Fishermen and Scientists Research Society

March 15, 2020

2020 4VsW Sentinel Monitoring Program

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INTRODUCTION AND OVERVIEW

The Fishermen and Scientists Research Society (FSRS) in cooperation with the Department of Fisheries and Oceans (DFO) have conducted the 25th Sentinel Monitoring Program in NAFO area 4VsW. The Sentinel Monitoring Program previously consisted of two separate survey phases, a Sentinel Survey phase, and a Commercial Index phase. The Sentinel Survey phase has been scaled down to the Sentinel Monitoring Program and the Commercial Index phase was discontinued in 2007.

The Sentinel Survey phase requires vessels to set gear at pre-selected random locations within the 4VsW area. The Commercial Index phase was used to emulate normal fishing practices and patterns. The design and implementation of the Sentinel Program provides fishermen and scientists with the opportunity to work more closely together. This knowledge sharing and co-education has been one of the outstanding positive results of the 4VsW Sentinel Program.

The 4VsW Sentinel Survey phase was initiated in large part by fishermen who noted that DFO otter trawl surveys did not reflect the fishery as seen by fixed gear fishermen. Since the early 1970's, DFO has engaged in highly standardized scientific groundfish surveys on the Eastern Scotian Shelf NAFO Division 4VsW. These surveys use small mesh otter trawls as the sampling gear and are primarily conducted outside the 50-fathom line. While DFO's random survey is of scientific importance, it does not effectively sample the inshore waters of <50 fathoms. Commercial longliners can sample waters less than 50 fathoms, in addition to providing greater information on fish that are recruited into the fishery by catching fish greater than 30 cm long.

From 2004 to present, the Sentinel Survey phase has been reduced in scale due to economic challenges. Previous 4VsW Sentinel Surveys investigated up to 253 random stations. Beginning in 2004, a reduction in the number of stations was required. Due to the large reduction in the number of stations, the 4VsW Sentinel Survey has been renamed the *4VsW Sentinel Monitoring Project*. The 4VsW Sentinel Monitoring Project is a bridging groundfish survey with a reduced number of stations sampled in pre-selected strata. The Sentinel Monitoring Project maintained continuity in six strata surveyed, including 462, 463, 464, 465, 468, 469. These strata were chosen to be monitored in the reduced project because they had previously showed higher catch

rates of several economically valuable groundfish species that warranted continued survey. In 2012, further budget restrictions reduced the monitoring program to 18 stations in the inshore strata (468, 469). By monitoring catch rates in the surveyed strata, it is hoped that if significant changes occur in groundfish abundance within 4VsW, they will be recognized. If significant changes are observed within these two strata, it would then be beneficial to reinstate the 4VsW Sentinel Survey phase at full capacity.

Two longline vessels were formerly employed to survey the two strata chosen in the 4VsW Sentinel Monitoring Program. In recent years, only one vessel has been contracted to survey the chosen strata (Table I).

Table 1. 2020 4VsW Sentinel Monitoring Program participant

Name	Vessel	Home Port	Zone
Leonard Connors	Alex & Jen	Tangier	1

4VsW SENTINEL MONITORING PROGRAM RESULTS

In 2020, one vessel sampled 18 randomly generated stations with a total of 26715 hooks set. Table 2 summarizes the catch results from 2014 to 2020 for the random stations sampled by participants.

In the 2020 4VsW sentinel sets, 402 fish were caught, with a total kept weight of 1164lbs and the total discard weight exceeded 281[1] lbs. In the 2019 sentinel sets, 1097 fish were caught, with a total kept weight of 3019 lbs and a total discarded weight of 289 lbs.

The total weight of the cod caught in 2019 (3113 lbs) was greater than the total weight of cod caught in 2020 (1159 lbs). The average weight per cod in 2020 was 3.54 lbs, which is more than the average weight per cod caught in 2019 (3.28 lbs). The average weight of cod caught in the 4VsW Sentinel Monitoring Program follows an upward trend when we compare the average weight per cod caught in 2020 (3.54 lbs) with the average weight per cod caught in 2019 (3.28 lbs) and 2018 (3.1 lbs).

