



## ASSESSMENT OF ST. MARY'S BAY LONGHORN SCULPIN (*MYOXOCEPHALUS OCTODECEMSPINOSUS*)



Longhorn Sculpin (*Myoxocephalus octodecemspinosus*)

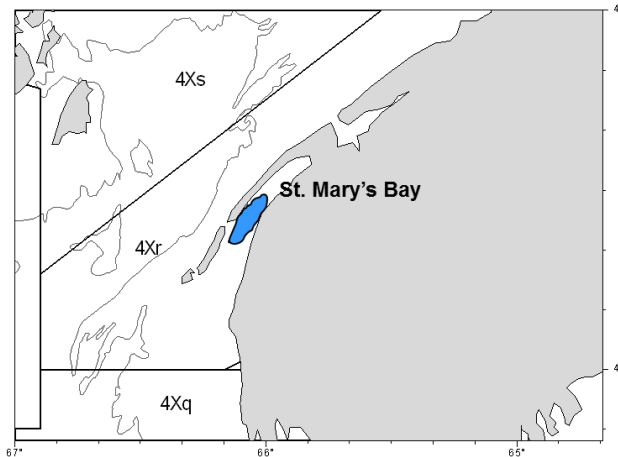


Figure 1. Location of the directed Longhorn Sculpin fishery in St. Mary's Bay, Nova Scotia.

### Context:

Since 1999, four license holders have been permitted to direct for Longhorn Sculpin in St. Mary's Bay, Nova Scotia, using otter trawls with 90–100 mm diamond mesh cod ends. The fishery occurs over a 6 week period during April and May, and the sculpin catch is sold for Lobster bait. There has been no annual Total Allowable Catch (TAC) established for this fishery. The last assessment of this stock was completed in 2008.

Industry participants have recently expressed concern about the sustainability of this fishery and the decreasing size of Longhorn Sculpin in their catches. Consequently, Fisheries and Oceans (DFO) Resource Management asked DFO Science to review all information available for evaluating the sustainability of this fishery, including fishery and survey indices, commercial fishery catch rates and in-season exploitation rates, and bycatch of non-target species, and to identify indices to monitor the fishery. This Science Advisory Report is from the March 3, 2020 Assessment of the St. Mary's Bay Longhorn Sculpin (*Myoxocephalus octodecemspinosus*) Fishery. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

## SUMMARY

- Landings of St. Mary's Bay Longhorn Sculpin peaked at 235 t and 229 t in 2011 and 2012, respectively, but declined to 29 t in 2019.
- Since 2011, landings of Winter Flounder bycatch in the Sculpin fishery have increased steadily and exceeded Sculpin landings in 2019. Other landed species include unspecified skates, Haddock, and Atlantic Halibut.
- Crustaceans represented 74% of all discarded bycatch (1999–2019 average) and included American Lobster, Jonah Crab, and Rock Crab. Winter Flounder discards represented 40% of all discards in 2018 and 2019.
- The average size of Longhorn Sculpin and the percentage of fish >23 cm (size-at-50% maturity) in the fishery catch-at-size declined during the early (1999–2006) and more recent (2009–2019) periods of the fishery, and they have both been below the long-term average since 2015.
- Although the overall spatial distribution of Longhorn Sculpin from the DFO Summer Research Vessel (RV) Survey does not appear to have changed, there has been a notable decrease in survey catches on the eastern Scotian Shelf and the outer Bay of Fundy since 2000.
- Biomass indices for survey strata in 4X and stratum 490 (adjacent to St Mary's Bay) have been below the long-term mean (1970–2019) since 2010.
- The average size of Longhorn Sculpin and percentage of fish >23 cm in DFO Summer RV Survey catches show a declining trend in survey strata in 4X and stratum 490 from 1970 to 2019, but the decline is steeper for stratum 490, especially since 2000.
- In season exploitation rates were above 30% in 2006 and from 2009–2015, and potentially as high as 75–76% in 2011 and 2012, when landings were highest.
- The median of the Catch Per Unit Effort (CPUE) time series was used as a proxy of biomass at maximum sustainable yield ( $B_{MSY}$ ). The Limit Reference Point (LRP) was calculated as 40% of  $B_{MSY}$ . The 3-year median CPUE is used for determining stock status.
- The CPUE declined rapidly to levels approaching 40% of the time series median (LRP proxy) in 2006 and 2019, in close proximity to the Cautious/Critical zone boundary.
- Additional indices to monitor the stock were identified and support the conclusion that the stock is approaching the Cautious/Critical zone boundary.

## BACKGROUND

A directed fishery for Longhorn Sculpin (*Myoxocephalus octodemspinus*) in St. Mary's Bay began in 1999. It continued through to 2019, with the exception of 2007 and 2008 when the fishery was closed (Figure 1). Four license holders are permitted to direct for Longhorn Sculpin using otter trawls with 90–100 mm diamond mesh cod ends deployed by "Generalist" mobile gear vessels under 65 feet in length. Small mesh gear is used in this fishery to reduce entanglement damage to American Lobster bycatch.

There has been no annual Total Allowable Catch (TAC) established for this fishery. Conservation measures include 100% Dockside Monitoring, mandatory hail out/hail in, and a target observer coverage level of 25%. The main bycatch species include American Lobster, which are released alive, and Winter Flounder, most of which are retained.

The previous stock assessment evaluated the impact of the directed fishery on Longhorn Sculpin and American Lobster populations within St. Mary's Bay, as well as on the benthic habitat where the fishery occurs (DFO 2008, Comeau et al. 2009). The main conclusions from this assessment were:

- Sculpin catch rates declined during the first years of the 1999–2006 directed fishery then stabilized at low levels.
- The abundance of larger (>23 cm) Longhorn Sculpin declined during this period, as well as the size of Longhorn Sculpin in the adjacent Fisheries and Oceans Canada (DFO) Summer Research Vessel (RV) Survey stratum (490).
- Within season exploitation rates were considered to be high (>30%), but insufficient information was available at the time to determine what level would be sustainable.
- While lobster bycatch was high, all animals were released and less than 1% were reported as damaged or dead; however, there was a poor understanding of any sub-lethal effects on lobsters after they were released.
- The habitat over which the directed Longhorn Sculpin fishery occurred was considered to be highly energetic and of low bottom complexity; the impact of the Longhorn Sculpin fishery on the sea floor was expected to be low.

### Species Biology

The Longhorn Sculpin is a bottom dwelling fish found in coastal waters of the western North Atlantic ranging from the Strait of Belle Isle, Newfoundland, south to the coast of northern Virginia (Collette and Klein-MacPhee 2002). Off Nova Scotia, they are found on Banquereau and Sable Island banks and are also common throughout the Bay of Fundy and St. Mary's Bay. Their preferred depth range on the Scotian Shelf is <90 m (Scott 1982), but they have been found at depths of up to 192 m (Collette and Klein-MacPhee 2002).

Longhorn Sculpin can reach a length of 46 cm; however, they rarely grow larger than 35 cm (Scott and Scott 1988). Information on age and growth is limited to Morrow (1951). This work suggested that sculpin from southern New England waters were 5.5 cm at Age 1, 18 cm at Age 2, 21 cm at Age 3, 25 cm at Age 4, 27 cm at Age 5, and 30 cm at Age 6.

