

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

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**Pickering Nuclear Generating Station
2020 Impingement Monitoring Report****P-REP-07263-00014-R000**

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Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 2 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

Table of Contents

	Page
List of Tables and Figures	4
Revision Summary.....	5
Executive Summary	6
1.0 INTRODUCTION.....	7
2.0 IMPINGEMENT AVOIDANCE AND MITIGATION MEASURES	7
2.1 Fish Diversion System	7
2.1.1 Design and Design Modifications	7
2.1.2 Installation and Removal	7
2.1.3 Operations and Maintenance	8
2.1.4 Functionality and Performance	8
3.0 IMPINGEMENT MONITORING	12
3.1 Monitoring Effort.....	12
3.2 Unit Operating Status and Intake Volume	14
3.3 Data Quality Management	15
3.3.1 Atypical Impingement Volumes that were Potential Data Outliers	16
3.4 Impingement Estimate	16
4.0 2020 FISH IMPINGEMENT.....	17
4.1 All Species and Life Stages	17
4.2 Species Impinged in 2020 to be Included in Age-1 Equivalency Estimates.....	21
4.3 Regulated and Other Aquatic Invasive Fish and Mussel Species.....	21
4.4 Species at Risk Act Schedule 1 Fish Species.....	22
4.5 Endangered Species Act Species at Risk in Ontario List fish species	22
4.6 Northern Pike	22
4.7 Episodic Fish Kill Events	23
5.0 IMPINGEMENT TRENDS	23
5.1 Comparison with FAA Impingement Predictions	23
5.2 Trends	23
6.0 UNCERTAINTY	23

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 3 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

7.0	CONCLUSION	25
8.0	REFERENCES.....	26
	Appendix A: Management of Bin Outliers in Fish Impingement Database	27
	Appendix B: Estimation of Annual Impingement	30

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 4 of 30
Title: Pickering Nuclear Generating Station 2020 Impingement Monitoring Report		

List of Tables and Figures

Page

Figure 1: Daily average depth of FDS float lines on the East facing aspect.	11
Figure 2: Daily average depth of FDS float lines on the South facing aspect.	11
Figure 3: Daily average depth of FDS float lines on the West facing aspect.	11
Figure 4: Annual cumulative biomass (kg) of fish of all species and ages impinged from 2015-2020....	18
Table 1: Fraction of week that each aspect of the FDS secondary skirt was at the surface or not greater than 30 cm below the surface from June to November 2020.	9
Table 2: Time frequency that primary and secondary float lines were in individual depth ranges based on depth logger data.	12
Table 3: Comparison of yearly impingement monitoring effort during different monitoring periods.....	14
Table 4: CCW operating status in 2020.Unit.....	15
Table 5: Individual bins identified as having count or biomass estimates that were potential data outliers.	16
Table 6: Monthly biomass and annual fish impinged (kg) at Pickering Nuclear Generating Station in 2020.	19
Table 7: Number of fish impinged at Pickering Nuclear Generating Station in 2020.	20
Table 8: Impinged biomass, intake volume and impingement rate by volume.	21
Table 9: Number and biomass in Northern Pike impinged in 2010-2020.	22

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 5 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

Revision Summary

Revision Number	Date	Comments
R000	2021-02-08	Initial issue.

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 6 of 30

Title: Pickering Nuclear Generating Station 2020 Impingement Monitoring Report
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Executive Summary

This report documents outcomes of impingement mitigation measures and impingement monitoring for the 2020 calendar year. The report satisfies both condition 3.1 and condition 3.2.1 of the *Fisheries Act* Authorization for the Ontario Power Generation (OPG) Pickering Nuclear Generating Station (PNGS), which was issued in January 2018.

The primary measure to avoid or mitigate fish impingement at PNGS is the Fish Diversion System (FDS). The FDS is a net comprised of 20 mesh panels that extend from the lake bottom to the water surface and encompass the intake. Connected, the FDS panels have a combined length of 610 m. Primary and secondary skirts are attached to the main net and are designed to deploy if the float line of the main net sinks or is pulled beneath the surface. The FDS was in place and functioning from May 12 to November 7, 2020.

Consistent with prior years, depth loggers, recording instantaneous depth at 15-minute intervals, were installed on the FDS to monitor the float line depth relative to the water surface. The loggers were attached to the main net, the primary skirt and the secondary skirt. According to logger data, the secondary skirt on the East, West and South aspect was within the target 30 cm of the water surface 79%, 32% and 58% of the time respectively, indicating degraded performance on West and South aspects. However, data shows that secondary skirts on the East, West and South aspect were within 50 cm of the surface, 92%, 95% and 100% of the time, indicating skirts were still close to surface most of the time.

Impingement monitoring occurred throughout the calendar year. Fish collected in bar screen and travelling screen bins during the sampling periods were identified, counted and weighed to calculate impingement numbers, biomass and rates of biomass impinged per unit volume of intake water. In 2020, 334 bins were assessed.

A total of 35 taxa, identifiable to the species level were impinged. The combined biomass of all species and ages impinged in 2020 was 3,525.72 kg, a rate equivalent to 0.72 kg per million cubic metres of station intake volume. Gizzard Shad (2,031.5 kg; 57.6% of total biomass) and Alewife (336.5 kg; 9.5% of total biomass) were most common, as expected.

There were no Species at Risk Act (SARA) Schedule 1 fish species observed impinged in 2020. Thirteen American Eel, with a combined biomass of 16.6 kg, were documented during impingement monitoring. The extrapolated number is 73 individuals with an estimated combined biomass of 90.45 kg. Eight Northern Pike were documented. The annualized estimate was 49 individuals with a combined biomass of 99.16 kg. There were no episodic fish kill events in 2020.

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 7 of 30
Title: Pickering Nuclear Generating Station 2020 Impingement Monitoring Report		

1.0 INTRODUCTION

Ontario Power Generation Inc. (OPG) is the owner and operator of the Pickering Nuclear Generating Station (PNGS). PNGS, located on the north shore of Lake Ontario, has eight CANDU pressurized heavy water reactors (Units) on the site. PNGS has six Units operating with two Units in Safe Storage state. PNGS has been operating safely and generating electric power since 1971. PNGS draws large volumes of lake water, through a surface water intake, for cooling purposes. An environmental effect of using lake water for cooling is impingement of aquatic organisms.

A *Fisheries Act* Authorization for PNGS (Authorization) was issued to OPG on January 17, 2018 (DFO, 2018). The Authorization period extends from the date of issue to December 31, 2028.

This report is being submitted to satisfy both condition 3.1 and condition 3.2.1 of the Authorization.

2.0 IMPINGEMENT AVOIDANCE AND MITIGATION MEASURES

2.1 Fish Diversion System

2.1.1 Design and Design Modifications

The FDS is the primary measure to avoid and mitigate fish impingement. The FDS design consists of a main net, which covers the entire depth of the water column, and a primary skirt and secondary skirt that self-deploy when water depths increase or the main net is pulled subsurface.

There were no modifications made to the FDS design in 2020.

2.1.2 Installation and Removal

A complete check of the FDS system components was completed by OPG prior to installation.

Condition 2.1.1.1 of the Authorization requires installation of the main net by May 1 of each year and installation of the secondary net by June 1 of each year. OPG completed installation of the FDS main net by May 12, 2020; and the primary and secondary skirts were installed by May 23, 2020.

There was a delay in installation of the FDS main net that resulted from a portion of the anchoring systems being buried by drifting sand over the winter period. The DFO was notified of the potential delay in installation of the FDS in a meeting on April 24, 2020 and by email on April 27, 2020. OPG subsequently sent notifications and sought approval from applicable regulators to perform daylighting work to remove the sand to expose FDS connection hardware. Though rough weather conditions caused additional delays, the daylighting work was completed by May 9, 2020 and the installation of the main net was completed by May 12, 2020.

