Carmine Shiner (*Notropis percobromus*) relative abundance and distribution in the Whitemouth and Winnipeg river drainages, Manitoba

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CARMINE SHINER (*NOTROPIS PERCOBROMUS*) RELATIVE ABUNDANCE AND DISTRIBUTION IN THE WHITEMOUTH AND WINNIPEG RIVER DRAINAGES, MANITOBA

by

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Carmine Shiner *(Notropis percobromus)* is a small-bodied Leuciscidae that in Canada is restricted to the Whitemouth and Winnipeg river drainages in Manitoba. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) last assessed Carmine Shiner as *Endangered* (COSEWIC 2018). Currently, Carmine Shiner is listed as *Endangered* under Canada's *Species at Risk Act* (SARA). COSEWIC is responsible for assessing the status of species in Canada, and an important consideration of that assessment is the relative abundance and present distribution. Using a standardized sampling protocol developed by Fisheries and Oceans Canada, field work was undertaken in July 2021 at 16 access points within the known range of Carmine Shiner. Species range extension was assessed at three additional access points. Carmine Shiner (n = 2,819) were confirmed at all access points within the species known range. Three specimens were collected at a range expansion access point downstream of McArthur Falls Generating Station on the Winnipeg River.

RÉSUMÉ

Watkinson, D.A., Teillet, R., Giesbrecht, M., Durhack, T.C., Enders, E.C., and Gutowsky, L.F.G. 2026. Carmine Shiner (*Notropis percobromus*) relative abundance and distribution in the Whitemouth and Winnipeg river drainages, Manitoba. Can. Data Rep. Fish. Aquat. Sci. 1461: vii + 21 p.

La tête carminée (*Notropis percobromus*) est un Leuciscidae de petite taille qui, au Canada, est limité aux bassins hydrographiques des rivières Whitemouth et Winnipeg, au Manitoba. Le Comité sur la situation des espèces en péril au Canada (COSEPAC) a évalué pour la dernière fois la tête carminée comme étant en voie de disparition (COSEPAC, 2018). Actuellement, la tête carminée est inscrite sur la liste des espèces en voie de disparition en vertu de la Loi sur les espèces en péril (LEP) du Canada. Le COSEPAC est chargé d'évaluer la situation des espèces au Canada et un élément important de cette évaluation est l'abondance relative et la répartition actuelle. À l'aide d'un protocole d'échantillonnage normalisé élaboré par Pêches et Océans Canada, des travaux sur le terrain ont été entrepris en juillet 2021 à 16 points d'accès dans l'aire de répartition connue de la tête carminée. L'extension de l'aire de répartition des espèces a été évaluée à trois points d'accès supplémentaires. Des têtes carminées (n = 2 819) ont été confirmées à tous les points d'accès dans l'aire de répartition connue de l'espèce. Trois spécimens ont été collectés à un point d'accès à l'expansion de l'aire de répartition en aval de la centrale électrique de McArthur Falls, sur la rivière Winnipeg.

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1.0 INTRODUCTION

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) last assessed Carmine Shiner (*Notropis percobromus*) as *Endangered* (COSEWIC 2018), and the species is currently listed as *Endangered* under Canada's *Species at Risk Act* (SARA). In Canada, the range of this small-bodied minnow of the family Leuciscidae is restricted to the portions of the Winnipeg River drainages in Manitoba (COSEWIC 2018; Figure 1). Carmine Shiner are endangered due to projected population declines from habitat loss and pollution. These factors along with dams and water management use put the species at risk of extinction in Canada.

In an effort to provide science information for Species at Risk Program recovery objectives (Fisheries and Oceans Canada 2013) and inform future COSEWIC re-assessments, Fisheries and Oceans Canada developed a standardized sampling protocol (Macnaughton et al. 2020) to assess the relative abundance and distribution of Carmine Shiner in Canada. Macnaughton et al. (2020) details (1) the sampling gear, (2) the sampling effort and timing of sampling, and (3) the sampling sites for Carmine Shiner abundance and range extension monitoring. This standardized sampling is intended to improve monitoring and inform population trend assessments throughout the species' range in Canada. Results stemming from this methodology are intended to lead to better-informed management of Carmine Shiner.

2.0 METHODS

2.1 Study System and Site Selection

In the Winnipeg River drainage, Carmine Shiner are most abundant in the Whitemouth and Birch rivers (COSEWIC 2018; Macnaughton et al. 2020; Figure 1). The species is also found in restricted locations of the Bird River, Pinawa Channel, and Winnipeg River below the confluence with the Whitemouth River (Figure 1). The Bird River and Pinawa Channel sites where Carmine Shiner have been collected are small in area. Both sites are confluent with the backwatering effects of the McArthur Falls Generating Station forebay. The Pinawa Channel site is part of an artificial channel that has a barrier to fish passage in both upstream and downstream directions at its upstream confluence with the Winnipeg River. The sampling site is also below a decommissioned hydro dam that remains a barrier to upstream movement by fish. The upstream sections of the watersheds containing Carmine Shiner are largely unmodified with intact riparian areas (Figure 2). The species is distributed within the lower reaches of the Whitemouth and Birch rivers where a corridor of row crop agriculture is found. As well, the lower portions of the Whitemouth and Birch rivers have a limited number of residential and recreational properties. Here, riparian forest cover has often been modified or removed completely.

Sampling was conducted from 16 access points spread somewhat evenly within the known range of Carmine Shiner (Macnaughton et al. 2020) (Table 1). Three additional access points including Boggy River, Winnipeg River, and Peterson Creek were selected to assess possible range expansion within southeast Manitoba (Table 1). All access points can be reached by vehicle and/or boat. The McArthur Falls range extension site on the Winnipeg River was not indicated in Macnaughton et al. (2020) as the authors of that report had in error listed an access point downstream of Great Falls Generating Station

(GS), i.e., the GS downstream of McArthur Falls GS on the Winnipeg River. Sampling was not conducted on the Winnipeg River below Great Falls GS.

2.2 Density Estimation

Depletion sampling involves iteratively removing fish in successive seine hauls at a given site. In the absence of immigration or emigration, either because animals move little or the site is blocked off, the procedure can be used to estimate cumulative abundance and density. A common methodology is the Leslie depletion (Ricker 1975), where the model assumes a linear relationship between catch per unit effort (CPUE) and cumulative catch. After fitting a linear regression to these data, the estimated total abundance is represented by the x-intercept (i.e., the initial abundance prior to seining), and the density is calculated as the initial abundance per unit area. Where no depletion was detected, density estimates were zero if no fish were captured or estimated from the first seine haul only.

2.3 Habitat and Site Descriptions

Habitat sampling and description followed the protocol outlined in Macnaughton et al. (2020). The following variables were measured at each access point: water temperature (°C), conductivity ($\mu S \cdot cm^{-1}$), turbidity (Nephelometric Turbidity Unit, NTU), and Secchi depth (m, when suitable water depth was present). Wetted and rooted width (m) of the channel were measured at each fish sampling site. At each sample site, water depth (m) was measured with a wading rod and water velocity ($m \cdot s^{-1}$) with a Marsh-McBirney Flo-Mate flow meter. Both water depth and velocity were taken at three points, each at the approximate center of the area sampled by the seine net divided into equal thirds (Figure 3). Water depth (m) was also measured at the deepest location between wetted banks. Percent substrate composition was estimated with a visual or tactile assessment within three, 1 m^2 quadrats similarly positioned at the approximate center of the area sampled by the seine net divided into equal thirds (Figure 3) using a modified Wentworth scale (Wentworth 1922). Percent macrophyte cover was recorded in the three quadrats as well (Macnaughton et al. 2020). Georeferencing and photographs were taken at each seine site.