In southern New England, spawning occurs during winter months (November–January) in inshore areas (Collette and Klein-MacPhee 2002); however, the exact timing of spawning is uncertain for St. Mary's Bay. Spawning occurs inshore on rocky bottoms (Scott and Scott 1988) where the average female deposits approximately 8,000 eggs (Collette and Klein-MacPhee 2002). The eggs are demersal, adhesive, and deposited in clusters on sponges or in cavities on hard bottom (Scott and Scott 1988). The size of Longhorn Sculpin at 50% maturity in the Maritimes area of the northwest Atlantic is reported to be 23 cm for females and 24 cm for males (Beacham 1982), which roughly corresponds to ages 3–4.

Longhorn Sculpin are opportunistic feeders and consume fish (Haddock, Sand Lance), shrimp, and crabs. Predators include Atlantic Cod, Spiny Dogfish, Little Skate, Winter Skate, Sea Raven, Monkfish, White Hake, and other sculpins. Other attributes of Longhorn Sculpin biology are provided in Comeau et al. (2009).

### Commercial Fishery Landings

Sculpin landings first appear in the Maritimes regional landings statistics in 1990 (Table 1; Figure 2). The Northwest Atlantic Fisheries Organization (NAFO) Division 4X accounts for 98% of total reported landings from 1990–2019, with the remaining 2% from NAFO Divisions 4VW, 5ZE, and 5Y. Total landings averaged <25 t/year in 4VWX5 from 1990–1998 when sculpin were

reported as bycatch in other fisheries. Landings increased in 1999, when the directed sculpin fishery began in St. Mary's Bay (Figure 2). The period of highest landings in NAFO Divisions 4VWX5 occurred from 2009–2016 when reported catches ranged from 260–434 t.

*Table 1. Reported annual landings (t) of Sculpin (all species) by NAFO Division, 1990–2019. Cells with dashes (-) have no data available; cells with 0 have landings <1 t. SMB = St. Mary's Bay directed fishery.*

Year(s)	4V	4W	4X (excl SBM)	SMB	5Y	5ZE	Total
1990–98 (avg)	1	1	23	-	0	0	24
1999	-	0	21	62	0	1	84
2000	-	-	25	141	0	1	166
2001	-	0	21	152	0	4	177
2002	-	0	42	101	0	0	143
2003	-	0	47	74	1	0	122
2004	-	0	64	42	0	1	108
2005	-	0	94	87	1	2	184
2006	9	1	100	88	0	6	204
2007	4	0	141	-	0	2	147
2008	-	0	144	-	0	1	146
2009	-	1	183	156	8	-	348
2010	-	0	155	208	0	0	363
2011	-	0	195	235	4	0	434
2012	12	0	154	228	5	1	401
2013	4	2	143	172	3	1	325
2014	0	0	213	195	0	1	410
2015	0	0	216	127	0	-	345
2016	0	2	165	93	0	0	260
2017	4	2	103	74	0	0	183
2018	1	0	90	56	0	2	148
2019	2	10	111	29	0	0	151

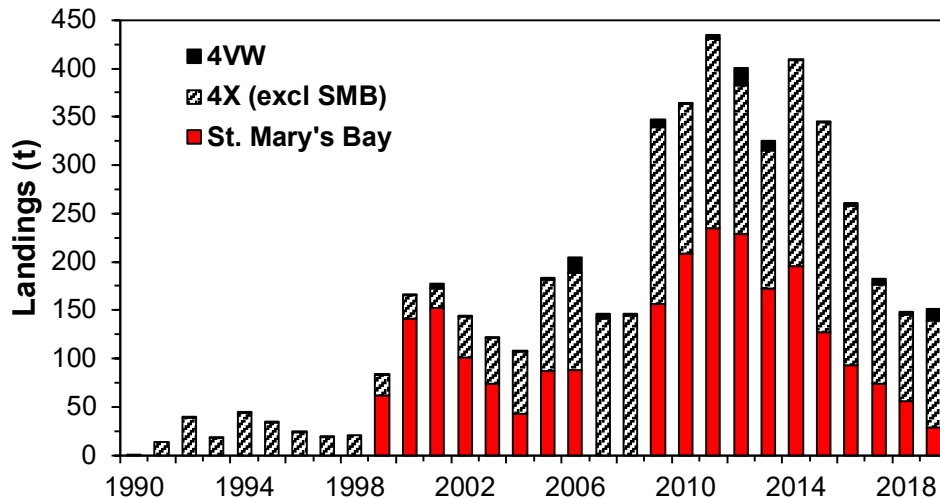


Figure 2. Landings (t) of Sculpin (all species) in NAFO Divisions 4X (excluding St. Mary's Bay) and 4WV (1990–2019) and the St. Mary's Bay directed Longhorn Sculpin fishery (1999–2019).

The majority of Sculpin landings are from NAFO Division 4X bottom trawl fisheries in St. Mary's Bay, the outer and inner Bay of Fundy, north of Browns Bank and in the western Gulf of Maine (average= 234 t/yr for 2002–2019). Bottom trawl catches of Sculpin from outside St. Mary's Bay are likely bycatch from Haddock or Winter Flounder directed fisheries. Landings are also reported from 4X groundfish gillnet fisheries (average = 8 t/yr for 2002–2019) that occur in the outer reaches of St. Mary's and St. Margaret's bays, as well as on German Bank. Incidental Sculpin landings from Lobster trap fisheries are only available for 2018 and 2019 in 4X (2018: 9 t; 2019: 29 t) and for 2019 in 4W (2019: 9 t). Sculpin catches have also been reported from 4X groundfish longline fisheries, but amounts are low (average <1 t/yr for 2002–2019).

Longhorn Sculpin landings from the directed fishery in St. Mary's Bay averaged 94 t/year from 1999–2006 (63% of 4X landings) and 143 t/year from 2009–2019 (44% of 4X landings) (Table 1; Figure 2). Although there was no directed fishery in 2007 and 2008, Sculpin bycatch landings in 4X were 141 t and 147 t, respectively. Landings from the directed fishery peaked at 235 t and 229 t in 2011 and 2012, but they have steadily declined since 2014, with greater contributions from outside of St. Mary's Bay in unit areas 4Xoqrs as bycatch in other fisheries. In 2019, reported landings from the directed fishery were 29 t, the lowest amount reported for the 1999–2006 and 2009–2019 time series; however, only three of the four licensed vessels were fishing in 2019.

## ANALYSIS

### Landings of Bycatch Species

Winter Flounder is the predominant landed bycatch species in the directed Longhorn Sculpin fishery in St. Mary's Bay (Figure 3). Since 2011, Winter Flounder landings have steadily increased and exceeded Longhorn Sculpin landings in 2019 (i.e., 51 t of Winter Flounder compared to 29 t of Longhorn Sculpin). Winter Flounder bycatch increased from 1% of total landings in 2011 to 58% in 2019. Skate landings displayed a similar trend, increasing from 1% of total landings in 2014 to 6% in 2019. Other landed species included skates (<1.0–5.0 t), Haddock (<1.0–3.6 t), and Atlantic Halibut (<1.0–0.5 t).