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 8 of 30
Title: Pickering Nuclear Generating Station 2020 Impingement Monitoring Report		

Once installed, the FDS was in place and functioning until November 7, 2020. The FDS system was removed from the Lake in its entirety by December 8, 2020. The removal date complies with condition 2.1.1.2 of the Authorization which requires the FDS, in its entirety, to remain in place and functioning until November 1st of each year.

2.1.3 Operations and Maintenance

While installed, the FDS was inspected and maintained on an ongoing basis. Inspection and maintenance consisted of:

- Visual checks of net floats by Nuclear Security Officers to assess if main, primary or secondary floats were below the surface;
- If visual checks indicated some of the floats were submerged, follow up checks were completed to determine the cause of the net sag and whether or not additional maintenance was necessary; and
- Multi-day per week subsurface inspection, hydraulic cleaning, and net maintenance by the Dive Operations team of OPG's Advance Inspection Maintenance (AIM) Department.

2.1.4 Functionality and Performance

The Authorization requires OPG to demonstrate the FDS is functioning as intended. During operations, functionality and performance are measured through visual checks, inspections and maintenance as described above. If the FDS is not functioning as intended, the cause is investigated and addressed.

The performance of the net (portion of time that floats are on or within 30 cm of the surface) was assessed using depth loggers. The loggers are attached to the FDS while it is installed and are removed and data is downloaded after the FDS is removed. A total of twenty-one depth loggers were installed on the FDS in 2020 to monitor the depth of the main net, primary skirt and secondary skirt float lines relative to the water surface. There are four loggers attached to each aspect of the secondary skirt, two loggers to each aspect of the primary skirt and one logger on each aspect of the main net. All 21 loggers were retrieved, however three (3) loggers malfunctioned during the season; namely one on each of the Main-West, Main-East and Primary-West Skirt. The malfunctioning loggers are being replaced for the 2021 season.

Due to rough weather and algae issues, depth loggers were not attached to the nets until the second week of June in 2020.

By design, gaps typically occur only if the main net, primary skirt and secondary skirt are all submerged simultaneously. For impingement risk to increase, fish would also need to be in the vicinity, find the gap, and swim through the gap and into the intake forebay. For monitoring purposes, FDS performance is generally deemed acceptable when the loggers on the secondary skirt are at the surface or submerged to depths not exceeding 30 cm. The data obtained from each logger is used to determine the depth of the float line at the specified attachment point on the FDS and also to validate visual or field observations.

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 9 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

If the FDS fails in any capacity, repairs are expedited and visual inspections are increased until functionality is restored.

Challenges with FDS during 2020, as reported by visual checks and field observations, are as follows:

- On May 21, the south and east sections of the main net were reported to be degraded due to rough weather conditions, unusually strong currents and an unprecedented amount of algae on the FDS. Due to rough weather conditions, dive crews began cleaning degraded areas of the net on the next day (May 22).
- On May 30 and 31, it was reported that the west float line closest to shore was beginning to occasionally dip below the water surface, but was still deemed to be stopping fish. There were high winds reported from the west /northwest during this period, causing waves go over the buoys at times. By June 1, this self-resolved.
- On June 11 and 12, the middle of the west float line was observed to be sagging due to very windy conditions, along with elevated amounts of algae. By June 13, reduced winds and additional net cleaning resolved the sagging.
- On August 5, west side floats were reported to be degraded and heavily loaded with algae due to unusually strong winds and unfavorable weather conditions. By August 6, this was resolved. FDS logger data also indicated the submergence of primary and secondary nets during this period.
- On August 6, the south side was observed to be slightly degraded. By August 7, this self-resolved. The FDS logger data also indicated submergence of portions of all sides of the FDS during this period.
- On August 9, the west side was observed to be degraded due to wave conditions. This self-resolved by August 10 when the weather improved. FDS logger data also indicated submergence of parts of the secondary and primary nets during this period.

Table 1 provides a weekly summary of the percentage of time that floats on the secondary skirt were functioning as required (i.e. between the surface and 30 cm depth), for each aspect of the FDS, for the period it was in service. Five hours of submergence below 30 cm depth equates to 3% availability.

Table 1: Fraction of week that each aspect of the FDS secondary skirt was at the surface or not greater than 30 cm below the surface from June to November 2020.

Week		Aspect		
Start	End	East	South	West
09-Jun-20	14-Jun-20	100%	100%	100%
14-Jun-20	21-Jun-20	96%	83%	71%
21-Jun-20	28-Jun-20	93%	61%	28%
28-Jun-20	05-Jul-20	78%	65%	10%

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 10 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

Week		Aspect		
Start	End	East	South	West
05-Jul-20	12-Jul-20	86%	69%	51%
12-Jul-20	19-Jul-20	90%	66%	46%
19-Jul-20	26-Jul-20	77%	41%	8%
26-Jul-20	02-Aug-20	79%	60%	6%
02-Aug-20	09-Aug-20	70%	39%	10%
09-Aug-20	16-Aug-20	67%	47%	4%
16-Aug-20	23-Aug-20	71%	47%	42%
23-Aug-20	30-Aug-20	76%	54%	48%
30-Aug-20	06-Sep-20	74%	46%	21%
06-Sep-20	13-Sep-20	69%	48%	16%
13-Sep-20	20-Sep-20	71%	45%	19%
20-Sep-20	27-Sep-20	68%	47%	30%
27-Sep-20	04-Oct-20	82%	51%	40%
04-Oct-20	11-Oct-20	89%	58%	28%
11-Oct-20	18-Oct-20	71%	50%	29%
18-Oct-20	25-Oct-20	81%	51%	23%
25-Oct-20	01-Nov-20	70%	48%	9%
01-Nov-20	08-Nov-20	69%	70%	30%
08-Nov-20	15-Nov-20	92%	100%	89%

Figure 1, Figure 2 and Figure 3 provide the time series of average daily depth of the East, South and West aspects of the FDS, respectively. Table 2 provides a summary of the depth data as a frequency distribution during the monitoring period. On the East aspect, the secondary skirt was located within 30 cm of the water surface 78% of the time and was within 50 cm of the surface more than 100% of the time. The secondary skirt on the West aspect was within 30 cm of the surface 32% of the time and within 50 cm of the surface 92% of the time. For the South aspect, the secondary skirt was within 30 cm of the water surface 58% of the time and within 50 cm of the surface 95% of the time. The primary skirt was located within 30 cm of the water surface, 88%, 26% and 68% of the time for East, West and South, respectively.

Although the South and West extended skirts both dipped below the 30 cm threshold on several occasions during the season, they remained within 50 cm of the surface. The low fish impingement numbers during the period the FDS was installed (discussed in *Section 4.0 Fish Impingement*) indicate that it was effective in mitigating fish impingement.

The sagging experienced, particularly by West and South aspects of the FDS was likely caused by algae build-up, often in combination with strong winds and waves, as evidenced by the visual inspection reports. In late May and June, large amounts of algae were reported in the vicinity of the FDS, which required significant maintenance efforts. Based on operational experience the West and South aspect are more prone to algae build-up and being impacted by strong winds and waves than the East aspect.

