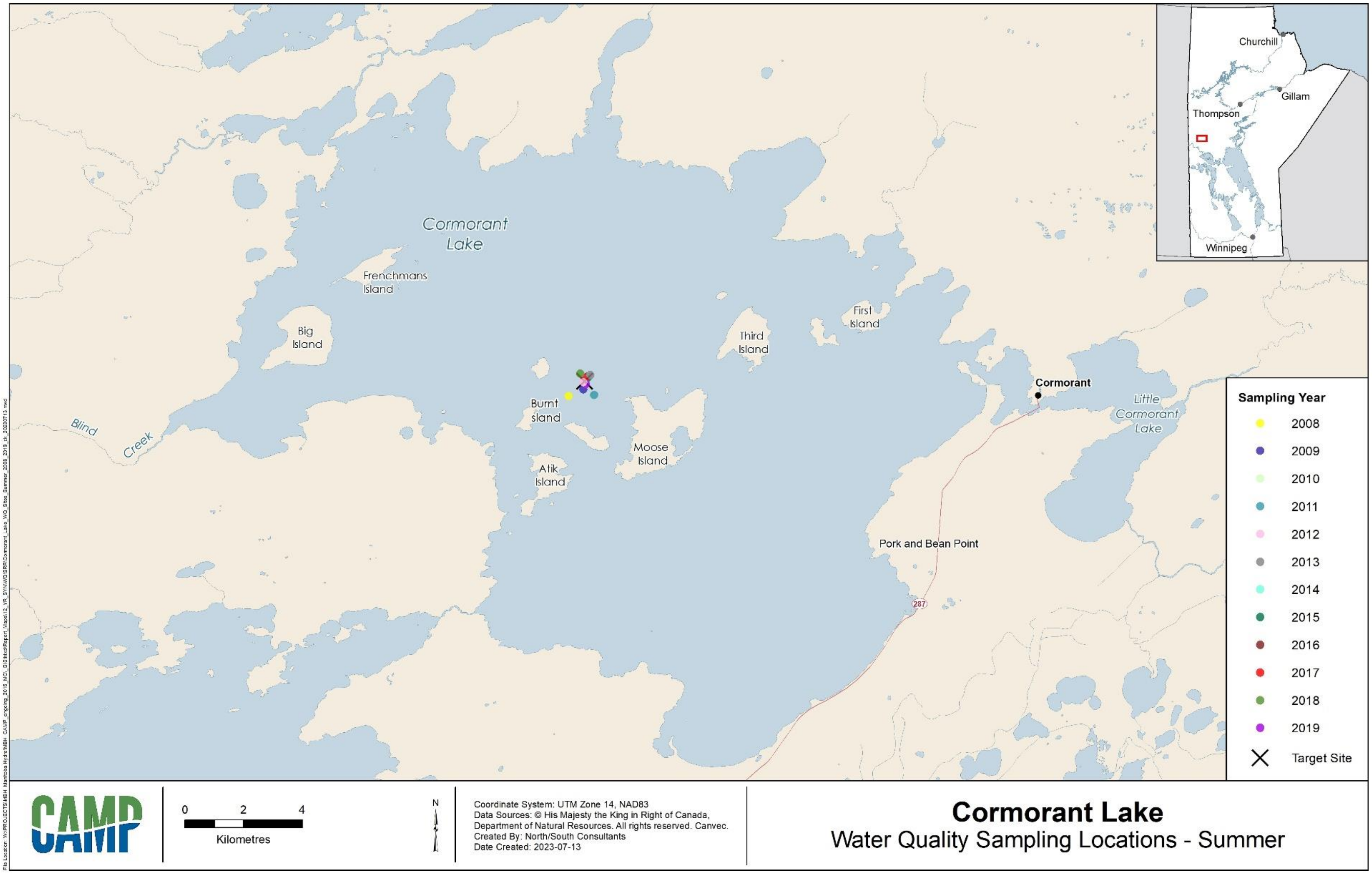


Figure A3-1-22. Summer water quality sampling locations: Cormorant Lake.

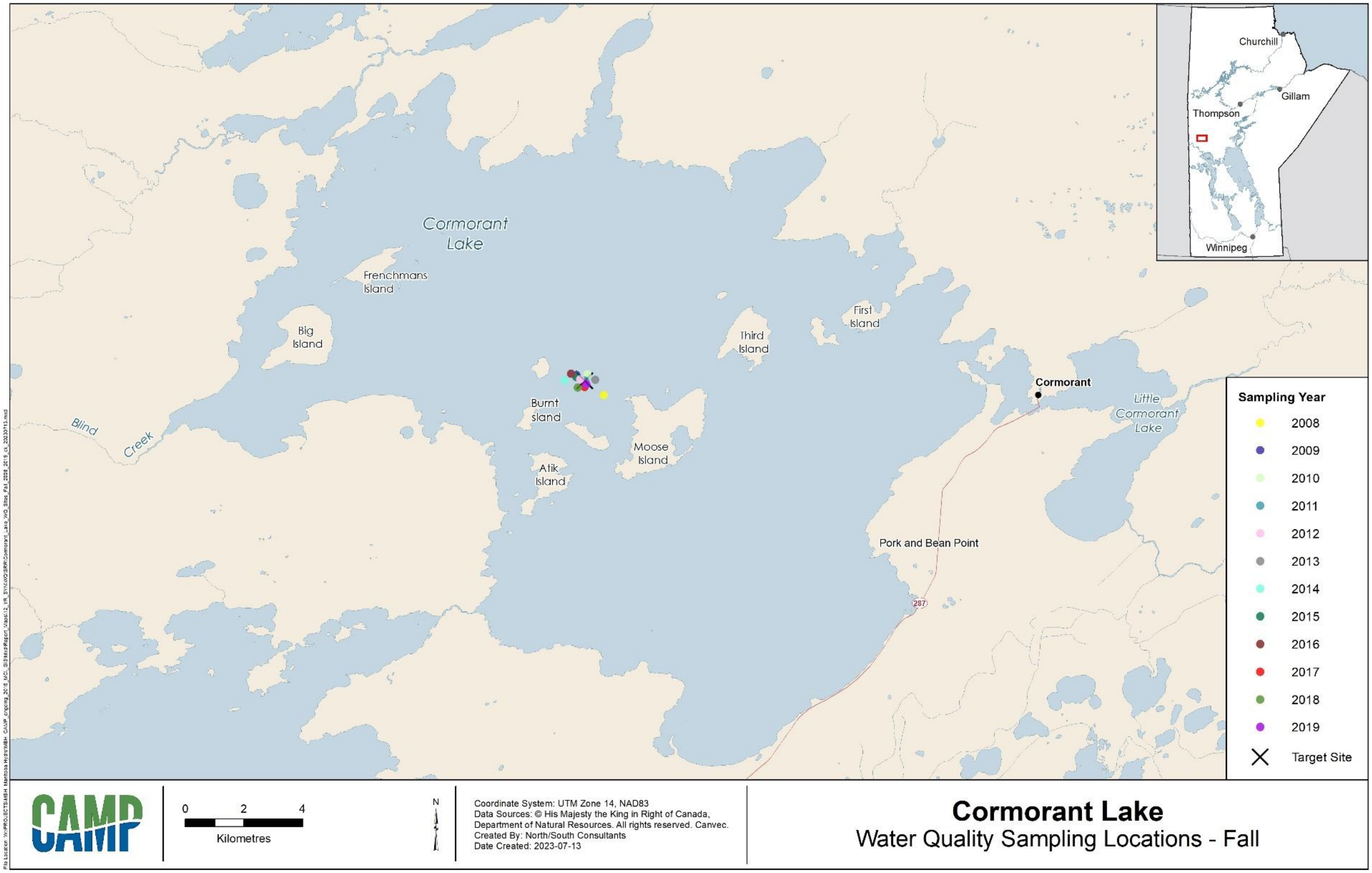


Figure A3-1-23. Fall water quality sampling locations: Cormorant Lake.

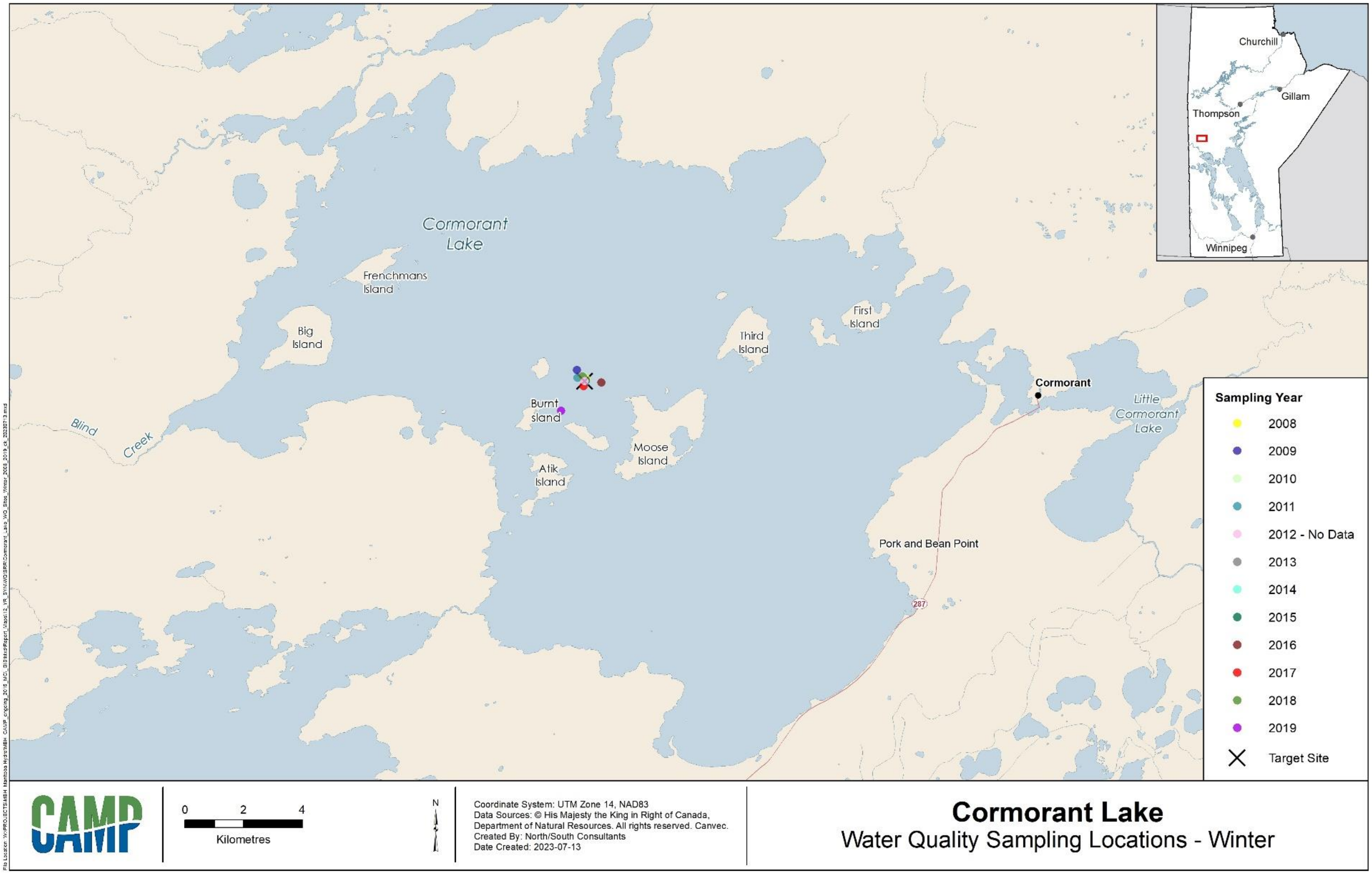


Figure A3-1-24. Winter water quality sampling locations: Cormorant Lake.

4.0 BENTHIC INVERTEBRATES

4.1 INTRODUCTION

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

Eight waterbodies were monitored in the Saskatchewan River Region: two on-system annual sites (Cedar Lake – Southeast and Lake Winnipeg – Grand Rapids); three on-system rotational sites (the Saskatchewan River, South Moose Lake, and Cedar Lake - West); and one off-system annual site (Cormorant Lake; Table 4.1-1 and Figure 4.1-1). Annual sampling at the on-system Lake Winnipeg – Grand Rapids site began in 2013 and is described based on seven years of monitoring data.

Two sampling polygons (nearshore and offshore) defined by water depth, flow, and substrate composition were sampled in each waterbody in late summer/fall per year (Appendix 4-1). 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, with the following exception:

- Over the four years of monitoring (2010, 2013, 2016, and 2019), the Saskatchewan River nearshore polygon was sampled with a benthic grab instead of a kick net sampler because most of the shoreline is deep cut banks and not wadable.

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).

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

Site	Sampling Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CEDAR-SE		-[1]	●	●	●	●	●	●	●	●	●	●
LW-GR[2]						●	●	●	●	●	●	●
SASK[3]			●			●			●			●
SMOOSE		-[1]			●			●			●	
CEDAR-W							●			●		
CORM	-[1]	-[1]	●	●	●	●	●	●	●	●	●	●

Notes:

1. Dataset excluded from analysis and reporting due to change in sampling design in 2010.
2. Annual sampling at LW-GR began in 2013.
3. SASK nearshore polygon sampled with benthic grab due to deep cut banks at shoreline; units are no. per m^2.

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

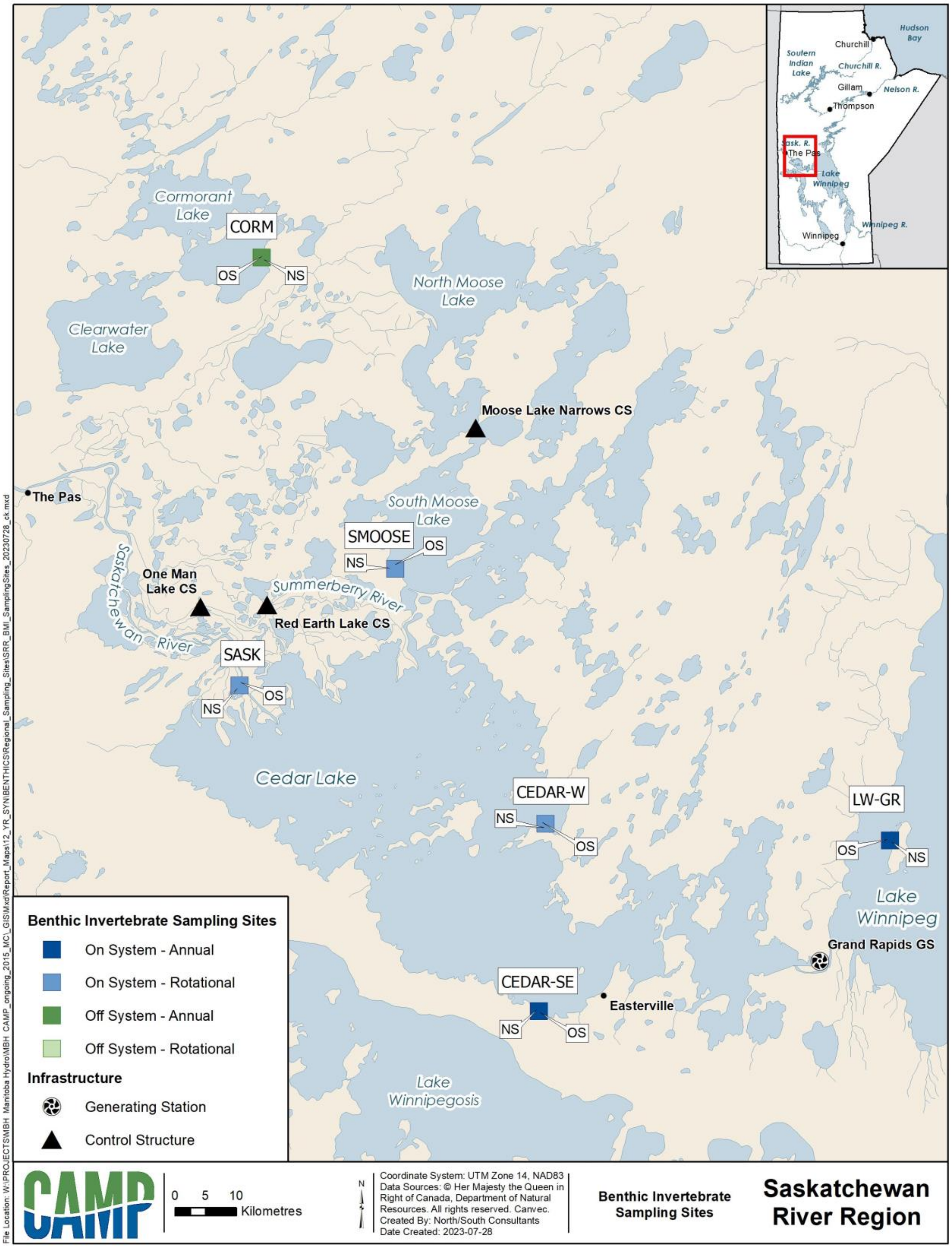


Figure 4.1-1. 2010-2019 Benthic invertebrate nearshore (NS) and offshore (OS) sampling sites

4.2 ABUNDANCE

4.2.1 TOTAL INVERTEBRATE ABUNDANCE

4.2.1.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

Nearshore Habitat

Annual mean abundance over the ten years of monitoring ranged from 1,068 invertebrates per sample (2010) to 8,171 invertebrates per sample (2015; Figure 4.2-1). The overall mean abundance was 3,897 invertebrates per sample, the overall median abundance was 2,972 invertebrates per sample, and the IQR was 1,679 to 4,369 invertebrates per sample. Annual means were below the IQR in 2010 and 2013, and above the IQR in 2015, 2017 and 2019.

Offshore Habitat

Annual mean abundance (density) over the ten years of monitoring ranged from 4,011 invertebrates per m^2 (2013) to 17,379 invertebrates per m^2 (2015; Figure 4.2-2). The overall mean abundance was 10,592 invertebrates per m^2, the overall median abundance was 9,457 invertebrates per m^2, and the IQR was 6,680 to 14,298 invertebrates per m^2. Annual means were below the IQR in 2010 and 2013, and above the IQR from 2014, 2015, and 2016.

Lake Winnipeg – Grand Rapids

Nearshore Habitat

Annual mean abundance over the seven years of monitoring ranged from 5,453 invertebrates per sample (2018) to 60,092 invertebrates per sample (2015; Figure 4.2-1). The overall mean abundance was 20,619 invertebrates per sample, the overall median abundance was 12,225 invertebrates per sample, and the IQR was 6,574 to 18,822 invertebrates per sample. Annual means were below the IQR in 2018, and above the IQR in 2013 and 2015.

Offshore Habitat

Annual mean abundance (density) over the seven years of monitoring ranged from 6,152 invertebrates per m^2 (2018) to 19,846 invertebrates per m^2 (2015; Figure 4.2-2). The overall mean abundance was 10,626 invertebrates per m^2, the overall median abundance was 9,551 invertebrates per m^2, and the IQR was 7,387 to 11,686 invertebrates per m^2. Annual means were below the IQR in 2018, and above the IQR in 2015 and 2019.

ROTATIONAL SITES

Saskatchewan River

Nearshore Habitat

Annual mean abundance (density) over the four years of monitoring ranged from 1,925 invertebrates per m^2 (2016) to 4,969 invertebrates per m^2 (2019; Figure 4.2-1). The overall mean abundance was 3,004 invertebrates per m^2, the overall median abundance was 2,424 invertebrates per m^2, and the IQR was 1,749 to 3,441 invertebrates per m^2. Annual means were within the IQR, except in 2019 (above).

Offshore Habitat

Annual mean abundance (density) over the four years of monitoring ranged from 912 invertebrates per m^2 (2010) to 2,285 invertebrates per m^2 (2016; Figure 4.2-2). The overall mean abundance was 1,868 invertebrates per m^2, the overall median abundance was 1,493 invertebrates per m^2, and the IQR was 916 to 2,644 invertebrates per m^2. Annual means were within the IQR, except in 2010 (below).

South Moose Lake

Nearshore Habitat

Annual mean abundance over the three years of monitoring ranged from 1,530 invertebrates per sample (2018) to 2,912 invertebrates per sample (2015; Figure 4.2-1). The overall mean abundance was 2,259 invertebrates per sample, the overall median abundance was 2,046 invertebrates per sample, and the IQR was 1,300 to 2,808 invertebrates per sample. Annual means were within the IQR, except in 2015 (above).

Offshore Habitat

Annual mean abundance (density) over the three years of monitoring ranged from 1,506 invertebrates per m^2 (2018) to 2,458 invertebrates per m^2 (2015; Figure 4.2-2). The overall mean abundance was 2,020 invertebrates per m^2, the overall median abundance was 1,573 invertebrates per m^2, and the IQR was 1,378 to 2,381 invertebrates per m^2. Annual means were within the IQR, except in 2015 (above).

Cedar Lake - West

Nearshore Habitat

Annual mean abundance over the two years of monitoring ranged from 2,012 invertebrates per sample (2014) to 5,064 invertebrates per sample (2017; Figure 4.2-1). The overall mean abundance was 3,538 invertebrates per sample, the overall median abundance was 3,344 invertebrates per sample, and the IQR was 2,123 to 4,444 invertebrates per sample. Annual means were below the IQR in 2014, and above the IQR in 2017.

Offshore Habitat

Annual mean abundance (density) over the two years of monitoring ranged from 2,170 invertebrates per m^2 (2017) to 8,478 invertebrates per m^2 (2014; Figure 4.2-2). The overall mean abundance was 5,324 invertebrates per m^2, the overall median abundance was 4,545 invertebrates per m^2, and the IQR was 2,651 to 6,929 invertebrates per m^2. Annual means were below the IQR in 2017, and above the IQR in 2014.

4.2.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

Nearshore Habitat

Annual mean abundance over the ten years of monitoring ranged from 244 invertebrates per sample (2013) to 1,242 invertebrates per sample (2016; Figure 4.2-1). The overall mean abundance was 709 invertebrates per sample, the overall median abundance was 388 invertebrates per sample, and the IQR was 182 to 740 invertebrates per sample. Annual means were above the IQR in 2012, 2014, 2015, and 2016.

Offshore Habitat

Annual mean abundance (density) over the ten years of monitoring ranged from 1,195 invertebrates per m^2 (2012) to 3,018 invertebrates per m^2 (2014; Figure 4.2-2). The overall mean abundance was 2,163 invertebrates per m^2, the overall median abundance was 2,142 invertebrates per m^2, and the IQR was 1,706 to 2,712 invertebrates per m^2. Annual means were below the IQR in 2012 and 2018, and above the IQR in 2014, 2016 and 2019.

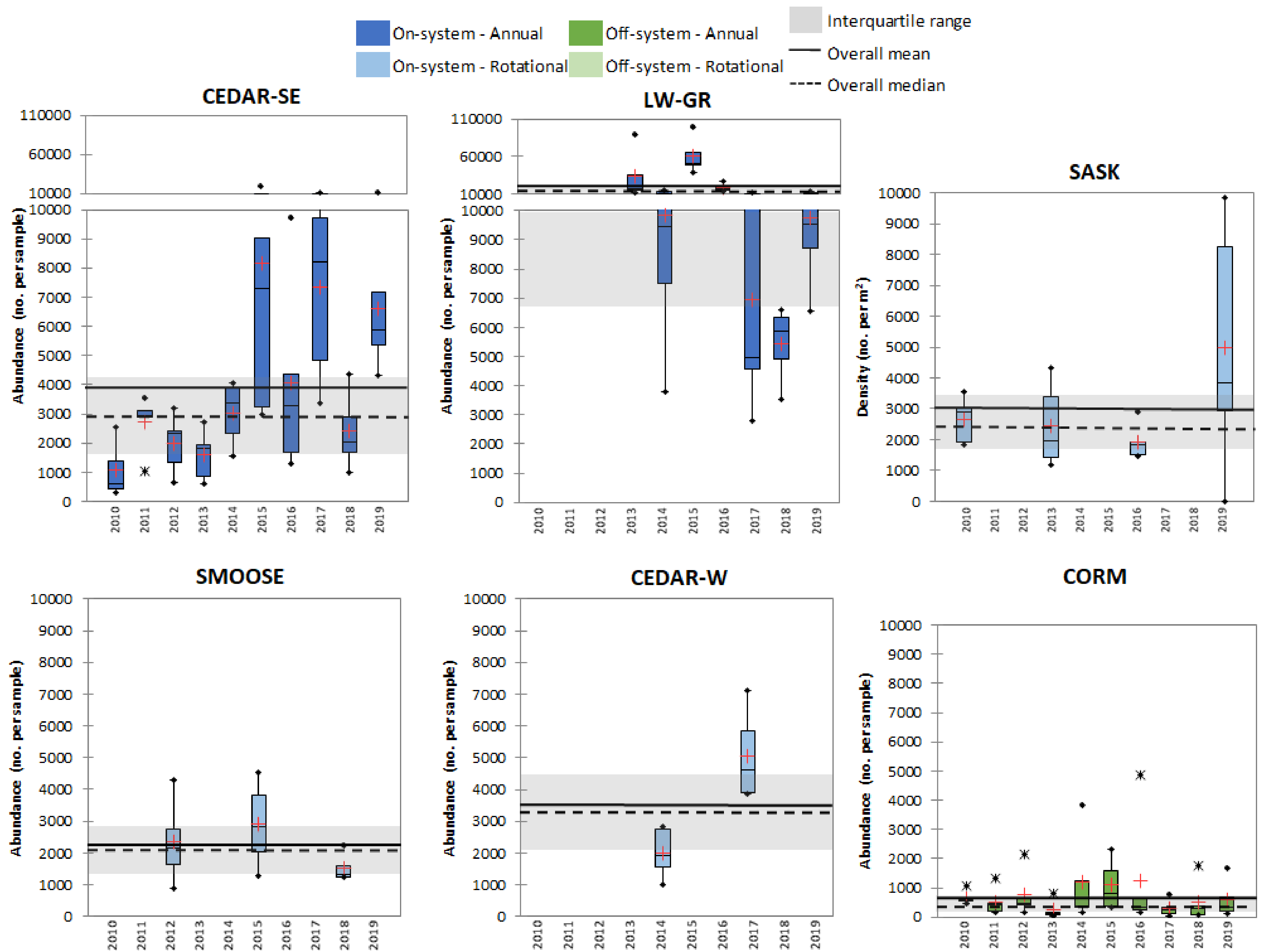


Figure 4.2-1. 2010 to 2019 Nearshore benthic invertebrate abundance (total no. per sample; SASK density, no. per m^2).

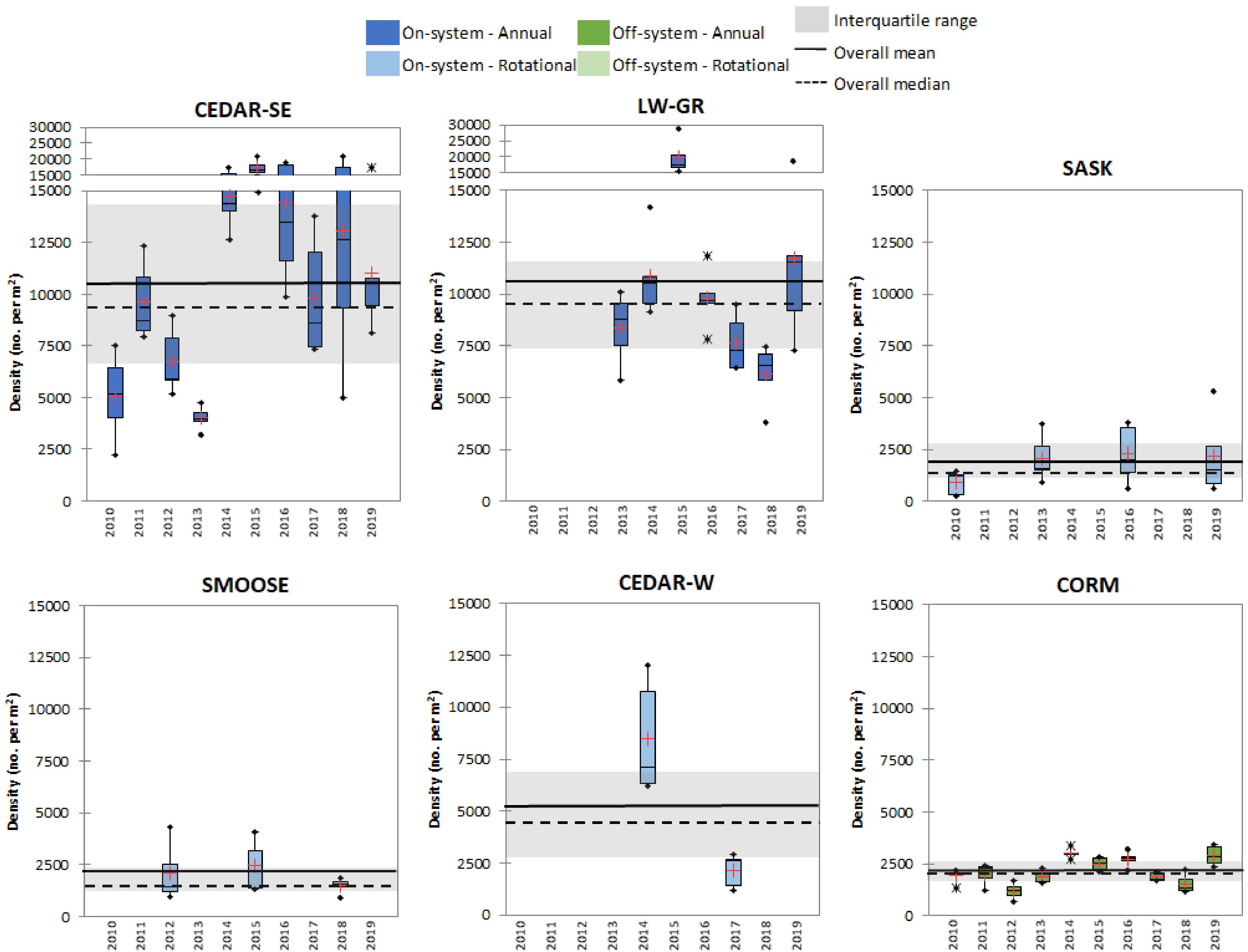


Figure 4.2-2. 2010 to 2019 Offshore benthic invertebrate abundance (density, total no. per m[2]).

4.3 COMMUNITY COMPOSITION

4.3.1 RELATIVE ABUNDANCE

4.3.1.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

Nearshore Habitat

Amphipoda (freshwater shrimps, mainly Hyalellidae) and/or Gastropoda (snails, mainly Lymnaeidae and Valvatidae) dominated the benthic invertebrate community in all ten years of monitoring (2010 to 2019; Table 4.3-1). Among those years, mean relative abundances of Amphipoda ranged from 9% (2019) to 60% (2010), and mean relative abundances of Gastropoda ranged from 5% (2013) to 53% (2019). Ephemeroptera (mayflies, mainly Caenidae, 27%) was the second most relatively abundant taxon in 2012. Corixidae (water boatmen, 29%) was the second most relatively abundant taxon in 2013.

Offshore Habitat

Oligochaeta (aquatic segmented worms) dominated the benthic invertebrate community in six of the ten years of monitoring (2010, 2012, 2016, 2017, 2018, and 2019; Table 4.3-2). Of those years, mean relative abundances of Oligochaeta ranged from 33% (2010) to 60% (2019). Chironomidae (non-biting midges) was the most abundant taxon in 2011 (32%), followed by Oligochaeta (26%). Amphipoda (freshwater shrimps, Hyalellidae and Pontoporeiidae) was the dominant group in 2013 (41%). Oligochaeta (21%), Amphipoda (mainly Hyalellidae, 29%), Bivalvia (clams, mainly Sphaeriidae, 23%), and Chironomidae (22%) dominated the 2014 community. Chironomidae was the dominant taxon in 2015 (41%).

Lake Winnipeg – Grand Rapids

Nearshore Habitat

Amphipoda (freshwater shrimps, mainly Hyalellidae) dominated the benthic invertebrate community in all seven years of monitoring (2013 to 2019; Table 4.3-3). Among those years, mean annual relative abundances of Amphipoda ranged from 44% (2016) to 73% (2015). Oligochaeta (aquatic segmented worms) was the second most relatively abundant taxon in 2014 (27%) and

2017 (18%). Chironomidae (non-biting midges) was the second most relatively abundant group in 2015 (15%) and 2016 (28%).

Offshore Habitat

Amphipod (freshwater shrimps, mainly Pontoporeiidae) dominated the benthic invertebrate community in six of the seven years of monitoring (2013 to 2018; Table 4.3-4). Among those years, mean annual relative abundances of Amphipoda ranged from 40% (2018) to 77% (2017). Chironomidae (non-biting midges; 53%) was the dominant taxon in 2019.

ROTATIONAL SITES

Saskatchewan River

Nearshore Habitat

Benthic invertebrate community composition varied over the four years of monitoring (2010, 2013, 2016, and 2019; Table 4.3-5). Ephemeroptera (mayflies, mainly Ephemeridae) dominated the invertebrate community 2010 (59%) and 2016 (69%). Oligochaeta (aquatic segmented worms) was the dominant taxon (71%) in 2013. Bivalvia (Sphaeriidae) dominated the invertebrate community in 2019 (48%), followed by Ephemeroptera (Ephemeridae, 29%).

Offshore Habitat

Benthic invertebrate community composition varied over the four years of monitoring (2010, 2013, 2016, and 2019; Table 4.3-6). Oligochaeta (aquatic segmented worms), Chironomidae (non-biting midges), and Trichoptera (caddisflies, mainly Hydropsychidae, 25%) dominated the community in 2010. Oligochaeta dominated in 2013 (45%). Ephemeroptera (mayflies, mainly Ephemeridae, 68%) dominated the community in 2016. Bivalvia (clams, Sphaeriidae, 37%) and Ephemeroptera (mainly Ephemeridae) dominated in 2019.

South Moose Lake

Nearshore Habitat

Oligochaeta (aquatic segmented worms) dominated the benthic invertebrate community in two of the three years of monitoring (2012 and 2018; Table 4.3-7). In both years, the mean relative abundances were 36%. In 2015, Amphipoda (mainly Hyalellidae) was the most abundant taxon (33%), followed by Gastropoda (snails, mainly Valvatidae, 24%).

Offshore Habitat

Oligochaeta (aquatic segmented worms) and Chironomidae (non-biting midges) dominated the benthic invertebrate community over the three years of monitoring (2012, 2015, and 2018; Table 4.3-8). Among those years, mean annual relative abundances of Oligochaeta ranged from 37% (2018) to 51% (2012); and mean annual relative abundances Chironomidae ranged from 26% (2012) to 53% (2018).

Cedar Lake - West

Nearshore Habitat

Benthic invertebrate community composition varied over the two years of monitoring (2014 and 2017; Table 4.3-9). The "All other taxa" category (mainly Hydrachnidae, water mites, 45%) was the most relatively abundant group in 2014. Oligochaeta (non-segmented worms, 32%) and Chironomidae (non-biting midges, 36%) were nearly co-dominant in 2017.

Offshore Habitat

Benthic invertebrate community composition varied over the two years of monitoring (2014 and 2017; Table 4.3-10). Oligochaeta (aquatic segmented worms, 33%), Bivalvia (clams, Sphaeriidae, 26%), and Chironomidae (non-biting midges, 31%) dominated in 2014; and Chironomidae (93%) dominated in 2017.

4.3.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

Nearshore Habitat

Benthic invertebrate community composition varied over the ten years of monitoring (2010 to 2019; Table 4.3-11). Chironomidae (non-biting midges) was the dominant taxon in 2010 (48%) and 2012 (51%). Ceratopogonidae (biting midges; 28%) and Ephemeroptera (mayflies, mainly Caenidae; 29%) were nearly co-dominant in 2011. Amphipoda (mainly Hyalellidae) was the dominant taxon in 2013 (53%), 2014 (45%), 2016 (28%) and 2017 (47%). Oligochaeta (aquatic segmented worms, 16%), Amphipoda (mainly Hyalellidae, 22%) and Chironomidae (18%) dominated in 2015. Oligochaeta was the most abundant taxon (34%) in 2018. Amphipoda (mainly Hyalellidae, 22%) and Chironomidae (29%) dominated in 2019.

Offshore Habitat

Amphipoda (mainly Pontoporeiidae) dominated the benthic invertebrate community over the ten years of monitoring (2010 to 2019; Table 4.3-12). Among those years, mean annual relative abundances of Amphipoda ranged from 31% (2011) to 75% (2019).

Table 4.3-1. 2010 to 2019 Cedar Lake - Southeast 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	3%	1%	4%	4%	4%	3%	2%	3%	8%	2%
Amphipoda	60%	45%	42%	37%	22%	20%	20%	17%	27%	9%
Bivalvia	2%	4%	4%	3%	13%	8%	10%	3%	9%	5%
Gastropoda	17%	31%	10%	5%	27%	50%	51%	51%	19%	53%
Ceratopogonidae	0%	0%	0%	<1%	0%	0%	0%	0%	0%	<1%
Chironomidae	5%	2%	5%	1%	8%	2%	3%	9%	13%	4%
Other Diptera	<1%	1%	1%	2%	<1%	<1%	1%	<1%	<1%	1%
Ephemeroptera	7%	11%	27%	16%	8%	5%	4%	8%	5%	3%
Plecoptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Trichoptera	2%	2%	3%	2%	5%	2%	2%	3%	1%	2%
Corixidae	3%	2%	3%	29%	14%	9%	7%	4%	16%	20%
Coleoptera	<1%	0%	<1%	0%	0%	<1%	0%	<1%	<1%	<1%
All other taxa	<1%	1%	1%	<1%	<1%	<1%	<1%	1%	1%	1%

Table 4.3-2. 2010 to 2019 Cedar Lake - Southeast 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	33%	26%	47%	1%	21%	24%	47%	48%	49%	60%
Amphipoda	26%	14%	12%	41%	29%	15%	11%	11%	19%	13%
Bivalvia	23%	23%	17%	26%	23%	16%	9%	12%	7%	9%
Gastropoda	2%	2%	3%	2%	1%	1%	1%	1%	<1%	<1%
Ceratopogonidae	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chironomidae	14%	32%	17%	25%	22%	41%	30%	27%	23%	15%
Other Diptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Ephemeroptera	2%	2%	4%	4%	1%	1%	1%	<1%	1%	1%
Plecoptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Trichoptera	1%	<1%	1%	1%	1%	1%	<1%	1%	<1%	1%
Corixidae	0%	1%	<1%	<1%	1%	1%	<1%	<1%	0%	<1%
Coleoptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
All other taxa	<1%	<1%	<1%	1%	1%	<1%	<1%	<1%	<1%	<1%

Table 4.3-3. 2010 to 2019 Lake Winnipeg – Grand Rapids nearshore benthic invertebrate relative abundance.

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

Invertebrate Taxa	2013	2014	2015	2016	2017	2018	2019
Oligochaeta	2%	27%	6%	3%	5%	4%	18%
Amphipoda	69%	56%	73%	44%	45%	54%	47%
Bivalvia	<1%	<1%	0%	0%	0%	<1%	0%
Gastropoda	13%	2%	3%	14%	22%	13%	7%
Ceratopogonidae	0%	0%	0%	0%	0%	0%	0%
Chironomidae	12%	12%	15%	28%	16%	14%	9%
Other Diptera	0%	<1%	0%	<1%	0%	0%	0%
Ephemeroptera	2%	<1%	1%	4%	2%	2%	1%
Plecoptera	0%	0%	0%	0%	0%	0%	0%
Trichoptera	<1%	1%	1%	1%	2%	2%	3%
Corixidae	<1%	<1%	0%	1%	7%	11%	12%
Coleoptera	<1%	<1%	<1%	<1%	1%	<1%	<1%
All other taxa	<1%	2%	<1%	4%	1%	<1%	4%

Table 4.3-4. 2010 to 2019 Lake Winnipeg – Grand Rapids offshore benthic invertebrate relative abundance.

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

Invertebrate Taxa	2013	2014	2015	2016	2017	2018	2019
Oligochaeta	1%	<1%	2%	0%	<1%	<1%	1%
Amphipoda	53%	73%	61%	54%	77%	40%	19%
Bivalvia	18%	18%	17%	34%	15%	27%	22%
Gastropoda	1%	1%	<1%	2%	1%	2%	2%
Ceratopogonidae	0%	0%	0%	0%	0%	0%	0%
Chironomidae	21%	5%	19%	5%	4%	27%	53%
Other Diptera	0%	0%	0%	0%	0%	0%	0%
Ephemeroptera	6%	3%	1%	4%	3%	3%	2%
Plecoptera	0%	0%	0%	0%	0%	0%	0%
Trichoptera	0%	<1%	<1%	1%	<1%	1%	<1%
Corixidae	<1%	0%	0%	0%	0%	<1%	0%
Coleoptera	<1%	0%	0%	0%	0%	0%	0%
All other taxa	0%	0%	<1%	<1%	<1%	<1%	<1%

Table 4.3-5. 2010 to 2019 Saskatchewan River nearshore benthic invertebrate relative abundance.

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

Invertebrate Taxa	2010	2013	2016	2019
Oligochaeta	17%	71%	3%	16%
Amphipoda	<1%	1%	1%	<1%
Bivalvia	14%	1%	17%	48%
Gastropoda	3%	0%	0%	6%
Ceratopogonidae	<1%	<1%	0%	<1%
Chironomidae	7%	5%	9%	2%
Other Diptera	0%	<1%	0%	0%
Ephemeroptera	59%	21%	69%	29%
Plecoptera	0%	0%	0%	0%
Trichoptera	0%	<1%	1%	0%
Corixidae	0%	0%	0%	<1%
Coleoptera	0%	0%	0%	0%
All other taxa	0%	<1%	<1%	<1%

Table 4.3-6. 2010 to 2019 Saskatchewan River offshore benthic invertebrate relative abundance.

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

Invertebrate Taxa	2010	2013	2016	2019
Oligochaeta	27%	45%	1%	22%
Amphipoda	0%	1%	0%	<1%
Bivalvia	11%	21%	16%	37%
Gastropoda	0%	<1%	1%	1%
Ceratopogonidae	1%	0%	0%	0%
Chironomidae	22%	3%	9%	4%
Other Diptera	1%	<1%	<1%	0%
Ephemeroptera	13%	10%	68%	30%
Plecoptera	1%	0%	0%	0%
Trichoptera	25%	20%	5%	5%
Corixidae	0%	0%	0%	0%
Coleoptera	0%	0%	0%	0%
All other taxa	<1%	0%	0%	0%

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

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

Invertebrate Taxa	2012	2015	2018
Oligochaeta	36%	15%	36%
Amphipoda	22%	33%	10%
Bivalvia	0%	<1%	0%
Gastropoda	13%	24%	14%
Ceratopogonidae	0%	0%	0%
Chironomidae	12%	13%	19%
Other Diptera	1%	3%	3%
Ephemeroptera	9%	6%	3%
Plecoptera	0%	0%	0%
Trichoptera	5%	4%	12%
Corixidae	<1%	<1%	<1%
Coleoptera	0%	<1%	0%
All other taxa	1%	2%	3%

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

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

Invertebrate Taxa	2012	2015	2018
Oligochaeta	51%	48%	37%
Amphipoda	0%	1%	0%
Bivalvia	12%	2%	5%
Gastropoda	2%	<1%	<1%
Ceratopogonidae	0%	0%	0%
Chironomidae	26%	47%	53%
Other Diptera	9%	<1%	4%
Ephemeroptera	1%	<1%	1%
Plecoptera	0%	0%	0%
Trichoptera	0%	<1%	0%
Corixidae	0%	<1%	0%
Coleoptera	0%	0%	0%
All other taxa	0%	<1%	<1%

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

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

Invertebrate Taxa	2014	2017
Oligochaeta	8%	32%
Amphipoda	10%	21%
Bivalvia	0%	0%
Gastropoda	7%	13%
Ceratopogonidae	0%	0%
Chironomidae	21%	29%
Other Diptera	1%	1%
Ephemeroptera	3%	2%
Plecoptera	0%	0%
Trichoptera	3%	1%
Corixidae	2%	<1%
Coleoptera	0%	0%
All other taxa	45%	1%

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

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

Invertebrate Taxa	2014	2017
Oligochaeta	33%	<1%
Amphipoda	1%	1%
Bivalvia	26%	4%
Gastropoda	4%	1%
Ceratopogonidae	<1%	0%
Chironomidae	31%	93%
Other Diptera	0%	0%
Ephemeroptera	2%	0%
Plecoptera	0%	0%
Trichoptera	1%	0%
Corixidae	<1%	<1%
Coleoptera	0%	0%
All other taxa	1%	<1%

Table 4.3-11. 2010 to 2019 Cormorant 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	5%	3%	9%	18%	19%	16%	6%	3%	34%	3%
Amphipoda	12%	4%	12%	53%	45%	22%	28%	47%	19%	22%
Bivalvia	<1%	<1%	<1%	0%	<1%	1%	<1%	<1%	0%	<1%
Gastropoda	<1%	4%	1%	<1%	<1%	2%	9%	8%	5%	7%
Ceratopogonidae	0%	28%	0%	0%	<1%	14%	0%	0%	<1%	<1%
Chironomidae	48%	8%	51%	9%	22%	18%	16%	23%	16%	29%
Other Diptera	7%	12%	5%	8%	1%	6%	11%	7%	4%	15%
Ephemeroptera	20%	29%	9%	6%	7%	4%	20%	2%	9%	3%
Plecoptera	<1%	<1%	0%	0%	<1%	0%	0%	0%	0%	0%
Trichoptera	4%	8%	6%	4%	3%	7%	3%	6%	6%	13%
Corixidae	2%	2%	7%	<1%	2%	5%	5%	3%	6%	6%
Coleoptera	1%	1%	1%	<1%	0%	2%	2%	1%	2%	<1%
All other taxa	1%	2%	<1%	1%	1%	3%	2%	1%	1%	1%

Table 4.3-12. 2010 to 2019 Cormorant 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	1%	8%	3%	<1%	3%	10%	1%	2%	2%	2%
Amphipoda	37%	31%	45%	56%	64%	52%	47%	63%	71%	75%
Bivalvia	9%	18%	15%	13%	14%	9%	14%	12%	8%	3%
Gastropoda	11%	14%	15%	2%	6%	5%	9%	7%	3%	3%
Ceratopogonidae	2%	0%	<1%	0%	0%	<1%	<1%	0%	<1%	<1%
Chironomidae	20%	15%	8%	9%	5%	11%	5%	3%	7%	5%
Other Diptera	0%	0%	0%	0%	0%	0%	<1%	1%	0%	0%
Ephemeroptera	15%	9%	10%	15%	6%	11%	19%	9%	6%	10%
Plecoptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Trichoptera	4%	3%	1%	4%	2%	1%	3%	2%	2%	1%
Corixidae	1%	1%	0%	1%	0%	<1%	<1%	0%	0%	<1%
Coleoptera	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
All other taxa	0%	2%	<1%	0%	0%	1%	1%	<1%	1%	<1%

4.3.2 EPT INDEX

4.3.2.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

Nearshore Habitat

Annual mean EPT Index over the ten years of monitoring ranged from less than 6% (2018 and 2019) to 34% (2012; Figure 4.3-1). The overall mean was 12%, the overall median was 10%, and the IQR was more than 6% to 16%. Annual means were below the IQR in 2016, 2018 and 2019, and above the IQR in 2012 and 2013.

Offshore Habitat

Annual mean EPT Index over the ten years of monitoring ranged from less than 1% (2018) to 5% (2013; Figure 4.3-2). The overall mean and median were 2%, and the IQR was less than 1% to 3%. Annual means were below the IQR in 2018, and above the IQR in 2012 and 2013.

Lake Winnipeg – Grand Rapids

Nearshore Habitat

Annual mean EPT Index over the seven years of monitoring ranged from less than 1% (2014) to 5% (2016; Figure 4.3-1). The overall mean and median were 3%, and the IQR was less than 2% to less than 4%. Annual means were below the IQR in 2014, and above the IQR in 2016 and 2018.

Offshore Habitat

Annual mean EPT Index over the seven years of monitoring ranged from 1% (2015) to 6% (2013; Figure 4.3-2). The overall mean was 4%, the overall median was 3%, and the IQR was 2% to more than 4%. Annual means were below the IQR in 2015, and above the IQR in 2013 and 2016.

ROTATIONAL SITES

Saskatchewan River

Nearshore Habitat

Annual mean EPT Index over the four years of monitoring ranged from less than 25% (2013) to 73% (2016; Figure 4.3-1). The overall mean was 46%, the overall median was 49%, and the IQR was 25% to 64%. Annual means were below the IQR in 2013, and above the IQR in 2016.

Offshore Habitat

Annual mean EPT Index over the four years of monitoring ranged from 33% (2010) to 67% (2016; Figure 4.3-2). The overall mean was 47%, the overall median was 48%, and the IQR was 22% to 79%. Annual means for all years fell within the IQR.

South Moose Lake

Nearshore Habitat

Annual mean EPT Index over the three years of monitoring ranged from 11% (2015) to 15% (2012; Figure 4.3-1). The overall mean was 13%, the overall median was 10%, and the IQR was 9% to 14%. Annual means were within the IQR, except in 2012 (above).

Offshore Habitat

Annual mean EPT Index over the three years of monitoring was less than 1% (2012, 2015, and 2018; Figure 4.3-2). The overall mean and median were less than 1%, and the IQR was 0% to 1%. Annual means for all years fell within the IQR.

Cedar Lake - West

Nearshore Habitat

Annual mean EPT Index over the two years of monitoring ranged from 3% (2017) to 7% (2014; Figure 4.3-1). The overall mean was 5%, the overall median was 4%, and the IQR was 3% to 4%. Annual means were within the IQR, except in 2014 (above).

Offshore Habitat

Annual mean EPT Index over the two years of monitoring ranged from 0% (2017) to more than 3% (2014; Figure 4.3-2). The overall mean was 2%, the overall median was 1%, and the IQR was 0% to 3%. Annual means were within the IQR, except in 2014 (above).

4.3.2.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

Nearshore Habitat

Annual mean EPT Index over the ten years of monitoring ranged from 8% (2017) to 27% (2011; Figure 4.3-1). The overall mean was 15%, the overall median was 14%, and the IQR was 9% to 20%. Annual means were below the IQR in 2017, and above the IQR in 2010, 2011 and 2016.

Offshore Habitat

Annual mean EPT Index over the ten years of monitoring ranged from 8% (2014) to 22% (2016; Figure 4.3-2). The overall mean was 14%, the overall median was 12%, and the IQR was 9% to 18%. Annual means were below the IQR in 2014 and 2018, and above the IQR in 2010, 2013 and 2016.

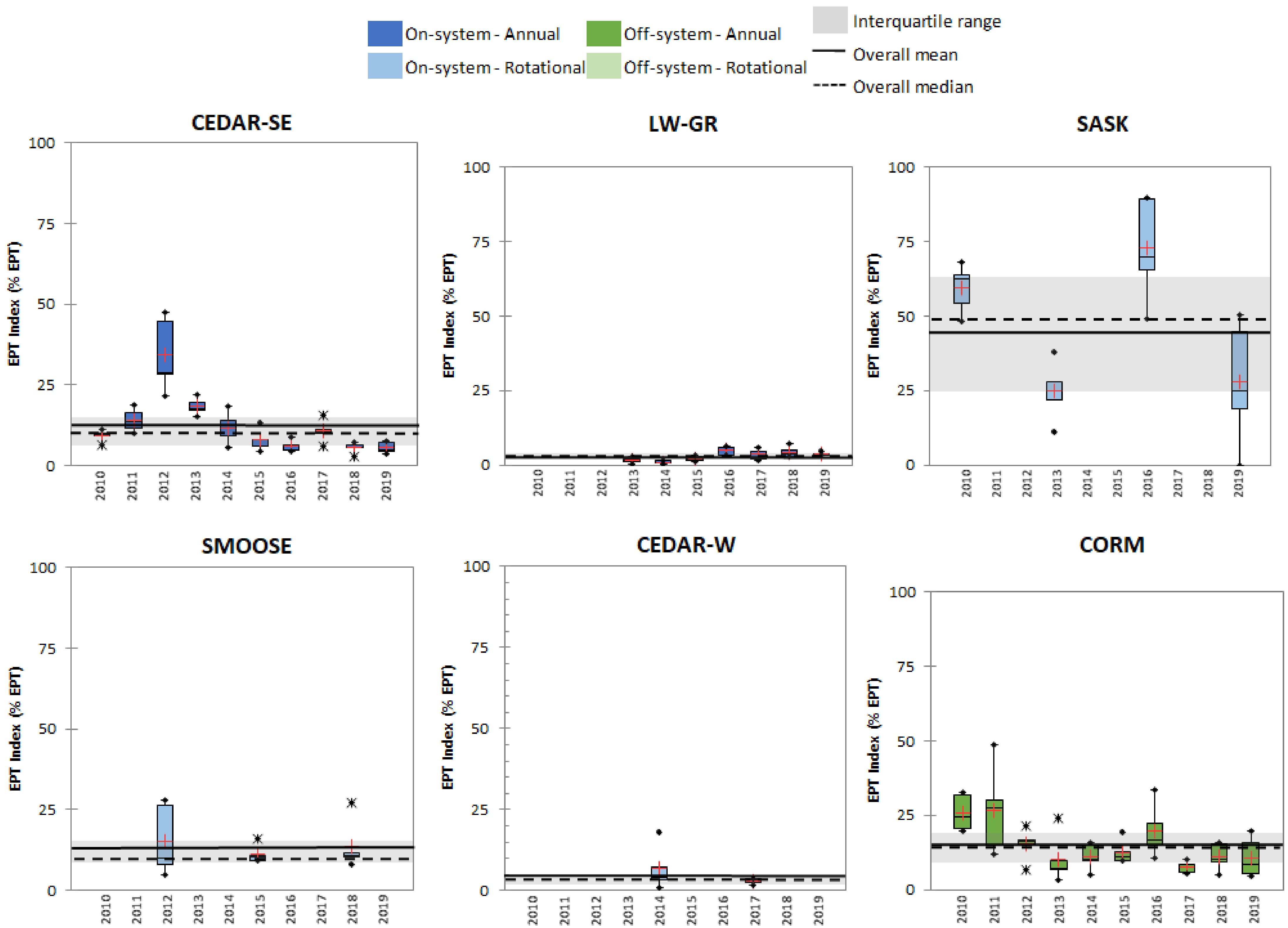


Figure 4.3-1. 2010 to 2019 Nearshore benthic invertebrate EPT Index.

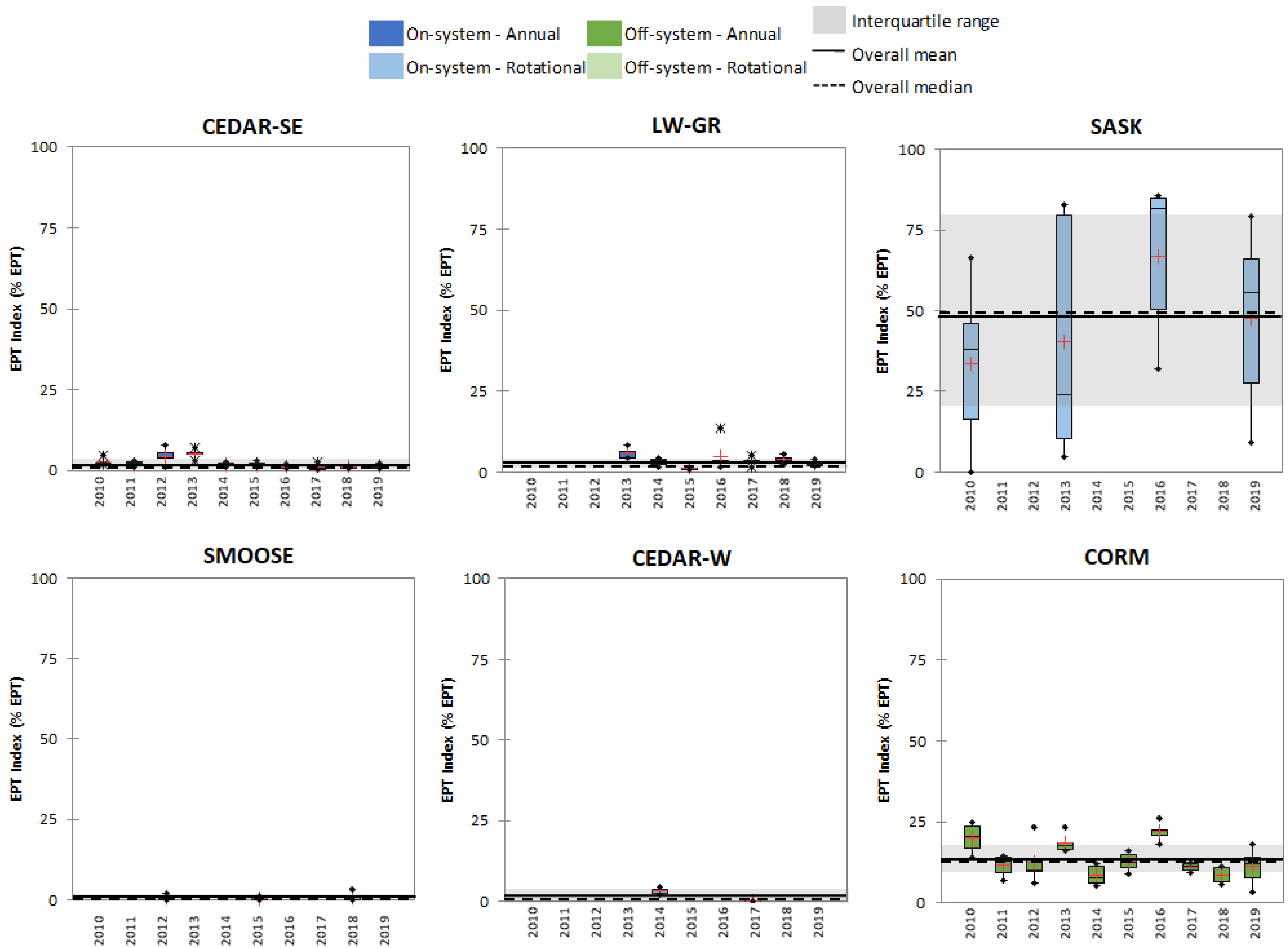


Figure 4.3-2. 2010 to 2019 Offshore benthic invertebrate EPT Index.

