Lobster Quality 2023-2024

Preseason & In-season Sampling Program

Southwest Nova Scotia LFA33 & LFA34

Final Report

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1 Background


Figure 1: Banded lobsters in a dry tote.

The 2023-2024 Lobster Quality Preseason Sampling Program continues the long-standing Atlantic Lobster Moult and Quality (ALMQ) project, a collaboration between lobster harvesters, buyers, dealers, and scientists. The ALMQ database originated in 2006 as an initiative of the Fishermen & Scientists Research Society (FSRS 2022). In 2024, the sampling program represents the largest continuous database of lobster sampling globally with 19 years of uninterrupted sampling. It is a credit to all collaborators to have the opportunity to produce this final report for the 2023-2024 commercial season. As in the past, we endeavour to summarize all the results of the preseason and in-season sampling program data collection and provide information that will be of direct use to the lobster sector in Nova Scotia. The lobster industry in Nova Scotia faces many challenges. The quality of lobsters captured at the beginning of the lobster fishing season in southwest Nova Scotia (LFAs 33& 34), the area of the world's largest *Homarus americanus* commercial harvests, remains a significant issue for improved product valuation.

Since the early 2000s, there have been noted fluctuations in the quality of lobster landed in southwest Nova Scotia with higher proportions of soft-shell and lower-meated lobsters landed, resulting in lower quality live lobster product. This represents a serious economic challenge for the industry, especially in international markets where, in 2020, over 80% of Canadian lobsters were shipped live to markets in the United States of America (43%), China (47%), and the European Union (<10%) (Fisheries and Oceans Canada 2021). Since 2019, exports of live product to China exceeded that to the US (Fisheries and Oceans Canada 2021). Results of past ALMQ sampling in southwest Nova have shown that lobster quality at harvest is directly related to the timing of lobsters' moulting processes. These processes are affected by factors including water temperature, available lobster diet, and other ecosystem factors. Understanding the incidences of those factors that control the proportion of soft-shelled lobsters and the annual variation in lobster quality at the beginning of the commercial season (last Monday in November, annually) is vital to the sustainability, health, and viability of the live lobster industry in Nova Scotia.

In 2017, the Province of Nova Scotia announced the creation of Université Sainte-Anne's Lobster Quality Research and Innovation Centre (LQRIC, Nova Scotia 2020). The LQRIC, renamed the Lobster Quality Centre (LQC) in 2023, has been established to aid in the research and development of live lobster product quality through ongoing sampling and modelling and analysis of the live lobster supply chain. The Lobster Quality Centre acknowledges the financing for this project as part of a Scientific Partnership Grant from the Atlantic Fisheries Fund (AFF) award for 2020-2023 as well as the continuing support of Fisheries and Oceans, Canada, the Nova Scotia Department of Fisheries and Aquaculture, and our industry partners.

The purpose of this annual report is to present and analyse the data observed on lobster quality from extensive preseason and selected in-season lobster sampling, and to report on the status of lobster quality for the 2023-2024 commercial season in subareas of LFAs 33 & 34 that terminates at the end of May 2024. The report follows the directives of the Report of the Maritime Lobster Panel that sought changes to 'improve the quality of lobster being landed in the Maritime Provinces' including the development of 'industry grading standards' (Thériault et al 2013, pp.44-43).

This report provides the detailed observations of the 2023-24 preseason and in-season at-sea sampling conducted by Coldwater Lobster Association (Coldwater Lobster Association 2023) in 8 locations within LFA33 and LFA34 designated as the 'inside' and 'outside' areas of Lobster Bay, St. Mary's Bay, Yarmouth Bar in LFA34, and Port La Tour in LFA33. Preseason sampling commenced September 4, 2023 and continued until November 14, 2023. The report also presents selected in-season sampling carried out in 7 of 8 LFA33&34 subareas from December 14, 2023 through February 27, 2024. All sampling was conducted by Coldwater Lobster Association according to the ALMQ protocols established since 2006. Table 1 below describes the samples information gathered on individual lobsters. After observations are taken from sampled legal-sized lobsters, all lobsters are released.

Table 1. 2023 Lobster Sampling Data Description

No.	***Individual Lobster Sampling Data Item***
1	Depth of string (F, fathoms); typically 4 strings are used for sampling with 10 pots per string, for a total of 40 pots per sample
2	Counts of legal and sub-legal lobster captured (only legal lobsters were used in subsequent sampling)
By the protocol, 150 legal-sized lobsters are sampled from the captured counts and the following items recorded for each lobster during preseason sampling:	
3	Lobster Carapace Length (CL, millimetres)
4	Lobster Sex (M-male '1'; F-female '2'; BF-berried female '3')
5	Lobster Shell hardness (Soft '2'; Medium '4'; Hard '5')
6	Lobster Blood protein level – measured via refractometer as the BRIX Index (units/ml, Figure 2)
7	Lobster Moult stage ('0' – no activity; '1' to '5') – from selected lobsters' (30 per sample) pleopod removal and post-at-sea sample examination under a microscope (Factor 1995, see also Figure 3 below)
8	Damage (coded descriptions for visual impacts, e.g., culls, as well as "blackened" shell disease)
9	Lobster vitality status through leg and tail reflex observed: "weak" or "not weak" status indicated.

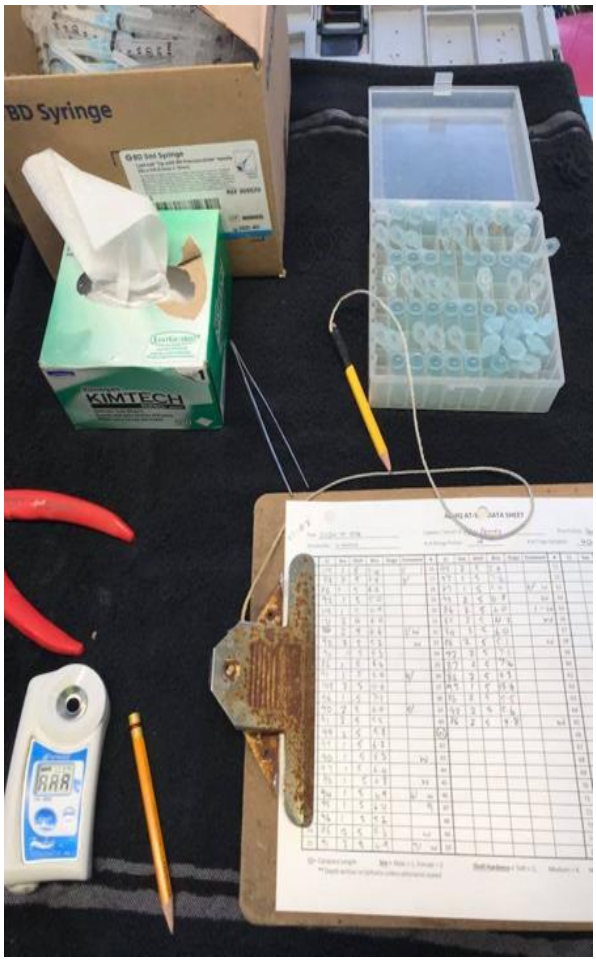


Figure 2: Survey sampling tools.

The collected data by the Coldwater Lobster Association technician are designed to proxy lobster quality – live lobster meat content and suitability for storage and shipping. Data analyses of the samples and collected data were carried out by the Centre de recherche marine/Marine Research Centre of the Université Sainte-Anne, Petit de Grat Campus and the LQC team. Results of the preseason component of the sampling program are provided in the 2023 preseason summary (Mattock, Mulock, and Lane 2023) as an indicator to the Nova Scotia lobster industry about the early season status of the post-moult lobster harvest in the designated sampling areas of LFAs 33 & 34.

The results presented here also provide focus on: (i) sampling catch counts; and (ii) the distribution of the recorded BRIX levels for the 2023 preseason (September to November 2023) and the 2023-2024 in-season sampling (December 2023 to February 2024) compared to past years' samples from similar preseason and in-season times and sampling locations over the period 2012-2023. This information enables the industry to compare the 2023-2024 sample results to known past years of observed preseason and subsequent in-season lobster quality and status.

1.1 Lobster Quality Determinants

For the first time in 2021, consolidated data from each sample date by location are classified into lobster quality categories derived from the full ALMQ database (2006-2024). Lobster quality categories for each consolidated location sample and date are based on collective lobster sample characteristics of the sampled lobsters for each sampling date. The historical consolidated sample data were categorized into 5 'lobster quality' categories. The results of this analysis enable the numerical description of each category, and subsequently, the assignment of each of the 2023-24 sample dates into the most probable lobster quality category.

1.2 Blood Protein, BRIX Levels

In 2023, as per the protocol in the past, blood protein levels, represented by the BRIX index, are a key indicator of individual lobster quality. BRIX index values below 6.0 units/ml in the samples provide a probable indication of poor quality and less than fully-meated lobster that are less suitable for storage and shipping. These lobsters often appear weak, potentially soft shell, and would not be ideal for holding or shipping.

BRIX index values between 6.0–7.99 indicate that lobsters may still be recovering from their prior moult and may still be of concern with respect to quality. BRIX levels at 8 or above are indicative of good quality, are more fully-meated lobsters and are likely more suitable for storage and shipping. It is noted that BRIX levels are not a perfect determinant of lobster quality and meat content (see also Thériault, David, Samson, Frame, Mdaini, and Lane 2024 in press). Table 2 below summarizes the BRIX index categories by lobster quality determinants as interpreted in the full ALMQ database.

Table 2. BRIX Levels Lobster Quality Categories

BRIX Quality Category:	**"Poor"**	**"Medium"**	**"Good"**
Meat Content:	Most likely low	Not likely fully-meated	Likely fully-meated
Storage/Shipping:	Not ideal	Concerns	Likely suitable
Observed Lobster Quality Indicators:			
Blood Protein Level, BRIX index (units/ml)	**Less than 6.0**	**6.0 to 7.99**	**8.0 or greater**
Shell Hardness	Potentially "Soft" (2)	Potentially "Medium" (4), recovering from previous moult	Likely "Hard" (5)
Appearance	Pale colour, evidence of carapace abnormalities, and/or shell disease	Acceptable colour, little evidence of carapace abnormalities or shell disease	Spring black-bodied, few carapace abnormalities
Shape/size	Culls, misshapen claws, damage to carapace	Small size, misshapen claws, limited damage to carapace	Commercial size, good body shape

1.3 Lobster Shell Hardness

The manual assessment of shell hardness is a subjective indicator of lobster quality. Guidelines are in place for manual estimates of each sampled lobster's shell hardness using a subjective non-numeric scale of 2 ("Soft"), 4 ("Medium"), and 5 ("Hard"). In 2023-2024, shell hardness measures are poorly correlated with continuously measured BRIX levels, and correlations (between lobster's BRIX and Hardness) are mostly not significantly different from zero for all sample location-dates. Consequently, shell hardness measures are not a lone determining factor in lobster quality prediction.

1.4 Lobster Appearance

Similarly, lobster appearance and lobster carapace shape and size are qualitative quality indicators based on simple accept-reject categories, i.e., if a lobster has carapace abnormalities such as evidence of culls, misshapen claws, missing swimmerets, or poor colour, then such lobsters are rejected for storage or shipping. Like shell hardness measures, lobster appearance, shape and size cannot be singular determining factors in assessing lobster quality. Rather, the information is used as supplemental to determining lobster quality.

1.5 Lobster Moult Stage

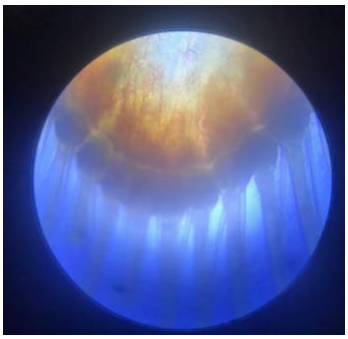


Figure 3. View of lobster pleopod under microscope.

Moult stage analyses are carried out by analysing selected lobsters. According to the ALMQ protocol in place since 2006, 30 lobsters from each sample of 150 lobsters per sampling location-date have their pleopods (swimmeret) removed. Each lobster's moult status is determined by microscopic analysis of the lobster pleopod as per the descriptions provided by Factor (1995) (see also Figure 3). Moult stage levels of zero indicate no moult activity is pending. Advanced moult stages (Stages 3+) indicate the moult is approaching. Pleopod analysis in female lobsters may also indicate the onset of the egg-bearing cycle (Factor 1995). Lobsters with advanced moult stage are not considered for storage and shipping.

2 Sampling Survey Information and Summary Results in 2023-2024

The objective of the ALMQ project is to develop a lobster monitoring program, based on biological indicators of moult-timing, lobster quality measures, and environmental conditions, in order to predict the quality of lobsters at the start of the lobster commercial fishing season in LFAs 33&34. This program requires a combination of continuous at-sea quality monitoring (preseason and in-season confirmation of results) as well as the development of a prediction model incorporating historical data records for in-season quality. The following paragraphs describe the information obtained from the 2023 preseason sampling and the 2023-24 in-season sampling.

Figure 4: Drawing blood for refractometer for BRIX

In 2023, a total of 6,071 preseason lobster samples were taken over the 3-month period from September 4 to November 14, a period of approximately 9 weeks. For the in-season survey of December 2023 through February 2024, a total of 1,274 lobster samples were taken in 13 in-season trips over 7 dates for 7 of the 8 sample location subareas, not including Yarmouth Inside (Table 3).

During sampling, minimal by-catch appeared in the traps, especially as the lobster counts increased (in most locations) toward the latter part of the preseason survey from October through November. In general terms, over all location-areas sampled, it is noted that BRIX levels observed at the beginning of the 2023 survey in mid-September deemed to be 'average', generally dropped off as more berried females, soft shell, and "weak" lobsters started appearing more often in the traps (through October 2023). As the weeks went by in the survey, a noticeable shift from higher to lower lobster counts for inside areas occurred, while lower to higher counts of lobster began appearing in corresponding outside locations along with increased BRIX levels and reductions in soft and weak lobsters. Inside areas over all 4 inside locations averaged 19.57 Fathoms in depth; outside areas over all 4 outside locations averaged 40.75 Fathoms in depth.