Report

OPG Proprietary

Document Number:

P-REP-07263-00014

Usage Classification:

N/A

Sheet Number:

N/A

Revision Number:

R000

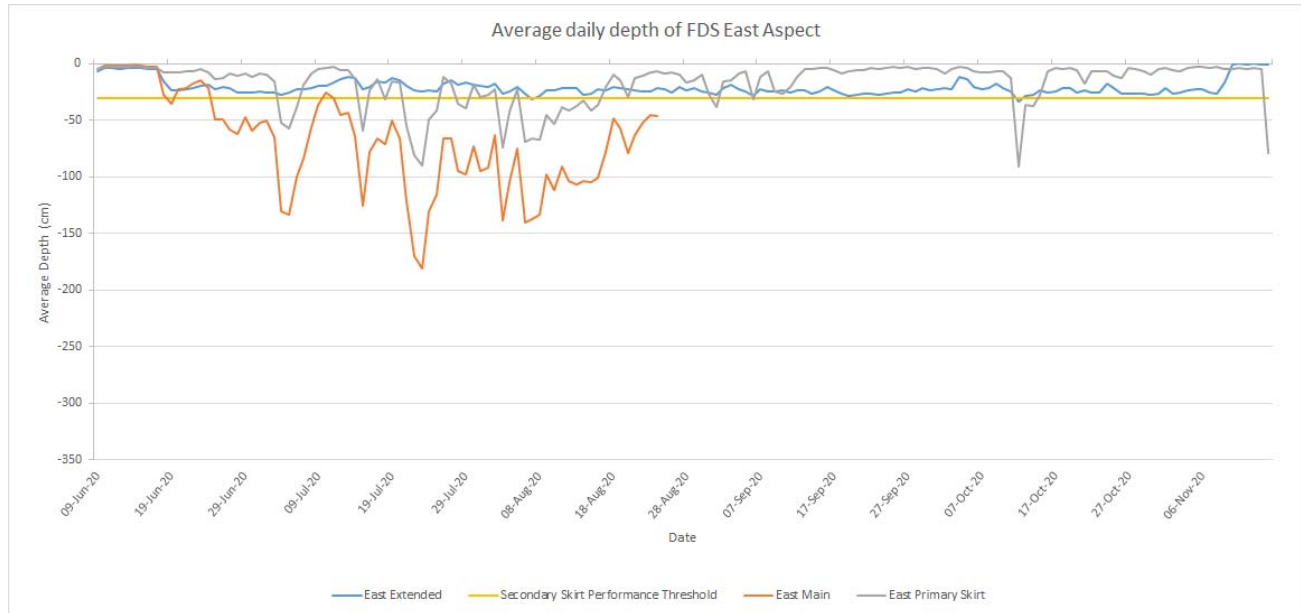
Page:

11 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

Figure 1: Daily average depth of FDS float lines on the East facing aspect.



*Main-East logger malfunctioned end of August.

Figure 2: Daily average depth of FDS float lines on the South facing aspect.

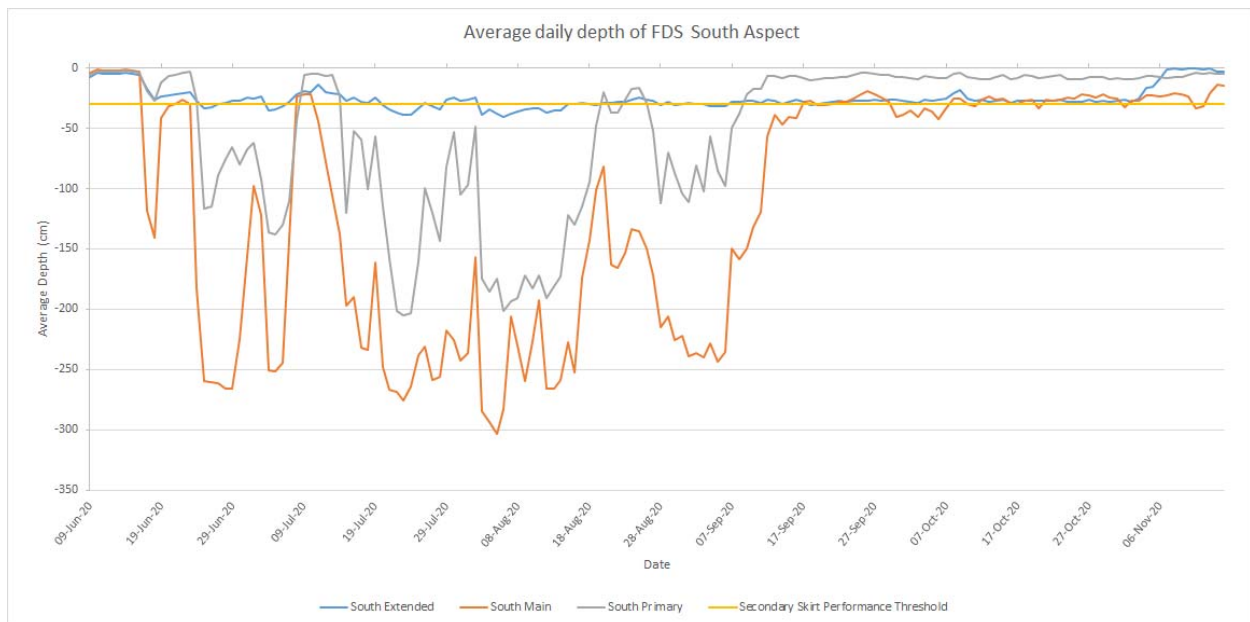


Figure 3: Daily average depth of FDS float lines on the West facing aspect.

Report

OPG Proprietary

Document Number:

P-REP-07263-00014

Usage Classification:

N/A

Sheet Number:

N/A

Revision Number:

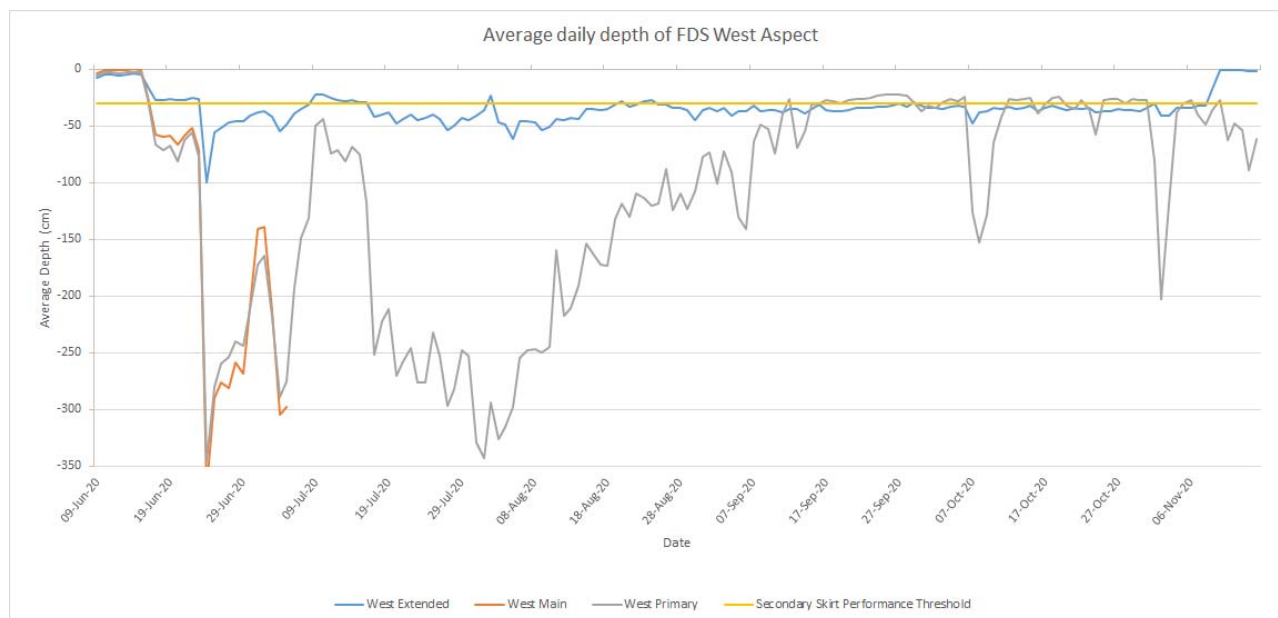
R000

Page:

12 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report



*Main-West logger malfunctioned end of June.