4.3.3 O+C INDEX

4.3.3.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

Nearshore Habitat

Annual mean O+C Index over the ten years of monitoring ranged from 3% (2011) to 25% (2018; Figure 4.3-3). The overall mean was 9%, the overall median was 8%, and the IQR was 4% to 12%. Annual means were below the IQR in 2011, and above the IQR in 2017 and 2018.

Offshore Habitat

Annual mean O+C Index over the ten years of monitoring ranged from 26% (2013) to 77% (2016; Figure 4.3-4). The overall mean was 60%, the overall median was 63%, and the IQR was 48% to 75%. Annual means were below the IQR in 2010, 2013 and 2014, and above the IQR in 2016, 2017 and 2019.

Lake Winnipeg – Grand Rapids

Nearshore Habitat

Annual mean O+C Index over the seven years of monitoring ranged from 15% (2013) to 39% (2014; Figure 4.3-3). The overall mean was 24%, the overall median was 22%, and the IQR was 17% to 32%. Annual means were below the IQR in 2013, and above the IQR in 2014.

Offshore Habitat

Annual mean O+C Index over the seven years of monitoring ranged from 4% (2017) to 53% (2019; Figure 4.3-4). The overall mean was 20%, the overall median was 18%, and the IQR was 6% to 28%. Annual means were below the IQR in 2014, 2016 and 2017, and above the IQR in 2019.

ROTATIONAL SITES

Saskatchewan River

Nearshore Habitat

Annual mean O+C Index over the four years of monitoring ranged from 12% (2016) to 72% (2013; Figure 4.3-3). The overall mean was 32%, the overall median was 24%, and the IQR was 12% to 55%. Annual means were within the IQR, except in 2013 (above).

Offshore Habitat

Annual mean O+C Index over the four years of monitoring ranged from 9% (2016) to 48% (2010; Figure 4.3-4). The overall mean was 30%, the overall median was 19%, and the IQR was less than 10% to 41%. Annual means were below the IQR in 2016, and above the IQR in 2010 and 2013.

South Moose Lake

Nearshore Habitat

Annual mean O+C Index over the three years of monitoring ranged from 28% (2015) to 54% (2018; Figure 4.3-3). The overall mean was 43%, the overall median was 38%, and the IQR was 34% to 56%. Annual means were within the IQR, except in 2015 (below).

Offshore Habitat

Annual mean O+C Index over the three years of monitoring ranged from 72% (2012) to 94% (2015; Figure 4.3-4). The overall mean was 85%, the overall median was 87%, and the IQR was 79% to 96%. Annual means were within the IQR, except in 2012 (below).

Cedar Lake - West

Nearshore Habitat

Annual mean O+C Index over the two years of monitoring ranged from 29% (2014) to 59% (2017; Figure 4.3-3). The overall mean was 44%, the overall median was 39%, and the IQR was 28% to 59%. Annual means were within the IQR, except in 2017 (above).

Offshore Habitat

Annual mean O+C Index over the two years of monitoring ranged from 64% (2014) to 93% (2017; Figure 4.3-4). The overall mean was less than 79%, the overall median was 90%, and the IQR was less than 65% to less than 93%. Annual means were within the IQR, except in 2017 (above).

4.3.3.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

Nearshore Habitat

Annual mean O+C Index over the ten years of monitoring ranged from 11% (2011) to 62% (2018; Figure 4.3-3). The overall mean was 42%, the overall median was 43%, and the IQR was 29% to 56%. Annual means were below the IQR in 2011, and above the IQR in 2012 and 2018.

Offshore Habitat

Annual mean O+C Index over the ten years of monitoring ranged from less than 6% (2017) to 23% (2011; Figure 4.3-4). The overall mean was 12%, the overall median was 10%, and the IQR was 7% to 19%. Annual means were below the IQR in 2016 and 2017, and above the IQR in 2010, 2011 and 2015.

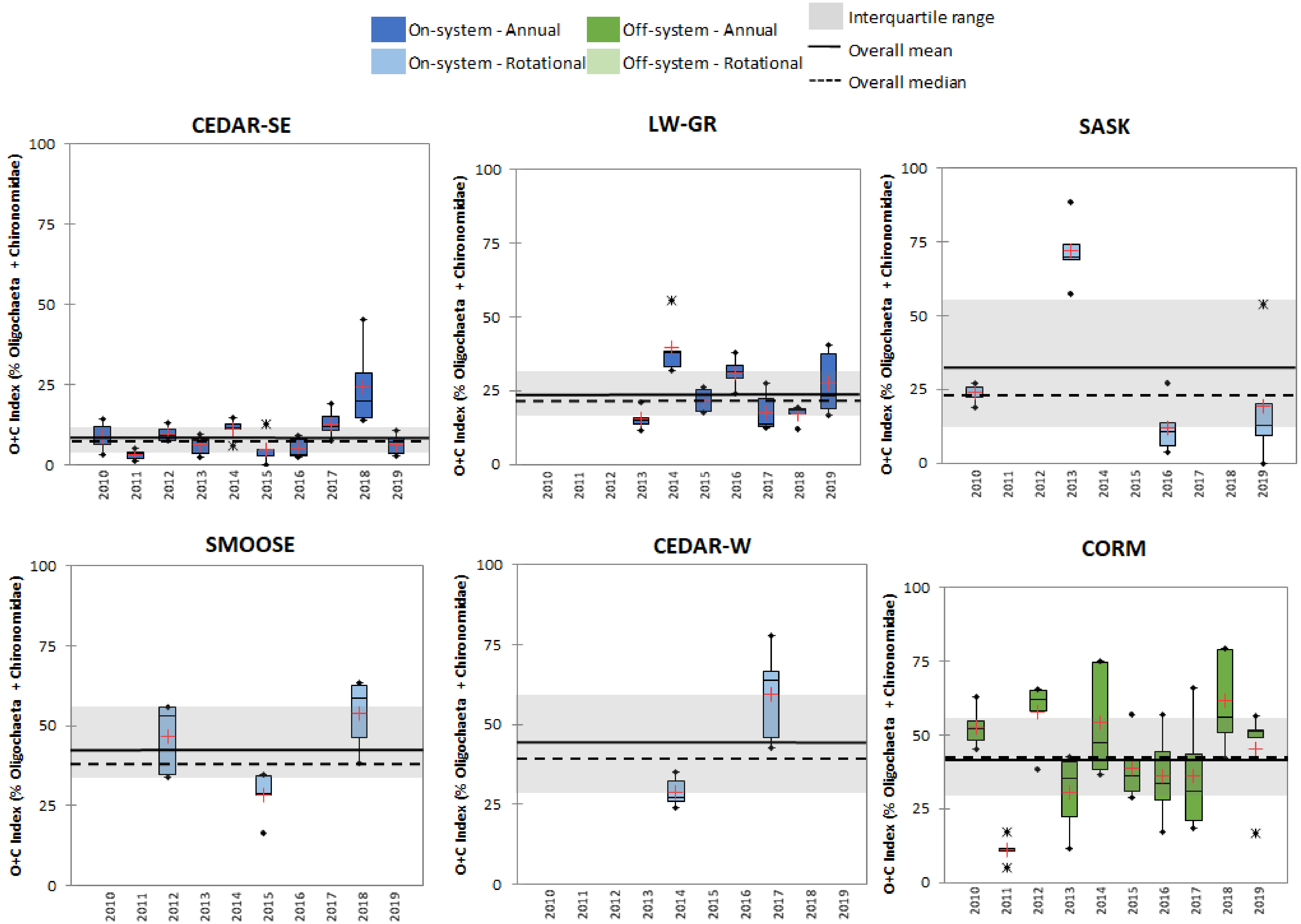


Figure 4.3-3. 2010 to 2019 Nearshore benthic invertebrate O+C Index.

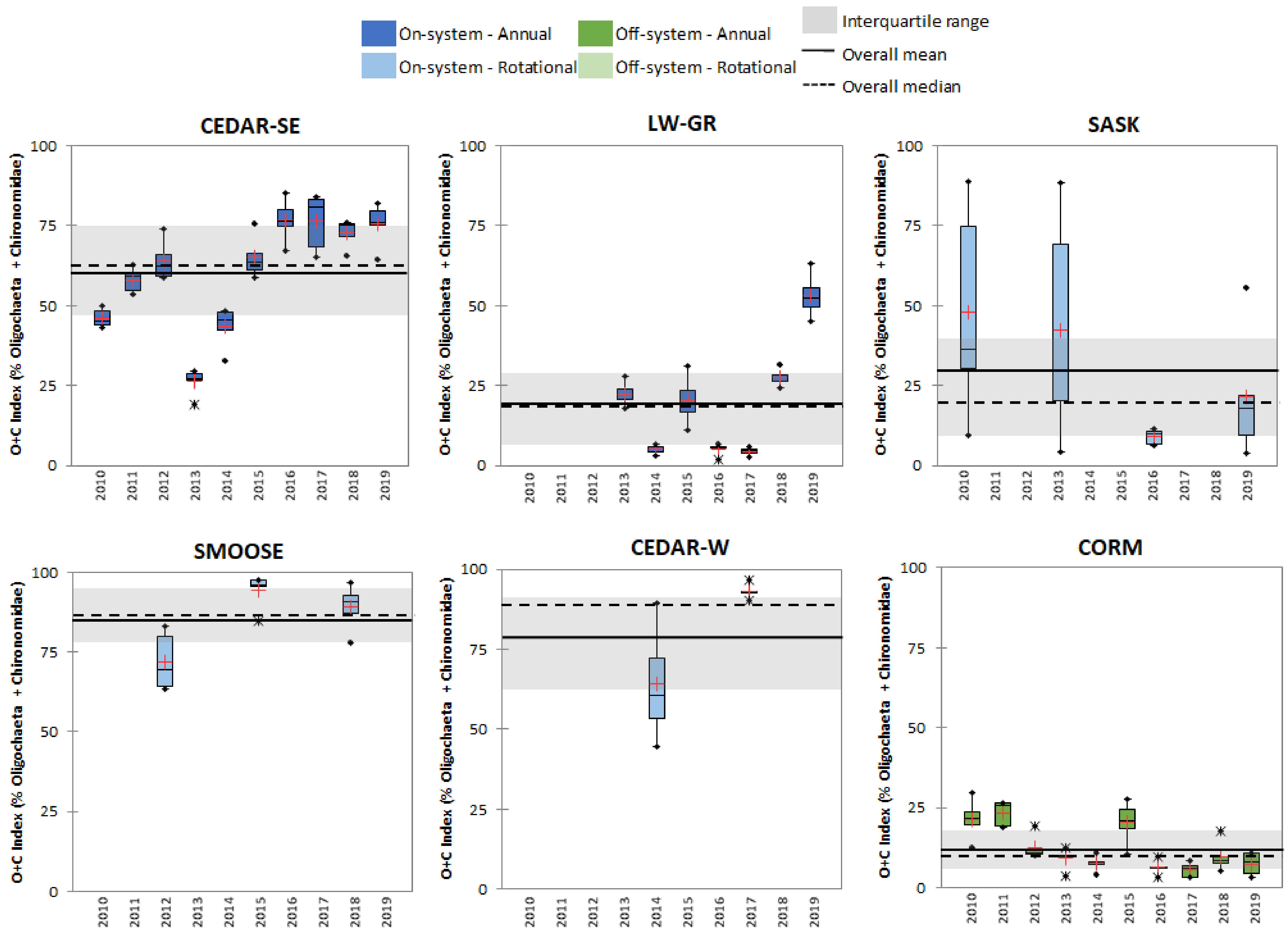


Figure 4.3-4. 2010 to 2019 Offshore benthic invertebrate O+C Index.

4.4 RICHNESS

4.4.1 TOTAL TAXA RICHNESS

4.4.1.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

Nearshore Habitat

Annual mean total taxa richness over the ten years of monitoring ranged from less than 18 families (2014) to 22 families (2012; Figure 4.4-1). The overall mean and median were 20 families, and the IQR was 18 to 21 families. Annual means were below the IQR in 2014, and above the IQR in 2012.

Offshore Habitat

Annual mean total taxa richness over the ten years of monitoring ranged from eight families (2017) to 13 families (2014; Figure 4.4-2). The overall mean was more than ten families, the median was ten families, and the IQR was 9 to 12 families. Annual means were below the IQR in 2017 and 2018, and above the IQR in 2014 and 2015.

Lake Winnipeg – Grand Rapids

Nearshore Habitat

Annual mean total taxa richness over the seven years of monitoring ranged from less than 13 families (2014 and 2015) to less than 16 families (2016; Figure 4.4-1). The overall mean and median were 14 families, and the IQR was less than 14 to 16 families. Annual means were within the IQR, except in 2014 and 2015 (below).

Offshore Habitat

Annual mean total taxa richness over the seven years of monitoring ranged from less than seven families (2014) to more than nine families (2018; Figure 4.4-2). The overall mean was less than eight families, the median was eight families, and the IQR was 7 to less than 9 families. Annual means were below the IQR in 2014, and above the IQR in 2018.

ROTATIONAL SITES

Saskatchewan River

Nearshore Habitat

Annual mean total taxa richness over the four years of monitoring ranged from five families (2016) to less than seven families (2019; Figure 4.4-1). The overall mean and median were six families, and the IQR was 5 to 7 families. Annual means for all years fell within the IQR.

Offshore Habitat

Annual mean total taxa richness over the four years of monitoring ranged from six families (2010 and 2016) to less than seven families (2013; Figure 4.4-2). The overall mean was more than six families, the median was six families, and the IQR was less than 6 to 7 families. Annual means for all years fell within the IQR.

South Moose Lake

Nearshore Habitat

Annual mean total taxa richness over the three years of monitoring ranged from less than 15 families (2012) to 20 families (2015; Figure 4.4-1). The overall mean was 18 families, the overall median was 17 families, and the IQR was less than 17 to 19 families. Annual means were below the IQR in 2012, and above the IQR in 2015.

Offshore Habitat

Annual mean total taxa richness over the three years of monitoring ranged from less than five families (2018) to six families (2015; Figure 4.4-2). The overall mean and median were five families, and the IQR was 4 to 6 families. Annual means for all years fell within the IQR.

Cedar Lake - West

Nearshore Habitat

Annual mean total taxa richness over the two years of monitoring ranged from less than 15 families (2017) to 15 families (2014; Figure 4.4-1). The overall mean was 15 families, the overall median was 14 families, and the IQR was 14 to 16 families. Annual means for all years fell within the IQR.

Offshore Habitat

Annual mean total taxa richness over the two years of monitoring ranged from five families (2017) to less than 12 families (2014; Figure 4.4-2). The overall mean was more than eight families, the median was eight families, and the IQR was 4 to 12 families. Annual means for all years fell within the IQR.

4.4.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

Nearshore Habitat

Annual mean total taxa richness over the ten years of monitoring ranged from 11 families (2013) to 21 families (2015; Figure 4.4-1). The overall mean was less than 17 families, the median was 17 families, and the IQR was 13 to 20 families. Annual means were below the IQR in 2013, and above the IQR in 2015.

Offshore Habitat

Annual mean total taxa richness over the ten years of monitoring ranged from less than nine families (2013) to 13 families (2010; Figure 4.4-2). The overall mean was less than 11 families, the median was 11 families, and the IQR was 10 to 12 families. Annual means were below the IQR in 2013, 2017 and 2018, and above the IQR in 2010 and 2011.

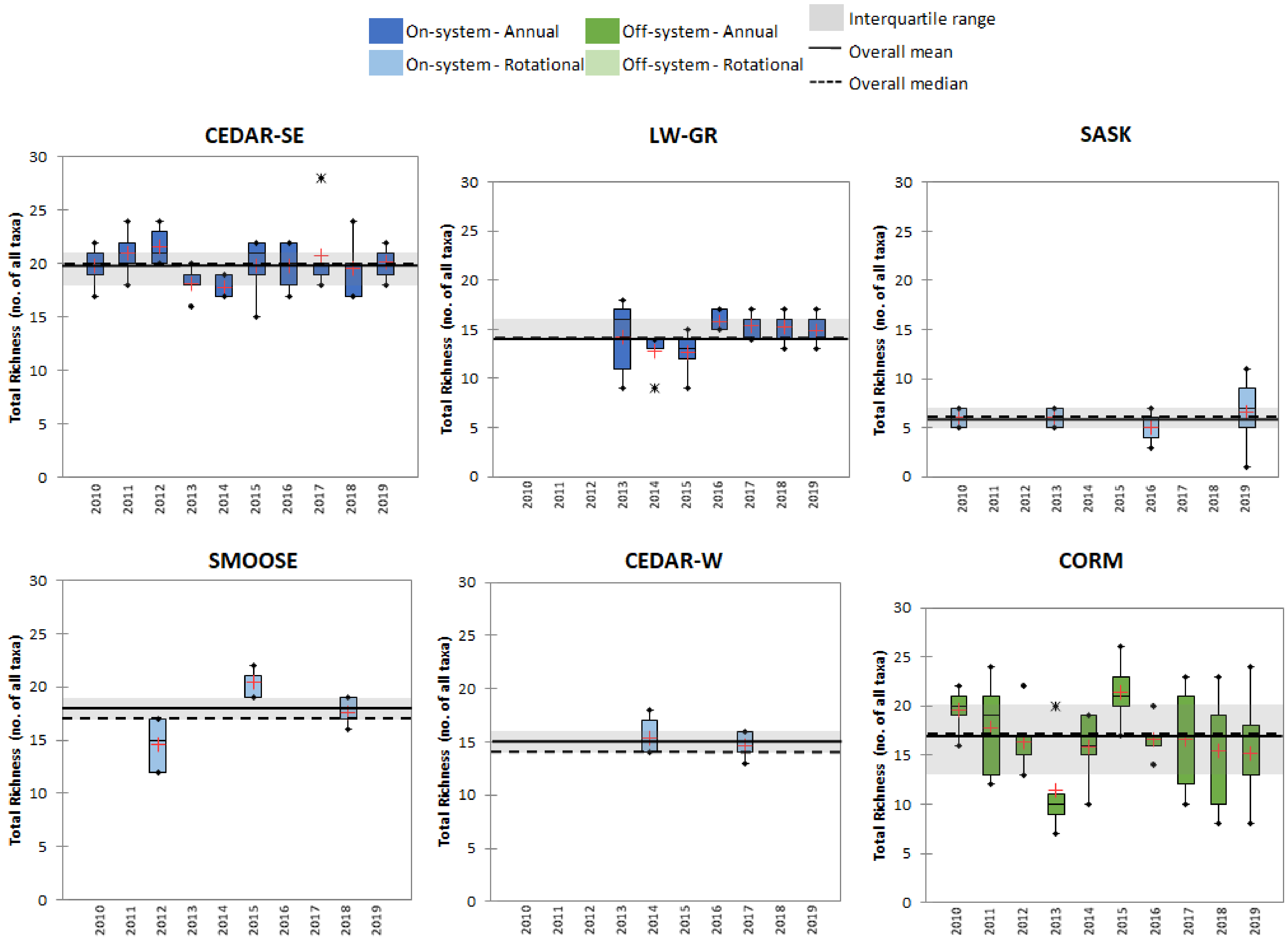


Figure 4.4-1. 2010 to 2019 Nearshore benthic invertebrate total richness (family-level).

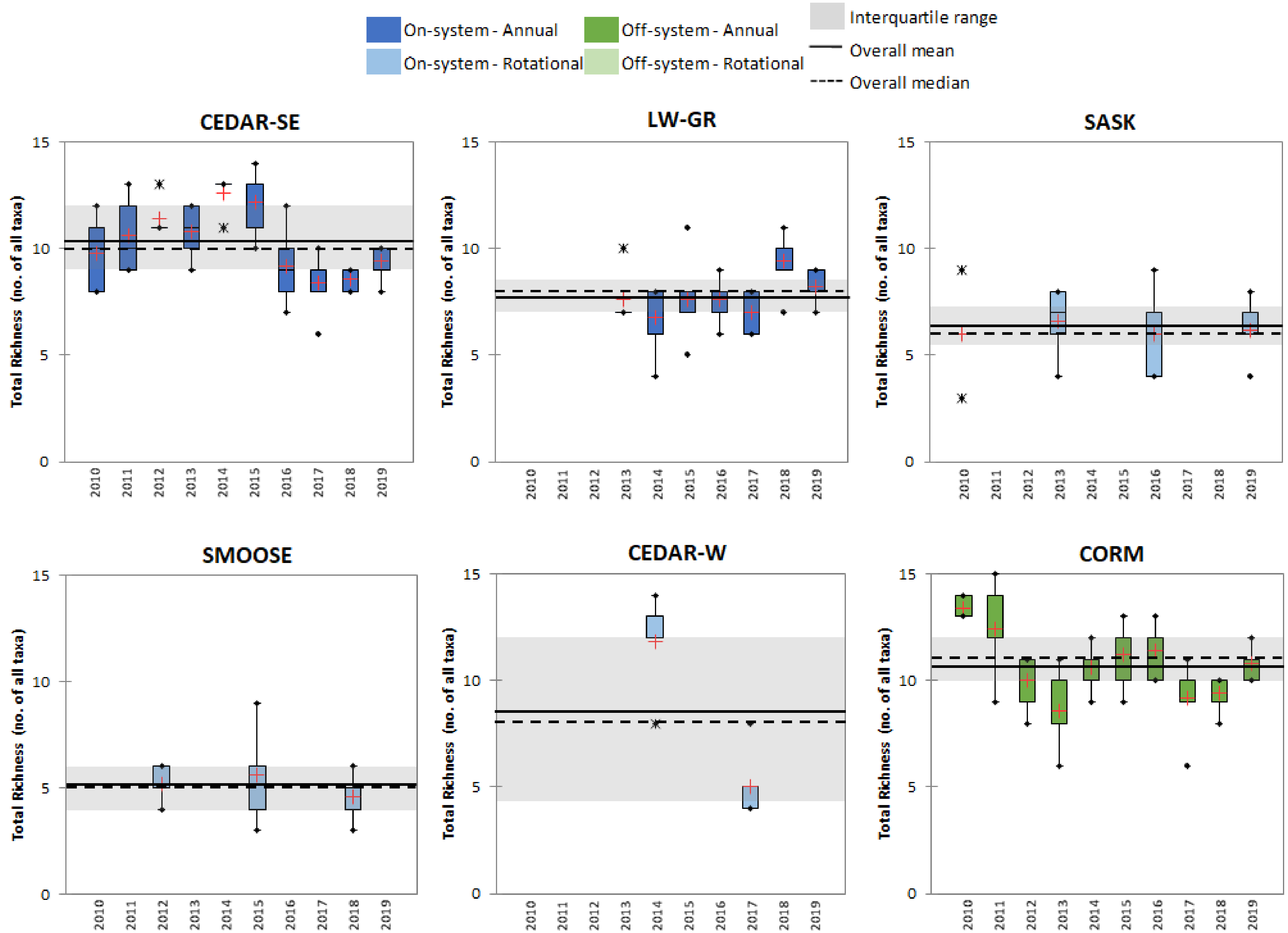


Figure 4.4-2. 2010 to 2019 Offshore benthic invertebrate total richness (family-level).

4.4.2 EPT TAXA RICHNESS

4.4.2.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

Nearshore Habitat

Annual mean EPT taxa richness over the ten years of monitoring ranged from less than six families (2014) to nine families (2012; Figure 4.4-3). The overall mean and median were seven families, and the IQR was 6 to 8 families. Annual means were below the IQR in 2014, and above the IQR in 2012.

Offshore Habitat

Annual mean EPT taxa richness over the ten years of monitoring ranged from more than one family (2017) to less than three families (2015; Figure 4.4-4). The overall mean was more than two families, the median was two families, and the IQR was 2 to 3 families. Annual means were within the IQR, except in 2011, 2017 and 2018 (below).

Lake Winnipeg – Grand Rapids

Nearshore Habitat

Annual mean EPT taxa richness over the seven years of monitoring ranged from three families (2013, 2014, 2015, and 2019) to five families (2016; Figure 4.4-3). The overall mean was less than four families, the median was four families, and the IQR was 3 to 4 families. Annual means were within the IQR, except in 2016 and 2018 (above).

Offshore Habitat

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

ROTATIONAL SITES

Saskatchewan River

Nearshore Habitat

Annual mean EPT taxa richness over the four years of monitoring ranged from less than one family (2019) to two families (2016; Figure 4.4-3). The overall mean and median were one family, and the IQR was within 1 family. Annual means were below the IQR in 2019, and above the IQR in 2013 and 2016.

Offshore Habitat

Annual mean EPT taxa richness over the four years of monitoring ranged from less than three families (2010, 2016 and 2019) to three families (2013; Figure 4.4-4). The overall mean was less than three families, the median was three families, and the IQR was less than 2 to 4 families. Annual means for all years fell within the IQR.

South Moose Lake

Nearshore Habitat

Annual mean EPT taxa richness over the three years of monitoring ranged from four families (2012) to more than six families (2015; Figure 4.4-3). The overall mean and median were five families, and the IQR was 4 to 6 families. Annual means were within the IQR, except in 2015 (above).

Offshore Habitat

Annual mean EPT taxa richness over the three years of monitoring were less than one family (2012, 2015, and 2018; Figure 4.4-4). The overall mean was less than one family, the median was one family, and the IQR was 0 to 1 family. Annual means for all years fell within the IQR.

Cedar Lake - West

Nearshore Habitat

Annual mean EPT taxa richness over the two years of monitoring ranged from four families (2017) to less than five families (2014; Figure 4.4-3). The overall mean was four families, the overall median was five families, and the IQR was 4 to 5 families. Annual means for all years fell within the IQR.

Offshore Habitat

Annual mean EPT taxa richness over the two years of monitoring ranged from zero families (2017) to more than two families (2014; Figure 4.4-4). The overall mean was more than one family, the median was one family, and the IQR was 0 to 2 families. Annual means were within the IQR, except in 2014 (above).

4.4.2.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

Nearshore Habitat

Annual mean EPT taxa richness over the ten years of monitoring ranged from less than four families (2013) to ten families (2010; Figure 4.4-3). The overall mean and median were six families, and the IQR was 4 to 8 families. Annual means were below the IQR in 2013, and above the IQR in 2010.

Offshore Habitat

Annual mean EPT taxa richness over the ten years of monitoring ranged from less than two families (2017 and 2019) to more than four families (2010; Figure 4.4-4). The overall mean was less than three families. the median was two families, and the IQR was 2 to 3 families. Annual means were below the IQR in 2017 and 2019, and above the IQR in 2010.

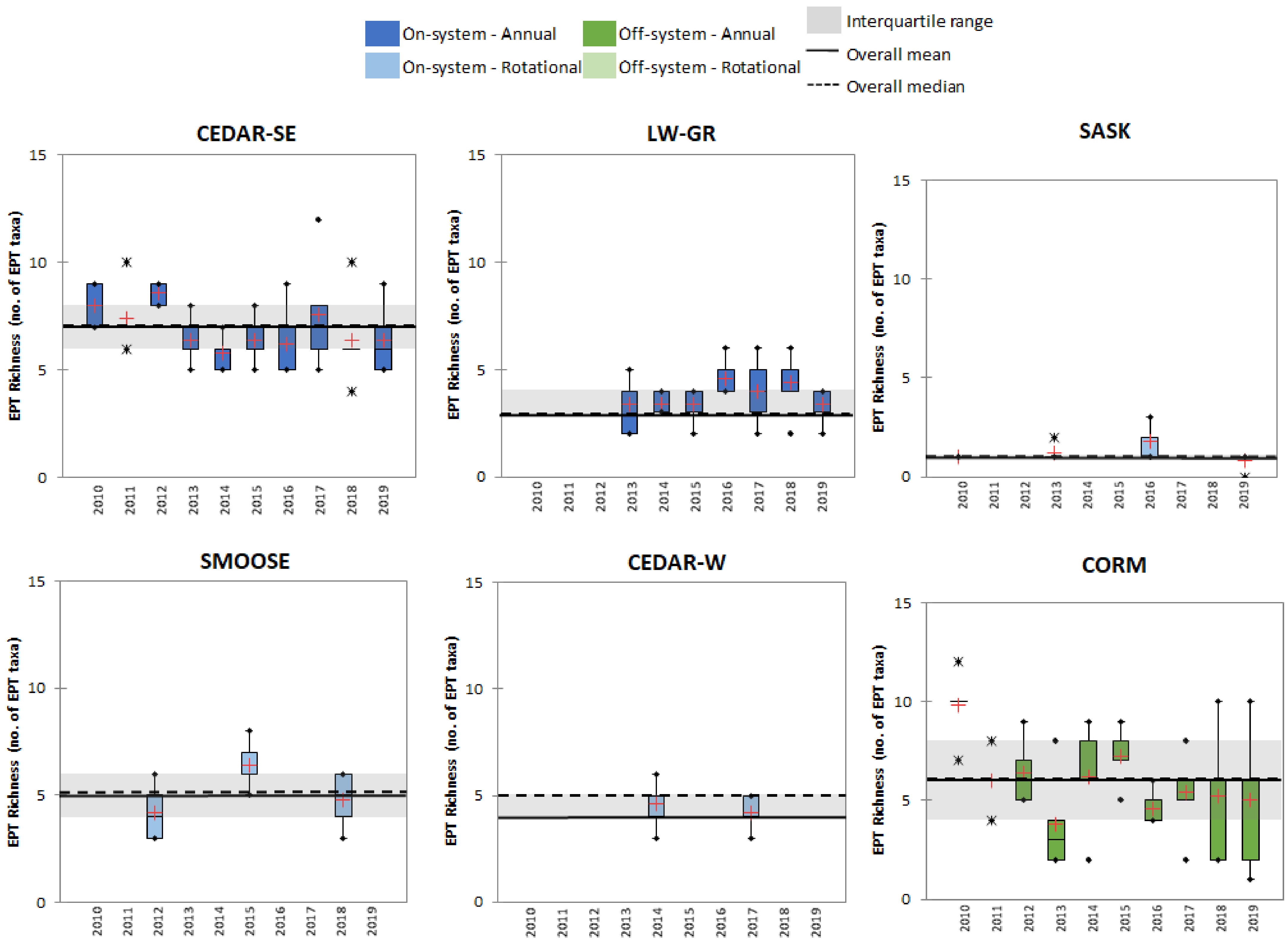


Figure 4.4-3. 2010 to 2019 Nearshore benthic invertebrate EPT richness (family-level).

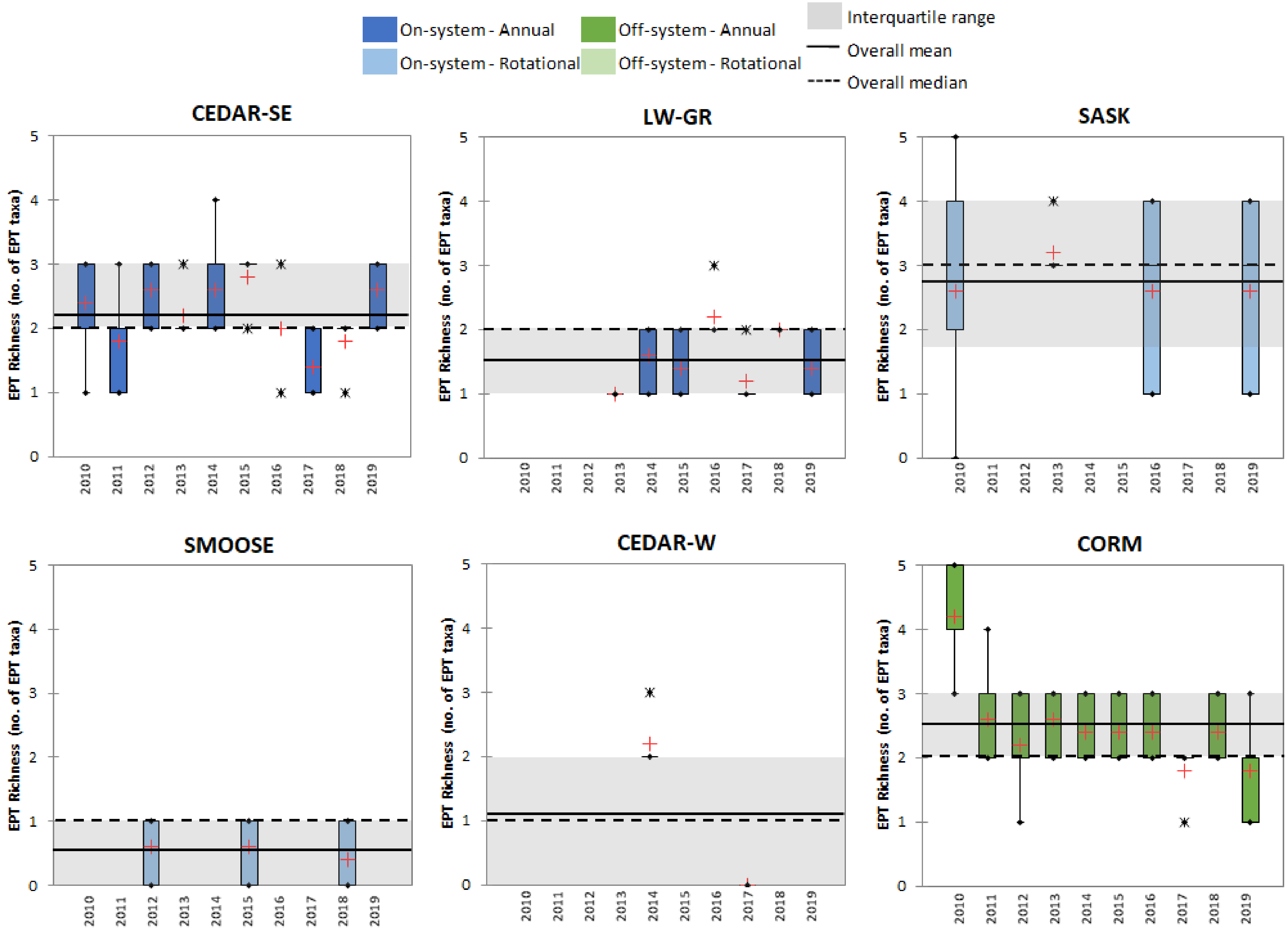


Figure 4.4-4. 2010 to 2019 Offshore benthic invertebrate EPT richness (family-level).

4.5 DIVERSITY

4.5.1 HILL'S EFFECTIVE RICHNESS

4.5.1.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

Nearshore Habitat

Annual mean Hill's effective richness (Hill's index) over the ten years of monitoring ranged from more than five (2010 and 2013) to nine (2014; Figure 4.5-1). The overall mean and median were eight, and the IQR was 6 to less than 9. Annual means were below the IQR in 2010 and 2013, and above the IQR in 2014.

Offshore Habitat

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

Lake Winnipeg – Grand Rapids

Nearshore Habitat

Annual mean Hill's index over the seven years of monitoring ranged from less than three (2013 and 2015) to five (2016 and 2019; Figure 4.5-1). The overall mean was four, the median was less than four, and the IQR was 3 to 5. Annual means were below the IQR in 2013 and 2015, and above the IQR in 2017 and 2019.

Offshore Habitat

Annual mean Hill's index over the seven years of monitoring ranged from two (2014 and 2017) to less than four (2018; Figure 4.5-2). The overall mean and median were three, and the IQR was more than more than 2 to less than 4. Annual means were below the IQR in 2014 and 2017, and above the IQR in 2018.

ROTATIONAL SITES

Saskatchewan River

Nearshore Habitat

Annual mean Hill's index over the four years of monitoring ranged from more than two (2016) to more than three (2010; Figure 4.5-1). The overall mean and median were less than three, and the IQR was less than 3 to 3. Annual means were below the IQR in 2013 and 2016, and above the IQR in 2010.

Offshore Habitat

Annual mean Hill's index over the four years of monitoring ranged from less than three (2013) to four (2019; Figure 4.5-2). The overall mean and median were more than three, and the IQR was less than 3 to 4. Annual means for all years fell within the IQR.

South Moose Lake

Nearshore Habitat

Annual mean Hill's index over the three years of monitoring ranged from less than six (2012) to eight (2015; Figure 4.5-1). The overall mean was seven, the median was less than seven, and the IQR was 6 to 8. Annual means were within the IQR, except in 2012 (below).

Offshore Habitat

Annual mean Hill's index over the three years of monitoring ranged from more than two (2015) to more than three (2012; Figure 4.5-2). The overall mean and median were less than three, and the IQR was more than 2 to 3. Annual means were within the IQR, except in 2012 (above).

Cedar Lake - West

Nearshore Habitat

Annual mean Hill's index over the two years of monitoring ranged from five (2017) to less than six (2014; Figure 4.5-1). The overall mean and median were more than five, and the IQR was more than 4 to less than 6. Annual means for all years fell within the IQR.

Offshore Habitat

Annual mean Hill's index over the two years of monitoring ranged from one (2017) to four (2014; Figure 4.5-2). The overall mean was less than three, the overall median was more than two, and the IQR was 1 to 4. Annual means for all years fell within the IQR.

4.5.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

Nearshore Habitat

Annual mean Hill's index over the ten years of monitoring ranged from less than five (2013) to nine (2015; Figure 4.5-1). The overall mean and median were more than six, and the IQR was less than 5 to more than 7. Annual means were below the IQR in 2013 and above the IQR in 2011, 2015, and 2016.

Offshore Habitat

Annual mean Hill's index over the ten years of monitoring ranged from less than four (2017 and 2019) to eight (2011; Figure 4.5-2). The overall mean was more than five, the median was less than five, and the IQR was more than 4 to more than 6. Annual means were below the IQR in 2017 and 2019, and above the IQR in 2010 and 2011.

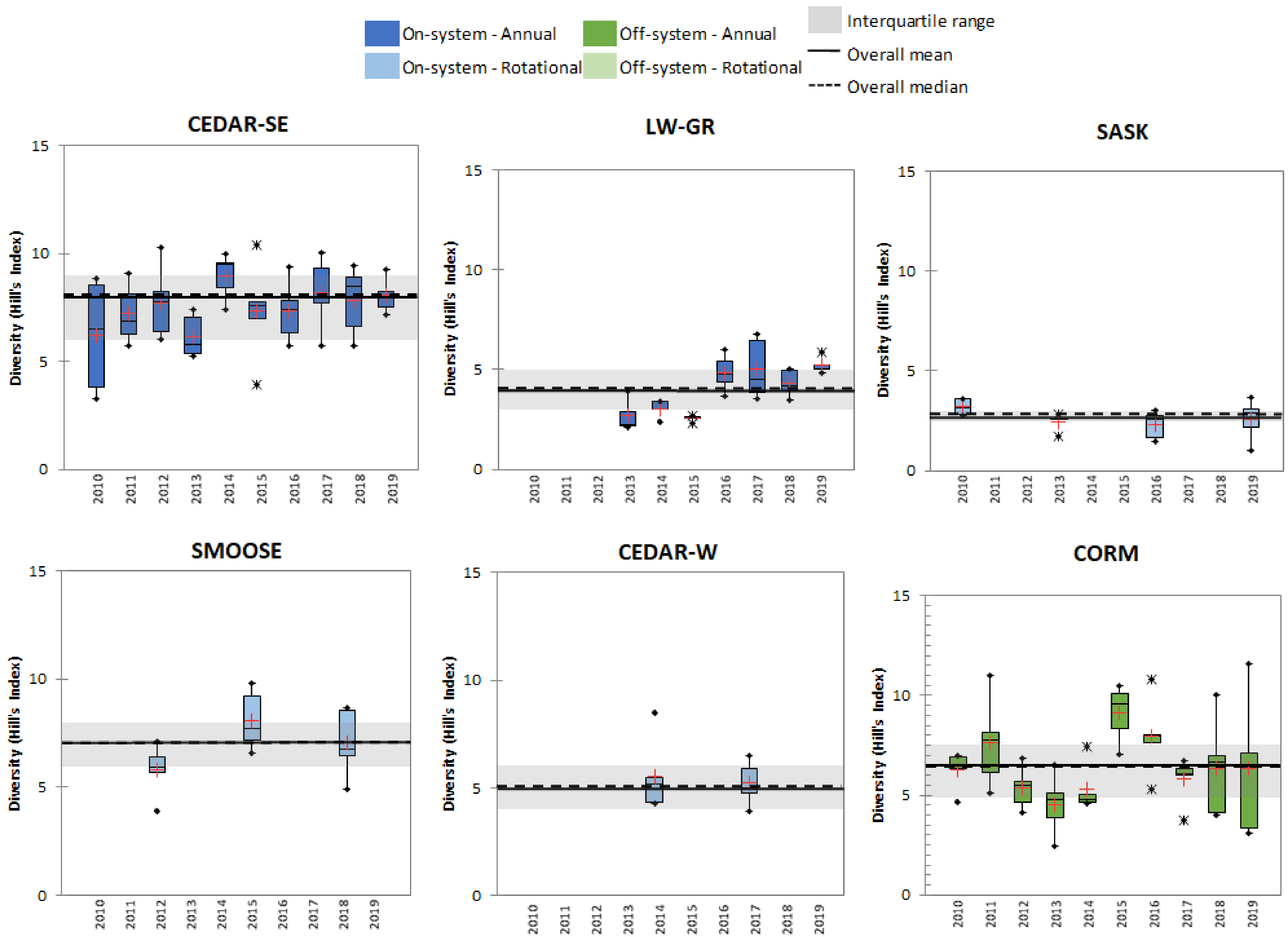


Figure 4.5-1. 2010 to 2019 Nearshore benthic invertebrate diversity (family-level).

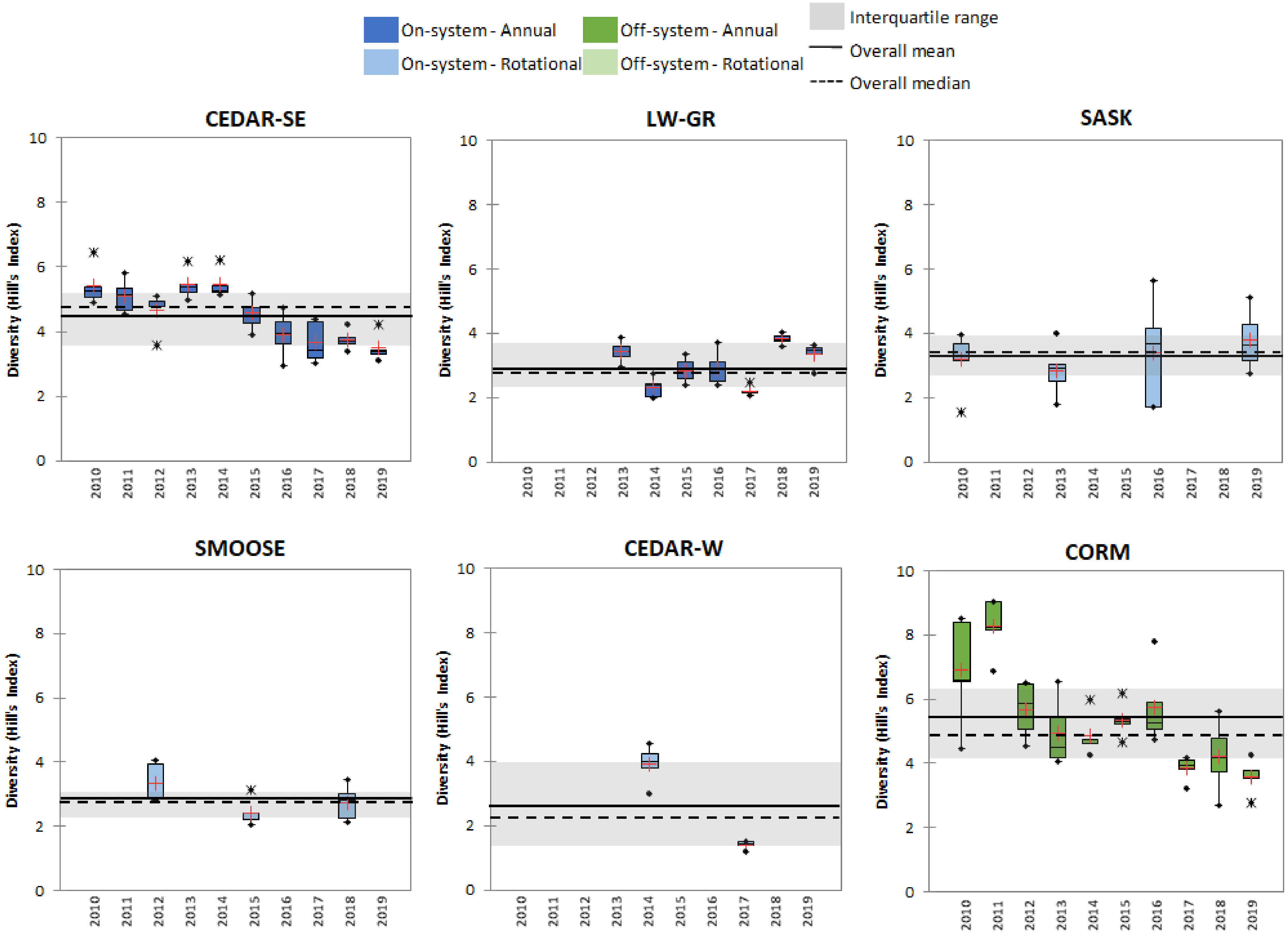


Figure 4.5-2. 2010 to 2019 Offshore benthic invertebrate diversity (family-level).

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

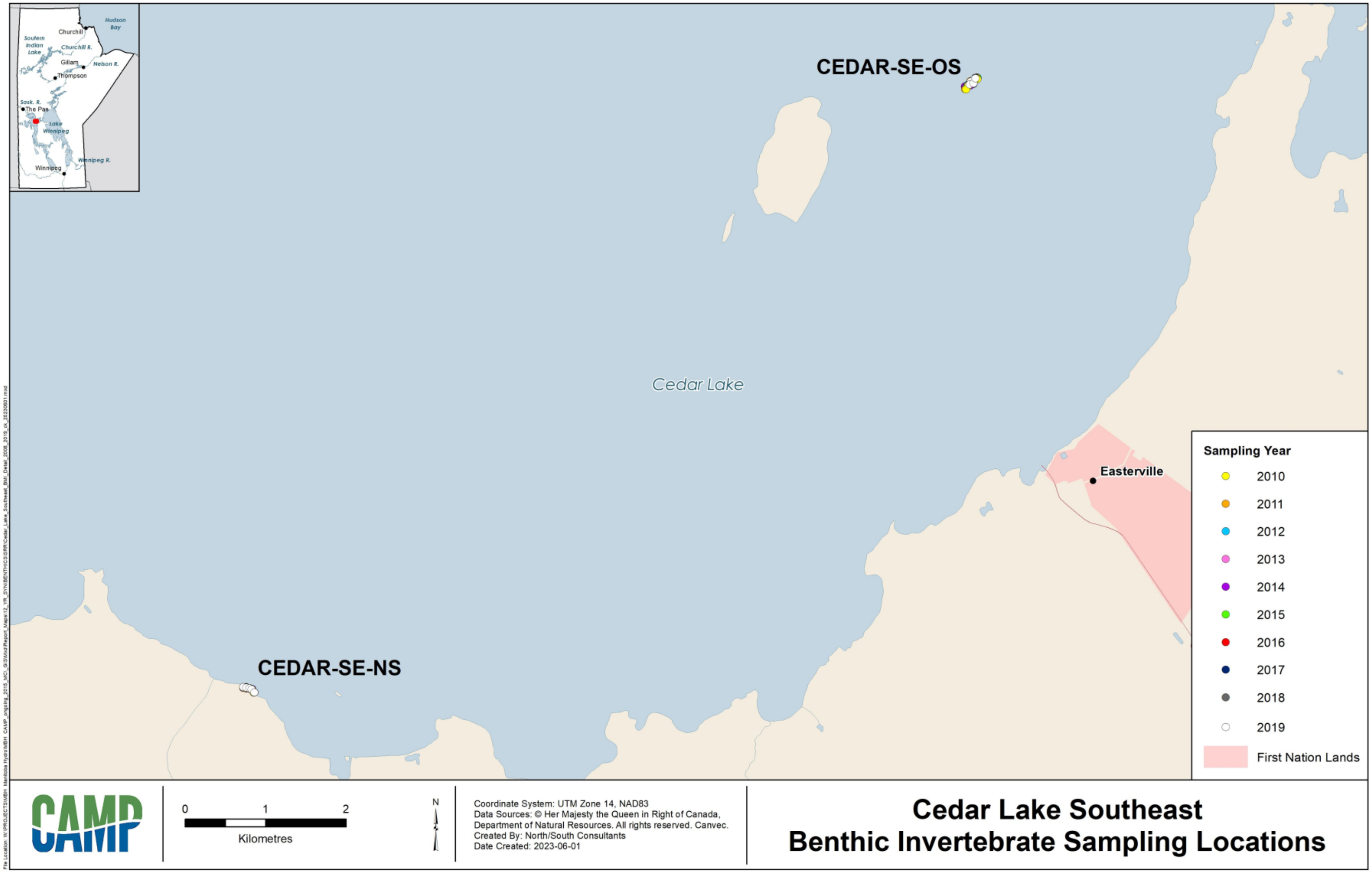


Figure A4-1-1. 2010 to 2019 Cedar Lake – Southeast nearshore (NS) and offshore (OS) benthic invertebrate sampling sites.

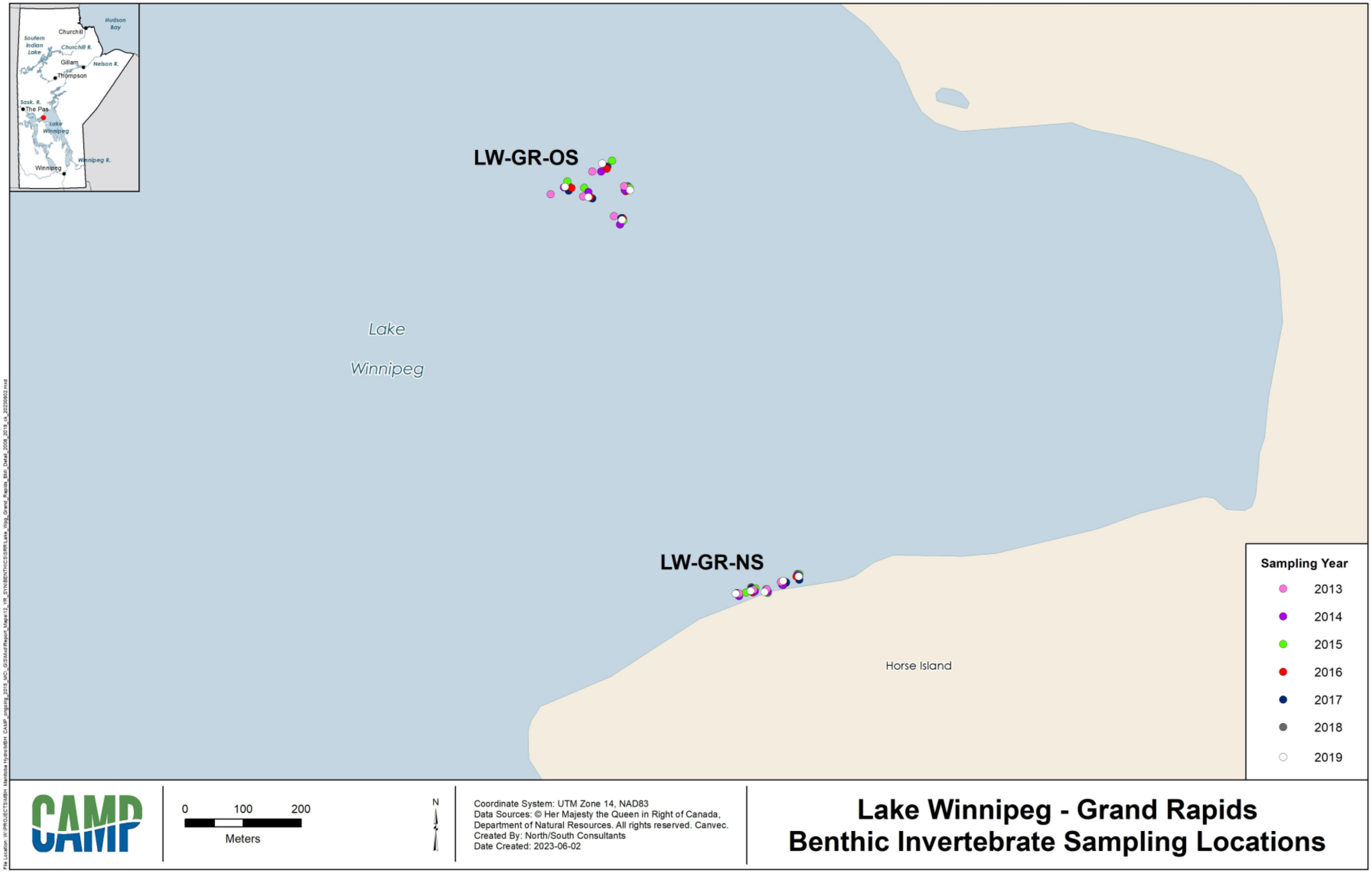


Figure A4-1-2. 2010 to 2019 Lake Winnipeg – Grand Rapids nearshore (NS) and offshore (OS) benthic invertebrate sampling sites.

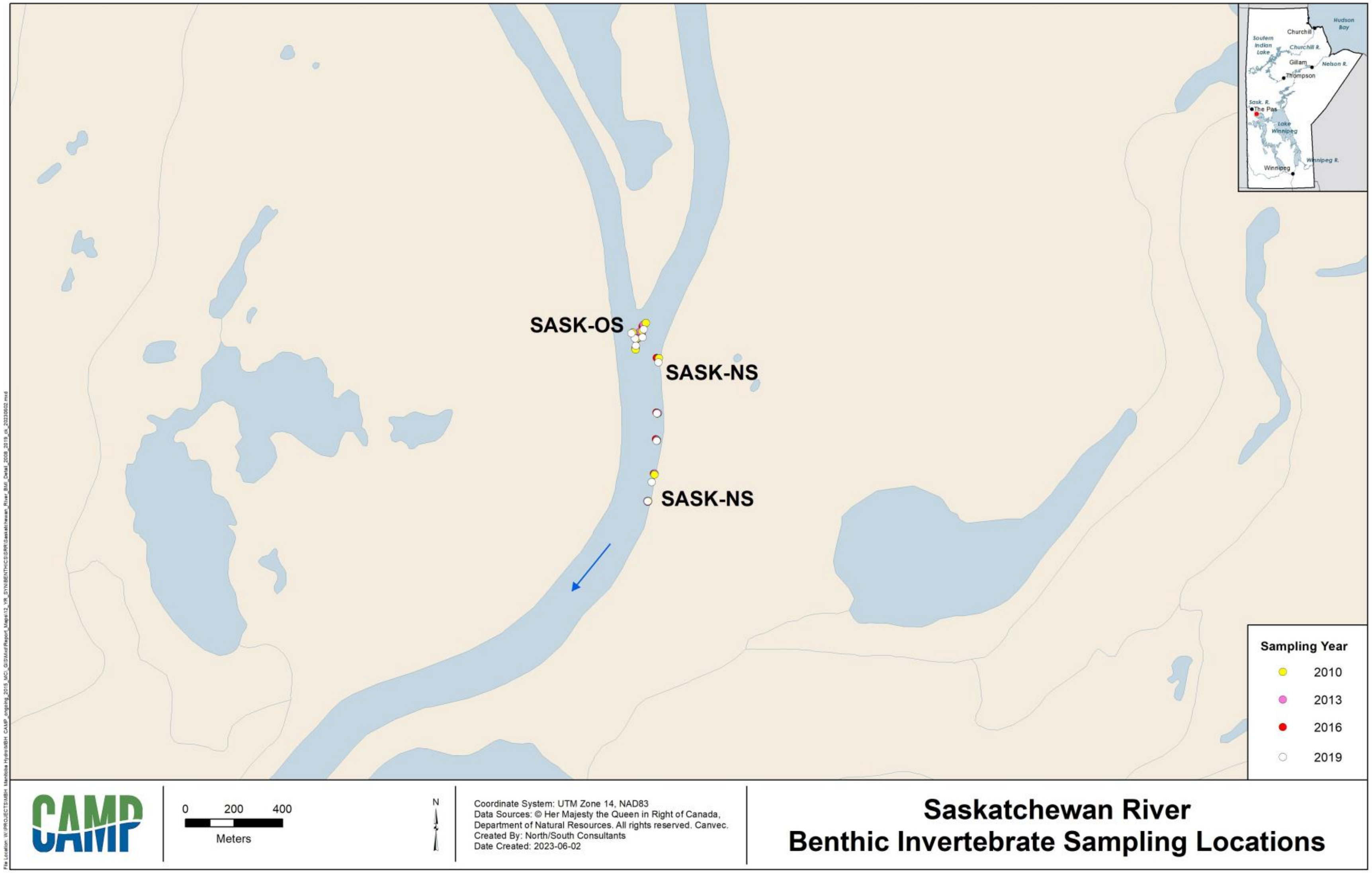


Figure A4-1-3. 2010 to 2019 Saskatchewan River nearshore (NS) and offshore (OS) benthic invertebrate sampling sites.