[1] The weight of one Halibut exceeded 100 lbs but could not be accurately measured onboard the vessel.

There were three Halibut caught in the 2020 4VsW Sentinel Monitoring Program. This continues the trend of a decrease in halibut caught in this program, as there were six halibut caught in 2019 and eight halibut caught in 2018. All the halibut caught in the 2020 4VsW Sentinel Monitoring Program exceeded the average weight of halibut caught in the 2019 Sentinel Monitoring Program (28 lbs). The two smaller halibut weighed 30 lbs and 38 lbs. The final halibut exceeded 100 lbs and could not be accurately weighed onboard the vessel.

When examining Table 2, recall that the numbers from year to year are not directly comparable as there have been variations in the number of stations completed each year (2013-2017: 18 stations; 2018: 21 stations, 2019-2020: 18 stations). To compare one year to another, the catches must be adjusted by strata.

Table 2. Summary of catch results from all stations from 2014 – 2020 in the 4VsW Sentinel Monitoring Program

Species	Kept Weight (lbs)						Discard Weight (lbs)						Number of Fish					
Year	2015	2016	2017	2018	2019	2020	2015	2016	2017	2018	2019	2020	2015	2016	2017	2018	2019	2020
Cod	703	515	670	449	3113	1159	0	0	0	0	0	0	320	235	486	144	943	327
Haddock	0	0	0	4.5	2	0	1	1	0	0	0	0	1	0	6	9	1	0
W. hake	0	0	5.9	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Pollock	0	0	1.9	0	0	0	0	1	0	1	0	0	2	1	2	0	0	0
Cusk	175	46	19	14	20	5	0	0	0	0	0	0	7	3	3	12	3	1
Halibut	0	0	0	0	0	0	426	190	176	223	168	169	4	3	9	8	6	3
Am. Plaice	0	0	1.1	0	0	0	0	0	0	0.5	1	0	0	1	1	2	1	0
Dogfish	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Thorny skate	0	0	0	0	0	0	6	0	0	3	5	5	0	0	4	1	3	2

Table 2 includes the catch data from all sentinel sets completed from 2015 to 2020. The total number of fish captured are the sum of the kept and discarded fish. Halibut are no longer permitted as a kept species. Not all fish species caught are shown in this table. Snow crab, redfish, longhorn sculpin, sea raven, shorthorn sculpin, spotted wolfish, Striped wolfish, Atlantic wolfish, redfish, northern stone crab were also caught. Fish such as cod, haddock, cusk, and American plaice that were badly damaged by seals, dogfish or sand fleas - i.e.; no tail or no head, were discarded and weights estimated by finding the average weight of that species for that set.

Table 3. 2014– 2020 Summary of length frequencies (LF) and fish measured in the 4VsW Sentinel Monitoring Program

Species	**Number of Length Frequencies**							**Number of Fish Measured**						
Year	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Cod	16	17	12	13	5	16	11	263	316	223	459	88	923	367
Halibut	6	4	3	6	5	5	3	0	15	4	3	8	6	3

In 2020, 14 length frequencies were completed, with 370 fish measured. Most fish measured were cod (367 individuals), which was a decrease in the number of individuals measured from the past years of the 4VsW Sentinel Monitoring Program (Table 3). The remaining 3 measurements were halibut.

It is important to note that sampling by participating fishermen continues to be appreciated. The participating fishermen are doing an excellent job collecting the required scientific information. This is a positive indication of the dedication of participants, and evidence of the success of tested sampling protocols.