Table 2: Time frequency that primary and secondary float lines were in individual depth ranges based on depth logger data.

Depth Range	West			South			East		
	2nd Skirt	1st Skirt	Main Net	2nd Skirt	1st Skirt	Main Net	2nd Skirt	1st Skirt	Main Net
0-30	32%	26%	26%	58%	68%	37%	79%	88%	23%
30-50	60%	12%	8%	37%	4%	13%	21%	3%	20%
50-100	8%	13%	20%	5%	6%	5%	0%	4%	31%
100-200	0%	17%	11%	0%	14%	14%	0%	5%	25%
200-300	0%	24%	22%	0%	8%	30%	0%	0%	1%
> 300	0%	8%	12%	0%	0%	1%	0%	0%	0%

3.0 IMPINGEMENT MONITORING

3.1 Monitoring Effort

From 2010 to 2012, OPG undertook an extensive trial study to demonstrate that the FDS was capable of meeting the CNSC impingement reduction targets. In 2012, the CNSC accepted that the FDS met the trial target of 80% reduction (CNSC 2012). Subsequently, in 2013, the

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 13 of 30
Title: Pickering Nuclear Generating Station 2020 Impingement Monitoring Report		

objective of the sampling program was changed from performance demonstration to compliance verification. Consequently, in April 2013 the sampling program to monitor fish impingement was reduced from five events per week to one event per week (OPG, 2013). Impingement monitoring effort during the Authorization period was proposed in the FAA and is based on the effort employed during the 2013-2017 compliance verification period. Retention of fish collected in bar screen and travelling screen bins in operating units is presently targeted to occur for one weekly 24-hour period from about May 1 to October 31 (when the FDS is installed as a mitigation measure) and one weekly 48-hour period the remainder of the year (when the FDS is removed).

Fish collected in bins during the sampling periods are identified, counted and weighed to calculate impingement numbers, biomass and rate of biomass impinged per unit volume of intake water. Table 3 displays the sampling effort in 2020 and compares it with the previous years. Results indicate that the fraction of time sampled in 2020 is comparable to that of the FDS compliance verification period, as intended.

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 14 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

Table 3: Comparison of yearly impingement monitoring effort during different monitoring periods.

Period	Year	# Bins Sampled	Total In-Service Bin Hours sampled	% of time sampled ³
Pre-FDS	2003 - 2004	574	32,236	46%
	2006 ¹	234	25,420	36%
FDS Performance Evaluation	2010	1,505	37,904	54%
	2011	1,456	38,541	55%
	2012	1,181	29,415	42%
FDS Compliance Verification ²	2013	400	14,711	21%
	2014	353	12,178	17%
	2015	281	9,516	14%
	2016	338	12,012	17%
	2017	327	11,808	17%
Fisheries Act Authorization Monitoring ²	2018	354	11,495	16%
	2019	353	12,439	18%
	2020 ⁴	334	10,374	15%

Notes:

- Monitoring in 2006 encompassed spring, summer and fall only.
- In addition to the weekly routine impingement sampling, OPG has committed to undertake event based sampling if a fish run occurred between the regularly scheduled sampling events.
- Based on full year of service for the 8 bin location.
- For 2020, totals exclude bins out of service for the months of January to December inclusive at Unit 12TS and January to March at Unit 34TS. Surrogate data was used to conservatively estimate impingement in these bins over the out-of-service period.

3.2 Unit Operating Status and Intake Volume

Table 4 provides the number of days that condenser cooling water (CCW) pumps were not operating at a specific Unit in 2020. Total CCW intake volume in 2020 was 4.91 billion cubic metres. PNGS Unit 2 and Unit 3 are in a safe storage state and the CCW pumps are not used,

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 15 of 30

Title: Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

as these Units are not generating power, nor are the CCW pumps providing water for other purposes. When operating, each Unit normally has two CCW pumps running.

Table 4: CCW pump operating status in 2020.

Unit	Days with no CCW pumps operating
1	97
2	365
3	365
4	132
5	0
6	107
7	0
8	0

3.3 Data Quality Management

OPG undertakes data quality management of the fish impingement monitoring program at various steps during the program design, data collection, data entry, data analysis and results reporting process. Impingement monitoring followed OPG approved procedures, standards, guides and manuals.

Fish were identified and enumerated by staff that are trained in identification of Ontario fish species. Photos of impinged fish that are measured and weighed were taken and archived to assist in subsequent species verification, if an identification was uncertain. If captured, identification of species listed in Schedule 1 of the Species at Risk Act (SARA) are verified by the Royal Ontario Museum (ROM) or other qualified third party; however, none were captured in 2020. The identification of uncommon species was checked and verified by OPG biologists. In some cases uncommon species are also verified by ROM staff; however all species could be identified by OPG in 2020.

Field results were entered into an impingement database and independently verified. The total number of routine monitoring samples and monitoring hours for each month at each bin monitoring location was reviewed. In 2020, Unit 12 trash screens (12TS) were out-of-service for the entire year, and Unit 34 trash screens (34TS) were out-of-service from January to March. Since either the CCW pumps were operational, or service water supply to the station was still being obtained, impingement for January to March was estimated at both 12TS and 34TS using April fish data from 34TS. For 12TS, impingement for April to December was estimated using fish data from 34TS for the same months. Bin sampling and fish data were assumed to be equal, while intake volumes were unit specific (i.e. the original intake volumes were still applied to the impingement calculations).

Report

OPG Proprietary

Document Number:

P-REP-07263-00014

Usage Classification:

N/A

Sheet Number:

N/A

Revision Number:

R000

Page:

16 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

3.3.1 Atypical Impingement Volumes that were Potential Data Outliers

Once all entered data was validated, queries in the database that are designed to calculate impinged numbers and biomass for each bin sampled during routine monitoring were run. The total count and total biomass in each bin for each monitoring event was reviewed and compared against historic (2010-2018) rates, standardized to a 24 hour collection period, to flag potential outliers. Each potential outlier was investigated and a determination was made as to how the data should be treated in the monthly calculations. If the record contained errors that could not be rectified, the record was excluded entirely. This has the effect of reducing the sample size, duration and sampled volume for that bin. If the record was above the assessment threshold identified in Table 5, but impingement observed on subsequent days suggested the data was representative, then normal monthly calculations were applied. Finally, if the record was not deemed representative and determined to be a valid outlier, that sampling event for that bin was excluded from the normal monthly extrapolation. The impingement number and biomass for that date for that specific bin was then added to the extrapolated monthly value and the values summed to determine the total monthly result (see Appendix A for more details).

Five of the 334 bins sampled had impingement biomass estimates that exceeded the mean \pm 3 standard deviation thresholds used to identify outliers at the bin level (Table 5). A close evaluation of data from other bins on days prior to or following the sample date, suggested that impingement rates were also elevated; therefore, the bins were assumed representative of the week (i.e. not outliers).

Table 4: Individual bins identified as having count or biomass estimates that were potential data outliers.

Date	Bin Location	Calculated 24 hr Count	Calculated 24 hr Biomass (gm)	2010-2018 Bin Outlier Threshold	
				24 hr Count	24 hr Weight
6-Jan-20	12 BS	3	3,901	92	3622
27-Jan-20	56 BS	29	31,977	90	17882
24-Feb-20	56 BS	24	21,905	90	17882
23-Mar-20	56 BS	21	20,279	90	17882
23-Mar-20	78 BS	12	11,078	357	10845

3.4 Impingement Estimate

The formulas used to calculate monthly impingement and extrapolate it over the year are provided in Appendix B.

