



UPDATE OF SPAWNER ABUNDANCE AND BIOLOGICAL CHARACTERISTICS OF STRIPED BASS (*MORONE SAXATILIS*) IN THE SOUTHERN GULF OF ST. LAWRENCE TO 2021

Context

The Striped Bass population of the southern Gulf of St. Lawrence had declined to less than 5,000 spawners in the late 1990s and subsequently increased to over 900,000 spawners by 2017. Due to conservation concerns, the commercial fishery closed in 1996 and the recreational and Indigenous fisheries for Striped Bass were closed in 2000. A small number of food, social, and ceremonial (FSC) fisheries were reinstated in 2012 and allocations of Striped Bass to Indigenous groups have gradually increased since then. The recreational fishery reopened in 2013 and a pilot Indigenous commercial fishery began in 2018. As the fisheries management measures were responsive to changes in abundance of the southern Gulf Striped Bass population, Fisheries and Oceans Canada (DFO) Gulf Ecosystems and Fisheries Management branch requested an update on the size of the spawning stock and information on biological characteristics to 2021. This Science Response Report results from the Regional Science Response Process of December 14, 2021 on the Determination of spawner abundance, age-class distribution and biological characteristics for striped bass for 2021.

Background

Southern Gulf of St. Lawrence Striped Bass (*Morone saxatilis*) are distributed in near shore waters and estuaries from the north shore of the Gaspé Peninsula in Quebec to the northern tip of Cape Breton Island, Nova Scotia. The only confirmed spawning location known to produce annual recruitment in the southern Gulf of St. Lawrence is the Northwest Miramichi River (NW); consequently, this was the location chosen to develop annual abundance indices. Since 1994, monitoring of the bycatch in the commercial gaspereau trapnets of the Miramichi River has been the principal source of information for assessing the Striped Bass spawning population of the southern Gulf. The spawner abundance was usually estimated from mark and recapture experiments in which adult Striped Bass were tagged early in May and monitored throughout June as they were captured and released as bycatch in the gaspereau fishery of the Northwest Miramichi estuary (Bradford and Chaput 1996; Douglas and Chaput 2011). Catch per unit effort (CPUE) from this fishery has also been used as an index of abundance for Striped Bass (Douglas and Chaput 2011). The start date of the four-week gaspereau season has progressively increased from 15 May in 1995 (and prior) to 1 June since 2014. Biological characteristics of Striped Bass (e.g. fork length, age, sex, and spawning stage) were recorded from fish captured in commercial gaspereau trapnets (May-June) and at index trapnet monitoring facilities operated by DFO Science (May-October).

Analysis and Response

Spawner abundance

For the purpose of the 2021 Striped Bass assessment program, one trapnet was operated in the Northwest Miramichi River between 4 May and 4 June specifically to tag Striped Bass and collect biological information on the population. In 2021, the regular gaspereau season in the NW was scheduled from 6 pm on 1 June to 6 pm on 29 June. The first gaspereau trapnet in the NW was set on 3 June which resulted in the first opportunity to monitor for Striped Bass bycatch on 5 June. Gaspereau catches were monitored regularly throughout the fishing season with 46 of a possible 192 (24%) trapnet hauls sampled for Striped Bass bycatch in the NW.

Striped Bass bycatch data collected between 5 June and 9 June was considered to be the most appropriate information for estimating the abundance of Striped Bass spawners in the NW. Similar to previous years, the bycatch of Striped Bass was highest early in the season and decreased to low levels by mid-June (Appendix 1). The first report of spawning Striped Bass in 2021 was in the Cassilis area (Northwest Miramichi) on 21 May (Appendix 1).

The Bayesian hierarchical model used in previous Striped Bass assessments was applied to the 2021 CPUE information from the gaspereau fishery (Chaput and Douglas 2011; Appendix 2). Since 2014, an adjustment to the model has been made to account for the observed spawning behaviour of Striped Bass carrying internal acoustic tags (DFO 2015; 2016; 2017; 2018; 2019; 2020). The movements of 69 Striped Bass carrying acoustic transmitters were monitored with receiver arrays anchored throughout the Miramichi during May and June 2021. The tracking of acoustically tagged Striped Bass provided information on the daily distribution of spawners in the Miramichi system and therefore their availability (or not) for capture in the gaspereau trapnets of the NW.