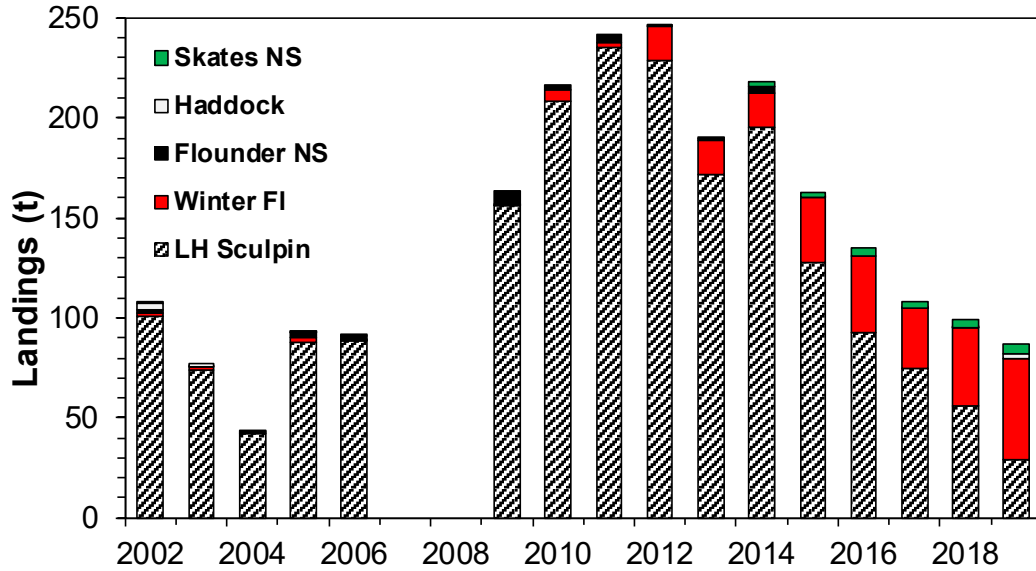


Figure 3. Reported annual landings (t) of species from the St. Mary's Bay Longhorn Sculpin directed fishery, 2002–2006 and 2009–2019. NS = non-specified, FI = Flounder, LH = Longhorn.

### Winter Flounder Catch Rates

From 1999 to 2006, Winter Flounder catch rates declined from 0.015 t/hr (1999) to <0.001 t/hr (2006) (Figure 4). After the resumption of the Longhorn Sculpin directed fishery in 2009, catch rates increased from <0.001 t/hr to 0.07 t/hr, an increase of more than a factor of 7. It is unclear if this increase was due to an increase in Winter Flounder abundance in St. Mary's Bay or to the targeting of this species by the directed sculpin fishery license holders, but it coincides with the declining Longhorn Sculpin catches.

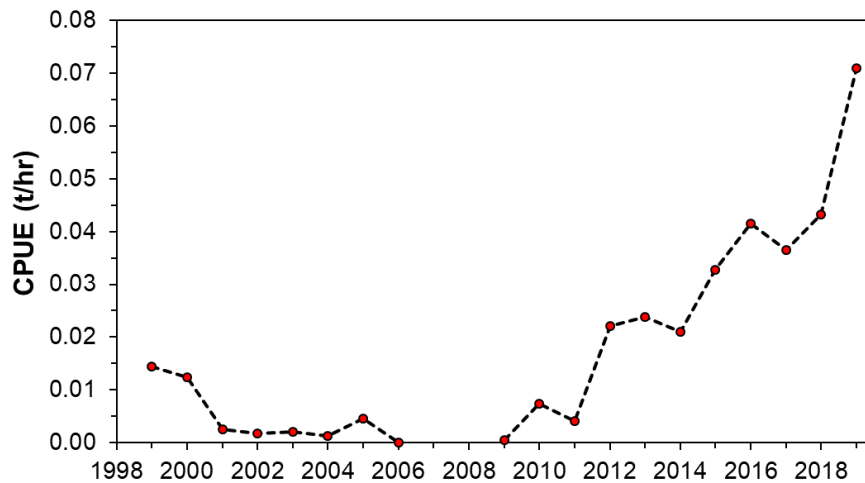


Figure 4. Trends in Catch Per Unit Effort (CPUE; t/hr) for Winter Flounder bycatch from the St. Mary's Bay directed Longhorn Sculpin fishery, 1999–2019. The directed fishery was closed in 2007 and 2008.

### At-Sea Observer Data

Estimates of at-sea observer coverage levels for the St. Mary's Bay Longhorn Sculpin fishery use data from the Observer Program Database and the Maritimes Region Commercial Landings Database (MARFIS). Coverage from 1999–2001 was 100% of trips and landings; from 2002 to

2006, coverage ranged from 30–70%; and from 2009–2019, coverage declined to 10–19% of trips and landings (2009–2019 average = 15%).

A discard:kept ratio estimator was used to estimate the kept and discarded catch from the St. Mary's Bay Longhorn Sculpin fishery. The estimator calculates the total kept and discarded amounts that are expanded to total landings for years when observer coverage was <100%. Similar to the MARFIS landings, Winter Flounder is the primary kept species after Longhorn Sculpin and represent an increasing amount of total kept catch since 2011, followed by Sea Raven, skates (Little, Winter, Thorny), and Atlantic Halibut (Figure 5; upper panel). Sea Raven is recognized by at-sea observers as a separate species; however, within the MARFIS commercial landings database, Sea Raven is included in the "Sculpin" category along with grubbies and Shorthorn Sculpin (approximately 3% kept sculpin catch). No adjustments to the landings data were made to account for this in the current assessment.

At-sea observers reported over 90 species as discards from the St. Mary's Bay Longhorn Sculpin fishery (Figure 5; lower panel shows the top 8). Crustaceans account for most of the discarded bycatch and included American Lobster (average = 23 t/yr), Jonah Crab (average = 13 t/yr), and Rock Crab (average = 7 t/yr). Winter Flounder discards averaged 6 t/yr, but increased to 33 t and 29 t in 2018 and 2019, respectively. This represented 40% of all discards for these years. Additional discarded species include sturgeon (2.5 t/yr), skates (1.8 t/yr), Ocean Pout (1 t/yr), and Windowpane Flounder (1 t/yr).