Preseason sampling in 2023 resulted in total catches of 20,655 sublegal and legal lobsters for an average of 11.74 lobsters per trap over the 44 preseason sampling dates (a decrease of 23% over the 2022 preseason catch of lobster per trap of 15.19). The average BRIX index for individual lobsters was 9.78 units/ml for the 44 preseason sample location-dates in 2023 (an increase of 3% vs 2022 average BRIX of 9.46). The BRIX index for the 13 in-season sample location-dates (December 2023 through February 2024) was 11.44 units/ml or 17% higher on average than the preseason average of 9.78 units/ml.

Overall, for preseason and in-season samples combined, there were 2.78% "Soft" and 11.22% "Weak" lobsters observed in 2023-2024 sampling. This represents a slight increase in "Soft" (vs 2.66% in 2022-23) and a 15% decrease in "Weaks" (vs 13.29% in 2022-23) compared to the 2022-2023 report. These data are summarized below in Table 3 – "2023 Preseason and 2023-24 In-season Sampling Survey Information Summary".

Table 3. 2023 Preseason and 2023-2024 In-season Sampling Survey Information Summary

Sampling Location	Sites Subarea	Sampling Dates	Harvested Counts	Total Samples	Sample Ave BRIX (units/ml)	Sample % Soft	Sample % Weak
Lobster Bay LFA 34	Inside	12-Sep	896	150	9.11	1.33%	12.67%
		26-Sep	832	150	9.58	5.33%	14.00%
		11-Oct	648	150	10.19	10.00%	16.00%
		25-Oct	1095	150	11.40	4.00%	16.67%
		07-Nov	750	150	11.02	6.00%	23.33%
		04-Jan	134	50	13.99	0.00%	4.00%
	Outside	11-Sep	312	150	10.10	2.00%	4.67%
		25-Sep	489	150	8.74	2.67%	24.67%
		10-Oct	930	150	9.95	4.67%	8.00%
		24-Oct	1410	150	10.58	1.33%	6.67%
		06-Nov	670	150	10.49	3.33%	21.33%
		04-Jan	287	127	13.47	2.36%	6.30%
Port La Tour LFA 33	Inside	13-Sep	252	150	7.62	4.67%	12.67%
		27-Sep	503	150	7.79	5.33%	5.33%
		12-Oct	452	150	10.43	1.33%	6.67%
		25-Oct	386	150	11.26	0.67%	2.00%
		08-Nov	301	150	12.31	0.00%	4.67%
		14-Dec	543	150	11.34	0.00%	5.33%
		02-Jan	137	73	13.61	0.00%	0.00%
	Outside	12-Sep	6	4	9.83	0.00%	0.00%
		26-Sep	1	1	7.00	100.00%	0.00%
		11-Oct	262	150	7.93	9.33%	41.33%
		24-Oct	232	150	8.68	7.33%	20.67%
		07-Nov	230	150	8.83	0.00%	14.00%
		14-Dec	476	150	10.10	2.67%	9.33%
		02-Jan	84	57	9.90	1.75%	7.02%

St. Mary's Bay LFA 34	Inside	06-Sep	272	150	9.06	1.33%	14.67%
		22-Sep	481	150	8.75	2.67%	11.33%
		05-Oct	512	150	9.39	2.00%	8.00%
		22-Oct	618	150	9.42	1.33%	18.00%
		31-Oct	431	150	10.42	1.33%	18.67%
		14-Nov	229	150	11.03	0.67%	9.33%
		28-Dec	437	150	11.04	1.33%	8.00%
		24-Jan	168	65	11.80	0.00%	9.23%
		27-Feb	40	29	11.67	0.00%	0.00%
	Outside	05-Sep	15	13	9.02	0.00%	0.00%
		21-Sep	115	111	8.45	1.80%	9.01%
		04-Oct	585	150	9.24	1.33%	7.33%
		17-Oct	488	150	8.93	4.00%	10.00%
		30-Oct	722	150	9.01	1.33%	26.00%
		13-Nov	516	150	9.55	2.67%	18.00%
		28-Dec	318	150	10.26	4.00%	3.33%
		24-Jan	186	73	10.45	1.37%	8.22%
		27-Feb	123	50	11.52	0.00%	0.00%
Yarmouth LFA 34	Inside	05-Sep	372	150	9.56	4.00%	8.67%
		21-Sep	854	150	9.80	1.33%	4.00%
		04-Oct	530	150	10.35	1.33%	7.33%
		17-Oct	588	150	11.24	2.67%	5.33%
		31-Oct	418	150	11.35	0.67%	7.33%
		14-Nov	340	150	11.18	1.33%	9.33%
	Outside	04-Sep	138	104	9.70	4.81%	4.81%
		20-Sep	339	150	9.40	3.33%	9.33%
		03-Oct	178	138	10.33	0.00%	5.07%
		16-Oct	346	150	9.55	2.67%	9.33%
		30-Oct	603	150	9.64	2.67%	16.67%
		13-Nov	308	150	9.38	9.33%	12.00%
		27-Dec	450	150	11.66	2.00%	5.33%
Overall Totals	**8 Subareas**	**57 Sampling Dates**	**24,038 Lobsters Landed**	**7,345 Sampled Lobsters**	**10.07 units/ml Ave BRIX**	**2.78% Overall % Soft**	**11.22% Overall % Weak**
In-season Totals		**13 dates**	**3,383**	**1,274**	**11.44**	**1.57%**	**5.73%**

*Denotes In-season samples (shaded) for selected sampling locations: Lobster Bay (2), Port La Tour (4), St. Mary's Bay (6), and Yarmouth (1)).

2.1 Sampling Protocols

During the 2023-2024 lobster sampling program, the following project outcomes were achieved:

- At-sea quality monitoring – successful observations over 8 locations within LFA33 and LFA34 over a total of 57 sampling dates from September 4, 2023 to February 27, 2024;
- Development of pre-season prediction report for industry – as reported in Mattock, Mulock, and Lane (2023) summary report released on November 24, 2023; see also: https://www.coldwaterlobster.ca/wp-content/uploads/2023/11/ALMQ_2023-Preseason-Summary-Report-November-2023.pdf
- In-season quality sampling – successful completion of 13 sampling location-dates from December 2023 through February 2024 in 7 of 8 subareas of LFAs33 & 34;
- Temperature data collection (pre-season and in season) – incomplete: no temperature data were analysed in the 2023-2024 sampling program;
- Lobster tagging program – not initiated in the 2023-2024 sampling program;
- Base line data on berried females – successful data collection across 57 preseason and in-season sampling location-dates; and
- Base line data on catch, including counts of sub-legal and legal, male and female lobsters in all 8 subareas of LFAs33&34– successful observations of harvested lobsters in 8 locations in 44 preseason and 13 in-season sampling location-dates in 2023-2024.

2.2 Sampling Sites and Schedule

The 2023-2024 sampling schedules, sampling dates, locations, and numbers of lobsters harvested, numbers of individual lobster samples made, proportion of soft/weak lobster status, and average location-date BRIX index are provided in Table 3 above. The map of Figure 5 below contains a single screen that illustrates the provided mapped tabulated information about the precise location of the sample harvests (latitude and longitude of first string), as well as time of haul statistics for: (i) sea state (in meters); (ii) surface temperature (where available); and (iii) weather description at time of set haul. Additional data includes total lobster harvest counts at site, the number of trap hauls, lobster counts per trap, average lobster BRIX from site samples, and the number of "weaks" in site sample.

This mapped information for 2023-24, including mapped sampling information for all 4 years of the sampling program: 2020-21, 2021-22, and 2022-23 are available for viewing on Google maps. A public link is available at the following site:

https://www.google.com/maps/d/edit?mid=14NsroLb5FWDSt9HQEn7h2J4zodkv7iAD&usp=sharing

(Please send any feedback or questions about the mapped sampling information to D. Lane at Daniel.Lane@usainteanne.ca.)

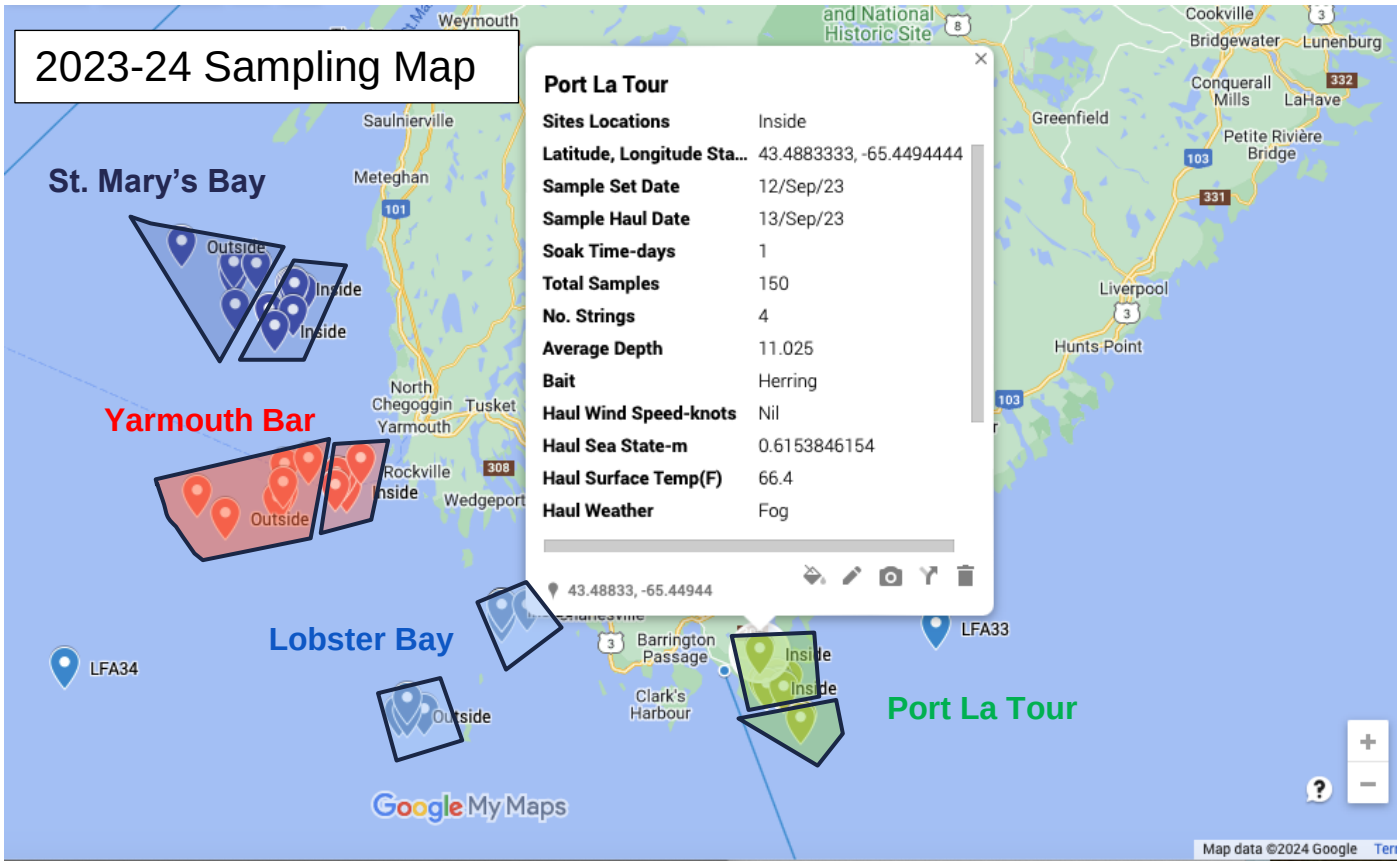


Figure 5. Google map of 2023-2024 At-sea survey area and related information.

2.3 2023-2024 Report on Conditions and Collections

In the past, weather conditions, described by strong winds and a blustery sea state, presented great challenges for scheduling sampling days. Sampling during the months of October and November 2023 became more challenging as the weather windows decreased, therefore shortening soak times before hauling was required. In-season sampling was very difficult to schedule sampling days as, more often than not, the sea state was of poor condition.

The 2023-2024 commercial lobster fishery in LFAs 33&34 was scheduled to open on Monday, November 27, 2023. However, once again this year, weather delayed dumping day. LFA 33 area fishermen took advantage of a two-day flexibility window and started the season early on Sunday, November 26, 2023. However, LFA34 saw a 5-day delay before opening on December 2, 2023. (See also: https://www.saltwire.com/atlantic-canada/news/gone-fishing-2023-lobster-season-opens-dec-2-in-southwestern-ns-after-weather-delays-100917377/.) In 2022, the LFA 34 fishery opened on December 5, 2022, after a one-week delay to the season start due to weather. The LFA 33 fishery opened on Nov. 29, 2022, after a one-day delay. In 2021, there was a two-day delay in dumping day, while in 2020, the delay was 8 days (among the longest in the history of the fishery).

Again in 2023-2024, captains have been strongly committed to the preseason lobster sampling survey which greatly simplifies the sampling schedule. As well, having additional vessels on standby if the event that the participating captain cannot deploy at their scheduled times is helpful to ensure that all required sampling dates are met.

Preseason sampling provides a snapshot of lobster quality in selected locations of LFA 33 and LFA 34. In 2023-24 sampling was conducted from depths ranging from 7.6 Fathoms (Port La Tour Inside) to 74 Fathoms (St. Mary's Bay Outside). It is noted that preseason samples do not provide an indication on the quality of lobsters caught outside the selected areas or outside the noted depth range. It is noted that during the commercial lobster season in LFAs33 and 34 there is a significant percentage of vessels fishing in depths greater than 60 Fathoms.