2.4 Fish Sampling Protocol

Wadable Access Points

Fish sampling methods followed the protocol outlined in Macnaughton et al. (2020), with fish capture approved by SARA (21-PCAA-00021) and Manitoba (Scientific Collection Permit 22765468). At each access point (Table 1), three sites were sampled using a 9.14 m long by 1.8 m high seine net, with a 1.8 m by 1.8 m bag and 4.76 mm mesh. The distance between the three seine sites was 50–100 m, as determined by a random number generator. Seining followed methods outlined in Guy et al. (2009), where the net was held at one end on shore while the other end was extended upstream and then pulled in an upstream to downstream 180° arch semi-circle (area = ~100 m^2; Macnaughton et al. 2020) (Figure 3). The lead line was then pulled up quickly along the shoreline. At each of the three sample sites, three passes were made for a total of nine hauls at each access point (Macnaughton et al. 2020). Sampling began at the most downstream site and proceeded upstream. Any captured fish were retained in a separate container of river water for each seine haul. To avoid pseudoreplication, fish were released after all samples were collected. All captured fishes were identified to species and tallied separately for each seine haul. A representative

voucher specimen was retained from each access point. These specimens were preserved in ethanol for identification confirmation in the lab. Collected specimens were stored at the Freshwater Institute in Winnipeg, Manitoba. Biological data, including fork length (FL) (mm) and total length (TL) (mm) was measured for each captured Carmine Shiner. Catch per unit effort (CPUE) was calculated as the number of Carmine Shiner caught per 100 m^2, both collectively across three seine hauls at a site and separately for each haul to compare catch rates.

Non-wadable Access Points

Fish sampling was conducted by boat electrofishing at four access points that were non-wadable (Table 1). Electrofishing was conducted with a SR20-EH, GPP 5.0 (Smith-Root Inc.), dual boom electrofishing boat. Approximately 600 s of fishing effort was used at each sampled site. E-fisher settings were dependent on the conditions and water conductivity. The GPP 5.0 was fished at 50–1000 V, between 35–50% of power, and 60 pulses·s^{-1} DC. Similar to the seine sampling, all fishes captured were identified to species. A representative voucher specimen was retained from each access point. Collected specimens were preserved in ethanol and transported to the Freshwater Institute for identification and storage.

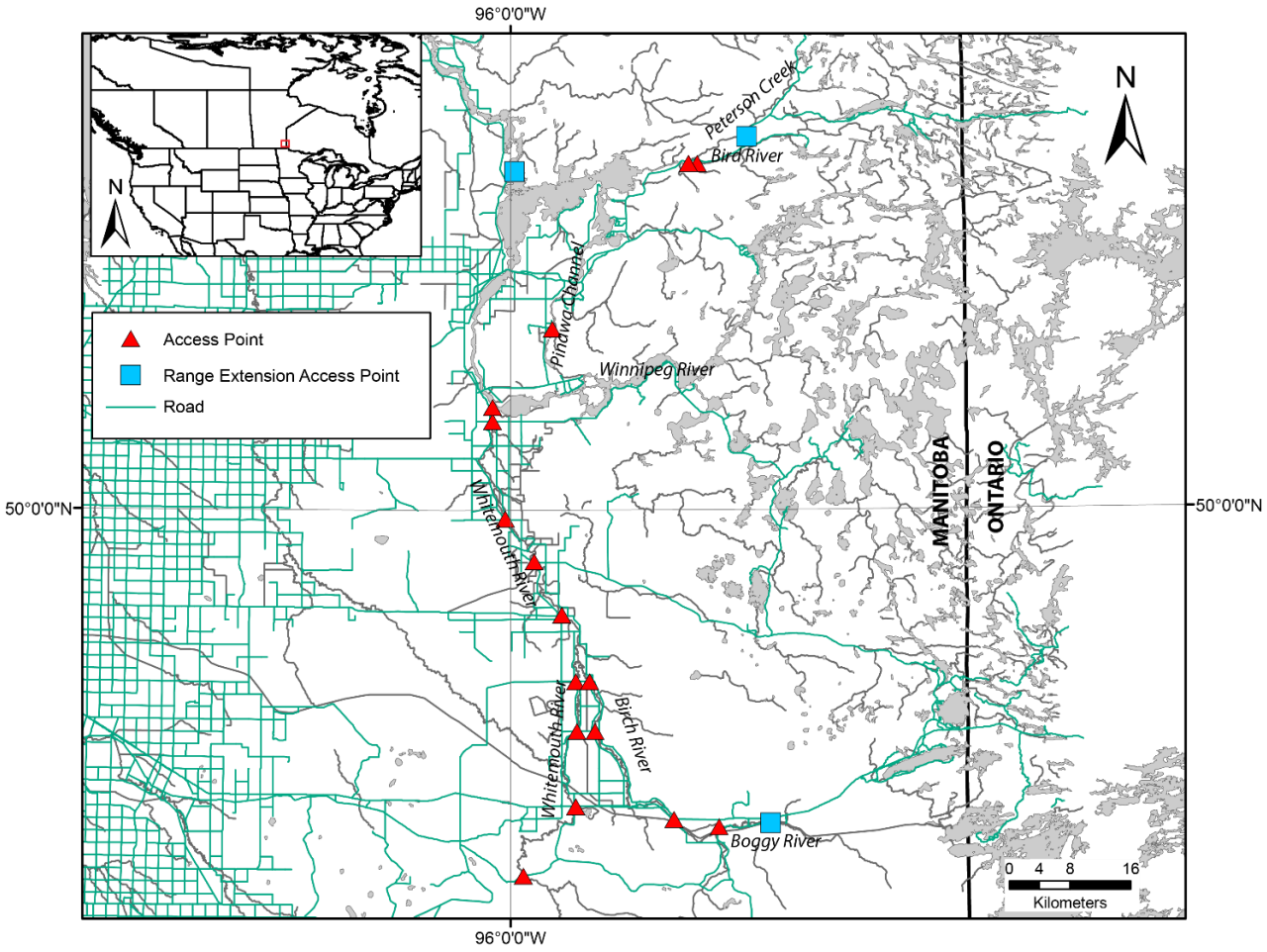

Figure 1. Map of access points sampled for Carmine Shiner in southeastern Manitoba during July 2021.

Figure 2. Photo of a Birch River site near Provincial Road 506. These conditions depict the typical riparian habitat for Carmine Shiner, with the exception that exceptionally low flows are exposing normally submerged shallow margin habitat.

Table 1. Access points sampled from roads, Provincial Roads (PR), Provincial Trunk Highways (PTH), the Trans-Canada Highway (TCH), and by boat within the known range and potential range extension sites of Carmine Shiner in Canada.

Waterbody	Access Point	Sample Gear	Date Sampled (dd/mm/yyyy)	Access Type	Latitude	Longitude
Boggy River	Wye Road	seine	09/07/2021	Range Extension	49.63065	-95.52740
Boggy River	PR 308 Crossing	seine	14/07/2021	Known Range	49.73797	-95.84641
Birch River	East of PR 506	seine	07/07/2021	Known Range	49.79760	-95.85396
Birch River	East of PR 507	seine	13/07/2021	Known Range	49.73983	-95.84765
Birch River	TCH #1 Crossing	seine	15/07/2021	Known Range	49.64891	-95.72525
Whitemouth River	PR 506 Crossing	seine	08/07/2021	Known Range	49.79854	-95.88041
Whitemouth River	PR 507 Crossing	seine	13/07/2021	Known Range	49.73950	-95.87936
Whitemouth River	End of PR 505	seine	14/07/2021	Known Range	49.56796	-95.97668
Whitemouth River	TCH #1 Crossing	seine	15/07/2021	Known Range	49.65103	-95.88203
Whitemouth River	PR 408 Crossing	seine	19/07/2021	Known Range	49.99076	-96.01005
Whitemouth River	PTH 11 at Elma	seine	19/07/2021	Known Range	49.87648	-95.91037
Whitemouth River	PTH 11 at PTH 44	seine	19/07/2021	Known Range	49.94025	-95.95704
Whitemouth River	River Hills	seine	22/07/2021	Known Range	50.07657	-96.03313
Peterson Creek	Provincial Road 315	seine	23/07/2021	Range Extension	50.48748	-95.49515
Winnipeg River	Whitemouth River confluence	seine	22/07/2021	Known Range	50.12203	-96.03570
Bird River	Bird River Falls	seine	27/07/2021	Known Range	50.41226	-95.65628
Bird River	Bird River Falls	boat e-fisher	27/07/2021	Known Range	50.41226	-95.65628
Bird River	Peterson Creek confluence	boat e-fisher	27/07/2021	Known Range	50.41226	-95.65628
Winnipeg River	Old Pinawa Dam	boat e-fisher	27/07/2021	Known Range	50.21546	-95.92346
Winnipeg River	McArthur Falls	boat e-fisher	28/07/2021	Range Extension	50.39898	-95.98708