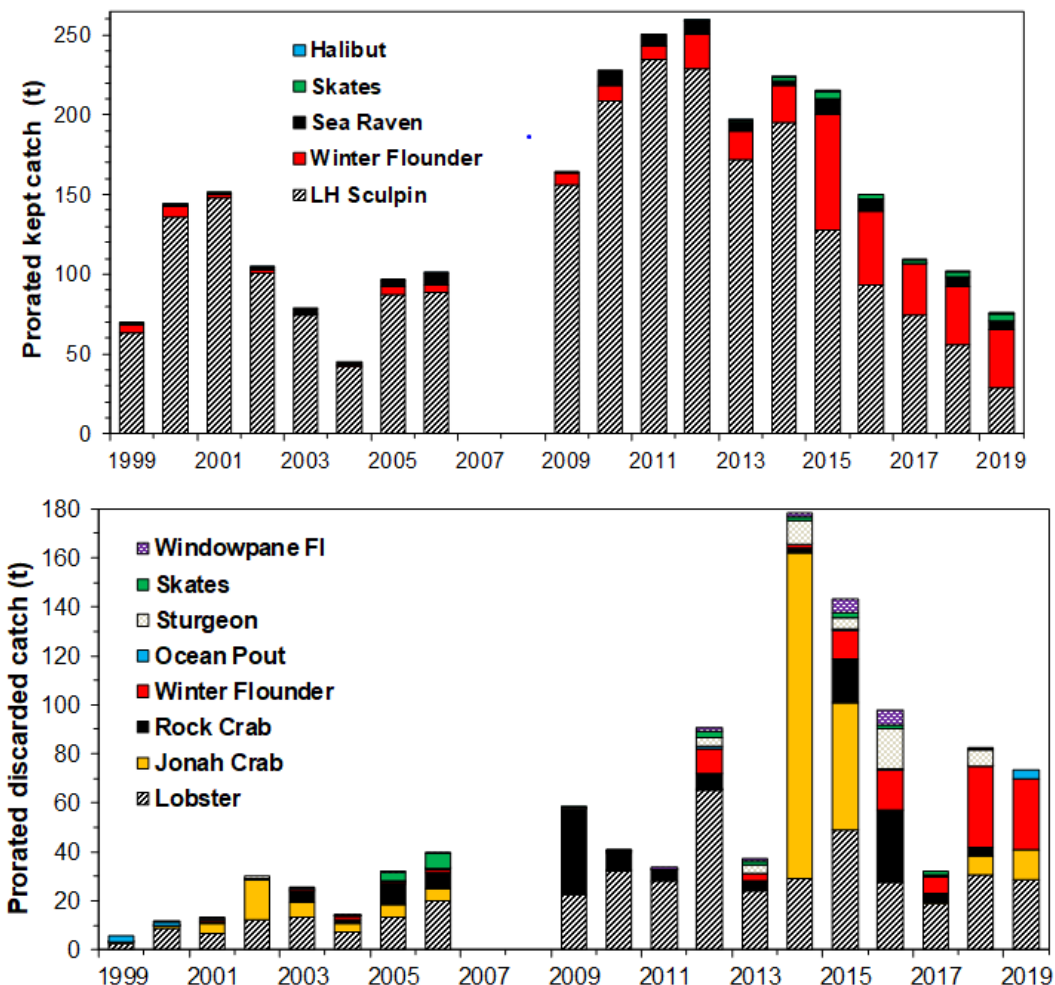


Figure 5. Prorated total kept catch (t, upper panel) and discarded catch (t, lower panel) by species from the St. Mary's Bay Longhorn Sculpin fishery, 1999–2019. LH = Longhorn, FI = Flounder.

### Fishery Dependent Indices

The directed Longhorn Sculpin fishery catch-at-size was calculated using annual length-frequency samples from at-sea observers. These were expanded to the fishery level using annual commercial landings data and a length-weight relationship derived from the DFO Summer RV Survey data. The average size of Longhorn Sculpin (weighted mean length calculated from the fishery catch-at-size) declined during the early (1999–2006) and more recent (2009–2019) period of the fishery, with annual means falling below the time-series mean of 24.2 cm in 2005 and 2006 and from 2016–2019 (Figure 6). In 2005, the weighted mean length was influenced by a recruitment pulse of small sculpin (mean = 11 cm total length) that reduced the overall mean to 21 cm.

The percentage of fish >23 cm (size-at-50% maturity) in the fishery catch-at-size declined from 80% to 60% during 1999–2006 (Figure 6). Only 36% of the catch was >23 cm when the fishery resumed in 2009, then increased to 60–85% from 2011–2015 (Figure 6). Since 2015, the percentage of Longhorn Sculpin >23 cm has been below the time-series mean of 62%, averaging 45% for 2016–2019.



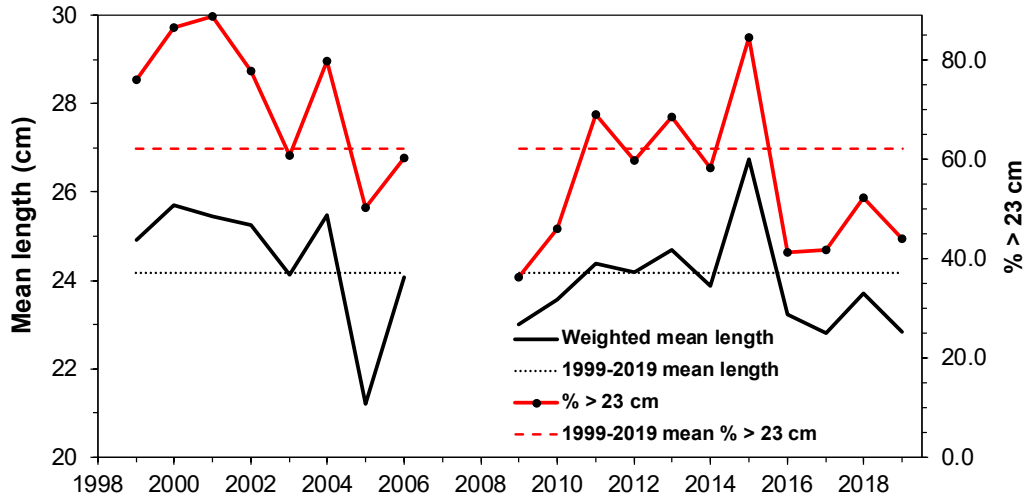


Figure 6. Weighted mean length (cm) of Longhorn Sculpin from the commercial fishery catch-at-size and the percentage of the catch-at-size >23 cm (= size-at-50% maturity) for 1999–2019. Dashed lines are the 1999–2019 means for each series. The directed fishery was closed in 2007 and 2008.

### DFO Summer Research Vessel Survey

#### Spatial Distribution and Biomass Trends

Fisheries and Oceans Canada has conducted an annual summer stratified random bottom trawl survey of the Scotian Shelf/Bay of Fundy area since 1970. Over the 49-year time series, there were persistent aggregations of Longhorn Sculpin on the Scotian Shelf, the main areas being offshore on Sable Island and Banquereau banks, Browns Bank, and the outer Bay of Fundy (Figure 7). Although the overall spatial distribution does not appear to have changed, survey catches on the eastern Scotian Shelf and the outer Bay of Fundy have decreased since 2000 (Figure 7; 2000–2009 and 2010–2019).