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

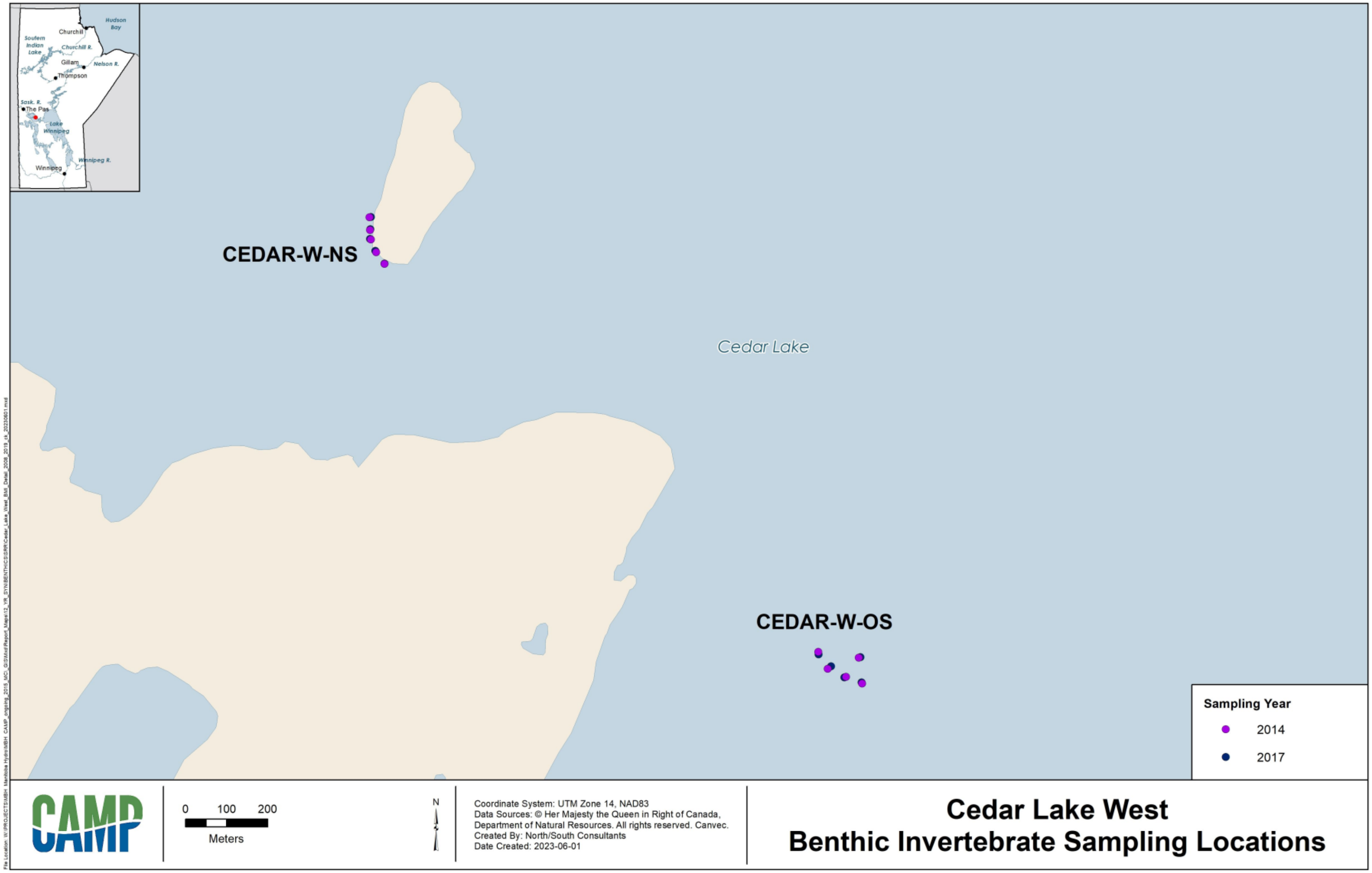


Figure A4-1-5. 2010 to 2019 Cedar Lake - West nearshore (NS) and offshore (OS) benthic invertebrate sampling sites.

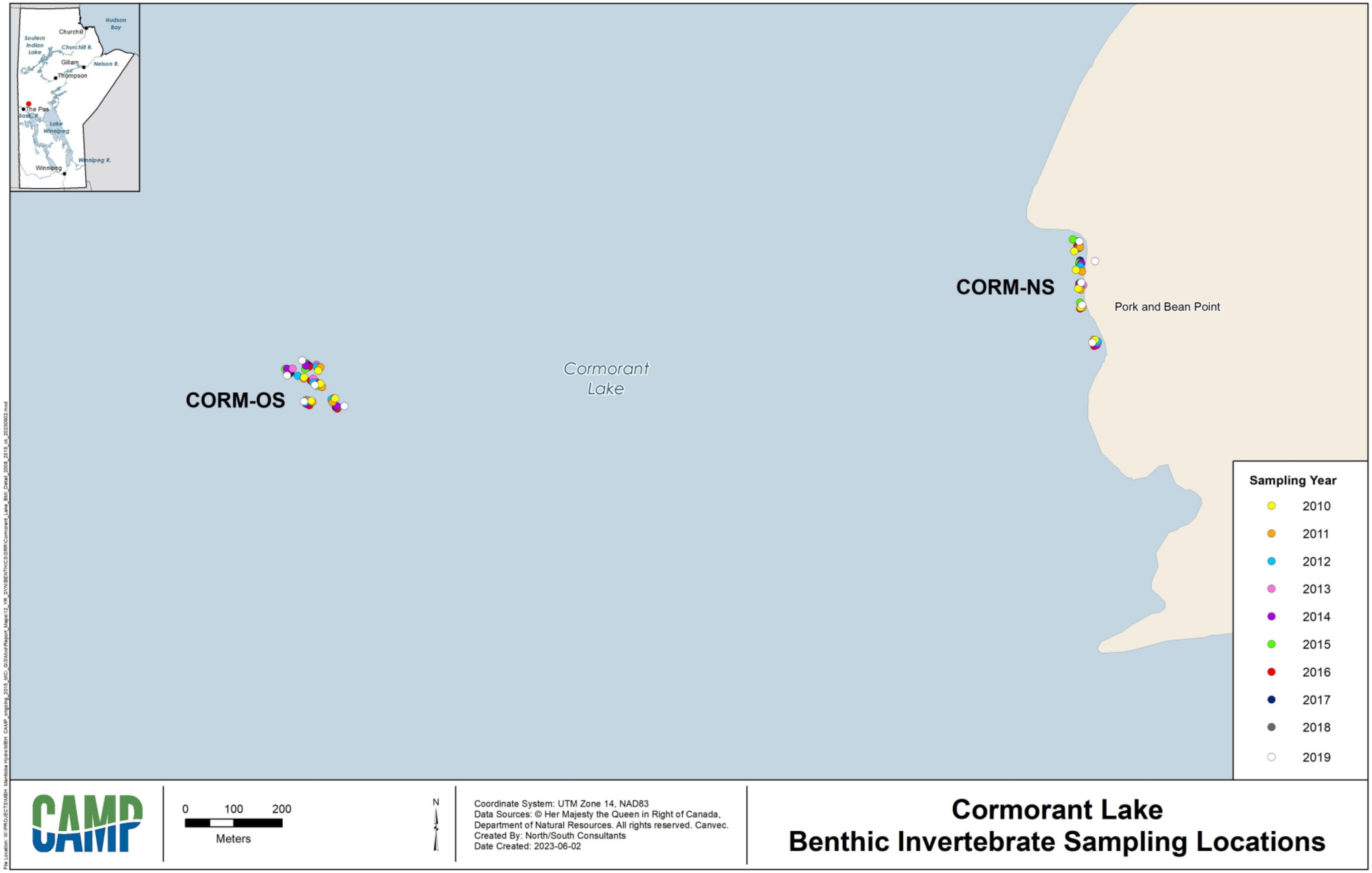


Figure A4-1-6. 2010 to 2019 Cormorant Lake nearshore (NS) and offshore (OS) benthic invertebrate sampling sites.

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

Table A4-2-1. 2010 to 2019 Cedar Lake – Southeast 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 and coarse	no sample	-	-	-	-	-
2011	hard and coarse	no sample	-	-	-	-	-
2012	hard and coarse	no sample	-	-	-	-	-
2013	hard and coarse	no sample	-	-	-	-	-
2014	hard and coarse	no sample	-	-	-	-	-
2015	hard and coarse	no sample	-	-	-	-	-
2016	coarse	no sample	-	-	-	-	-
2017	hard and coarse	no sample	-	-	-	-	-
2018	hard and coarse	no sample	-	-	-	-	-
2019	hard and coarse	no sample	-	-	-	-	-

Notes:
1. TOC = Total organic carbon.

Table A4-2-2. 2010 to 2019 Cedar Lake - Southeast 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 and organics	6.4	41.1	25.2	33.7	21.4	Clay loam
2011	fines and organics	6.2	34.9	37.7	27.5	19.5	Clay loam
2012	fines and organics	6.2	36.0	39.4	24.7	20.1	Loam
2013	organics	6.1	13.4	68.1	18.5	18.3	Silt loam
2014	organics	6.0	23.9	58.7	17.4	19.0	Silt loam
2015	fines and organics	6.1	18.8	62.2	18.9	20.1	Silt loam
2016	organics	6.2	34.1	42.3	23.6	21.4	Loam
2017	organics	6.3	9.8	63.0	27.2	23.4	Silty clay loam
2018	fines and organics	6.1	26.3	66.5	7.3	22.4	Silt loam
2019	fines and organics	6.2	16.4	56.2	27.4	25.0	Silty clay loam

Table A4-2-3. 2010 to 2019 Lake Winnipeg – Grand Rapids nearshore supporting benthic substrate data.

Year	Dominant Substrate	Sample Water Depth (m)	Supporting Substrate Analysis				
			Mean Particle Size (%)			Mean TOC (%)	Texture
			Sand	Silt	Clay		
2013	coarse	no sample	-	-	-	-	-
2014	hard and coarse	no sample	-	-	-	-	-
2015	hard and coarse	no sample	-	-	-	-	-
2016	coarse	no sample	-	-	-	-	-
2017	coarse	no sample	-	-	-	-	-
2018	hard and coarse	no sample	-	-	-	-	-
2019	hard and coarse	no sample	-	-	-	-	-

Notes:
1. TOC = Total organic carbon.

Table A4-2-4. 2010 to 2019 Lake Winnipeg – Grand Rapids offshore supporting benthic substrate data.

Year	Dominant Substrate	Sample Water Depth (m)	Supporting Substrate Analysis				
			Mean Particle Size (%)			Mean TOC (%)	Texture
			Sand	Silt	Clay		
2013	clay	6.2	3.5	78.5	18.0	2.5	Silt loam
2014	clay/silt	6.5	4.6	79.1	16.3	2.3	Silt loam
2015	clay/silt	6.0	5.1	75.0	19.9	2.2	Silt loam
2016	clay	6.0	2.6	86.6	10.7	5.1	Silt
2017	clay	5.9	3.6	77.0	19.5	5.8	Silt loam
2018	silt/clay	5.6	3.8	71.8	24.4	4.8	Silt loam
2019	clay/silt/sand	6.2	4.2	70.2	25.6	4.4	Silt loam

Notes:
1. TOC = Total organic carbon.

Table A4-2-5. 2010 to 2019 Saskatchewan River 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 and organics	0.8	14.1	62.0	23.9	1.7	Silt loam
2013	fines	0.3	39.8	45.8	14.4	1.1	Silt loam
2016	fines	2.4	18.5	57.4	24.1	2.5	Loam
2019	fines and organics	0.9	27.7	55.4	16.9	1.8	Silt loam

Notes:

1. TOC = Total organic carbon.

Table A4-2-6. 2010 to 2019 Saskatchewan River 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 and organics	6.5	19.9	52.7	27.4	1.3	Silty clay/Loam
2013	fines	6.5	34.8	41.9	23.3	1.1	Loam
2016	fines	6.6	19.2	54.9	26.0	2.1	Silt loam
2019	fines, organics, and coarse	6.7	18.2	64.9	16.9	1.6	Silt loam

Notes:

1. TOC = Total organic carbon.

Table A4-2-7. 2010 to 2019 South Moose 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		
2012	coarse and hard	no sample	-	-	-	-	-
2015	coarse and hard	no sample	-	-	-	-	-
2018	coarse and hard	no sample	-	-	-	-	-

Notes:
1. TOC = Total organic carbon.

Table A4-2-8. 2010 to 2019 South Moose 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		
2012	fines	6.8	0.7	90.2	9.1	4.3	Silt
2015	fines	6.6	0.3	58.0	41.9	4.5	Silty clay loam
2018	fines	7.0	<1.0	90.7	9.0	4.3	Silt

Notes:
1. TOC = Total organic carbon.

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

Year	Dominant Substrate	Sample Water Depth (m)	Supporting Substrate Analysis				
			Mean Particle Size (%)			Mean TOC (%)	Texture
			Sand	Silt	Clay		
2014	coarse and hard	no sample	-	-	-	-	-
2017	hard	no sample	-	-	-	-	-

Notes:
1. TOC = Total organic carbon.

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

Year	Dominant Substrate	Sample Water Depth (m)	Supporting Substrate Analysis				
			Mean Particle Size (%)			Mean TOC (%)	Texture
			Sand	Silt	Clay		
2014	fines	5.9	0.5	50.4	49.2	5.5	Silty clay
2017	fines	5.9	<1.0	49.1	50.6	6.1	Silty clay

Notes:

1. TOC = Total organic carbon.

Table A4-2-11. 2010 to 2019 Cormorant 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 and hard	no sample	-	-	-	-	-
2011	coarse and hard	no sample	-	-	-	-	-
2012	coarse and hard	no sample	-	-	-	-	-
2013	coarse and hard	no sample	-	-	-	-	-
2014	coarse and hard	no sample	-	-	-	-	-
2015	coarse and hard	no sample	-	-	-	-	-
2016	coarse and hard	no sample	-	-	-	-	-
2017	coarse and hard	no sample	-	-	-	-	-
2018	coarse and hard	no sample	-	-	-	-	-
2019	coarse and hard	no sample	-	-	-	-	-

Notes:

1. TOC = Total organic carbon.

Table A4-2-12. 2010 to 2019 Cormorant 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 and organics	7.4	57.1	24.8	18.2	0.9	Loam/Sandy loam
2011	fines and organics	7.9	40.2	39.1	20.7	0.9	Loam
2012	fines	7.9	47.7	31.3	21.0	1.0	Loam
2013	fines	8.4	62.7	23.6	13.8	0.9	Sandy loam
2014	fines and organics	8.7	61.4	25.8	12.7	1.0	Sandy loam
2015	fines and organics	7.9	39.5	35.6	24.9	1.2	Silt/Clay loam
2016	fines	7.9	45.0	38.3	16.7	1.4	Sandy loam
2017	fines	8.5	42.8	35.5	21.7	1.5	Clay loam
2018	fines and organics	8.5	53.7	36.9	9.5	1.2	Silt loam
2019	fines and organics	8.3	42.7	33.9	23.5	1.3	Loam/Clay 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 Saskatchewan River Region. Six waterbodies were monitored in the Saskatchewan River Region: two on-system annual sites (Cedar Lake – Southeast and Lake Winnipeg – Grand Rapids); three on-system rotational sites (the Saskatchewan River between the Town of The Pas and Cedar Lake [hereafter referred to as the Saskatchewan River], South Moose Lake, and Cedar Lake – West); and one off-system annual site (Cormorant Lake; Table 5.1-1 and Figure 5.1-1).

There was one departure from the planned field sampling during the 12-year period. Cedar Lake – West was sampled in 2018 because it was not sampled as scheduled in 2017.

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 with a few exceptions:

- Cedar Lake – Southeast was sampled later in 2014 and 2019 (mid/late-September) compared to other years (mid-Aug to early-September);
- sampling at the Lake Winnipeg – Grand Rapids varied from mid-June/early-July (2009-2012, 2015-2017 and 2019), to mid-July (2013, 2014, and 2018), to mid-August (2008);
- the Saskatchewan River was sampled later in 2013 (late-October) compared to other years (mid-September); and
- Cormorant Lake was sampled later in 2011 (early-October) compared to other years (mid-August to mid-September).

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: Lake Whitefish (LKWH; *Coregonus clupeaformis*) and Walleye (WALL; *Sander vitreus*) from all waterbodies in all years; Northern Pike (NRPK; *Esox lucius*) from all waterbodies in all years except at Grand Rapids in Lake Winnipeg where it was added as a target species in 2013 (although age data was not collected until 2015); Sauger (SAUG; *S. canadensis*) was a target species at Lake Winnipeg – Grand Rapids in all years, but was not included as a target species until 2017 at the other waterbodies (although age data was not collected until 2018); and White Sucker (WHSC; *Catostomus commersonii*) from all waterbodies starting in 2010 (although biometric data was not collected until 2013 at Lake Winnipeg - Grand Rapids and South Moose Lake). 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
CEDAR-SE		●	●	●	●	●	●	●	●	●	●	●
LW-GR	●	●	●	●	●	●	●	●	●	●	●	●
SASK			●			●			●			●
SMOOSE		●			●			●			●	
CEDAR-W				●			●			[1]	●	
CORM	●	●	●	●	●	●	●	●	●	●	●	●

Notes:

1. Cedar Lake - West was not sampled on schedule in 2017 and was sampled instead in 2018.

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.

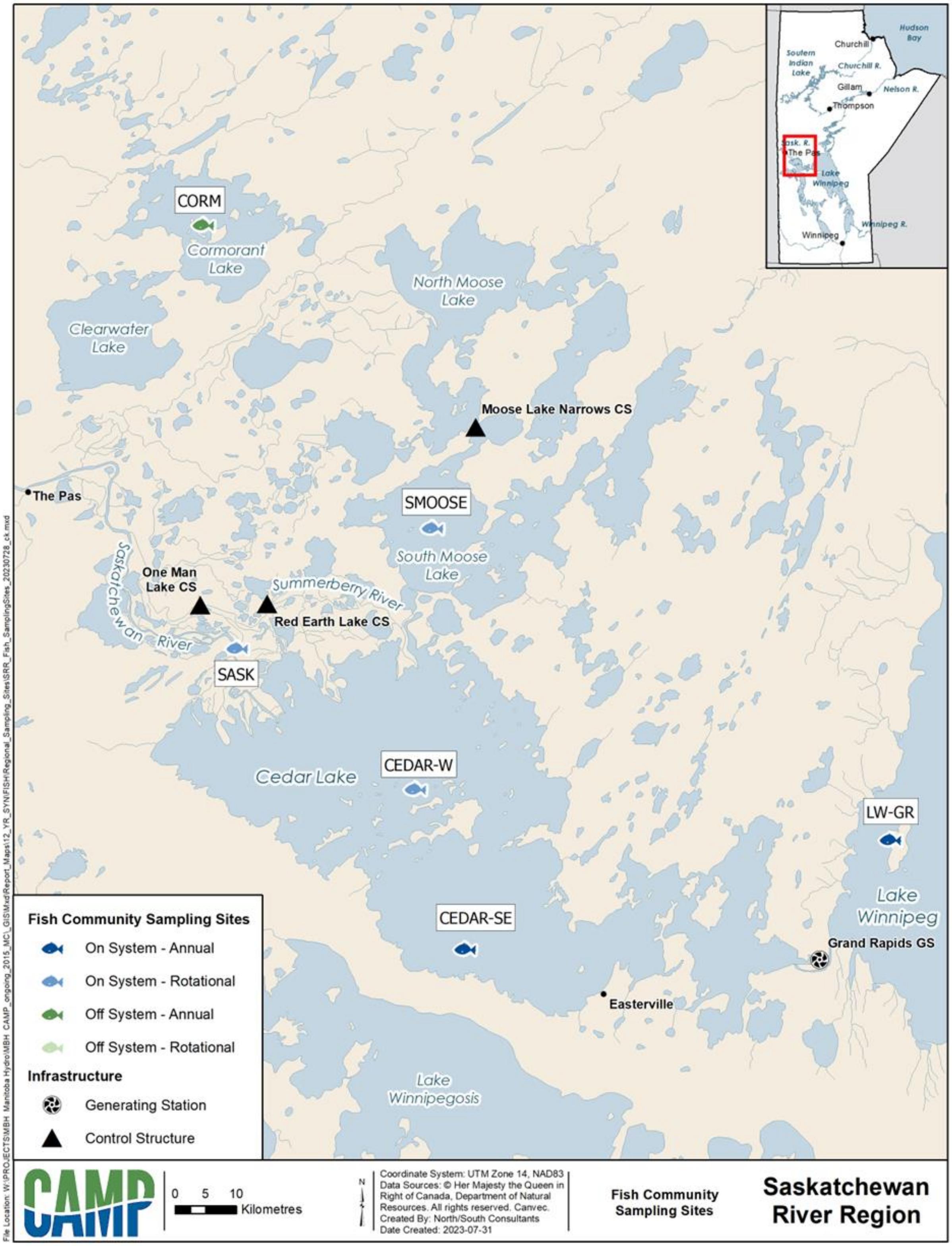


Figure 5.1-1. 2008-2019 Saskatchewan River fish community sampling sites.

5.2 ABUNDANCE

5.2.1 CATCH-PER-UNIT-EFFORT

5.2.1.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake – Southeast

Standard Gang Index Gill Nets

The annual mean CPUE over the 11 years of monitoring varied up to about two-fold from year-to-year, with the mean ranging from a low of 33.2 in 2017 to a maximum of 73.3 fish/100 m/24 h in 2011 (Table 5.2-1; Figure 5.2-1).

The overall mean CPUE was 54.4, the median was 53.8, and the interquartile range (IQR) was 41.1-64.5 fish/100 m/24 h (Figure 5.2-1). The annual mean CPUE fell within the overall IQR except in 2017 when it was below the IQR and in 2010, 2011, and 2018 when it was above the IQR.

Small Mesh Index Gill Nets

The annual mean CPUE in the small mesh gangs over the 10 years of monitoring was more variable than in the standard gangs, with the mean ranging from a low of 40.7 in 2009 to a high of 344.9 fish/30 m/24 h in 2012 (Table 5.2-1; Figure 5.2-2). Small mesh gangs were not set at target locations in 2010 (Appendix 5-1).

The overall mean CPUE was 117.1, the median was 90.6, and the IQR was 61.5-134.3 fish/30 m/24 h (Figure 5.2-2). The annual mean CPUE fell within the overall IQR except in 2009, 2013, and 2019 when it was below the IQR and in 2011, 2012, and 2018 when it was above the IQR.

Lake Whitefish

Catches of Lake Whitefish were low at Cedar Lake – Southeast over the 11 years of monitoring, with the annual mean CPUE ranging from a low of zero in most years (2010, 2015 to 2019) to a high of 0.2 fish/100 m/24 h in 2012 (Table 5.2-1; Figure 5.2-3).

The overall mean CPUE was <0.1, the median was zero, and the IQR was 0-0.1 fish/100 m/24 h (Figure 5.2-3). The annual mean CPUE fell within the overall IQR except in 2012 when it was above the IQR.

Northern Pike

Catches of Northern Pike were relatively low at Cedar Lake – Southeast over the 11 years of monitoring, with the annual mean CPUE ranging from 1.6 in 2010 to a high of 5.9 fish/100 m/24 h in 2018 (Table 5.2-1; Figure 5.2-4).

The overall mean CPUE was 3.1, the median was 2.9, and the IQR was 2.2-3.8 fish/100 m/24 h (Figure 5.2-4). The annual mean CPUE fell within the overall IQR except in 2010 and 2011 when it was below the IQR and in 2014, 2015, and 2018 when it was above the IQR.

Sauger

The annual mean CPUE over the 11 years of monitoring was generally similar, with the annual mean ranging from a low of 2.0 in 2016 and 2017 to a high of 10.4 fish/100 m/24 h in 2011 (Table 5.2-1; Figure 5.2-5).

The overall mean CPUE was 5.5, the median was 4.5, and the IQR was 3.9-7.7 fish/100 m/24 h (Figure 5.2-5). The annual mean CPUE fell within the overall IQR except in 2016 and 2017 when it was below the IQR and in 2009, 2010, and 2011 when it was above the IQR.

Walleye

The annual mean CPUE over the 11 years of monitoring varied by up to about three-fold from year-to-year, ranging from a low of 6.7 in 2012 to a high of 19.8 fish/100 m/24 h in 2009 (Table 5.2-1; Figure 5.2-6).

The overall mean CPUE was 12.6, the median was 13.1, and the IQR was 8.4-16.1 fish/100 m/24 h (Figure 5.2-6). The annual mean CPUE fell within the overall IQR except in 2012, 2017, and 2019 when it was below the IQR and in 2009, 2011, and 2018 when it was above the IQR.

White Sucker

The annual mean CPUE over the 11 years of monitoring varied by up to about four-fold, with the mean ranging from a low of 6.5 in 2019 to a high of 28.8 fish/100 m/24 h in 2018 (Table 5.2-1; Figure 5.2-7).

The overall mean CPUE was 13.9, the median was 12.3, and the IQR was 10.2-15.6 fish/100 m/24 h (Figure 5.2-7). The annual mean CPUE fell within the overall IQR except in 2012, 2013, and 2019 when it was below the IQR and in 2009, 2015, and 2018 when it was above the IQR.

Lake Winnipeg – Grand Rapids

Standard Gang Index Gill Nets

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 57.2 in 2017 to a high of 195.4 fish/100 m/24 h in 2013 (Table 5.2-1; Figure 5.2-1).

The overall mean CPUE was 109.1, the median was 106.8, and the IQR was 93.5-122.4 fish/100 m/24 h (Figure 5.2-1). The annual mean CPUE fell within the overall IQR except in 2008, 2017, and 2018 when it was below the IQR and in 2012, 2013, and 2016 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 38.2 in 2018 to a high of 1344.0 fish/30 m/24 h in 2011 (Table 5.2-1; Figure 5.2-2).

The overall mean CPUE was 385.0, the median was 125.1, and the IQR was 68.1-485.8 fish/30 m/24 h (Figure 5.2-2). The annual mean CPUE fell within the overall IQR except in 2015, 2017, and 2018 when it was below the IQR and in 2009, 2011, and 2013 when it was above the IQR.

Lake Whitefish

Catches of Lake Whitefish were relatively low in the Grand Rapids area of Lake Winnipeg over the 12 years of monitoring, with the annual mean ranging from zero in 2018 to a high of 8.8 fish/100 m/24 in 2012 (Table 5.2-1; Figure 5.2-3).

The overall mean CPUE was 2.6, the median was 2.3, and the IQR was 0.5-4.0 fish/100 m/24 (Figure 5.2-3). The annual mean CPUE fell within the overall IQR except in 2008, 2016, and 2018 when it was below the IQR and in 2012 when it was above the IQR.

Northern Pike

Catches of Northern Pike were low in the Grand Rapids area of Lake Winnipeg over the 12 years of monitoring, with the annual mean CPUE ranging from zero in 2014 to a high of 1.4 fish/100 m/24 h in 2008 (Table 5.2-1; Figure 5.2-4).

The overall mean CPUE was 0.5, the median was 0.3, and the IQR was 0.3-0.7 fish/100 m/24 (Figure 5.2-4). The annual mean CPUE fell within the overall IQR except in 2014 and 2015 when it was below the IQR and in 2008, 2012, and 2019 when it was above the IQR.

Sauger

The annual mean CPUE over the 12 years of monitoring was variable from year-to-year, ranging from a low of 0.3 in 2009 to a high of 23.1 fish/100 m/24 h in 2013 (Table 5.2-1; Figure 5.2-5).

The overall mean CPUE was 9.6, the median was 8.7, and the IQR was 4.3-12.4 fish/100 m/24 h (Figure 5.2-5). The annual mean CPUE fell within the overall IQR except in 2008, 2009, and 2010 when it was below the IQR and in 2012, 2013, and 2014 when it was above the IQR.

Walleye

The annual mean CPUE over the 12 years of monitoring varied up to about four-fold from year-to-year, with the mean ranging from a low of 18.0 in 2014 to a high of 73.8 fish/100 m/24 h in 2010 (Table 5.2-1; Figure 5.2-6).

The overall mean CPUE was 45.7, the median was 44.5, and the IQR was 38.5-56.3 fish/100 m/24 h (Figure 5.2-6). The annual mean CPUE fell within the overall IQR except in 2014, 2017, and 2018 when it was below the IQR and in 2010, 2016, and 2019 when it was above the IQR.

White Sucker

The annual mean CPUE over the 12 years of monitoring was variable from year-to-year, ranging from a low of 5.3 in 2010 to a high of 42.3 fish/100 m/24 h in 2014 (Table 5.2-1; Figure 5.2-7).

The overall mean CPUE was 18.6, the median was 18.8, and the IQR was 8.4-23.8 fish/100 m/24 h (Figure 5.2-7). The annual mean CPUE fell within the overall IQR except in 2010, 2017, and 2019 when it was below the IQR and in 2008, 2011, and 2014 when it was above the IQR.

ROTATIONAL SITES

Saskatchewan River between The Pas and Cedar Lake

Standard Gang Index Gill Nets

The annual mean CPUE over the four years of monitoring varied by up to about two-fold from year-to-year, with the mean ranging from a low of 13.0 in 2013 to a high of 32.9 fish/100 m/24 h in 2019 (Table 5.2-1; Figure 5.2-1).

The overall mean CPUE was 20.6, the median was 18.2, and the IQR was 15.3-23.5 fish/100 m/24 h (Figure 5.2-1). The annual mean CPUE was below the IQR in 2013 and was above the IQR in 2019.

Small Mesh Index Gill Nets

The annual mean CPUE over the four years of monitoring was generally similar among years ranging from a low of zero in 2010 to a high of 8.6 fish/30 m/24 h in 2019 (Table 5.2-1; Figure 5.2-2).

The overall mean CPUE was 3.2, the median was 2.1, and the IQR was 1.2-4.2 fish/30 m/24 h (Figure 5.2-2). The annual mean CPUE was below the IQR in 2010 and was above the IQR in 2019.

Lake Whitefish

Lake Whitefish were not captured in the Saskatchewan River over the four years of monitoring (Table 5.2-1).

Northern Pike

Catches of Northern Pike were generally low in the Saskatchewan River over the four years of monitoring, with the annual mean CPUE ranging from 0.2 in 2016 to a high of 4.0 fish/100 m/24 h in 2013 (Table 5.2-1; Figure 5.2-4).

The overall mean CPUE was 1.3, the median was 0.5, and the IQR was 0.3-1.4 fish/100 m/24 h (Figure 5.2-4). The annual mean CPUE was below the IQR in 2016 and was above the IQR in 2013.

Sauger

Catches of Sauger were relatively low in the Saskatchewan River over the four years of monitoring, with the annual mean ranging from a low of 0.3 in 2013 to a high of 3.7 fish/100 m/24 h in 2019 (Table 5.2-1; Figure 5.2-5).

The overall mean CPUE was 1.6, the median was 1.3, and the IQR was 0.8-2.1 fish/100 m/24 h (Figure 5.2-5). The annual mean CPUE was below the IQR in 2013 and was above the IQR in 2019.

Walleye

The annual mean CPUE over the four years of monitoring varied by up to about three-fold from year-to-year, with the mean ranging from a low of 2.5 in 2013 to a high of 8.7 fish/100 m/24 h in 2019 (Table 5.2-1; Figure 5.2-6).

The overall mean CPUE was 6.1, the median was 6.6, and the IQR was 4.9-7.8 fish/100 m/24 h (Figure 5.2-6). The annual mean CPUE was below the IQR in 2013 and above the IQR in 2019.

White Sucker

The annual mean CPUE over the four years of monitoring varied by up to about three-fold, with the mean ranging from a low of 2.8 in 2010 to a high of 10.0 fish/100 m/24 h in 2019 (Table 5.2-1; Figure 5.2-7).

The overall mean CPUE was 5.5, the median was 4.6, and the IQR was 3.1-7.0 fish/100 m/24 h (Figure 5.2-7). The annual mean CPUE was slightly below the IQR in 2010 and was above the IQR in 2019.

South Moose Lake

Standard Gang Index Gill Nets

The annual mean CPUE over the four years of monitoring was generally similar ranging from a low of 38.7 in 2009 to a high of 61.1 fish/100 m/24 h in 2012 (Table 5.2-1; Figure 5.2-1).

The overall mean was 47.6, the median was 45.3, and the IQR was 43.6-49.3 fish/100 m/24 h (Figure 5.2-1). The annual mean CPUE was below the IQR in 2009 and was above the IQR in 2012.

Small Mesh Index Gill Nets

The annual mean CPUE over the four years of monitoring varied by up to about two-fold from year-to-year, with the mean ranging from a low of 516.6 in 2009 to a high of 1001.3 fish/30 m/24 h in 2015 (Table 5.2-1; Figure 5.2-2).

The overall mean CPUE was 669.0, the median was 579.1, and the IQR was 544.4-703.8 fish/30 m/24 h (Figure 5.2-2). The annual mean CPUE was below the IQR in 2009 and was above the IQR in 2015.

Lake Whitefish

Catches of Lake Whitefish were relatively low in South Moose Lake over the four years of monitoring, with the annual mean ranging from 0.2 in 2018 to a high of 3.1 fish/100 m/24 in 2015 (Table 5.2-1; Figure 5.2-3).

The overall mean and median CPUE were 1.6 and the IQR was 1.0-2.2 fish/100 m/24 h (Figure 5.2-3). The annual mean CPUE was below the IQR in 2018 and was above the IQR in 2015.

Northern Pike

The annual mean CPUE over the four years of monitoring was generally similar, with the annual mean ranging from a low of 5.4 in 2009 to a high of 10.9 fish/100 m/24 in 2012 and 2018 (Table 5.2-1; Figure 5.2-4).

The overall mean CPUE was 8.6, the median was 9.1, and the IQR was 6.8-10.9 fish/100 m/24 h (Figure 5.2-4). The annual mean CPUE was below the IQR in 2009.

Sauger

A single Sauger was captured in South Moose Lake over the four years of monitoring in 2009 (Table 5.2-1). The annual CPUE in 2009 was 0.1 fish/100 m/24 (Figure 5.2-5).

Walleye

The annual mean CPUE over the four years of monitoring varied by up to about four-fold, with the mean ranging from a low of 3.2 in 2009 to a high of 15.1 fish/100 m/24 h in 2015 (Table 5.2-1; Figure 5.2-6).

The overall mean CPUE was 8.4, the median was 7.7, and the IQR was 6.3-9.8 fish/100 m/24 h (Figure 5.2-6). The annual mean CPUE was below the IQR in 2009 and was above the IQR in 2015.

White Sucker

The annual mean CPUE over the four years of monitoring was generally similar ranging from a low of 17.8 in 2015 to a high of 27.6 fish/100 m/24 h in 2012 (Table 5.2-1; Figure 5.2-7).

The overall mean CPUE was 21.6, the median was 20.4, and the IQR was 19.4-22.6 fish/100 m/24 h (Figure 5.2-7). The annual mean CPUE was below the IQR in 2015 and was above the IQR in 2012.

Cedar Lake – West

Standard Gang Index Gill Nets

The annual mean CPUE over the three years of monitoring varied little among years ranging from a low of 56.4 in 2018 to a high of 59.6 fish/100 m/24 h in 2011 (Table 5.2-1; Figure 5.2-1).

The overall mean CPUE was 58.2, the median was 58.8, and the IQR was 57.6-59.2 fish/100 m/24 h (Figure 5.2-1). The annual mean CPUE was slightly below the IQR in 2018 and was slightly above the IQR in 2011.

Small Mesh Index Gill Nets

The annual mean CPUE over the three years of monitoring varied little among years ranging from a low of 52.0 in 2018 to a high of 63.0 fish/30 m/24 h in 2011 (Table 5.2-1; Figure 5.2-2).

The overall mean CPUE was 57.1 the median was 56.3, and the IQR was 54.2-59.7 fish/30 m/24 h (Figure 5.2-2). The annual mean CPUE was below the IQR in 2018 and was above the IQR in 2011.

Lake Whitefish

Lake Whitefish were not captured at Cedar Lake – West over the three years of monitoring (Table 5.2-1).

Northern Pike

The annual mean CPUE over the three years of monitoring was generally similar, with the annual mean ranging from a low of 4.7 in 2011 to a high of 8.0 fish/100 m/24 in 2018 (Table 5.2-1; Figure 5.2-4).

The overall mean CPUE was 6.5, the median was 6.9, and the IQR was 5.8-7.5 fish/100 m/24 h (Figure 5.2-4). The annual mean CPUE was below the IQR in 2011 and slightly above the IQR in 2018.

Sauger

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 7.8 in 2014 to a high of 19.8 fish/100 m/24 h in 2011 (Table 5.2-1; Figure 5.2-5).

The overall mean CPUE was 12.7, the median was 10.5, and the IQR was 9.2-15.2 fish/100 m/24 h (Figure 5.2-5). The annual mean CPUE was below the IQR in 2014 and was above the IQR in 2011.

Walleye

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 10.3 in 2011 to a high of 20.3 fish/100 m/24 h in 2018 (Table 5.2-1; Figure 5.2-6).

The overall mean CPUE was 16.6, the median was 19.1, and the IQR was 14.7-19.7 fish/100 m/24 h (Figure 5.2-6). The annual mean CPUE was below the IQR in 2011 and was slightly above the IQR in 2018.

White Sucker

The annual mean CPUE over the three years of monitoring was generally similar among years, ranging from a low of 11.5 in 2011 to a high of 18.2 fish/100 m/24 h in 2014 (Table 5.2-1; Figure 5.2-7).

The overall mean CPUE was 14.8, the median was 14.6, and the IQR was 13.0-16.4 fish/100 m/24 h (Figure 5.2-7). The annual mean CPUE was slightly below the IQR in 2011 and was above the IQR in 2014.

5.2.1.2 OFF-SYSTEM SITES

ANNUAL SITES

<u>**Cormorant Lake**</u>

Standard Gang Index Gill Nets

The annual mean CPUE over the 12 years of monitoring was generally similar ranging from a low of 41.1 in 2012 to a high of 65.7 fish/100 m/24 h in 2009 (Table 5.2-1; Figure 5.2-1).

The overall mean CPUE was 51.3, the median was 50.2, and the IQR was 45.4-56.3 fish/100 m/24 h (Figure 5.2-1). The annual mean CPUE fell within the overall IQR except in in 2012 and 2018 when it was below the IQR and in 2008, 2009, and 2013 when it was above the IQR.

Small Mesh Index Gill Nets

The annual mean CPUE in the small mesh gangs over the 11 years of monitoring was more variable than in the standard gangs, with the mean ranging from a low of 69.0 in 2015 to a high of 449.5 fish/30 m/24 h in 2013 (Table 5.2-1; Figure 5.2-2). Small mesh gangs were not set at target locations in 2010 (Appendix 5-1).

The overall mean CPUE was 190.4, the median was 186.6, and the IQR was 100.7-214.5 fish/30 m/24 h (Figure 5.2-2). The annual mean CPUE fell within the overall IQR except in 2009, 2011, and 2015 when it was below the IQR and in 2008, 2013, and 2014 when it was above the IQR.

Lake Whitefish

Catches of Lake Whitefish were relatively low in Cormorant Lake over the 12 years of monitoring, with the annual mean CPUE ranging from a low of 0.9 in 2013 to a high of 7.9 fish/100 m/24 h in 2011 (Table 5.2-1; Figure 5.2-3).

The overall mean CPUE was 5.0, the median was 5.9, and the IQR was 3.2-6.9 fish/100 m/24 h (Figure 5.2-3). The annual mean CPUE fell within the overall IQR except in 2013, 2015, and 2017 when it was below the IQR and in 2011 when it was above the IQR.

Northern Pike

The annual mean CPUE over the 12 years of monitoring was generally similar, with the annual mean ranging from a low of 2.7 in 2010 to a high of 8.0 fish/100 m/24 h in 2011 (Table 5.2-1; Figure 5.2-4).

The overall mean CPUE was 4.5, the median was 4.1, and the IQR was 3.5-5.3 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 2011 and 2019 when it was above the IQR.

Sauger

The annual mean CPUE over the 12 years of monitoring was generally similar, with the annual mean ranging from a low of 0.5 in 2019 to a high of 3.3 fish/100 m/24 h in 2013 (Table 5.2-1; Figure 5.2-5).

The overall mean and median CPUE were 1.5 and the IQR was 1.1-2.0 fish/100 m/24 h (Figure 5.2-5). The annual mean CPUE fell within the overall IQR except in in 2011 and 2019 when it was below the IQR and in 2013 when it was above the IQR.

Walleye

The annual mean CPUE over the 12 years of monitoring was generally similar, with the annual mean ranging from a low of 9.7 in 2010 to a high of 17.8 fish/100 m/24 h in 2018 (Table 5.2-1; Figure 5.2-6).

The overall mean CPUE was 14.0, the median was 14.3, and the IQR was 12.1-15.8 fish/100 m/24 h (Figure 5.2-6). The annual mean CPUE fell within the overall IQR except in in 2008 and 2010 when it was below the IQR and in 2009 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 two-fold, with the mean ranging from a low of 15.0 in 2019 to a high of 31.9 fish/100 m/24 h in 2009 (Table 5.2-1; Figure 5.2-7).

The overall mean CPUE was 21.8, the median was 19.5, and the IQR was 18.0-26.8 fish/100 m/24 h (Figure 5.2-7). The annual mean CPUE fell within the overall IQR except 2018 and 2019 when it was below the IQR and in 2008 and 2009 when it was above the IQR.

ROTATIONAL SITES

There are no waterbodies in the SRR that are monitored on a rotational basis.

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

Waterbody	Year	Small Mesh Catch[1]				Total Catch[2]				LKWH			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	n_F	Mean	SE
CEDAR-SE	2009	1	36	40.7	0.0	9	547	60.1	2.3	1	0.1	0.1	18	2.0	0.4	73	8.0	1.9	179	19.8	2.4	177	19.5	2.6
	2010	0	-	-	-	12	972	69.6	11.0	0	-	-	22	1.6	0.7	122	8.7	2.0	144	10.3	2.9	199	14.3	3.7
	2011	4	460	140.9	44.1	12	932	73.3	11.3	1	0.1	0.1	19	1.7	0.8	127	10.4	2.2	223	17.6	3.7	139	10.7	2.7
	2012	4	1280	344.9	123.5	12	706	53.8	7.3	2	0.2	0.1	41	3.1	0.5	73	5.5	1.1	86	6.7	1.1	126	9.6	2.2
	2013	4	169	58.5	20.5	12	564	49.0	12.0	1	0.1	0.1	25	2.3	0.8	87	7.4	2.5	144	13.1	3.5	99	8.1	2.8
	2014	4	289	86.6	25.0	12	529	44.1	3.2	1	0.1	0.1	48	4.1	0.8	47	3.9	0.8	108	9.1	1.3	140	11.8	2.8
	2015	3	255	114.6	16.3	12	686	62.4	10.5	0	-	-	58	5.0	1.1	50	4.5	1.2	157	14.5	3.2	199	16.8	3.2
	2016	4	324	94.5	34.2	12	480	44.1	4.4	0	-	-	36	3.4	1.1	21	2.0	0.4	166	14.7	2.1	132	12.3	2.9
	2017	4	227	70.5	24.8	12	375	33.2	6.0	0	-	-	28	2.3	0.6	23	2.0	0.9	85	7.5	1.5	161	14.3	3.3
	2018	4	432	164.6	27.0	12	573	66.5	8.3	0	-	-	55	5.9	1.0	33	3.9	1.2	155	17.8	2.5	244	28.8	5.5
	2019	3	93	54.9	7.7	12	355	42.7	7.6	0	-	-	29	2.9	0.9	34	4.1	0.8	63	7.8	1.4	51	6.5	1.4
LW-GR	2008	2	387	302.2	65.0	7	510	90.3	16.4	1	0.2	0.2	8	1.4	0.6	14	2.5	0.7	234	39.5	8.5	157	28.4	8.4
	2009	2	1170	669.5	56.0	9	815	115.3	10.9	27	4.3	1.5	2	0.3	0.2	2	0.3	0.2	287	41.7	3.8	166	23.2	2.7
	2010	0	-	-	-	4	366	99.7	32.6	18	4.1	2.1	2	0.6	0.3	9	2.4	0.9	260	73.8	36.3	20	5.3	1.3
	2011	1	756	1344.0	0.0	5	404	113.9	11.3	8	2.2	1.1	1	0.3	0.3	35	10.0	2.2	143	41.4	12.2	87	24.6	2.6
	2012	3	431	240.5	90.2	8	665	123.8	19.2	50	8.8	3.7	5	0.9	0.3	107	20.4	6.1	294	56.0	14.6	105	19.4	3.6
	2013	3	2028	1243.9	650.2	9	1329	195.4	22.9	25	3.3	1.8	2	0.3	0.2	159	23.1	3.2	318	47.3	4.3	161	23.6	9.4
	2014	3	243	125.1	29.4	9	669	94.6	8.9	13	1.6	0.7	0	-	-	104	14.9	2.5	129	18.0	1.7	285	42.3	8.3
	2015	3	119	65.3	22.6	9	820	121.9	10.1	16	2.3	1.0	1	0.1	0.1	76	11.6	2.9	326	49.1	10.1	111	16.7	3.9
	2016	3	136	70.8	16.4	9	898	130.0	12.2	3	0.4	0.2	2	0.3	0.2	56	8.2	1.3	388	57.3	8.8	126	18.1	3.2
	2017	3	91	39.6	2.5	9	454	57.2	5.8	4	0.5	0.2	2	0.3	0.2	39	4.9	1.0	237	29.8	3.0	50	6.4	1.6
	2018	3	92	38.2	11.7	9	580	70.4	5.1	0	-	-	5	0.6	0.2	75	9.2	0.9	281	35.4	6.0	77	9.0	2.9
	2019	2	142	95.7	30.4	9	777	97.4	9.3	30	4.0	2.0	7	0.9	0.5	65	8.2	1.3	469	58.5	8.4	54	6.9	3.7
SASK	2010	1	0	0.0	0.0	3	53	16.1	5.0	0	-	-	1	0.3	0.3	5	1.5	0.7	25	7.5	3.2	9	2.8	0.9
	2013	3	4	1.6	1.3	12	153	13.0	3.9	0	-	-	47	4.0	1.6	3	0.3	0.2	28	2.5	1.3	39	3.2	1.0
	2016	2	5	2.7	1.1	12	257	20.4	3.7	0	-	-	3	0.2	0.2	13	1.0	0.3	72	5.7	2.0	75	6.0	2.7
	2019	3	20	8.6	5.8	12	379	32.9	4.1	0	-	-	7	0.6	0.2	44	3.7	1.7	98	8.7	2.1	109	10.0	2.5
SMOOSE	2009	2	897	516.6	314.4	8	310	38.7	9.3	10	1.2	0.5	43	5.4	1.3	1	0.1	0.1	25	3.2	1.3	167	21.0	7.3
	2012	1	529	604.6	0.0	8	510	61.1	3.1	16	1.9	0.8	90	10.9	1.8	0	-	-	66	8.0	2.0	229	27.6	5.2
	2015	2	1836	1001.3	467.4	8	384	45.2	3.0	24	3.1	1.8	62	7.3	0.8	0	-	-	132	15.1	3.4	150	17.8	2.3
	2018	2	943	553.7	143.6	8	358	45.4	2.9	2	0.2	0.1	86	10.9	1.1	0	-	-	58	7.4	1.7	159	19.9	2.5
CEDAR-W	2011	3	176	63.0	6.8	12	741	59.6	9.1	0	-	-	53	4.7	1.8	252	19.8	5.1	124	10.3	2.5	144	11.5	3.7
	2014	3	147	56.3	11.8	12	678	58.8	4.3	0	-	-	84	6.9	1.1	93	7.8	2.7	213	19.1	2.3	209	18.2	2.4
	2018	3	109	52.0	20.5	12	561	56.4	7.8	0	-	-	80	8.0	2.2	107	10.5	2.3	202	20.3	5.7	143	14.6	3.7

Table 5.2-1. continued.

Waterbody	Year	Small Mesh Catch[1]				Total Catch[2]				LKWH			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	n_F	Mean	SE
CORM	2008	1	196	226.7	0.0	11	686	58.7	6.1	67	5.9	1.2	38	3.2	0.7	25	2.2	0.6	122	10.3	2.3	344	29.6	5.0
	2009	1	63	83.2	0.0	10	531	65.7	4.5	46	5.8	1.7	28	3.5	0.7	16	2.0	1.4	132	16.4	2.7	259	31.9	3.5
	2010	0	-	-	-	9	515	56.0	6.4	67	7.1	2.1	25	2.7	0.3	15	1.7	0.6	90	9.7	2.0	248	26.7	2.5
	2011	3	253	99.5	26.6	16	865	54.8	5.2	119	7.9	1.4	127	8.0	1.4	10	0.6	0.3	246	15.8	2.6	279	17.5	2.1
	2012	3	253	101.9	6.8	11	437	41.1	4.5	39	3.6	0.6	36	3.3	0.5	18	1.8	0.6	133	12.2	2.6	190	18.1	3.1
	2013	2	595	449.5	253.9	15	772	57.3	8.5	13	0.9	0.3	54	3.5	0.7	44	3.3	0.7	170	11.9	1.7	358	27.2	4.2
	2014	2	484	319.1	51.0	16	810	53.1	5.8	99	7.0	2.0	82	5.3	1.1	20	1.2	0.4	248	15.8	2.4	301	20.0	2.7
	2015	3	183	69.0	11.8	16	729	45.6	5.2	25	1.5	0.4	88	5.5	1.4	16	1.1	0.4	228	14.1	2.1	352	22.1	2.5
	2016	2	305	201.5	25.1	16	763	47.3	3.0	108	6.8	1.1	69	4.5	1.3	18	1.1	0.3	235	14.5	1.4	305	18.8	2.4
	2017	3	500	186.6	25.6	16	777	46.9	3.7	32	2.0	0.5	77	4.8	0.8	33	2.0	0.9	263	15.8	1.5	320	19.1	1.2
	2018	3	382	154.8	54.7	16	747	44.0	2.4	85	4.9	1.1	63	3.7	0.6	18	1.0	0.4	304	17.8	2.0	252	15.1	1.2
	2019	3	479	202.3	81.8	16	733	45.0	3.5	111	6.8	1.1	104	6.3	1.0	9	0.5	0.2	214	13.2	2.0	242	15.0	1.9

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.

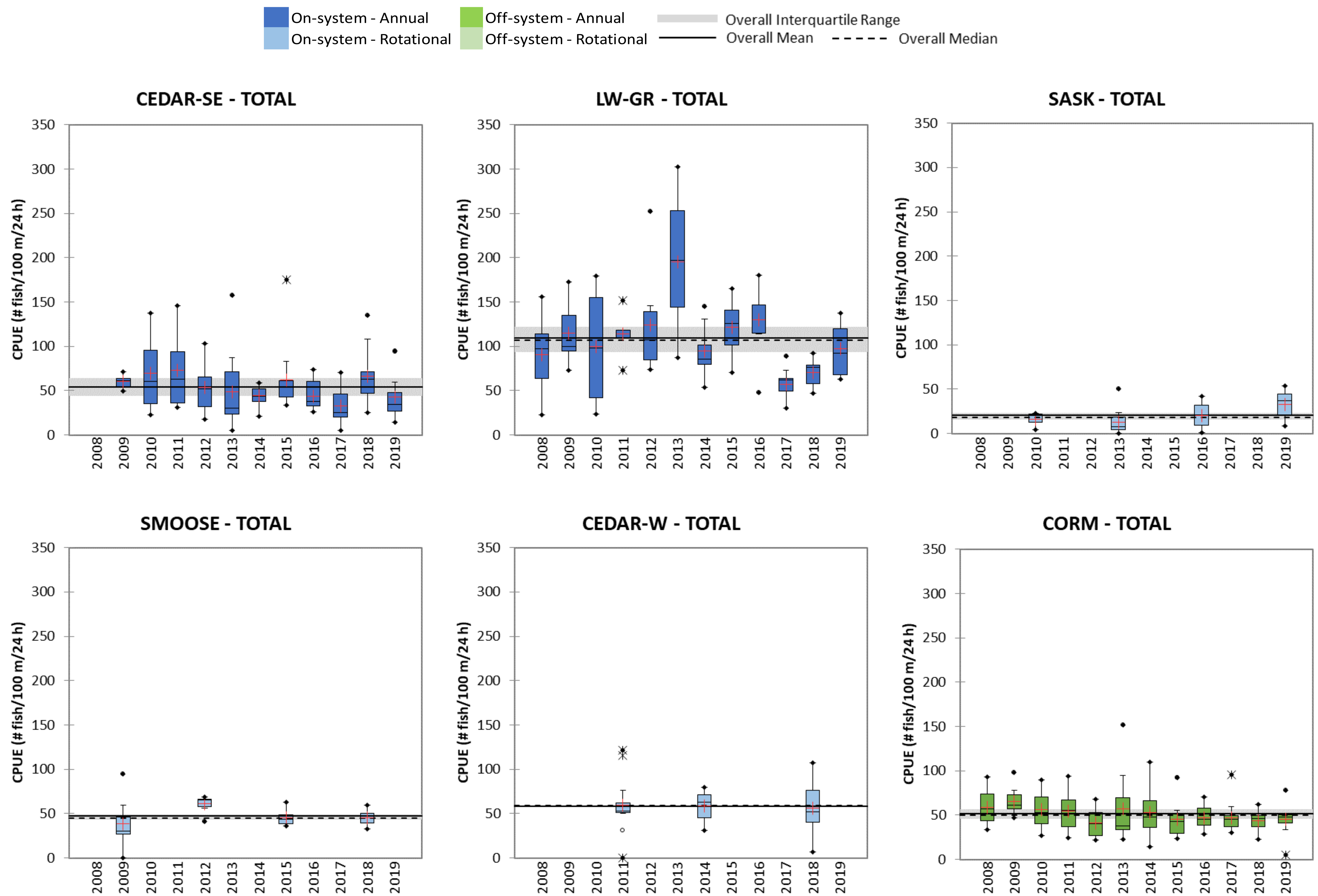


Figure 5.2-1. 2008-2019 Catch-per-unit-effort (CPUE) of standard gang index gill nets.

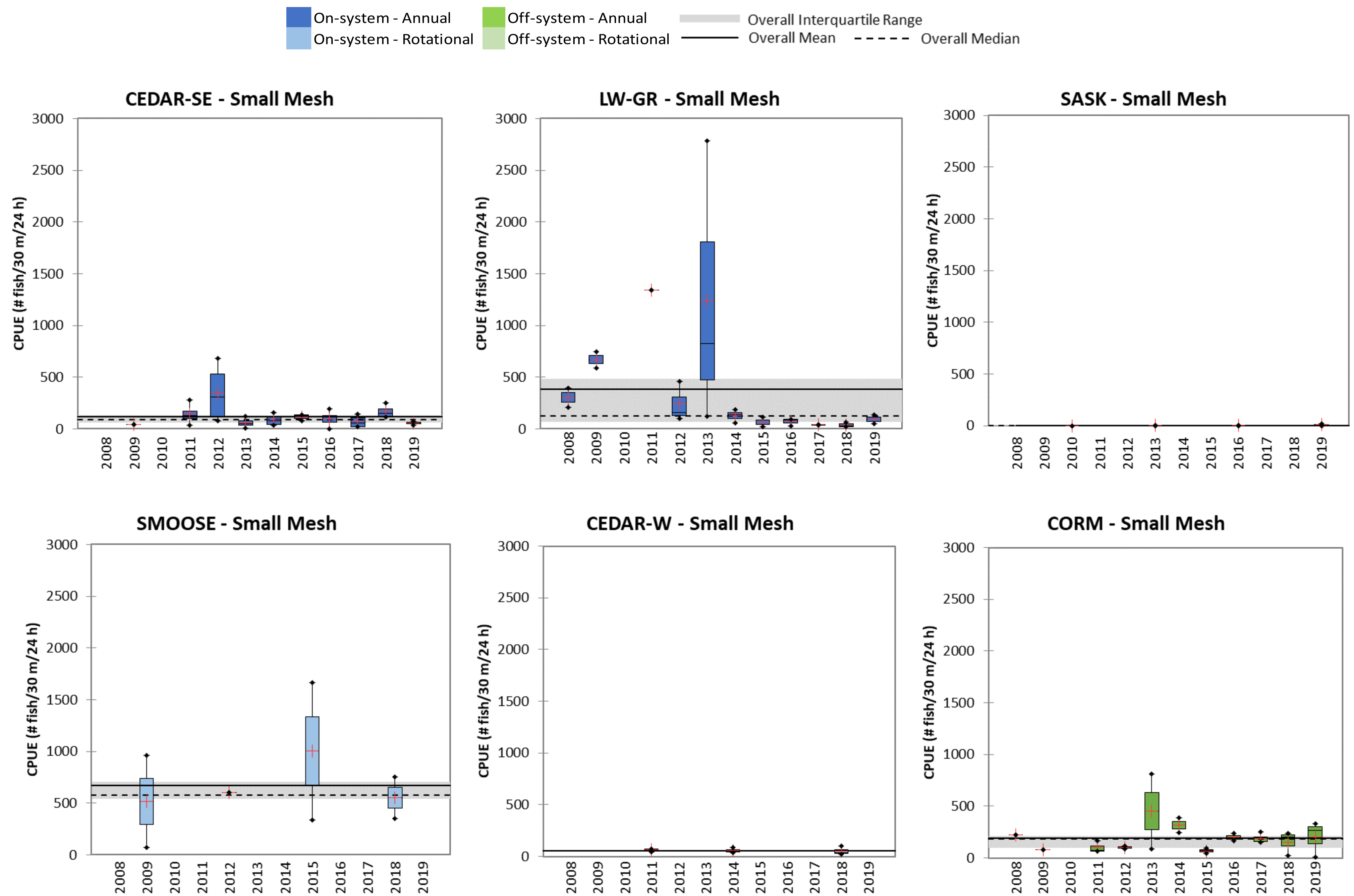


Figure 5.2-2. 2008-2019 Catch-per-unit-effort (CPUE) of small mesh index gill nets.