Table 4. 2015-2020 Summary of fish otoliths, stomachs, and individual weights collected in the 4VsW Sentinel Monitoring Program

Species	Number of Otolith Pairs Collected						Number of Stomachs Collected						Number of Individual Weights Collected					
Year	2015	2016	2017	2018	2019	2020	2015	2016	2017	2018	2019	2020	2015	2016	2017	2018	2019	2020
Cod	209	150	244	62	348	179	33	27	16	10	53	18	209	150	244	63	348	367
Halibut	0	0	0	0	0	0	0	0	0	0	0	0	4	2	6	8	5	3

In 2020, detailed sampling resulted in the collection of 179 pairs of cod otoliths and 18 stomachs to be further processed by FSRS technicians (Table 4). In addition, 367 individual fish were weighed (Table 4). In 2019, there were 348 otoliths pairs collected, 53 stomachs sampled and 353 individual fish were weighed (Table 4). The 2013-2017 monitoring project had fish collected from 18 stations as opposed to 21 stations in 2018 (see complete list of the number of monitoring stations from 1996-2018 in Appendix C). In 2019-2020 the stations sampled were once again reduced to 18 randomly selected stations.

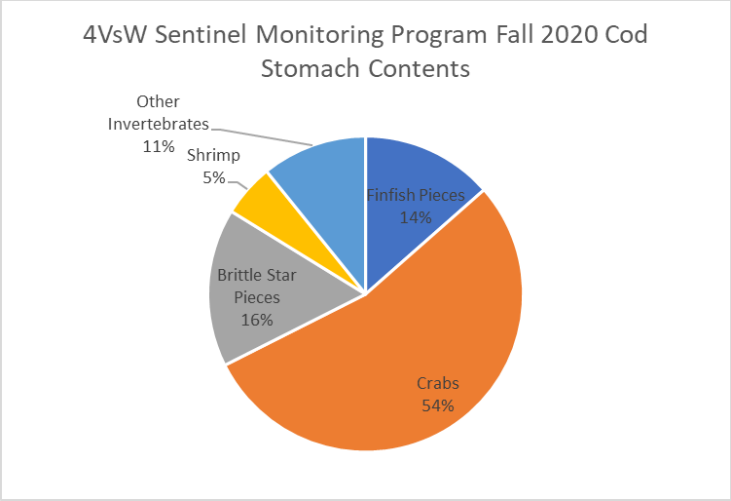

Figure 1. 2020 4VsW Sentinel Monitoring Program cod stomach contents analysis results

Figure 1 shows the contents of cod stomachs that were processed from the 2020 4VsW Sentinel Monitoring program. Participants do not collect empty stomachs. However, they indicate with a code 16 to show the stomach was checked. Participants examined many more stomachs than they collected. Also note, fish captured on longline gear are thought to have less in their stomachs because they are seeking bait due to hunger. This makes it difficult to obtain large numbers of full fish stomach samples from the Sentinel Monitoring Project. The majority of animals found in the cod stomachs were crabs (Figure 1). The species of crabs identified were mostly toad crabs, with several hermit crabs, one long snow crab leg and one rock crab. The finfish species were not distinguishable through visual examination, as most evidence of teleost fishes was partially digested. Undigested invertebrates found in the stomachs included one sea cucumber and one amphipod. Appendix H shows 2019 4VsW Sentinel monitoring program cod stomach contents analysis results. Note that stomach contents analysis results from year to year are not directly comparable and must be adjusted by the number of stomachs collected.