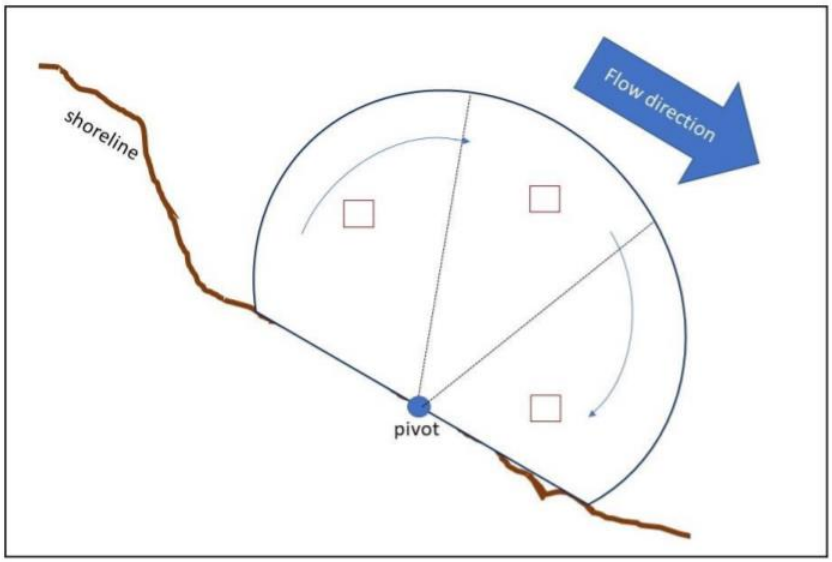

Figure 3. Schematic of the direction of seine sampling and location of survey quadrats. From Macnaughton et al. (2020).

3.0 RESULTS

3.1 Habitat

Sampling occurred during a drought period from July 7 to July 28, 2021, when flows in the Whitemouth River were <0.6 $m^3 \cdot s^{-1}$. In July, median flows in the Whitemouth River are typically ~15 $m^3 \cdot s^{-1}$ (05PH003; ECCC 2023). The observed flows were close to the historic minimum for July 7 to 15. Measurements taken July 16 to 22 established new minimum flows for this period (1942-2023) (05PH003; ECCC 2023). In the Birch River, flows were the lowest observed for the entire sample period on a recently established gauge near Prawda (2012-2023) (05PH007; ECCC 2023).

Water temperatures during sampling ranged from 21.5–26.6 °C (Table 2). Conductivity ranged from 44–475 $\mu S \cdot cm^{-1}$ with a mean of 230 $\mu S \cdot cm^{-1}$ (Table 2). The lowest conductivity levels were measured at the Bird River access points, and the highest conductivity was measured at the Whitemouth River sites (Table 2). Turbidity ranged from 1.34 NTU at Bird River Falls to 24.0 NTU at the Boggy River site at Wye Road, with a mean of 6.16 NTU (Table 2). When the Secchi distance was measured, it ranged from 0.24 m at the Boggy River site at Wye Road to 1.67 m at Bird River Falls. Wetted and channel width at seine sites in the Boggy, Birch, and Whitemouth rivers where Carmine Shiner were collected ranged from 9.4–2.3 m and 14.5–46.3 m, respectively (Table 2). Wetted and channel width were less at range expansion sites in the Boggy River and Peterson Creek and generally higher in the Winnipeg River access points. Water velocity was measured and recorded at all seine sample sites and one of the four boat e-fisher sites (Table 3). Water velocity ranged from 0–0.19 $m \cdot s^{-1}$, with a mean of 0.03 $m \cdot s^{-1}$ (Table 3). At seine sites, water depth ranged from 0.11–0.92 m, with a mean of 0.55 m (Table 3). At boat e-fisher sites, water depth ranged from 0.90–1.77 m, with a mean of 1.29 m (Table 3). Substrates ranged from clay to bedrock, with clay the highest mean substrate (26.7%) at seine sites and silt (37.0%) at boat e-fisher sites

(Table 3). At both seine and boat e-fisher sites, coarser substrates, ranging from gravels to boulders combined were the greatest component of the substrate.

Table 2. Summary of water quality variables at each access point sampled in July 2021 from roads, Provincial Roads (PR), Provincial Trunk Highways (PTH), the Trans-Canada Highway (TCH), and by boat. For the boat accessed sites, water temperature, conductivity, and turbidity were averaged across sample sites. Mean channel and wetted widths were calculated for each access point. Range extension sites are marked with an asterisk (*). NA refers to no-available data.

Waterbody	Access Point	Sample Gear	Date Sampled (dd/mm/yyyy)	Water Temperature (°C)	Conductivity ($\mu S \cdot cm^{-1}$.)	Turbidity (NTU)	Secchi(m)	Wetted Width (m)	Channel Width (m)
*Boggy River	Wye Road	seine	09/07/2021	21.7	244	24.0	0.24	9.40	12.0
Boggy River	PR 308 Crossing	seine	14/07/2021	22.4	285	11.5	0.30	10.9	14.5
Birch River	East of PR 506	seine	07/07/2021	NA	NA	NA	NA	17.1	22.5
Birch River	East of PR 507	seine	13/07/2021	25.4	292	4.40	0.29	14.8	18.7
Birch River	TCH #1 Crossing	seine	15/07/2021	24.2	205	12.2	0.64	12.9	19.3
Whitemouth River	PR 506 Crossing	seine	08/07/2021	21.5	331	3.36	0.94	18.4	22.6
Whitemouth River	PR 507 Crossing	seine	13/07/2021	24.1	348	2.63	0.65	20.7	23.1
Whitemouth River	End of PR 505	seine	14/07/2021	26.3	289	4.28	0.70	19.3	28.3
Whitemouth River	TCH #1 Crossing	seine	15/07/2021	22.2	343	1.96	0.88	20.7	24.8
Whitemouth River	PR 408 Crossing	seine	19/07/2021	26.6	323	2.36	0.80	31.6	38.2
Whitemouth River	PTH 11 at Elma	seine	19/07/2021	25.5	325	6.67	1.12	41.1	45.5
Whitemouth River	PTH 11 at PTH 44	seine	19/07/2021	25.3	329	4.16	0.86	36.4	39.9
Whitemouth River	River Hills	seine	22/07/2021	25.6	328	6.26	0.61	42.3	46.3
*Peterson Creek	Provincial Road 315	seine	23/07/2021	23.7	44	4.85	0.89	7.50	10.7
Winnipeg River	Whitemouth River confluence	seine	22/07/2021	26.4	170	4.71	0.88	140	150
Bird River	Bird River Falls	seine	27/07/2021	22.9	45	1.34	NA	18.0	23.0
Bird River	Bird River Falls	boat e-fisher	27/07/2021	25.3	43	3.22	1.67	18.0	23.0
Bird River	Peterson Creek confluence	boat e-fisher	27/07/2021	26.5	47	6.80	1.26	104	104
Winnipeg River	Old Pinawa Dam	boat e-fisher	27/07/2021	23.9	99	3.18	NA	82.0	82.0
*Winnipeg River	McArthur Falls	boat e-fisher	28/07/2021	24.2	95	6.24	1.21	$1.17 \cdot 10^3$	$1.17 \cdot 10^3$

Table 3. Mean water velocity ($m \cdot s^{-1}$), water depth (m), and substrate composition (%) at the 19 access points sampled from roads, Provincial Roads (PR), Provincial Trunk Highways (PTH), the Trans-Canada Highway (TCH), and by boat in Manitoba in July 2021. Range extension access points are marked with an asterisk (*). NA refers to no-available data.