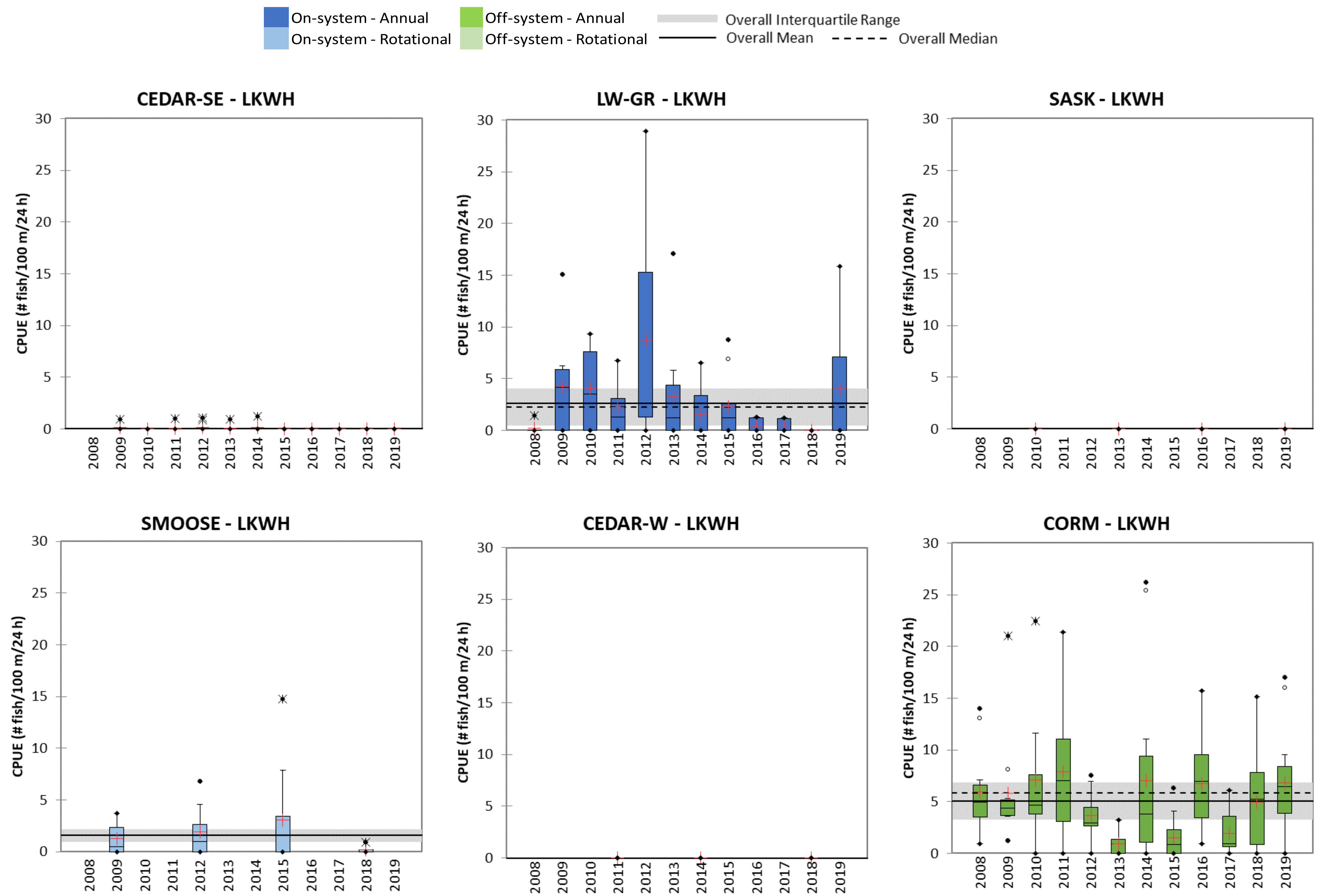


Figure 5.2-3. 2008-2019 Catch-per-unit-effort (CPUE) of Lake Whitefish.

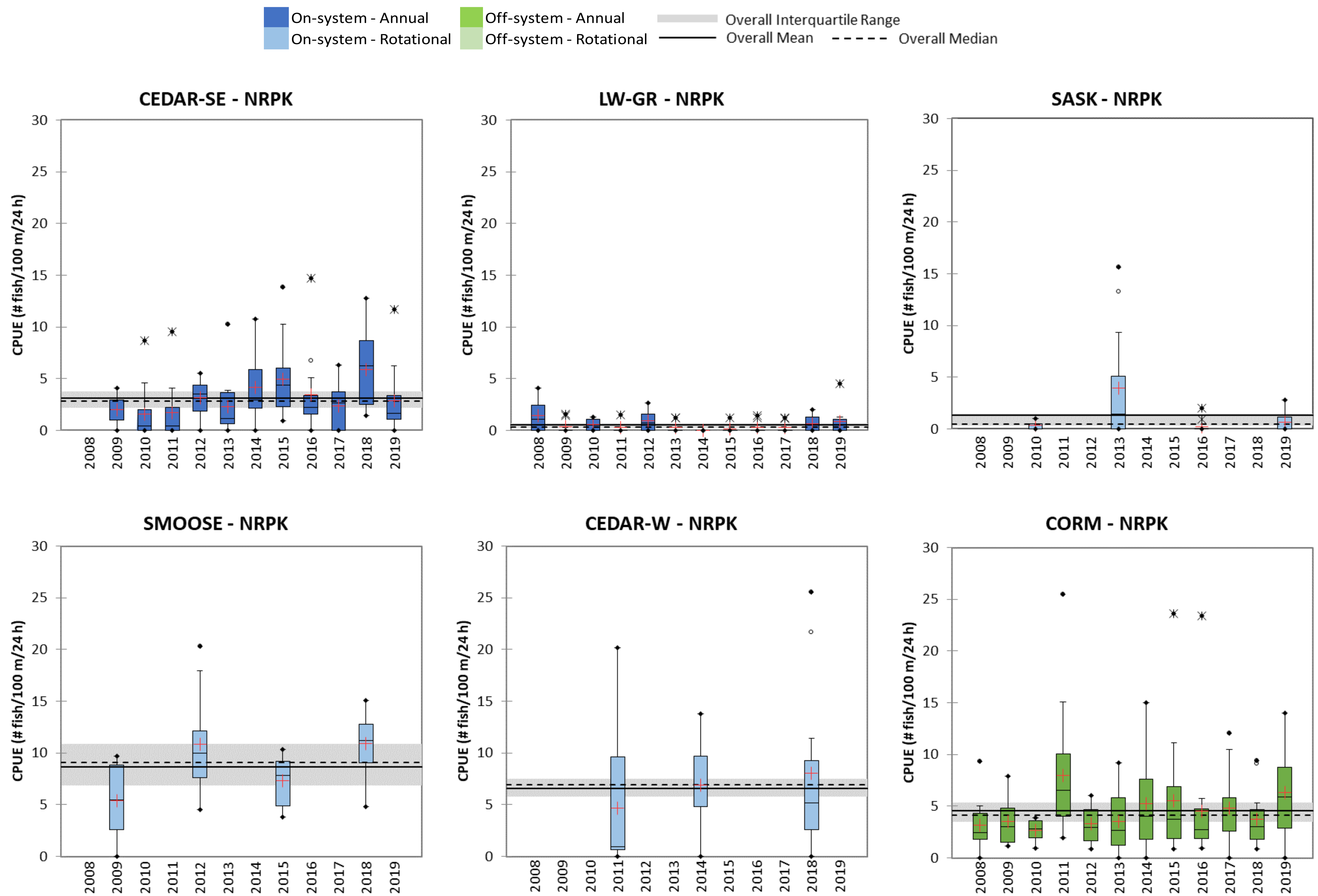


Figure 5.2-4. 2008-2019 Catch-per-unit-effort (CPUE) of Northern Pike.

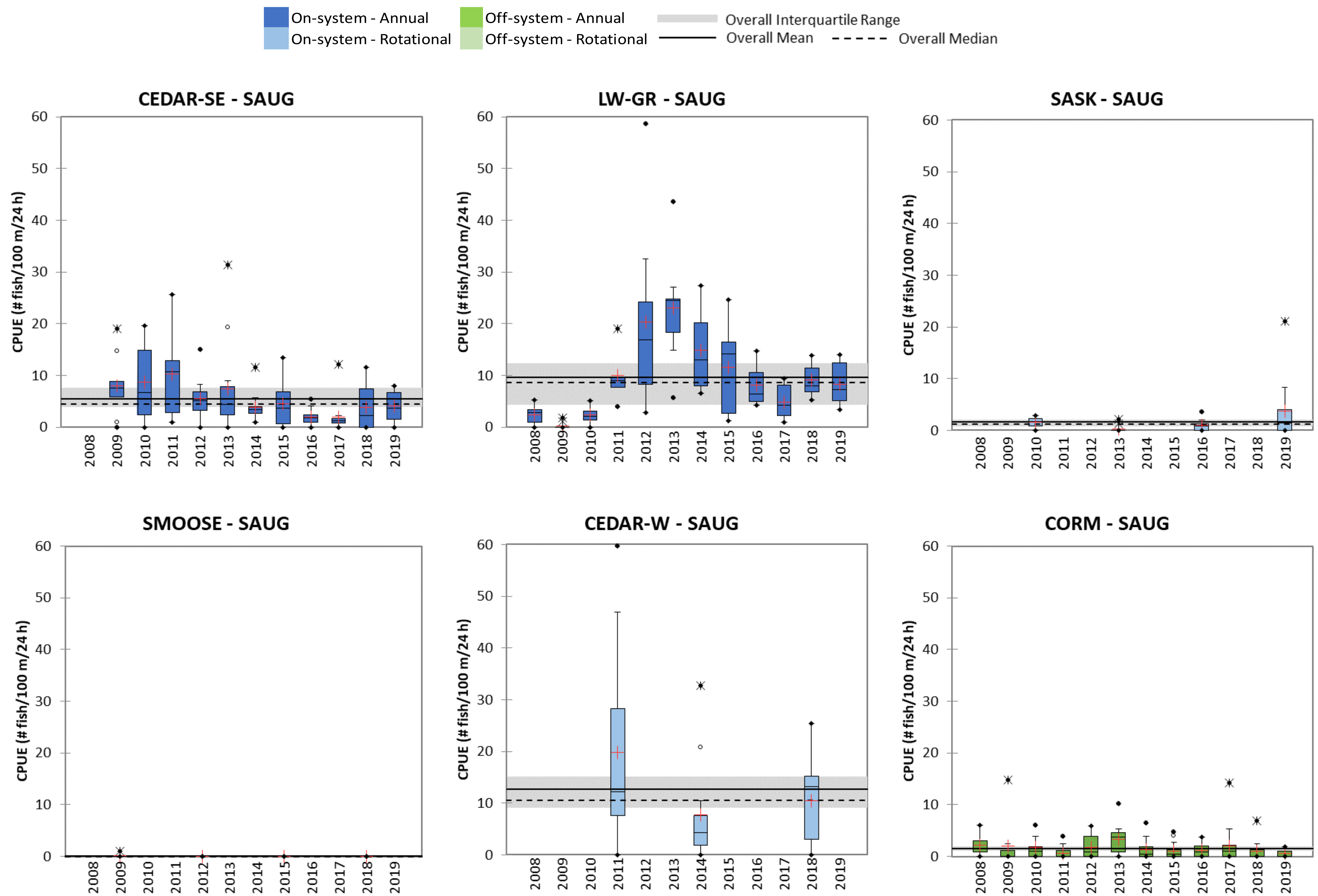


Figure 5.2-5 2008-2019 Catch-per-unit-effort (CPUE) of Sauger.

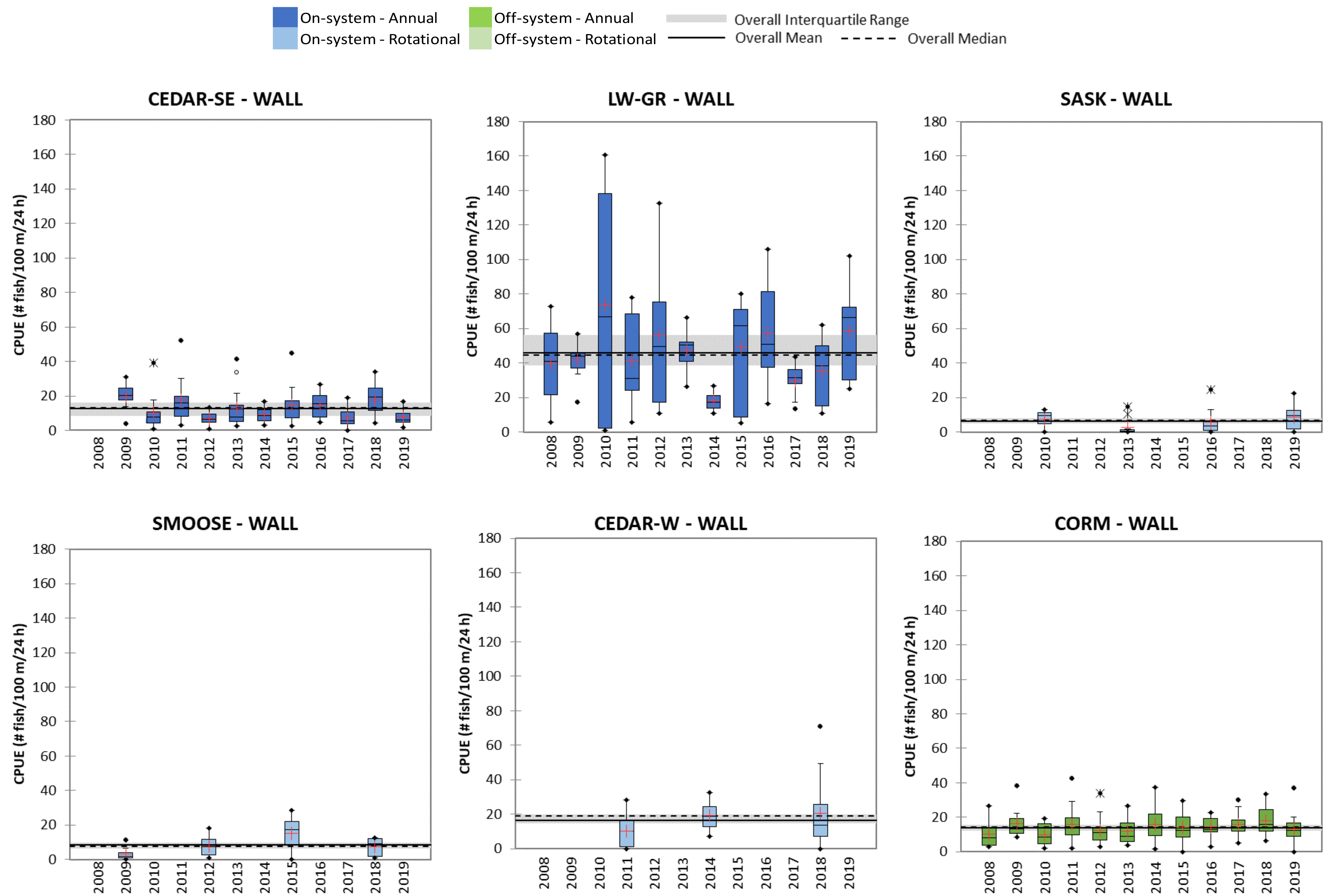


Figure 5.2-6. 2008-2019 Catch-per-unit-effort (CPUE) of Walleye.

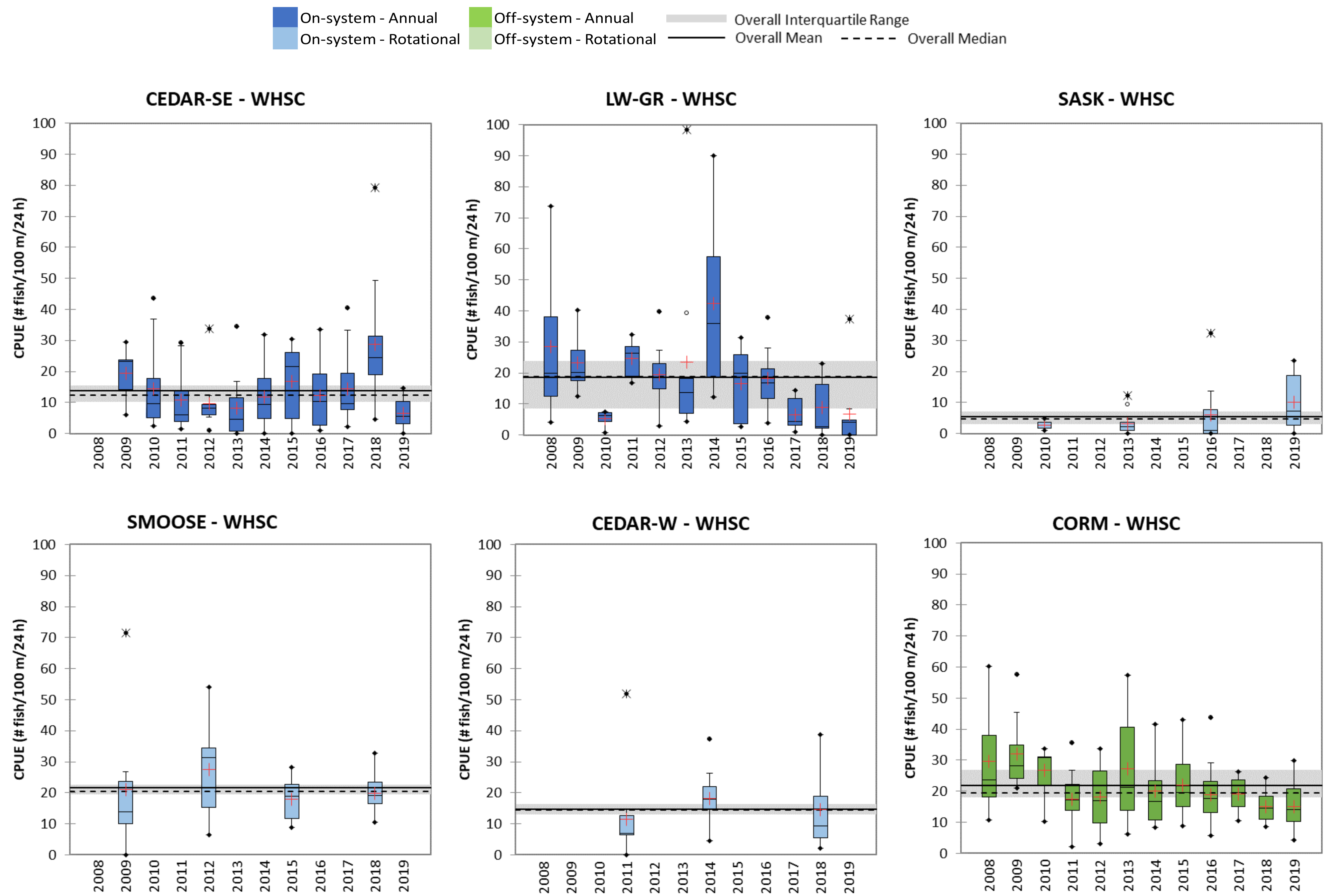


Figure 5.2-7. 2008-2019 Catch-per-unit-effort (CPUE) of White Sucker.

5.3 CONDITION

5.3.1 FULTON'S CONDITION FACTOR

5.3.1.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake – Southeast

Lake Whitefish

Over the 11 years of monitoring only five Lake Whitefish between 300 and 499 mm in fork length were captured over four years (Table 5.3-1). The annual KF in these years ranged from 1.22 in 2013 to 1.59 in 2009 (Figure 5.3-1).

There were too few Lake Whitefish captured at Cedar Lake – Southeast to calculate the overall metrics.

Northern Pike

The annual mean KF of Northern Pike between 400 and 699 mm in fork length over the 11 years of monitoring ranged from a low of 0.72 in 2018 to a high of 0.86 in 2011 (Table 5.3-1; Figure 5.3-2).

The overall mean and median KF were 0.76 and the IQR was 0.75-0.77 (Figure 5.3-2). The annual mean KF fell within the overall IQR except in 2018 and 2019 when it was below the IQR and in 2010 and 2011 when it was above the IQR.

Sauger

Sauger was not a target species at Cedar Lake – Southeast until 2017; the annual mean KF of Sauger between 200 and 349 mm in fork length over the three years of monitoring ranged from a low of 0.94 in 2018 to a high of 0.99 in 2017 and 2019 (Table 5.3-1; Figure 5.3-3).

The overall mean KF was 0.97, the median was 0.99, and the IQR was 0.94-0.99 (Figure 5.3-3). The annual mean KF was equal to or fell within the overall IQR in all three years.

Walleye

The annual mean KF of Walleye between 300 and 499 mm in fork length over the 11 years of monitoring ranged from a low of 1.10 in 2017 to a high of 1.26 in 2009 (Table 5.3-1; Figure 5.3-4).

The overall mean KF was 1.17, the median was 1.16, and the IQR was 1.13-1.21 (Figure 5.3-4). The annual mean KF fell within the overall IQR except in 2017 and 2018 when it was below the IQR and in 2009 and 2010 when it was above the IQR.

White Sucker

White Sucker was not a target species at Cedar Lake – Southeast until 2010 and were not measured for length in 2013. The annual mean KF of White Sucker between 300 and 499 mm in fork length over the nine years of monitoring ranged from a low of 1.54 in 2012 to a high of 1.66 in 2014 (Table 5.3-1; Figure 5.3-5).

The overall mean KF was 1.60, the median was 1.59, and the IQR was 1.58-1.61 (Figure 5.3-5). The annual mean KF fell within the overall IQR except in 2012 when it was below the IQR and in 2014 when it was above the IQR.

Lake Winnipeg – Grand Rapids

Lake Whitefish

The annual mean KF of Lake Whitefish between 300 and 499 mm in fork length over the 12 years of monitoring ranged from a low of 1.33 in 2011 to a high of 1.83 in 2019 (Table 5.3-1; Figure 5.3-1). No Lake Whitefish were captured in the Grand Rapids area in 2018.

The overall mean KF was 1.52, the median was 1.48, and the IQR was 1.40-1.48 (Figure 5.3-1). The annual mean KF fell within the overall IQR except in 2011 and 2012 when it was below the IQR and 2008, 2009, 2016, 2017, and 2019 when it was above the IQR.

Northern Pike

Northern Pike were not measured for length at the Grand Rapids area of Lake Winnipeg until 2013; the annual mean KF of Northern Pike between 400 and 699 mm in fork length over the seven years of monitoring ranged from a low of 0.71 in 2016 to a high of 0.97 in 2013 (Table 5.3-1; Figure 5.3-2). Northern Pike were not captured at Grand Rapids in 2014 and the only Northern Pike captured in 2015 was >699 mm.

The overall mean KF was 0.78, the median was 0.77, and the IQR was 0.76-0.77 (Figure 5.3-2). The annual mean KF fell within the overall IQR except in 2016 and 2017 when it was below the IQR and in 2013 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 0.92 in 2018 to a high of 1.22 in 2010 (Table 5.3-1; Figure 5.3-3). The two Sauger captured at Grand Rapids in 2009 were > 349 mm.

The overall mean and median KF were 1.01 and the IQR was 0.95-1.07 (Figure 5.3-3). The annual mean KF fell within the overall IQR except in 2018 and 2019 when it was below the IQR and in 2008, 2010, 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 0.95 in 2017 to a high of 1.29 in 2010 (Table 5.3-1; Figure 5.3-4).

The overall mean KF was 1.10, the median was 1.05, and the IQR was 0.98-1.23 (Figure 5.3-4). The annual mean KF fell within the overall IQR except in 2017 when it was below the IQR and in 2010, 2011, and 2012 when it was above the IQR.

White Sucker

White Sucker were not measured for length at the Grand Rapids area of Lake Winnipeg until 2013; the annual mean KF of White Sucker between 300 and 499 mm in fork length over the seven years of monitoring ranged from a low of 1.50 in 2015 to a high of 1.64 in 2017 (Table 5.3-1; Figure 5.3-5).

The overall mean KF was 1.56, the median was 1.58, and the IQR was 1.51-1.58 (Figure 5.3-5). The annual mean KF fell within the overall IQR except in 2017 and 2018 when it was above the IQR.

ROTATIONAL SITES

Saskatchewan River between The Pas and Cedar Lake

Lake Whitefish

Lake Whitefish were not captured in the Saskatchewan River over the four years of monitoring (Table 5.3-1).

Northern Pike

The annual mean KF of Northern Pike between 400 and 699 mm in fork length over the three years it was measured for length ranged from a low of 0.68 in 2016 to a high of 0.80 in 2013 (Table 5.3-1; Figure 5.3-2).

The overall mean KF was 0.78 and the median and IQR were 0.80 (Figure 5.3-2). The annual mean KF was below the IQR in 2016 and 2019.

Sauger

Over the four years of monitoring, Sauger was only a target species in the Saskatchewan River in 2019. In this year, Sauger between 200 and 349 mm in fork length had a mean KF of 0.93 (Table 5.3-1; Figure 5.3-3).

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 1.07 in 2016 to a high of 1.23 in 2013 (Table 5.3-1; Figure 5.3-4).

The overall mean and median KF was 1.11 and the IQR was 1.07-1.11 (Figure 5.3-4). The annual mean KF was above the IQR in 2010 and 2013.

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 1.54 in 2010 to a high of 1.71 in 2013 (Table 5.3-1; Figure 5.3-5).

The overall mean KF was 1.62, the median was 1.60, and the IQR was 1.60-1.62 (Figure 5.3-5). The annual mean KF was below the IQR in 2010 and was above the IQR in 2013.

South Moose Lake

Lake Whitefish

The annual mean KF of Lake Whitefish between 300 and 499 mm in fork length over the four years of monitoring ranged from a low of 1.24 in 2018 to a high of 1.38 in 2009 (Table 5.3-1; Figure 5.3-1).

The overall mean KF was 1.32, the median was 1.35, and the IQR was 1.28-1.35 (Figure 5.3-1). The annual mean KF was below the IQR in 2018 and was above the IQR in 2009.

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 0.70 in 2018 to a high of 0.73 in 2015 (Table 5.3-1; Figure 5.3-2).

The overall mean KF was 0.71, the median was 0.72, and IQR was 0.70-0.72 (Figure 5.3-2). The annual mean KF was equal to or fell within the overall IQR in all four years.

Sauger

Sauger were not captured in South Moose Lake since it became a target species in 2017 (Table 5.3-1).

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 1.13 in 2012 to a high of 1.18 in 2009 (Table 5.3-1; Figure 5.3-4).

The overall mean and median KF were 1.14 and the IQR was 1.14-1.15 (Figure 5.3-4). The annual mean KF was above the IQR in 2009.

White Sucker

White Sucker was not measured for length in South Moose Lake until 2015; the annual mean KF of White Sucker between 300 and 499 mm in fork length was 1.49 in 2015 and 1.52 in 2018 (Table 5.3-1; Figure 5.3-5).

Cedar Lake – West

Lake Whitefish

Lake Whitefish were not captured at Cedar Lake – West over the three years of monitoring (Table 5.3-1).

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 0.70 in 2011 and 2018 to a high of 0.71 in 2014 (Table 5.3-1; Figure 5.3-2).

The overall mean KF was 0.71, the median was 0.70, and the IQR was 0.70-0.71 (Figure 5.3-2). The annual mean KF was equal to or fell within the overall IQR in all three years.

Sauger

Over three years of monitoring, Sauger was only a target species at Cedar Lake - West in 2018. In this year, Sauger between 200 and 349 mm in fork length had a mean KF of 1.04 (Table 5.3-1; Figure 5.3-3).

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 1.14 in 2011 to a high of 1.18 in 2014 (Table 5.3-1; Figure 5.3-4).

The overall mean and median KF were 1.16 and the IQR was 1.16-1.18 (Figure 5.3-4). The annual mean KF was below the IQR in 2011.

White Sucker

The annual mean KF of White Sucker between 300 and 499 mm in fork length over the three years of monitoring ranged from a low of 1.69 in 2011 to a high of 1.78 in 2018 (Table 5.3-1; Figure 5.3-5).

The overall mean KF was 1.73, the median was 1.71, and the IQR was 1.69-1.78 (Figure 5.3-5). 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

Cormorant Lake

Lake Whitefish

The annual mean KF of Lake Whitefish between 300 and 499 mm in fork length over the 12 years of monitoring ranged from a low of 1.25 in 2012 to a high of 1.35 in 2009, 2015, and 2017 (Table 5.3-1; Figure 5.3-1).

The overall mean and median KF were 1.29 and the IQR was 1.27-1.30 (Figure 5.3-1). The annual mean KF fell within the overall IQR except in 2012 when it was below the IQR and 2009, 2015, and 2017 when it was above the IQR.

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 0.69 in 2015 and 2017 to a high of 0.74 in 2009 and 2010 (Table 5.3-1; Figure 5.3-2).

The overall mean KF was 0.71, the median was 0.70, and the IQR was 0.70-0.73 (Figure 5.3-2). The annual mean KF fell within the overall IQR except in 2015 and 2017 when it was below the IQR and in 2009 and 2010 when it was above the IQR.

Sauger

Sauger was not a target species in Cormorant Lake until 2017; the annual mean KF of Sauger between 200 and 349 mm in fork length over the three years of monitoring ranged from a low of 0.75 in 2019 to a high of 0.78 in 2017 (Table 5.3-1; Figure 5.3-3).

The overall mean KF was 0.77, the median was 0.78, and the IQR was 0.76-0.78 (Figure 5.3-3). The annual mean KF was below the IQR in 2019.

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 0.98 in 2019 to a high of 1.10 in 2011 (Table 5.3-1; Figure 5.3-4).

The overall mean KF was 1.03, the median was 1.02, and the IQR was 0.99-1.08 (Figure 5.3-4). The annual mean KF fell within the overall IQR except in 2011 and 2014 when it was above the IQR.

White Sucker

White Sucker was not a target species in Cormorant Lake until 2010 and was not measured for length in 2011 or 2012. The annual mean KF of White Sucker between 300 and 499 mm in fork length over the eight years of monitoring ranged from a low of 1.41 in 2013 to a high of 1.47 in 2014 and 2015 (Table 5.3-1; Figure 5.3-5).

The overall mean and median KF were 1.44 and the IQR was 1.43-1.47 (Figure 5.3-5). The annual mean KF fell within the overall IQR except in 2013 when it was below the IQR.

ROTATIONAL SITES

There are no waterbodies in the SRR that are monitored on a rotational basis.

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

Waterbody	Year	LKWH			NRPK			SAUG			WALL			WHSC		
		n_F[1]	Mean	SE[2]	n_F	Mean	SE	n_F	Mean	SE	n_F	Mean	SE	n_F	Mean	SE
CEDAR-SE	2009	1	1.59	1.59	15	0.77	0.01				125	1.26	0.02			
	2010	-	-	-	20	0.80	0.02				133	1.23	0.01	121	1.61	0.01
	2011	1	1.45	1.45	17	0.86	0.02				155	1.20	0.02	78	1.58	0.02
	2012	2	1.45	1.02	40	0.77	0.01				64	1.14	0.01	59	1.54	0.01
	2013	1	1.22	1.22	21	0.76	0.02				100	1.13	0.01			
	2014	-	-	-	47	0.77	0.01				86	1.17	0.01	129	1.66	0.01
	2015	-	-	-	57	0.75	0.01				126	1.16	0.01	170	1.58	0.01
	2016	-	-	-	35	0.76	0.01				142	1.13	0.01	118	1.59	0.01
	2017	-	-	-	27	0.77	0.02	17	0.99	0.05	63	1.10	0.01	139	1.59	0.01
	2018	-	-	-	46	0.72	0.01	39	0.94	0.01	134	1.12	0.01	222	1.59	0.01
	2019	-	-	-	29	0.74	0.01	34	0.99	0.02	54	1.21	0.01	32	1.62	0.04
LW-GR	2008	1	1.63	1.63				12	1.15	0.03	157	1.22	0.01			
	2009	25	1.59	0.32				-	-	-	265	1.23	0.01			
	2010	16	1.48	0.37				6	1.22	0.04	95	1.29	0.01			
	2011	4	1.33	0.66				31	1.01	0.01	120	1.27	0.01			
	2012	15	1.37	0.35				103	0.99	0.01	196	1.24	0.01			
	2013	23	1.40	0.29	2	0.97	0.04	153	1.02	0.01	161	1.14	0.01	19	1.54	0.06
	2014	12	1.45	0.42	-	-	-	118	1.09	0.01	102	1.14	0.01	198	1.58	0.01
	2015	14	1.48	0.40	-	-	-	67	1.07	0.02	221	1.02	0.00	83	1.50	0.02
	2016	3	1.59	0.92	1	0.71	0.00	69	1.00	0.02	290	0.98	0.01	105	1.51	0.02
	2017	4	1.68	0.84	2	0.73	0.05	39	0.95	0.02	197	0.95	0.01	36	1.64	0.07
	2018	-	-	-	4	0.76	0.02	85	0.92	0.01	165	0.98	0.01	73	1.63	0.02
	2019	17	1.83	0.44	6	0.77	0.01	78	0.93	0.01	399	1.05	0.01	37	1.53	0.03
SASK	2010	-	-	-							14	1.15	0.02	7	1.54	0.05
	2013	-	-	-	32	0.80	0.02				24	1.23	0.02	38	1.71	0.02
	2016	-	-	-	2	0.68	0.02				68	1.07	0.01	73	1.62	0.01
	2019	-	-	-	5	0.73	0.02	35	0.93	0.02	91	1.11	0.01	105	1.60	0.01
SMOOSE	2009	10	1.38	0.44	42	0.71	0.01				18	1.18	0.03			
	2012	15	1.35	0.35	87	0.72	0.01				43	1.13	0.01			
	2015	18	1.28	0.30	61	0.73	0.01				126	1.14	0.01	130	1.49	0.01
	2018	2	1.24	0.88	79	0.70	0.01	-	-	-	50	1.15	0.01	123	1.52	0.01
CEDAR-W	2011	-	-	-	25	0.70	0.01				103	1.14	0.01	135	1.69	0.02
	2014	-	-	-	74	0.71	0.01				187	1.18	0.01	204	1.71	0.01
	2018	-	-	-	60	0.70	0.01	88	1.04	0.01	195	1.16	0.01	137	1.78	0.03
CORM	2008	20	1.27	0.28	11	0.70	0.02				78	1.06	0.01			
	2009	37	1.35	0.22	22	0.74	0.02				77	1.08	0.01			
	2010	59	1.29	0.17	20	0.74	0.02				60	1.04	0.01	197	1.43	0.01
	2011	81	1.31	0.15	106	0.73	0.01				182	1.10	0.01			
	2012	35	1.25	0.21	31	0.72	0.01				104	0.99	0.01			
	2013	13	1.27	0.35	53	0.70	0.01				153	1.00	0.01	250	1.41	0.01
	2014	70	1.26	0.15	75	0.71	0.01				184	1.09	0.01	261	1.47	0.01
	2015	18	1.35	0.32	80	0.69	0.01				153	1.03	0.01	300	1.47	0.01
	2016	93	1.27	0.13	67	0.73	0.01				147	1.02	0.01	256	1.44	0.01
	2017	23	1.35	0.28	76	0.69	0.01	33	0.78	0.01	158	1.00	0.01	257	1.45	0.01
	2018	80	1.27	0.14	52	0.70	0.01	18	0.76	0.03	232	0.99	0.01	197	1.44	0.01
	2019	107	1.30	0.13	103	0.70	0.01	10	0.75	0.02	176	0.98	0.01	204	1.42	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.

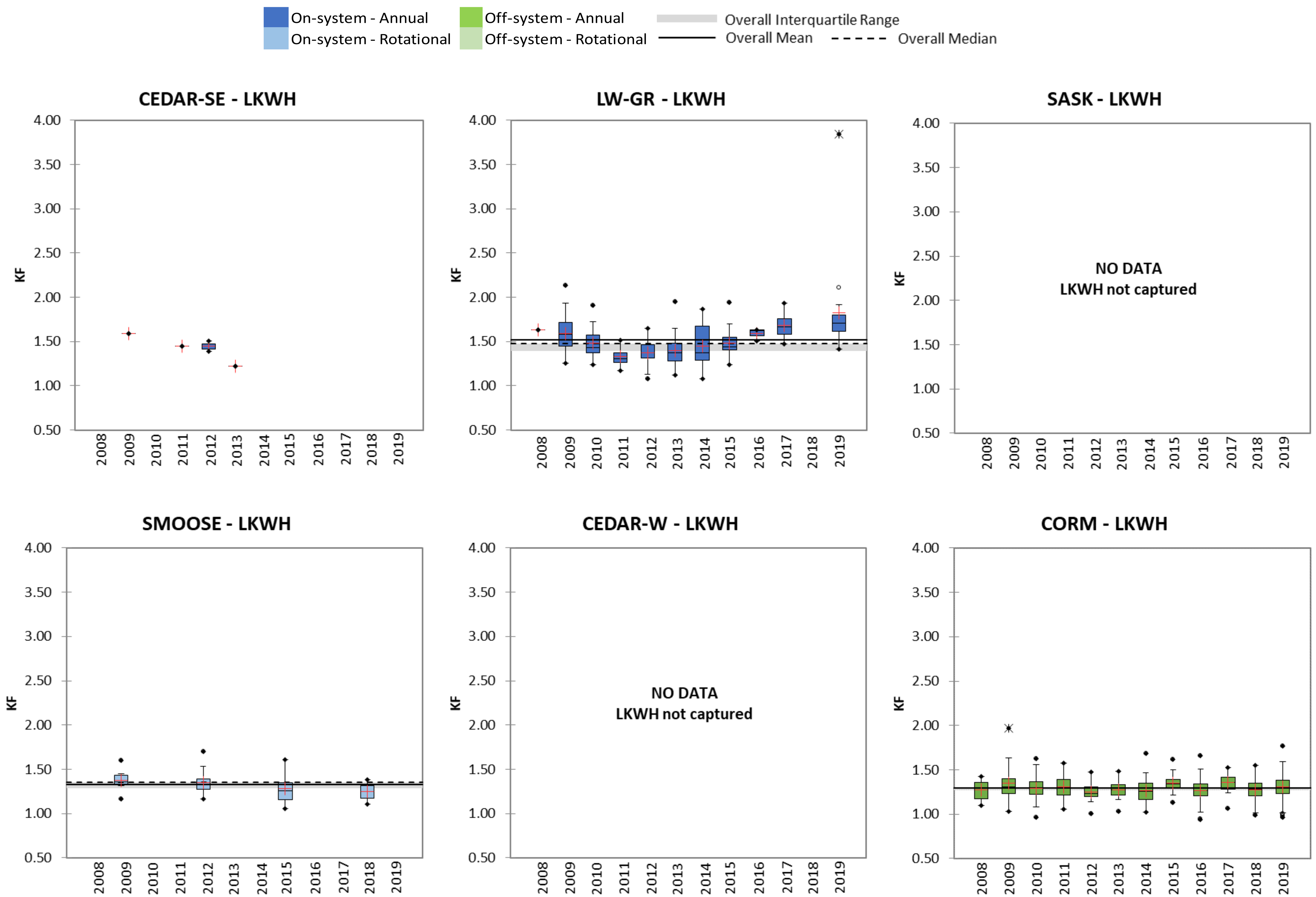


Figure 5.3-1. 2008-2019 Fulton's condition factor (KF) of Lake Whitefish.

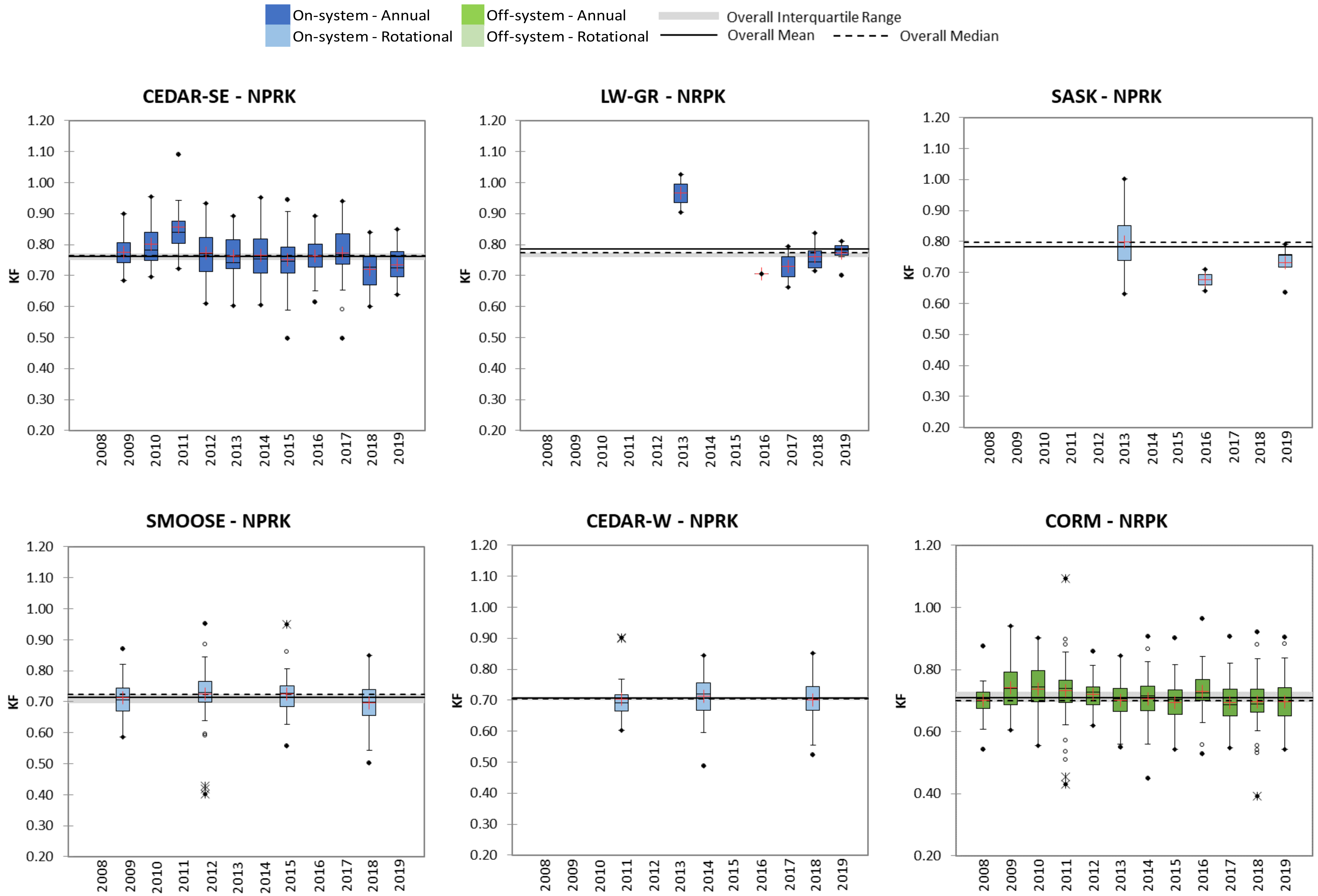


Figure 5.3-2. 2008-2019 Fulton's condition factor (KF) of Northern Pike.

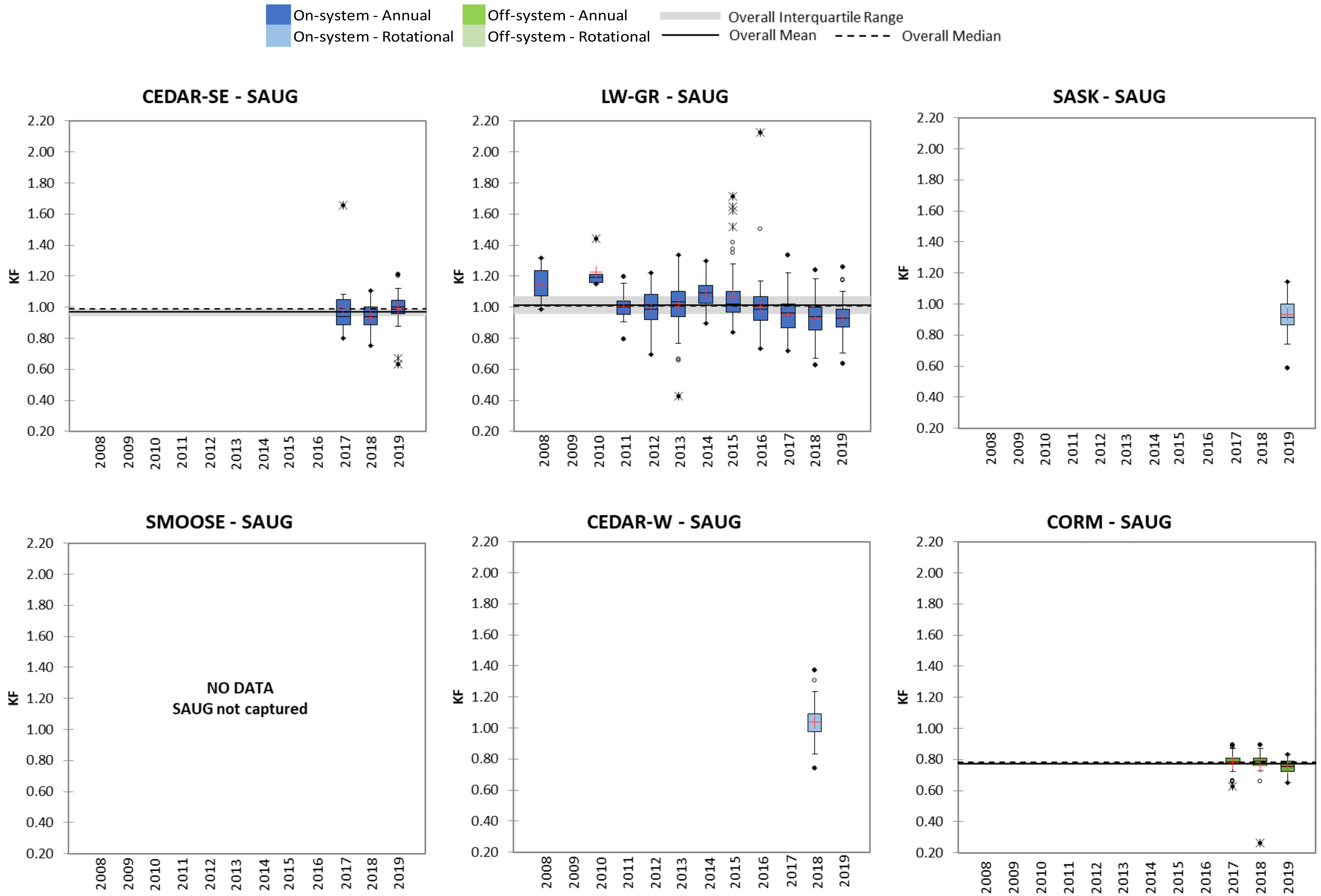


Figure 5.3-3. 2008-2019 Fulton's condition factor (KF) of Sauger.

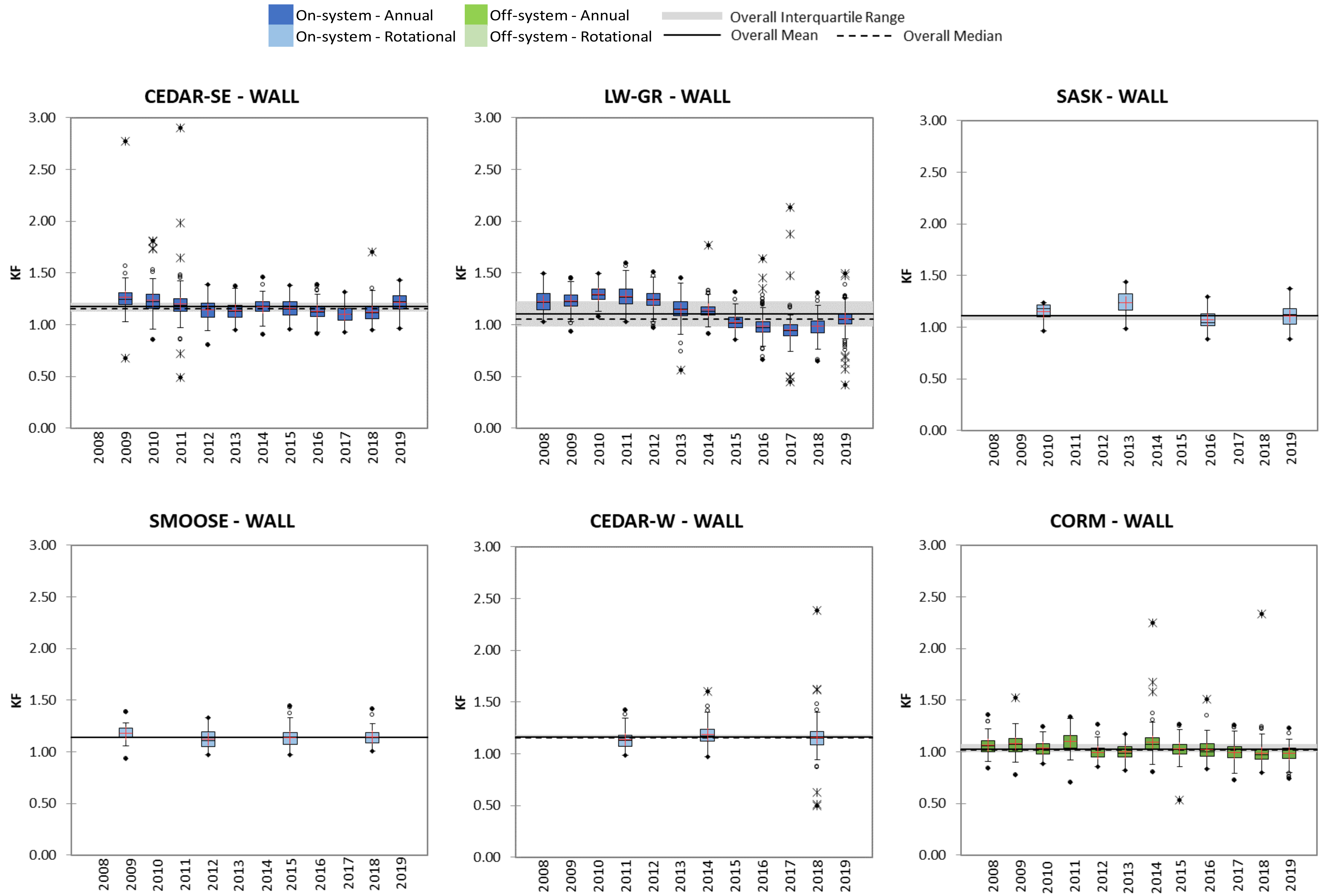


Figure 5.3-4. 2008-2019 Fulton's condition factor (KF) of Walleye.

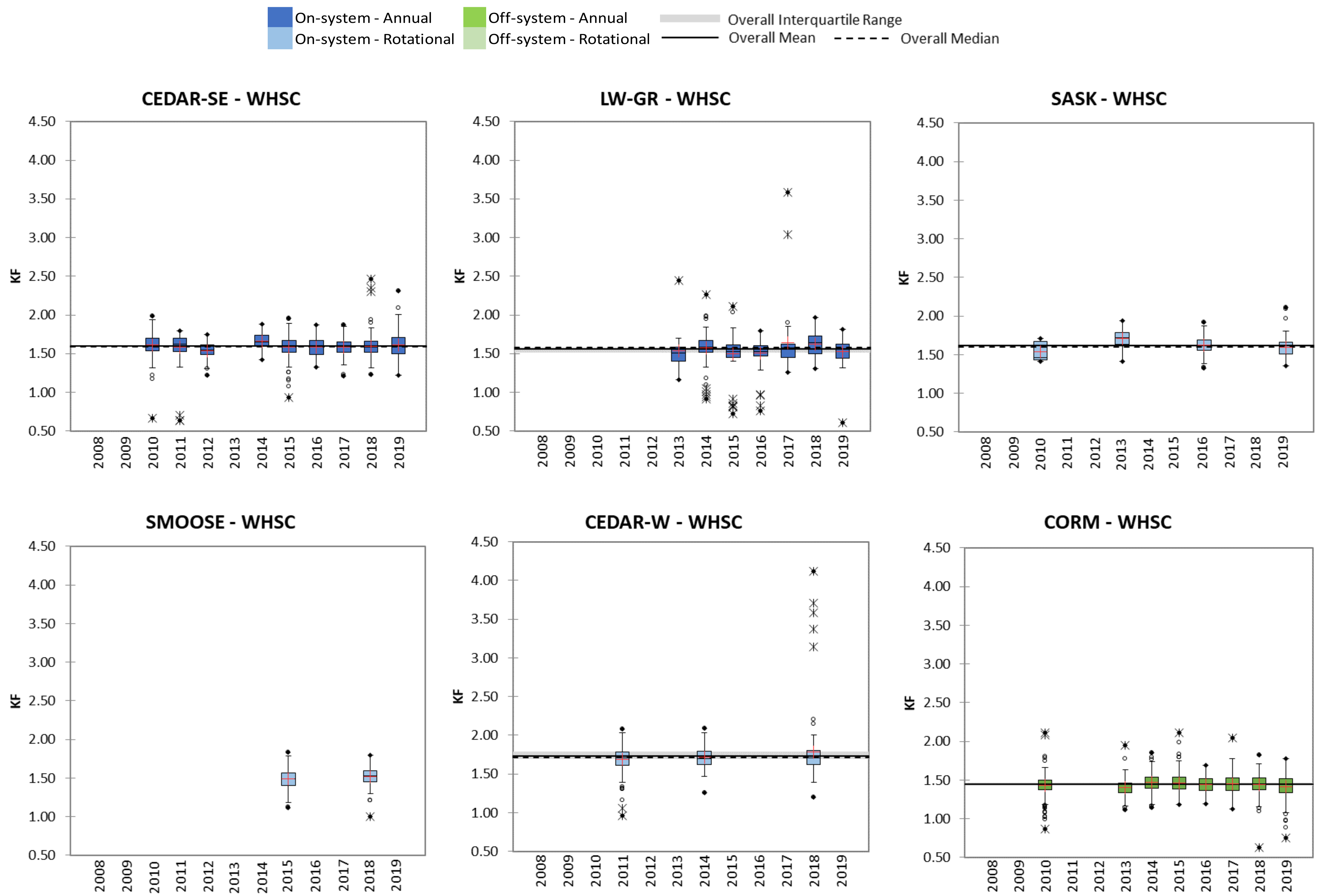


Figure 5.3-5. 2008-2019 Fulton's condition factor (KF) of White Sucker.

5.3.2 RELATIVE WEIGHT

5.3.2.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake – Southeast

Lake Whitefish

Over the 11 years of monitoring only seven Lake Whitefish between 99 mm and 701 mm in total length were captured (Table 5.3-2). The annual Wr in the five years they were caught ranged from 89 in 2013 to 124 in 2014 (Figure 5.3-6).

There were too few Lake Whitefish captured at Cedar Lake – Southeast to calculate the overall metrics.

Northern Pike

The annual mean Wr of Northern Pike greater than 99 mm in total length over the 11 years of monitoring ranged from a low of 89 in 2018 to a high of 103 in 2011 (Table 5.3-2; Figure 5.3-7).

The overall mean and median Wr were 94 and the IQR was 92-95 (Figure 5.3-7). The annual mean Wr fell within the overall IQR except in 2018 and 2019 when it was below the IQR and in 2010 and 2011 when it was above the IQR.

Sauger

Sauger was not a target species at Cedar Lake – Southeast until 2017; the annual mean Wr of Sauger greater than 69 mm in total length over the three years of monitoring ranged from a low of 88 in 2018 to a high of 94 in 2019 (Table 5.3-2; Figure 5.3-8).

The overall mean Wr was 90, the median was 89, and the IQR was 88-94 (Figure 5.3-8). The annual mean Wr was equal to or fell within the overall IQR in all three years.

Walleye

The annual mean Wr of Walleye greater than 29 mm in total length over the 11 years of monitoring ranged from a low of 83 in 2012 to a high of 101 in 2009 (Table 5.3-2; Figure 5.3-9).

The overall mean and median Wr were 92 and the IQR was 87-97 (Figure 5.3-9). The annual mean Wr fell within the overall IQR except in 2012 when it was below the IQR and in 2009 and 2010 when it was above the IQR.

White Sucker

White Sucker was not a target species at Cedar Lake – Southeast until 2010 and were not measured for length in 2013. The annual mean Wr of White Sucker greater than 99 mm in total length over the nine years of monitoring ranged from a low of 97 in 2012 to a high of 107 in 2014 (Table 5.3-2; Figure 5.3-10).