In 2023, preseason lobster samples were taken over the approximately 9-week period from September 4 to November 14. Weather conditions for sampling over the 44 preseason trips completed in the Fall of 2023 were generally quite favourable with light winds and calm seas. The 2023-2024 pre-season and in-season sampling days were achieved through the flexibility of choosing the best fair-weather days each week as there were periods of rough weather during the preseason period which were avoided. The weather turned once the LFA33&34 season opened in southwest Nova Scotia presenting more challenges to achieving sampling days for the month of December. January saw a significant decrease in catch rates on back-to-back hauls therefore captains reduced the number of trips made each week to allow the gear to soak for longer to maintain a respectable harvest on the chosen day fished. The weather allowed for more hauls for the month of January (compared with past seasons) and this, combined with longer soaks, enabled the captains to report an overall increase of lobster caught for the month. Lobster quality increased in December leading into January, and that, corresponding to the highest lobster price per pound on record, helped alleviate the increased price of fuel and bait required. February also proved to be even more challenging as water temperature decreased and more storms passed through the fishing grounds that led to slowing of the catch rate to an economical point and fishing became more about servicing/maintaining the traps as per DFO requirements.

2.4 Lobster Quality Category Classification

For the first time in 2021, consolidated data from each sample date by location were classified into lobster quality categories derived from the extended ALMQ database (2006-2021). Lobster quality categories for each consolidated location sample are based on collective lobster sample characteristics by sample date of – typically – 150 lobster samples for each location-date. The consolidated sample date data include: the means, medians, ranges, and moments for the 150 lobster BRIX values, and the 150 lobster carapace lengths, as well as sample month and days prior to the season opening. For example, the following graphic (Figure 6) displays the consolidated BRIX (only) data for the Lobster Bay (Inside) area for the 2006-2020 samples (n=158) in this location. The box-and-whisker plot shows the distribution of the summary average BRIX values across all samples in each year for Lobster Bay (Inside).

Of note in Figure 6 is the separation of the distributions of the consolidated annual average BRIX values into 2 notable groups: (1) 2006-2013; and (2) 2014-2022. The first group represents a relatively higher and consistent average BRIX regime. The second group illustrates an apparent shift in lobster average BRIX values to a consistently lower average BRIX regime. This time shift phenomenon occurs in each of the 8 lobster sampling locations and is the expected result of an environmental/ecosystem shift that persists into 2024. With this in mind, a subjective assignment of each year's consolidated annual BRIX values were assigned into one of 5 lobster quality categories. Preseason Lobster Quality categories are particular to the history of each of the 8 locations. These categories are described in Table 4 below.

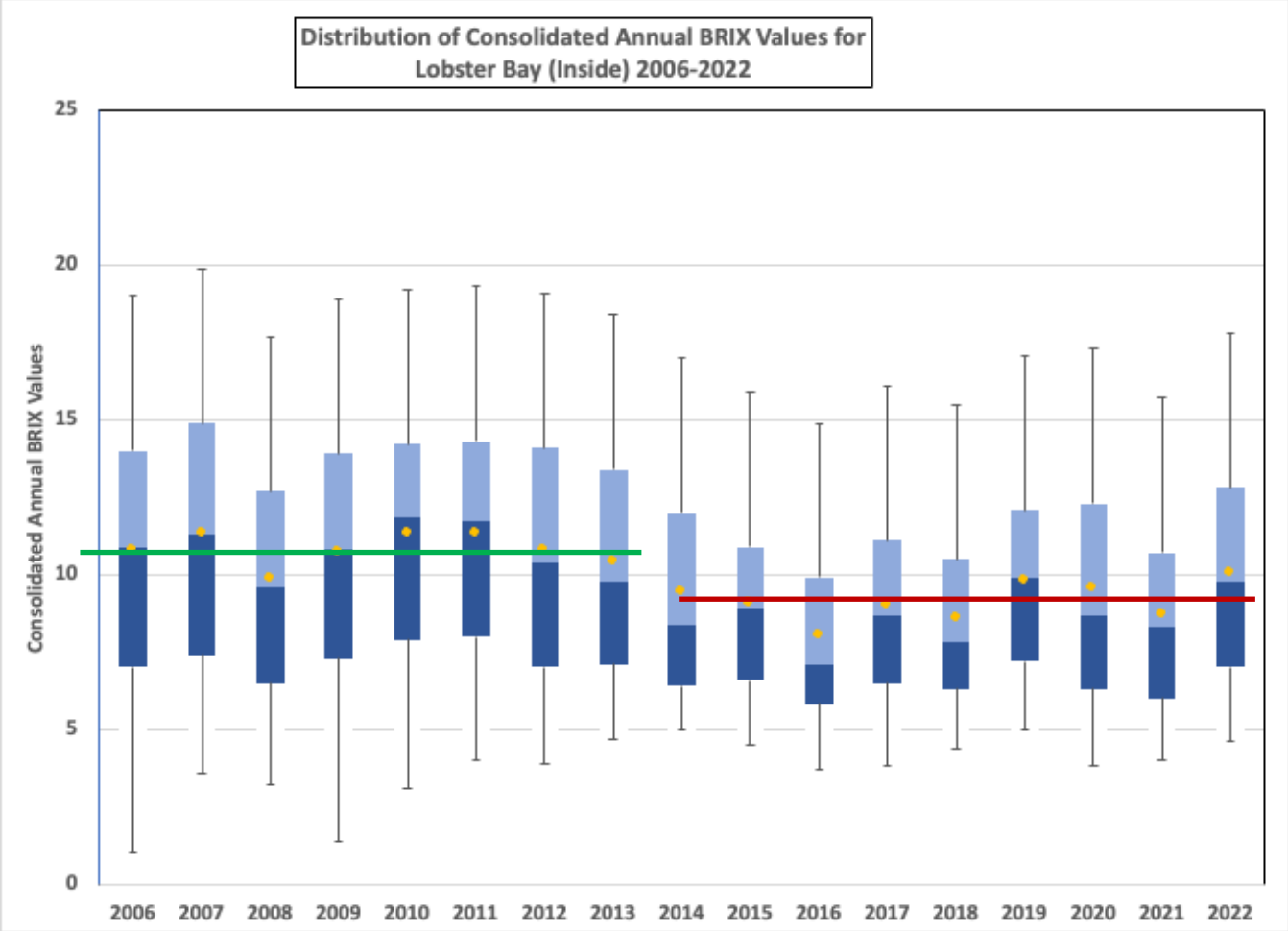


Figure 6. Box-and-Whisker plot of Consolidated Annual BRIX values for Lobster Bay (Inside). Annual mean BRIX values are denoted by yellow dots; rectangles are interquartile ranges; annual median BRIX are lines separating light and dark range; vertical lines (minimum to maximum BRIX) indicate annual consolidated BRIX values outside interquartile range.

Table 4. Lobster Quality Category Descriptions

Level	Lobster Quality Category	Description of Sample Location-Date Distribution
1	**High (H)**	This category is indicative of a consolidated sample date of 150 lobsters with elevated average BRIX value specific to the location over the database period, e.g., exceeding 10 for most locations, and other positive distribution characteristics, e.g., high relative BRIX median and range
2	**Moderate–High (MH)**	This category is indicative of a consolidated sample date of 150 lobsters with slightly above-average BRIX values specific to the location over the database period, e.g., approximately between 9.5 and 10 in most locations
3	**Moderate (M)**	This category is indicative of a consolidated sample date of 150 lobsters with near average BRIX values specific to the location over the database period, e.g., approximately between 8.5 and 9.5 for most locations
4	**Moderate–Low (ML)**	This category is indicative of a consolidated sample date of 150 lobsters with slightly below-average BRIX values specific to the location over the database period, e.g., approximately between 7.5 and 8.5 for most locations
5	**Low (L)**	This category is indicative of a consolidated sample date of 150 lobsters with below average BRIX values specific to the location over the database period, e.g., less than 7.5 for most locations

Using linear discriminant analysis, the historical consolidated sample data were categorized into these 5 'lobster quality categories' for each location. The results of the analysis enabled the numerical description of each category, and subsequently, the assignment of each of the 2021-22, 2022-23, and 2023-24 sample dates into its most probable lobster quality category.

Preseason sample results for 2023 by location are compared to past preseason sampling years. If, for example, 2023 preseason sample results for Lobster Bay Inside compare favorably to past preseason survey years of Low (L) Lobster Quality Category for Lobster Bay Inside (historically estimated from the data to have occurred in 2016 and 2018–see also Table 5 below), then the 2023 preseason data may predict that the 2023-2024 commercial season is comparable to the known commercial seasons of 2016-2017 or 2018-2019 that followed these same low survey results.

Table 5. 2006-2022 Lobster Quality Category Assignments*

Locations: Year	Yarmouth Inside	Yarmouth Outside	Lobster Bay Inside	Lobster Bay Outside	Port La Tour Inside	Port La Tour Outside	St.Mary's Bay Inside	St.Mary's Bay Outside	Total Annual Sample Dates
2006	MH	H	H	MH	MH	H	H	MH	68
2007	H	H	H	MH	M	-	H	H	61
2008	H	MH	MH	MH	MH	-	MH	MH	60
2009	MH	H	H	MH	MH	MH	M	M	67
2010	H	MH	H	H	H	MH	MH	H	73
2011	MH	M	H	MH	MH	H	MH	-	65
2012	MH	MH	MH	H	M	M	MH	-	63
2013	M	M	MH	H	M	M	M	-	52
2014	ML	ML	M	M	L	ML	-	-	34
2015	ML	ML	ML	M	L	L	-	-	32
2016	L	L	L	L	L	M	ML	ML	52
2017	ML	ML	ML	L	L	L	ML	ML	52
2018	L	ML	L	ML	MH	L	L	L	46
2019	ML	L	M	ML	ML	ML	-	L	12
2020	ML	L	M	ML	ML	ML	ML	M	56
2021	ML	M	M	M	M	M	M	M	51
2022	ML	ML	ML/M	ML	ML	ML	MH	M	62
Sample Dates	145	143	171	128	155	56	62	47	907

*2006-2013 (Green)–Historical period of higher average BRIX; 2014-2022 (Red)–Current period of lower average BRIX.

Table 5 presents the annual time series of assigned Lobster Quality Category for each location from 2006 to 2022. The relative decline over time of lobster quality measured by average BRIX across all locations in LFAs 33&34 over the full period 2006 to 2022 is evident from Table 5 and the example of the annual box plots for Lobster Bay Inside (Figure 5). Lobster quality categories from 2006-2013 exhibit higher categories (moderate (M) or higher (MH, H)) throughout the period from 2006 to 2013 (Figure 5, green line).

Since 2014, however, assigned Lobster Quality Categories across the locations are nearly all designated as moderate (M) levels or below (ML, and L) (Figure 5, red line). Although it is difficult to identify trends in the consolidated data (i.e., combined annual survey samples by location), it generally appears that since 2018, there may be the beginning of a recovery of lobster quality indicators from L to ML going forward to 2022. These data provided the backdrop for the predictions of lobster quality categories for the 57 preseason sample dates by location in the 2023 preseason period. Table 6 presents the summary lobster

quality category classification for the 2023 preseason sample subarea locations. These results average the lobster quality categories over the preseason and in-season sampling dates by subarea locations. Information on average BRIX, average counts of legal-sized lobster per trap, percentage of weak lobsters in samples, and percentage of soft and medium hardness lobsters in samples, as well as most comparable historical years compared to 2023 are included in Table 6. A description of the statistical analyses of the consolidated annual data by location is provided in the LQC Working Paper "Statistical Analyses for Lobster Quality Determinants and Predictions" (in progress) (Lane et al 2023).

Table 6. 2023-24 Preseason and In-season Lobster Quality Category Assignments by Subarea

Locations: / 2023 Samples	Yarmouth Inside	Yarmouth Outside	Lobster Bay Inside	Lobster Bay Outside	Port La Tour Inside	Port La Tour Outside	St.Mary's Bay Inside	St.Mary's Bay Outside	Overall Locations
Average BRIX (units/ml)	10.58	9.96	10.49	10.48	10.39	8.98	10.03	9.47	10.07
Ave Legal Counts Per Trap	8.32	6.73	11.80	12.76	6.84	3.50	6.71	7.06	7.72
%Soft+Medium	17.89%	21.98%	20.63%	19.73%	15.93%	37.92%	20.37%	20.96%	21.31%
%Weaks	7.00%	8.94%	14.44%	11.94%	5.24%	13.19%	10.80%	9.10%	11.22%
Bimodal BRIX Dist? Yes/No	**Yes**	No	**Yes**	**Yes**	No	No	**Yes**	**Yes**	**Yes**
Estimated Overall Lobster Quality Category	M	M	M	M	M	M	M	M	M
No. of Location-dates	6	7	6	6	7	7	9	9	57
Comparable Years	2013, 2020	2013	2018	2022	2020	2012	2022	2022	2020- 2022

Average BRIX by location overall preseason and in-season sampling are relatively constant and all locations have average BRIX values exceeding 8 or "Good" (Table 2) with average BRIX over all locations of 10.07 units/ml. Similarly, estimated overall lobster quality category across the board is "Medium" which places 2023-24 in the ongoing current regime of lower BRIX experienced since 2014.

Average legal counts per sampling trap are an indicator of commercial catch counts. As in the past, Port La Tour, LFA33 shows lower relative sample counts than other locations with low of 3.5 lobsters per sampling trap (Inside) in 2023-24 samples. Sampling trap catch counts in Lobster Bay (Inside and Outside) exceed all other areas (11.8 and 12.8 respectively). Catch counts in St. Mary's Bay for 2023-24 samples (Inside – 6.71, Outside – 7.06) are below the average counts per trap over all locations (7.72).

The percentage of weak lobsters per sample are relatively higher in Lobster Bay (Inside and Outside) than other areas. Finally, the end of preseason samples (to November 14) for Lobster Bay and St. Mary's Bay demonstrate that the BRIX distributions of these samples – especially males – have significant bimodal behaviour which may indicate the presence of later or multiple periods of moulting lobsters in these areas.

3 Preseason Sampling Data

Since 2006, preseason and in-season data have been collected annually on lobsters in selected harvest areas of LFA33 and 34. Previously, these data have been used in each year, independently, to estimate average moult times over all subareas and to predict lobster quality based on overall moult conditions at the start of each season. In hindsight, the estimate of a general moult time was subject to considerable uncertainty and spatial and temporal variation such that a generalized prediction about lobsters' average moult time was difficult to determine.