The median of the estimated spawner abundance in 2021 was 260,700 (5th to 95th percentile range of 130,000 to 585,000) (Figure 1). The catch rates on individual sampling dates were assumed to be proportional to the abundance of adult Striped Bass in the NW. Spawner abundance for those dates was estimated as the product of the total spawner abundance at the beginning of the spawning period and the proportion of the acoustically tagged bass still in the Miramichi. Based on acoustically tagged bass data in 2021, the percentages declined from 6% on 5 June to 1% on 9 June (Appendix 1).

Catches of Striped Bass at DFO index trapnets at Millerton on the Southwest Miramichi River and at Cassilis on the Northwest Miramichi River provide fishery-independent indices of the southern Gulf Striped Bass population (Appendix 3). In 2021, the trapnet at Cassilis operated between 13 May and 27 October while the trapnet at Millerton operated between 25 May and 29 October. The Millerton trapnet did not operate between 11 and 20 September because of a washout that was caused by heavy rain and high water levels associated with hurricane Larry. Counting individual Striped Bass at index trapnets when catches are large is impractical so estimation of the catch is sometimes required. The combined catch of Striped Bass at these facilities in May and June 2021 ($n = 20,700$) was higher than in 2019 and among the highest of the spring time series (Appendix 3). The combined catch of Striped Bass at these facilities ($n = 12,500$) in September and October 2021 was lower than in 2019 and similar to 2016 and 2018 (Appendix 3).

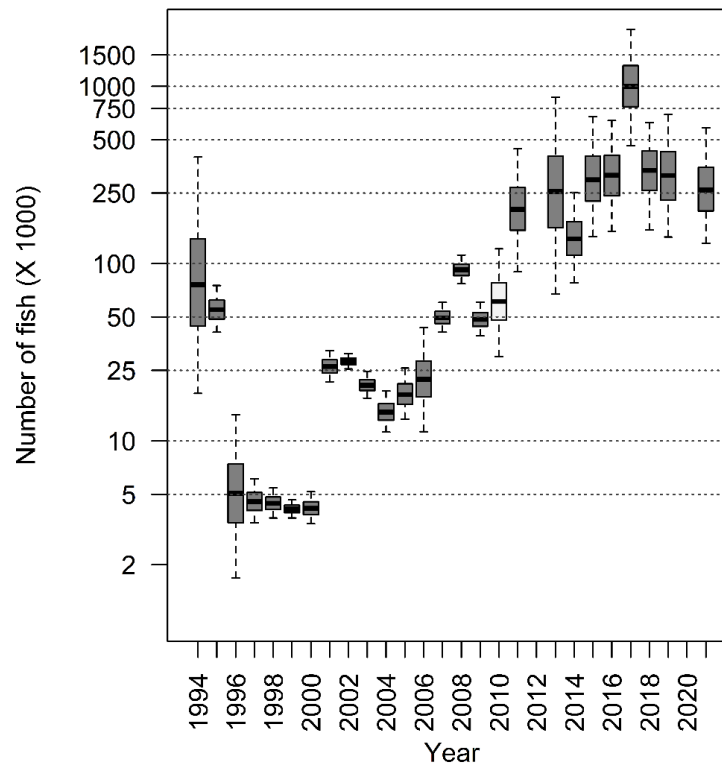


Figure 1. Estimated abundance of adult Striped Bass spawners in the Northwest Miramichi estuary between 1994 and 2021. The estimates are shown on a logarithmic scale for visibility of the full range of abundance values over the time series, from low abundances of approximately 5,000 spawners during 1996 to 2000 to the 2017 high value of approximately 1 million fish. The estimate for 2010 (unshaded interquartile box) is considered to be an underestimate due to the earlier timing of the spawning events (Douglas and Chaput 2011). There is no estimate for 2012 because spawning was very early and bass left the sampling area prior to monitoring activities. There is no estimate for 2020 due to the inability to conduct field work activities. Box plots are interpreted as follows: dash is the median, boxes are the interquartile range, and the vertical dashes are the 5th to 95th percentile ranges.