The overall mean and median Wr were 101 and the IQR was 100-102 (Figure 5.3-10). The annual mean Wr fell within the overall IQR except in 2012 when it was below the IQR and in 2014 when it was above the IQR.

Lake Winnipeg – Grand Rapids

Lake Whitefish

The annual mean Wr of Lake Whitefish between 99 mm and 701 mm in total length over the 12 years of monitoring ranged from a low of 95 in 2012 to a high of 123 in 2019 (Table 5.3-2; Figure 5.3-6). No Lake Whitefish were captured in the Grand Rapids area in 2018.

The overall mean Wr was 105, the median was 103, and the IQR was 95-111 (Figure 5.3-6). The annual mean Wr fell within the overall IQR except in 2008, 2017, and 2019 when it was above the IQR.

Northern Pike

Northern Pike was not measured for length at the Grand Rapids area of Lake Winnipeg until 2013; the annual mean Wr of Northern Pike greater than 99 mm in total length over the seven years of monitoring ranged from a low of 86 in 2016 to a high of 118 in 2013 (Table 5.3-2; Figure 5.3-7). Northern Pike were not captured at Grand Rapids in 2014.

The overall mean Wr was 95, the median was 94, and the IQR was 93-95 (Figure 5.3-7). The annual mean Wr fell within the overall IQR except in 2016 and 2017 when it was below the IQ and in 2013 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 88 in 2019 to a high of 111 in 2008 (Table 5.3-2; Figure 5.3-8).

The overall mean Wr was 96, the median was 97, and the IQR was 92-100 (Figure 5.3-8). The annual mean Wr fell within the overall IQR except in 2018 and 2019 when it was below the IQR and in 2008, 2009, 2010, and 2014 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 78 in 2017 to a high of 103 in 2010 (Table 5.3-2; Figure 5.3-9).

The overall mean Wr was 90, the median was 86, and the IQR was 83-97 (Figure 5.3-9). The annual mean Wr fell within the overall IQR except in 2016 and 2017 when it was below the IQR and in 2008, 2009, 2010, and 2011 when it was above the IQR.

White Sucker

White Sucker were not measured for length at the Grand Rapids area of Lake Winnipeg until 2013; the annual mean Wr of White Sucker greater than 99 mm in total length over the seven years of monitoring ranged from a low of 95 in 2013 to a high of 104 in 2018 (Table 5.3-2; Figure 5.3-10).

The overall mean Wr was 99, the median was 101, and the IQR was 96-101 (Figure 5.3-10). The annual mean Wr fell within the overall IQR except in 2013 when it was below the IQR and in 2017 and 2018 when it was above the IQR.

ROTATIONAL SITES

Saskatchewan River between The Pas and Cedar Lake

Lake Whitefish

Lake Whitefish were not captured in the Saskatchewan River over the four years of monitoring (Table 5.3-2).

Northern Pike

The annual mean Wr of Northern Pike greater than 99 mm in total length over the three years it was measured for length ranged from a low of 86 in 2016 to a high of 98 in 2013 (Table 5.3-2; Figure 5.3-7).

The overall mean Wr was 96 and the median and IQR were 98 (Figure 5.3-7). The annual mean Wr was below the IQR in 2016 and 2019.

Sauger

Over the four years of monitoring, Sauger was only a target species in the Saskatchewan River in 2019. In this year, Sauger greater than 69 mm in total length had a mean Wr of 90 (Table 5.3-2; Figure 5.3-8).

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 85 in 2016 to a high of 98 in 2013 (Table 5.3-2; Figure 5.3-9).

The overall mean and median KF were 88 and the IQR was 85-88 (Figure 5.3-9). The annual mean Wr was above the IQR in 2010 and 2013.

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 100 in 2010 to a high of 111 in 2013 (Table 5.3-2; Figure 5.3-10).

The overall mean Wr was 106, the median was 104, and the IQR was 104-106 (Figure 5.3-10). The annual mean Wr was below the IQR in 2010 and was above the IQR in 2013.

South Moose Lake

Lake Whitefish

The annual mean Wr of Lake Whitefish between 99 mm and 701 mm in total length over the four years of monitoring ranged from a low of 88 in 2015 to a high of 97 in 2009 (Table 5.3-2; Figure 5.3-6).

The overall mean Wr was 92, the median was 89, and the IQR was 88-95 (Figure 5.3-6). The annual mean Wr was above the IQR in 2009.

Northern Pike

The annual mean KF of Northern Pike greater than 99 mm in total length over the four years of monitoring ranged from a low of 85 in 2018 to a high of 89 in 2012 and 2015 (Table 5.3-2; Figure 5.3-7).

The overall mean Wr was 88, the median was 89, and IQR was 85-89 (Figure 5.3-7). The annual mean Wr was equal to or fell within the overall IQR in all four years.

Sauger

Sauger were not captured in South Moose Lake since it became a target species in 2017 (Table 5.3-2).

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 91 in 2012, 2015, and 2018 to a high of 93 in 2009 (Table 5.3-2; Figure 5.3-9).

The overall mean and median Wr and the IQR were 91 (Figure 5.3-9). The annual mean Wr was above the IQR in 2009.

White Sucker

White Sucker was not measured for length in South Moose Lake until 2015; the annual mean Wr of White Sucker greater than 99 mm in total length was 95 in 2015 and 97 in 2018 (Table 5.3-2; Figure 5.3-10).

Cedar Lake – West

Lake Whitefish

Lake Whitefish were not captured at Cedar Lake – West over the three years of monitoring (Table 5.3-2).

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 88 in 2014 to a high of 95 in 2018 (Table 5.3-2; Figure 5.3-7).

The overall mean Wr was 91, the median was 89, and the IQR was 88-95 (Figure 5.3-7). The annual mean Wr was equal to or fell within the overall IQR in all three years.

Sauger

Over three years of monitoring, Sauger was only a target species at Cedar Lake - West in 2018. In this year, Sauger greater than 69 mm in total length had a mean Wr of 95 (Table 5.3-2; Figure 5.3-8).

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 91 in 2011 to a high of 93 in 2018 (Table 5.3-2; Figure 5.3-9).

The overall mean and median Wr were 92 and the IQR was 92-93 (Figure 5.3-9). The annual mean Wr was below the IQR in 2011.

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 109 in 2011 to a high of 115 in 2018 (Table 5.3-2; Figure 5.3-10).

The overall mean and median Wr were 111 and the IQR was 109-115 (Figure 5.3-10). 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

Cormorant Lake

Lake Whitefish

The annual mean Wr of Lake Whitefish between 99 mm and 701 mm in total length over the 12 years of monitoring ranged from a low of 88 in 2012 and 2013 to a high of 94 in 2009 and 2015 (Table 5.3-2; Figure 5.3-6).

The overall mean Wr was 91, the median was 90, and the IQR was 89-92 (Figure 5.3-6). The annual mean Wr fell within the overall IQR except in 2012 and 2013 when it was below the IQR and in 2009 and 2015 when it was above the IQR.

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 85 in 2015, 2017, and 2018 to a high of 91 in 2009 and 2010 (Table 5.3-2; Figure 5.3-7).

The overall mean Wr was 87, the median was 86, and the IQR was 85-90 (Figure 5.3-7). The annual mean Wr fell within the overall IQR in all 12 years.

Sauger

Sauger was not a target species in Cormorant Lake until 2017; the annual mean Wr of Sauger greater than 69 mm in total length over the three years of monitoring ranged from a low of 71 in 2019 to a high of 74 in 2017 (Table 5.3-2; Figure 5.3-8).

The overall mean Wr was 73, the median was 74, and the IQR was 73-74 (Figure 5.3-8). The annual mean Wr was below the IQR in 2019.

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 79 in 2012, 2013, 2017, and 2019 to a high of 88 in 2011 (Table 5.3-2; Figure 5.3-9).

The overall mean Wr was 82, the median was 80, and the IQR was 79-84 (Figure 5.3-9). The annual mean Wr fell within the overall IQR except in 2011 and 2014 when it was above the IQR.

White Sucker

White Sucker was not a target species in Cormorant Lake until 2010 and was not measured for length in 2011 or 2012. The annual mean Wr of White Sucker greater than 99 mm in total length over the eight years of monitoring ranged from a low of 89 in 2013 and 2019 to a high of 94 in 2014 (Table 5.3-2; Figure 5.3-10).

The overall mean and median Wr were 91 and the IQR was 90-93 (Figure 5.3-10). The annual mean Wr fell within the overall IQR except in 2013 when it was below the IQR and in 2014 when it was above the IQR.

ROTATIONAL SITES

There are no waterbodies in the SRR that are monitored on a rotational basis.

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

Waterbody	Year	LKWH			NRPK			SAUG			WALL			WHSC		
		n_F[1]	Mean	SE[2]	n_F	Mean	SE	n_F	Mean	SE	n_F	Mean	SE	n_F	Mean	SE
CEDAR-SE	2009	1	110	-	18	95	2				177	101	1			
	2010	-	-	-	22	99	2				144	99	1	199	100	1
	2011	1	103	-	19	103	2				223	97	1	139	100	1
	2012	3	104	2	44	95	1				177	83	1	73	97	1
	2013	1	89	-	25	95	2				144	89	1			
	2014	1	124	-	50	94	1				127	92	1	140	107	1
	2015	-	-	-	60	92	1				158	92	1	198	100	1
	2016	-	-	-	37	94	1				198	87	1	132	102	1
	2017	-	-	-	28	95	2	24	89	4	89	87	1	161	101	1
	2018	-	-	-	59	89	1	43	88	2	160	88	1	245	102	1
	2019	-	-	-	29	91	1	34	94	2	63	97	1	44	99	2
LW-GR	2008	1	114	-				14	111	3	234	99	0			
	2009	26	111	3				2	107	3	337	98	0			
	2010	18	105	3				9	110	4	132	103	1			
	2011	8	99	3				35	97	1	143	101	1			
	2012	50	95	2				107	94	1	294	97	1			
	2013	25	99	2	2	118	5	183	97	1	387	93	1	41	95	2
	2014	14	104	5	-	-	-	146	103	1	165	95	1	285	101	1
	2015	16	103	4	1	94	-	81	100	2	340	86	1	111	96	1
	2016	3	111	1	2	86	1	86	95	2	417	81	1	127	97	1
	2017	4	118	5	2	90	6	55	92	5	249	78	1	50	102	4
	2018	-	-	-	5	93	3	102	89	1	297	83	1	77	104	1
	2019	29	123	6	7	95	2	83	88	1	487	86	1	54	96	2
SASK	2010	-	-	-							14	92	2	7	100	3
	2013	-	-	-	46	98	1				28	98	2	39	111	1
	2016	-	-	-	3	86	3				74	85	1	75	106	1
	2019	-	-	-	7	89	2	46	90	2	99	88	1	109	104	1
SMOOSE	2009	10	97	2	43	88	1				19	93	2			
	2012	15	95	2	94	89	1	-	-	-	66	91	1			
	2015	24	88	2	71	89	1	-	-	-	132	91	1	150	95	1
	2018	2	89	7	92	85	1	-	-	-	61	91	1	159	97	1
CEDAR-W	2011	-	-	-	53	89	1				122	91	1	142	109	1
	2014	-	-	-	85	88	1				239	92	1	210	111	1
	2018	-	-	-	83	95	4	118	95	1	213	93	1	142	115	2
CORM	2008	21	90	2	12	86	3				123	84	1			
	2009	44	94	2	26	91	2				138	84	1			
	2010	67	91	1	25	91	2				90	83	1	224	91	1
	2011	118	90	1	127	90	1				246	88	0			
	2012	39	88	1	36	88	1				131	79	1			
	2013	14	88	2	59	86	1				199	79	0	324	89	0
	2014	102	90	1	87	87	1				275	86	1	307	94	0
	2015	24	94	2	88	85	1				244	80	0	345	93	0
	2016	109	89	1	71	90	1				239	80	0	305	90	1
	2017	32	93	1	85	85	1	33	74	1	267	79	0	320	91	1
	2018	86	89	1	63	85	1	22	73	2	306	80	0	254	91	1
	2019	117	92	1	108	86	1	10	71	2	221	79	0	242	89	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.

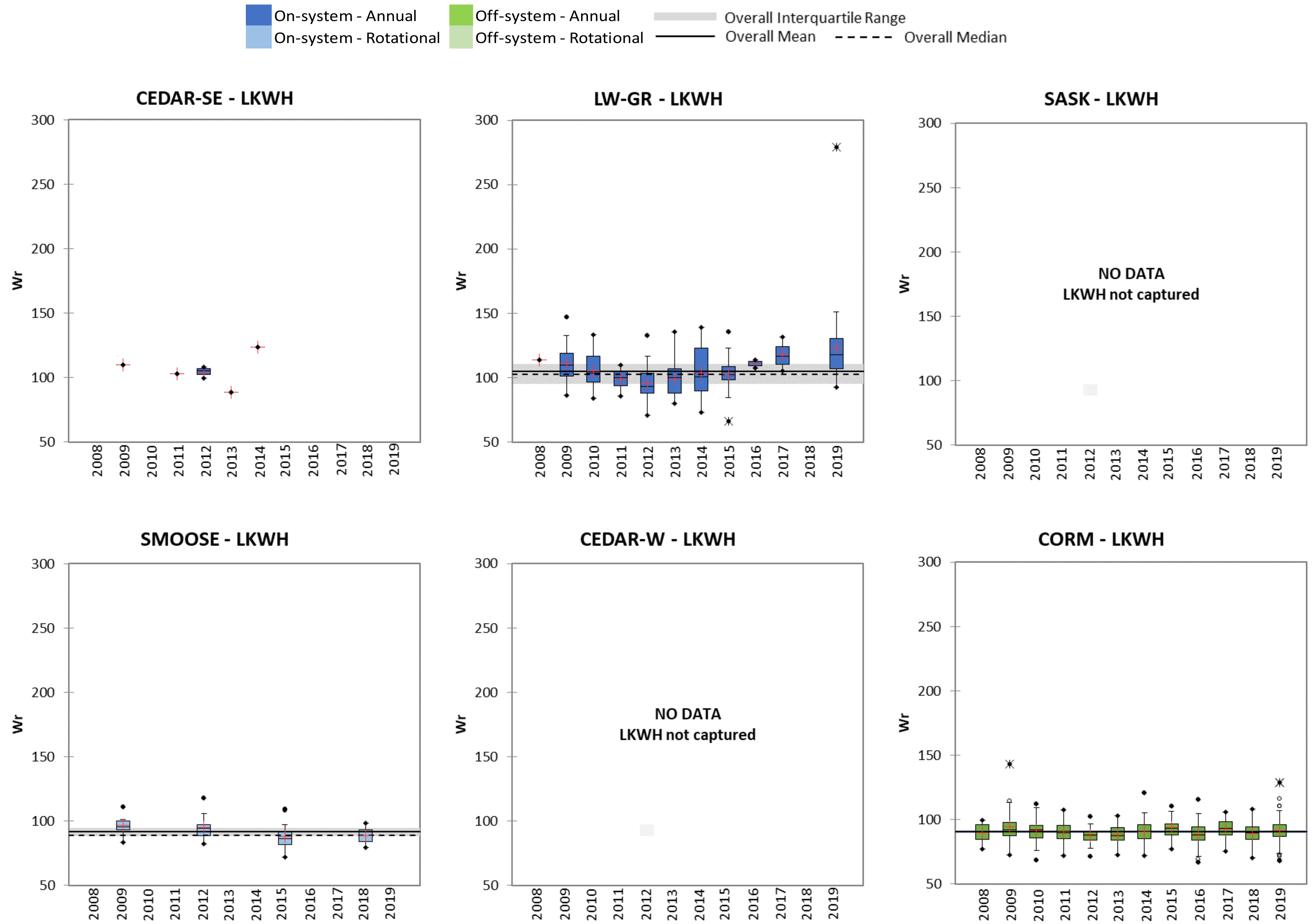


Figure 5.3-6. 2008-2019 Relative weight (Wr) of Lake Whitefish.

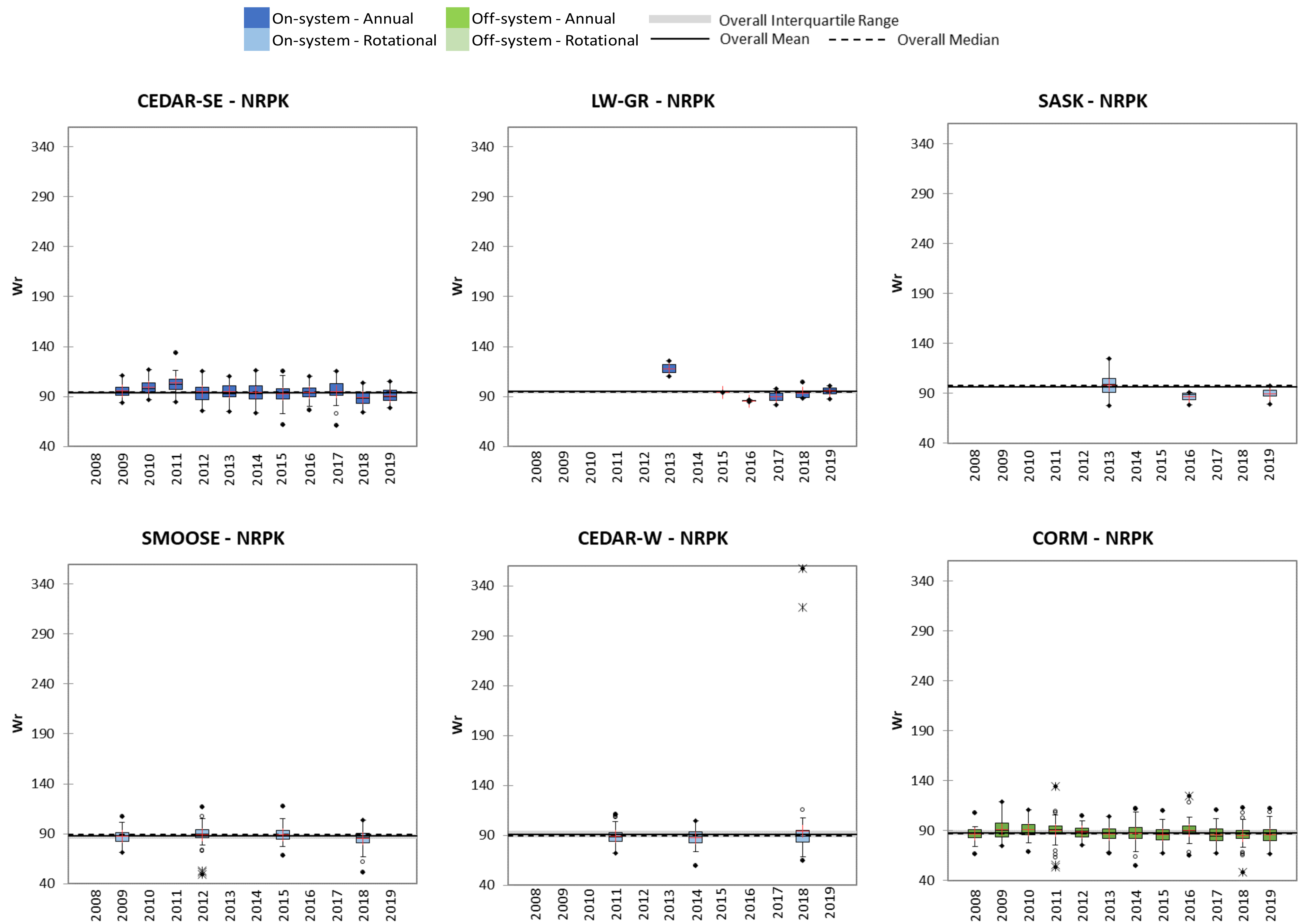


Figure 5.3-7. 2008-2019 Relative weight (Wr) of Northern Pike.

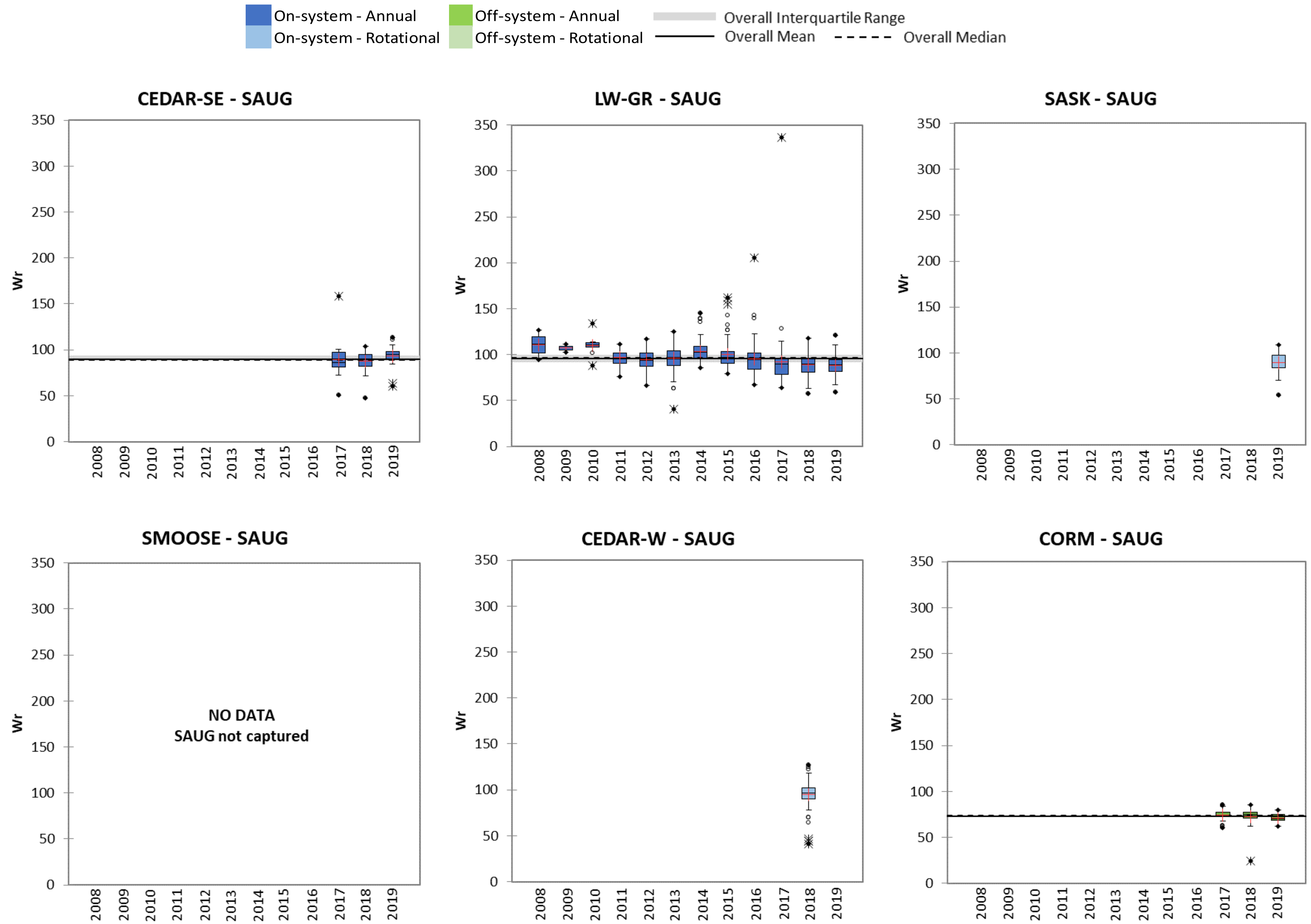


Figure 5.3-8. 2008-2019 Relative weight (Wr) of Sauger.

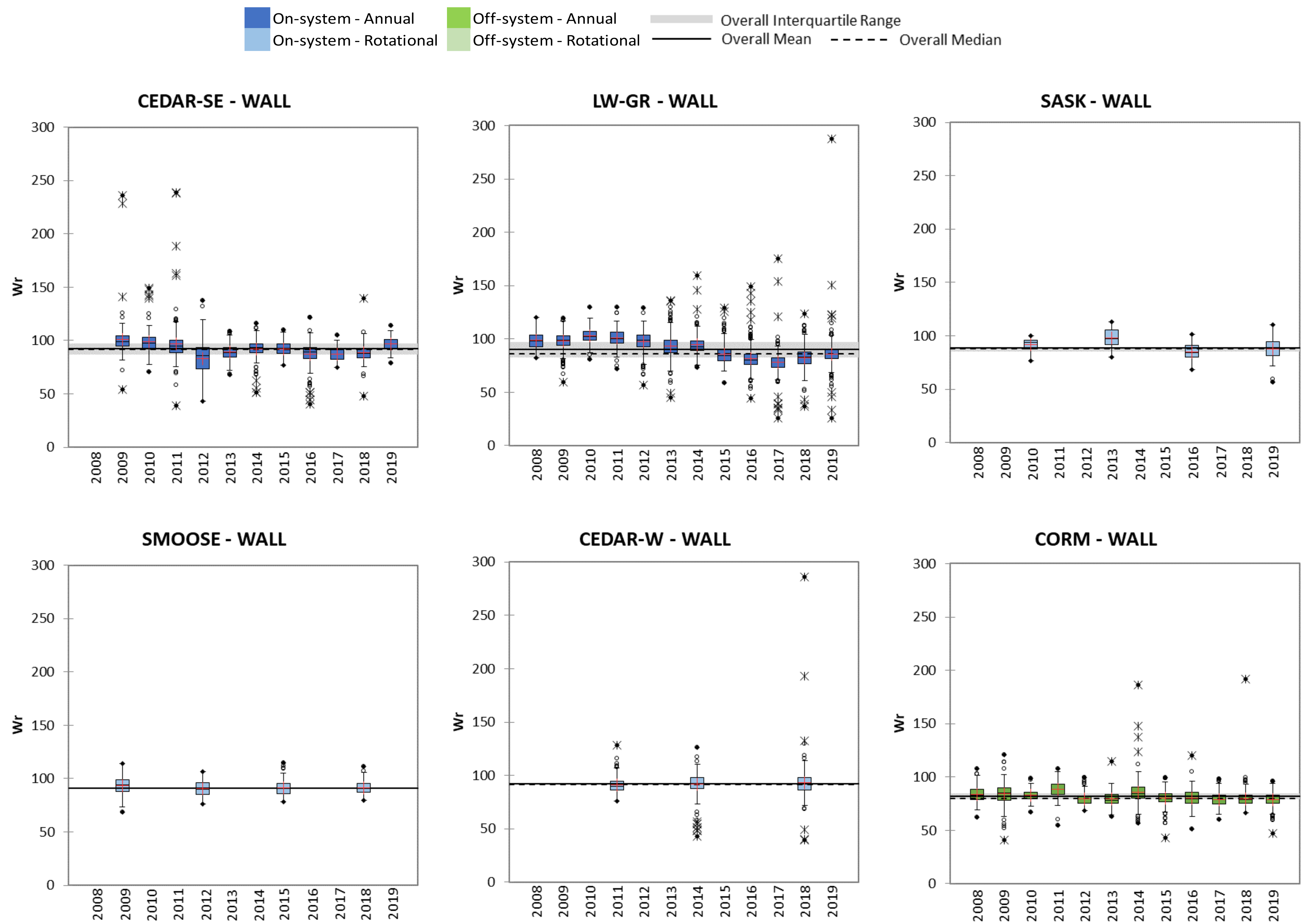


Figure 5.3-9. 2008-2019 Relative weight (Wr) of Walleye.

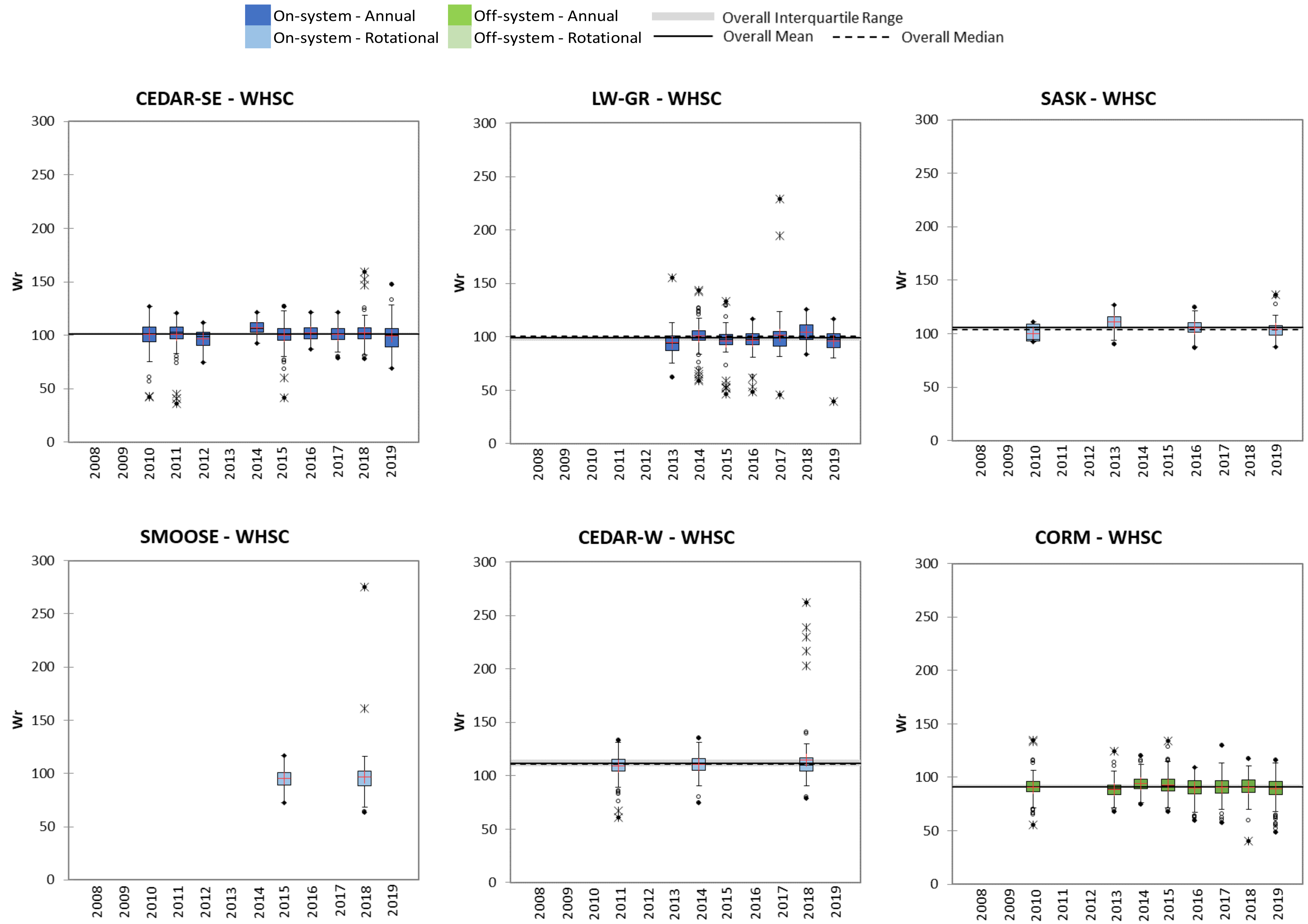


Figure 5.3-10. 2008-2019 Relative weight (Wr) of White Sucker.

5.4 GROWTH

5.4.1 LENGTH-AT-AGE

5.4.1.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake – Southeast

Lake Whitefish

Over the 11 years of monitoring only two 4-year-old Lake Whitefish were captured (Table 5.4-1). The FLA of these fish were 366 mm in 2011 and 340 mm in 2012 (Figure 5.4-1).

There were too few 4-year-old Lake Whitefish captured at Cedar Lake - Southeast to calculate the overall metrics.

Northern Pike

The annual mean FLA of 4-year-old Northern Pike over the 11 years of monitoring ranged from a low of 487 in 2009 to a high of 639 mm in 2011 (Table 5.4-1; Figure 5.4-2).

The overall mean FLA was 560, the median was 569, and the IQR was 550-583 mm (Figure 5.4-2). The annual mean FLA fell within the overall IQR except in 2009, 2010, and 2016 when it was below the IQR and in 2011 and 2013 when it was above the IQR.

Sauger

Aging structures were not collected from Sauger from Cedar Lake – Southeast until 2018; the annual mean FLA of 3-year-old Sauger over the two years of monitoring was 212 in 2018 and 225 mm in 2019 (Table 5.4-1; Figure 5.4-3).

Walleye

The annual mean FLA of 3-year-old Walleye over the 11 years of monitoring ranged from a low of 225 in 2019 to a high of 338 mm in 2016 (Table 5.4-1; Figure 5.4-4).

The overall mean FLA was 254, the median was 244, and the IQR was 239-277 mm (Figure 5.4-4). The annual mean FLA fell within the overall IQR except in 2009 and 2019 when it was below the IQR and in 2016 when it was above the IQR.

White Sucker

White Sucker was not aged as part of CAMP.

Lake Winnipeg – Grand Rapids

Lake Whitefish

The annual mean FLA of 4-year-old Lake Whitefish over the 12 years of monitoring ranged from a low of 338 in 2013 to a high of 406 mm in 2008 (Table 5.4-1; Figure 5.4-1). Four-year-olds were not caught at Grand Rapids in 2010, 2014, 2016, or 2018.

The overall mean FLA was 352, the median was 347, and the IQR was 345-357 mm (Figure 5.4-1). The annual mean FLA fell within the overall IQR except in 2013 when it was below the IQR and in 2008 and 2019 when it was above the IQR.

Northern Pike

Over the six years that age data was collected from Northern Pike from the Grand Rapids area of Lake Winnipeg, only three 4-year-old Northern Pike were captured (Table 5.4-1). The FLA of these fish was 562 in 2017 and 480 mm in 2019 (Figure 5.4-2).

There were too few Northern Pike captured in the Grand Rapids area of Lake Winnipeg to calculate the overall metrics.

Sauger

The annual mean FLA of 3-year-old Sauger over the 12 years of monitoring ranged from a low of 172 in 2016 to a high of 260 mm in 2014 (Table 5.4-1; Figure 5.4-3). Three-year-olds were not caught in 2009.

The overall mean FLA was 219, the median was 224, and the IQR was 190-235 mm (Figure 5.4-3). The annual mean FLA fell within the overall IQR except in 2015, 2016, and 2018 when it was below the IQR and in 2008 and 2014 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 219 in 2019 to a high of 328 mm in 2008 (Table 5.4-1; Figure 5.4-4).

The overall mean FLA was 275, the median was 274, and the IQR was 264-305 mm (Figure 5.4-4). The annual mean FLA fell within the overall IQR except in 2015, 2016, 2017, 2018, and 2019 when it was below the IQR and in 2008 when it was above the IQR.

White Sucker

White Sucker was not aged as part of CAMP.

ROTATIONAL SITES

Saskatchewan River between The Pas and Cedar Lake

Lake Whitefish

Lake Whitefish were not captured in the Saskatchewan River over the four years of monitoring (Table 5.4-1).

Northern Pike

Over the four years of monitoring 4-year-old Northern Pike were only captured in 2013 (Table 5.4-1). In this year, the mean FLA was 602 mm (Figure 5.4-2).

Sauger

Over four years of monitoring, Sauger was only a target species in the Saskatchewan River in 2019. In this year, 3-year-old Sauger had a mean FLA of 261 mm (Table 5.4-1; Figure 5.4-3).

Walleye

The annual mean FLA of 3-year-old Walleye over the four years of monitoring ranged from a low of 285 in 2019 to a high of 354 mm in 2016 (Table 5.4-1; Figure 5.4-4). Three-year-olds were not caught in 2010.

There were too few three-year-old Walleye captured at Cedar Lake – Southeast to calculate the overall metrics.

White Sucker

White Sucker was not aged as part of CAMP.

South Moose Lake

Lake Whitefish

The annual mean FLA of 4-year-old Lake Whitefish over the four years of monitoring ranged from a low of 270 in 2015 to a high of 363 mm in 2009 (Table 5.4-1; Figure 5.4-1). Four-year-olds were not caught in 2012.

The overall mean FLA was 323, the median was 350, and the IQR was 270-363 mm (Figure 5.4-1). The annual mean Wr was equal to or fell within the overall IQR in all three years.

Northern Pike

The annual mean FLA of 4-year-old Northern Pike over the four years of monitoring ranged from a low of 550 in 2009 to a high of 589 mm in 2015 (Table 5.4-1; Figure 5.4-2).

The overall mean FLA was 571, the median was 578, and the IQR was 550-578 mm (Figure 5.4-2). The annual mean FLA fell within the overall IQR except in 2015 when it was above the IQR.

Sauger

Sauger were not captured in South Moose Lake since it became a target species in 2017 (Table 5.4-1).

Walleye

The annual mean FLA of 3-year-old Walleye over the four years of monitoring ranged from a low of 342 in 2018 to a high of 374 mm in 2012 (Table 5.4-1; Figure 5.4-4).

The overall mean FLA was 350 and the median and IQR were 348 mm (Figure 5.4-4). The annual mean FLA was below the IQR in 2018 and above the IQR in 2009 and 2012.

White Sucker

White Sucker was not aged as part of CAMP.

<u>Cedar Lake - West</u>

Lake Whitefish

Lake Whitefish were not captured at Cedar Lake – West over the four years of monitoring (Table 5.4-1).

Northern Pike

The annual mean FLA of 4-year-old Northern Pike over the three years of monitoring ranged from a low of 349 in 2011 to a high of 540 mm in 2014 (Table 5.4-1; Figure 5.4-2).

The overall mean FLA was 483, the median was 516, and the IQR was 349-540 mm (Figure 5.4-2). The annual mean Wr was equal to or fell within the overall IQR in all three years.

Sauger

Over three years of monitoring, Sauger was only a target species at Cedar Lake - West in 2018. In this year, 3-year-old Sauger had a mean FLA of 252 mm (Table 5.4-1; Figure 5.4-3).

Walleye

The annual mean FLA of 3-year-old Walleye over the three years of monitoring ranged from a low of 220 in 2011 to a high of 288 mm in 2014 (Table 5.4-1; Figure 5.4-4).

The overall mean FLA was 277 and the median and IQR were 288 mm (Figure 5.4-4). The annual mean FLA was below the IQR in 2011 and 2018.

White Sucker

White Sucker was not aged as part of CAMP.

5.4.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

Lake Whitefish

The annual mean FLA of 4-year-old Lake Whitefish over the 12 years of monitoring ranged from a low of 262 in 2014 to a high of 314 mm in 2010 (Table 5.4-1; Figure 5.4-1). Four year olds were not captured in 2008, 2012, 2013, or 2017.

The overall mean FLA was 271, the median was 263, and the IQR was 263-280 mm (Figure 5.4-1). The annual mean FLA fell within the overall IQR except in 2010 and 2019 when it was above the IQR.

Northern Pike

The annual mean FLA of 4-year-old Northern Pike over the 12 years of monitoring ranged from a low of 528 in 2015 to a high of 616 mm in 2009 (Table 5.4-1; Figure 5.4-2).

The overall mean FLA was 547, the median was 540, and the IQR was 539-567 mm (Figure 5.4-2). The annual mean FLA fell within the overall IQR except in 2008, 2010, 2012, and 2015 when it was below the IQR and in 2009, 2013, and 2014 when it was above the IQR.

Sauger

Aging structures were not collected from Sauger from Cormorant Lake until 2018. The annual mean FLA of 3-year-old Sauger was 181 mm in 2018 (Table 5.4-1; Figure 5.4-3). Three-year-olds were not captured in 2019.

Walleye

The annual mean FLA of 3-year-old Walleye over the 12 years of monitoring ranged from a low of 267 in 2009 to a high of 329 mm in 2012 (Table 5.4-1; Figure 5.4-4). Three-year-olds were not captured in 2014.

The overall mean FLA was 293, the median was 295, and the IQR was 282-299 mm (Figure 5.4-4). The annual mean FLA fell within the overall IQR except in 2009 and 2019 when it was below the IQR and in 2011, 2012, 2013, and 2016 when it was above the IQR.

White Sucker

White Sucker was not aged as part of CAMP.

ROTATIONAL SITES

There are no waterbodies in the SRR that are monitored on a rotational basis.

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

Waterbody	Year	LKWH			NRPK			SAUG			WALL		
		n_F[1]	Mean	SE[2]	n_F	Mean	SE	n_F	Mean	SE	n_F	Mean	SE
CEDAR-SE	2009	-	-	-	3	487	16				26	229	5
	2010	-	-	-	6	496	15				1	263	-
	2011	1	366	-	5	639	29				27	239	6
	2012	1	340	-	6	567	20				9	272	13
	2013	-	-	-	3	591	33				21	244	4
	2014	-	-	-	15	569	12				25	277	6
	2015	-	-	-	17	583	10				5	277	3
	2016	-	-	-	7	507	10				8	338	18
	2017	-	-	-	5	556	22				20	250	4
	2018	-	-	-	4	556	19	6	212	3	7	241	9
	2019	-	-	-	6	550	14	3	225	11	2	225	4
LW-GR	2008	1	406	-				7	239	11	97	328	3
	2009	5	357	11				-	-	-	39	305	4
	2010	-	-	-				2	209	15	38	273	5
	2011	2	345	25				19	224	4	23	267	9
	2012	4	353	22				4	219	13	73	264	4
	2013	7	338	7				23	235	7	141	274	3
	2014	-	-	-	-	-	-	17	260	13	21	260	13
	2015	8	347	7	-	-	-	3	188	5	73	232	3
	2016	-	-	-	-	-	-	7	172	7	9	228	9
	2017	1	350	-	2	562	20	7	190	10	7	223	7
	2018	-	-	-	-	-	-	17	182	6	1	224	-
	2019	2	391	28	1	480		3	201	12	10	219	3
SASK	2010	-	-	-	-	-	-				-	-	-
	2013	-	-	-	7	602	22				1	352	-
	2016	-	-	-	-	-	-				1	354	-
	2019	-	-	-	-	-	-	10	261	5	2	285	11
SMOOSE	2009	2	363	9	19	550	11				5	359	13
	2012	-	-	-	12	574	14				9	374	7
	2015	2	270	28	13	589	18				56	348	3
	2018	1	350	-	19	578	13	-	-	-	12	342	8
CEDAR-W	2011	-	-	-	13	349	15				4	220	4
	2014	-	-	-	22	540	15				30	288	5
	2018	-	-	-	15	516	23	11	252	6	2	239	2
CORM	2008	-	-	-	2	535	4				11	285	5
	2009	2	263	2	1	616	-				8	267	14
	2010	1	314	-	5	534	12				21	299	6
	2011	18	263	3	12	547	11				5	314	9
	2012	-	-	-	6	530	11				4	329	17
	2013	-	-	-	6	578	21				20	310	6
	2014	10	262	6	5	571	22				-	-	-
	2015	1	280	-	14	528	11				23	293	5
	2016	5	271	9	23	539	9				13	314	5
	2017	-	-	-	14	540	10				80	295	2
	2018	5	281	7	13	547	12	3	181	7	53	282	3
	2019	5	297	5	21	567	9	-	-	-	6	268	7

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.

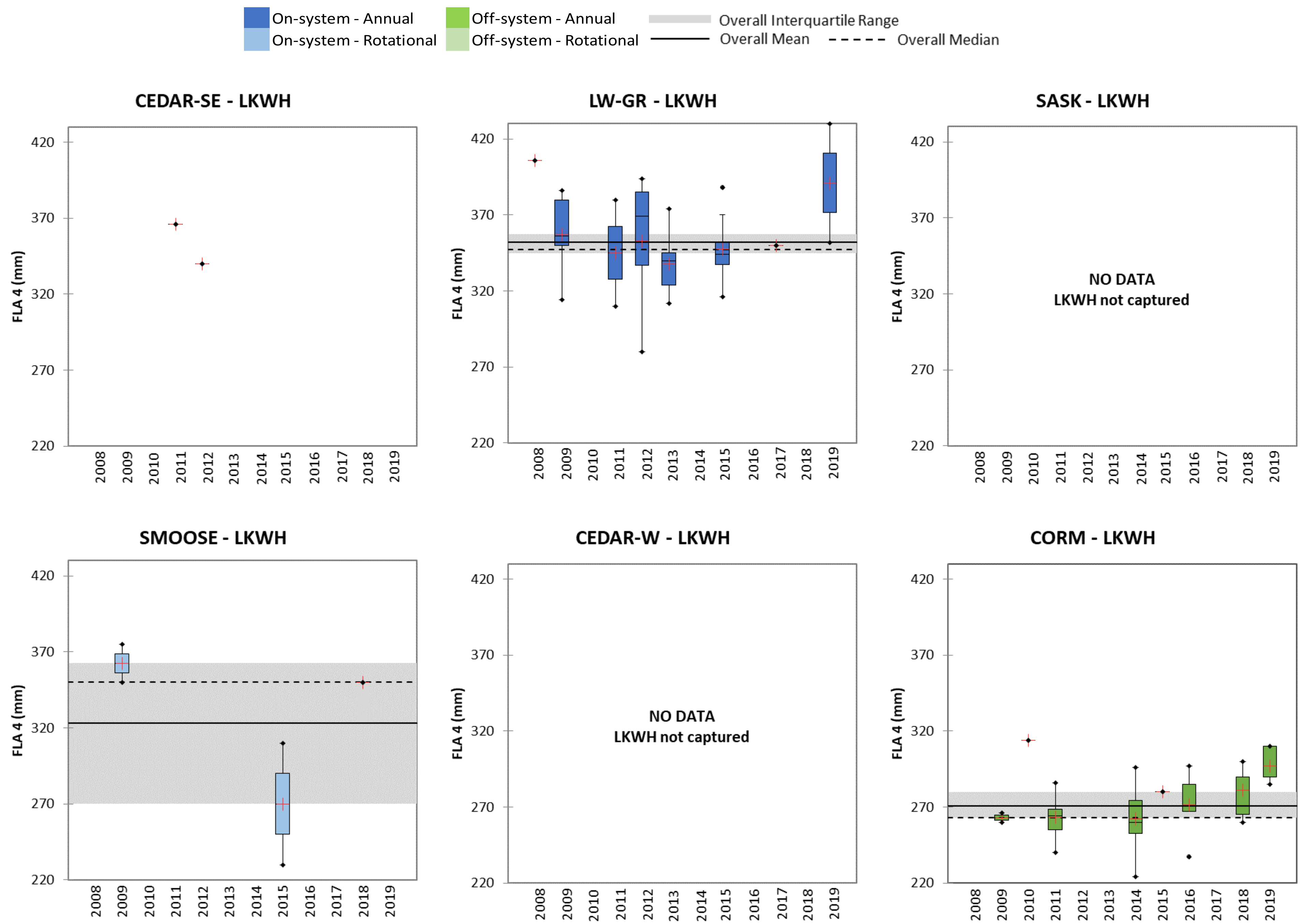


Figure 5.4-1. 2008-2019 Fork length-at-age (FLA) 4 of Lake Whitefish.

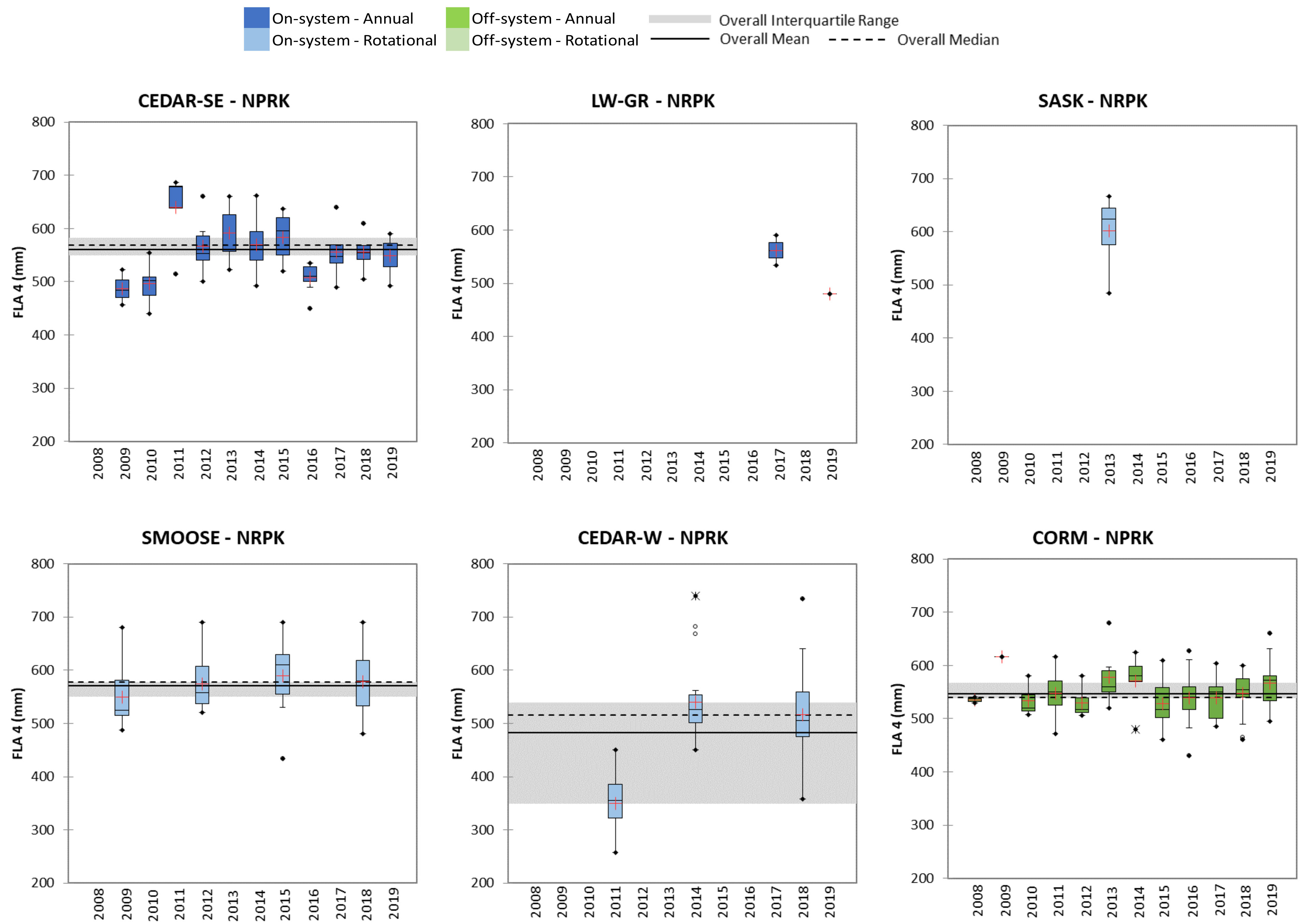


Figure 5.4-2. 2008-2019 Fork length-at-age (FLA) 4 of Northern Pike.

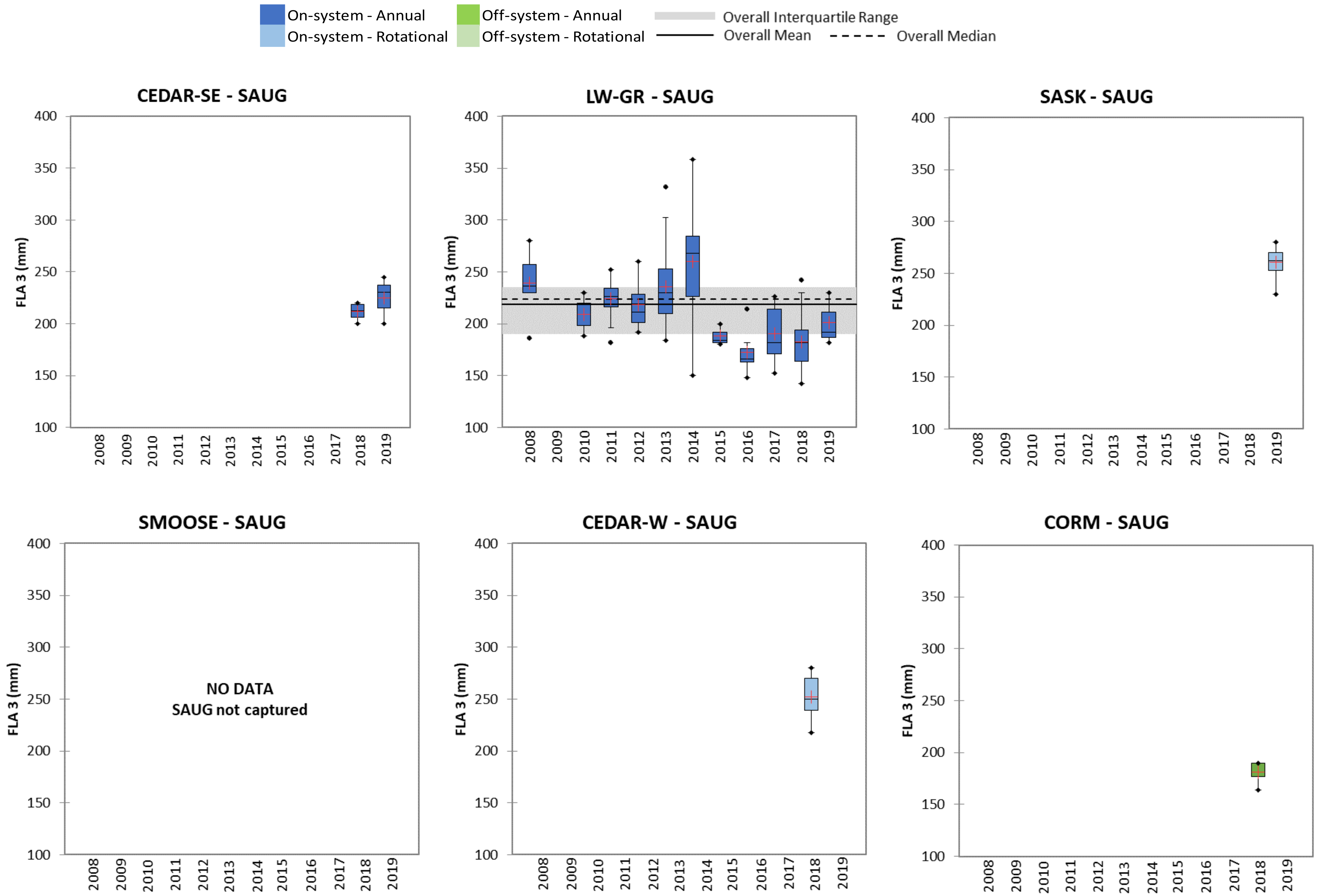


Figure 5.4-3. 2008-2019 Fork length-at-age (FLA) 3 of Sauger.

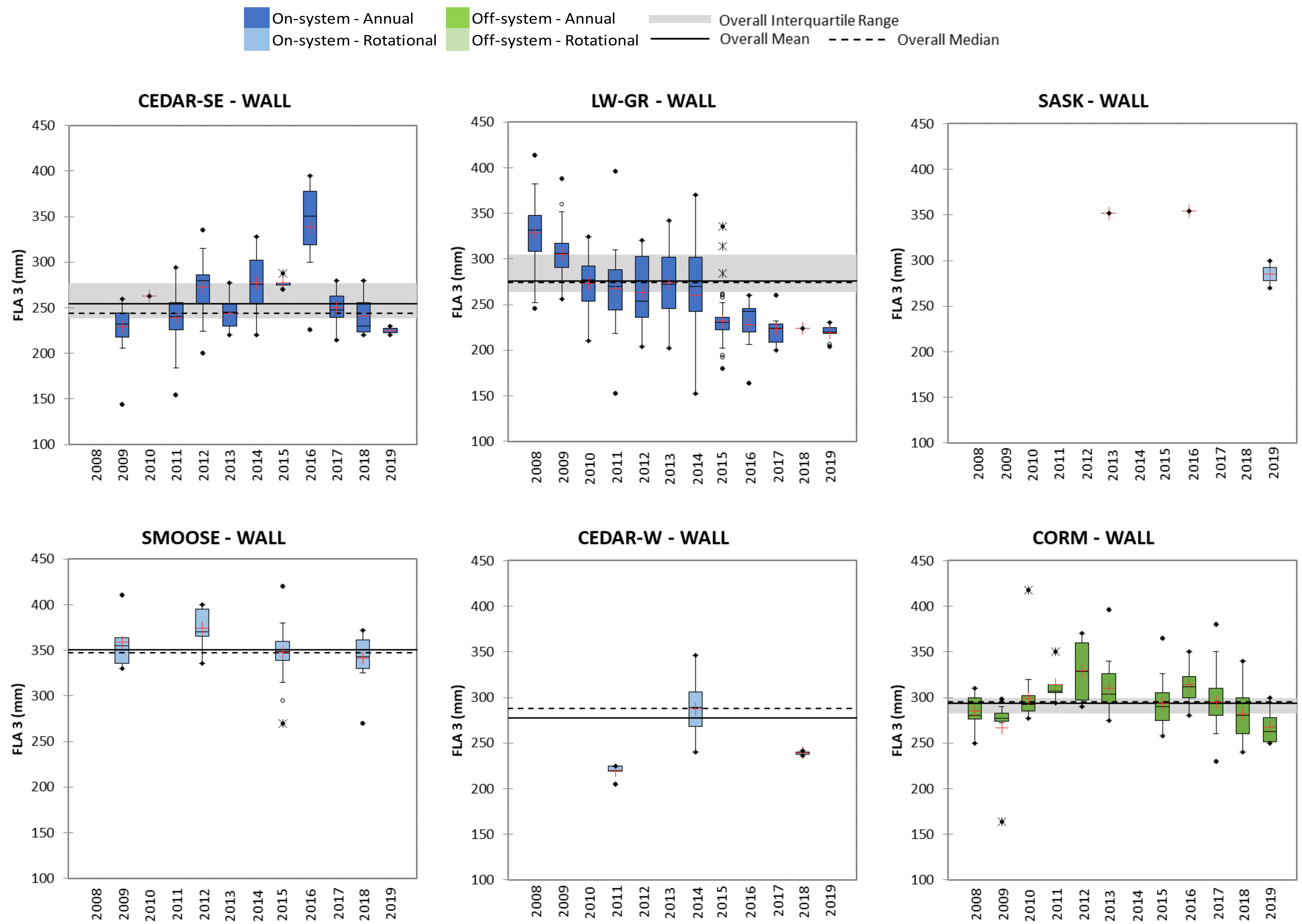


Figure 5.4-4. 2008-2019 Fork length-at-age (FLA) 3 of Walleye.