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 17 of 30
Title: Pickering Nuclear Generating Station 2020 Impingement Monitoring Report		

4.0 2020 FISH IMPINGEMENT

4.1 All Species and Life Stages

Figure 4 and Table 6 provide the biomass of fish impinged in 2020. The quantity of fish impinged is provided in Table 7, and the rate of biomass impinged per unit volume of intake water used by the CCW pumps is provided in Table 8. All estimates are for all species and life stages of fish impinged. Consistent with prior impingement reports for the Authorization period, Figure 4 and Table 8 exclude the 2017 impingement event. For clarity, OPG notes that the Authorization value is based on Age-1 equivalent impingement and entrainment estimates for 23 modelled species only. Any of the 23 species that were impinged in 2020 are denoted with an asterisk (*) beside the species name in Table 6 and Table 7.

The combined biomass of all species and ages impinged in 2020 was 3,523.72 kg, a rate equivalent to 0.72 kg per million cubic metres of station intake volume. Impingement rates during the period the FDS was installed were within the anticipated range (Figure 4).

Before FDS installation and after FDS removal, impingement rates can be sporadic and highly variable. During these periods, impingement rates are more influenced by several variables beyond the control of OPG. These factors include (but are not limited to) total fish biomass in the lake, weather, coastal processes, water temperature fluctuations, mass seasonal movements and sporadic impingement events. During the period the FDS was not installed in 2020, the monthly impingement rates were below projected values with the exception of March, which had elevated impingement. It is worth noting that since the monthly impingement rates are extrapolated from weekly estimates, the bins identified in Table 5 are substantial contributors to monthly and cumulative annual impingement.

Impingement is also influenced by trends in lake-wide abundance of various fish species. Fish populations are monitored by the Lake Ontario Management Unit of the Ontario Ministry of Natural Resources and Forestry. Their most recent annual report (for 2019) is available online at http://glfc.org/lakecom/loc/mgmt_unit/. A comparison of impingement rates to species population trends is beyond the scope of this report.

Report

OPG Proprietary

Document Number:
P-REP-07263-00014

Usage Classification:
N/A

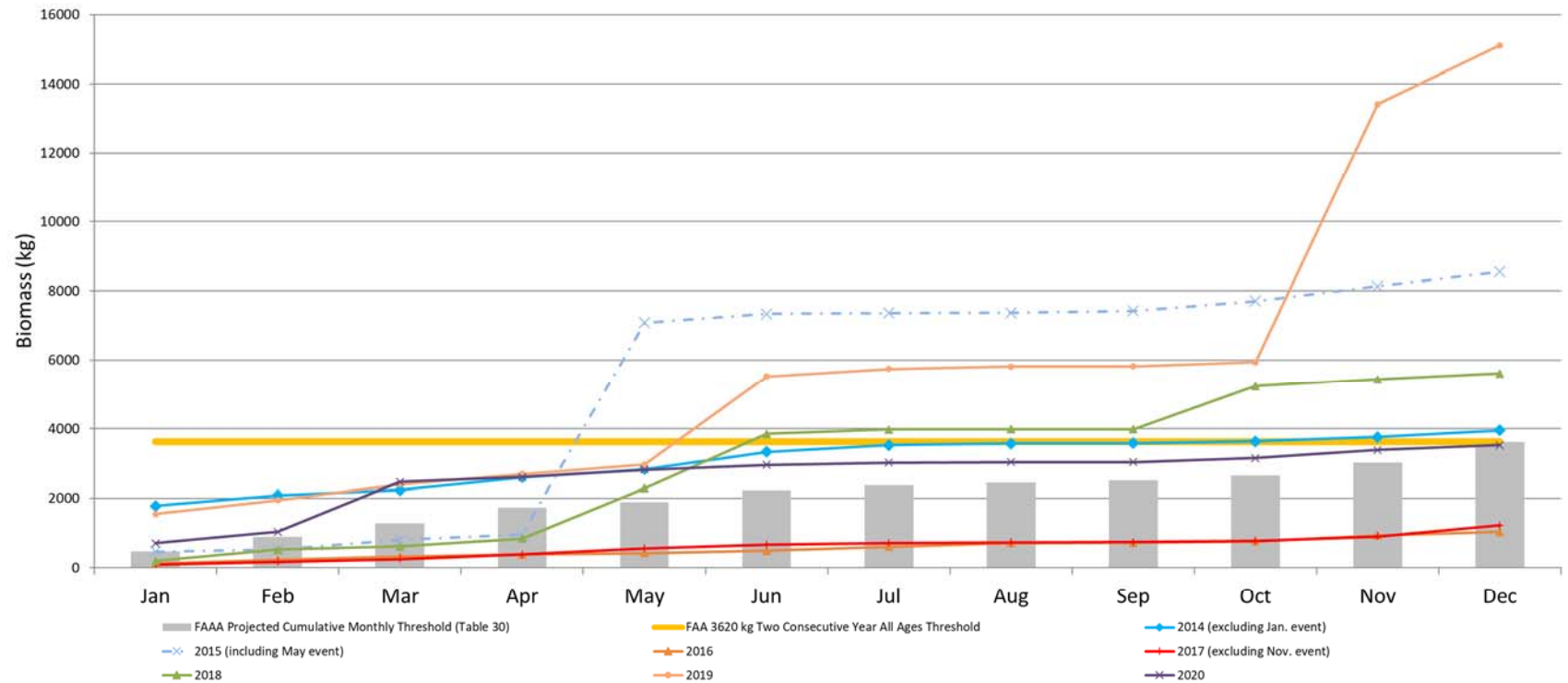
Sheet Number:
N/A

Revision Number:
R000

Page:
18 of 30

Title: **Pickering Nuclear Generating Station 2020 Impingement Monitoring Report**

Figure 4: Annual cumulative biomass (kg) of fish of all species and ages impinged from 2015-2020.



Notes:
012 TS equipment was out of service for all of 2020 and 034 TS was out of service for January to March inclusive.
012 TS and 034 TS January to March impingement based on weekly April 034 TS impingement data. 012 TS April-December impingement based on corresponding weekly data from 034 TS.

Report

OPG Proprietary

Document Number:

P-REP-07263-00014

Usage Classification:

N/A

Sheet Number:

N/A

Revision Number:

R000

Page:

19 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

Table 5: Monthly biomass and annual fish impinged (kg) at Pickering Nuclear Generating Station in 2020.