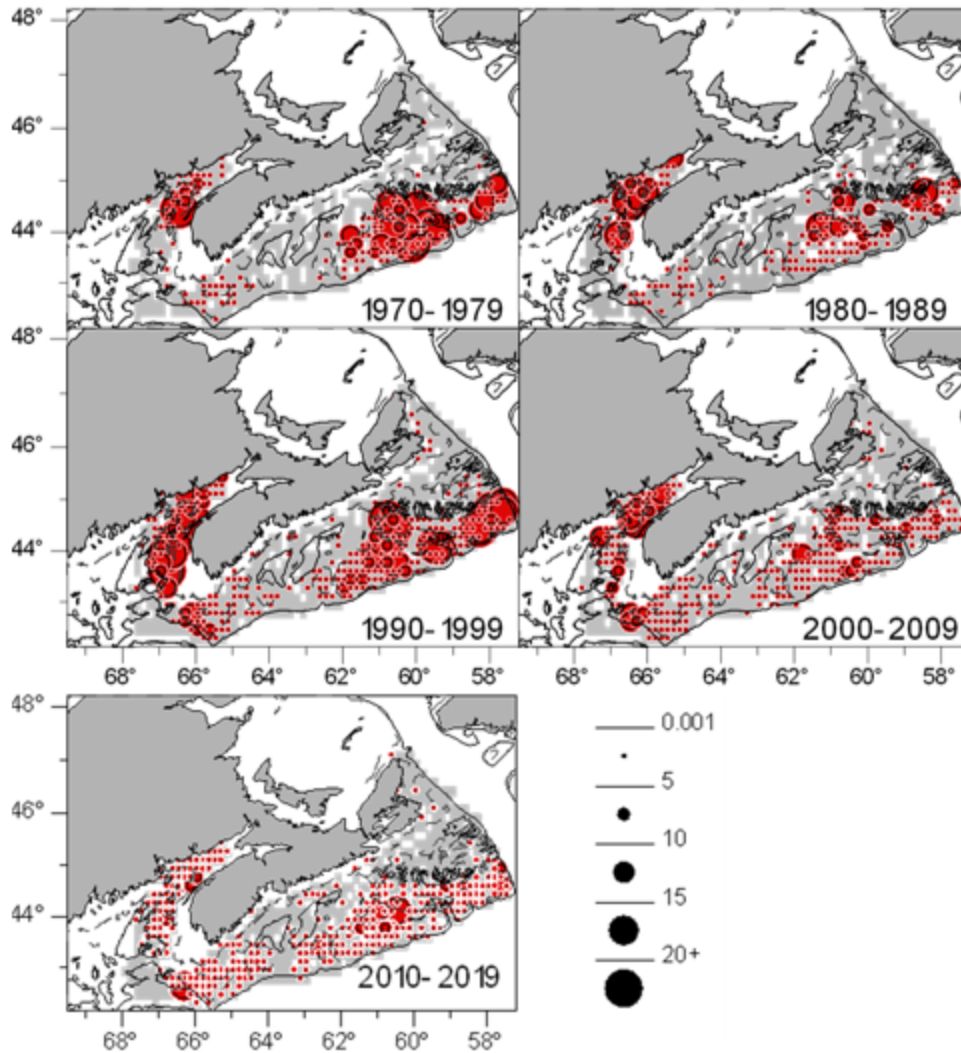


Figure 7. Distribution of Longhorn Sculpin catches (10-year average weight (kg)/tow aggregated by 10 minute squares) from the DFO Summer Research Vessel Survey strata 470–495, 1970–2019. Grey shading indicates extent of area surveyed. Circle size is proportional to 10-year average weight (kg)/tow within 10 minute rectangles.

The DFO Summer RV Survey does not provide coverage of St. Mary's Bay; therefore, there is currently no fishery independent index of abundance for Longhorn Sculpin in this area. The DFO Summer RV Survey stratum 490, which is located adjacent to and west of St. Mary's Bay (Figure 8), is used for comparing trends in Longhorn Sculpin biomass and abundance with those from NAFO Divisions 4X (strata 470–495) and 4VW (strata 440–466).

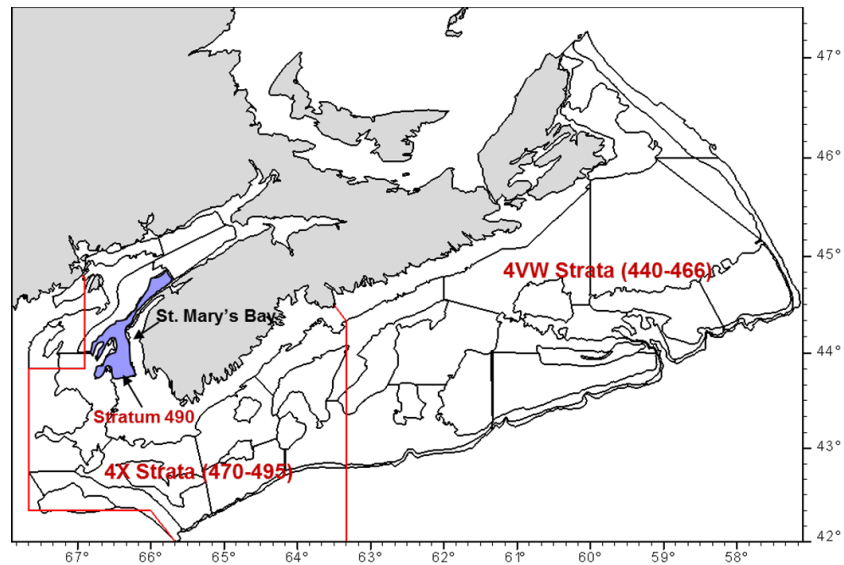


Figure 8. Location of DFO Summer Research Vessel Survey stratum 490 (adjacent to St. Mary's Bay, Nova Scotia), 4X strata (470–495), and 4VW strata (440–466).

Annual DFO Summer RV Survey minimum trawlable biomass estimates for stratum 490 and the 4X and 4VW strata are quite variable over the 49-year time series (Figure 9). Applying a three-year Geometric Mean (GM; 3-year moving average) to the annual trawlable biomass estimates provides a clearer indication of long-term trends by smoothing some of the variability. The smoothed biomass index was below the long-term GM (1970–2019) for the 4X strata and stratum 490 from the early 1970s to the mid 1980s, followed by a period of higher biomass during the 1990s. After 2000, the biomass decline in stratum 490 is steeper than in the 4X strata, which coincides with start of the St. Mary's Bay directed sculpin fishery. Both series have been below the long-term GM since 2010.

Unlike the 4X strata and stratum 490, the smoothed biomass index for the 4VW strata was above the long-term GM in the 1970s, then variable up to the mid 2000s, but has been below the time series GM since 2008 (Figure 9). Longhorn Sculpin biomass has declined across the Scotian Shelf/Bay of Fundy area since the late 2000s.