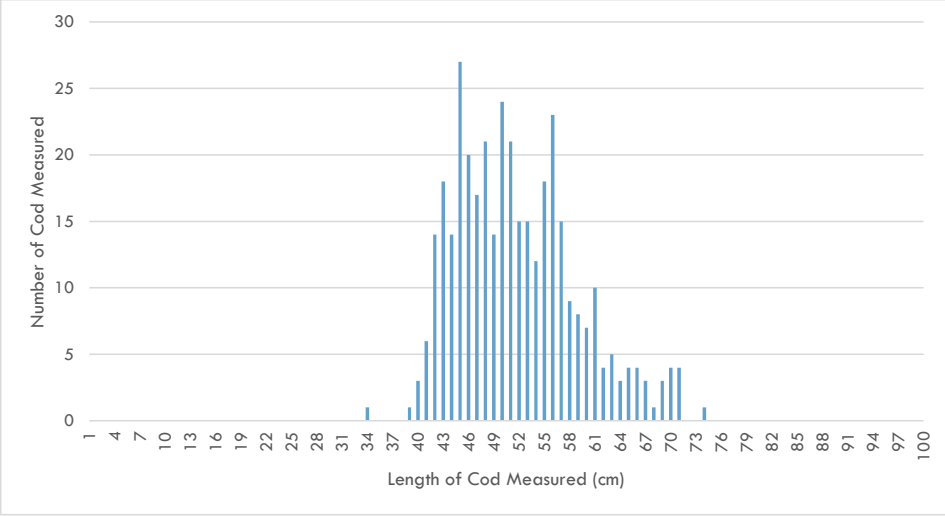

Figure 2. Length (cm) distribution of cod caught in the 2020 4VsW Sentinel Monitoring Program

Figure 2 shows the length (cm) distribution of cod caught and measured in the 2020 4VsW Sentinel Monitoring Program. Refer to Appendix F for the length (cm) distribution of cod caught in the 2019 4VsW Sentinel Monitoring Program. Note that the length distribution of cod from one

year to the next is not directly comparable and must be adjusted by the number of fish measured. The average length of cod measured in the 2020 4VsW Sentinel Monitoring Program was 51.6 cm. The median length of cod measured in the 2020 4VsW Sentinel Monitoring Program was 51 cm. The minimum length of cod measured in the 2020 4VsW Sentinel Monitoring Program was 34 cm while the maximum length of cod measured was 74 cm (Figure 2). The mean and median length of cod measured in the 2019 4VsW Sentinel Monitoring Program were 53 cm and 52 cm respectively. The minimum length of cod measured in the 2019 4VsW Sentinel Monitoring Program was 35 cm while the maximum length of cod measured was 94 cm.

OCEANOGRAPHIC DATA

No CTD profiler was deployed in the 2020 sentinel monitoring program. The FSRS has acquired additional environmental monitoring gear, including pH and Oxygen sensors, that could be deployed in future years to collect more robust oceanographic data.

One Seabird 19 CTD Profiler was deployed during the 2015-2016 monitoring project. There were two CTD casts to perform during the 2014 program (Stations: 1 and 10). All CTD casts were completed successfully.

TEMPERATURE DATA

Participants deployed VEMCO data loggers on their longline gear. Temperature data was collected between October 3 and October 7, 2020, at depths between 40m and 144m below sea level. The average bottom temperature in 2020 was 3.80°C.

Bottom temperatures have been collected throughout the duration of the sentinel project. Figure 2. Illustrates trends in average bottom temperature data collected from 1996 to 2018. Average bottom temperatures from 1998 to 2000, 2003 to 2006 and 2013 to 2018 show warming trends. 2020 had the coldest bottom temperature on record for the 4VsW Sentinel Monitoring Program.

Please refer to Appendix E for bottom temperatures collected during the 4VsW Sentinel Monitoring Program.