Waterbody	Access Point	Sample Gear	Mean Water Velocity ($m \cdot s^{-1}$)	Mean Water Depth (m)	Clay (%)	Silt (%)	Sand (%)	Small Gravel (%)	Large Gravel (%)	Cobble (%)	Boulder (%)	Detritus (%)	Bedrock (%)
*Boggy R.	Wye Road	seine	0	0.65	73.3	22.2	0	3.90	0	0.6	0	0	0
Boggy R.	PR 308 Crossing	seine	0.01	0.69	49.5	20.0	0	30.5	0	0	0	0	0
Birch R.	East of PR 506	seine	0	0.32	0	0	20.0	27.5	28.4	20.9	3.3	0	0
Birch R.	East of PR 507	seine	0.02	0.38	75.5	0.1	11.1	13.3	0	0	0	0	0
Birch R.	TCH #1 Crossing	seine	0.02	0.48	0	2.8	11.1	27.8	11.1	25.0	0	0	22.2
Whitemouth R.	PR 506 Crossing	seine	0.19	0.44	2.2	0	40.6	13.9	13.3	26.7	3.3	0	0
Whitemouth R.	PR 507 Crossing	seine	0.07	0.39	16.3	0	18.3	27.2	24.8	8.9	4.4	0	0
Whitemouth R.	End of PR 505	seine	0.04	0.59	0	0	23.9	22.2	23.3	13.9	16.7	0	0
Whitemouth R.	TCH #1 Crossing	seine	0.03	0.70	17.2	36.1	35.0	11.7	0	0	0	0	0
Whitemouth R.	PR 408 Crossing	seine	0.02	0.53	15.0	6.7	12.8	18.3	13.3	21.1	12.8	0	0
Whitemouth R.	PTH 11 at Elma	seine	0.01	0.58	0	12.8	27.8	20.0	15.5	12.2	11.7	0	0
Whitemouth R.	PTH 11 at PTH 44	seine	0.01	0.46	3.9	9.4	13.9	13.9	16.1	38.3	4.4	0	0
Whitemouth R.	River Hills	seine	0.01	0.92	76.7	3.3	10.0	6.1	2.2	1.1	0.6	0	0
*Peterson C.	Provincial Road 315	seine	0	0.82	26.9	25.3	1.10	0	0	0	0	46.7	0
Winnipeg R.	Whitemouth River confluence	seine	0.01	0.80	70.5	0	6.1	2.2	7.2	0	2.8	0	11.1
Bird R.	Bird River Falls	seine	0.04	0.11	0	0	3.3	1.7	3.3	56.7	35.0	0	0
	Mean	seine	0.03	0.55	26.7	8.7	14.7	15.0	9.9	14.1	5.9	2.9	2.1
Bird R.	Bird River Falls	boat e-fisher	NA	1.50	0	50.0	2.5	2.5	0	30.0	15.0	0	0
Bird R.	Peterson Creek confluence	boat e-fisher	NA	1.00	0	80.0	0	0	0	10.0	10.0	0	0
Winnipeg R.	Old Pinawa Dam	boat e-fisher	NA	0.90	0	0	0	0	0	50.0	50.0	0	0
*Winnipeg R.	McArthur Falls	boat e-fisher	NA	1.77	0	18.0	12.0	4.0	4.0	12.0	19.0	8.0	23.0
	Mean	boat e-fisher	NA	1.29	0	37.0	3.6	1.6	1.0	25.5	23.5	2.0	5.8

3.2 Fish Abundance and Distribution

Seining or boat e-fishing across the 19 access points resulted in 17,120 fish captures represented by 34 species as well as unidentified ammocetes (*Ichthyomyzon spp.*) and sculpins (*Cottus spp.*). (Table 4). The most abundant species was the Common Shiner (*Luxilus cornutus*; n = 6,916), followed by the Carmine Shiner (n = 2,819). Carmine Shiner were collected at all 16 access points within their previously known range, as well as one of the three range extension access points (n = 3, McArthur Falls, Table 4). The largest catches of Carmine Shiner occurred in the Whitemouth River at Provincial Road 408 (n = 381) and in the Birch River East of Provincial Road 506 (n = 364; Table 4). Carmine Shiner typically co-occurred with Common Shiner, Hornyhead Chub (*Nocomis biguttatus*), White Sucker (*Catostomus commersonii*), Rock Bass (*Ambloplites rupestris*), Johnny Darter (*Etheostoma nigrum*), and Blackside Darter (*Percina maculata*).

All access points sampled via seine were fished at three sites with the exception of the Bird River Falls access point where only one site was sampled, as high-water velocity, coarse substrate, and deep water in that reach of the Bird River did not allow for seining at any other sites. The mean CPUE for Carmine Shiner for single seine hauls at a site was 0.20 fish·m^{-2}, with a maximum of 1.17 fish·m^{-2} from Birch River East of Provincial Road 506 (Table A2).

The boat electrofishing sampling effort was ~600 sec at each of the 11 sites electrofished, with the number of sites sampled at an access point ranging from one to seven (Table A2). The mean Carmine Shiner CPUE at electrofished sites was 0.18 fish·min^{-1}, with a maximum CPUE of 1.30 fish·min^{-1} at the Old Pinawa Dam.

CPUE typically declined with each successive seine haul (Figure 5). No depletion was detected at 17 sites (17/43, 39%). Based on the Leslie method and estimated density from the first seine haul when no depletion was detected, the average Carmine Shiner density was 1.0 fish·$m^{-2\ Leslie}$. Maximum density was 8.9 fish·$m^{-2\ Leslie}$, which occurred at Birch River, East of PR 506 (Table A2). Of the 2,819 Carmine Shiner collected, 33 escaped during handling. The remaining 2,786 were measured for FL and TL. Carmine Shiner had a mean FL of 41.7 mm, ranging from 15 to 68 mm (Figure 4). The largest individual was collected from McArthur Falls (FL = 68 mm), and the smallest individual was caught in the Whitemouth River at the Provincial Road 408 (FL = 15 mm, Figures A1). Carmine Shiner had a mean TL of 45.3 mm, ranging from 17 to 73 mm. The largest individual was collected from the Whitemouth River at Provincial Road 507 (TL = 73 mm). The smallest individual was caught in the Whitemouth River at Provincial Road 408 (FL = 17 mm, Figures A1). The FL of Carmine Shiner at Boggy Creek (PR 308 Crossing), Bird River (Bird River Falls), Bird River (Peterson Creek confluence), and the Winnipeg River (McArthur Falls) were 41; 56, 59; 56, 56; and 42, 44, 68 mm, respectively. Length frequency for FL of Carmine Shiner was generally centered around the mean (Figures A1-A3). FL versus TL followed a linear relationship ($y = 0.9132x + 0.3692$; $R^2 = 0.9836$). Frequency distributions of FL was strongly unimodal near the mean at most access points, with the exception of River Hills, where a bimodal distribution was observed (FL =16–32 mm and 38–50 mm, Figures A1-A6). Carmine Shiner were not specifically accessed for sexual maturity during sampling; however, sex was noted when fish were freely releasing gametes during handling. Thirty-six females and 18 males were noted as mature, with mature individuals noted from the first to the last day of sampling (July 7, 2021 to July 27, 2021). Mature females' mean FL was 55.5 mm (range 38 to 65 mm), with a mean TL of 60.5 mm (range 42 to 71 mm). Mature male mean FL was 50.3 mm (range 38 to 67 mm), with a mean TL of 54.5 mm (range 42 to 73 mm).

Table 4. Total catch per species at the 19 access points sampled from roads, Provincial Roads (PR), Provincial Trunk Highways (PTH), the Trans-Canada Highway (TCH), and by boat in Manitoba in July 2021. Range extension sites are marked with an asterisk (*).