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (kg)
Alewife*	0.67	0.16	1.21	0.00	30.40	75.88	44.29	13.59	0.05	110.23	59.04	0.98	336.50
American Eel	23.03		27.17		10.45	6.36						23.45	90.45
Atlantic Salmon*				0.24									0.24
Black Bullhead*			1.38		2.34		1.74						5.46
Bowfin			8.74								24.38		33.12
Brown Bullhead*	1.74	0.67	2.30	0.70		1.26					1.78	1.20	9.64
Brown Trout	14.19		0.74										14.93
Carp/Gold Fish	1.38												1.38
Channel Catfish	30.68		15.56	19.90	23.37	0.53					7.10		97.15
Chinook Salmon*	0.25	0.09	63.95	0.52	0.14	0.02					14.19		79.17
Coho Salmon		0.12	1.00										1.12
Common Carp*	48.93		37.91										86.84
Emerald Shiner*	0.06				0.14					0.10		23.86	24.17
Fathead Minnow					0.55								0.55
Freshwater Drum*	27.70		21.08										48.78
Gizzard Shad*	465.41	293.02	939.14	68.71	71.66	23.48	0.27	0.09		0.63	122.11	46.97	2,031.49
Lake Trout*												18.31	18.31
Logperch				0.33									0.33
Longnose Gar												0.78	0.78
Northern Pike*	22.29	15.06	53.90									7.92	99.16
Pumpkinseed											0.19		0.19
Rainbow Smelt*		3.43	42.00	4.70	4.29	0.56				0.10	0.20	0.79	56.07
Rainbow Trout*	22.98	0.00	98.20	15.33								0.06	136.58
Rock Bass				0.71	1.26								1.97
Round Goby	2.50	6.06	69.82	26.68	61.13	33.22	16.56	3.29	1.09	2.23	1.84	1.38	225.80
Sea Lamprey												1.27	1.27
Smallmouth Bass*		2.39									1.90		4.30
Three-spine Stickleback*	9.87	2.36	9.56	1.33	0.82	0.27	0.01			0.03	0.11	13.35	37.71
Trout-Perch			0.09								0.00		0.09
Unid	0.07												0.07
Unid-Sucker Species			20.23										20.23
Walleye*	21.92												21.92
White Bass*		2.62	8.73										11.36
White Perch*	5.93			0.25							0.29	0.76	7.22
White Sucker*	2.97		5.14										8.11
Yellow Perch*	1.50		6.84	1.54	3.13							0.28	13.28
Total (kg)	704.05	325.98	1,434.70	140.92	209.69	141.59	62.88	16.97	1.13	113.33	233.12	141.37	3,525.72

Report

OPG Proprietary

Document Number:

P-REP-07263-00014

Usage Classification:

N/A

Sheet Number:

N/A

Revision Number:

R000

Page:

20 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

Table 6: Number of fish impinged at Pickering Nuclear Generating Station in 2020.

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (#)
Alewife*	46	4	62		3,205	7,737	1,926	16,168	120	11,648	18,885	202	60,002
American Eel	21		23		8	6						15	73
Atlantic Salmon*				5									5
Black Bullhead*			8		8		8						23
Bowfin			8								20		28
Brown Bullhead*	9	7	15	5		12					19	16	83
Brown Trout	12		15										28
Carp/Gold Fish	5												5
Channel Catfish	6		8	5	8	6					42		74
Chinook Salmon*	26	4	85	10	8	12					4		148
Coho Salmon		4	16										19
Common Carp*	10		16										25
Emerald Shiner*	26				40					32		10,103	10,202
Fathead Minnow					16								16
Freshwater Drum*	6		8										13
Gizzard Shad*	1,292	347	1,201	103	93	29	78	12		80	878	48	4,162
Lake Trout*												4	4
Logperch				29									29
Longnose Gar												4	4
Northern Pike*	10	4	31									4	49
Pumpkinseed											4		4
Rainbow Smelt*		429	6,184	1,864	1,593	180				80	67	102	10,499
Rainbow Trout*	11		46	5								15	78
Rock Bass				5	8								13
Round Goby	231	284	4,783	2,956	5,178	3,224	1,061	457	209	303	130	64	18,879
Sea Lamprey												4	4
Smallmouth Bass*		4									16		20
Three-spine Stickleback*	7,699	1,622	5,703	841	462	199	16			40	81	8,193	24,856
Trout-Perch			15										15
Unid	23												23
Unid-Sucker Species			23										23
Walleye*	10												10
White Bass*		4	15										19
White Perch*	5			10							16	40	71
White Sucker*	35		8										42
Yellow Perch*	31		212	49	88							44	424
Total (#)	9,514	2,710	18,485	5,886	10,715	11,406	3,088	16,637	330	12,183	20,161	18,857	129,971

Report**OPG Proprietary**

Document Number:

P-REP-07263-00014

Usage Classification:

N/A

Sheet Number:

N/A

Revision Number:

R000

Page:

21 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

Table 7: Impinged biomass, intake volume and impingement rate by volume.

Year	Annual Biomass (kg)	Annual Station Flow (billion m ³)	Annual Rate (kg/million m ³)
2003/2004	18,214	4.19	4.35
2010	4,617	4.88	0.95
2011	4,012	4.77	0.84
2012	1,706	4.94	0.35
2013	2,926	4.86	0.60
2014	3,953	4.82	0.82
2015 ¹	8,553	5.07	1.69
2016	1,035	4.70	0.22
2017	1,217	5.05	0.24
2018	5,616	4.88	1.15
2019	15,114	5.27	2.87
2020	3,525	4.91	0.72

Note: ¹ 6,000 kg of impingement in 2015 was attributable to a single event in May 2015 caused by an opening in the net seam. Excluding this event, the impingement rate in 2015 was 2,553 kg or 0.50 kg/million m³ of station intake volume.

4.2 Species Impinged in 2020 to be Included in Age-1 Equivalency Estimates

The Authorization value is based on the modeled Age-1 equivalent biomass for 23 species which were used in the FAAA modeling. In 2020, 20 of the 23 species were impinged. Bluegill, Largemouth Bass and Round Whitefish were not observed in impingement monitoring in 2020. The combined biomass impinged for the 20 species was 1005 kg, representing 29% of the total biomass impinged.

4.3 Regulated and Other Aquatic Invasive Fish and Mussel Species

One regulated invasive species, Round Goby (225.8 kg) was impinged in 2020. Round Goby is an invasive species listed in Part 2 of SOR/2015-121 Aquatic Invasive Species Regulations and is a Species Subject to Prohibitions and Controls. The Aquatic Invasive Species Regulations also applies to Grass Carp, Bighead Carp, Silver Carp, Black Carp, Zebra Mussel, Quagga Mussel, any species of the Snakehead family, Ruffe, Rudd, and Tubenose Goby. Zebra Mussel and Quagga Mussel are impinged consistently, but similar to Round Goby these species are not included in estimates of serious harm to fish due to impingement.

Though Round Goby is included in impingement estimates for all species and age classes, DFO agreed in their review of the FAAA and the Authorization that they are not included in estimates of Age-1 equivalent losses.

Report

OPG Proprietary

Document Number:

P-REP-07263-00014

Usage Classification:

N/A

Sheet Number:

N/A

Revision Number:

R000

Page:

22 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

4.4 Species at Risk Act Schedule 1 Fish Species

There were no SARA Schedule 1 fish species observed impinged in 2020

4.5 Endangered Species Act Species at Risk in Ontario List fish species

American Eel is a species listed as Endangered in the Species at Risk in Ontario (SARO) List of the Endangered Species Act (ESA). During 2020, OPG held permits for species protection or recovery issued under the authority of clause 17(2)(b) of the ESA. Impinged American Eel are reported to MNRF as a condition of the permits. In 2020 OPG voluntarily collected additional information on impinged individuals to assist in recovery efforts for the species.

Thirteen (13) American Eel, with a combined biomass of 16.6 kg, were documented during impingement counts in 2020. All but one were impinged when the FDS was removed. The extrapolated number of impinged American Eel was 73 individuals with an estimated combined biomass of 90.45 kg for 2020.

4.6 Northern Pike

In 2008, the CNSC requested that OPG implement measures to verify there is no population level impact on Northern Pike (CNSC 2008). Although effective at deterring all but the smallest of Northern Pike while installed, the FDS was unable to achieve a reduction in Northern Pike impingement during the FDS performance validation period, as impingement of this species occurs primarily in the winter period when the FDS is not installed.

In 2020, OPG documented eight Northern Pike with a combined mass of 17.47 kg during impingement monitoring. All were captured outside of the period the FDS was installed. The annualized estimate of impingement in 2019 was 49 individuals with a combined biomass of 99.16 kg. Table 9 provides a summary of Northern Pike impingement since 2010.

Table 8: Number and biomass in Northern Pike impinged in 2010-2020.