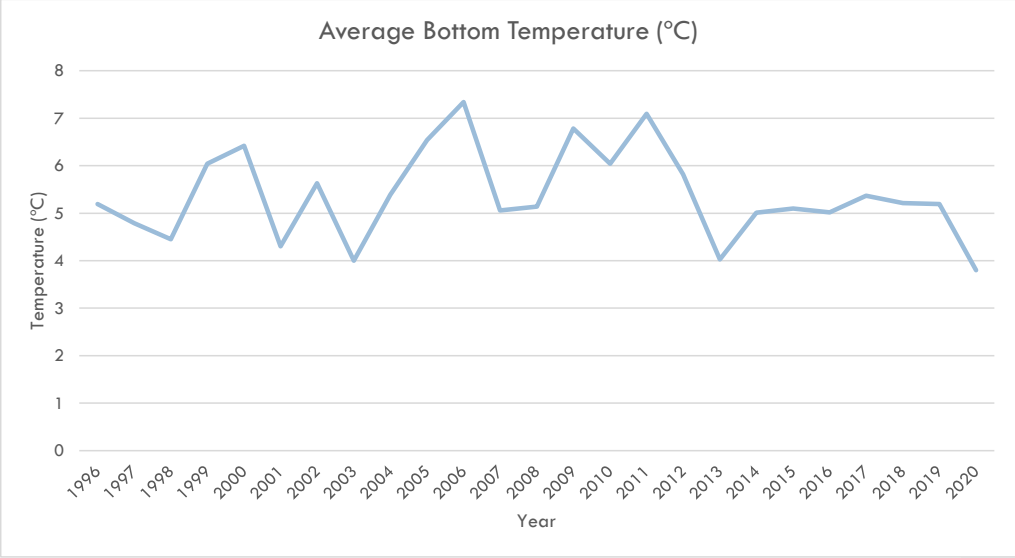

Figure 3. Average bottom temperature from 1996-2020 collected during the 4VsW Sentinel Monitoring Program

RECOMMENDATIONS

Commented [SSL1]: Other recommendations?

The FSRS recommends that the number of assigned stations be increased, and the samples extended to include strata that were sampled in the past. With rising ocean temperatures, increased storm events, and the associated potential change in distribution of groundfish stocks, it is critical to document all changes that may arise.

CONCLUSIONS AND ACKNOWLEDGEMENTS

Overall, the 2020 4VsW Sentinel Monitoring Program was successful. The scientific data that was collected will be added to the DFO ISDB database for future consideration when looking at stock assessment and the data needed. We are hopeful that this data be considered of value and utilized by the DFO Groundfish team, and that the sampling methodology be modified as deemed necessary. We greatly appreciate the work that the captains and crew invest in gathering valuable scientific data.

APPENDIX A: Items Supplied to Participating Vessels and Equipment Inventory

Table 5. List of items supplied to participating vessels.

Item	# of Units
50kg scale	1
3kg scale	1
Minilog temperature gauges	6
Sampling baskets	2
3-gallon buckets	3
Whirlpack bags	100
Knife	1
Measuring board	1
Measuring tape	1
Clipboard	1
Waterproof markers	2
Data sheets	10
Pencils	2
Elastics	1 bag

Table 6. Inventory of sentinel monitoring project equipment.

Item	# of Units
50kg spring scale	8
3kg scale	3
Sampling baskets	2
3 gallon buckets	5
Whirlpack bags (box of 500)	1
Otolith envelopes (box)	1
Knife	3
Measuring tape	2
Clipboards	2
Large plastic tubs with lids	2
Digital stopwatch	3
Toolkit	1
Seacat 19 CTD Profiler	2
Forceps	3

APPENDIX B: Number of Monitoring Stations

Table 7. Number of monitoring stations from 1996-2020.

Year	# of Stations
1996	252
1997	252
1998	252
1999	252
2000	252
2001	201
2002	191
2003	202
2004	53
2005	53
2006	50
2007	53
2008	53
2009	53
2010	61
2011	53
2012	17
2013	18
2014	18
2015	18
2016	18
2017	18
2018	21
2019	18
2020	18

APPENDIX C: Station Actual Locations

These are the locations where the stations were set. These may differ slightly from the randomly generated positions due to obstacles or other factors (Appendix G).