Waterbody	Access Point	Sample Gear	Effort (m^2 or ^{s})	Black Crappie	Blackchin Shiner	Blacknose Shiner	Blackside Darter	Brook Stickleback	Burbot	Carmine Shiner	Central Mudminnow	Common Shiner	Emerald Shiner	Fathead Minnow	Finescale Dace	Golden Shiner	Hornyhead Chub	Iowa Darter	Johnny Darter	Larval lamprey	Logperch	Longnose Dace	Mimic Shiner	Mooneye	Mottled Sculpin	Northern Pearl Dace	Northern Pike	Northern Redbelly Dace	River Darter	Rock Bass	Sculpin unknown	Shorthead Redhorse	Silver Redhorse	Smallmouth Bass	Spottail Shiner	Walleye	Weed Shiner	White Sucker	Yellow Perch
*Boggy R.	Wye Road	seine	300				17	202			10	488		6	2				1			1				732		216									180	
Boggy R.	PR 308 Crossing	seine	300			7	10	21		1		874			1		5	2	3	1						20		1		162			2				183	
Birch R.	East of PR 506	seine	300				3			364		278					10		1								1										1	
Birch R.	East of PR 507	seine	300				23			184		130					3		26	1				4								1					5	
Birch R.	TCH #1 Crossing	seine	300			1	25	1		41	4	1570		1			39		2			14				14				37			2				66	
Whitemouth R.	PR 506 Crossing	seine	300				14			367		159							1			2								4							8	
Whitemouth R.	PR 507 Crossing	seine	300				1			233		313					20													1							3	
Whitemouth R.	End of PR 505	seine	300				10			175		480					21	2	7	1		6				1				50					1	1	
Whitemouth R.	TCH #1 Crossing	seine	300				12			219	1	32					47		28	1										34							35	
Whitemouth R.	PTH 11 at Elma	seine	300				6			307		166				5			12		2						1			18		1	5				1	
Whitemouth R.	PTH 11 at PTH 44	seine	300				4			222		320					48		1		1									5			3				2	
Whitemouth R.	PR 408 Crossing	seine	300				18			381		644					50		2														3					
Whitemouth R.	River Hills	seine	300							283		1320					1													43								
*Peterson Creek	Provincial Road 315	seine	300			163		724			19			1	58											12		1119									2	6
Winnipeg R.	Whitemouth River confluence	seine	300		1		10			22		142						3		59		56		1			2			444			9	11	27		122	567
Bird R.	Bird River Falls	seine	100															1																				1
Bird R.	Bird River Falls	boat e-fisher	1200	2					1	2			3			3		3			14		3					19				1	4					37
Bird R.	Peterson Creek confluence	boat e-fisher	600	2						2			60					2					3					1										85
Winnipeg R.	Old Pinawa Dam	boat e-fisher	600							13									2		9		2				2			5			16	4				3
*Winnipeg R.	McArthur Falls	boat e-fisher	4219	9	2	21				3			19	2		2			9		6		31	1			5			14	2			13	14	2	20	29	866
	Total			13	3	192	153	948	1	2819	34	6916	82	10	61	10	247	10	154	4	88	23	40	1	4	779	11	1336	20	817	2	1	42	32	41	3	20	638	1565

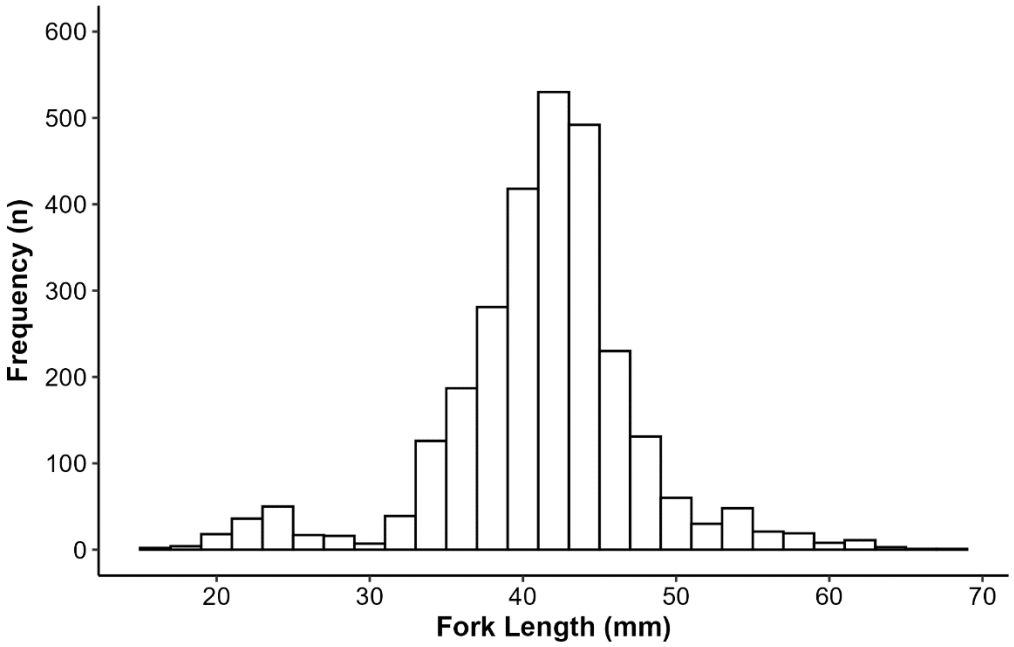

Figure 4. Frequency distribution of Carmine Shiner fork length (mm) (n = 2,786).

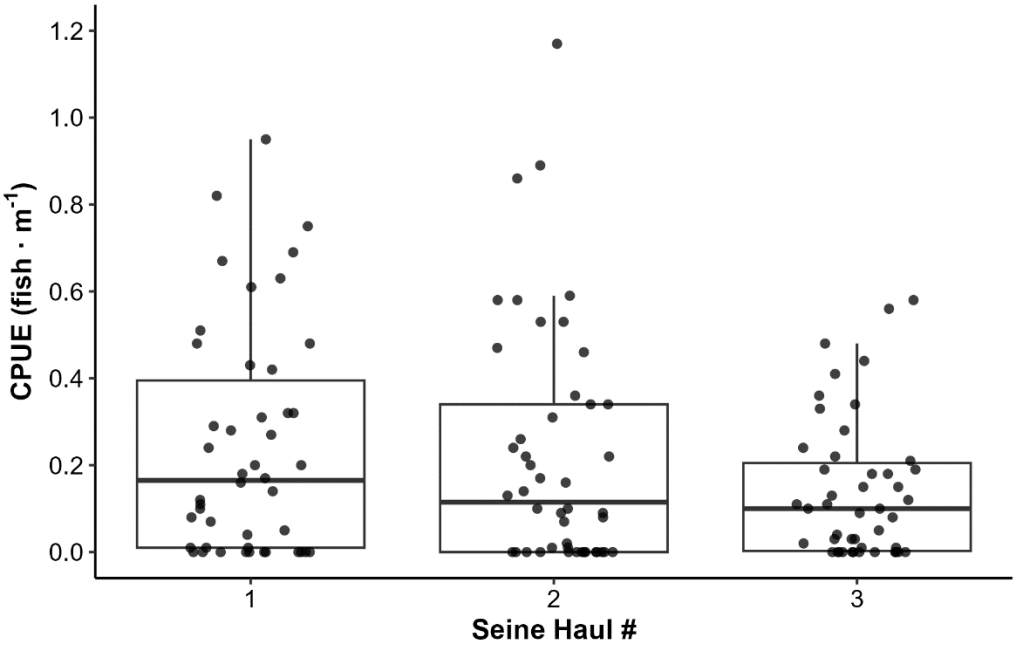

Figure 5. Catch per unit effort (CPUE) of Carmine Shiner in each of three seine hauls conducted at each sample site.

4.0 DISCUSSION

Carmine Shiner were present throughout all 16 access points sampled within the known species distribution in the Winnipeg, Whitemouth, Boggy, Birch, and Bird rivers, as well as a new distribution record on the Winnipeg River downstream of McArthur Falls (Table 2). The highest catches of Carmine

Shiner were obtained by seining (Table 3). Seining and e-fishing were not used at the same access point, except at Bird River Falls. Here, no Carmine Shiner were captured by seining; however, two specimens were captured by boat electrofishing (Table 3).

Rather than representing a range expansion per se, the three Carmine Shiner captured below McArthur Falls likely represent a population that has not previously been sampled. As far as records seem to indicate, no scientific sampling for small-bodied fish had previously been conducted in this reach of the Winnipeg River. This population is isolated from the other Carmine Shiner in Canada, with only downstream movement possible because McArthur Falls GS has no upstream fish passage structure. The new distribution record indicates that sampling should be extended downstream on the Winnipeg River to below Great Falls GS. Located ~8 river kilometers downstream of McArthur Falls GS, Great Falls GS also has no upstream fish passage structure. Sampling upstream on the Winnipeg River should also be considered, as the possibility exists that Carmine Shiner are distributed elsewhere in the Winnipeg River or its tributaries.