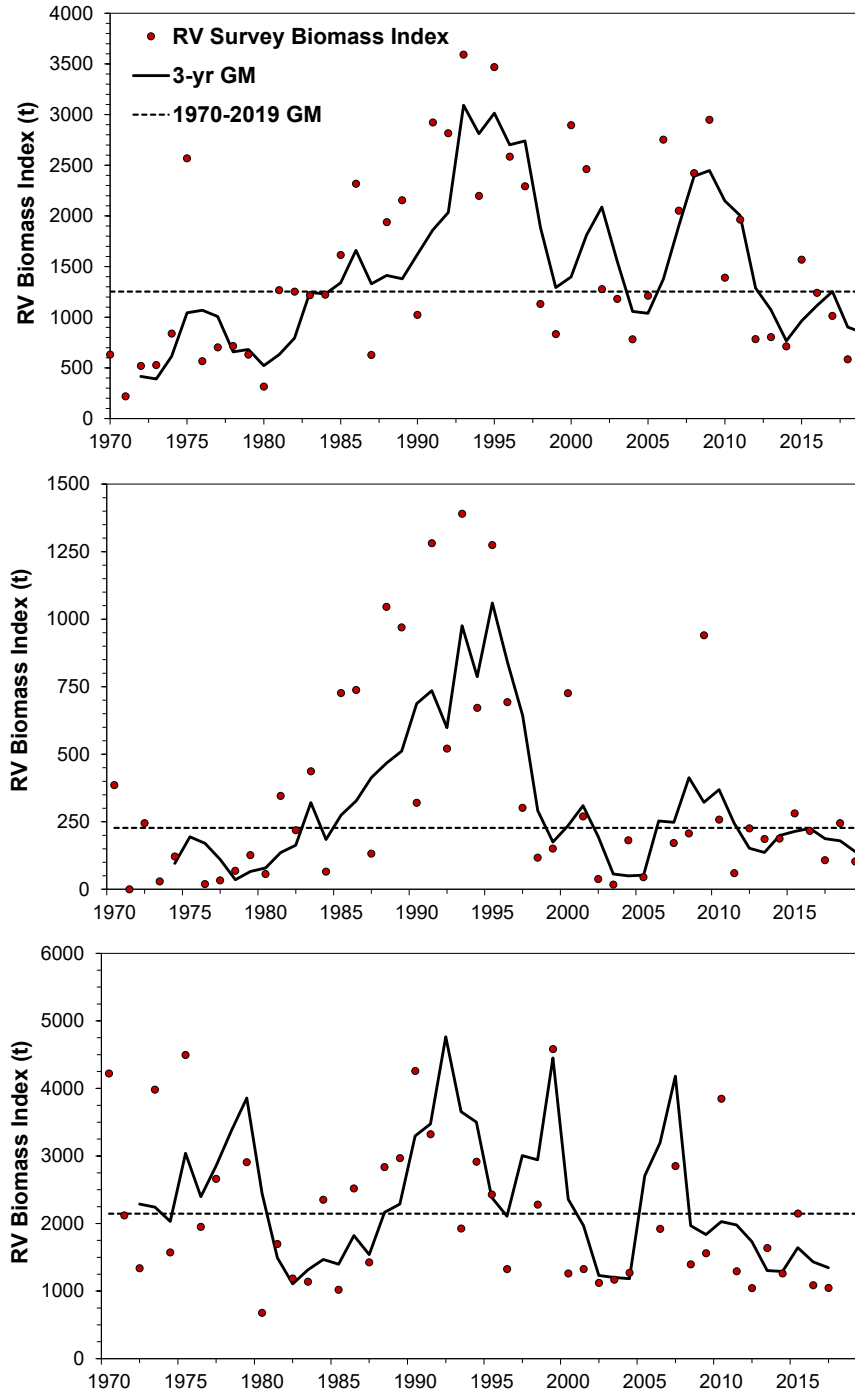


Figure 9. Trends in the Longhorn Sculpin minimum trawlable biomass index (t) from the DFO Summer Research Vessel (RV) Survey for 4X strata (470–495; top panel), stratum 490 (middle panel), and 4VW strata (440–466; bottom panel), 1970–2019. The red dots are the annual survey index values, the solid black line is the 3-year moving geometric mean, and the dashed line is the geometric mean for the complete time series.

**Weighted Mean Length and Percentage >23 cm**

Similar to the commercial fishery, the weighted mean length (cm) of Longhorn Sculpin from the DFO Summer RV Survey catch-at-size and percentage of catch-at-size >23 cm for stratum 490

and strata 470–495 (4X) declined over the survey time series from 1970–2019 (Figure 10). The rate of decline (linear trend) in average length and percentage >23 cm is steeper for stratum 490 compared to the 4X strata, with the greatest divergence occurring after 2000 (i.e., lower for stratum 490). Although the St. Mary's Bay fishery began in 1999, it is unclear if the start of the fishery influenced the steeper decline in weighted mean length and the percentage >23cm in stratum 490 after 2000.

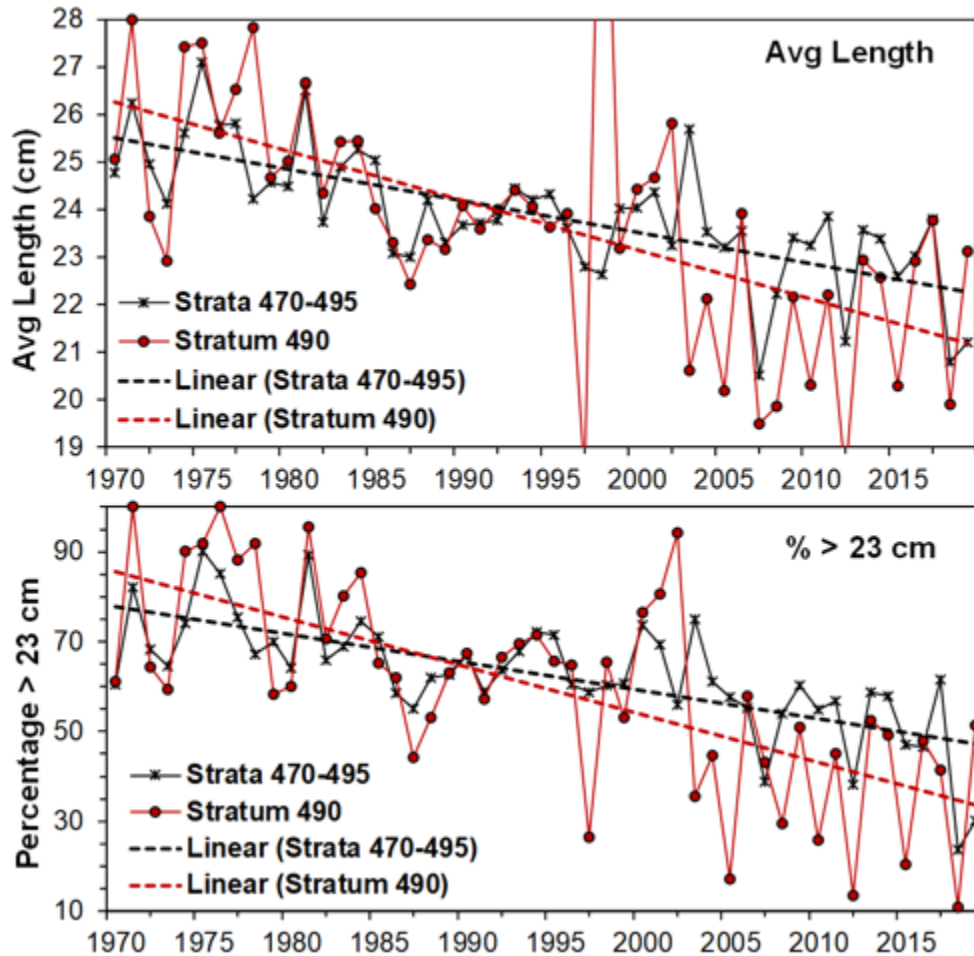


Figure 10. Weighted mean length (cm) of Longhorn Sculpin from the DFO Summer RV Survey catch-at-size (upper panel) and percentage of catch-at-size >23 cm total length (lower panel) for stratum 490 and strata 470–495 (4X), 1970–2019. Dashed lines are the linear trends for strata 490 (red) and strata 470–495 (black).