Estimate of egg deposition relative to reference points

Reference points that conform to Precautionary Approach (PA) management principles were recently developed for the Striped Bass population of the southern Gulf of St. Lawrence (DFO 2021). Model consensus was not achieved and two models (Model 4 and Model 5) were carried forward to define potential reference points. The proposed Upper Stock Reference Point (USR) corresponded to the median estimate of eggs (spawner abundance) at 80% B_{msy} (biomass at maximum sustainable yield) and was defined, according to Model 4 as, 54,300 million eggs (equivalent to approximately 720 thousand spawners), and by Model 5 as, 91,320 million eggs (equivalent to approximately 2.1 million spawners). The Limit Reference Point (LRP) corresponded to the median estimate of eggs that resulted in 50% of the Beverton-Holt carrying capacity value K (half saturation) and was defined according to Model 4 as 17,300 million eggs (equivalent to approximately 330 thousand spawners), and by Model 5 as, 29,950 million eggs (equivalent to approximately 560 thousand spawners) (DFO 2021).

While the perspective on stock status is model dependent, DFO (2021) suggested that based on the trajectory of this population over the relatively short period of assessment, maintaining

Gulf Region

spawners above 330 thousand fish (equivalent to the median LRP value from Model 4) should be sufficient to avoid serious harm.

Considering the size (fork lengths) and estimated abundance of Striped Bass adults sampled in May and June, the median estimate of eggs in spawners was 17,901 million eggs (5th to 95th percentile range of 8,926 to 40,169 million), marginally above the LRP in 2021. The Striped Bass population of the southern Gulf has only exceeded the LRP in all assessed years since 2017, while the USR has only been exceeded once (5th percentile > LRP; 2017) throughout the time series of spawner abundance estimates (Figure 2).

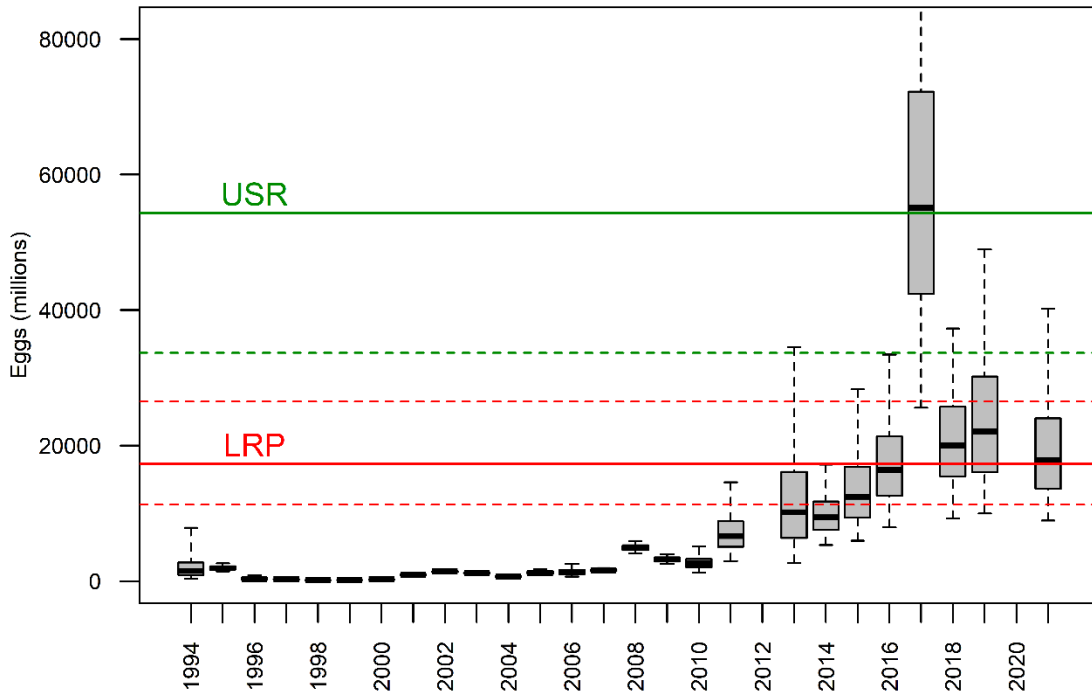


Figure 2. Estimated abundance of eggs in spawners (boxplots; eggs in millions) and status relative to the USR (solid green horizontal line) and the LRP (solid red horizontal line) reference points for the Striped Bass population of the southern Gulf of St. Lawrence, 1994 to 2021 (DFO 2021). The USR corresponds to the median estimate of eggs at 80% B_{msy} and the LRP corresponds to the median estimate of eggs that result in 50% of Beverton-Holt K (half saturation). The dashed red and green lines are the 5th to 95th percentile ranges of the LRP and USR respectively. Note the 95th percentile line of the USR and the 95th percentile point for eggs in 2017 are off the scale.