Figure 4. 2020 4VsW Sentinel Monitoring Program station actual sets
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Table 8. 2020 4Vsw Sentinel Monitoring Program station actual coordinates
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Figure 5. 2019 4VsW Sentinel Monitoring Program station actual sets

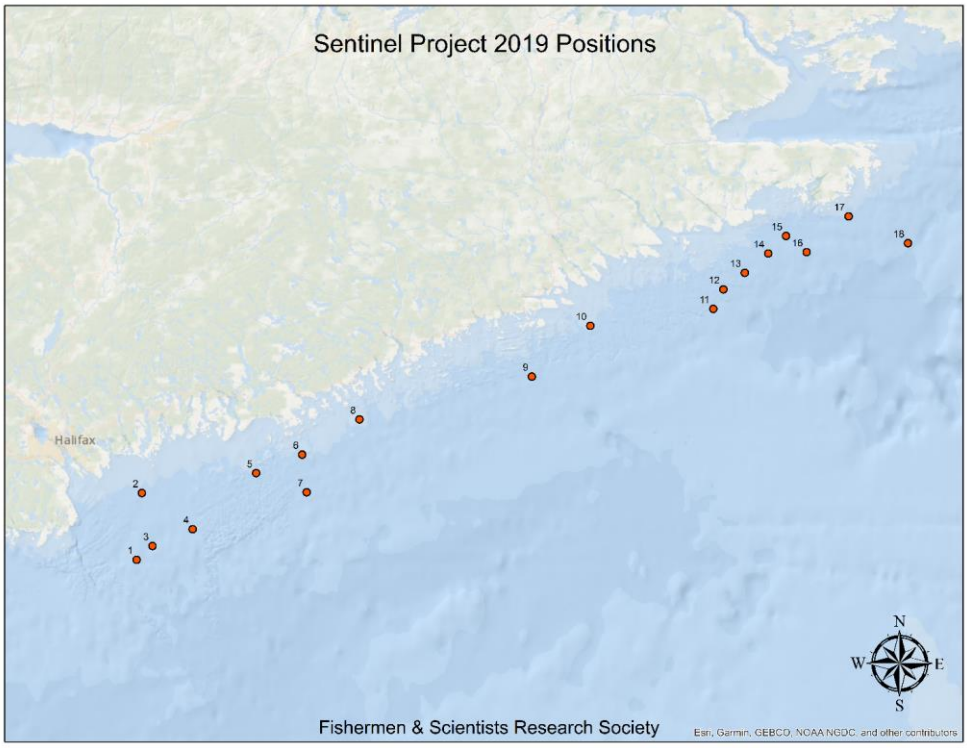

Table 9. 2019 4Vsw Sentinel Monitoring Program station actual coordinates

Station	Latitude	Longitude
1	4424.23	6319.84
2	4433.38	6318.82
3	4426.12	6316.80
4	4428.42	6309.06
5	4436.10	6256.86
6	4438.64	6248.00
7	4433.48	6247.14
8	4443.44	6236.99
9	4449.29	6203.83
10	4456.20	6152.57
11	4458.50	6128.94
12	4501.15	6127.00
13	4503.40	6122.89
14	4506.02	6118.39
15	4508.40	6114.96
16	4506.2	6111.00
17	4511.05	6102.93
18	4507.42	6051.51

APPENDIX D: Bottom Water Temperature

Table 10. Average Bottom Temperatures collected in the sentinel monitoring project from 1996-2020

Year	Average Bottom Temperature (ºC)
1996	5.19
1997	4.79
1998	4.45
1999	6.04
2000	6.42
2001	4.30
2002	5.63
2003	4.00
2004	5.39
2005	6.54
2006	7.34
2007	5.06
2008	5.14
2009	6.78
2010	6.04
2011	7.09
2012	5.82
2013	4.03
2014	5.01
2015	5.10
2016	5.02
2017	5.37
2018	5.21
2019	5.19
2020	3.80

APPENDIX E: Length frequency distribution of cod in the 2019 4VsW Sentinel Monitoring Program