5.5 RECRUITMENT

5.5.1 RELATIVE YEAR-CLASS STRENGTH

5.5.1.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

Lake Whitefish

Age data for Lake Whitefish were insufficient to allow year-class strength determination.

Northern Pike

The RYCS of Northern Pike over the 11 years of monitoring ranged from a low of 52 for the 2008 cohort to a high of 151 for the 2004 cohort (Figure 5.5-1). There were no missing cohorts from 2004-2014. Strong cohorts (>100) were produced in over half of the years, from 2004-2005, 2007, 2009-2010, and 2014

Sauger

Since age data has only been collected from Sauger from Cedar Lake – Southeast since 2018 there are not enough years of data for RYCS analysis.

Walleye

The RYCS of Walleye over the 12 years of monitoring ranged from a low of 24 for the 2013 cohort to a high of 205 for the 2014 cohort (Figure 5.5-2). There were no missing cohorts from 2002-2014. Strong cohorts (>100) were produced over two-year intervals, in 2002-2003, 2005-2006, 2010-2011, and again in 2014 and each of these intervals was followed by a particularly weak cohort (<50) in 2004, 2007, and 2012.

White Sucker

White Sucker was not aged as part of CAMP.

Lake Winnipeg – Grand Rapids

Lake Whitefish

Age data for Lake Whitefish were insufficient to allow year-class strength determination.

Northern Pike

Age data for Northern Pike were insufficient to allow year-class strength determination.

Sauger

The RYCS of Sauger over the nine years of monitoring that there is sufficient age data (2012-2019) ranged from a low of 5 for the 2006 cohort to a high of 223 for the 2008 cohort (Figure 5.5-3). There were no missing cohorts from 2006-2014 although the 2006 cohort was particularly weak. Strong cohorts (>100) were produced in 2008, 2010, and 2011.

Walleye

Only a subsample of the Walleye catch was aged in 2010 and 2014 therefore RYCS analysis was conducted on data collected from 2015-2019 because at least three consecutive years of data are required. The RYCS of Walleye over the five years of monitoring ranged from a low of 20 for the 2013 cohort to a high of 213 for the 2012 cohort (Figure 5.5-2). There were no missing cohorts from 2009-2014. Strong cohorts (>100) were produced from 2010-2012 and was followed by a particularly weak cohort (<50) in 2013.

White Sucker

White Sucker was 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

Cormorant Lake

Lake Whitefish

Age data for Lake Whitefish were insufficient to allow year-class strength determination.

Northern Pike

The RYCS of Northern Pike over the 11 years that age data was collected ranged from a low of 57 for the 2009 cohort to a high of 142 for the 2012 cohort (Figure 5.5-1). There were no missing cohorts from 2004-2014. Strong cohorts (>100) were produced from 2004-2006, 2011-2012, and again in 2014.

Sauger

Since age data has only been collected from Sauger from Cormorant Lake since 2018 there are not enough years of data for RYCS analysis.

Walleye

The RYCS of Walleye over the 12 years of monitoring ranged from a low of 21 for the 2011 cohort to a high of 240 for the 2014 cohort (Figure 5.5-2). There were no missing cohorts from 2002-2014. Strong cohorts (>100) were produced approximately every other year, in 2005, 2007, 2010, 2012, and 2014. A particularly weak cohort (<50) occurred in 2002, 2004, 2008, 2009, and 2011.

White Sucker

White Sucker was not aged as part of CAMP.

ROTATIONAL SITES

There are no waterbodies in the SRR that are monitored on a rotational basis.

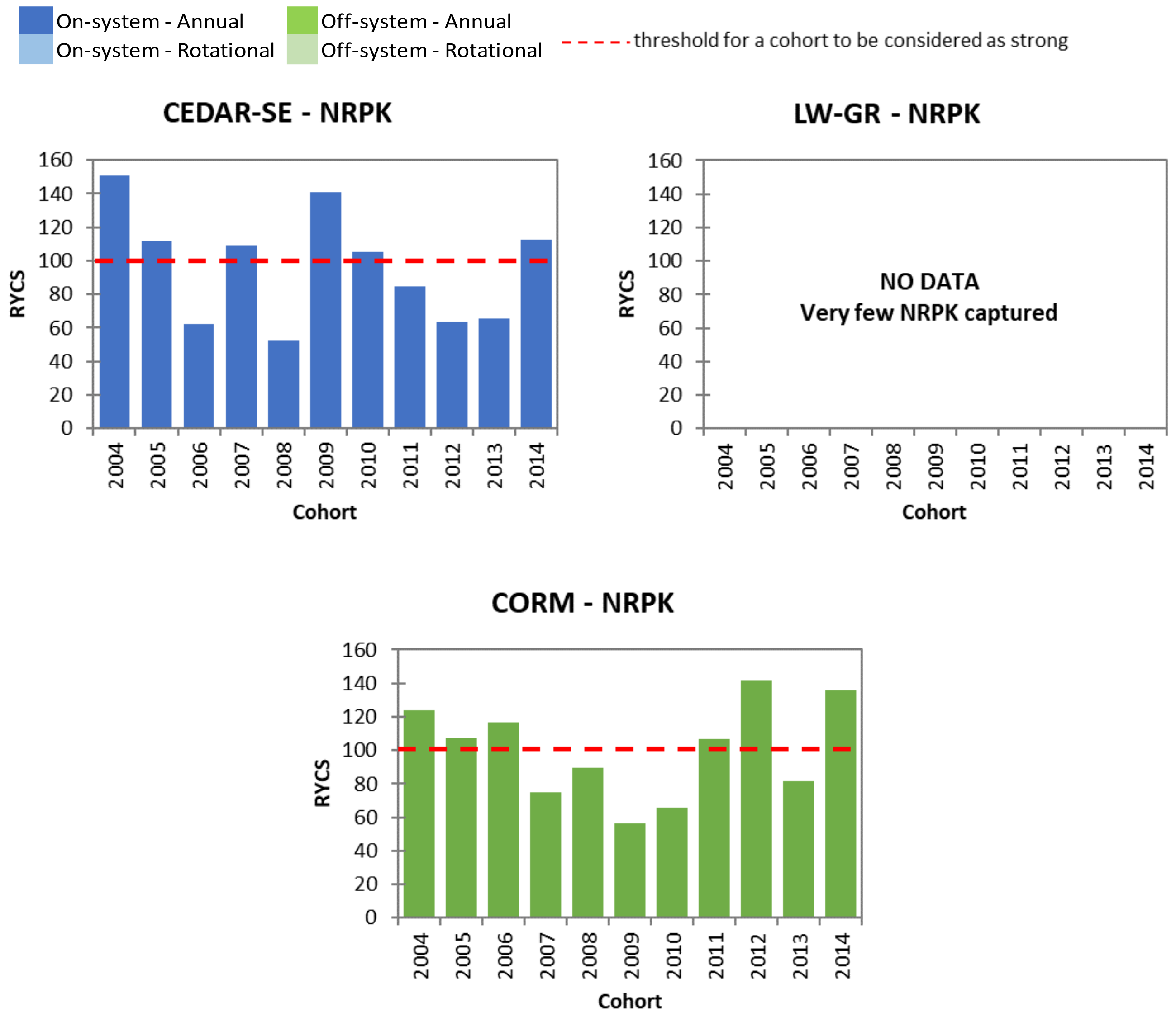


Figure 5.5-1. Relative year-class strength (RYCS) of Northern Pike.

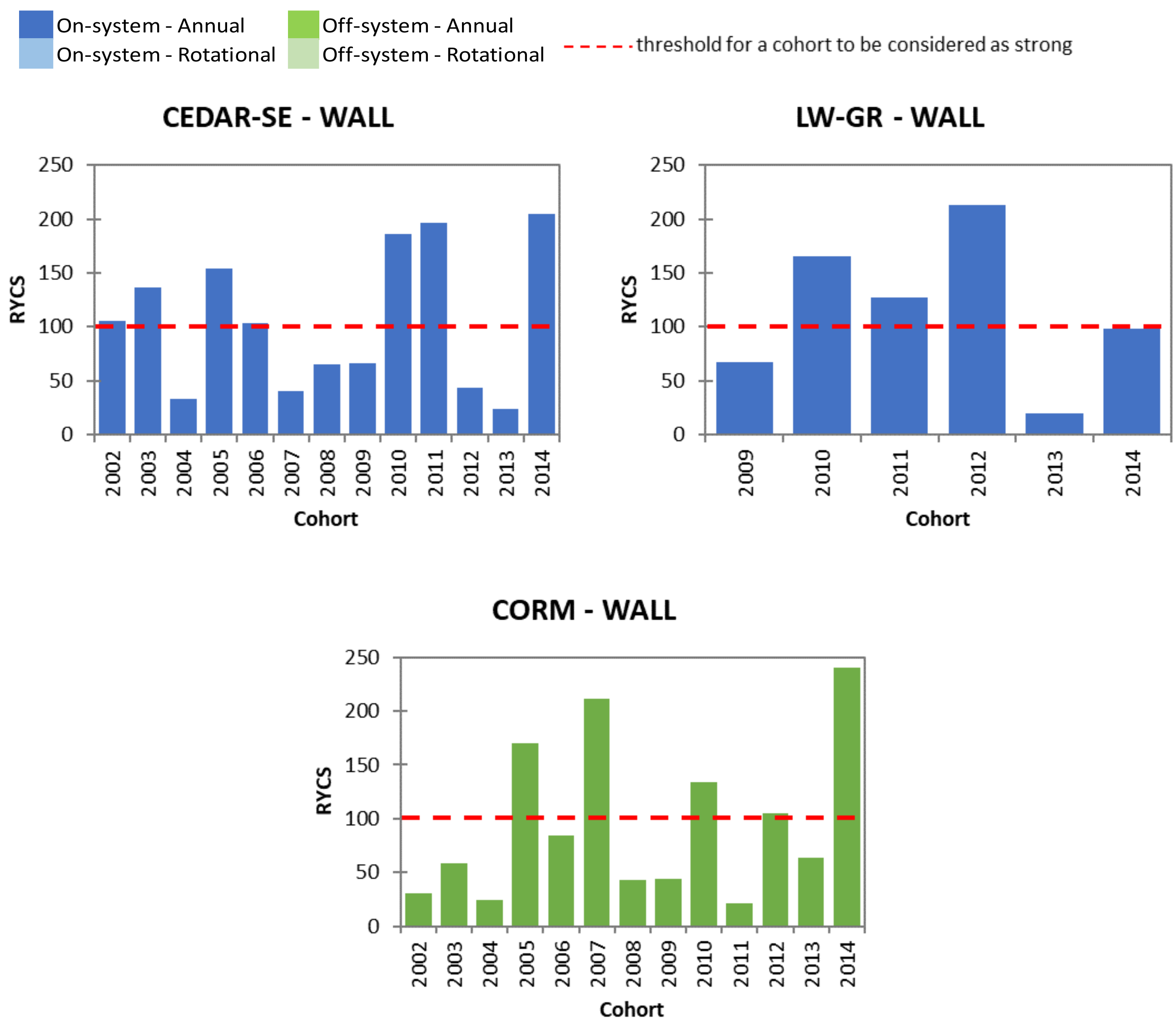


Figure 5.5-2. Relative year-class (RYCS) strength of Walleye.

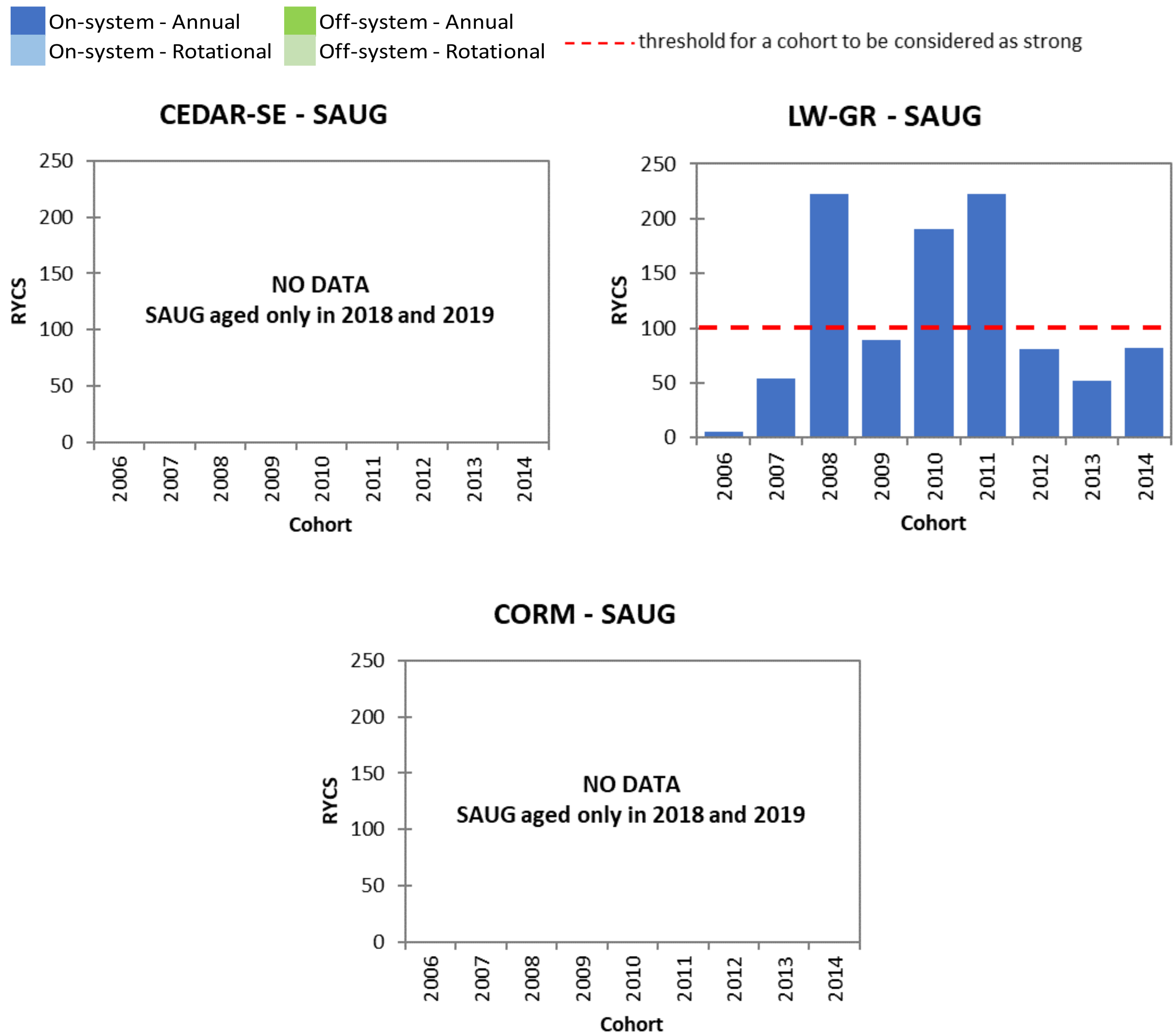


Figure 5.5-3. Relative year class-strength (RYCS) of Sauger.

5.6 DIVERSITY

5.6.1 RELATIVE SPECIES ABUNDANCE

5.6.1.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake - Southeast

A total of 15 fish species were captured in the combined standard and small mesh gangs at Cedar Lake - Southeast over 11 years of monitoring (Table 5.6-1) with the number of species caught each year ranging from 9-14 (Tables 5.6-2 and 5.6-3).

Standard Gang Index Gill Nets

White Sucker was the most frequently captured species at Cedar Lake – Southeast over 11 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 14% in 2019 to a high of 43% in 2017 and 2018. Two species accounted for >25% of the catch in some years, Walleye in 2009, 2013, 2016, and 2018 and Cisco (*Coregonus artedi*) from 2010-2013 and 2019.

Small Mesh Index Gill Nets

No one species accounted for >25% of the catch in small mesh nets over the 10 years of monitoring that small mesh gangs were set at the target sites (Table 5.6-3). Five species accounted for >25% of the catch in some years: Emerald Shiner (*Notropis atherinoides*) in 2011, 2013, and 2014; Spottail Shiner (*Notropis hudsonius*) in 2011, 2014, and 2018; Yellow Perch (*Perca flavescens*) in 2012, 2016, and 2019; Sauger in 2009; and Walleye in 2009, 2015, 2017, and 2018.

Lake Winnipeg – Grand Rapids

A total of 18 fish species were captured in the combined standard and small mesh gangs in the Grand Rapids area of Lake Winnipeg over 12 years of monitoring (Table 5.6-1), with the number of species caught each year ranging from 8-13 (Tables 5.6-4 and 5.6-5). The Grand Rapids area was the only location in the Saskatchewan River Region where Rainbow Smelt (*Osmerus mordax*) were captured.

Standard Gang Index Gill Nets

Walleye was the most frequently captured species at the Grand Rapids area over 12 years of monitoring, accounting for an average of >25% of the catch (Table 5.6-4). The annual RSA for Walleye ranged from a low of 19% in 2014 to a high of 71% in 2010. Two species accounted for >25% of the catch in some years, White Sucker in 2008 and 2014 and Yellow Perch in 2009, 2013, and 2016.

Small Mesh Index Gill Nets

The most common species captured in the Grand Rapids area over 11 years small mesh gangs were set at the target sites was Trout-perch (*Percopsis omiscomaycus*), accounting for an average of >25% of the catch (Table 5.6-5). The annual RSA for Trout-perch ranged from a low of 5% in 2008 to a high of 69% in 2011. Three species accounted for >25% of the catch in some years: Rainbow Smelt in 2008, 2012, and 2013; Sauger in 2018; and Walleye in 2012.

ROTATIONAL SITES

Saskatchewan River between The Pas and Cedar Lake

A total of 14 fish species were captured in the combined standard and small mesh gangs in the Saskatchewan River over four years of monitoring (Table 5.6-1), with the number of species caught each year ranging from 8-12 (Tables 5.6-6 and 5.6-7).

Standard Gang Index Gill Nets

Walleye and White Sucker were the most frequently captured species in the Saskatchewan River over four years of monitoring, each accounting for an average of >25% of the catch (Table 5.6-6). The annual RSA for Walleye ranged from a low of 18% in 2013 to a high of 47% in 2010. The annual RSA for White Sucker ranged from a low of 17% in 2010 to a high of 29% in 2016 and 2019. Northern Pike accounted for > 25% of the catch in 2013.

Small Mesh Index Gill Nets

No one species accounted for >25% of the catch in small mesh nets over four years of monitoring (Table 5.6-7). Three species accounted for >25% of the catch in some years: Goldeye (*Hiodon alosoides*) in 2013; Sauger in 2016; and Walleye in 2016.

South Moose Lake

A total of 13 fish species were captured in the combined standard and small mesh gangs at South Moose Lake over four years of monitoring (Table 5.6-1), with the number of species caught each year ranging from 7-12 (Tables 5.6-8 and 5.6-9).

Standard Gang Index Gill Nets

White Sucker was the most frequently captured species at South Moose Lake over four years of monitoring, accounting for an average of >25% of the catch (Table 5.6-8). The annual RSA of White Sucker ranged from a low of 39% in 2015 to a high of 54% in 2009. Walleye accounted for >25% of the catch in 2015.

Small Mesh Index Gill Nets

The most common species captured in South Moose Lake over four years of monitoring was Yellow Perch, which accounted for an average of >25% of the catch (Table 5.6-9). The annual RSA for Yellow Perch ranged from a low of 48% in 2018 to a high of 90% in 2009. Spottail Shiner accounted for >25% of the catch in 2018.

Cedar Lake – West

A total of 12 fish species were captured in the combined standard and small mesh gangs at Cedar Lake – West over three years of monitoring (Table 5.6-1), with the number of species caught each year ranging from 10-15 (Tables 5.6-10 and 5.6-11).

Standard Gang Index Gill Nets

Walleye and White Sucker were the most frequently captured species at Cedar Lake - west over three years of monitoring, each accounting for an average of >25% of the catch (Table 5.6-10). The annual RSA of Walleye ranged from a low of 17% in 2011 to a high of 36% in 2018. The annual RSA of White Sucker ranged from a low of 19% in 2011 to a high of 31% in 2014. Sauger accounted for >25% of the catch in 2011.

Small Mesh Index Gill Nets

The most common species captured in the Cedar Lake – West over three years of monitoring were Emerald Shiner and Trout-perch, each of which accounted for an average of >25% of the catch (Table 5.6-11). The annual RSA for Emerald Shiner ranged from a low of 18% in 2011 to a high of 41% in 2014. The annual RSA for Trout-perch ranged from a low of 1% in 2014 to a high of 47% in 2011. No other species accounted for >25% of the catch in any year.

5.6.1.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

A total of 16 fish species were captured in the combined standard and small mesh gangs at Cormorant Lake over 12 years of monitoring (Table 5.6-1), with the number of species caught each year ranging from 8-14 (Tables 5.6-12 and 5.6-13).

Standard Gang Index Gill Nets

White Sucker and Walleye were the most frequently captured species at Cormorant Lake over 12 years of monitoring, accounting for an average of >25% of the catch (Table 5.6-12). The annual RSA for White Sucker ranged from a low of 32% in 2011 to a high of 50% in 2008. The annual RSA for Walleye ranged from a low of 17% in 2010 to a high of 41% in 2018. No other species accounted for >25% of the catch in any year.

Small Mesh Index Gill Nets

The most common species captured in Cormorant Lake over 11 years small mesh gangs were set at the target sites was Yellow Perch and Spottail Shiner, each of which accounted for an average of >25% of the catch (Table 5.6-13). The annual RSA for Yellow Perch ranged from a low of 15% in 2008 to a high of 70% in 2012. The annual RSA for Spottail Shiner ranged from a low of 0% in 2008 to a high of 51% in 2013. Two other species accounted for >25% of the catch in some years, Emerald Shiner in 2008 and Sauger in 2009.

ROTATIONAL SITES

There are no waterbodies in the SRR that are monitored on a rotational basis.

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

Family	Species	Abbreviation	Status[1]	Target Species	CEDAR-SE	LW-GR	SASK	SMOOSE	CEDAR-W	CORM
Acipenseridae	Lake Sturgeon[2]	LKST	Native			●	●			
Hiodontidae	Mooneye	MOON	Native				●			
	Goldeye	GOLD	Native				●		●	
Cyprinidae	Lake Chub	LKCH	Native							●
	Common Shiner	CMSH	Native							●
	Emerald Shiner	EMSH	Native		●	●	●	●	●	●
	Spottail Shiner	SPSH	Native		●	●	●	●	●	●
Catostomidae	Longnose Sucker	LNSC	Native		●	●	●	●		●
	White Sucker	WHSC	Native	●	●	●	●	●	●	●
	Shorthead Redhorse	SHRD	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							●
Centrarchidae	Rock Bass	RCBS	Native			●				
Percidae	Yellow Perch	YLPR	Native		●	●		●	●	●
	Logperch	LGPR	Native		●	●				●
	Sauger	SAUG	Native	●	●	●	●	●	●	●
	Walleye	WALL	Native	●	●	●	●	●	●	●
Sciaenidae	Freshwater Drum	FRDR	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 Cedar Lake – Southeast.

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

Group	Species	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
Target	LKWH	0.2%	0%	0.1%	0.3%	0.2%	0.2%	0%	0%	0%	0%	0%	0.1%
	NRPK	3%	2%	2%	6%	4%	9%	8%	8%	7%	10%	8%	6%
	SAUG	13%	13%	14%	10%	15%	9%	7%	4%	6%	6%	10%	10%
	WALL	33%	15%	24%	12%	26%	20%	23%	35%	23%	27%	18%	23%
	WHSC	32%	20%	15%	18%	18%	26%	29%	28%	43%	43%	14%	26%
Sturgeon	LKST	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%
	GOLD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Minnows	EMSH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Suckers	LNSC	2%	2%	2%	0%	1%	4%	3%	1%	2%	1%	1%	2%
	SHRD	1%	0.1%	0%	0%	0%	1%	0%	1%	1%	3%	0.3%	1%
Smelts	RNSM	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Coregonids	CISC	3%	40%	34%	44%	26%	23%	11%	15%	3%	8%	39%	23%
Trout-perch	TRPR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Codfishes	BURB	0%	0.1%	0.1%	0%	0%	1%	0.1%	0.2%	1%	0.2%	0%	0.2%
Perch	YLPR	11%	8%	8%	9%	10%	6%	17%	9%	14%	3%	9%	10%
Drums	FRDR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 5.6-3. 2008-2019 Relative species abundance in small mesh index gill nets in Cedar Lake – Southeast.

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

Group	Species	2009	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
Mooneyes	GOLD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Minnows	LKCH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	CMSH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	EMSH	0%	27%	1%	42%	30%	2%	2%	1%	2%	9%	12%
	SPSH	0%	28%	19%	17%	28%	4%	2%	6%	33%	24%	16%
Suckers	LNSC	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.04%
	WHSC	0%	0.2%	0.4%	0%	0%	0%	0%	0%	0.2%	1%	0.2%
	SHRD	0%	0%	0%	0%	0%	0%	0%	0%	0.2%	0%	0.0%
Pikes	NRPK	0%	0%	0.2%	0%	1%	1%	0.3%	0%	1%	1%	0.4%
Smelts	RNSM	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Coregonids	CISC	6%	1%	1%	5%	6%	16%	6%	0.4%	3%	0%	4%
	LKWH	0%	0%	0.1%	0%	0%	0%	0%	0%	0%	0%	0.0%
Trout-perch	TRPR	0%	16%	3%	0%	2%	11%	10%	7%	6%	5%	6%
Codfishes	BURB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sculpins	MTSC	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	SLSC	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sunfishes	RCBS	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Perch	YLPR	0%	16%	65%	11%	21%	23%	53%	13%	12%	30%	25%
	LGPR	0%	0%	1%	2%	1%	1%	1%	11%	0.5%	0%	2%
	Sander spp.	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	SAUG	61%	2%	2%	4%	5%	5%	12%	5%	4%	10%	11%
	WALL	33%	10%	8%	18%	7%	38%	12%	56%	37%	20%	24%

Table 5.6-4. 2008-2019 Relative species abundance in standard gang index gill nets in Lake Winnipeg – Grand Rapids.

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	0.2%	3%	5%	2%	8%	2%	2%	2%	0.3%	1%	0%	4%	2%
	NRPK	2%	0.2%	1%	0.2%	1%	0.2%	0%	0.1%	0.2%	0.4%	1%	1%	1%
	SAUG	3%	0.2%	2%	9%	16%	12%	16%	9%	6%	9%	13%	8%	9%
	WALL	46%	35%	71%	35%	44%	24%	19%	40%	43%	52%	48%	60%	43%
	WHSC	31%	20%	5%	22%	16%	12%	43%	14%	14%	11%	13%	7%	17%
Sturgeon	LKST	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.2%	0%	0.01%
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%
Minnows	EMSH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Suckers	LNSC	0.2%	3%	0.3%	1%	0%	0.2%	0.1%	0.1%	0%	0.4%	0%	0.3%	0.5%
	SHRD	0%	0%	0%	0%	0%	0%	0%	0.1%	0%	0%	0%	0%	0.01%
Smelts	RNSM	6%	0%	1%	1%	2%	1%	0%	0%	0%	0%	0%	0%	1%
Coregonids	CISC	2%	2%	9%	6%	3%	20%	10%	20%	9%	7%	2%	4%	8%
Trout-perch	TRPR	0%	0%	0.3%	0%	0%	0.1%	0%	0%	0%	0%	0%	0%	0.03%
Codfishes	BURB	0%	0.2%	0%	0.2%	0.2%	0.1%	0%	0%	0%	0.2%	0%	0%	0.1%
Perch	YLPR	10%	35%	4%	24%	10%	29%	11%	15%	27%	19%	22%	16%	18%
Drums	FRDR	1%	0%	1%	0%	0.2%	0.4%	0%	0%	0%	0%	0%	0%	0.2%

Table 5.6-5. 2008-2019 Relative species abundance in small mesh index gill nets in Lake Winnipeg – Grand Rapids.

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

Group	Species	2008	2009	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
Mooneyes	GOLD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Minnows	LKCH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	CMSH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	EMSH	0.3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0.2%
	SPSH	9%	0.1%	1%	0%	0.2%	2%	5%	1%	0%	0%	0%	2%
Suckers	LNSC	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	WHSC	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0.2%
	SHRD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pikes	NRPK	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Smelts	RNSM	51%	18%	7%	31%	77%	0%	3%	0%	0%	0%	0%	17%
Coregonids	CISC	0%	0%	0%	0.5%	1%	2%	3%	2%	1%	0%	0%	1%
	LKWH	0%	0%	0.1%	1%	0%	0.4%	0%	0%	0%	0%	0%	0.2%
Trout-perch	TRPR	5%	58%	69%	20%	14%	39%	68%	29%	66%	47%	63%	44%
Codfishes	BURB	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%
	SLSC	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sunfishes	RCBS	0%	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0.4%
Perch	YLPR	13%	16%	2%	1%	3%	19%	5%	24%	2%	7%	10%	9%
	LGPR	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0.1%
	Sander spp.	0%	0%	22%	0%	0%	0%	0%	0%	0%	0%	0%	2%
	SAUG	0%	0%	0%	17%	1%	17%	4%	22%	18%	29%	13%	11%
	WALL	21%	7%	0%	29%	3%	15%	12%	21%	13%	17%	13%	14%

Table 5.6-6. 2008-2019 Relative species abundance in standard gang index gill nets in the Saskatchewan River between The Pas and Cedar Lake.

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

Group	Species	2010	2013	2016	2019	Mean
Target	LKWH	0%	0%	0%	0%	0%
	NRPK	2%	31%	1%	2%	9%
	SAUG	9%	2%	5%	12%	7%
	WALL	47%	18%	28%	26%	30%
	WHSC	17%	25%	29%	29%	25%
Sturgeon	LKST	0%	0%	12%	4%	4%
Mooneyes	MOON	0%	4%	0%	0%	1%
	GOLD	4%	4%	5%	13%	7%
Minnows	EMSH	0%	0%	0%	0%	0%
Suckers	LNSC	8%	8%	9%	6%	8%
	SHRD	11%	3%	9%	8%	8%
Smelts	RNSM	0%	0%	0%	0%	0%
Coregonids	CISC	2%	3%	0%	0%	1%
Trout-perch	TRPR	0%	0%	0%	0%	0%
Codfishes	BURB	0%	2%	1%	0.3%	1%
Perch	YLPR	0%	0%	0%	0%	0%
Drums	FRDR	0%	0%	0%	0%	0%

Table 5.6-7. 2008-2019 Relative species abundance in small mesh index gill nets in the Saskatchewan River between The Pas and Cedar Lake.

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

Group	Species	2010	2013	2016	2019	Mean
Mooneyes	GOLD	0%	75%	0%	0%	25%
Minnows	LKCH	0%	0%	0%	0%	0%
	CMSH	0%	0%	0%	0%	0%
	EMSH	0%	0%	20%	25%	15%
	SPSH	0%	0%	0%	10%	3%
Suckers	LNSC	0%	0%	0%	0%	0%
	WHSC	0%	0%	0%	0%	0%
	SHRD	0%	0%	0%	5%	2%
Pikes	NRPK	0%	0%	0%	5%	2%
Smelts	RNSM	0%	0%	0%	0%	0%
Coregonids	CISC	0%	0%	0%	0%	0%
	LKWH	0%	0%	0%	0%	0%
Trout-perch	TRPR	0%	0%	0%	15%	5%
Codfishes	BURB	0%	25%	0%	0%	8%
Sculpins	MTSC	0%	0%	0%	0%	0%
	SLSC	0%	0%	0%	0%	0%
Sunfishes	RCBS	0%	0%	0%	0%	0%
Perch	YLPR	0%	0%	0%	0%	0%
	LGPR	0%	0%	0%	0%	0%
	Sander spp.	0%	0%	0%	0%	0%
	SAUG	0%	0%	40%	20%	20%
	WALL	0%	0%	40%	20%	20%

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

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

Group	Species	2009	2012	2015	2018	Mean
Target	LKWH	3%	3%	6%	1%	3%
	NRPK	14%	18%	16%	24%	18%
	SAUG	0.3%	0%	0%	0%	0.1%
	WALL	8%	13%	34%	16%	18%
	WHSC	54%	45%	39%	44%	46%
Sturgeon	LKST	0%	0%	0%	0%	0%
Mooneyes	MOON	0%	0%	0%	0%	0%
	GOLD	0%	0%	0%	0%	0%
Minnows	EMSH	0%	0%	0%	0%	0%
Suckers	LNSC	3%	0%	0%	0%	1%
	SHRD	0.3%	0%	0%	0%	0.1%
Smelts	RNSM	0%	0%	0%	0%	0%
Coregonids	CISC	16%	10%	3%	10%	10%
Trout-perch	TRPR	0%	0%	0%	0%	0%
Codfishes	BURB	0%	0.2%	0%	0%	0.05%
Perch	YLPR	1%	11%	1%	4%	4%
Drums	FRDR	0%	0%	0%	0%	0%

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

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

Group	Species	2009	2012	2015	2018	Mean
Mooneyes	GOLD	0%	0%	0%	0%	0%
Minnows	LKCH	0%	0%	0%	0%	0%
	CMSH	0%	0%	0%	0%	0%
	EMSH	5%	4%	0%	15%	6%
	SPSH	4%	7%	11%	35%	14%
Suckers	LNSC	0%	0%	0%	0%	0%
	WHSC	1%	0.2%	0%	0.1%	0.2%
	SHRD	0%	0%	0%	0%	0%
Pikes	NRPK	0.3%	1%	1%	1%	1%
Smelts	RNSM	0%	0%	0%	0%	0%
Coregonids	CISC	0%	0%	0%	0.1%	0.03%
	LKWH	0%	0%	0%	0%	0%
Trout-perch	TRPR	0.3%	0%	0%	1%	0.4%
Codfishes	BURB	0%	0%	0%	0%	0%
Sculpins	MTSC	0%	0%	0%	0%	0%
	SLSC	0%	0%	0%	0%	0%
Sunfishes	RCBS	0%	0%	0%	0%	0%
Perch	YLPR	90%	88%	89%	48%	78%
	LGPR	0%	0%	0%	0%	0%
	Sander spp.	0%	0%	0%	0%	0%
	SAUG	0%	0%	0%	0%	0%
	WALL	0%	0.2%	0.1%	0.3%	0.2%

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

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

Group	Species	2011	2014	2018	Mean
Target	LKWH	0%	0%	0%	0%
	NRPK	7%	12%	14%	11%
	SAUG	34%	14%	19%	22%
	WALL	17%	31%	36%	28%
	WHSC	19%	31%	25%	25%
Sturgeon	LKST	0%	0%	0%	0%
Mooneyes	MOON	0%	0%	0%	0%
	GOLD	0.3%	1%	0.2%	0.4%
Minnows	EMSH	0.1%	0%	0%	0.04%
Suckers	LNSC	0%	0%	0%	0%
	SHRD	1%	1%	1%	1%
Smelts	RNSM	0%	0%	0%	0%
Coregonids	CISC	15%	8%	2%	8%
Trout-perch	TRPR	0%	0%	0%	0%
Codfishes	BURB	0.1%	0.4%	1%	1%
Perch	YLPR	7%	1%	1%	3%
Drums	FRDR	0%	0%	0%	0%

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

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

Group	Species	2011	2014	2018	Mean
Mooneyes	GOLD	1%	1%	1%	1%
Minnows	LKCH	0%	0%	0%	0%
	CMSH	0%	0%	0%	0%
	EMSH	18%	41%	28%	29%
	SPSH	2%	20%	8%	10%
Suckers	LNSC	0%	0%	0%	0%
	WHSC	0%	1%	0%	0.2%
	SHRD	0%	0%	0%	0%
Pikes	NRPK	2%	1%	3%	2%
Smelts	RNSM	0%	0%	0%	0%
Coregonids	CISC	5%	5%	1%	4%
	LKWH	0%	0%	0%	0%
Trout-perch	TRPR	47%	1%	38%	28%
Codfishes	BURB	0%	0%	1%	0.3%
Sculpins	MTSC	0%	0%	0%	0%
	SLSC	0%	0%	0%	0%
Sunfishes	RCBS	0%	0%	0%	0%
Perch	YLPR	6%	4%	0%	3%
	LGPR	0%	0%	0%	0%
	Sander spp.	0%	0%	0%	0%
	SAUG	14%	9%	10%	11%
	WALL	6%	18%	10%	11%

Table 5.6-12. 2008-2019 Relative species abundance in standard gang index gill nets in Cormorant 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%	9%	13%	14%	9%	2%	12%	3%	14%	4%	11%	15%	10%
	NRPK	6%	5%	5%	15%	8%	7%	10%	12%	9%	10%	8%	14%	9%
	SAUG	4%	3%	3%	1%	4%	6%	2%	2%	2%	4%	2%	1%	3%
	WALL	18%	25%	17%	28%	30%	22%	31%	31%	31%	34%	41%	29%	28%
	WHSC	50%	49%	48%	32%	43%	46%	37%	48%	40%	41%	34%	33%	42%
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%
Minnows	EMSH	0%	0%	0%	0%	0%	11%	0%	0%	0%	0%	0%	0%	1%
Suckers	LNSC	1%	0.4%	2%	0.5%	0%	1%	0.5%	1%	1%	1%	0%	1%	1%
	SHRD	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	8%	5%	9%	8%	2%	4%	5%	1%	3%	4%	2%	5%	5%
Trout-perch	TRPR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Codfishes	BURB	0.3%	0.2%	0%	1%	0%	0.1%	1%	0.1%	0.3%	0.3%	0.3%	1%	0.4%
Perch	YLPR	4%	4%	2%	0.2%	3%	1%	1%	1%	0.1%	1%	1%	1%	2%
Drums	FRDR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 5.6-13. 2008-2019 Relative species abundance in small mesh index gill nets in Cormorant Lake.

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

Group	Species	2008	2009	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
Mooneyes	GOLD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Minnows	LKCH	0%	0%	0.4%	0%	0%	0%	0%	0%	0%	0%	0%	0.04%
	CMSH	0%	0%	12%	0%	0%	0%	0%	0%	0%	0%	0%	1%
	EMSH	77%	0%	0%	1%	14%	9%	0%	14%	21%	15%	17%	15%
	SPSH	0%	6%	11%	13%	51%	47%	21%	49%	34%	18%	41%	26%
Suckers	LNSC	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0.2%
	WHSC	2%	5%	8%	0%	1%	2%	1%	1%	1%	2%	4%	2%
	SHRD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pikes	NRPK	0%	0%	0%	0%	0%	1%	1%	1%	2%	0%	1%	0.5%
Smelts	RNSM	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Coregonids	CISC	0%	0%	0%	0.4%	2%	1%	1%	0.3%	0%	0.3%	0.2%	0.4%
	LKWH	3%	3%	1%	0%	0%	1%	0%	0.3%	0%	0.3%	2%	1%
Trout-perch	TRPR	0%	0%	0%	7%	1%	0.2%	2%	2%	0%	0.3%	1%	1%
Codfishes	BURB	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%
	SLSC	0%	0%	1%	0%	0%	0%	0%	0.3%	0%	0%	0%	0.1%
Sunfishes	RCBS	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Perch	YLPR	15%	24%	56%	70%	26%	27%	42%	28%	36%	59%	31%	38%
	LGPR	0%	0%	6%	8%	0%	4%	9%	4%	3%	3%	1%	3%
	Sander spp.	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	SAUG	1%	52%	0%	1%	5%	1%	7%	0%	2%	1%	0.4%	6%
	WALL	4%	10%	5%	0.4%	1%	6%	17%	1%	1%	1%	3%	4%

5.6.2 HILL'S EFFECTIVE RICHNESS

5.6.2.1 ON-SYSTEM SITES

ANNUAL SITES

Cedar Lake – Southeast

The Hill's effective species richness over the 11 years of monitoring ranged from a low of 5.1 in 2009 and 2010 to a high of 8.8 species in 2014 (Table 5.6-14; Figure 5.6-1).

The overall mean Hill's index value was 6.6, the median was 6.7, and the IQR was 5.8-7.1 species (Figure 5.6-1). The annual mean Hill's index value fell within the overall IQR except in 2009, 2010, and 2012 when it was below the IQR and in 2011 and 2014 when it was above the IQR.

Lake Winnipeg – Grand Rapids

The Hill's effective species richness over the 12 years of monitoring ranged from a low of 3.1 in 2010 to a high of 6.2 species in 2014 (Table 5.6-14; Figure 5.6-1).

The overall mean Hill's index value was 5.0, the median was 5.1, and the IQR was 4.7-5.5 species (Figure 5.6-1). The annual mean Hill's index value fell within the overall IQR except in 2010 and 2019 when it was below the IQR and in 2012, 2014, and 2015 when it was above the IQR.

ROTATIONAL SITES

Saskatchewan River between The Pas and Cedar Lake

The Hill's effective species richness over the four years of monitoring ranged from a low of 4.9 in 2010 to a high of 6.9 species in 2019 (Table 5.6-14; Figure 5.6-1).

The overall mean Hill's index value was 6.1, the median was 6.4, and the IQR was 6.0-6.6 species (Figure 5.6-1). The annual mean Hill's index value was below the IQR in 2010 and was above the IQR in 2019.

South Moose Lake

The Hill's effective species richness over the four years of monitoring ranged from a low of 2.7 in 2015 to a high of 5.5 species in 2018 (Table 5.6-14; Figure 5.6-1).

The overall mean Hill's index value was 4.0, the median was 3.9, and the IQR was 3.2-4.7 species (Figure 5.6-1). The annual mean Hill's index value fell within the overall IQR except in 2015 when it was below the IQR and in 2018 when it was above the IQR.

Cedar Lake – West

The Hill's effective species richness over the three years of monitoring ranged from a low of 6.3 in 2018 to a high of 7.1 species in 2011 (Table 5.6-14; Figure 5.6-1).

The overall mean and median Hill's index value were 6.7 and the IQR was 6.5-6.9 species (Figure 5.6-1). The annual mean Hill's index value was below the IQR in 2018 and was above the IQR in 2011.

5.6.2.2 OFF-SYSTEM SITES

ANNUAL SITES

Cormorant Lake

The Hill's effective species richness over the 12 years of monitoring ranged from a low of 4.7 in 2010 to a high of 7.8 species in 2019 (Table 5.6-14; Figure 5.6-1).

The overall mean Hill's index value was 6.6, the median was 6.9, and the IQR was 5.9-7.3 species (Figure 5.6-1). The annual mean Hill's index value fell within the overall IQR except in 2009, 2010, and 2015 when it was below the IQR and in 2014 and 2019 when it was above the IQR.

ROTATIONAL SITES

There are no waterbodies in the SRR that are monitored on a rotational basis.

Table 5.6-14. 2008-2019 Hill's effective species richness.

Waterbody	Year	n_F[1]	n_{spp}[2]	Value
CEDAR-SE	2009	583	9	5.1
	2010	972	9	5.1
	2011	1392	14	8.1
	2012	1986	11	5.4
	2013	733	11	7.2
	2014	818	14	8.8
	2015	941	12	6.7
	2016	804	13	6.6
	2017	602	13	6.2
	2018	1005	13	6.8
	2019	448	11	6.9
LW-GR	2008	897	13	5.4
	2009	1985	12	5.2
	2010	366	11	3.1
	2011	996	12	4.7
	2012	1096	11	6.1
	2013	3357	13	5.3
	2014	912	10	6.2
	2015	939	13	5.9
	2016	1034	9	4.7
	2017	545	10	5.0
	2018	672	8	4.6
	2019	919	10	4.5
SASK	2010	53	8	4.9
	2013	157	10	6.5
	2016	262	10	6.3
	2019	399	12	6.9
SMOOSE	2009	1207	12	3.4
	2012	1039	9	4.4
	2015	2220	7	2.7
	2018	1300	9	5.5
CEDAR-W	2011	458	10	7.1
	2014	301	15	6.7
	2018	464	13	6.3

Table 5.6-14. continued.

Waterbody	Year	n_F[1]	n_{spp}[2]	Value
CORM	2008	882	10	6.0
	2009	594	10	5.1
	2010	515	8	4.7
	2011	1118	14	7.3
	2012	690	11	6.5
	2013	1367	12	7.0
	2014	1294	13	7.7
	2015	912	12	5.4
	2016	1068	14	7.2
	2017	1277	12	7.4
	2018	1129	13	6.7
	2019	1212	13	7.8

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.

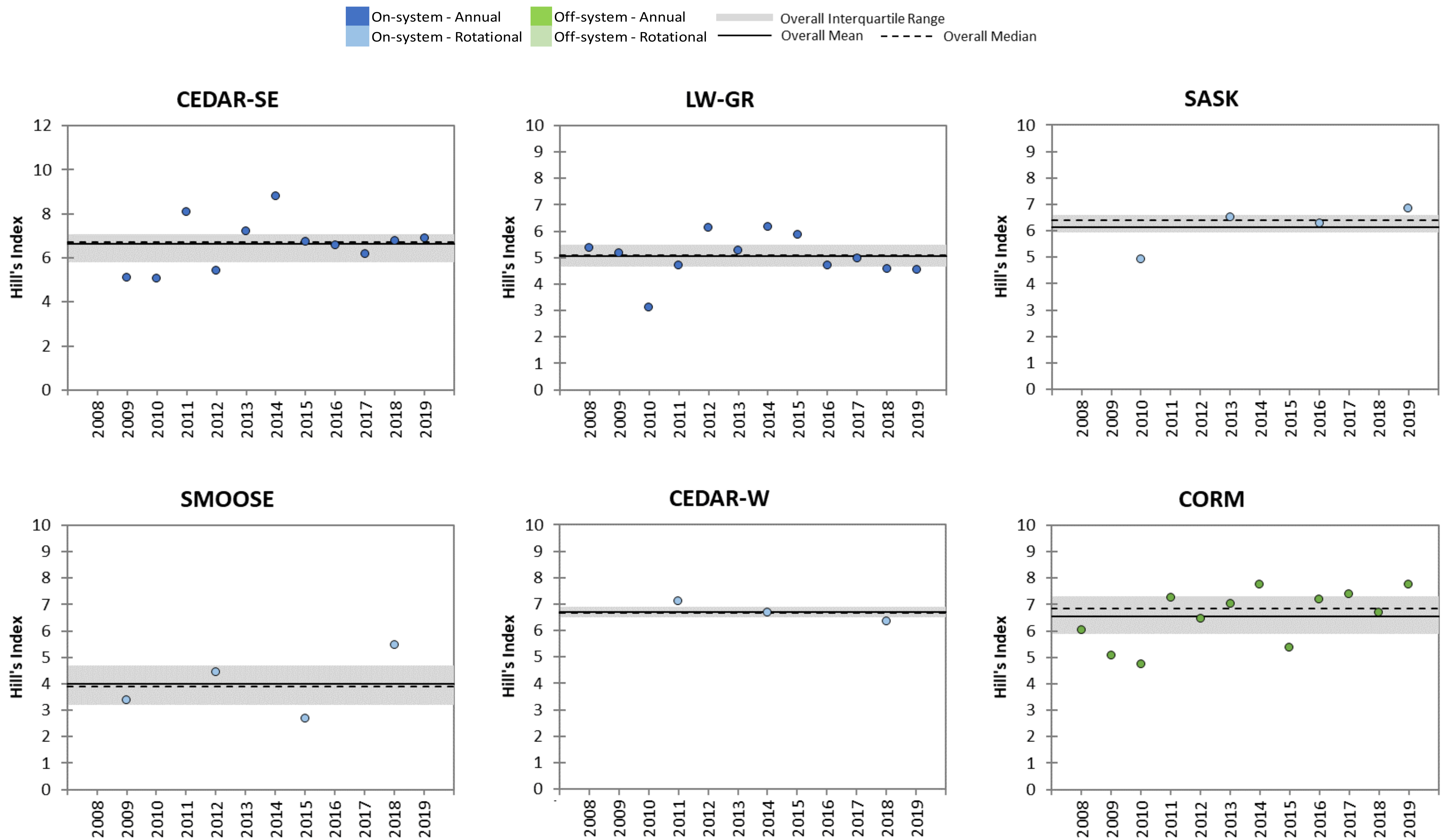


Figure 5.6-1. 2008-2019 Hill's effective species richness.

APPENDIX 5-1. GILLNETTING SITE INFORMATION AND LOCATIONS

The following is a summary of modifications and deviations in sampling locations over the 12 years of monitoring in the Saskatchewan River Region:

Cedar Lake – Southeast

- Gill nets were set at the target locations in all 11 years of monitoring with the following modifications and exceptions:
  - The target location of the standard gang sites was established in 2010; therefore sites in 2009 were selected for inclusion based on their proximity to the target sites (GN-01 was set near the target location for GN-07, GN-03 was set near the target location of GN-01, GN-06 was set near the target location of GN-11, GN-07 was set near the target location of GN-03, GN-15 was set near the target location of GN-02, GN-16 was set near the target location of GN-04, GN/SN-17 was set near the target location of GN/SN-06, GN-18 was set near the target location of GN-08, and GN-20 was set near the target location of GN-09).
  - There was only one small mesh net set at target locations in 2009 and none in 2010 because SN-03, SN-06, SN-08, and SN-12 were not selected as target locations until 2011 and there were no sites set in proximity to the target locations.
  - SN-03 was not set in 2015 and SN-06 was not set in 2019.
  - GN-09 was set in a slightly different location in 2012 and 2015.

Lake Winnipeg – Grand Rapids

- Gill nets were set at the target locations in all 12 years with several exceptions:
  - GN-11 and GN/SN-12 were not selected as target locations until 2009.
  - In 2014, 2015, 2016, and 2017 several nets were not set at the target location:
    i) GN/SN-01 was set at the target location of GN/SN-09,
    ii) GN-02 was set at the target location of GN-08,
    iii) GN-03 was set at the target location of GN-11,
    iv) GN/SN-05 was set at the target location of GN/SN-06,
    v) GN-06 was set at the target location of GN-04,
    vi) GN-07 was set at the target location of GN-03,
    vii) GN/SN-08 was set at the target location of GN/SN-12,
    viii) GN-09 was set at the at the target location of GN-02 (without the SN gang),
    ix) GN-10 was set at the target location of GN-05,

- GN-03, GN-04, GN/SN-05, GN/SN-06, and GN-08 were not set in 2010.
- GN-03, GN-04, GN/SN-05 were not set in 2011.
- GN-11 was not set at the target location in 2012.
- GN/SN-06 was not set in 2017.
- SN-09 was not set in 2009, 2010, and 2019.
- GN/SN-05 was used an alternate location to GN/SN-04 in 2008, 2012, and 2013, but the SN gang was only set in 2008.
- GN/SN-06 was used as an alternate location for GN/SN-05 in 2008, 2011, 2012, and 2013, but the SN gang was only set in 2012.
- GN-07 was used as an alternate location for GN-06 in 2008 and 2013; while SN-07 is not a target location, it was included as an alternate location to SN-06 in 2013.
- GN-08 was used as an alternate location for GN-11 in 2011.

Saskatchewan River between The Pas and Cedar Lake

- Gill nets were set at the target locations in all four years of monitoring with the following modifications and exceptions:
  - GN-13, GN-14, GN/SN-15, GN-16, GN-17, GN-18, GN-19, GN-20, and GN/SN-21 were not selected as target locations until 2013.
  - SN-09 was not set in 2016.

South Moose Lake

- Gill nets were set at the target locations in all four years of monitoring with the following exceptions:
  - In 2018, GN-02 was set at a different location from the target.
  - SN-08 was not set in 2012.

Cedar Lake - West

- Gill nets were set at the target locations in all three years with the following deviations:
  - In 2011, GN/SN-09 was set at a different location from the target.
  - In 2014, GN-01, GN-07, and GN-10 were set at different locations from the target.

Cormorant Lake

- Gill nets were set at the target locations in all 12 years with several exceptions:

- Modifications of the target location:
  i) GN-07, GN-08, GN-13, and GN-16 were not selected as target locations until 2009.
  ii) The target locations of GN-05 was established at a completely new location in 2011.
  iii) GN-10 was not selected as a target location until 2011.
  iv) There was only one small mesh net set at target locations in 2009 and none in 2010 because SN-03, SN-08, and SN-12 were not selected as target locations until 2011.
- Deviations from target locations:
  i) The location of GN-07 has been variable over time.
  ii) The location of GN-04 was slightly different from the target location in 2008, 2009, and 2010.
  iii) GN-10 was set at a slightly different location from the target in 2018.
  iv) GN/SN-12 was set at a slightly different location from the target in 2008 and 2017.
  v) GN-26 is not a target location but is included as an alternate to GN-07 since it was set in close proximity.
- Sites not set in some years:
  i) GN-01 and GN-07 were not set in 2010.
  ii) GN-02, GN-13, GN-14, GN-15, and GN-16 were not set in 2012.
  iii) GN-03, GN-04, GN-06, GN/SN-12 were not set in 2009 and 2010.
  iv) SN-08 was not set in 2010, 2014, and 2016.