Biological characteristics

The mean fork length (FL) of adult Striped Bass (assumed to be fish > 30 cm) measured in May and June 2021 was 49.1 cm (range 30.1 to 94.0 cm; $n > 6,700$). Thirty-six percent of Striped Bass sampled had fork lengths between 30 and 45 cm, 50% between 46 and 61 cm (equivalent to the retention slot regulation of 50 to 65 cm total length (TL)), and 11% were 62 cm or greater (Figure 3).

For adult Striped Bass sampled during the months of September and October 2021, the mean fork length was 50.1 cm (range 30.5 to 95.2; $n > 5,700$). Thirty-four percent of Striped Bass

sampled had fork lengths between 30 and 45 cm, 53% between 46 and 61 cm (equivalent to the retention slot regulation of 50 to 65 cm TL), and 12% were 62 cm or greater (Figure 3).

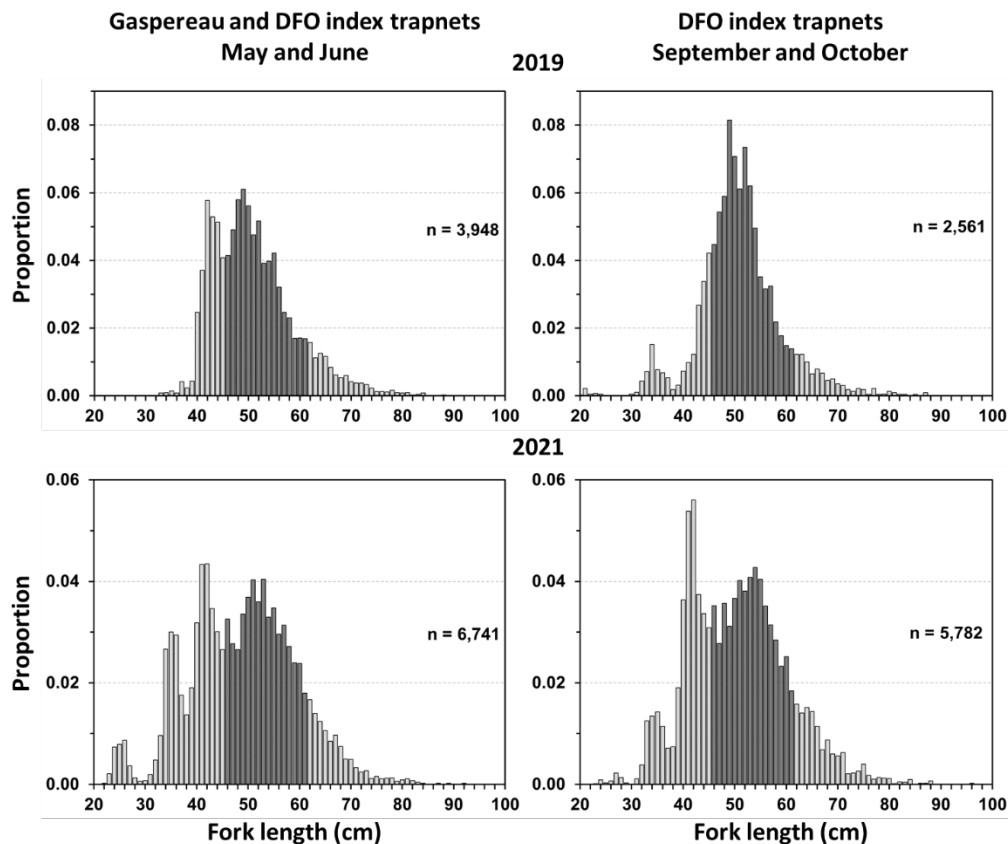


Figure 3. Relative fork length (cm) frequency distributions of Striped Bass sampled in May and June (left panel) and in September to October (right panel) from the gaspereau trapnet in the Northwest Miramichi and DFO index trapnets in 2019 (upper row) and 2021 (lower row). The dark grey shading represents Striped Bass between 46 and 61 cm fork length which is equivalent to the current recreational fishery regulation slot size for retention of bass between 50 to 65 cm total length. Biological characteristics were not collected from Striped Bass in 2020.

Conclusions

Striped Bass spawner abundance in 2021 was estimated at 260,700 fish with large uncertainty (5th and 95th percentile range of 130,000 to 585,000), as in previous years.