Sampling conducted in 2021 generally had high CPUE throughout the range of Carmine Shiner in Canada. It is possible to compare sampling conducted in the Birch River in 2021 to surveys completed with the same methods in the Birch River from June 6 to October 27, 2011 (Macnaughton et al. 2020). In 2011, the mean Carmine Shiner CPUE was 0.020 fish$\cdot m^{-2}$ across all months compared to 0.068 fish$\cdot m^{-2}$ in July 2021. The differences in catch rates between 2011 and 2021 may be a result of the timing of sampling and the sites sampled. Restricting the 2011 sampling to the same period as 2021 (July) and sample sites in the Birch River, the mean CPUE was 0.073 fish$\cdot m^{-2}$ in 2021 and 0.007 fish$\cdot m^{-2}$ in 2011. This order of magnitude difference in CPUE is likely influenced by habitat conditions, such as flow and water depth, which influence seine net capture efficiency (Guy et al. 2009). The flows in July of 2011 (~6 $m^3 \cdot s^{-1}$) were also an order of magnitude higher than in 2021 (<0.6 $m^3 \cdot s^{-1}$). The July 2021 flow was near the historic low, which improved catchability for all fish species, as seining was conducted in easily wadable waters. Additionally, the sampling team could see and avoid underwater hazards (e.g., rocks and trees) during site selection in 2021. Low flows further reduced wetted area and water depth, which increased densities of all fishes by concentrating fish into a smaller volume of water (Figure 2). Despite differences in sampling conditions between years, the substantially higher CPUE in 2021 suggests that Carmine Shiner's abundance may have been higher in 2021 than in 2011.

Overall, the sample protocol was effective at determining Carmine Shiner distribution and relative abundance across the species range in Canada. The size of Carmine Shiner collected in 2021 would suggest most fish were aged 1+ (Figure 4). Young-of-the-year fish first appeared on July 19th at the three access points sampled that day in the Whitemouth River, and by the last day of sampling on July 22nd, they were abundant at the Whitemouth River, River Hills access point. The measured FL resulted in a bimodal size distribution (Figure 1A) for River Hills. This suggests YOY from 2021 were beginning to recruit to the gear by the end of the sample period. The majority of the catch in 2011 was young of the year (YOY) Carmine Shiner collected in late summer and early fall (Macnaughton et al. 2020). It appears that the catch in 2021 would have been higher if sampling was conducted later in the year and YOY fish were large enough to be captured by the 4.76 mm mesh of the seine.

The Macnaughton et al. (2020) protocol proposed conducting three seine hauls within the same area. However, density could not be estimated by the Leslie method at seven sites with greater than zero catch, indicating that immigration and emigration likely occurred between seines. In these cases, the second and third seine hauls are not as representative of the density as the first, rendering the depletion method unreliable without greater effort. Given that the first haul generally collected the most fish (Figure 5), future sampling could be limited to one haul to reduce sampling and handling time for fish.

5.0 REFERENCES

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6.0 APPENDICES

Table A1. Species common names and genus and species names of fishes collected during the sampling.

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Blackchin Shiner	*Miniellus heterodon*
Blacknose Shiner	*Notropis heterolepis*
Blackside Darter	*Percina maculata*
Brook Stickleback	*Culaea inconstans*
Burbot	*Lota lota*
Carmine Shiner	*Notropis percobromus*
Central Mudminnow	*Umbra limi*
Common Shiner	*Luxilus cornutus*
Emerald Shiner	*Notropis atherinoides*
Fathead Minnow	*Pimephales promelas*
Finescale Dace	*Chrosomus neogaeus*
Golden Shiner	*Notemigonus crysoleucas*
Hornyhead Chub	*Nocomis biguttatus*
Iowa Darter	*Etheostoma exile*
Johnny Darter	*Etheostoma nigrum*
Larval lamprey	*Ichthyomyzon spp.*
Logperch	*Percina caprodes*
Longnose Dace	*Rhinichthys cataractae*
Mimic Shiner	*Paranotropis volucellus*
Mooneye	*Hiodon tergisus*
Mottled Sculpin	*Cottus bairdii*
Northern Pearl Dace	*Margariscus nachtriebi*
Northern Pike	*Esox lucius*
Northern Redbelly Dace	*Chrosomus eos*
River Darter	*Percina shumardi*
Rock Bass	*Ambloplites rupestris*
Sculpin unknown	*Cottus sp.*
Shorthead Redhorse	*Moxostoma macrolepidotum*
Silver Redhorse	*Moxostoma anisurum*
Smallmouth Bass	*Micropterus dolomieu*
Spottail Shiner	*Notropis hudsonius*
Walleye	*Sander vitreus*
Weed Shiner	*Alburnops texanus*
White Sucker	*Catostomus commersonii*
Yellow Perch	*Perca flavescens*

Table A2. Total effort (m^2 or min), catch per unit effort (fish·m^{-2} or fish·min^{-1}), and density (fish·m^{-2}) for each seine site or electrofishing pass at each of the 19 access points sampled from roads, Provincial Roads (PR), Provincial Trunk Highways (PTH), the Trans-Canada Highway (TCH), and by boat. For access points sampled with seine nets estimated density is either zero where no catch was recorded, calculated from the Leslie method, or based on the first seine haul if depletion was not detected (**). Range extension sites are marked with one asterisk (*).

Waterbody	Access Point	Sample Gear	Effort (m^2 or min)	Site	Seine pull	Carmine Shiner (n)	CPUE	Cumulative Catch (n)	Estimated Density (fish·m^{-2})
*Boggy R.	Wye Road	seine	100	1	1	0	0	0	
		seine	100	1	2	0	0	0	
		seine	100	1	3	0	0	0	0
		seine	100	2	1	0	0	0	
		seine	100	2	2	0	0	0	
		seine	100	2	3	0	0	0	0
		seine	100	3	1	0	0	0	
		seine	100	3	2	0	0	0	
		seine	100	3	3	0	0	0	0
Boggy R.	PR 308 Crossing	seine	100	1	1	0	0	0	
		seine	100	1	2	0	0	0	
		seine	100	1	3	0	0	0	0
		seine	100	2	1	0	0	0	
		seine	100	2	2	0	0	0	
		seine	100	2	3	0	0	0	0
		seine	100	3	1	1	0.01	1	
		seine	100	3	2	0	0	1	
		seine	100	3	3	0	0	1	0.01
Birch R.	TCH #1 Crossing	seine	100	1	1	1	0.01	1	
		seine	100	1	2	7	0.07	8	
		seine	100	1	3	3	0.03	11	0.727
		seine	100	2	1	1	0.01	1	
		seine	100	2	2	0	0	1	
		seine	100	2	3	0	0	1	0.01
		seine	100	3	1	8	0.08	8	
		seine	100	3	2	13	0.13	21	
		seine	100	3	3	8	0.08	29	2.703
Birch R.	East of PR 507	seine	100	1	1	32	0.32	32	
		seine	100	1	2	26	0.26	58	
		seine	100	1	3	28	0.28	86	4.202
		seine	100	2	1	5	0.05	5	
		seine	100	2	2	10	0.1	15	
		seine	100	2	3	22	0.22	37	0.05**
		seine	100	3	1	48	0.48	48	
		seine	100	3	2	9	0.09	57	
		seine	100	3	3	4	0.04	61	0.609
		seine	100	1	1	67	0.67	67	
		seine	100	1	2	117	1.17	184	
		seine	100	1	3	58	0.58	242	8.895
		seine	100	2	1	24	0.24	24	
		seine	100	2	2	17	0.17	41	
		seine	100	2	3	10	0.1	51	0.719
		seine	100	3	1	28	0.28	28	
		seine	100	3	2	34	0.34	62	
		seine	100	3	3	9	0.09	71	1.036