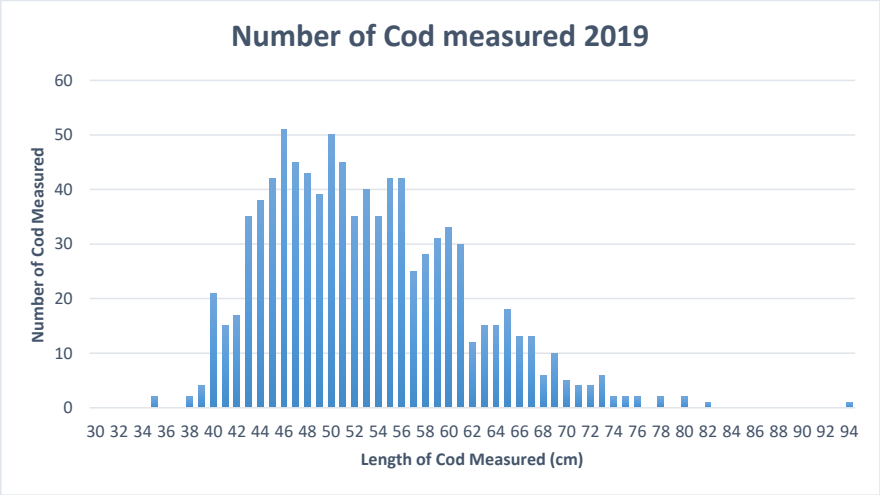

Figure 6. Length (cm) distribution of cod caught in the 2019 4VsW Sentinel Monitoring Program

APPENDIX F: Randomly selected Station Locations

Figure 7. 2020 4VsW Sentinel Monitoring Program randomly selected station locations

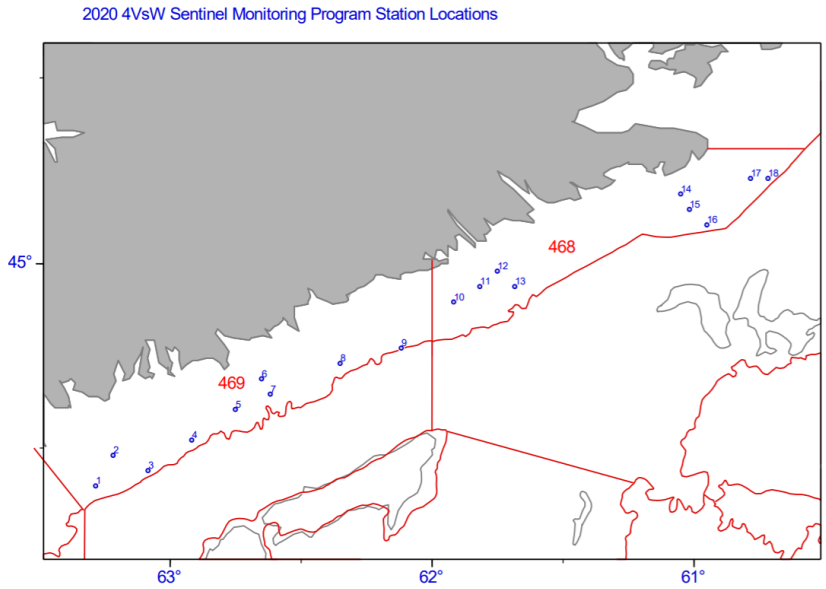

Table 11. 2020 4VsW Sentinel Monitoring Program coordinates for randomly selected station locations

Stratum	Station	Latitude	Longitude
469	1	4423.45	6317
469	2	4428.45	6313
469	3	4426.45	6350
469	4	4431.15	6255
469	5	4436.15	6245
469	6	4441.15	6239
469	7	4438.45	6237
469	8	4443.45	6221
469	9	4446.15	6207
468	10	4453.45	6155
468	11	4456.15	6149
468	12	4458.45	6145
468	13	4456.15	6141
468	14	4511.15	6103
468	15	4508.45	6101
468	16	4506.15	6057
468	17	4513.45	6047
468	18	4513.45	6043