The longitudinal database from the 2006 season onward permits direct comparison of pre-season and corresponding in-season samples over multiple years. Knowing the precise history of quality results in the subsequent commercial fishery over past years enables comparison of current results to actual quality of the past, e.g., the 2011-12 commercial season was a "high quality" season whereas the 2015-16 commercial season was a very poor-quality year throughout LFAs33&34. Preseason sampling results that compare well with the 2011-12 preseason sampling data should therefore be a good indicator of quality to follow into the commercial season. Similarly, preseason sampling that compares more closely to the 2015-16 preseason sampling data would suggest a prediction for poor quality to follow in the comparable commercial fishery.

To this end, we evaluate historical annual quality status and compare recent results to the history. This analysis begins with a view of the distribution of the lobster data collected for 2023-24.

3.1 Lobster Counts Sampling for 2023-2024

The at-sea sampling data were compiled into the '*Preseason Summary Report*' and distributed by Coldwater Lobster Association to the lobster industry and government funders on November 24, 2023 (Mattock, Mulock, and Lane 2023). This report contains summary information on the lobster counts harvested and sampled during the 2023 preseason and the 2032-24 in-season sampling program with comparison to the 3 previous year's 2020-2021, 2021-22 and 2022-23 lobster counts sampling results. Specific information on survey lobster counts includes: (1) section 3.1.1: lobster count location graphics per trap by sex, average BRIX indicator value, moult stage analysis, and manual hardness measures; and (2) section 3.1.2: comparative location results of catch per trap, and average BRIX indicator value. Complete graphics information on lobster counts sampling for each location is presented in Appendix A of this report for 2023-2024.

3.1.1 Location graphics (4 pages) - lobster counts (harvested and sampled) information (complete graphics are presented in Appendix A.1)

Location graphics results of lobster counts from the sampling program are as follows:

(a) Counts of lobsters harvested per trap by sex for Inside & Outside areas
(b) Counts of lobsters harvested per trap and BRIX for Inside & Outside areas
(c) Counts of lobsters sampled by Moult Stage - Outside areas
(d) Counts of lobsters sampled by Hardness and BRIX for Inside & Outside areas

Appendix A.1 – "Harvested and Sampled Lobster Count Location Graphics" contains the complete graphic record of this information for all locations, inside and outside areas by preseason and in-season sampling dates. Selected graphics are presented in this report below.

(a) Counts of lobsters harvested by Location per Trap by Sex for Inside and Outside Areas

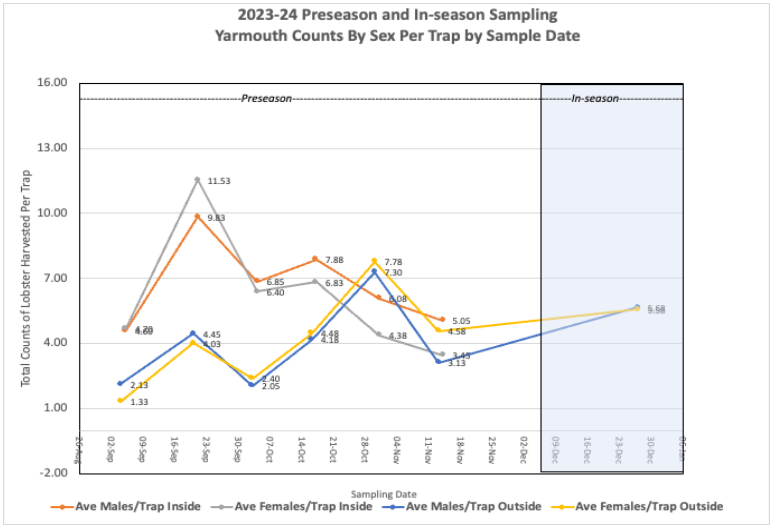
The counts per unit trap (CPUT) fishing effort measure provides general information about the propensity of available lobster to enter the trap during preseason sampling. As noted by the example of Yarmouth (Inside and Outside areas) in Figure 7 below, CPUT measures (males and females) for 2024-23(7a), 2023-22(7b), 2022-21(7c),and 2021-20(7d) for inside areas are generally flat or declining over the course of each preseason sampling dates (Figure 7a,b,c,d) and are either steady (2023-24, Figure 7a) or declining (2020-21, Figure 7c) during the commercial season. Comparison of annual CPUT for Yarmouth Inside areas shows that 2023 preseason catch rates were comparable to those of the 3 previous years 2022-2020. These results would suggest that Yarmouth Inside catch rates at the start of the commercial fishery in 2023-24 would be comparable to those of 2022, 2021, and 2020

For outside areas, preseason CPUT tends to rise over the preseason suggesting a movement of lobster from inside to outside areas over the preseason period August-November and a focus of the commercial fishery on outside areas as the season progresses. High CPUT for males and females in the outside areas during the later preseason sample dates are indicative of good catch rates at the start of the commercial season in these areas. Conversely, as experienced in 2023, Yarmouth Outside saw lower catch rates throughout the preseason and in-season periods (2023, Figure 7a) unlike the increases in Yarmouth Outside catch counts of the 3 previous years 2022-2020 (Figure 7bcd). These outside catch counts were also experienced in St. Mary's Bay and Port La Tour in 2023-24. These results led to lower predictions of outside area catches in these 3 areas (Lobster Bay excepted, see also Figure 8) at the start of the commercial fishery in LFAs33 and 34 for 2023-24.

(b) Counts of lobsters harvested per trap for Inside & Outside areas with BRIX averages

Preseason BRIX levels shift slightly over the course of preseason sampling in all areas. Figure 8 indicates the BRIX category levels for Lobster Bay. BRIX values tend to be flat initially in both Inside and Outside areas from the early preseason sampling dates (Augst to September) followed by a slight decline in value through October, then followed by a rise into early and mid-November at the end of the preseason sampling period and into the commercial season (2023-24, Figure 8a). Inside area BRIX averages were marginally higher than outside areas early in the sampling period. This reversed later in the period of the year when average BRIX values in the inside areas tended to fall, and outside areas' BRIX tended to rise. This behaviour of marginal differences within years BRIX was observed in all years 2023-2020. In Lobster Bay, average BRIX values, both Inside and Outside, have risen from 2020 to 2023 as this area begins to move back to the higher BRIX level regime of the pre-2014 period.

Overall, average counts were initially higher in Inside samples. Outside counts rose in later sampling dates in all years. (See also Appendix A, pp.A.2 through A.5 for 2023-24 sampling dates and locations.)



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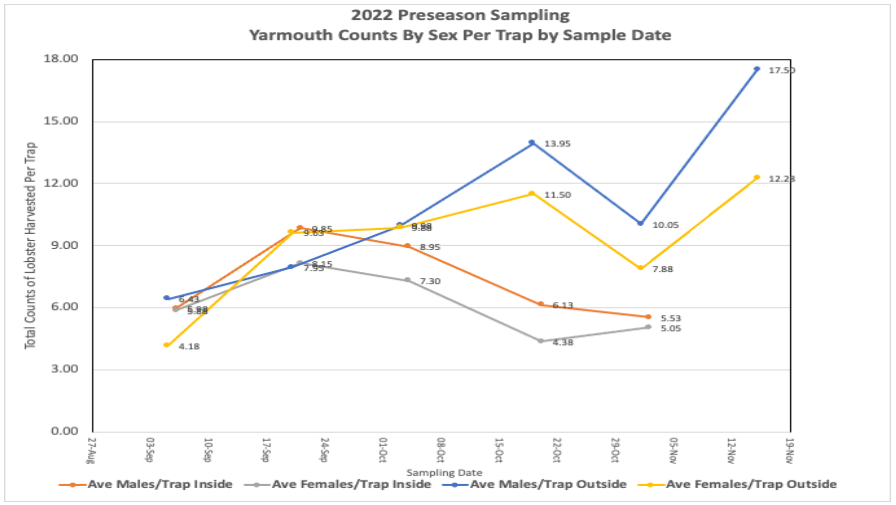

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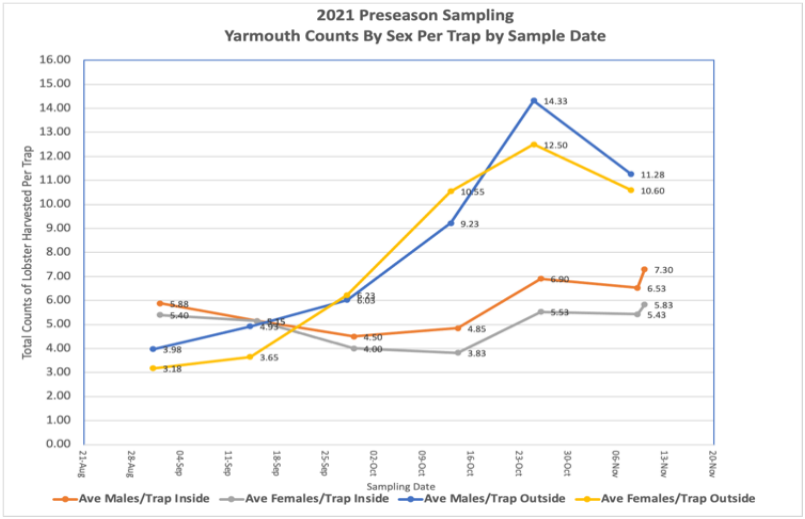

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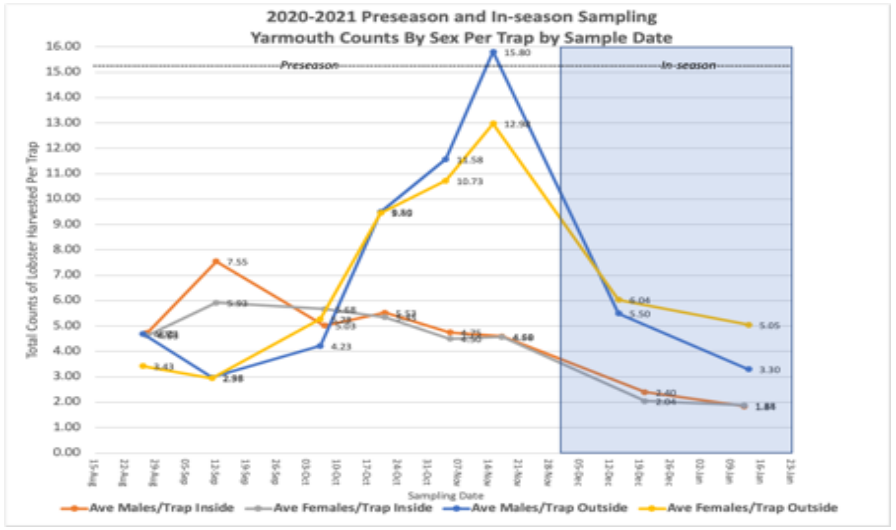
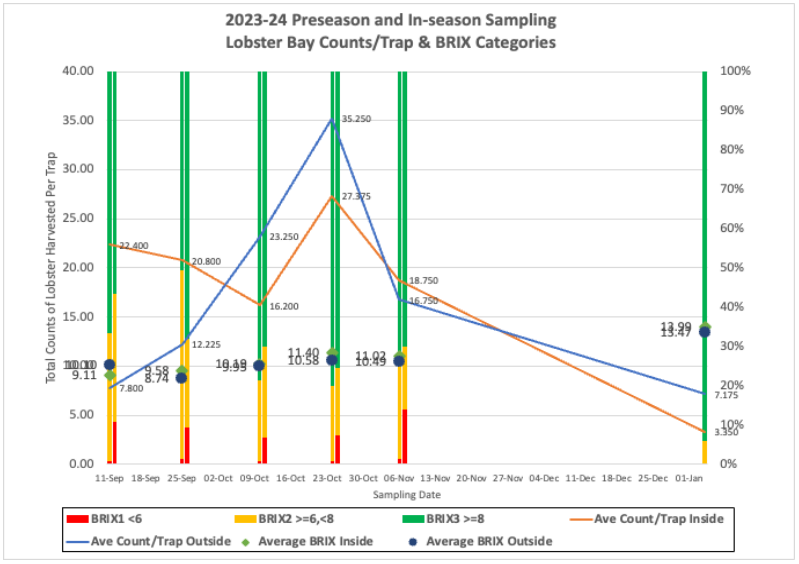


Figure 7. Preseason and In-season Yarmouth Counts by Sex per Trap for Inside/Outside locations: (a) 2023 Sample Dates; (b) 2022 Sample Dates; (c) 2021 Sample Dates; (d) 2020-21 Sample Dates.