Table A2 Cont'd

Waterbody	Access Point	Sample Gear	Effort (m^2 or min)	Site	Seine pull	Carmine Shiner (n)	CPUE	Cumulative Catch (n)	Estimated Density (fish·m^{-2})
Whitemouth R.	End of PR 505	seine	100	1	1	12	0.12	12	
		seine	100	1	2	8	0.08	20	
		seine	100	1	3	12	0.12	32	4.16
		seine	100	2	1	63	0.63	63	
		seine	100	2	2	53	0.53	116	
		seine	100	2	3	5	0.05	121	1.421
		seine	100	3	1	20	0.2	20	

		seine	100	3	2	0	0	20	
		seine	100	3	3	3	0.03	23	0.216
Whitemouth R.	TCH #1 Crossing	seine	100	1	1	43	0.43	43	
		seine	100	1	2	10	0.1	53	
		seine	100	1	3	19	0.19	72	0.759
		seine	100	2	1	29	0.29	29	
		seine	100	2	2	22	0.22	51	
		seine	100	2	3	18	0.18	69	1.327
		seine	100	3	1	14	0.14	14	
		seine	100	3	2	31	0.31	45	
		seine	100	3	3	33	0.33	78	0.14**
Whitemouth R.	PR 507 Crossing	seine	100	1	1	18	0.18	18	
		seine	100	1	2	0	0	18	
		seine	100	1	3	34	0.34	52	3.24
		seine	100	2	1	7	0.07	7	
		seine	100	2	2	47	0.47	54	
		seine	100	2	3	3	0.03	57	0.694
		seine	100	3	1	11	0.11	11	
		seine	100	3	2	89	0.89	100	
		seine	100	3	3	24	0.24	124	2.426
Whitemouth R.	PR 506 Crossing	seine	100	1	1	61	0.61	61	
		seine	100	1	2	34	0.34	95	
		seine	100	1	3	19	0.19	114	1.379
		seine	100	2	1	95	0.95	95	
		seine	100	2	2	14	0.14	109	
		seine	100	2	3	21	0.21	130	1.264
		seine	100	3	1	69	0.69	69	
		seine	100	3	2	36	0.36	105	
		seine	100	3	3	18	0.18	123	1.426
Whitemouth R.	PTH 11 at Elma	seine	100	1	1	10	0.1	10	
		seine	100	1	2	9	0.09	19	
		seine	100	1	3	48	0.48	67	0.1**
		seine	100	2	1	4	0.04	4	
		seine	100	2	2	86	0.86	90	
		seine	100	2	3	11	0.11	101	1.264
		seine	100	3	1	42	0.42	42	
		seine	100	3	2	53	0.53	95	
		seine	100	3	3	44	0.44	139	0.42**
Whitemouth R.	PTH 11 & PTH 44 Crossing	seine	100	1	1	17	0.17	17	
		seine	100	1	2	16	0.16	33	
		seine	100	1	3	1	0.01	34	0.403
		seine	100	2	1	48	0.48	48	
		seine	100	2	2	2	0.02	50	
		seine	100	2	3	13	0.13	63	0.583
		seine	100	3	1	31	0.31	31	
		seine	100	3	2	58	0.58	89	
		seine	100	3	3	36	0.36	125	0.31**

Table A2 Cont'd

Waterbody	Access Point	Sample Gear	Effort (m^2 or min)	Site	Seine pull	Carmine Shiner (n)	CPUE	Cumulative Catch (n)	Estimated Density (fish·m^{-2})
Whitemouth R.	PR 408 Crossing	seine	100	1	1	27	0.27	27	
		seine	100	1	2	58	0.58	85	
		seine	100	1	3	15	0.15	100	1.783
		seine	100	2	1	32	0.32	32	
		seine	100	2	2	46	0.46	78	
		seine	100	2	3	56	0.56	134	0.32**
		seine	100	3	1	82	0.82	82	
		seine	100	3	2	24	0.24	106	
		seine	100	3	3	41	0.41	147	1.671
Whitemouth R.	River Hills	seine	100	1	1	20	0.2	20	
		seine	100	1	2	22	0.22	42	
		seine	100	1	3	11	0.11	53	1.013
		seine	100	2	1	75	0.75	75	

		seine	100	2	2	20	0.2	95	
		seine	100	2	3	10	0.1	105	1.068
		seine	100	3	1	51	0.51	51	
		seine	100	3	2	59	0.59	110	
		seine	100	3	3	15	0.15	125	1.769
*Peterson C.	PR 315	seine	100	1	1	0	0	0	
		seine	100	1	2	0	0	0	
		seine	100	1	3	0	0	0	0
		seine	100	2	1	0	0	0	
		seine	100	2	2	0	0	0	
		seine	100	2	3	0	0	0	0
		seine	100	3	1	0	0	0	
		seine	100	3	2	0	0	0	
		seine	100	3	3	0	0	0	0
Bird R.	Bird River Falls	seine	100	1	1	0	0	0	
		seine	100	1	2	0	0	0	
		seine	100	1	3	0	0	0	0
Winnipeg R.	Whitemouth Falls	seine	100	1	1	16	0.16	16	
		seine	100	1	2	1	0.01	17	
		seine	100	1	3	2	0.02	19	0.182
		seine	100	2	1	0	0	0	
		seine	100	2	2	1	0.01	1	
		seine	100	2	3	1	0.01	2	0.01**
		seine	100	3	1	0	0	0	
		seine	100	3	2	0	0	0	
		seine	100	3	3	0	0	0	0
	Mean					20.3	0.20	43.9	1.05
	Maximum					117	1.17	242	8.90

Table A2 Cont'd

Waterbody	Access Point	Sample Gear	Effort (m^2 or min)	Site	Seine pull	Carmine Shiner (n)	CPUE	Cumulative Catch (n)	Estimated Density (fish·m^{-2})
Bird R.	Peterson Creek confluence	efish	10	1		2	0.2		
Bird R.	Bird River Falls	efish	10	1		2	0.2		
		efish	10	2		0	0		
Winnipeg R.	Old Pinawa Dam	efish	10	1		13	1.3		
*Winnipeg R.	McArthur Falls	efish	10.3	1		0	0		
		efish	10	2		0	0		
		efish	10	3		0	0		
		efish	10	4		0	0		
		efish	10	5		0	0		
		efish	10	6		0	0		
		efish	10	7		3	0.3		
	Mean					1.8	0.18		
	Maximum					13	1.3		