Year	Annual Number	Annual Biomass (kg)
2010	50	51
2011	46	120
2012	46	133
2013	58	188
2014	36	112
2015	27	70
2016	12	31
2017	33	21
2018	67	106

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 23 of 30
Title: Pickering Nuclear Generating Station 2020 Impingement Monitoring Report		

2019	92	143
2020	49	99

4.7 Episodic Fish Kill Events

There were no episodic fish kill events in 2020.

5.0 IMPINGEMENT TRENDS

5.1 Comparison with FAA Impingement Predictions

OPG's FAAA provided annual, all ages biomass estimates of impinged fish in 2003/2004 and from 2010 to 2016. FAAA estimates were used to define an annual all ages impingement threshold of 3,619 kg in each of two consecutive years of impingement monitoring during the Authorization period. Condition 3.2.1.1 of the FAA states that if this threshold is exceeded, communications with DFO should be held to discuss the root causes, with the potential need for subsequent adaptive management. This commitment was included as a condition of the Authorization.

The impingement estimates provided in 2019 were above 3,619 kg, but impingement in 2020 was below 3,619 kg. Therefore impingement was below the two-year threshold.

5.2 Trends

The 2020 impingement rate was 0.72 kg/million cubic metres of CCW intake volume compared to the five-year mean of 1.04 kg/million cubic metres of CCW intake volume.

The species with the largest all ages biomass impinged were Gizzard Shad (2,031.5 kg, 57.6% of total biomass), Alewife (336.5 kg; 9.5% of total biomass), Round Goby (225.8 kg; 6.4% of total biomass) and Rainbow Trout (136.58 kg; 3.9% of total biomass). Gizzard Shad and Alewife were also the top two species in the 2013 to 2018 period, with the exception of 2014, where Common Carp were the second most abundant, followed by Alewife.

6.0 UNCERTAINTY

The following are the primary factors that contribute to uncertainty in the impingement estimates:

- There is uncertainty associated with the performance of the FDS. Depth loggers are used to assess the performance of the FDS over the installation period, placement of loggers on net can have an impact on the final performance numbers for nets.

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 24 of 30
Title: Pickering Nuclear Generating Station 2020 Impingement Monitoring Report		

- There is uncertainty associated with numbers and species of fish that may be present in the forebay prior to FDS installation, and the number of additional fish that may enter the forebay if performance is affected by natural causes, tears or small holes.
- There is a lag effect between the period that fish enter the forebay and the time they may be impinged. Some large fish with strong swimming capabilities may never be impinged and could leave the forebay after the FDS is removed. The lag effect and how this affects monthly impingement numbers and biomass varies between species and life stages.
- There is uncertainty associated with the identification of fish sampled from the bins (physical counting, length/weight measurements, subsamples and identification), largely due to the physical condition of the fish after being impinged. To mitigate the physical condition of the fish, bins are exchanged prior to weekly monitoring. To mitigate misidentification, sampling practices have been proceduralized and monitoring is undertaken by qualified individuals that have completed the Royal Ontario Museum (ROM) fish identification course. Photos are taken of collected fishes which aid in validation. Misidentification may result in small errors associated with the individual species data reported in Tables 6 and 7.
- There is uncertainty associated with missing or incomplete data from field forms. This has been minimized by self checks, peer checks and follow up communications. If necessary, missing values for certain parameters (e.g. fish length, weight) can be estimated using descriptive statistics calculated or interpreted from available data, as described in Section 3.4
- There is uncertainty in extrapolating data for periods that bins are out-of-service and non-sampled time periods. Surrogate data was used to conservatively estimate impingement for out-of-service periods, for Unit 12TS (from January to December) and Unit 34TS (from January to March). There is also high natural variability from season to season. This uncertainty has been reduced by extrapolating data within each month, and appropriate flagging, verification and treatment of outliers in the database and associated number and biomass calculations.
- There is high natural variability from day to day, which is largely influenced by environmental factors and movement of fishes through the zone affected by the PNGS intake. The variability associated with this is real and cannot be reduced through increased sampling effort. Typically, impingement rates are more stable when the FDS is installed as the FDS deters migration of many species and life stages into the intake forebay. However, Monte Carlo simulations on the 2011 data indicated that reducing the sampling frequency from five to one day per week would have minimal impact on the 95% confidence intervals.

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 25 of 30
Title: Pickering Nuclear Generating Station 2020 Impingement Monitoring Report		

7.0 CONCLUSION

This report documents outcomes of impingement mitigation measures and impingement estimates for the 2020 calendar year, and is submitted to satisfy both condition 3.1 and condition 3.2.1 of the Authorization.

The primary measure to avoid or mitigate fish impingement at PNGS is the FDS. The start of installation was delayed beyond May 1 and the rationale was reported to and acknowledged by DFO. The notification and completion dates for installation of the combined FDS including secondary skirt complies with condition 2.1.1.1. The removal date was after November 1, which complies with condition 2.1.1.2 of the Authorization.

Impingement monitoring was conducted throughout the calendar year. Fish collected in bins during the sampling periods were identified, counted and weighed to calculate impingement numbers, biomass and rates. Over 2020, 334 bins were assessed during routine impingement monitoring in Units 1, 4, 5, 6, 7 and 8 combined.

All ages impingement in 2020 was 3,525.72 kg or 0.72 kg/million cubic meters of CCW intake volume. A total of 35 taxa, identifiable to the species level and an estimated 129,971 fish were impinged in 2020.

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 26 of 30
Title: Pickering Nuclear Generating Station 2020 Impingement Monitoring Report		

8.0 REFERENCES

CNSC 2008. Letter, T.E. Schaubel to W.M. Elliot and P.F. Tremblay. Pickering NGS A and B: Mitigation Measures to Reduce Rates of Fish Mortality, New Action Item #2008-4-14. October 2, 2008. P-CORR-00531-03269

CNSC 2012. Letter, M. Santini to G. Jager. Pickering NGS – Intake and Thermal Fish Mortality: Closure of Action Items 2008-4-13 (RIB # 2433), 2008-4-14 (RIB # 2434) and New Action Item 2012-48-3489. August 13, 2012. e-Doc 3970429. P-CORR-00531-03773.

DFO 2018. Letter, D. Nicholson to R. Lockwood. Paragraph 35(2)(b) *Fisheries Act* Authorization for the OPG Pickering Nuclear Generating Station. January 17, 2018. P-CORR-00539.4-00003.

OPG 2013. Letter, G. Jager to M. Santini. Long-Term Fish Impingement and Entrainment Monitoring Program, Action Notice 4 of Action item 2012-48-3489, June 13, 2013. P-CORR-00531-04216.

OPG. 2017. Letter, R. Lockwood to C. Boros, DFO . Submission of an Application for Authorization under Paragraph 35(2)(b) of the *Fisheries Act*, Pickering Nuclear Generating Station. December 20, 2017P-CORR-00539.4-00002

Report	OPG Proprietary		
	Document Number: P-REP-07263-00014		Usage Classification: N/A
	Sheet Number: N/A	Revision Number: R000	Page: 27 of 30
Title: Pickering Nuclear Generating Station 2020 Impingement Monitoring Report			

Appendix A: Management of Bin Outliers in Fish Impingement Database

Background

The fish impingement program at Pickering collects a nominal daily composite sample each week. These samples are used to estimate a total monthly impingement in each bar screen and travelling screen bin located in each operating unit using linear extrapolation as follows:

$$\text{EQN 1: Monthly Impingement for Bin Location 1} = \frac{[S1 + S2 + S3 + S4] \times \text{Monthly Flow}}{\text{Flow1} + \text{Flow2} + \text{Flow3} + \text{Flow4}}$$

Where S1 to S4 is the number and biomass of fish impinged on each sample day 1
Flow1 to Flow 4 is the volume of water that passed through the screen on that sample day
Monthly Flow is the total volume of water that passed through the screen in the month.