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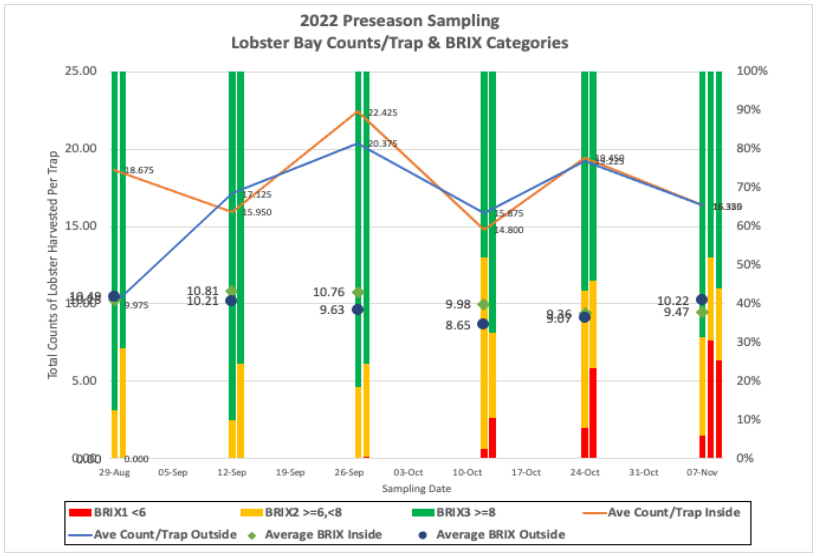

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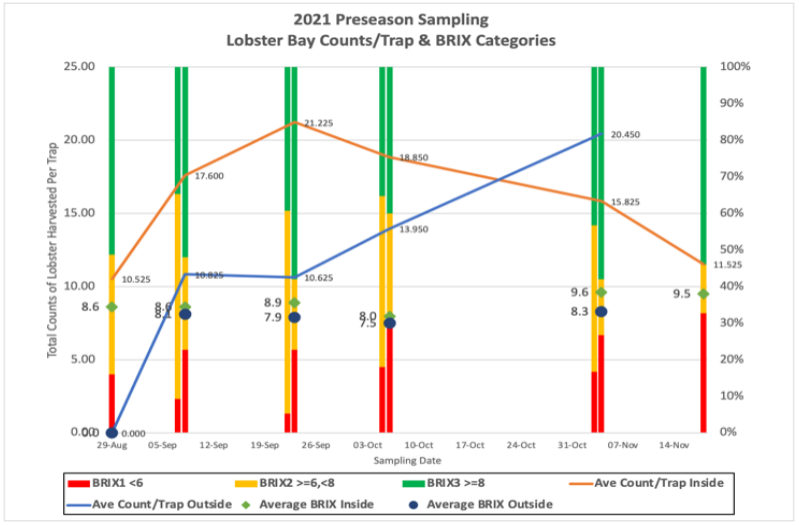

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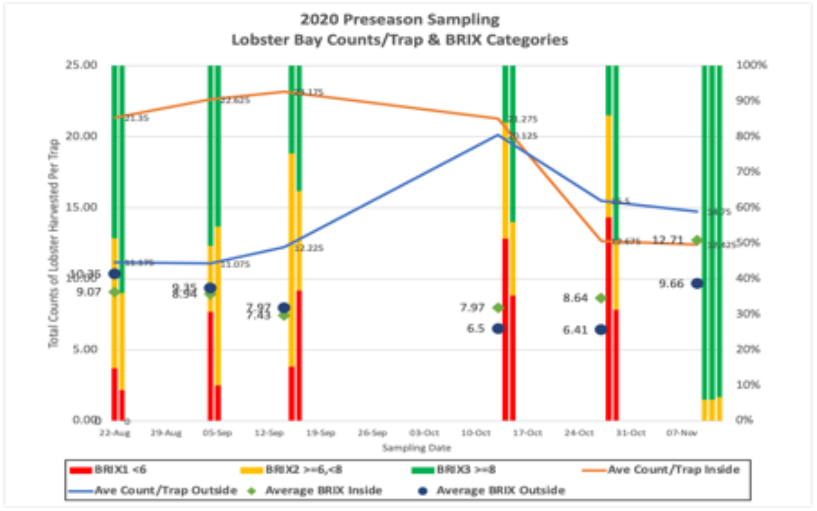


Figure 8. Preseason and In-season Lobster Bay Counts per Trap by Inside and Outside Locations and BRIX Indicators: (a) 2023-24 Sample Dates; (b) 2022-2021 Sample Dates; (c) 2021-2020 Sample Dates; (d) 2020-2021 Sample Dates.

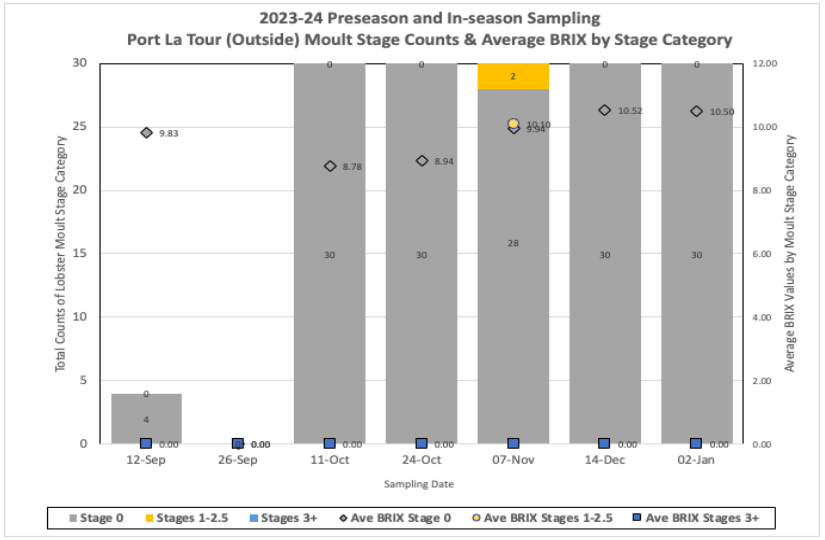
(c) Counts of lobster sampled by Moult Stage – Pleopod Data

As for 2020 to 2022, the 2023 preseason sampling program examined selected lobster's moult staging through the analysis of lobster pleopod (swimmeret) data under the microscope (Figure 3). As per Factor (1995, p.223), lobster moult categories are defined as: (1) Stage 0 (C4); (2) Stage 1-2.5 (D0); (3) Stages 3+ (D1). Moult stage information was recorded in 30 vials (as available) for each of the 8 sampling areas and for each preseason and in-season sampling date.

Figure 9abcd below shows the moult stage counts data by stage for Port La Tour Outside area preseason sampling. As in 2022 to 2020 (Figure 11bcd), early sampling efforts in Port La Tour (Outside) during 2023 sampling were unable to harvest significant legal lobsters (30) during the September 2023 sampling period (Figure 11a). By October, more lobsters were appearing in the Port La Tour Outside areas resulting in the full complement of 30 vials of pleopods. 2023 sampling in Port La Tour Outside lobster availability was below that compared to the 2022-23 sampling.

Figure 9 illustrates that the Port La Tour (Outside) samples in the remainder of the preseason and into the in-season sampling period for all 4 years result in a clear majority (90% or greater) of Stage 0 (no moult activity) samples. There are few (less than 5 samples) of Stage 2 lobsters and very limited Stage 3+ observations across all sample dates over all 4 years.

Among the 30 pleopod samples per location-date, roughly 1-2 vials recorded evidence of cement glands in female lobster ("CS", Factor's D2 and D3). Otherwise, zero moult activity stage is observed in Port La Tour (Outside) for the fourth successive year of preseason and in-season sampling there. (See also Appendix A, pp.A.2 through A.5 for moult stage information for all sampled locations in 2023-24.)



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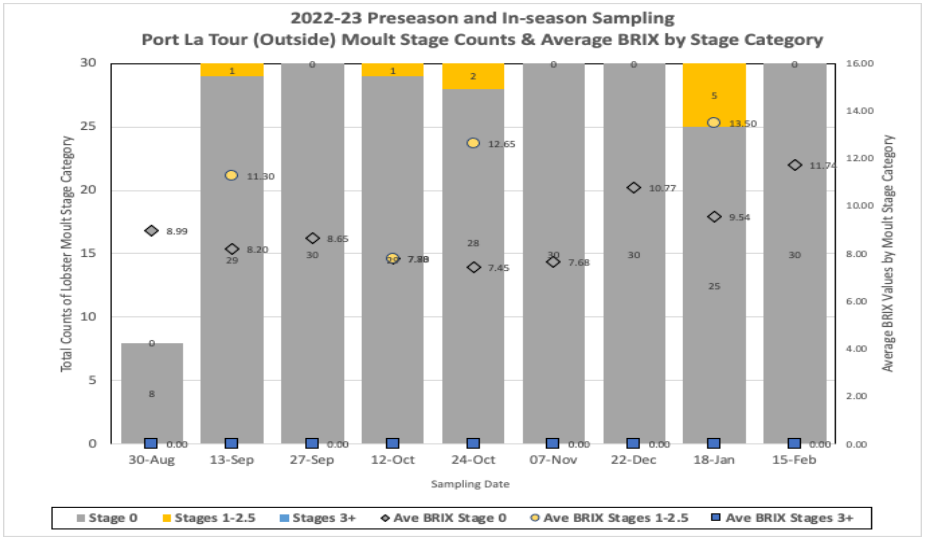

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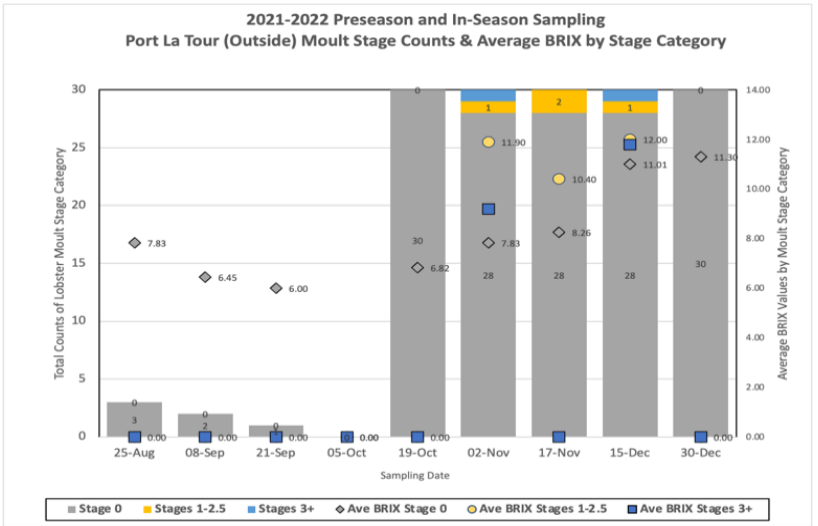

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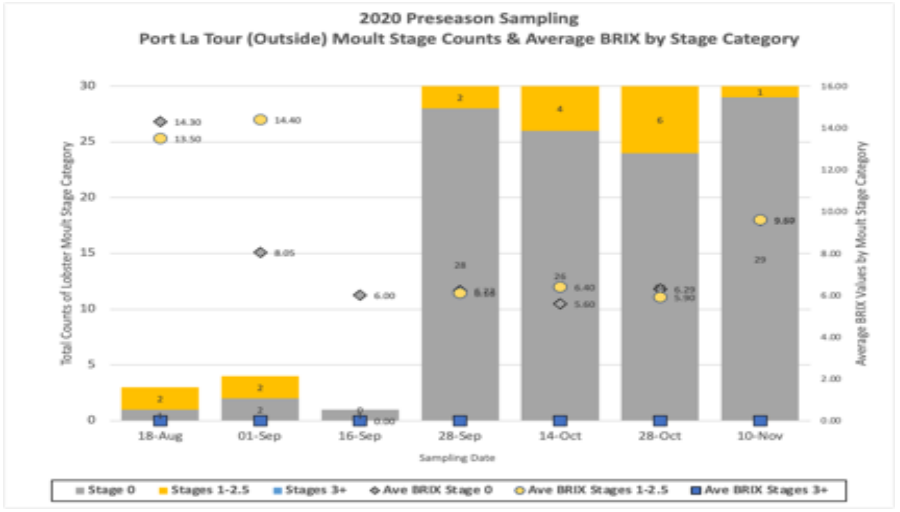


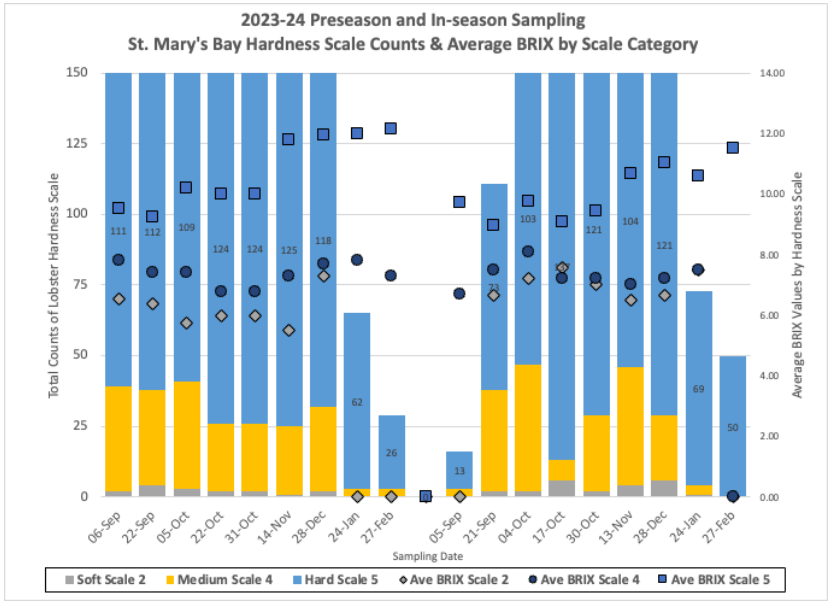
Figure 9. Preseason and In-season Port La Tour (Outside) Moult Stage Counts & Average BRIX by Stage Categories: (a) 2023-2024 Sample Dates; (b) 2022-23 Sample dates(c) 2021-22 Sample Dates; (d) 2021-20 Sample Dates.

(d) Counts of lobsters sampled by Hardness and BRIX for Inside & Outside areas

Lobster sampling included recording the manual hardness scale found by gently squeezing the lobster's carapace at harvest. In the 2020 sampling program, the evidence is that more than 90% of all sampled lobsters in all areas are recorded as "Hard" (scale "5"). This measure is not well-correlated with the much wider variation in lobsters' corresponding BRIX index values. However, over the recent 4-year sampling period 2020-2024 over all locations, new statistics reveal that more lobsters are being recorded with "Soft" and "Medium" status.

Figure 10 below provides the hardness measure results for St. Mary's Bay Inside and Outside sampling dates. In 2020-21 (Figure 10d), less than 1% of all sampled lobsters were assigned a "Soft" or "Medium" hardness level, i.e., almost all (98%+) lobster were assigned a "Hard" level. In 2021-22 sampling (Figure 10c), more "Medium" lobster were assigned in the St. Mary's Bay samples and approximately 5% of all lobsters (Inside and Outside areas combined) were recorded as "Soft" and "Medium" hardness. Numbers of "Soft" and "Medium" lobster in 2023 (Figure 10b) increased markedly in this location – and across all other locations – to the highest levels seen in the database since 2006 with totals "Soft" and "Medium" reaching 15-16% for both Inside and Outside subareas of St. Mary's Bay. This trend has continued into the latest sampling period in 2023-24 where the highest level of "Soft" and "Medium" have been recorded exceeding 20% in both Inside (20.37%) and Outside (20.96%) subareas.