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	
CEDAR-SE	GN-01	14	430477	5890926	14-Aug-09	20.6	6.0	6.2	18.3
	GN-03	14	449887	5895326	15-Aug-09	21.3	-	-	-
	GN-06	14	451422	5892957	15-Aug-09	21.6	-	-	-
	GN-07	14	442185	5887567	14-Aug-09	17.9	-	-	-
	GN-15	14	445892	5891153	16-Aug-09	21.9	2.3	2.0	-
	GN-16	14	445549	5887524	16-Aug-09	22.0	8.6	8.4	17.2
	GN-17	14	437011	5886227	17-Aug-09	21.2	12.3	12.0	17.1
	GN-18	14	428397	5887127	15-Aug-09	22.3	-	-	-
	GN-20	14	435329	5897042	18-Aug-09	21.3	9.9	10.6	17.4
	SN-17	14	437011	5886227	17-Aug-09	21.2	12.3	12.0	17.1
	GN-01	14	450391	5895322	7-Aug-10	24.8	7.7	6.2	19.0
	GN-02	14	445841	5891537	7-Aug-10	24.6	10.5	10.5	19.0
	GN-03	14	441852	5887384	4-Aug-10	24.2	3.2	2.8	20.0
	GN-04	14	445257	5886828	4-Aug-10	26.0	7.5	7.9	20.0
	GN-05	14	439933	5891981	6-Aug-10	24.8	9.3	9.4	21.0
	GN-06	14	434854	5884052	4-Aug-10	22.7	6.9	6.5	20.0
	GN-07	14	431936	5891452	5-Aug-10	25.2	11.3	11.6	23.0
	GN-08	14	424069	5889128	5-Aug-10	25.1	7.0	5.6	23.0
	GN-09	14	437062	5895716	6-Aug-10	22.6	8.7	8.6	21.0
	GN-10	14	416071	5891302	5-Aug-10	24.5	7.9	7.9	23.0
	GN-11	14	452785	5889995	7-Aug-10	24.5	12.5	12.1	19.0
	GN-12	14	431258	5898598	6-Aug-10	22.4	11.8	11.9	21.0
	GN-01	14	450554	5895342	20-Aug-11	21.3	6.4	6.1	20.1
	GN-02	14	445899	5891536	20-Aug-11	21.3	11.5	6.2	21.0
	GN-03	14	442135	5887222	19-Aug-11	17.6	5.1	3.0	20.5
	GN-04	14	445511	5886551	20-Aug-11	21.5	8.4	7.5	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	
CEDAR-SE	GN-05	14	440023	5891975	19-Aug-11	18.0	8.9	9.5	20.5
	GN-06	14	434917	5883972	19-Aug-11	15.4	7.3	7.3	20.8
	GN-07	14	432213	5891337	19-Aug-11	17.0	11.9	11.9	20.5
	GN-08	14	424105	5889290	18-Aug-11	25.7	9.1	9.1	20.5
	GN-09	14	436942	5895696	18-Aug-11	27.3	8.7	8.7	22.0
	GN-10	14	416051	5891329	18-Aug-11	25.2	8.2	8.2	21.0
	GN-11	14	453017	5889988	20-Aug-11	21.6	11.9	10.7	20.0
	GN-12	14	430956	5898686	18-Aug-11	26.9	10.9	10.7	21.0
	SN-03	14	442135	5887222	19-Aug-11	17.6	5.1	3.0	20.5
	SN-06	14	434917	5883972	19-Aug-11	15.4	7.3	7.3	20.8
	SN-08	14	424105	5889290	18-Aug-11	25.7	9.1	9.1	20.5
	SN-12	14	430956	5898686	18-Aug-11	26.9	10.9	10.7	21.0
	GN-01	14	450432	5895422	23-Aug-12	22.0	6.4	5.4	20.0
	GN-02	14	445736	5891229	22-Aug-12	22.4	12.9	10.8	20.0
	GN-03	14	442238	5887522	23-Aug-12	22.9	3.8	5.1	20.0
	GN-04	14	445443	5886555	23-Aug-12	22.8	8.7	7.3	20.0
	GN-05	14	439471	5892504	22-Aug-12	22.2	5.6	7.2	20.0
	GN-06	14	434813	5883956	22-Aug-12	20.2	7.0	6.4	20.0
	GN-07	14	432069	5891387	22-Aug-12	20.1	12.5	12.2	20.0
	GN-08	14	424089	5888961	21-Aug-12	25.0	9.6	9.4	20.0
	GN-09	14	434848	5897362	21-Aug-12	25.0	7.2	7.6	20.0
	GN-10	14	416041	5891305	21-Aug-12	23.8	8.3	8.2	20.0
	GN-11	14	452903	5889968	23-Aug-12	21.5	11.3	10.8	20.0
	GN-12	14	431416	5899059	21-Aug-12	24.5	12.2	9.5	20.0
	SN-03	14	442238	5887522	23-Aug-12	22.9	3.8	5.1	20.0
	SN-06	14	434813	5883956	22-Aug-12	20.2	7.0	6.4	20.0
	SN-08	14	424089	5888961	21-Aug-12	25.0	9.6	9.4	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	
CEDAR-SE	SN-12	14	431416	5899059	21-Aug-12	24.5	12.2	9.5	20.0
	GN-01	14	450446	5895372	14-Aug-13	23.3	5.2	5.6	20.0
	GN-02	14	445899	5891536	13-Aug-13	23.1	7.1	6.8	20.0
	GN-03	14	442016	5886551	14-Aug-13	21.5	-	-	20.0
	GN-04	14	445511	5886551	14-Aug-13	22.1	6.0	6.0	20.0
	GN-05	14	440023	5891975	13-Aug-13	22.7	7.2	6.7	20.0
	GN-06	14	435015	5883865	13-Aug-13	22.3	5.8	6.1	20.0
	GN-07	14	432213	5891337	13-Aug-13	22.0	3.7	4.3	20.0
	GN-08	14	424051	5889139	12-Aug-13	16.3	12.5	12.2	20.0
	GN-09	14	436942	5895696	12-Aug-13	16.4	2.0	2.3	20.0
	GN-10	14	416051	5891329	12-Aug-13	16.2	8.8	9.0	20.0
	GN-11	14	453017	5889988	14-Aug-13	23.6	7.6	7.9	20.0
	GN-12	14	430956	5898686	12-Aug-13	16.0	2.3	3.8	20.0
	SN-03	14	442016	5886551	14-Aug-13	21.5	4.0	4.0	20.0
	SN-06	14	435015	5883865	13-Aug-13	22.3	5.8	5.8	20.0
	SN-08	14	424051	5889139	12-Aug-13	16.3	12.5	12.5	20.0
	SN-12	14	430956	5898686	12-Aug-13	16.0	2.3	2.3	20.0
	GN-01	14	450552	5895363	22-Sep-14	22.3	5.9	5.7	12.9
	GN-02	14	445883	5891551	19-Sep-14	18.0	10.8	5.3	11.9
	GN-03	14	442076	5887150	19-Sep-14	17.6	1.9	2.2	12.1
	GN-04	14	445551	5886563	21-Sep-14	22.4	7.3	7.4	12.4
	GN-05	14	440021	5891965	19-Sep-14	18.9	8.7	8.8	12.1
	GN-06	14	434929	5883937	22-Sep-14	22.3	6.9	7.9	12.2
	GN-07	14	432233	5891368	20-Sep-14	21.7	12.1	12.0	12.0
	GN-08	14	424149	5889159	20-Sep-14	21.8	9.9	8.2	11.8
	GN-09	14	436930	5895696	21-Sep-14	20.9	8.5	8.4	12.1

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	
CEDAR-SE	GN-10	14	416116	5891305	20-Sep-14	22.1	8.1	8.2	11.1
	GN-11	14	453005	5889981	22-Sep-14	22.6	10.6	10.6	12.9
	GN-12	14	430955	5898742	21-Sep-14	22.0	10.5	10.5	12.1
	SN-03	14	442102	5887124	19-Sep-14	17.6	2.2	2.4	12.1
	SN-06	14	434922	5883976	22-Sep-14	22.3	7.9	6.6	12.2
	SN-08	14	424174	5889176	20-Sep-14	21.8	8.2	9.9	11.8
	SN-12	14	430935	5898713	21-Sep-14	22.0	10.5	10.5	12.1
	GN-01	14	450432	5895422	31-Aug-15	16.3	5.0	5.2	18.0
	GN-02	14	445736	5891229	1-Sep-15	22.5	6.7	7.1	19.0
	GN-03	14	442238	5887522	2-Sep-15	23.5	4.0	4.0	19.0
	GN-04	14	445443	5886555	2-Sep-15	22.8	6.0	6.0	19.0
	GN-05	14	439471	5892504	1-Sep-15	22.7	6.9	7.1	19.0
	GN-06	14	434813	5883956	1-Sep-15	17.1	11.5	11.5	19.0
	GN-07	14	432069	5891387	1-Sep-15	21.8	10.9	10.9	19.0
	GN-08	14	424089	5888961	31-Aug-15	16.4	10.0	10.0	17.0
	GN-09	14	434848	5897362	2-Sep-15	21.4	7.6	7.6	19.0
	GN-10	14	416041	5891305	31-Aug-15	17.6	10.0	10.0	17.0
	GN-11	14	452903	5889968	31-Aug-15	16.5	7.4	7.7	18.0
	GN-12	14	431416	5899059	2-Sep-15	21.4	7.6	7.6	19.0
	SN-06	14	434813	5883956	1-Sep-15	17.1	11.5	11.5	19.0
	SN-08	14	424089	5888961	31-Aug-15	16.4	10.0	10.0	17.0
	SN-12	14	431416	5899059	2-Sep-15	21.4	7.6	7.6	19.0
	GN-01	14	450446	5895372	15-Aug-16	15.3	-	-	-
	GN-02	14	445899	5891536	16-Aug-16	23.0	-	-	-
	GN-03	14	442135	5887222	17-Aug-16	15.5	-	-	-
	GN-04	14	445511	5886551	17-Aug-16	15.0	-	-	-

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	
CEDAR-SE	GN-05	14	440023	5891975	16-Aug-16	21.8	-	-	-
	GN-06	14	434917	5883972	15-Aug-16	19.0	10.4	-	-
	GN-07	14	432213	5891337	15-Aug-16	19.3	11.3	-	-
	GN-08	14	424105	5889290	16-Aug-16	24.0	9.8	-	-
	GN-09	14	436942	5895696	17-Aug-16	20.3	4.9	-	-
	GN-10	14	416051	5891329	16-Aug-16	24.6	7.6	-	-
	GN-11	14	453017	5889988	15-Aug-16	14.3	-	-	-
	GN-12	14	430956	5898686	17-Aug-16	21.8	7.3	-	-
	SN-03	14	442135	5887222	17-Aug-16	15.5	-	-	-
	SN-06	14	434917	5883972	15-Aug-16	19.0	10.4	-	-
	SN-08	14	424105	5889290	16-Aug-16	24.0	9.8	-	-
	SN-12	14	430956	5898686	17-Aug-16	21.8	7.3	-	-
	GN-01	14	450446	5895372	21-Aug-17	20.0	7.6	7.0	19.5
	GN-02	14	445899	5891536	22-Aug-17	23.0	6.0	6.7	20.0
	GN-03	14	442016	5887296	23-Aug-17	15.5	5.5	5.7	20.1
	GN-04	14	445511	5886551	23-Aug-17	15.5	8.5	8.6	20.2
	GN-05	14	440023	5891975	22-Aug-17	23.0	6.5	6.7	19.1
	GN-06	14	435015	5883865	23-Aug-17	23.7	11.5	11.5	21.0
	GN-07	14	432213	5891337	23-Aug-17	23.8	10.0	10.8	21.0
	GN-08	14	424051	5889139	21-Aug-17	19.0	7.5	7.4	19.0
	GN-09	14	436942	5895696	22-Aug-17	24.2	6.7	7.0	19.0
	GN-10	14	416051	5891329	21-Aug-17	18.9	8.2	8.9	19.0
	GN-11	14	453017	5889988	21-Aug-17	20.3	7.5	7.7	19.1
	GN-12	14	431001	5898825	22-Aug-17	24.2	8.0	8.1	18.9
	SN-03	14	442016	5887296	23-Aug-17	15.5	5.5	5.5	20.1
	SN-06	14	435015	5883865	23-Aug-17	23.7	11.0	11.5	21.0
	SN-08	14	424051	5889139	21-Aug-17	19.0	7.0	7.5	19.0

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	
CEDAR-SE	SN-12	14	431001	5898825	22-Aug-17	24.2	8.0	8.0	18.9
	GN-01	14	450446	5895372	13-Aug-18	14.8	7.5	7.6	19.0
	GN-02	14	445899	5891536	14-Aug-18	15.2	6.1	6.6	19.5
	GN-03	14	442016	5887296	15-Aug-18	14.8	5.4	5.6	19.0
	GN-04	14	445511	5886551	15-Aug-18	14.7	8.5	8.6	19.0
	GN-05	14	440023	5891975	14-Aug-18	14.0	6.5	6.7	14.0
	GN-06	14	435015	5883865	15-Aug-18	12.4	11.0	11.2	19.0
	GN-07	14	432213	5891337	15-Aug-18	13.0	10.1	10.7	19.5
	GN-08	14	424051	5889139	14-Aug-18	22.0	7.5	7.5	19.0
	GN-09	14	436942	5895696	13-Aug-18	14.0	6.8	7.0	19.0
	GN-10	14	416051	5891329	14-Aug-18	23.5	8.4	9.0	19.0
	GN-11	14	453017	5889988	13-Aug-18	14.8	7.6	7.5	7.6
	GN-12	14	431001	5898825	13-Aug-18	14.5	8.2	8.2	19.0
	SN-03	14	442016	5887296	15-Aug-18	14.8	-	5.4	19.0
	SN-06	14	435015	5883865	15-Aug-18	12.4	11.0	11.2	19.0
	SN-08	14	424051	5889139	14-Aug-18	22.0	-	7.5	19.0
	SN-12	14	431001	5898825	13-Aug-18	14.5	-	8.2	19.0
	GN-01	14	450446	5895372	22-Sep-19	12.9	-	-	18.3
	GN-02	14	445899	5891536	23-Sep-19	23.3	6.4	6.5	18.9
	GN-03	14	442133	5887236	25-Sep-19	14.7	-	5.7	19.4
	GN-04	14	445511	5886551	25-Sep-19	14.0	8.6	8.7	18.3
	GN-05	14	440023	5891975	22-Sep-19	13.9	6.8	6.9	18.9
	GN-06	14	435015	5883865	25-Sep-19	13.0	10.9	11.0	18.3
	GN-07	14	432213	5891337	25-Sep-19	13.0	10.0	11.0	18.9
	GN-08	14	424173	5889172	22-Sep-19	13.5	-	7.7	18.9
	GN-09	14	436942	5895696	23-Sep-19	14.0	7.0	7.2	18.3
	GN-10	14	416051	5891329	22-Sep-19	12.8	8.5	9.0	18.3

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	
CEDAR-SE	GN-11	14	453017	5889988	23-Sep-19	22.7	7.4	7.6	18.3
	GN-12	14	431099	5898749	23-Sep-19	13.0	-	8.2	18.3
	SN-03	14	442016	5887296	25-Sep-19	14.7	5.5	-	19.4
	SN-08	14	424051	5889139	22-Sep-19	13.5	7.6	-	18.9
	SN-12	14	431001	5898825	23-Sep-19	13.0	8.1	-	18.3
LW-GR	GN-02	14	492342	5910140	18-Aug-08	15.9	5.5	5.4	20.3
	GN-03	14	492340	5907652	18-Aug-08	14.5	6.0	6.0	20.3
	GN-05	14	485873	5906458	19-Aug-08	15.8	4.3	4.5	-
	GN-06	14	485470	5906040	19-Aug-08	20.2	4.3	4.9	-
	GN-07	14	485437	5905753	19-Aug-08	21.3	4.4	4.9	-
	GN-08	14	485249	5902971	20-Aug-08	15.4	3.9	4.8	-
	GN-09	14	485130	5902556	20-Aug-08	14.5	3.3	3.7	-
	SN-05	14	485873	5906458	19-Aug-08	15.8	4.3	4.5	-
	SN-09	14	485130	5902556	20-Aug-08	14.5	3.3	3.7	-
	GN-02	14	492253	5910440	22-Jun-09	14.3	6.2	5.9	15.0
	GN-03	14	492245	5907841	22-Jun-09	16.8	6.5	5.9	15.0
	GN-04	14	486101	5906369	23-Jun-09	18.8	5.7	5.7	15.0
	GN-05	14	485680	5906078	23-Jun-09	19.7	5.4	5.2	15.0
	GN-06	14	485401	5905874	23-Jun-09	25.4	5.1	4.6	15.0
	GN-08	14	485361	5902686	24-Jun-09	11.5	4.8	5.7	14.0
	GN-09	14	484964	5902333	24-Jun-09	13.6	3.0	3.6	14.0
	GN-11	14	485690	5903834	24-Jun-09	15.0	4.9	6.3	14.0
	GN-12	14	491649	5909170	22-Jun-09	15.3	6.5	6.9	15.0
	SN-06	14	485401	5905874	23-Jun-09	25.4	5.1	4.6	15.0
	SN-12	14	491649	5909170	22-Jun-09	15.3	6.5	6.9	15.0
	GN-02	14	492253	5910442	29-Jun-10	23.8	-	-	-

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	
LW-GR	GN-09	14	485098	5902336	28-Jun-10	16.7	-	-	-
	GN-11	14	485558	5903992	28-Jun-10	20.5	-	-	-
	GN-12	14	491648	5909171	29-Jun-10	22.5	-	-	-
	GN-02	14	492164	5910696	28-Jun-11	16.2	6.5	6.5	18.0
	GN-06	14	485680	5906080	28-Jun-11	15.0	6.7	6.8	18.0
	GN-08	14	485990	5903836	27-Jun-11	14.3	5.2	4.6	18.0
	GN-09	14	484964	5902334	27-Jun-11	13.5	2.7	3.3	18.0
	GN-12	14	491648	5909171	28-Jun-11	15.6	7.8	7.3	18.0
	SN-09	14	484964	5902334	27-Jun-11	13.5	2.7	3.3	18.0
	GN-02	14	492124	5910687	20-Jun-12	15.7	6.2	7.2	16.7
	GN-03	14	492240	5907839	20-Jun-12	14.5	6.1	6.6	16.7
	GN-05	14	486050	5906350	19-Jun-12	16.1	4.9	4.5	16.4
	GN-06	14	485730	5906058	19-Jun-12	15.7	4.9	4.6	16.4
	GN-08	14	485359	5902676	18-Jun-12	13.0	5.0	5.0	16.3
	GN-09	14	485633	5902427	18-Jun-12	12.2	5.9	5.9	16.3
	GN-11	14	485692	5903851	18-Jun-12	13.5	5.0	5.0	16.3
	GN-12	14	491804	5909167	20-Jun-12	15.0	6.3	6.6	16.7
	SN-06	14	485730	5906058	19-Jun-12	15.7	4.9	4.6	16.4
	SN-09	14	485633	5902427	18-Jun-12	12.2	5.9	5.9	16.3
	SN-12	14	491804	5909167	20-Jun-12	14.8	6.3	6.6	16.7
	GN-02	14	491977	5910572	17-Jul-13	19.3	-	-	18.0
	GN-03	14	492369	5907931	17-Jul-13	18.4	-	-	18.0
	GN-05	14	486124	5906327	16-Jul-13	14.8	-	-	18.0
	GN-06	14	485796	5905977	16-Jul-13	13.8	-	-	18.0
	GN-07	14	485635	5905727	16-Jul-13	17.8	-	-	18.0

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	
LW-GR	GN-08	14	485402	5902751	15-Jul-13	16.8	-	-	17.5
	GN-09	14	485662	5902400	15-Jul-13	11.6	-	-	17.5
	GN-11	14	485705	5903899	15-Jul-13	17.0	-	-	17.5
	GN-12	14	491811	5909217	17-Jul-13	14.5	-	-	18.0
	SN-07	14	485635	5905727	16-Jul-13	17.8	-	-	18.0
	SN-09	14	485662	5902400	15-Jul-13	11.6	-	-	17.5
	SN-12	14	491811	5909217	17-Jul-13	14.5	-	-	18.0
	GN-01	14	485693	5902410	14-Jul-14	12.5	-	-	16.0
	GN-02	14	485366	5902717	14-Jul-14	13.5	-	-	16.0
	GN-03	14	485702	5903820	14-Jul-14	13.8	-	-	16.0
	GN-05	14	485586	5905586	15-Jul-14	18.3	-	-	16.0
	GN-06	14	486165	5906317	15-Jul-14	19.8	-	-	16.0
	GN-07	14	492208	5907824	16-Jul-14	18.1	-	-	16.0
	GN-08	14	491480	5909110	16-Jul-14	18.8	-	-	16.0
	GN-09	14	492012	5910566	16-Jul-14	19.3	-	-	16.0
	GN-10	14	485793	5906021	15-Jul-14	19.0	-	-	16.0
	SN-01	14	485693	5902410	14-Jul-14	12.5	-	-	16.0
	SN-05	14	485586	5905586	15-Jul-14	18.3	-	-	16.0
	SN-08	14	491480	5909110	16-Jul-14	18.8	-	-	16.0
	GN-01	14	485616	5902422	29-Jun-15	14.0	4.2	4.3	16.0
	GN-02	14	485357	5902667	29-Jun-15	14.7	5.2	5.3	16.0
	GN-03	14	485376	5903579	29-Jun-15	15.3	4.5	3.3	16.0
	GN-05	14	485433	5905600	30-Jun-15	15.5	4.2	4.1	16.0
	GN-06	14	486081	5906384	30-Jun-15	17.0	4.1	4.3	16.0
	GN-07	14	491997	5907983	1-Jul-15	15.3	5.3	5.6	16.0

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	
LW-GR	GN-08	14	491676	5909116	1-Jul-15	16.0	5.2	5.1	16.0
	GN-09	14	491882	5910571	1-Jul-15	16.8	4.9	5.1	16.0
	GN-10	14	485559	5906245	30-Jun-15	16.3	4.3	4.2	16.0
	SN-01	14	485616	5902422	29-Jun-15	14.0	4.2	4.3	16.0
	SN-05	14	485433	5905600	30-Jun-15	15.5	4.2	4.1	16.0
	SN-08	14	491676	5909116	1-Jul-15	15.0	5.2	5.1	16.0
	GN-01	14	485408	5902365	27-Jun-16	14.3	5.3	5.8	17.4
	GN-02	14	485138	5902855	27-Jun-16	14.7	3.2	4.5	17.4
	GN-03	14	485692	5903862	27-Jun-16	16.0	3.7	5.3	17.4
	GN-05	14	485430	5905586	28-Jun-16	15.8	4.6	5.1	18.2
	GN-06	14	486149	5906365	28-Jun-16	16.8	5.3	5.2	18.2
	GN-07	14	492196	5907636	29-Jun-16	16.7	6.2	6.2	17.4
	GN-08	14	491489	5909276	29-Jun-16	17.0	6.7	8.5	17.4
	GN-09	14	492169	5910770	29-Jun-16	17.8	5.2	5.2	17.4
	GN-10	14	485767	5906064	28-Jun-16	16.3	5.1	5.2	18.2
	SN-01	14	485408	5902365	27-Jun-16	14.3	5.3	5.3	17.4
	SN-05	14	485430	5905586	28-Jun-16	15.8	4.6	4.6	18.2
	SN-08	14	491489	5909276	29-Jun-16	17.0	6.7	6.7	17.4
	GN-01	14	485593	5902279	30-Jun-17	17.4	20.4	22.4	-
	GN-02	14	485485	5902666	30-Jun-17	17.8	20.4	15.7	-
	GN-03	14	485013	5903811	30-Jun-17	17.9	14.5	21.5	-
	GN-04	14	486001	5906397	1-Jul-17	18.7	17.7	19.4	-
	GN-05	14	485462	5905771	1-Jul-17	18.0	16.8	17.8	-
	GN-07	14	492091	5907838	2-Jul-17	19.7	21.8	20.6	-
	GN-08	14	491792	5909270	2-Jul-17	20.0	22.7	22.3	-
	GN-09	14	492143	5910660	2-Jul-17	20.3	21.5	21.3	-

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	
LW-GR	GN-10	14	485790	5906175	1-Jul-17	18.3	16.9	16.7	-
	SN-01	14	485593	5902279	30-Jun-17	17.4	-	20.4	-
	SN-05	14	485462	5905771	1-Jul-17	18.0	-	16.8	-
	SN-08	14	491792	5909270	2-Jul-17	20.0	-	22.7	-
	GN-02	14	492164	5910696	10-Jul-18	21.9	5.1	5.4	-
	GN-03	14	492245	5907843	10-Jul-18	20.7	5.5	5.5	-
	GN-04	14	486101	5906370	11-Jul-18	21.8	4.5	3.7	-
	GN-05	14	485680	5906080	11-Jul-18	20.8	4.4	4.0	-
	GN-06	14	485401	5905876	11-Jul-18	19.8	4.3	4.0	-
	GN-08	14	485361	5902687	9-Jul-18	15.9	3.1	4.0	-
	GN-09	14	485584	5902449	9-Jul-18	15.3	5.3	5.4	-
	GN-11	14	485690	5903836	9-Jul-18	16.6	5.2	3.6	-
	GN-12	14	491648	5909171	10-Jul-18	21.3	5.9	5.9	-
	SN-06	14	485401	5905876	11-Jul-18	19.8	4.4	-	-
	SN-09	14	485584	5902449	9-Jul-18	15.3	5.3	-	-
	SN-12	14	491648	5909171	10-Jul-18	21.3	5.9	-	-
	GN-02	14	492240	5910466	28-Jun-19	16.1	5.3	5.4	17.5
	GN-03	14	492272	5907929	28-Jun-19	18.5	5.9	6.1	17.5
	GN-04	14	486137	5906439	29-Jun-19	20.6	4.8	5.2	17.5
	GN-05	14	485569	5906118	29-Jun-19	19.1	4.2	4.5	17.5
	GN-06	14	485314	5905787	29-Jun-19	17.8	3.9	4.5	17.5
	GN-08	14	485379	5902675	29-Jun-19	17.3	4.3	5.7	17.5
	GN-09	14	485034	5902385	29-Jun-19	18.5	2.2	3.2	17.5
	GN-11	14	485609	5903524	29-Jun-19	20.6	5.6	5.7	17.5
	GN-12	14	491605	5909168	28-Jun-19	17.8	6.3	6.3	17.5
	SN-06	14	485498	5905712	29-Jun-19	17.8	4.5	4.5	17.5

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	
LW-GR	SN-12	14	491639	5909173	28-Jun-19	17.8	6.3	6.3	17.5
SASK	GN-09	14	364428	5962373	20-Sep-10	21.4	1.2	4.6	-
	GN-10	14	368119	5958505	20-Sep-10	24.2	0.9	4.2	-
	GN-11	14	366449	5952015	20-Sep-10	22.1	0.9	1.8	-
	SN-09	14	364428	5962373	20-Sep-10	21.4	1.2	4.6	-
	GN-09	14	364322	5962219	24-Oct-13	20.1	5.0	2.5	-
	GN-10	14	368254	5957633	24-Oct-13	20.8	3.9	4.0	-
	GN-11	14	366467	5951931	26-Oct-13	23.7	0.5	1.5	2.8
	GN-13	14	318964	5973793	24-Oct-13	22.5	7.4	3.9	3.1
	GN-14	14	321226	5977000	24-Oct-13	21.8	5.6	2.5	3.0
	GN-15	14	333727	5986465	23-Oct-13	20.9	6.9	5.0	3.1
	GN-16	14	337252	5987817	23-Oct-13	19.7	6.0	7.1	3.2
	GN-17	14	339513	5974952	23-Oct-13	18.0	2.1	5.5	3.1
	GN-18	14	342616	5969720	23-Oct-13	17.2	3.0	3.3	3.2
	GN-19	14	368053	5945957	25-Oct-13	22.9	-	-	-
	GN-20	14	385494	5940034	26-Oct-13	23.9	5.4	4.1	2.7
	GN-21	14	385065	5934123	26-Oct-13	24.0	9.2	4.7	2.9
	SN-09	14	364322	5962219	24-Oct-13	20.1	5.0	2.5	-
	SN-15	14	333721	5986496	23-Oct-13	20.9	5.6	5.0	3.1
	SN-21	14	385033	5934087	26-Oct-13	24.0	10.1	4.7	2.9
	GN-09	14	364428	5962373	14-Sep-16	20.3	3.2	13.9	12.9
	GN-10	14	368119	5958505	15-Sep-16	23.3	10.1	14.2	12.1
	GN-11	14	366499	5952015	15-Sep-16	23.0	7.5	12.9	12.5
	GN-13	14	318948	5973695	12-Sep-16	22.8	25.2	33.0	13.3
	GN-14	14	321000	5976995	12-Sep-16	22.9	11.2	18.5	13.3
	GN-15	14	333812	5986268	12-Sep-16	22.8	14.0	26.5	13.2

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	
SASK	GN-16	14	337380	5987582	13-Sep-16	21.1	17.6	30.1	12.3
	GN-17	14	339499	5974908	13-Sep-16	21.3	9.6	15.0	13.0
	GN-18	14	342857	5969406	13-Sep-16	21.4	9.6	4.7	13.1
	GN-19	14	368111	5945965	14-Sep-16	22.2	4.1	5.2	12.8
	GN-20	14	385003	5941990	14-Sep-16	21.3	9.1	9.7	12.9
	GN-21	14	385049	5934168	15-Sep-16	22.0	21.6	31.6	12.5
	SN-15	14	333812	5986268	12-Sep-16	22.8	14.0	14.0	13.2
	SN-21	14	385049	5934168	15-Sep-16	22.0	21.6	21.6	12.5
	GN-09	14	364429	5962375	11-Sep-19	17.9	-	-	14.3
	GN-10	14	368120	5958508	11-Sep-19	17.2	-	-	14.2
	GN-11	14	366452	5952017	16-Sep-19	22.7	-	-	14.6
	GN-13	14	318949	5973696	10-Sep-19	24.5	-	-	13.7
	GN-14	14	321002	5976996	10-Sep-19	23.7	-	-	13.7
	GN-15	14	333730	5986364	10-Sep-19	22.8	-	-	13.7
	GN-16	14	337382	5987584	10-Sep-19	23.2	-	-	13.7
	GN-17	14	339498	5974909	11-Sep-19	17.6	-	-	12.4
	GN-18	14	342857	5969408	11-Sep-19	17.8	-	-	14.3
	GN-19	14	368047	5946070	16-Sep-19	22.4	-	-	14.4
	GN-20	14	385006	5941991	16-Sep-19	21.4	-	-	14.4
	GN-21	14	385046	5934167	16-Sep-19	20.8	-	-	14.7
	SN-09	14	364429	5962375	11-Sep-19	17.9	-	-	14.3
	SN-15	14	333814	5986268	10-Sep-19	22.8	-	-	13.7
	SN-21	14	385143	5934261	16-Sep-19	20.8	-	-	14.7
SMOOSE	GN-01	14	408467	5964536	9-Sep-09	20.5	2.5	3.8	-
	GN-02	14	410544	5964358	9-Sep-09	21.3	5.5	4.5	-
	GN-03	14	424671	5975209	10-Sep-09	21.7	1.8	2.2	-

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	
SMOOSE	GN-06	14	424091	5961138	11-Sep-09	19.5	6.1	6.0	-
	GN-07	14	427866	5961258	12-Sep-09	22.7	4.7	5.7	-
	GN-08	14	426193	5958815	12-Sep-09	20.8	8.9	8.8	-
	GN-10	14	434716	5966204	13-Sep-09	19.6	1.3	5.9	-
	GN-14	14	416124	5950831	15-Sep-09	20.3	1.7	1.5	18.0
	SN-01	14	408467	5964536	10-Sep-09	22.0	2.5	3.8	-
	SN-08	14	426193	5958815	12-Sep-09	20.8	8.9	8.9	-
	GN-01	14	408467	5964536	10-Sep-12	21.0	4.0	5.0	10.0
	GN-02	14	410544	5964358	10-Sep-12	23.5	5.5	6.7	9.0
	GN-03	14	424671	5975209	10-Sep-12	21.0	3.0	6.0	10.0
	GN-06	14	423872	5960739	13-Sep-12	21.7	6.4	6.4	11.0
	GN-07	14	427539	5960453	17-Sep-12	20.8	7.7	10.6	9.0
	GN-08	14	425905	5958434	17-Sep-12	20.6	4.4	12.3	9.0
	GN-10	14	433407	5965299	17-Sep-12	23.2	11.2	3.4	9.0
	GN-14	14	416081	5951204	18-Sep-12	23.0	3.0	3.1	9.0
	SN-01	14	408467	5964536	10-Sep-12	21.0	4.0	5.0	10.0
	GN-01	14	408467	5964536	19-Sep-15	24.1	5.6	6.5	13.6
	GN-02	14	410544	5964358	19-Sep-15	24.2	5.9	6.0	13.6
	GN-03	14	424671	5975209	19-Sep-15	23.6	4.1	4.1	13.6
	GN-06	14	424091	5961138	18-Sep-15	21.8	6.7	6.8	14.5
	GN-07	14	427866	5961258	18-Sep-15	21.3	10.9	7.3	14.4
	GN-08	14	426193	5958815	18-Sep-15	21.6	10.9	9.1	14.5
	GN-10	14	434716	5966204	17-Sep-15	18.6	4.2	6.2	14.8
	GN-14	14	416124	5950831	21-Sep-15	22.3	3.1	3.4	13.4
	SN-01	14	408467	5964536	19-Sep-15	24.1	5.6	5.6	13.6
	SN-08	14	426193	5958815	18-Sep-15	21.6	10.9	10.9	14.5

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	
SMOOSE	GN-01	14	409420	5964127	19-Sep-18	23.0	-	5.7	8.5
	GN-02	14	415974	5969119	19-Sep-18	23.5	6.5	6.7	8.0
	GN-03	14	424671	5975209	19-Sep-18	23.7	4.0	4.0	8.0
	GN-06	14	423758	5960713	20-Sep-18	21.9	4.0	5.0	9.5
	GN-07	14	427539	5960453	17-Sep-18	17.0	5.2	10.6	10.2
	GN-08	14	426037	5958514	17-Sep-18	19.3	-	10.3	10.5
	GN-10	14	433407	5965299	17-Sep-18	16.0	10.8	11.1	10.2
	GN-14	14	416081	5951204	18-Sep-18	22.5	2.5	2.7	9.3
	SN-01	14	409272	5964106	19-Sep-18	23.0	5.0	-	8.5
	SN-08	14	425905	5958434	17-Sep-18	19.3	12.1	-	10.5
CEDAR-W	GN-01	14	401050	5908130	23-Aug-11	18.4	2.3	2.3	18.0
	GN-02	14	393263	5910384	23-Aug-11	18.7	1.8	1.6	20.0
	GN-03	14	390547	5919722	24-Aug-11	21.8	2.2	2.2	18.0
	GN-04	14	404818	5915629	24-Aug-11	22.3	2.6	2.8	18.0
	GN-05	14	419640	5915065	24-Aug-11	23.7	4.1	4.1	18.0
	GN-06	14	397654	5921344	25-Aug-11	24.5	7.4	5.5	19.0
	GN-07	14	414389	5920670	25-Aug-11	23.2	3.4	3.4	19.0
	GN-08	14	425309	5916900	25-Aug-11	24.0	4.7	4.3	19.0
	GN-09	14	424455	5924065	26-Aug-11	21.1	3.5	3.3	19.0
	GN-10	14	429235	5919458	26-Aug-11	21.4	4.4	3.4	19.0
	GN-11	14	413167	5909663	26-Aug-11	20.1	4.4	3.4	19.0
	GN-12	14	407273	5907478	26-Aug-11	21.0	3.1	3.3	19.0
	SN-04	14	404795	5915685	24-Aug-11	22.3	2.6	2.7	18.0
	SN-05	14	419492	5915135	24-Aug-11	23.7	4.1	4.1	18.0
	SN-09	14	424497	5923921	26-Aug-11	21.1	3.3	3.3	19.0
	GN-01	14	406848	5908029	19-Sep-14	23.2	1.9	2.3	11.5

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	
CEDAR-W	GN-02	14	393263	5910384	18-Sep-14	15.9	1.5	1.7	12.8
	GN-03	14	390547	5919722	18-Sep-14	16.2	2.1	2.0	12.7
	GN-04	14	404776	5915745	19-Sep-14	19.8	2.1	2.4	11.5
	GN-05	14	419667	5914945	20-Sep-14	22.0	3.0	3.6	11.7
	GN-06	14	397654	5921344	18-Sep-14	13.0	6.4	1.8	12.7
	GN-07	14	415509	5919593	20-Sep-14	19.3	3.0	2.7	11.0
	GN-08	14	425323	5916776	21-Sep-14	22.4	14.0	4.5	12.0
	GN-09	14	424540	5916809	21-Sep-14	22.0	5.5	4.6	12.1
	GN-10	14	429267	5916334	21-Sep-14	22.8	4.0	4.3	12.0
	GN-11	14	413167	5909653	20-Sep-14	21.4	4.0	3.3	11.7
	GN-12	14	406839	5908260	19-Sep-14	23.2	2.3	3.9	11.6
	SN-04	14	404776	5915745	19-Sep-14	19.8	-	2.1	11.5
	SN-05	14	419667	5914945	20-Sep-14	22.0	-	3.0	11.7
	SN-09	14	424540	5916809	21-Sep-14	22.0	-	5.5	12.1
	GN-01	14	401277	5908158	17-Sep-18	17.4	-	3.0	9.0
	GN-02	14	393263	5910384	18-Sep-18	19.7	1.6	1.7	8.6
	GN-03	14	390547	5919722	18-Sep-18	20.0	2.6	2.7	8.7
	GN-04	14	405046	5915494	17-Sep-18	16.5	-	2.8	9.0
	GN-05	14	419627	5915137	19-Sep-18	17.3	3.5	4.3	9.6
	GN-06	14	397654	5921344	18-Sep-18	20.6	2.4	2.6	8.6
	GN-07	14	414300	5920634	19-Sep-18	19.3	3.3	3.2	11.4
	GN-08	14	425309	5916900	20-Sep-18	16.0	4.2	-	9.8
	GN-09	14	424455	5916900	20-Sep-18	17.1	5.2	5.9	9.9
	GN-10	14	429235	5919458	20-Sep-18	18.3	5.3	4.7	10.9
	GN-11	14	413266	5909614	19-Sep-18	15.4	3.4	4.6	9.6
	GN-12	14	407283	5907743	17-Sep-18	15.6	-	-	9.6
	SN-04	14	405046	5915494	17-Sep-18	16.5	-	-	9.0

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	
CEDAR-W	SN-05	14	419627	5915137	19-Sep-18	17.3	-	3.5	9.6
	SN-09	14	424455	5916900	20-Sep-18	17.1	-	5.2	9.9
CORM	GN-01	14	373359	6015127	16-Sep-08	20.9	10.7	11.9	14.7
	GN-02	14	373015	6017479	16-Sep-08	22.0	10.2	10.1	14.4
	GN-03	14	374306	6018714	16-Sep-08	23.1	9.4	14.4	14.4
	GN-04	14	388010	6012539	26-Aug-08	23.0	5.1	7.9	19.1
	GN-06	14	392862	6010526	18-Sep-08	19.5	8.7	8.5	14.5
	GN-09	14	381662	6009897	26-Aug-08	24.5	10.5	13.2	19.2
	GN-11	14	385983	6006500	27-Aug-08	20.7	14.8	15.7	18.3
	GN-12	14	393048	6011154	18-Sep-08	20.8	7.0	3.0	14.4
	GN-14	14	378351	6008658	29-Aug-08	24.8	15.1	11.9	18.4
	GN-15	14	369144	6010688	29-Aug-08	25.5	2.7	16.2	18.3
	GN-26	14	390270	6006911	27-Aug-08	19.9	7.6	7.3	17.6
	SN-12	14	393048	6011154	18-Sep-08	20.8	7.0	3.0	14.4
	GN-01	14	373160	6014695	17-Aug-09	15.9	2.7	11.9	16.9
	GN-02	14	372747	6017416	17-Aug-09	16.0	3.4	10.7	16.8
	GN-07	14	383450	6003367	21-Aug-09	17.0	3.1	5.8	17.0
	GN-08	14	384652	6010792	19-Aug-09	18.2	6.7	9.1	17.0
	GN-09	14	381704	6010060	21-Aug-09	17.4	13.1	14.3	17.0
	GN-11	14	385132	6007321	20-Aug-09	17.1	3.7	12.2	16.8
	GN-13	14	379334	6008537	18-Aug-09	17.5	4.3	12.8	17.0
	GN-14	14	377935	6009140	18-Aug-09	17.3	9.8	12.5	17.0
	GN-15	14	368965	6010577	17-Aug-09	16.0	4.9	10.7	16.7
	GN-16	14	388228	6011088	20-Aug-09	17.1	7.6	16.8	16.5
	SN-08	14	384652	6010792	19-Aug-09	18.2	6.7	6.7	17.0
	GN-02	14	372017	6018009	21-Aug-10	21.6	3.7	6.7	18.0

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	
CORM	GN-08	14	384531	6010791	17-Aug-10	17.6	11.9	11.6	18.0
	GN-09	14	381379	6009354	18-Aug-10	21.8	12.8	12.8	18.0
	GN-11	14	385101	6006950	18-Aug-10	21.6	13.4	12.8	17.9
	GN-13	14	379388	6008326	19-Aug-10	21.9	4.0	13.4	17.9
	GN-14	14	377771	6008309	19-Aug-10	22.5	6.1	13.4	17.9
	GN-15	14	369147	6010262	20-Aug-10	24.7	15.2	4.3	18.0
	GN-16	14	388234	6011052	22-Aug-10	22.4	6.1	6.1	18.0
	GN-26	14	389351	6006697	22-Aug-10	21.5	11.6	15.9	17.9
	GN-01	14	373255	6014417	3-Oct-11	19.5	4.2	11.4	13.1
	GN-02	14	372814	6017612	3-Oct-11	19.8	4.6	10.2	13.2
	GN-03	14	373576	6018713	3-Oct-11	20.0	4.6	9.9	13.1
	GN-04	14	387798	6011774	4-Oct-11	16.5	3.8	10.6	3.0
	GN-05	14	388899	6012075	4-Oct-11	16.5	3.6	9.9	12.2
	GN-06	14	392890	6010243	4-Oct-11	16.7	6.6	9.9	12.5
	GN-07	14	385506	6003941	5-Oct-11	20.6	5.6	6.6	12.5
	GN-08	14	384545	6010842	5-Oct-11	20.4	8.3	13.2	12.5
	GN-09	14	381491	6009485	5-Oct-11	20.3	6.6	13.9	12.6
	GN-10	14	382406	6001619	6-Oct-11	21.3	3.6	6.6	11.7
	GN-11	14	384356	6007023	6-Oct-11	21.3	3.6	15.2	12.7
	GN-12	14	393309	6010984	6-Oct-11	21.2	5.8	7.0	12.3
	GN-13	14	379230	6008287	7-Oct-11	28.6	2.4	12.8	12.7
	GN-14	14	378404	6009884	7-Oct-11	28.8	5.5	12.8	12.8
	GN-15	14	368911	6010243	7-Oct-11	29.3	4.3	15.2	12.8
	GN-16	14	388269	6011052	7-Oct-11	21.8	9.1	12.2	13.0
	SN-03	14	373576	6018713	3-Oct-11	20.0	4.6	4.6	13.1
	SN-08	14	384545	6010842	5-Oct-11	20.4	8.3	8.3	12.5

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	
CORM	SN-12	14	393309	6010984	6-Oct-11	21.2	5.8	5.8	12.3
	GN-01	14	373216	6014688	29-Aug-12	22.3	6.4	9.3	19.2
	GN-03	14	373537	6018401	29-Aug-12	20.8	6.0	9.0	19.2
	GN-04	14	387678	6012259	27-Aug-12	14.2	3.5	9.5	19.6
	GN-05	14	388742	6012214	27-Aug-12	14.3	6.5	11.0	19.7
	GN-06	14	392841	6009798	28-Aug-12	21.1	6.6	9.9	19.0
	GN-07	14	387492	6004938	31-Aug-12	22.5	6.1	7.0	18.8
	GN-08	14	384785	6010736	27-Aug-12	16.2	7.3	10.0	19.6
	GN-09	14	381454	6009451	28-Aug-12	24.3	4.6	11.6	18.9
	GN-10	14	380774	6001556	31-Aug-12	23.7	4.0	9.5	18.4
	GN-11	14	385756	6007481	31-Aug-12	21.2	7.0	7.2	18.9
	GN-12	14	392219	6011441	28-Aug-12	21.9	5.6	8.0	19.2
	SN-03	14	373537	6018401	29-Aug-12	20.8	6.0	9.0	19.2
	SN-08	14	384785	6010736	27-Aug-12	16.2	7.3	10.0	19.6
	SN-12	14	392219	6011441	28-Aug-12	21.9	5.6	8.0	19.2
	GN-01	14	373255	6014417	29-Aug-13	23.6	3.0	10.4	18.5
	GN-02	14	372814	6017612	29-Aug-13	22.8	6.0	9.2	18.6
	GN-03	14	373576	6018713	29-Aug-13	46.2	4.0	9.3	18.7
	GN-04	14	387798	6011774	28-Aug-13	15.8	4.6	10.8	19.0
	GN-05	14	388899	6012075	27-Aug-13	16.6	7.3	8.6	20.2
	GN-06	14	392890	6010243	27-Aug-13	16.1	6.5	9.0	20.3
	GN-07	14	385506	6003941	31-Aug-13	24.3	-	3.7	18.5
	GN-08	14	384545	6010842	28-Aug-13	17.3	6.6	12.2	19.4
	GN-09	14	381491	6009485	28-Aug-13	23.7	5.6	11.0	19.2
	GN-10	14	382406	6001619	31-Aug-13	24.4	-	6.9	18.5
	GN-11	14	384356	6007023	31-Aug-13	26.8	-	11.0	18.2
	GN-12	14	393309	6010984	27-Aug-13	15.7	3.5	7.7	20.6

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	
CORM	GN-13	14	387492	6004938	30-Aug-13	16.8	6.1	13.2	18.4
	GN-14	14	378404	6009884	30-Aug-13	17.3	-	20.2	19.5
	GN-15	14	368911	6010243	30-Aug-13	18.5	7.0	15.9	18.9
	GN-16	14	388269	6011052	31-Aug-13	26.0	-	15.8	18.2
	SN-03	14	373576	6018713	29-Aug-13	46.2	4.0	9.3	18.7
	SN-08	14	384545	6010842	28-Aug-13	17.3	6.6	12.2	19.4
	SN-12	14	393309	6010984	27-Aug-13	15.7	3.5	7.7	20.6
	GN-01	14	373292	6014754	10-Sep-14	22.0	6.7	13.5	14.6
	GN-02	14	372787	6017449	10-Sep-14	21.5	10.1	4.7	14.6
	GN-03	14	373550	6018380	10-Sep-14	20.9	10.9	5.0	14.5
	GN-04	14	388493	6012107	12-Sep-14	18.2	10.8	20.3	13.5
	GN-05	14	388974	6011834	9-Sep-14	17.6	3.9	7.2	15.1
	GN-06	14	392866	6010310	9-Sep-14	15.2	9.7	9.6	15.0
	GN-07	14	386280	6003801	13-Sep-14	22.8	16.1	17.3	13.5
	GN-08	14	384492	6010798	12-Sep-14	19.4	8.0	13.2	14.0
	GN-09	14	381388	6009367	12-Sep-14	20.6	13.7	23.3	14.0
	GN-10	14	382449	6001904	13-Sep-14	23.2	5.4	5.4	13.3
	GN-11	14	384764	6007026	13-Sep-14	21.8	15.5	16.6	13.7
	GN-12	14	392124	6011308	9-Sep-14	16.5	4.0	8.2	15.1
	GN-13	14	378420	6008311	11-Sep-14	24.1	12.7	16.4	14.5
	GN-14	14	378273	6010071	11-Sep-14	23.6	12.6	12.7	14.6
	GN-15	14	369135	6010289	11-Sep-14	23.3	9.3	16.7	14.3
	GN-16	14	388324	6010311	14-Sep-14	22.9	9.1	12.2	13.0
	SN-03	14	373550	6018380	10-Sep-14	20.9	10.9	10.9	14.5
	SN-12	14	392124	6011308	9-Sep-14	16.5	4.0	4.0	15.1
	GN-01	14	373292	6014754	18-Aug-15	24.0	3.8	9.6	19.2
	GN-02	14	372787	6017449	18-Aug-15	21.3	2.0	8.2	18.7

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	
CORM	GN-03	14	373550	6018380	18-Aug-15	21.3	7.0	7.2	18.6
	GN-04	14	388493	6012107	22-Aug-15	24.2	3.9	9.5	18.3
	GN-05	14	388974	6011834	21-Aug-15	20.8	2.7	8.8	18.7
	GN-06	14	392866	6010310	20-Aug-15	18.8	9.6	9.8	18.4
	GN-07	14	386280	6003801	24-Aug-15	21.9	7.2	14.0	18.3
	GN-08	14	384492	6010798	23-Aug-15	23.8	8.0	13.1	17.9
	GN-09	14	381388	6009367	23-Aug-15	23.5	13.5	23.1	17.9
	GN-10	14	382449	6001904	24-Aug-15	21.8	4.7	4.6	18.2
	GN-11	14	384764	6007026	22-Aug-15	24.2	11.0	19.7	18.4
	GN-12	14	392124	6011308	20-Aug-15	20.0	4.0	8.2	18.4
	GN-13	14	378420	6008311	19-Aug-15	13.2	9.0	13.5	18.8
	GN-14	14	378273	6010071	19-Aug-15	24.3	12.0	4.7	18.8
	GN-15	14	369135	6010289	19-Aug-15	23.8	3.9	5.0	18.6
	GN-16	14	388324	6010311	21-Aug-15	20.7	9.0	11.3	18.6
	SN-03	14	373550	6018380	18-Aug-15	21.3	7.0	7.0	18.6
	SN-08	14	384492	6010798	23-Aug-15	23.8	8.0	8.0	17.9
	SN-12	14	392124	6011308	20-Aug-15	20.0	4.0	4.0	18.4
	GN-01	14	373292	6014754	22-Aug-16	18.1	3.8	12.1	19.1
	GN-02	14	372787	6017449	22-Aug-16	17.9	1.8	7.3	19.0
	GN-03	14	373550	6018380	22-Aug-16	18.1	3.6	9.2	19.0
	GN-04	14	388493	6012107	23-Aug-16	18.1	6.2	9.1	18.4
	GN-05	14	388974	6011834	26-Aug-16	24.1	4.1	8.2	18.0
	GN-06	14	392866	6010310	23-Aug-16	18.1	6.1	8.6	18.4
	GN-07	14	386280	6003801	26-Aug-16	22.6	9.8	9.5	18.2
	GN-08	14	384492	6010798	24-Aug-16	23.3	5.7	9.1	18.1
	GN-09	14	381388	6009367	24-Aug-16	23.5	6.1	10.8	17.8
	GN-10	14	382449	6001904	26-Aug-16	22.5	5.2	4.9	17.7

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	
CORM	GN-11	14	384764	6007026	26-Aug-16	22.4	11.3	25.9	18.1
	GN-12	14	392124	6011308	23-Aug-16	18.2	5.6	6.9	18.4
	GN-13	14	378420	6008311	25-Aug-16	22.9	12.0	15.0	18.2
	GN-14	14	378273	6010071	25-Aug-16	22.8	2.3	12.1	18.2
	GN-15	14	369135	6010289	25-Aug-16	22.6	10.5	15.5	18.1
	GN-16	14	388324	6010311	24-Aug-16	23.0	8.3	9.8	18.0
	SN-03	14	373550	6018380	22-Aug-16	18.1	3.6	3.6	19.0
	SN-12	14	392124	6011308	23-Aug-16	18.2	5.6	5.6	18.4
	GN-01	14	373255	6014417	28-Aug-17	19.7	3.3	12.8	18.9
	GN-02	14	372814	6017612	28-Aug-17	19.1	4.9	9.1	18.8
	GN-03	14	373576	6018713	28-Aug-17	18.0	4.9	10.3	18.9
	GN-04	14	387798	6011774	30-Aug-17	23.8	4.6	9.6	18.4
	GN-05	14	388899	6012075	29-Aug-17	20.4	4.6	8.8	19.2
	GN-06	14	392890	6010243	30-Aug-17	22.3	6.1	9.5	18.9
	GN-07	14	385506	6003941	31-Aug-17	23.8	9.8	9.7	18.9
	GN-08	14	384545	6010842	30-Aug-17	23.8	6.8	7.3	18.5
	GN-09	14	381491	6009485	29-Aug-17	22.2	5.5	11.6	19.0
	GN-10	14	382406	6001619	31-Aug-17	23.9	5.2	4.9	18.9
	GN-11	14	384356	6007023	31-Aug-17	23.8	11.6	25.9	18.9
	GN-12	14	393309	6010984	30-Aug-17	22.3	3.7	7.7	18.9
	GN-13	14	379230	6008287	29-Aug-17	21.5	14.8	16.2	19.1
	GN-14	14	378404	6009884	29-Aug-17	21.8	6.9	12.8	19.0
	GN-15	14	368911	6010243	28-Aug-17	20.7	15.2	16.5	18.9
	GN-16	14	388269	6011052	31-Aug-17	23.8	8.3	9.8	18.4
	SN-03	14	373576	6018713	28-Aug-17	18.0	-	4.9	18.9
	SN-08	14	384545	6010842	30-Aug-17	23.8	-	6.8	18.5
	SN-12	14	393309	6010984	30-Aug-17	22.3	3.7	3.7	18.9

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	
CORM	GN-01	14	372818	6014412	23-Aug-18	25.3	4.3	12.8	16.8
	GN-02	14	372788	6017357	23-Aug-18	20.0	4.4	7.7	16.8
	GN-03	14	373523	6018361	23-Aug-18	20.0	5.0	10.7	16.7
	GN-04	14	387793	6012123	25-Aug-18	23.5	4.6	7.9	16.1
	GN-05	14	388902	6012149	20-Aug-18	18.6	3.9	9.0	18.5
	GN-06	14	393048	6010291	20-Aug-18	18.8	8.4	9.2	18.5
	GN-07	14	388920	6006293	25-Aug-18	23.2	12.2	11.4	16.2
	GN-08	14	384640	6010892	24-Aug-18	24.3	6.6	9.1	16.8
	GN-09	14	381483	6009431	24-Aug-18	24.2	4.3	11.6	16.7
	GN-10	14	383996	6004818	25-Aug-18	23.5	6.8	6.9	16.1
	GN-11	14	384589	6007025	25-Aug-18	23.3	3.9	26.6	16.2
	GN-12	14	392210	6011437	20-Aug-18	18.9	4.9	7.8	18.2
	GN-13	14	378413	6008432	24-Aug-18	24.4	14.1	15.8	16.7
	GN-14	14	378466	6010295	24-Aug-18	24.0	7.0	12.1	16.4
	GN-15	14	369107	6010457	23-Aug-18	25.1	12.7	16.6	17.3
	GN-16	14	388297	6011270	20-Aug-18	18.8	10.1	14.7	18.1
	SN-03	14	373523	6018361	23-Aug-18	20.0	5.0	-	16.9
	SN-08	14	384640	6010892	24-Aug-18	24.3	5.6	-	16.7
	SN-12	14	392210	6011437	20-Aug-18	18.9	4.9	-	18.0
	GN-01	14	372807	6014530	25-Aug-19	18.9	2.3	4.5	18.4
	GN-02	14	372635	6017260	25-Aug-19	18.3	2.4	6.2	18.4
	GN-03	14	373388	6018310	25-Aug-19	17.8	-	5.9	18.3
	GN-04	14	387738	6012129	28-Aug-19	22.3	2.4	8.2	13.1
	GN-05	14	388838	6012189	28-Aug-19	24.1	3.0	8.2	13.2
	GN-06	14	392930	6010337	28-Aug-19	24.2	5.5	8.8	13.0
	GN-07	14	385506	6003941	30-Aug-19	23.2	6.6	7.6	11.4
	GN-08	14	384678	6010578	28-Aug-19	22.2	-	7.9	13.0

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	
CORM	GN-09	14	381491	6009485	30-Aug-19	23.8	11.6	4.4	11.4
	GN-10	14	381816	6002199	30-Aug-19	21.8	3.7	4.9	12.9
	GN-11	14	386085	6008042	30-Aug-19	22.8	8.7	10.1	11.7
	GN-12	14	392009	6011459	29-Aug-19	20.3	-	5.5	12.7
	GN-13	14	378359	6008426	27-Aug-19	20.9	2.4	8.5	15.0
	GN-14	14	378483	6010146	28-Aug-19	21.0	2.4	9.4	14.9
	GN-15	14	369261	6010437	27-Aug-19	20.8	2.6	11.2	16.3
	GN-16	14	388326	6011141	29-Aug-19	22.0	-	11.0	12.0
	SN-03	14	373518	6018412	25-Aug-19	17.8	5.7	-	18.3
	SN-08	14	384704	6010743	28-Aug-19	22.2	3.0	-	13.0
	SN-12	14	392147	6011465	29-Aug-19	20.3	4.9	-	12.7

Notes:

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

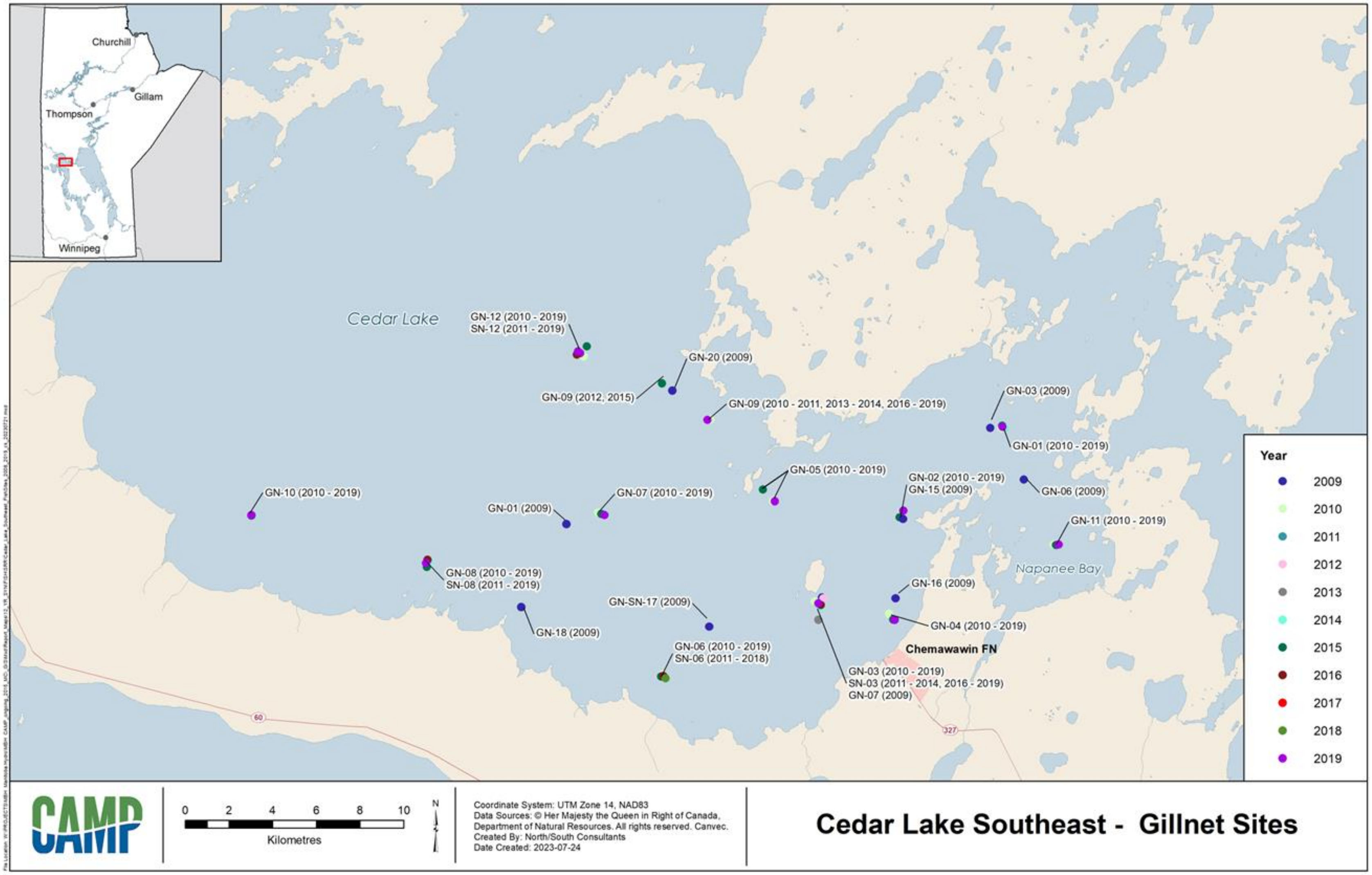


Figure A5-1-1. 2008-2019 Gillnetting sites at Cedar Lake - Southeast.