Note: For simplicity, the formula illustrated is based on four weekly samples in a month. There are eight bin sampling locations, and impingement at each location is quite different. The above calculation is repeated at each of the eight bin locations and is summed to provide a Total Monthly impingement estimate as per Appendix B.

This extrapolation method assumes that the samples collected in each of the four week are also representative of the unsampled days. This assumption is valid in most instances; however, occasionally a sample is not representative of the month and if used would produce an erroneous result if used directly in the monthly extrapolation provided in Appendix B. It is therefore justified to treat the non-representative sample differently, as follows:

$$\text{EQN 2: Monthly Impingement for Bin Location 1} = \frac{[S1 + S2 + S3] \times \text{Monthly Flow}}{\text{Flow1} + \text{Flow2} + \text{Flow3}} + S4$$

Where S4 is the non-representative sample.

The above formula uses the 3 representative samples to extrapolate the monthly total and then adds the non-representative sample as a single un-extrapolated value. This is consistent with the method OPG has previously used to incorporate an impingement event (whether or not that occurred on a scheduled or un-scheduled sampling day) into the monthly impingement value.

CSA Governance on Outliers

OPG follows the guidance provided in the N288 series of environmental standards. Outlier management is discussed in N288.4 (Environmental Monitoring Program), N288.5 (Effluent Monitoring Program), N288.6 (Environmental Risk Assessment) and N288.8 (Action Levels). N288.4 and N288.5 pertain to data collection, while N288.6 and N288.8 pertain to the use of data. These standards justify the treatment outliers differently than other data, provided there is supporting evidence that the outlier is truly an atypical result.

Report

OPG Proprietary

Document Number:

P-REP-07263-00014

Usage Classification:

N/A

Sheet Number:

N/A

Revision Number:

R000

Page:

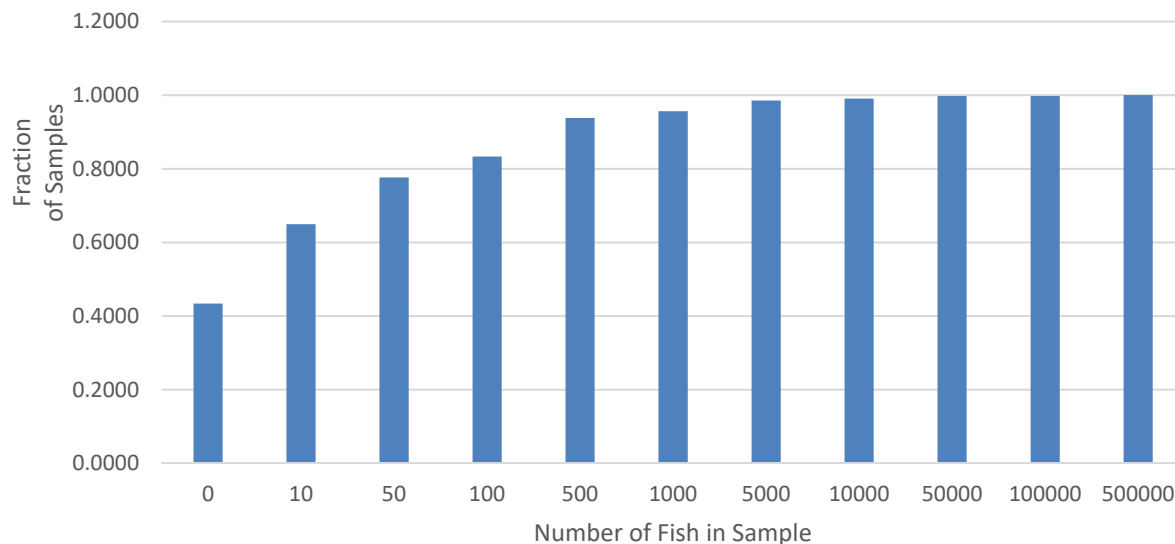
28 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

To illustrate, 2010 to 2018 bin data for the Unit 056 traveling screen, standardized to a 24 hour collection period, is shown in Appendix A Figure 1. Over 40% of the samples contained no fish, less than 5% contained more than 1,000 fish, and less than 1% contained more than 10,000 fish. So, in general we would not expect samples containing thousands of fish to occur more than once in a month and therefore it would be inappropriate to include such a sample in the data used to extrapolate the monthly impingement as it would produce a result which would significantly overestimate the impingement number or impingement biomass.

Appendix A Figure 1: Cumulative Frequency Distribution of Fish number at 056 TS



There is no single rule for the treatment of outliers that has been adopted by the scientific community. Many guidance documents suggest using the Mean+ 3 Standard Deviations as a rule of thumb to identify outliers. This corresponds to the 99.7th percentile, or a frequency of occurrence of 3 times in 1000 samples. This is approximately one day per year.

To develop the upper outlier threshold for each bin, data from 2010 to 2018 was used. The total number of fish per bin and total weight of fish per bin was standardized to a 24 hour period and M+3SD was calculated. The cumulative sample size for individual bins ranged from 600 to 800 per location, which was more than adequate to detect an occurrence of 3 in a 1000 samples.

Report**OPG Proprietary**

Document Number:

P-REP-07263-00014

Usage Classification:

N/A

Sheet Number:

N/A

Revision Number:

R000

Page:

29 of 30

Title:

Pickering Nuclear Generating Station 2020 Impingement Monitoring Report

Bin Location	Sample Size	24 hr Count Outlier	24 hr Weight Outlier
		Total number of fish in a bin	Total weight (gm) of fish in a bin)
12 BS	785	92	3,622
12 TS	677	421	5,214
34 BS	781	120	10,663
34 TS	619	549	6,508
56 BS	839	90	17,882
56 TS	707	54,182	343,765
78 BS	832	357	10,845
78 TS	696	18,591	160,196

Justification required

The 99.7th percentile represents a frequency of approximately 1 day per year when you would expect that value to occur by chance. Therefore, it is reasonable to exclude samples exceeding the 99.7th percentile from the monthly extrapolation in EQN 1 (where it would represent several occurrences in the month) and treat it as a single occurrence as in EQN 2 (where it would represent one occurrence in the month). The evidence necessary to support this visual observation of the bins on the days following the sample date to verify that large number of fish are not present.

Report

OPG Proprietary		
Document Number: P-REP-07263-00014		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 30 of 30
Title: Pickering Nuclear Generating Station 2020 Impingement Monitoring Report		

Appendix B: Estimation of Annual Impingement

The following formulas were used calculate monthly impinged biomass for each species:

$$\text{Monthly annualized biomass impinged for species x} = \sum_{Locn=1 \text{ to } 8} \left[\left(\sum_{Bin=1}^J \sum_{Fish=1}^i \text{Measured Fish Weighth} \right) * \frac{\text{Total Flow}}{\text{Sampled Flow}} \right]$$

Where:

- Fish = Record of individual fish in bin_j
- i = Total number of fish of species x in bin_j
- Bin = Record of bin sampled at a specific bin location
- j = Number of bins sampled at single bin location in one month
- Locn = one of 8 screenhouse bin locations
- Total Flow = Total monthly condenser cooling water and reactor building service water flow at the bin location
 $= \sum_{Day=1}^{\# \text{ Days in Month}} \text{Hourly Flow}_{day, locn} * 24 \text{ hr}$
- Sampled Flow = Total flow at the bin location for the sampled time periods
 $= \sum_{bin=1j} \text{Hourly Flow}_{day, locn} * \# \text{ Hours bin j was in Service}_{day, locn}$