It is noted that subjectively measured "Medium" and "Soft" lobster have lower BRIX values. However, the lack of variability in the hardness scale measure makes it difficult to obtain additional information about lobster quality from this subjective measure. As such, this determinant of lobster quality may be used to eliminate a proportion of lobster as unacceptable quality for storage and shipment. Appendix A.1, pp.A.2 through A.5, also contains hardness information for all sampled locations in 2023-24 sampling.



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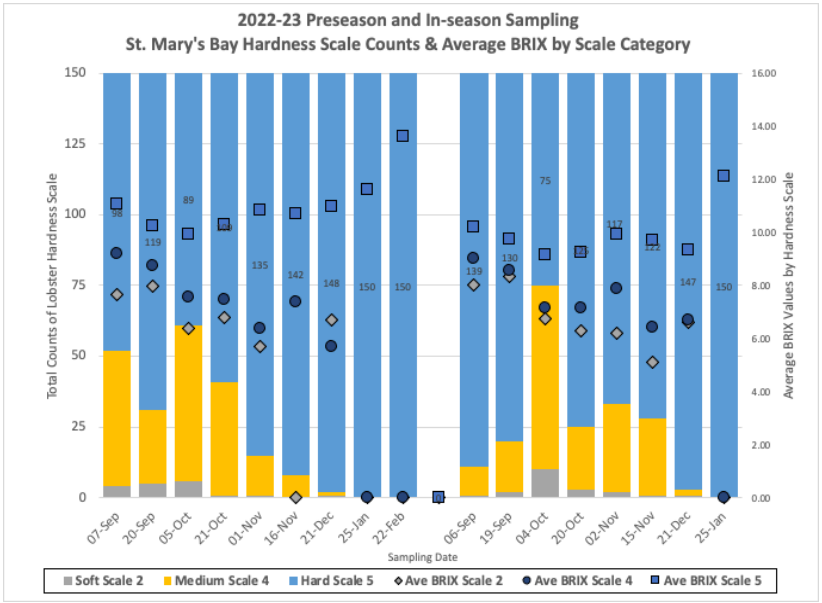

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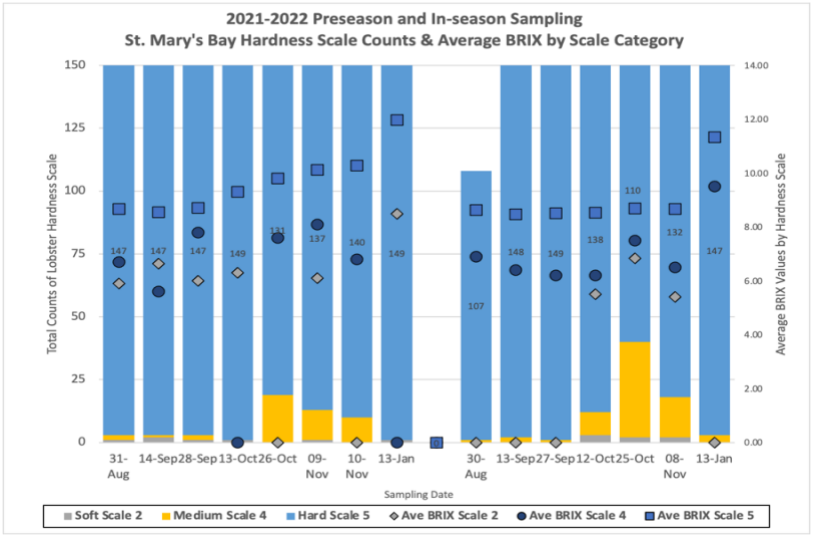

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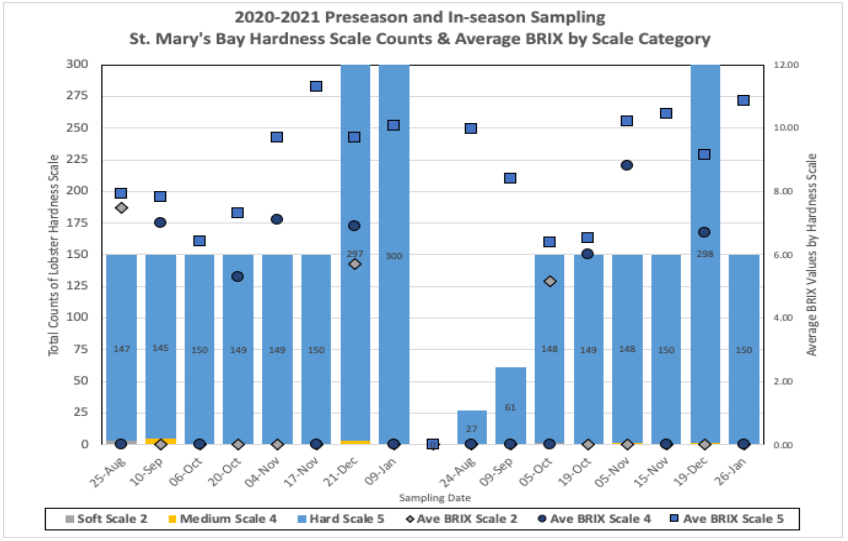


(d)

Figure 10. Preseason and In-season St. Mary's Bay (Inside and Outside) Hardness Counts per Trap & Average BRIX by Category: (a) 2023-2024 Sample Dates; (b) 2022-2023 Sample Dates; (c) 2021-2022 Sample Dates; (d) 2020-2021 Sample Dates.

3.1.2 Comparative Location graphics - lobster (harvested and sampled) counts information

Comparative location graphics from the sampling program are as follows:

(a) Counts of lobster harvested per trap by location for Inside areas
(b) Counts of lobster harvested per trap by location for Outside areas
(c) Average BRIX per sample by location of Inside areas
(d) Average BRIX per sample by location of Outside area

Appendix A.2 – "Comparative Location Graphics" contains the complete graphic record of this information. Selected graphics are presented in this report below and in Appendix A.2.

(a) Counts of lobster harvested per trap by location for Inside areas

As noted above in Section 3.1.1(a), the lobster counts per unit trap (CPUT) fishing effort measure provides general information about the propensity of available lobster to enter the sampling trap. In 2023, the trend across all inside locations is for CPUT to remain relatively flat from the beginning of the preseason sampling period and into the in-season period. Differences do exist among the different inside locations. Notably, Lobster Bay Inside has nearly twice the CPUT than the other inside locations (Port La Tour excepted) over the preseason sampling periods. See also Appendix A.2, p.A.6(a) for the Inside area graphic by location.

(b) Counts of lobster harvested per trap by location for Outside areas

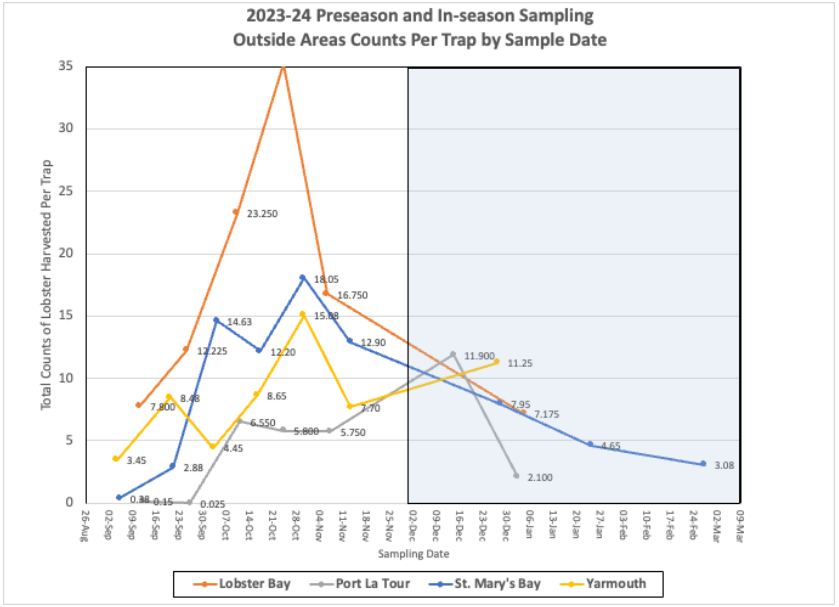
The trend across all outside locations is for CPUT to rise as lobster move into their associated outside areas over the preseason as is indicative of a movement of lobster from inside to outside areas over the sampling period August to November. This is illustrated by the trends seen in all 4 years of the 2020 to 2023 preseason periods in Figure 11abcd. Notably, in 2023-24 – with the exception of Lobster Bay Outside, all other Outside areas show a markedly lower catch count per trap over the sampling period. Once the commercial season begins, CPUT falls appreciably in the Outside areas as lobsters are fished down. Appendix A.2, p.A.6 contains more details.

(c) Average BRIX per sample by location of Inside areas

Comparison of average BRIX levels in the inside location samples are also provided in Appendix A.2, p.A.6(c) for the inside areas. Generally, in 2023-2024, as in the past years, Inside BRIX values are flat and/or in decline in the preseason sampling period (September and October), followed by a significant (50%) rise thereafter to the start of the commercial season at end November and into the commercial in-season sampling periods. See also Appendix A.2, p.A.6(c).

(d) Average BRIX per sample by location of Outside areas

Outside areas average BRIX values per sample tend to fall initially (August through September) from average levels of approximately 9-10 units/ml, remain flat through October (at levels of 7-8 units/ml) before rising by as much as 50% (to levels of 11-13 units/ml) across all areas and continuing into the I n-season sampling periods. This dynamic behavior over all 4 years 2020 to 2024 with respect to BRIX is illustrated in Figure 12abcd below for all locations. Average BRIX levels in 2023-24 have increased into the commercial fishery season to higher levels relative to past years. (See also Appendix A.2, p.A.6(d).)



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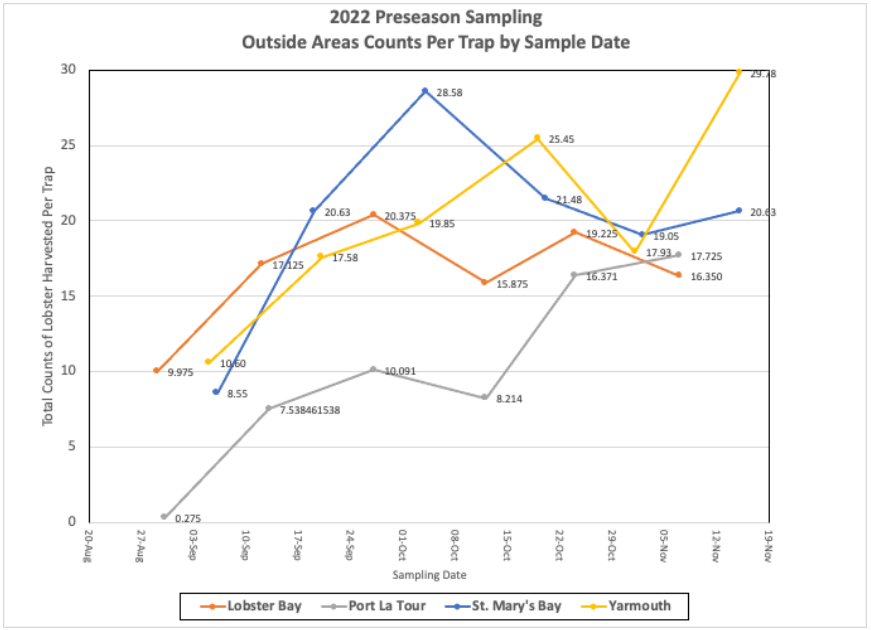

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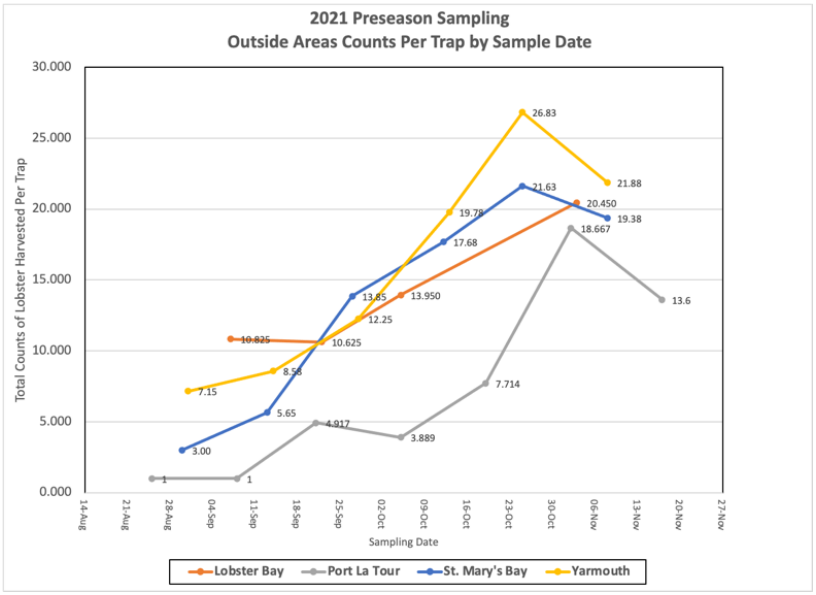


(d)