The median of the estimated egg abundance in adult Striped Bass exceeded the proposed LRP in 2021, similar to the period between 2017 and 2019. The proposed USR has only been met or exceeded once (2017) throughout the time series of spawner abundance estimates.

In 2021, Striped Bass that measured within the recreational fishery retention size slot of 50 to 65 cm TL (equivalent to 46 to 61 cm FL) was the most abundant size group in the spring (50% of fish sampled) and remained the same in the fall (53% of fish sampled).

The collection of the Striped Bass bycatch data used in this assessment is subject to the particulars of the Northwest Miramichi gaspereau fishery which only begins when there are sufficient numbers of gaspereau available to catch. The effective gaspereau fishing dates have been later in recent years than at the start of the time series. The monitoring of the movements

of Striped Bass onto and away from the spawning grounds using acoustic telemetry provides a method of estimating the total spawning population by correcting for the proportion of spawners that were available to capture in the bycatch monitoring program of the gaspereau fishery in the Northwest Miramichi, however this adjustment for the proportion of spawners in the area adds uncertainty to the population estimates. The Striped Bass catch rate data collected in 2021 were largely from the end of the spawning migration when the majority of the acoustically tagged bass had migrated out of the Northwest Miramichi by the first sampling date of the gaspereau fishery. All but one of the known females with acoustic tags had left the Northwest Miramichi by the first date of sampling. Female Striped Bass are known to leave the spawning area first whereas males stay longer (Douglas et al. 2009). Catches at the DFO index trapnets in 2021 confirm the sustained higher spawner abundance of Striped Bass in recent years.

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May 4, 2022

Sources of Information

This Science Response Report results from the Regional Science Response Process of December 14, 2021 on the determination of spawner abundance, age-class distribution and biological characteristics for striped bass for 2021. No additional publications from this process will be produced.

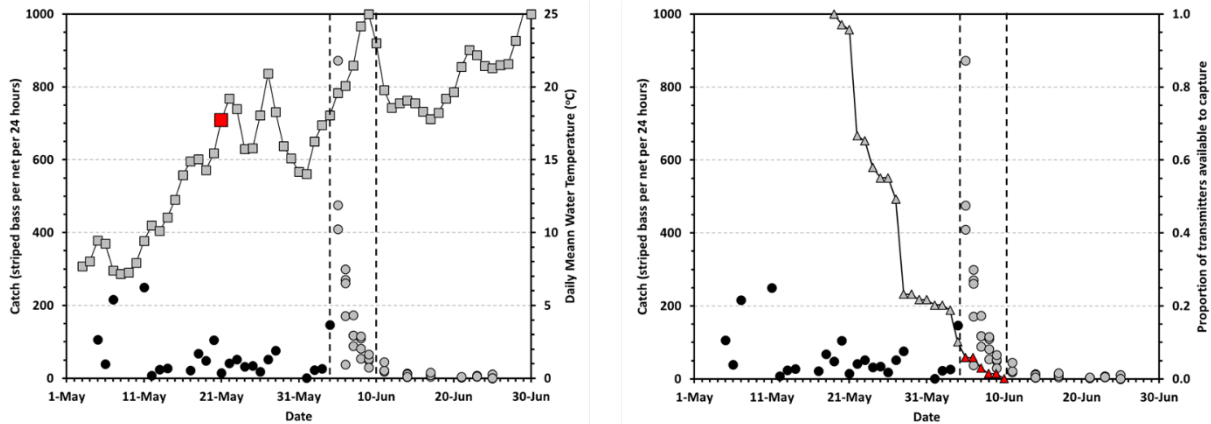
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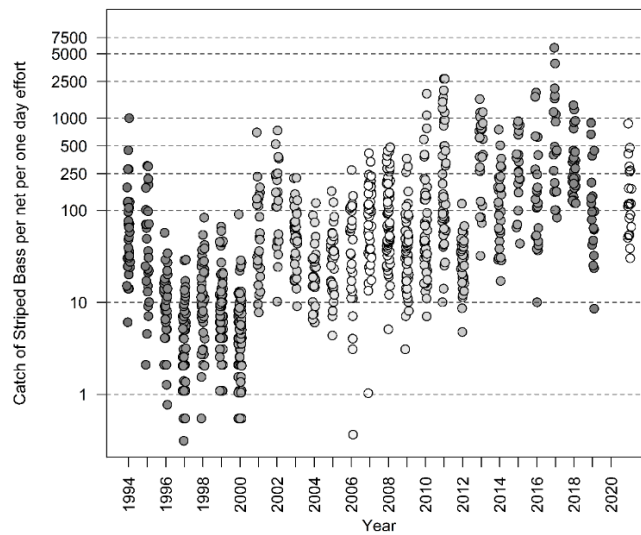
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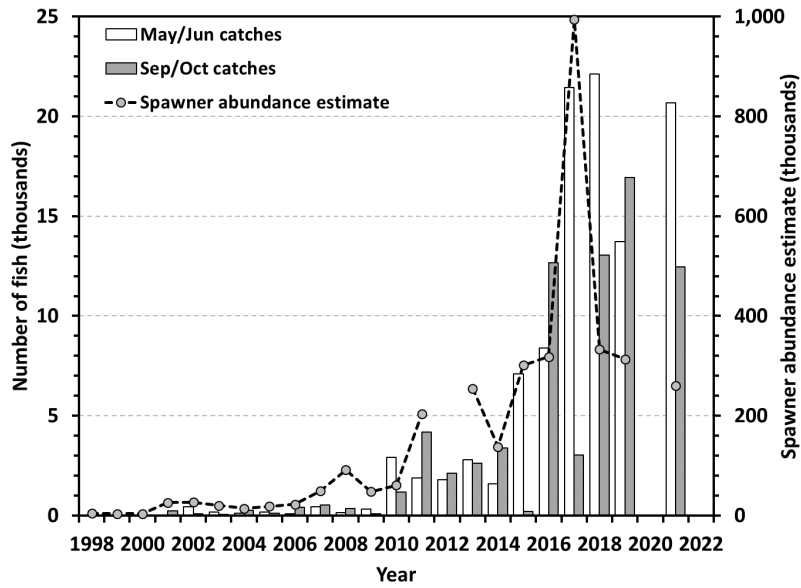
Appendices