Figure 8. 2019 4VsW Sentinel Monitoring Program randomly selected station locations

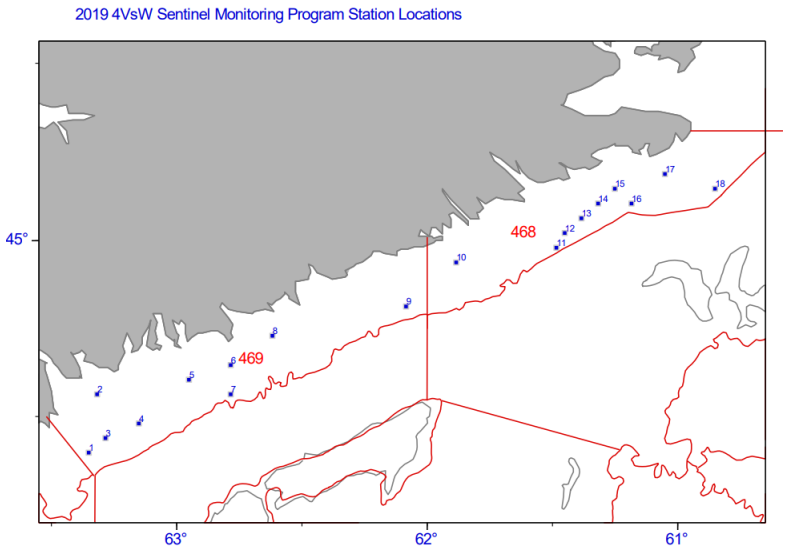

Table 12. 2019 4VsW Sentinel Monitoring Program coordinates for randomly selected station locations

Stratum	Station #	LatDeg.deg	LongDeg.deg
469	1	44.3958	63.3500
469	2	44.5625	63.3167
469	3	44.4375	63.2833
469	4	44.4792	63.1500
469	5	44.6042	62.9500
469	6	44.6458	62.7833
469	7	44.5625	62.7833
469	8	44.7292	62.6167
469	9	44.8125	62.0833
469	10	44.9375	61.8833
469	11	44.9792	61.4833
469	12	45.0208	61.4500
468	13	45.0625	61.3833
468	14	45.1042	61.3167
468	15	45.1458	61.2500
468	16	45.1042	61.1833
468	17	45.1875	61.0500
468	18	45.1458	60.8500

APPENDIX G: Cod Stomach Contents 2019

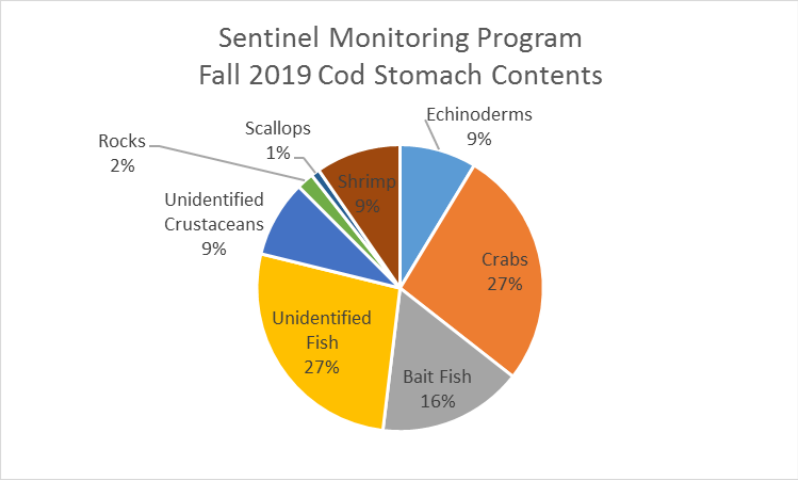

Figure 9: 4VsW Sentinel Monitoring Program 2019 cod stomach contents analysis results