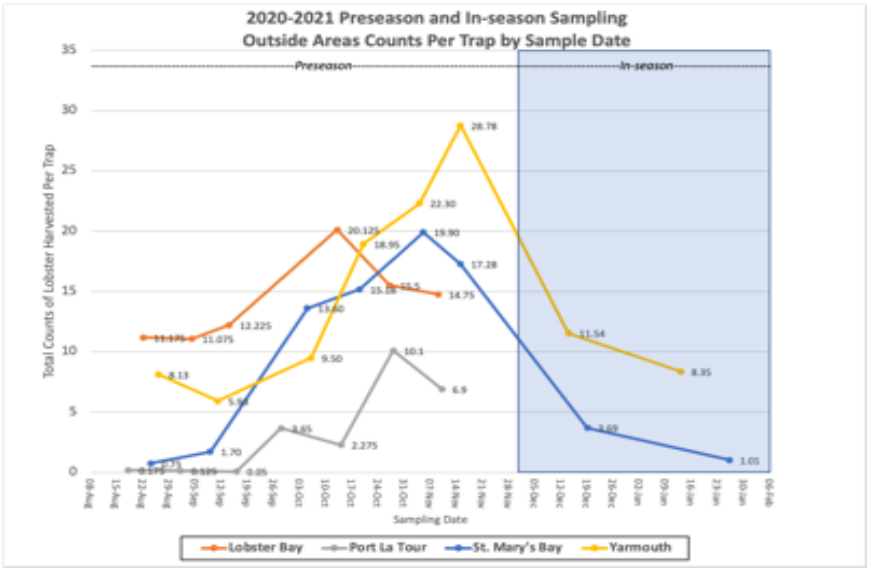
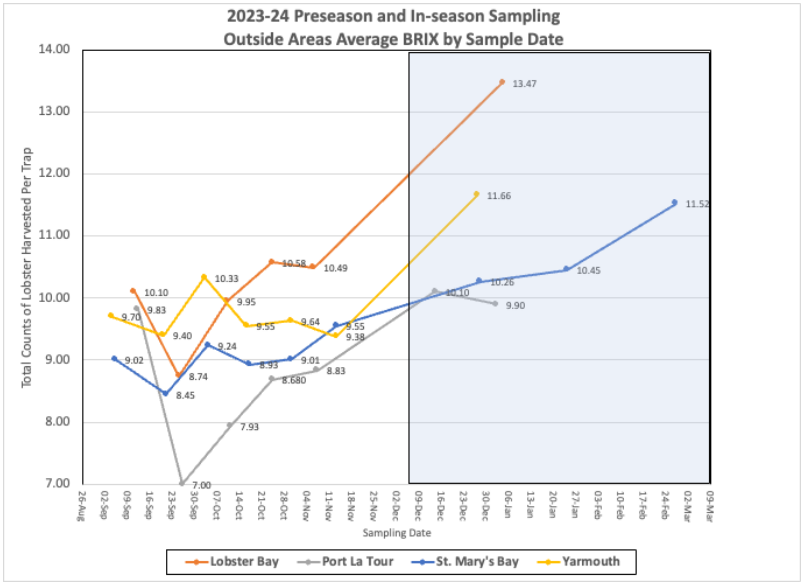
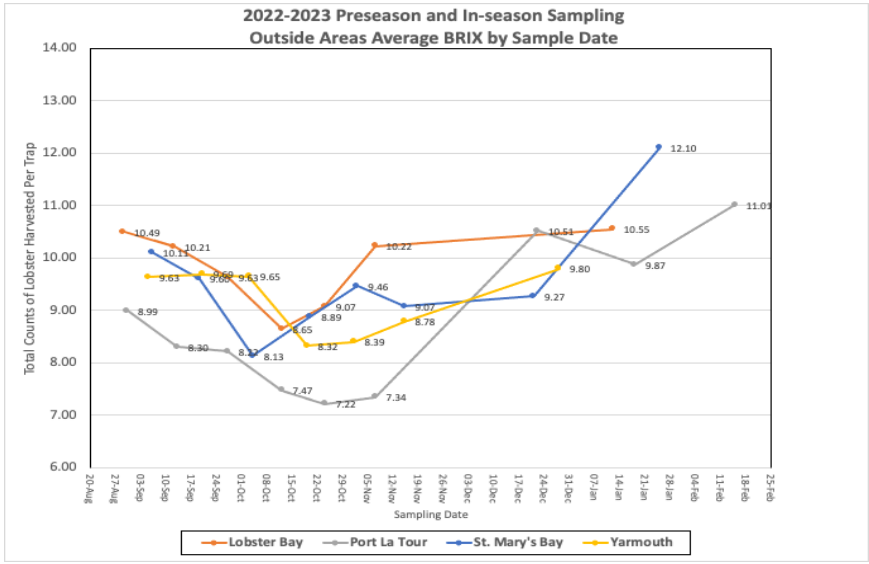


Figure 11. Preseason and In-season Outside Areas Counts per Trap: (a) 2023-24 Sample Dates; (b) 2022-23 Sample Dates; (c) 2021-22 Sample Dates; (d) 2020-21 Sample Dates.



(a)



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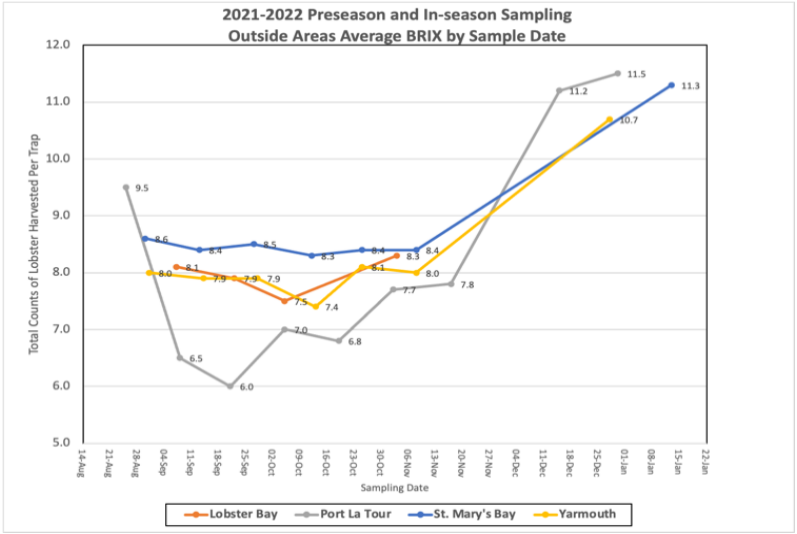


(d)

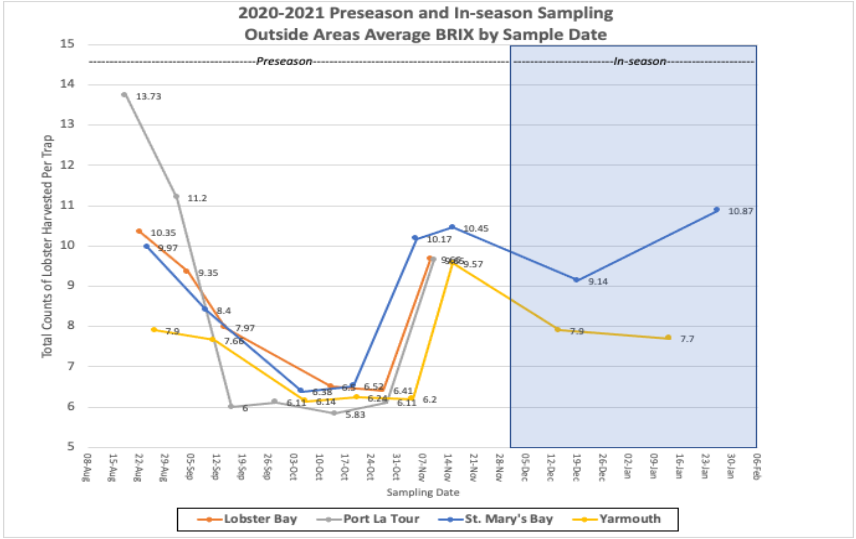


Figure 12. Preseason and In-season Outside Areas Average BRIX; (a) 2023-24 Sample Dates; (b) 2022-23 Sample Dates; (c) 2021-22 Sample Dates; (d) 2020-21 Sample Dates

3.2 Berried Females Sampling for 2023-2024

Berried (egg-bearing) females were examined again in the 2023-24 preseason and in-season survey. Each of the 57 preseason and in-season location-dates captured an average of 6.8 berried females in all moult stages or 3.44% (387) of all female lobsters captured (11,240) during the preseason and in-season sampling dates. In total, Inside areas accounted for almost 80% of total berried females collected. Lobster Bay Inside saw 170 berried females of 44% of the total in 2023-24 sampling. Only 16 berried females samples were found in Port La Tour Inside and Outside areas combined during 2023-24 sampling. Berried female analyses recorded carapace size, clutch fullness, egg stage and condition for each berried female lobster.

Data on berried females were compiled as part of the preseason and in-season sampling program in 2023-2024. This report contains summaries of the berried females information on selected harvested lobster counts. This information below includes: (1) Section 3.2.1 – berried females sampled counts information; and (2) Section 3.2.2 – berried females sampled stage counts information.

Appendix B.1 – "Location graphics – berried females sampled counts information Graphics" contains the complete graphic record of this information for all locations, inside and outside areas by preseason sampling dates (no berried female counts data were collected for the 2023-2024 in-season sampling dates). Selected graphics are presented in this report below.

3.2.1 Berried females sampled counts information (Appendix B.1)

1) Berried females sampled in 2023 and percent of harvest for Yarmouth Inside & Outside areas

The sample of berried females in Yarmouth – as for most areas – is variable with respect to counts of lobsters in stages. Most observations are Stage 1(41 on 64 observations or 64% over all sampling dates) with observations between 0 and 7 berried female lobsters in a single sample. In 2023, there are 21 Stage 2 observations (33%) and only 1 Stage 3 and 1 Stage 4 observations (1.6% each). In 2023, the percentage of Yarmouth berried females observations is 17% (64 Yarmouth observations on 387 total) of all berried female samples over all locations. These proportions are comparable to the 2022 berried female results for Yarmouth.

2) Berried females sampled in 2023 and percent of harvest for Lobster Bay Inside & Outside areas

Berried females counts in Lobster Bay accounted for 51% (198 on 387 observations) of all berried females observations across all locations. In 2022, Lobster Bay accounted for 32% berried females on 295 total observations. Stage 1 counts increase to early November and then fall into the commercial season – as happened in the past years 2020-2022. Lobster Bay berried females counts are dominated by Stage 1 observations accounting for 80% (159 observations on 198 total). There are 33 Stage 2 counts with 22 of these observed Inside in 2023 and 11 Outside. In 2023, there were 6 counts of Stage 3 and Stage 4 lobster combined (3%).

3) Berried females sampled and percent of harvest for Port La Tour Inside & Outside areas

Again in 2023 (as for 2020 to 2022), berried female counts in Port La Tour are the smallest of all areas with total counts of 15 (4% of total) and 3 berried females or less in any one sample. Stage 1 counts (9 observations) occur mainly (7 of 9) in the Inside Port La Tour area. Stage 3 observations (2) all occur in

one late sample date Outside during the In-season period (December 2023). There are only 2 counts of Stage 4 over all locations occurred Port La Tour.

4) Berried females sampled and percent of harvest for St. Mary's Bay Inside & Outside areas

Figure 13abcd illustrates the berried females report for St. Mary's Bay for 2020 through 2024. The counts of berried females in this location in 2023 are represented by 110 observations or 28% of all observations in 2023-24. Berried female counts in St. Mary's Bay (Inside) rose steadily from early sampling in September 2023 (1 observation) to 14 observations at end-October and mid-November sampling (Figure 13a). In Outside areas of St. Mary's Bay there are only 12 observations of berried females with 5 counts in a single Outside sample in November 2023. Only 2 observations of a Stage 2 lobster were observed Outside, and only 1 count of each of Stage 3 and Stage 4 (Figure 13a).

3.2.2 Comparative Location Graphics (2 pages) – berried female sampled stage counts information (Appendix B.2)

a) Berried females Stage 1 counts for Inside areas

Stage 1 berried females represent the largest counts of all stages for the inside areas (Figure 14abcd). In 2023, Stage 1 inside area counts (Figure 14a) fluctuate by location with Lobster Bay Inside having the highest counts of Stage 1 berried females by far (totals of 145) and Port La Tour Inside having the lowest counts (7). It is not possible to determine a trend over the 4 years of data in Stage 1 counts for any location.

b) Berried females Stage 1 counts for Outside areas

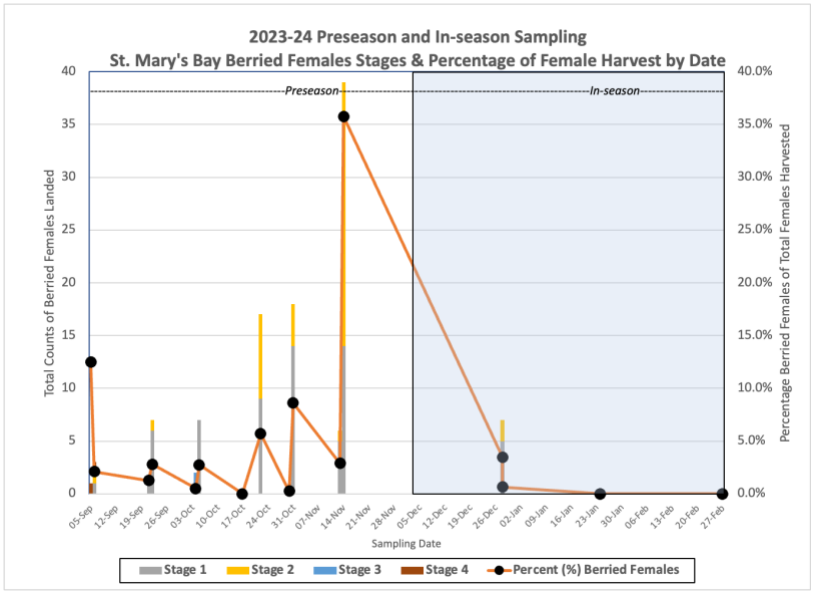
As for Stage 1 Inside counts, there is no evident trend in Outside counts for any or all areas over the 2023 preseason and in-season sampling periods. In 2023, Lobster Bay Outside has larger initial counts for the Outside areas (14), while Port La Tour once again has berried female counts in the Outside area that are negligible over all samples (2). Lobster Bay Outside also dominated berried females counts in 2021 sampling.