### Fishery Exploitation Rates

A depletion model known as the “Leslie Method” (Leslie and Davis 1939) was used to estimate the initial Longhorn Sculpin population size ( $N_0$ ) available for each year of the St. Mary's Bay fishery using catch and effort data from the MARFIS Commercial Landings Database for 2002–2019 and the Industry Surveys Database for 1999–2001. This approach involves regressing the daily CPUE index of abundance (t/hr) against cumulative daily catch (t). The X-intercept of the regression line is a proxy for the initial population size ( $N_0$ ) available at the beginning of the fishing season. The ratio of annual catch to initial population size provides an estimate of “in season” exploitation rate (similar to Relative F).

For this method to work, the fishery has to occur over a short time period (6 weeks for the St. Mary's Bay fishery) to limit the potential effects of immigration/emigration, and the stock has to be depleted by fishery removals (i.e., regression of daily CPUE to cumulative catch has a negative slope). For most years, the relationship between CPUE and cumulative catch had a negative slope; however, three years (1999, 2002, and 2004) had an increasing CPUE with cumulative catch and were not included in this analysis. The relationships between CPUE and cumulative catch in 2013, 2018, and 2019 had slightly negative slopes and were included in this assessment. The initial population size for these years is likely an overestimate, resulting in exploitations rates that are lower than expected in comparison with the CPUE series.

From 2000 to 2006, in-season exploitation rates increased from 12% to 38% (Figure 11). When the fishery resumed, exploitation was above 30% from 2009–2015 and potentially as high as 75–76% in 2011 and 2012, when landings were highest. In 2016 and 2017, exploitation declined to approximately 30%. The exploitation estimates for 2018 and 2019 (i.e., 23% and 18%, respectively) are inconsistent with the low catch rates observed for these years and are caused by the lack of contrast between CPUE and cumulative catch.

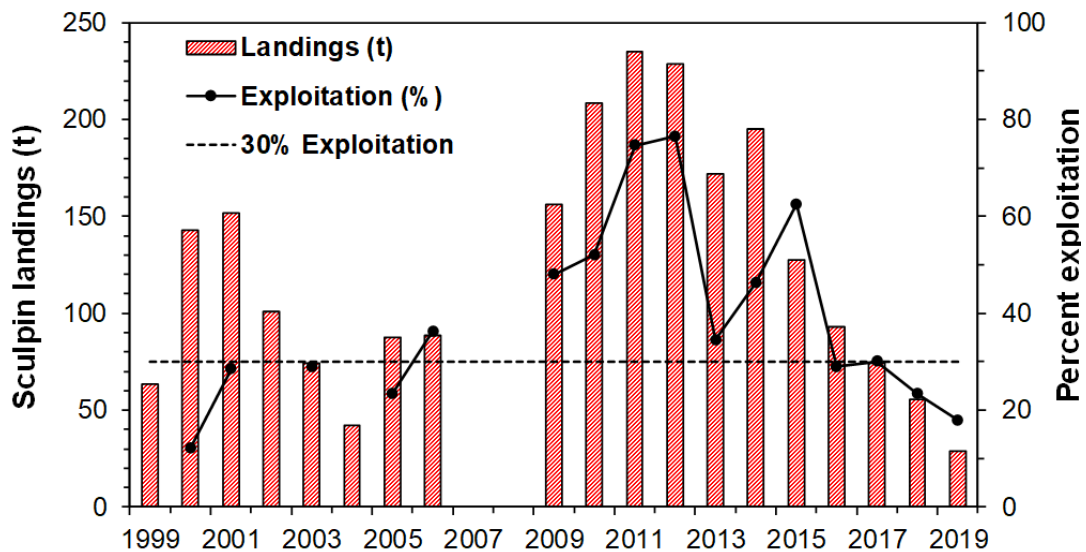


Figure 11. In season percent exploitation (black line) and total Longhorn Sculpin landings (red histograms) from the St. Mary's Bay directed fishery, 1999–2019. The black dashed line represents 30% level of exploitation, a level considered to be high for groundfish stocks. The directed fishery was closed in 2007 and 2008.

## Indicators of Stock Status

### Commercial Fishery Catch Rates

Nominal catch rates (t/hr) for the St. Mary's Bay directed Longhorn Sculpin fishery were calculated using landings and effort data from the Maritimes Region commercial landings database (MARFIS) for 2002–2019 and the Industry Survey Database (ISDB) for 1999–2001, when there was 100% at-sea observer coverage. During 1999–2006, fishing effort (hrs towed) was variable but peaked in 2006 even though landings did not increase at that time (Figure 12). Fishing effort from 2009–2014 showed a modest increase with increasing landings and remained high after 2014, despite declining landings.

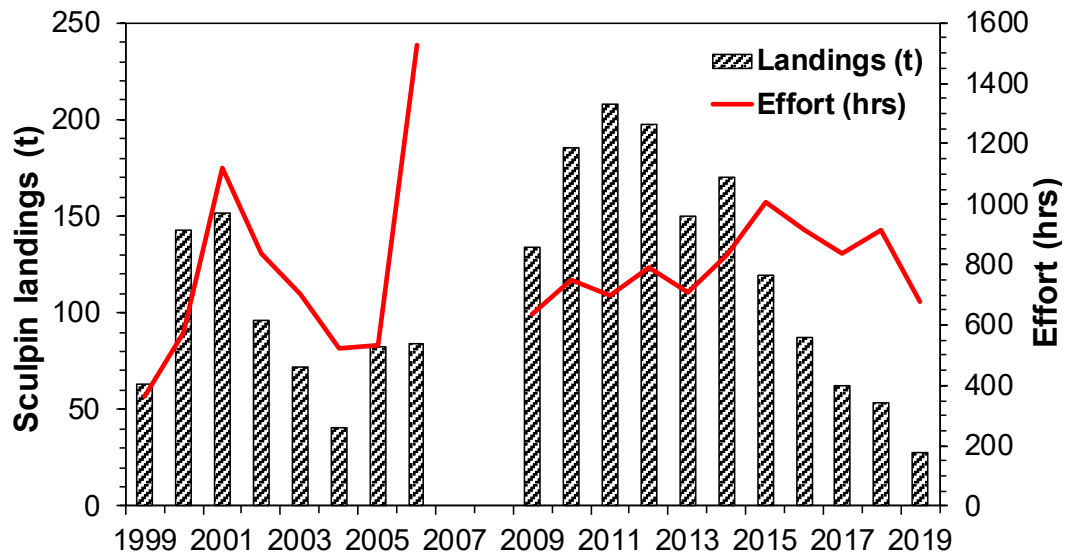


Figure 12. Fishing effort (hours towed; red line) and total Longhorn Sculpin landings (black histograms) from the St. Mary's Bay directed fishery, 1999–2019. The directed fishery was closed in 2007 and 2008.

The CPUE index showed a pattern of “fishing up” and then “fishing down” the stock, both before and after the 2-year closure (2007–2008), with peaks in 2000 and 2011 (Figure 12). Assuming the CPUE index is proportional to population abundance, this would indicate a decline in relative abundance from 2001–2006 and again from 2012–2019.