Appendix 1. The number of Striped Bass captured per individual net per day for the early part of the season to collect biological information on the population (black circles) and in the commercial gaspereau fishery trapnets of the Northwest Miramichi estuary in 2021 (grey circles). Vertical dashed lines encompass the Striped Bass bycatch data and the period used in the CPUE analyses. In the left panel, the squares show the mean daily water temperature at the DFO Cassilis trapnet which is adjacent to the Striped Bass spawning area and the red square represents the temperature on May 21, the date of the initial observation of Striped Bass spawning in the upper Northwest Miramichi estuary in 2021. The right panel replicates the daily catch rate data along with the estimated proportion of available acoustically tagged bass present in the Miramichi (upstream of Loggieville) in 2021 prior to the beginning (grey triangles) and during the active commercial gaspereau fishery (red triangles).



Appendix 2. The number of Striped Bass captured per net per day of effort from monitoring of the commercial gaspereau fishery in the Northwest Miramichi, 1994 to 2021. The catch rates are not adjusted for the proportion of the spawners available for capture in the fishery. In 2012, the spawning was very early and the majority of the fish were considered to have left the area and were not available to the fishery, hence no estimate was provided for that year. Striped Bass bycatch monitoring did not occur in 2020. The points within a year are jittered slightly for clarity.



Appendix 3. The combined number of Striped Bass captured in the DFO index trapnets at Cassilis on the Northwest Miramichi River and at Millerton on the Southwest Miramichi River during the spring (May/Jun) and autumn (Sep/Oct) from 1998 to 2021. The catches during the fall season in 2015 were very low due to flood conditions which ended the monitoring program on September 30 for the Southwest Miramichi trapnet and suspended it for the Northwest Miramichi trapnet for five days during the first week of October. DFO index trapnets were not operated in 2020.

This Report is Available from the:

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ISSN 1919-3769

ISBN 978-0-660-44042-2 Cat. No. Fs70-7/2022-024E-PDF

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Correct Citation for this Publication:

DFO. 2022. Update of spawner abundance and biological characteristics of Striped Bass (*Morone saxatilis*) in the southern Gulf of St. Lawrence to 2021. DFO Can. Sci. Advis. Sec. Sci. Resp. 2022/024.

Aussi disponible en français :

MPO. 2022. Mise à jour de 2021 sur l'abondance des reproducteurs et les caractéristiques biologiques du bar rayé (*Morone saxatilis*) du sud du golfe du Saint-Laurent. Secr. can. des avis sci. du MPO. Rép. des Sci. 2022/024.