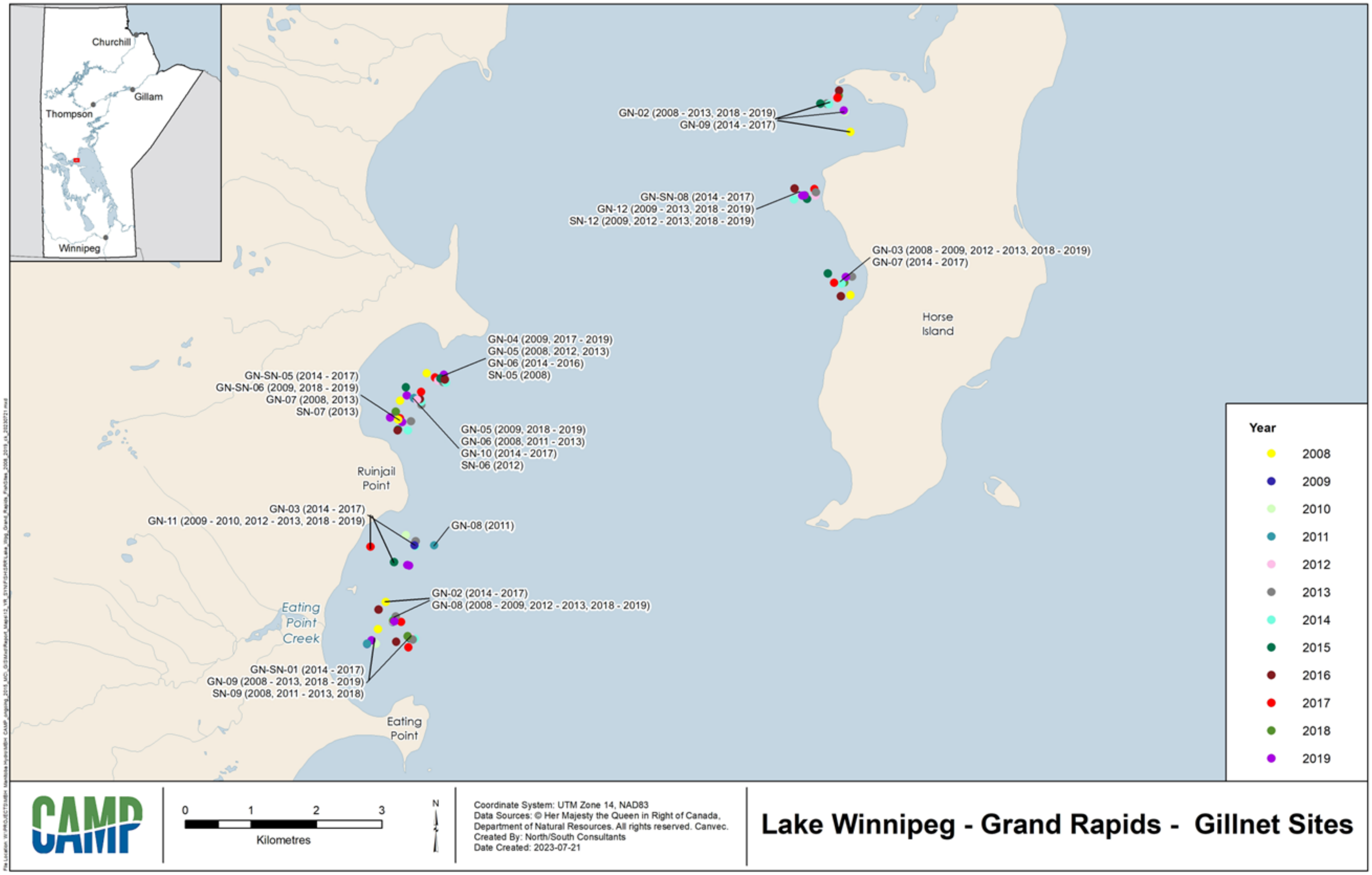


Figure A5-1-2. 2008-2019 Gillnetting sites in the Grand Rapids area of Lake Winnipeg.

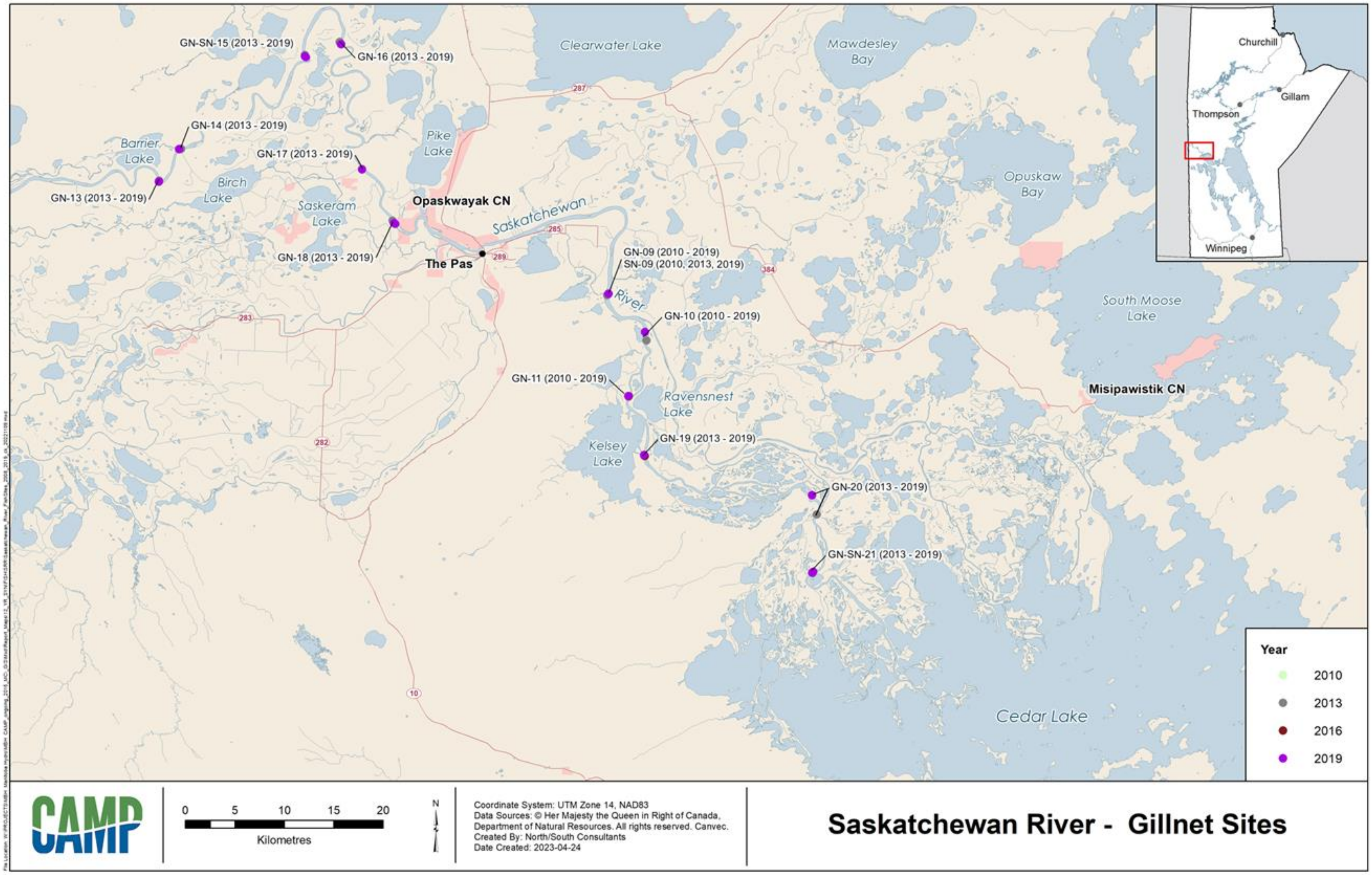


Figure A5-1-3. 2009-2018 Gillnetting sites in the Saskatchewan River between The Pas and Cedar Lake.

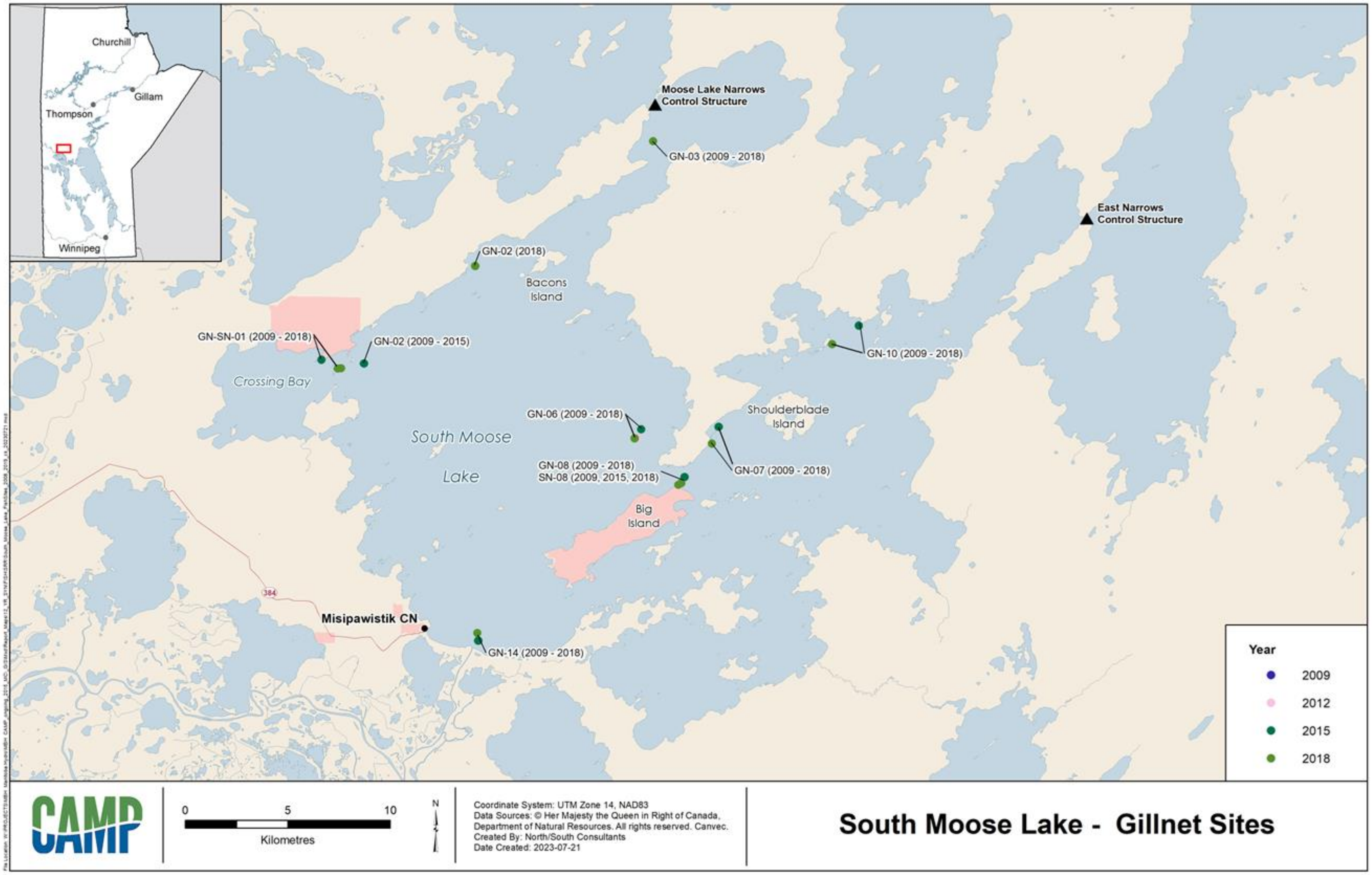


Figure A5-1-4. 2010-2019 Gillnetting sites in South Moose Lake.

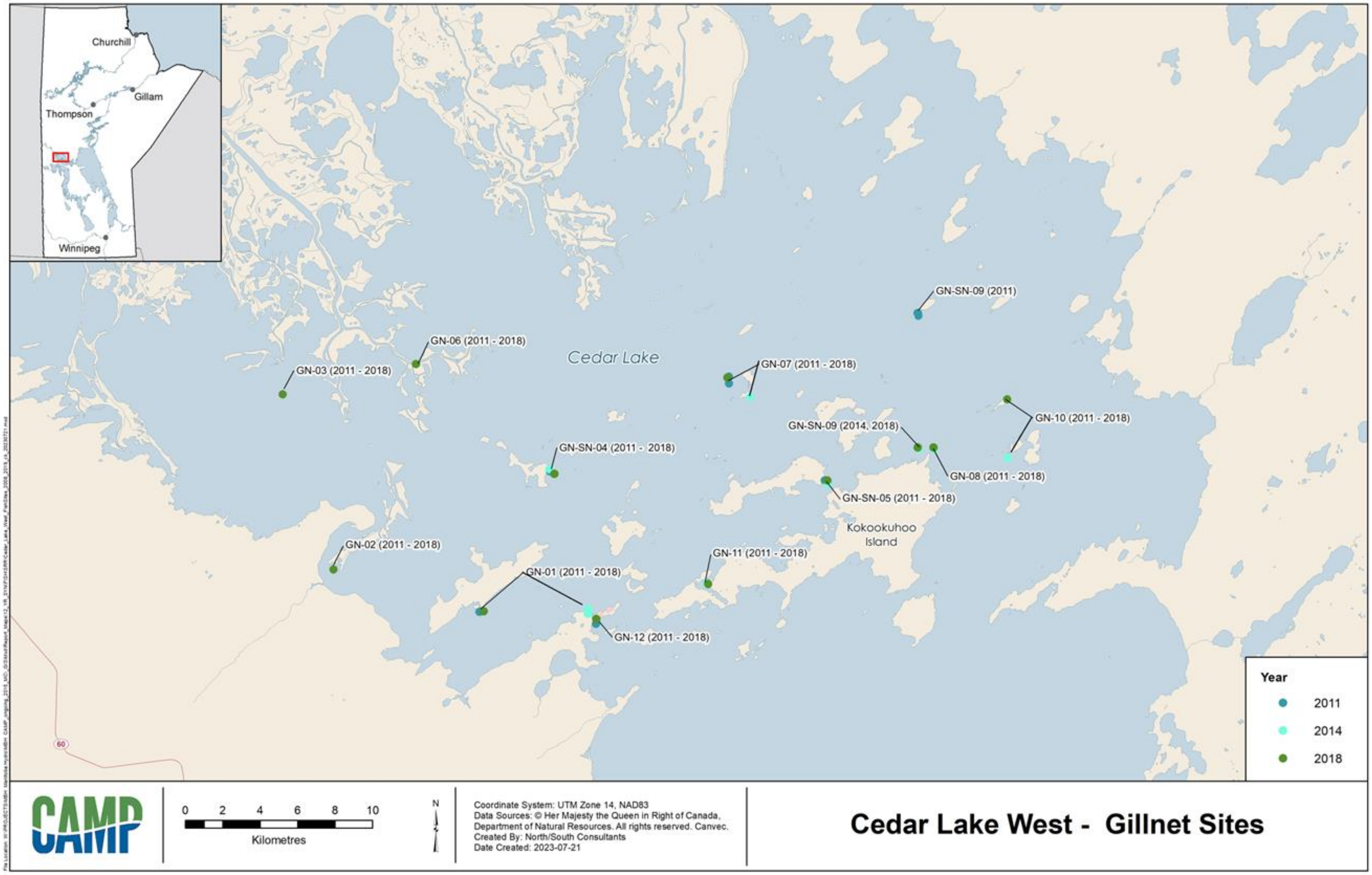


Figure A5-1-5. 2011-2017 Gillnetting sites at Cedar Lake - West.

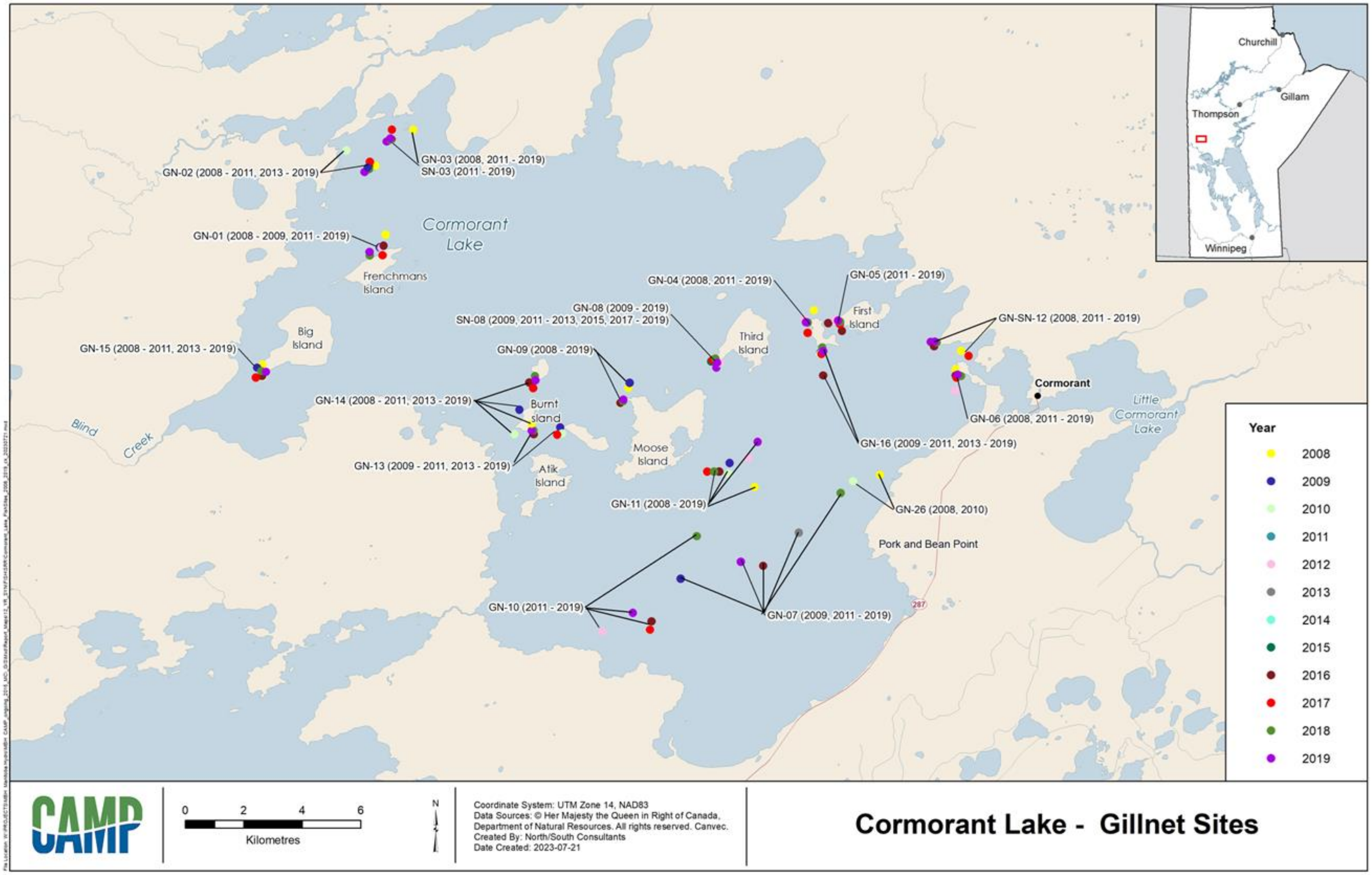


Figure A5-1-6. 2011-2017 Gillnetting sites in Cormorant Lake.

6.0 MERCURY IN FISH

6.1 INTRODUCTION

The following presents the results of fish mercury monitoring conducted from 2008-2019 in the Saskatchewan River Region. Fish mercury sampling was conducted on a three-year rotation beginning in 2010 at the on-system Cedar Lake - Southeast and the off-system Cormorant 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 four departures from the planned field sampling schedule during the 12-year period:

- mercury samples were collected from Cedar Lake - Southeast in 2017 because they were not collected as scheduled in 2016;
- mercury samples were not collected from Cormorant Lake as scheduled in 2017; and
- mercury samples were not collected from Cedar Lake - Southeast or Cormorant Lake as scheduled in 2019.

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

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.

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
CEDAR-SE			●			●			[1]	● [2]		[1]
CORM			●			●			●	● [3]		[1]

Notes:

1. Samples not collected in error.
2. Samples collected in 2017 because sampling did not occur in 2016 due to error.
3. Samples collected in error.

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

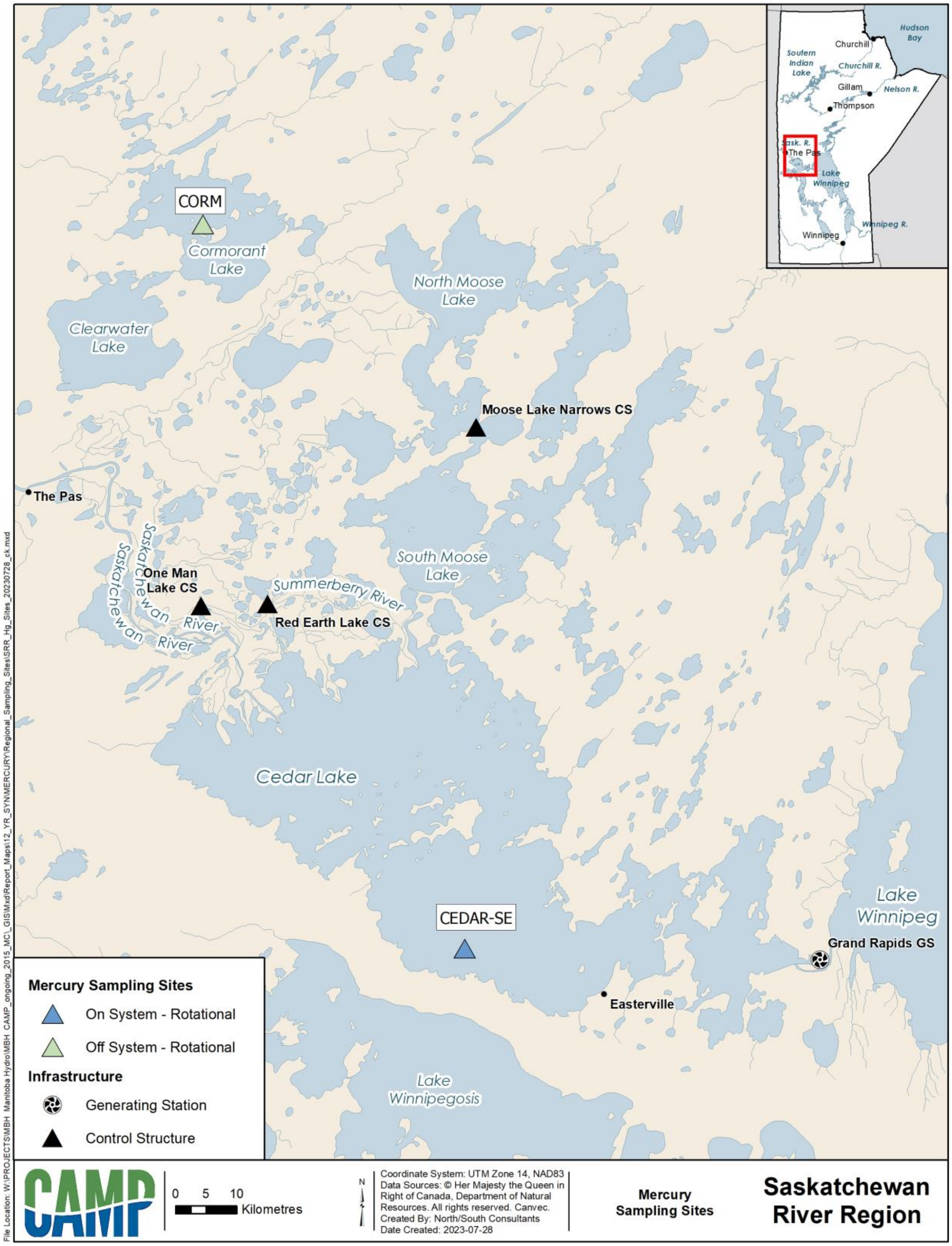


Figure 6.1-1. 2008-2019 Fish mercury sampling sites.

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 Saskatchewan River Region that are monitored for fish mercury annually.

ROTATIONAL SITES

Cedar Lake – Southeast

Lake Whitefish

Over the three years of monitoring Lake Whitefish were not submitted for mercury analysis from the Cedar Lake – Southeast due to low catches (only one whitefish was captured over this period; Table 6.2-1).

Northern Pike

The arithmetic mean mercury concentration of Northern Pike over the three years of monitoring ranged from a low of 0.116 parts per million (ppm) in 2010 to a high of 0.165 ppm in 2017 (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 three years of monitoring ranged from a low of 0.106 ppm in 2010 to a high of 0.180 ppm in 2017 (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 0.019 ppm in 2010 and 0.027 ppm in 2017 (Table 6.2-2; Figure 6.2-4). No Yellow Perch were collected for mercury analysis in 2013 in error.

6.2.1.2 OFF-SYSTEM SITES

ANNUAL SITES

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

ROTATIONAL SITES

Cormorant Lake

Lake Whitefish

The arithmetic mean mercury concentration of Lake Whitefish over the four years of monitoring ranged from a low of 0.058 ppm in 2010 to a high of 0.090 ppm in 2013 (Table 6.2-1). The mercury concentration typically increased with fork length, although 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 0.311 ppm in 2016 to a high of 0.407 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 0.192 ppm in 2017 to a high of 0.264 ppm in 2016 (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 one-year-old Yellow Perch over the four years of monitoring ranged from a low of 0.021 ppm in 2016 to a high of 0.027 ppm in 2010 (Table 6.2-2; Figure 6.2-4). None of the Yellow Perch collected for mercury analysis in 2017 was 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	CEDAR-SE	2010	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	-	
		2013	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	-	
		2017	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	-	
	CORM	2010	35	361	216	460	12	34	11	1	23	1	35	0.058	0.018	0.152	0.007	0.048	0.041-0.055
		2013	14	405	246	491	15	14	14	2	29	2	14	0.090	0.026	0.251	0.018	not significant	
		2016	32	379	285	493	10	31	12	4	21	1	32	0.081	0.029	0.169	0.008	0.060	0.051-0.071
		2017	18	405	210	520	22	18	13	2	27	2	18	0.063	0.021	0.122	0.007	0.050	0.039-0.064
NRPK	CEDAR-SE	2010	31	549	196	745	18	31	5	2	9	0	31	0.116	0.045	0.276	0.011	0.105	0.090-0.121
		2013	12	525	375	880	47	12	3	2	9	1	12	0.123	0.055	0.393	0.030	0.118	0.101-0.138
		2017	28	547	460	790	14	28	3	2	8	0	28	0.165	0.096	0.620	0.019	0.153	0.136-0.173
	CORM	2010	36	609	480	792	11	34	7	3	12	0	36	0.407	0.144	0.939	0.029	0.303	0.256-0.360
		2013	36	560	374	788	13	36	5	1	12	0	36	0.320	0.072	0.794	0.030	0.264	0.238-0.292
		2016	36	572	430	801	14	36	5	3	9	0	36	0.311	0.112	0.850	0.030	0.250	0.223-0.280
		2017	23	615	426	900	26	23	5	2	11	1	23	0.337	0.058	1.23	0.057	0.185	0.148-0.232
WALL	CEDAR-SE	2010	36	377	205	654	16	32	7	3	14	0	36	0.106	0.042	0.282	0.010	0.107	0.095-0.120
		2013	33	352	212	516	16	33	6	2	12	0	33	0.117	0.053	0.262	0.009	0.130	0.117-0.144
		2017	36	358	215	470	11	36	6	3	12	0	36	0.180	0.091	0.263	0.008	0.193	0.177-0.210
	CORM	2010	36	415	242	612	17	35	6	2	14	1	36	0.225	0.084	0.679	0.019	0.203	0.185-0.222
		2013	37	422	240	589	14	37	6	2	12	0	37	0.209	0.106	0.424	0.010	0.194	0.182-0.207
		2016	37	428	128	607	18	37	9	1	20	1	37	0.264	0.019	0.764	0.029	0.194	0.172-0.218
		2017	23	393	240	540	20	23	7	2	16	1	23	0.192	0.087	0.497	0.024	0.179	0.153-0.209

Notes:

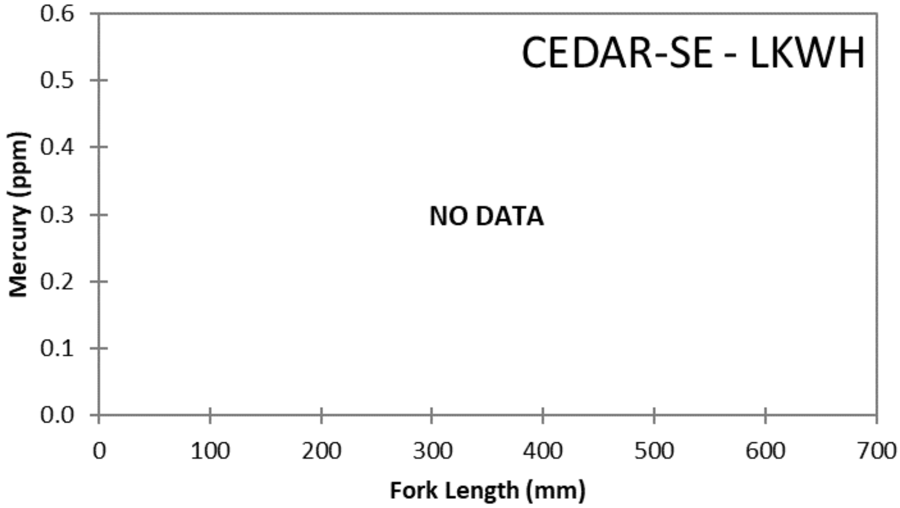
1. n = sample size.
2. Min = minimum; Max = maximum.
3. SE = standard error.
4. For standard lengths of 350 mm for LKWH, 550 mm for NRPK, and 400 mm for WALL.
5. CL = confidence limits.

Table 6.2-2. 2010-2019 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	CEDAR-SE	2010	10	83	75	95	2	0.019	0.012	0.034	0.002
		2013	0	-	-	-	-	-	-	-	-
		2017	8 [4]	62	59	66	1	0.027	0.0183	0.032	0.001
	CORM	2010	4	105	95	112	3	0.027	0.021	0.032	0.002
		2013	12	71	64	80	1	0.023	<0.010	0.048	0.003
		2016	2	72	68	75	2	0.021	0.018	0.023	0.002
		2017	0	-	-	-	-	-	-	-	-

Notes:

1. n = sample size.
2. Min = minimum; Max = maximum.
3. SE = standard error.
4. one fish not measured for fork length.



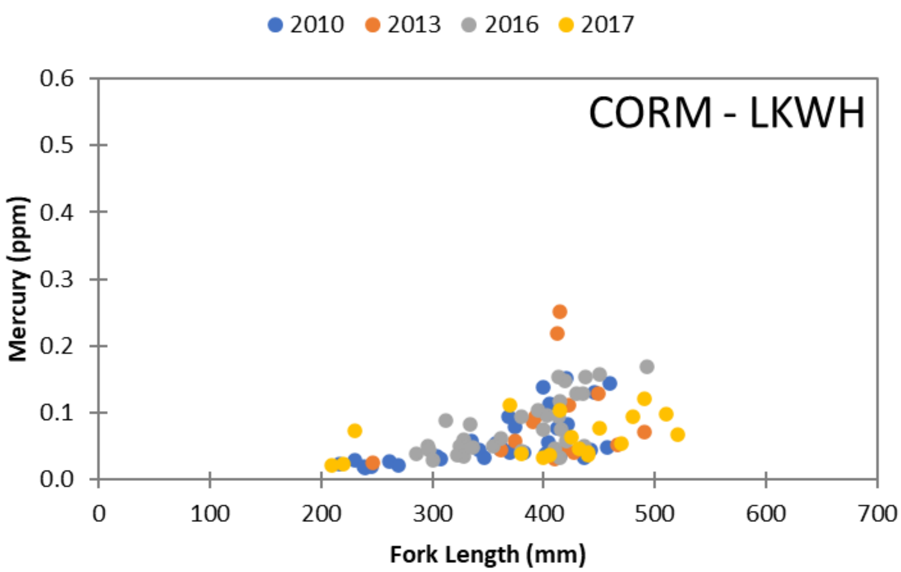


Figure 6.2-1. 2010-2019 Mercury concentration versus fork length of Lake Whitefish.

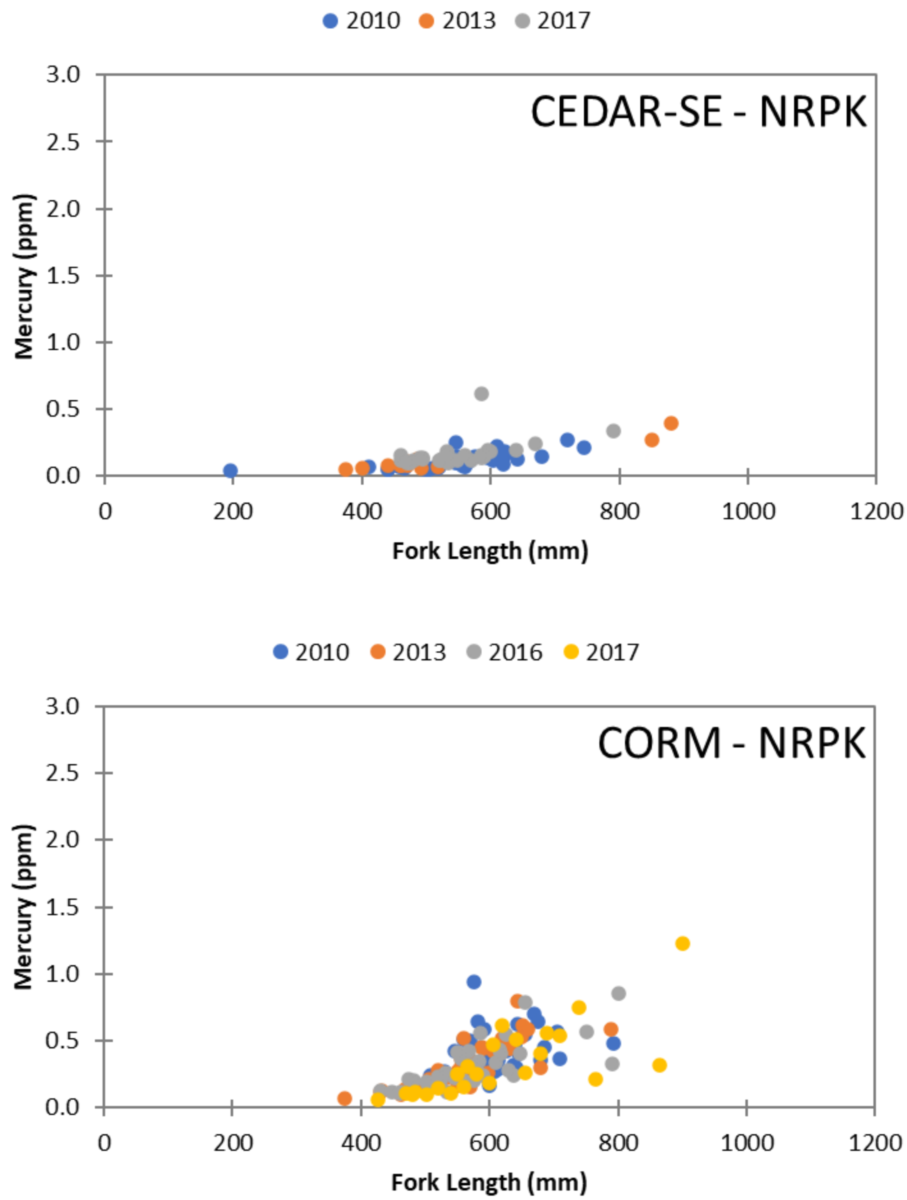


Figure 6.2-2. 2010-2019 Mercury concentration versus fork length of Northern Pike.

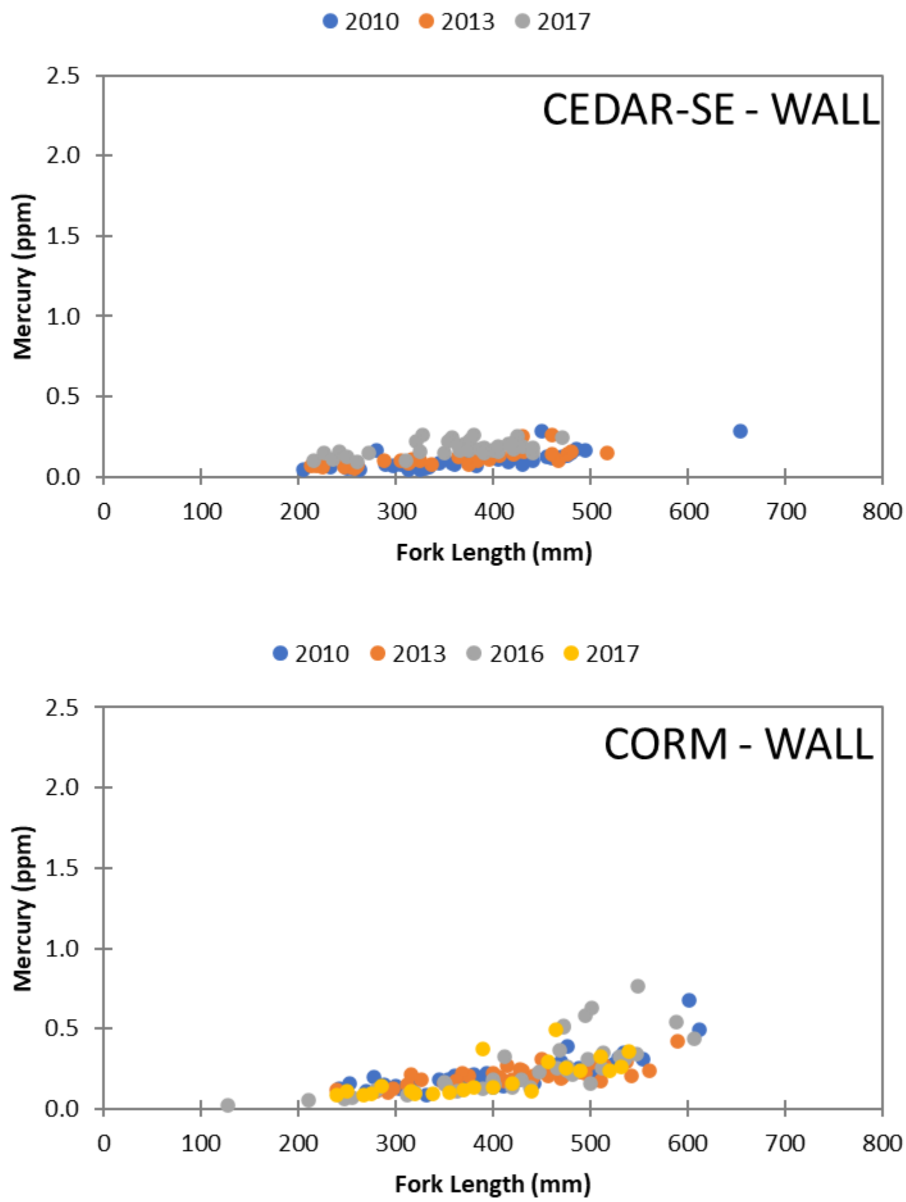


Figure 6.2-3. 2010-2019 Mercury concentration versus fork length of Walleye.

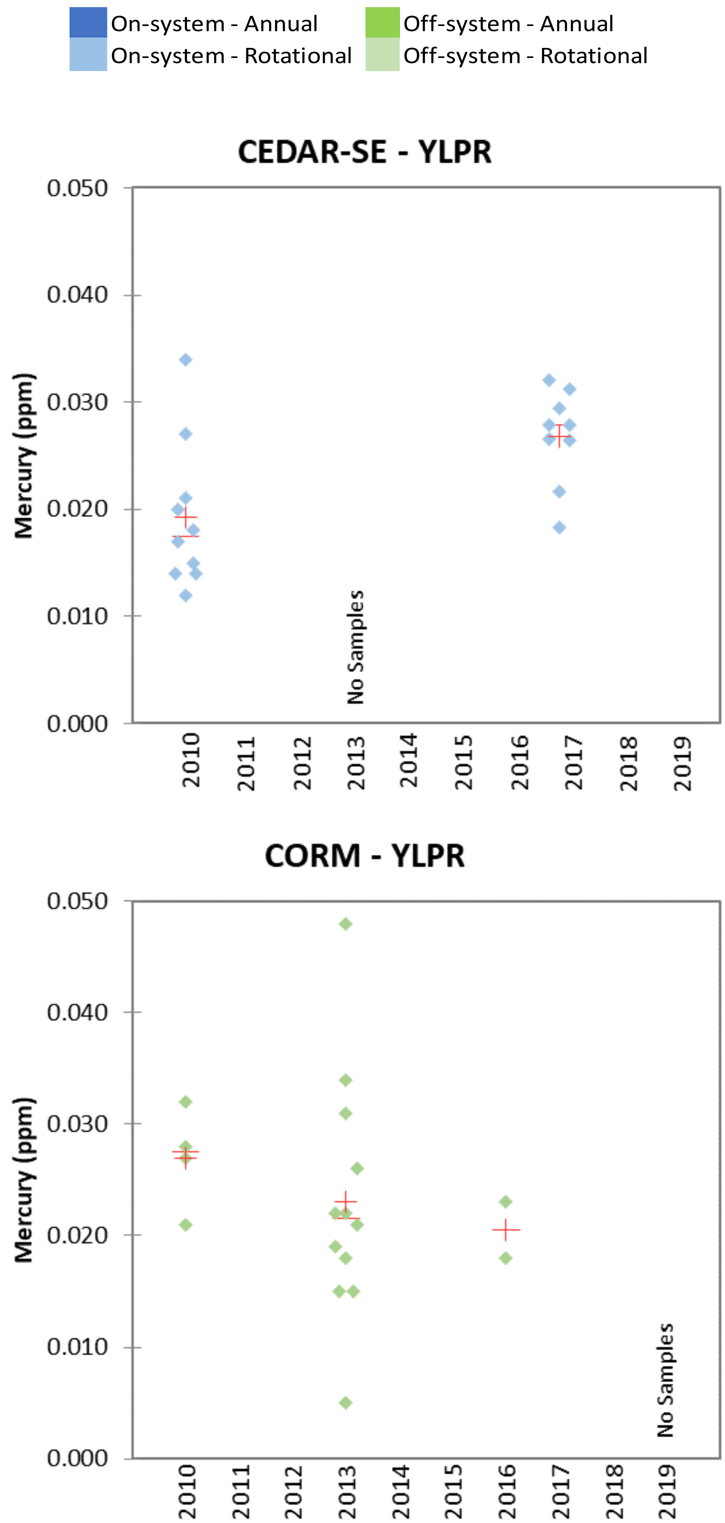


Figure 6.2-4. 2010-2019 Mercury concentrations of one-year-old Yellow Perch.

6.2.2 LENGTH-STANDARDIZED MEAN CONCENTRATION

6.2.2.1 ON-SYSTEM SITES

ANNUAL SITES

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

ROTATIONAL SITES

<u>**Cedar Lake – Southeast**</u>

Lake Whitefish

Over the three years of monitoring Lake Whitefish were not submitted for mercury analysis from Cedar Lake – Southeast (Table 6.2-1).

Northern Pike

The length-standardized mean mercury concentration of a 550 mm Northern Pike over the three years of monitoring ranged from a low of 0.105 ppm in 2010 to a high of 0.153 ppm in 2017 (Table 6.2-1).

The overall mean concentration was 0.125 ppm, the median concentration was 0.118 ppm, and the IQR was 0.111–0.136 ppm (Figure 6.2-6). The annual mean mercury concentration was below the IQR in 2010 and was above the IQR in 2017.

Walleye

The length-standardized mean mercury concentration of a 400 mm Walleye over the three years of monitoring ranged from a low of 0.107 ppm in 2010 to a high of 0.193 ppm in 2017 (Table 6.2-1).

The overall mean concentration was 0.143 ppm, the median concentration was 0.130 ppm, and the IQR was 0.118–0.161 ppm (Figure 6.2-7). The annual mean mercury concentration was below the IQR in 2010 and was above the IQR in 2017.

6.2.2.2 OFF-SYSTEM SITES

ANNUAL SITES

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

ROTATIONAL SITES

Cormorant Lake

Lake Whitefish

The length-standardized mean mercury concentration of a 350 mm Lake Whitefish over the four years of monitoring ranged from a low of 0.048 ppm in 2010 to a high of 0.060 ppm in 2016 (Table 6.2-1). A standard mean could not be calculated for 2013 because there was not a significant relationship between mercury concentration and fork length (Table 6.2-1).

The overall mean concentration was 0.053 ppm, the median concentration was 0.051 ppm, and the IQR was 0.049–0.055 ppm (Figure 6.2-5). The annual mean mercury concentration was below the IQR in 2010 and was above the IQR in 2016.

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 0.185 ppm in 2017 to a high of 0.303 ppm in 2010 (Table 6.2-1).

The overall mean concentration was 0.251 ppm, the median concentration was 0.257 ppm, and the IQR was 0.234–0.274 ppm (Figure 6.2-6). The annual mean mercury concentration fell within the IQR except in 2017 when it was below the IQR and in 2010 when it was above the IQR.

Walleye

The length-standardized mean mercury concentration of a 400 mm Walleye over the four years of monitoring ranged from a low of 0.179 ppm in 2017 to a high of 0.203 ppm in 2010 (Table 6.2-1).

The overall mean concentration was 0.192 ppm, the median concentration was 0.194 ppm, and the IQR was 0.190–0.196 ppm (Figure 6.2-7). The annual mean mercury concentration fell within the IQR except in 2017 when it was below the IQR and in 2010 when it was above the IQR.

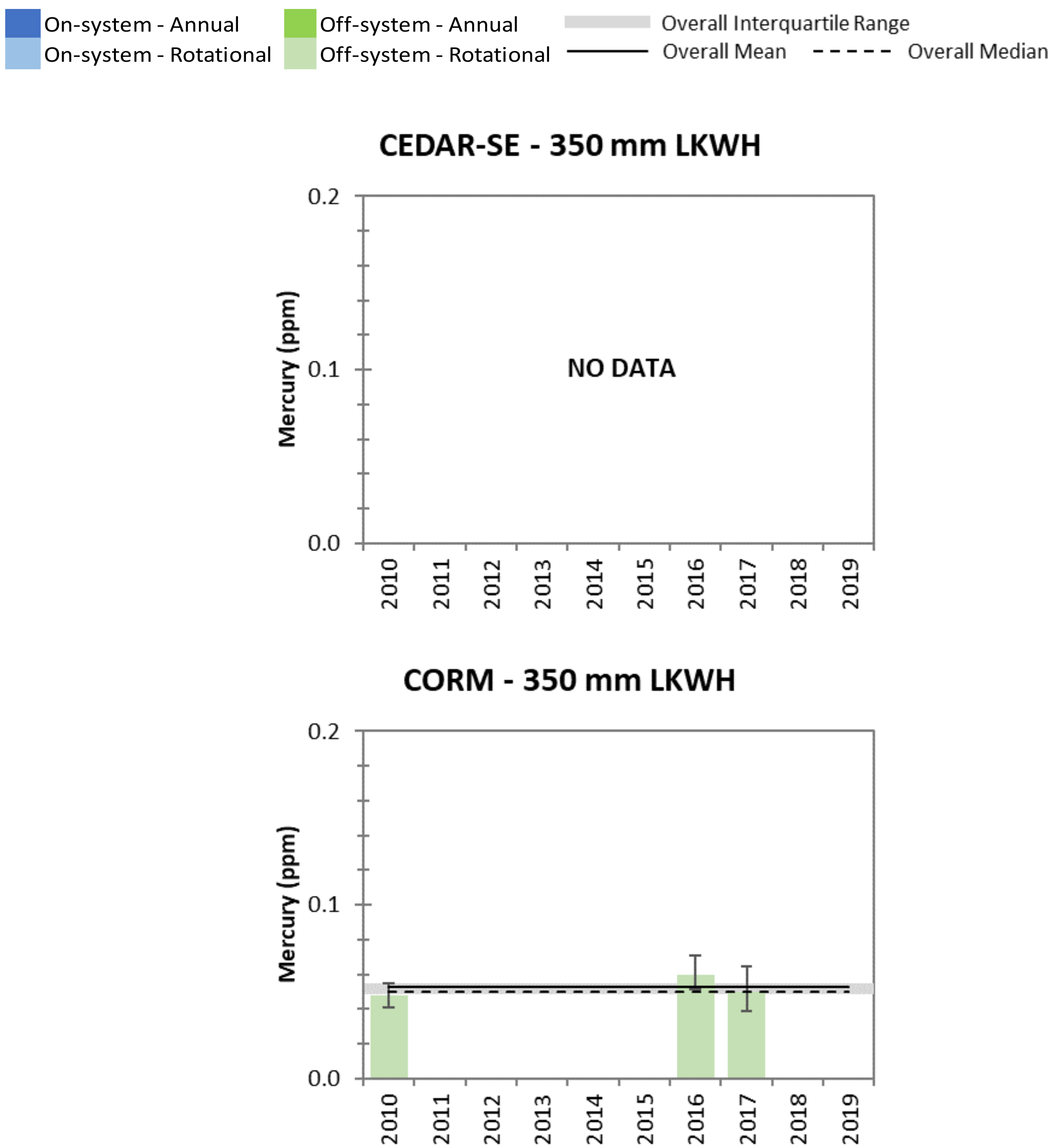


Figure 6.2-5. 2010-2019 Length-standardized mean mercury concentrations (±95% confidence intervals) of Lake Whitefish.

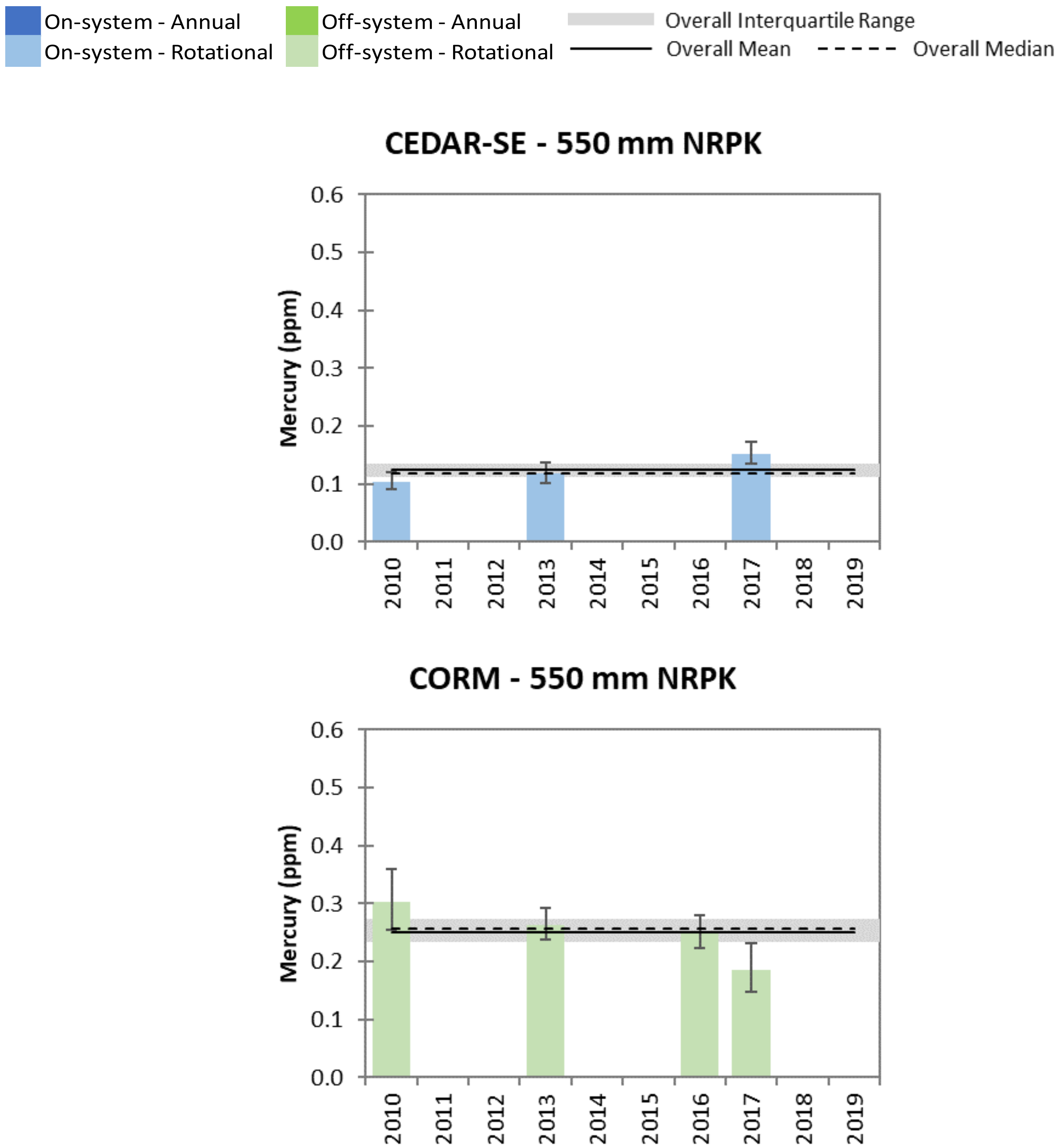


Figure 6.2-6. 2010-2019 Length-standardized mean mercury concentrations (±95% confidence intervals) of Northern Pike.

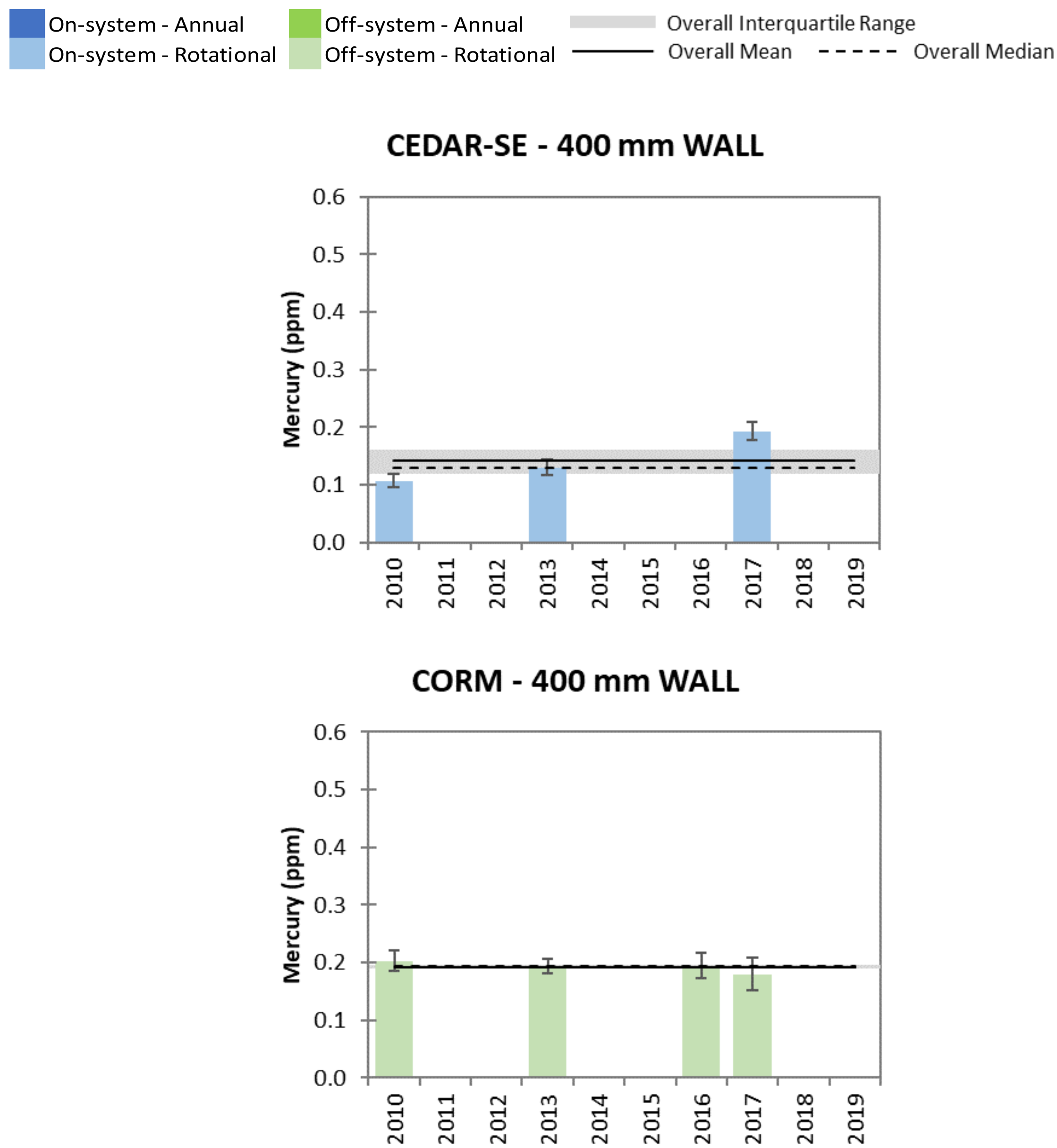


Figure 6.2-7. 2010-2019 Length-standardized mean mercury concentrations (±95% confidence intervals) of Walleye.

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