The CPUE time series median (0.132 t/hr) was used as a proxy for calculating a Limit Reference Point (LRP), which is 40% of the 1999–2019 median value (i.e.,  $0.132 \times 0.4 = 0.053$  t/hr). A smoothed CPUE index, calculated using a 3-year moving median to reduce variability in the time series, was used to determine the current level of relative abundance in relation to the LRP (Figure 13). In 2006 and 2019, the smoothed index was just above 40% of the time series median at 0.081 and 0.061 t/hr, respectively, placing the relative abundance of the St. Mary's Bay sculpin stock at the Cautious/Critical zone boundary.

In addition to CPUE, the following indicators could be used to monitor/assess stock status in future assessments: 1) Average length and percentage of fish >23 cm in the commercial fishery and DFO Summer RV Survey catches, 2) DFO Summer RV Survey total biomass and total abundance-at-length in stratum 490 and 470–495 (4X), and 3) In-season exploitation (Relative F) based on the Leslie depletion method.

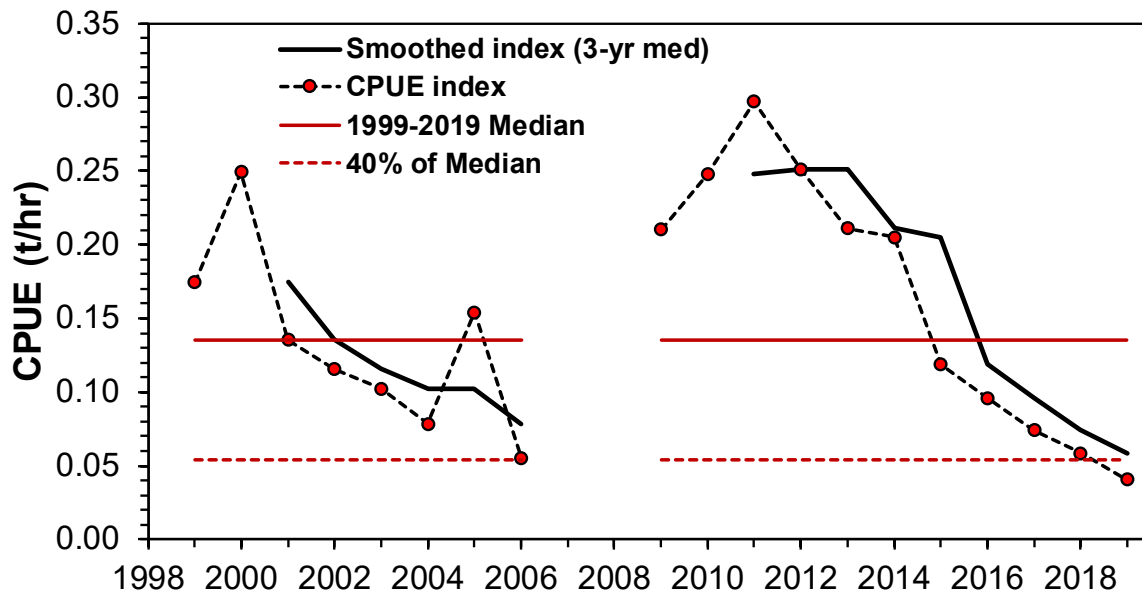


Figure 13. Catch Per Unit Effort (CPUE; t/hr) for the St. Mary's Bay directed Longhorn Sculpin fishery, 1999–2019. The nominal CPUE index is indicated by the dashed black line; the smoothed CPUE index (3- year running median) is indicated by the solid black line. The solid red line is the time series median (0.132 t/hr); the dashed red line is the LRP (0.053 t/hr). The directed fishery was closed in 2007 and 2008.

### Sources of Uncertainty

The DFO Summer RV Survey does not provide coverage of St. Mary's Bay, and, therefore, no fishery independent index (i.e., one without bias due to gear selectivity effects) of population biomass or size composition for Longhorn Sculpin currently exists for this area.

The extent of mixing of Longhorn Sculpin from St. Mary's Bay with the adjacent population in the outer Bay of Fundy is unknown. This would include movement of recruits in and out of St. Mary's Bay.

Sculpin landings in the MARFIS database include other species (i.e., Sea Raven, Shorthorn Sculpin, grubbies) that are not identified separately and could inflate catch amounts for Longhorn Sculpin.

### CONCLUSIONS AND ADVICE

Landings of St. Mary's Bay Longhorn Sculpin peaked at 235 t and 229 t in 2011 and 2012, respectively, but declined to 29 t in 2019. This coincides with increased landings of Winter Flounder bycatch from 1% of total landings in 2011 (3 t) to 58% in 2019 (51 t), and landings of Winter Flounder currently exceed those of sculpin. The average size of Longhorn Sculpin and the percentage of fish >23 cm (size-at-50% maturity) in fishery catches has been below the long-term average since 2015.

At-sea observer coverage levels for the 2009–2019 directed fishery have averaged 15% of landings and trips, which is lower than the earlier period of the fishery (1999–2006). Crustaceans represent 74% of all discarded bycatch (1999–2019 average) and include American Lobster, Jonah Crab, and Rock Crab. Since 2015, there has been an increase in the percentage of Winter Flounder discards, representing 40% of all discards in 2018 and 2019.



The spatial distribution of Longhorn Sculpin does not appear to have changed across the Scotian Shelf/Bay of Fundy area; however, catches of sculpin from the DFO Summer RV Survey have declined since 2000. Biomass indices for 4X strata and stratum 490 (adjacent to St Mary's Bay) have been below the long-term mean (1970–2019) since 2010. The average size of sculpin and percentage of fish >23 cm in survey catches show a declining trend in 4X strata and stratum 490 from 1970–2019, but the decline is steeper for stratum 490, especially since 2000. It is unclear if the trends observed in stratum 490 are influenced by the St. Mary's Bay Longhorn Sculpin fishery, but this stratum provides the only time series of data currently available from an area closest to the directed fishery.

The directed fishery CPUE index shows a pattern of “fishing up” and “fishing down” the stock before and after the 2007–2008 closure. In both periods, relative abundance declined to levels approaching 40% of the time series median (LRP proxy) in 2006 and 2019.

In season exploitation rates were above 30% from 2009–2015 and may have reached levels of 75–76% in 2011 and 2012, when landings were highest. Since 2016, the Longhorn Sculpin fishery exploitation rate has declined. At the same time, catch rates of Winter Flounder have increased since 2009, but it is unclear if this increase is due to an increase in Winter Flounder abundance or to targeting of this species by the directed sculpin fishery license holders.

The main indicator used to assess stock status is an LRP based on 40% of the 1999–2019 CPUE time series. A smoothed CPUE index, calculated using a 3-year moving median to reduce variability in the time series, was used to determine the current level of relative abundance in relation to the LRP. In 2006 and 2019, the smoothed index was 0.081 and 0.061 t/hr, respectively, placing the relative abundance of the St. Mary's Bay Sculpin stock at the Cautious/Critical zone boundary.

In addition to the CPUE time series, average length and percentage of fish >23 cm in the commercial fishery and DFO Summer RV Survey catches, the DFO Summer RV Survey total biomass and total abundance-at-length in stratum 490 and 470–495 (4X), and in-season exploitation rates (Relative F) could be used to assess stock status in the future.

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## SOURCES OF INFORMATION

This Science Advisory Report is from the March 3, 2020 Assessment of the St. Mary's Bay Longhorn Sculpin (*Myoxocephalus octodecemspinosus*) Fishery. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

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