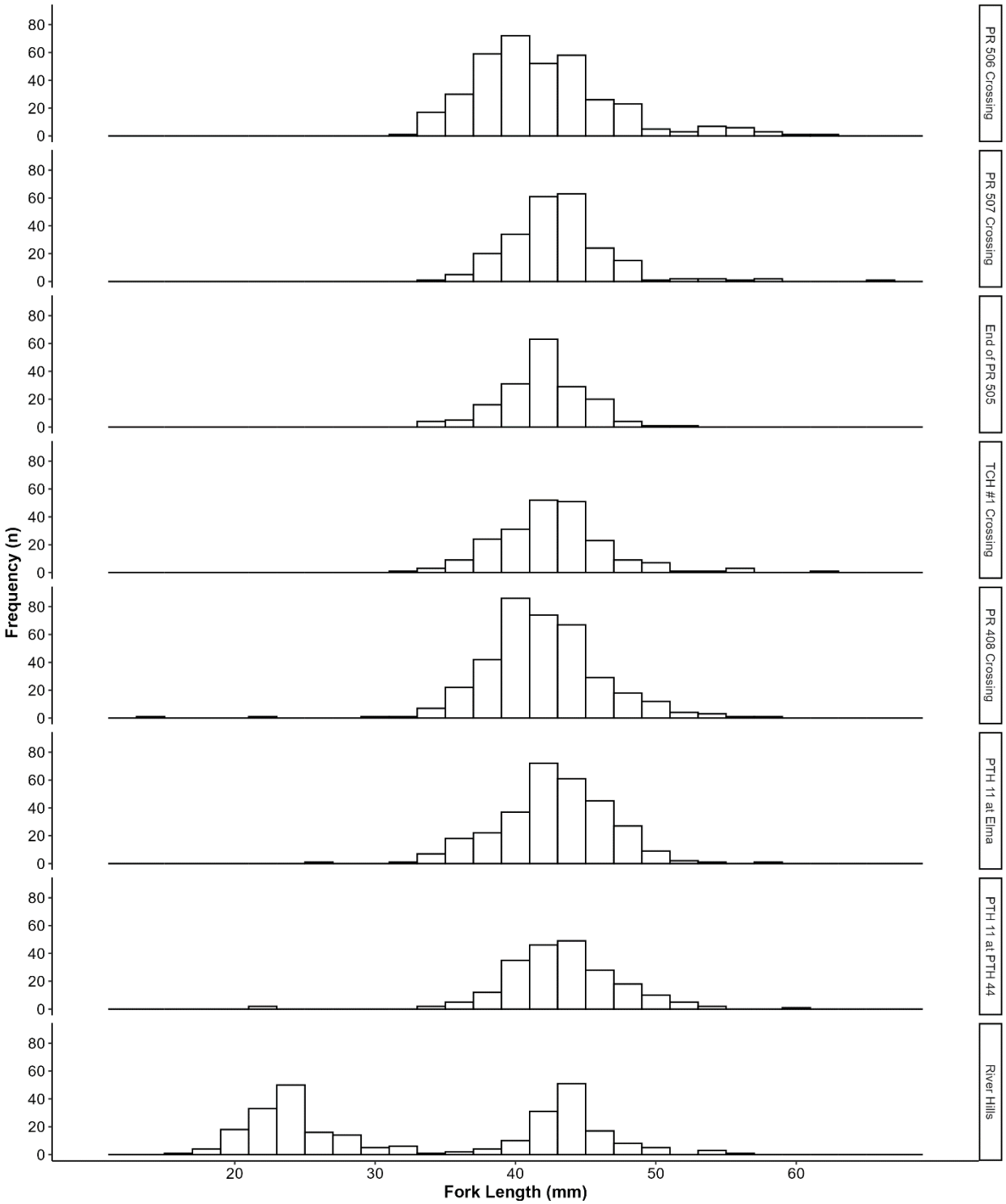

Figure A1. Frequency distribution of the fork length (mm) of Carmine Shiner at the eight access points where they were sampled in the Whitemouth River (seine; n = 2,155).

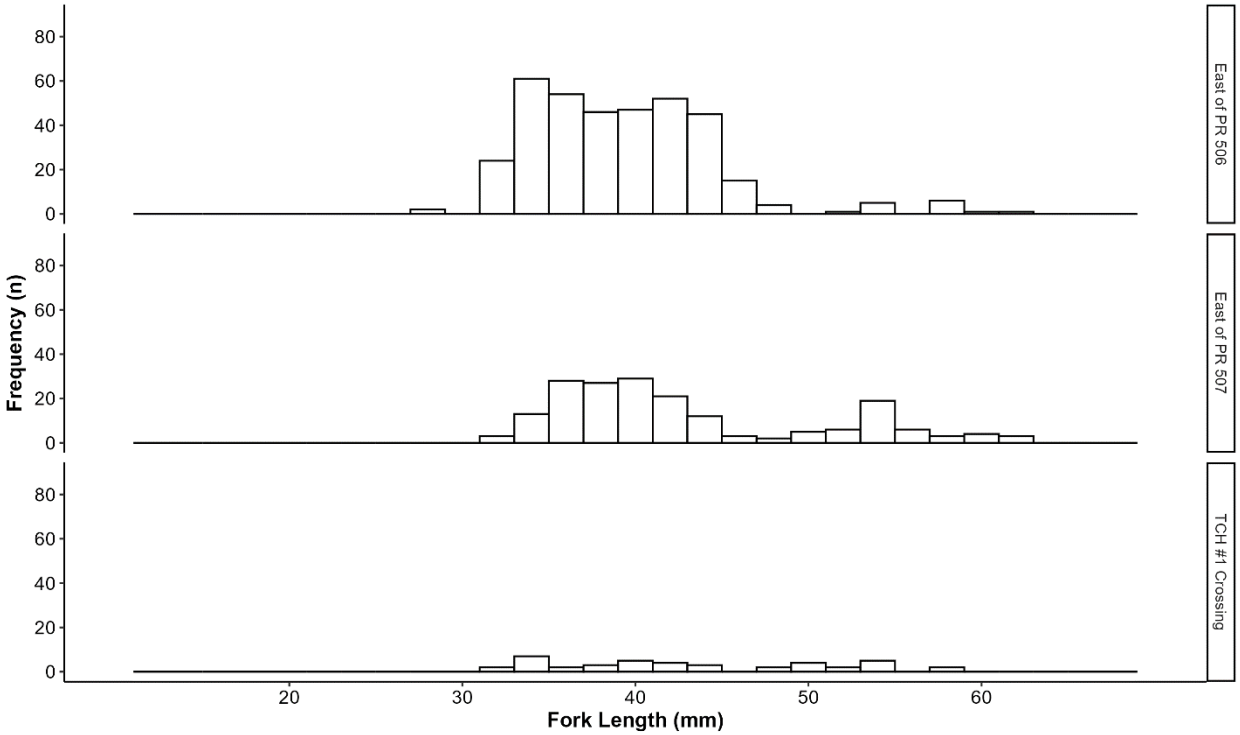

Figure A2. Frequency distribution of the fork length (mm) of Carmine Shiner at the three access points where they were sampled in the Birch River (seine; n = 589).

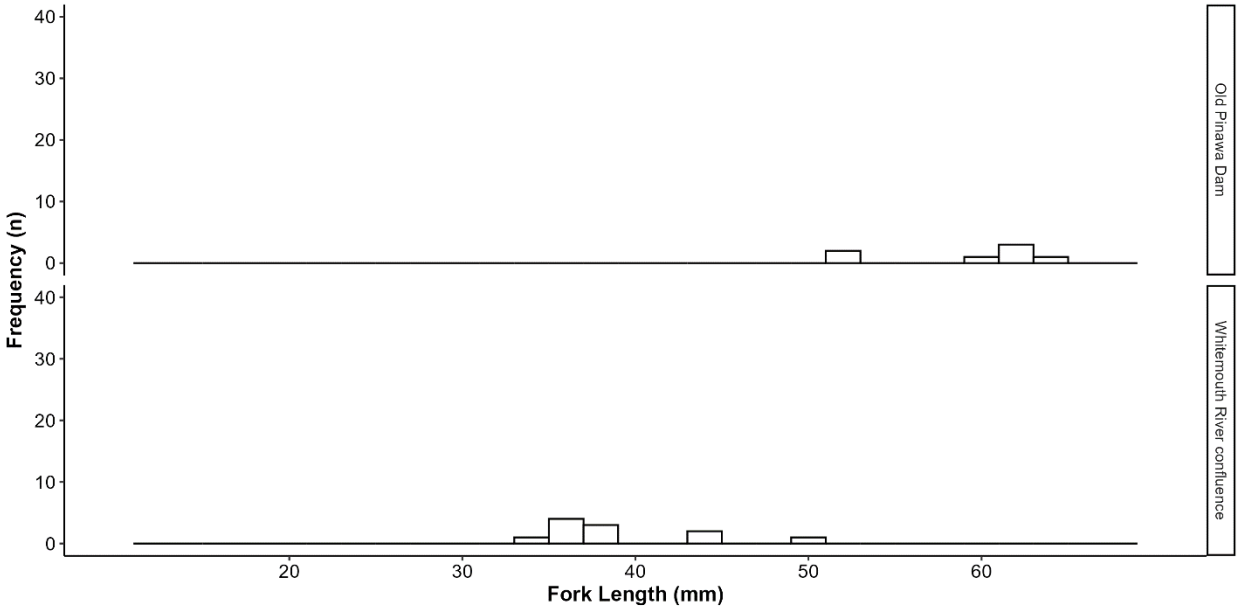

Figure A3. Frequency distribution of the fork length (mm) of Carmine Shiner at the access point downstream of the Whitemouth River confluence on the Winnipeg River (seine; n = 21) and Pinawa Channel sampled downstream of the Old Pinawa Dam (boat e-fisher; n = 13).