c) Berried females Stage 2 counts for Inside areas

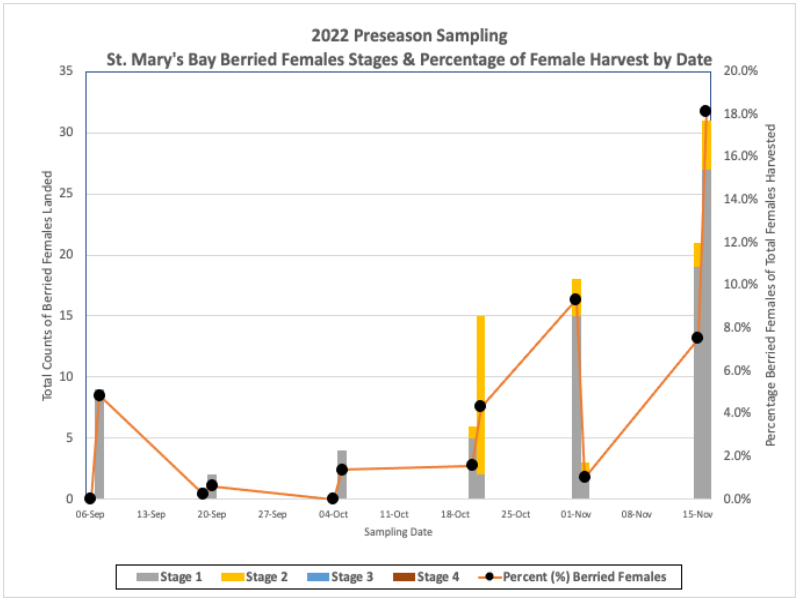
As for all years in the Inside areas (Figures 14abcd), Stage 2 berried female counts are less than the corresponding Stage 1 counts. In 2023, Stage 2 inside area berried females counts are largest in St. Mary's Bay Inside (41) with a single sample observation of 25 counts in mid-November 2023 (Figure 14a). Stage 2 counts for Lobster Bay Inside are 22 counts while Yarmouth (2) and Port La Tour (1) Inside counts are negligible.

d) Berried females Stage 2 counts for Outside areas

Observations of berried females in Stage 2 for the Outside areas are less than that of the Inside areas. Yarmouth and Lobster record counts of 14 and 11 berried females over all sampling periods. Port La Tour (1) and St. Mary's Bay Outside (2) counts of Stage 2 are negligible.

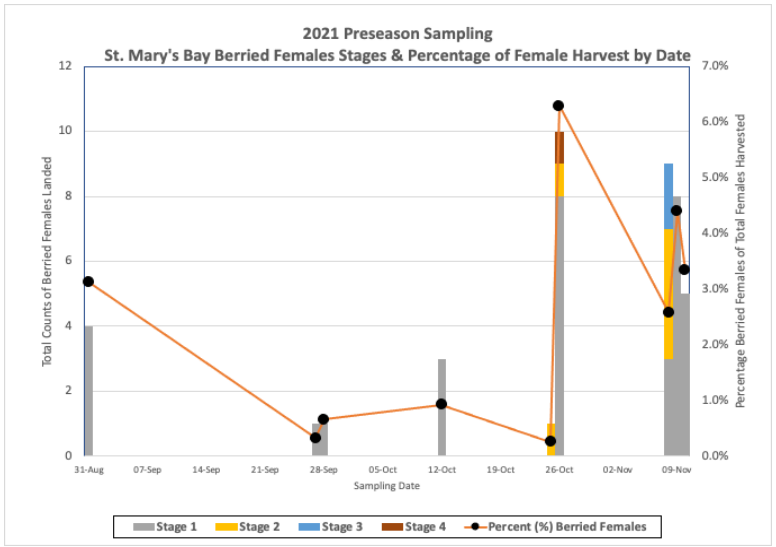


(a)



(b)

(c)



(d)

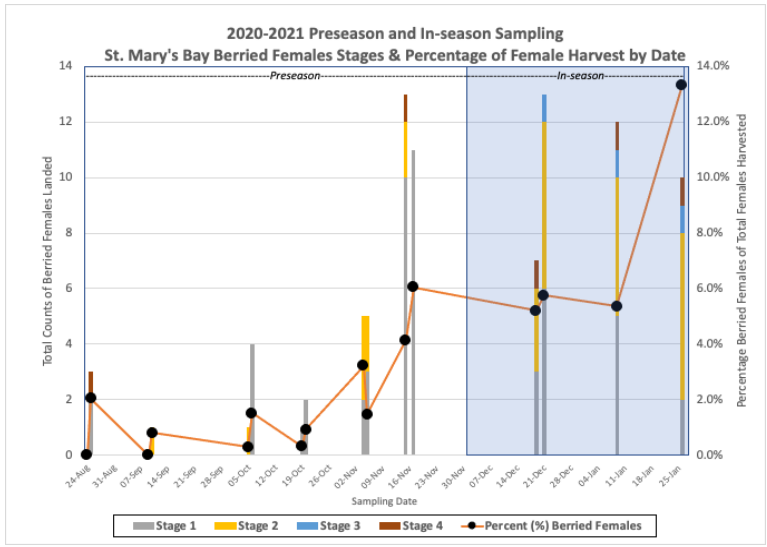
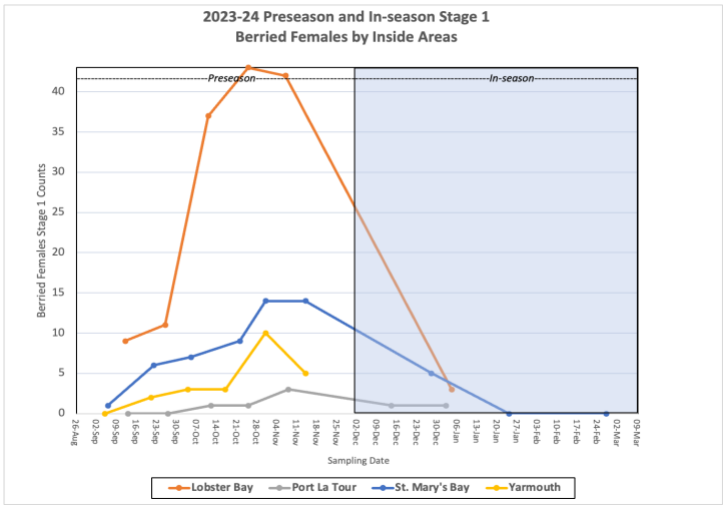
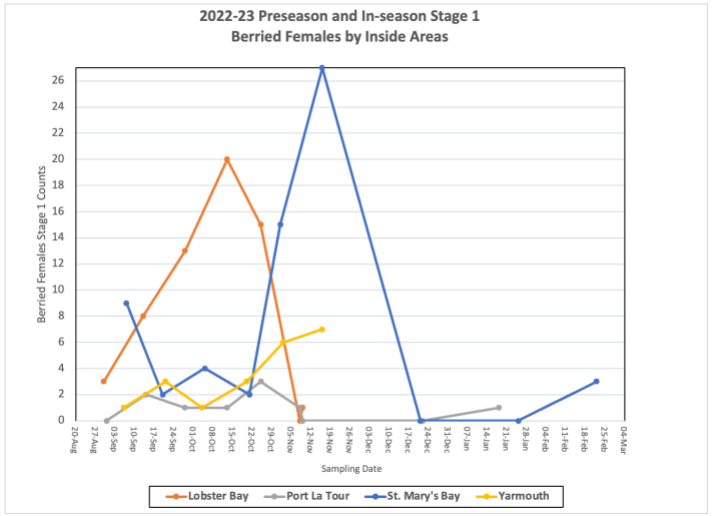


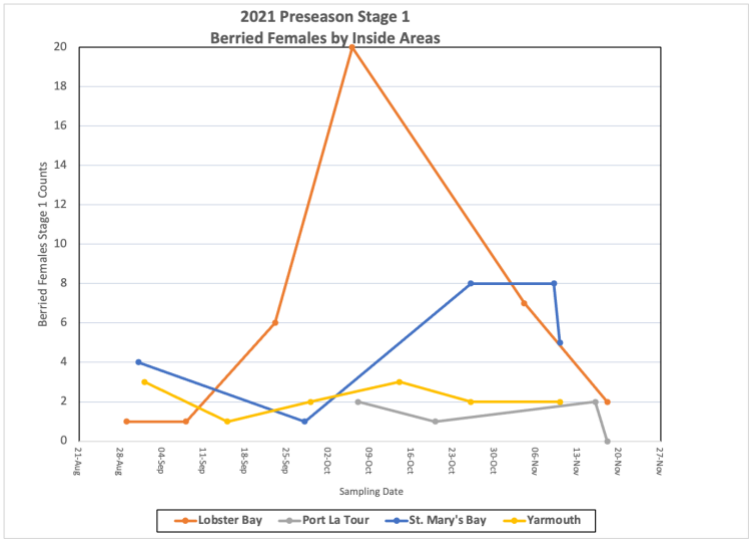
Figure 13. Preseason and In-season St. Mary's Bay Berried Females Stages and Percent of Female Harvest: (a) 2023-24 Sample Dates; (b) 2022-23 Sample Dates; (c) 2021-22 Sample Dates; and (d) 2020-21 Sample Dates



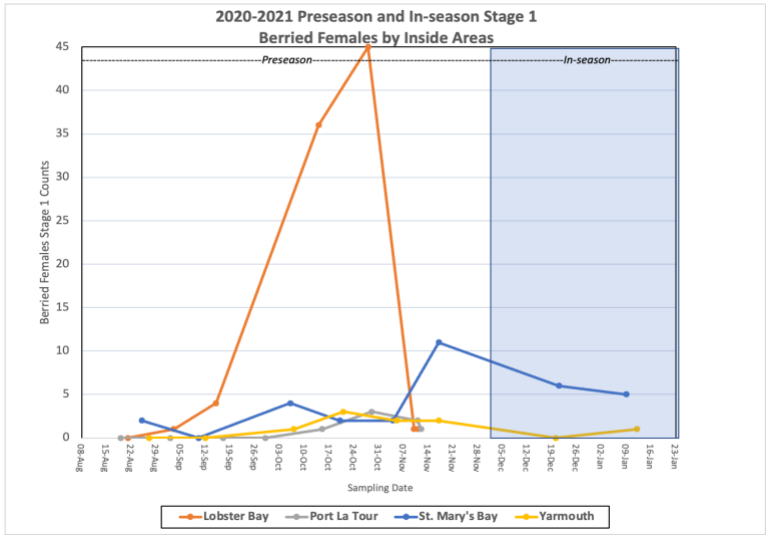
(a)



(b)



(c)



(d)

Figure 14. Preseason and In-season Inside Areas Berried Females Stage 1 Counts: (a) 2023-24 Sample Dates; (b) 2022-23 Sample Dates; (c) 2021-22 Sample Dates; (d) 2020-21 Sample Dates

e) Berried females Stages 3 & 4 counts for Inside areas

The counts of berried females observed to be in Stage 3 or 4 for inside areas over the sampling dates are negligible with no more than 2 counts in any sample across all areas. See also Appendix B.2, p.A.11(e).

f) Berried females Stages 3 & 4 counts for Outside areas

As for the inside areas, the counts of berried females observed to be in Stage 3 or 4 for outside areas over the sampling dates are very few and fluctuate from zero to a maximum single count of 2 in any sample across all areas. See also Appendix B.2, p.A.11(f).

In general, the counts of berried females over all locations and areas are expected to be low for the higher Stages 3 and 4 during the preseason and the in-season sampling period. Appreciable counts of higher moult stages climb significantly and are expected to be seen before the sampling period (in the Spring of the year, March-May) and after the end of the commercial season in LFAs33 and 34 when lobster eggs are released during the months of June and July and before the typical end August or early September sampling dates. Low counts of Stage 3 and 4 berried females are more of a concern after the end of the commercial season (i.e., in June and July). They are not a concern for the start of the commercial season (November-December). These data are recorded here for potential use with in-season observations aligned with the lobster moulting cycle during Spring and Summer months.

3.3 Temperature Data

It is recognized that collecting continuous data on bottom temperatures on the lobster fishing areas will provide valuable information and assist in making prediction models for the lobster moult cycle as a key determinant of lobster behaviour including as a trigger for moulting, and/or for epizootic shell disease conducive conditions. Again in 2023-2024, temperature data were not specifically collected as part of the lobster sampling surveys with one exception, namely, occasional water surface temperature at sampling location during haul dates. (See also Section 2.2 above, re surface temperature information recorded on the publicly available Google Map of all sampling locations 2020-2024.)

In future surveys, deploying additional temperature loggers to cover a wider range of depths across the two LFA's and for the different depths of the inside and outside areas are being considered. Data loggers that were originally deployed during a portion of the ALMQ survey are no longer available. Alternative temperature collection means are being explored for future sampling programs also with respect to warming water temperatures with the changing climate, and the potential corresponding incidence of epizootic shell disease (ESD).

4 2023 Preseason Highlights and Predictors

In the summary report presented prior to the start of the 2023-24 commercial season (Mattock, Mulock, Lane 2023), the 2023 Preseason Summary highlights were summarized for: (1) BRIX level values; (2) lobster counts per trap; (3) lobster carapace hardness 'soft' and 'medium' values; and (4) percent weak lobsters in the samples.

Table 7 presents the average BRIX results over all sample dates for each of the 8 locations in 2023-24. Summary statistics for landed lobster counts per trap by location as well as the percentage of weak lobsters, and the percentage of soft and medium lobster in samples are also recorded. Table 7 also shows each location's 2023 most closely comparable historical year(s) from the historical database. Finally, Table 8 indicator predictor values for the summary indicators for the start of the 2023-2024 commercial season are provided. These values are to be corroborated with the 2023-23 In-season sampling presented in Section 6 below.

Table 7. 2023 Preseason Sampling Summary Results

Locations: 2023 Preseason Samples	Yarmouth Inside	Yarmouth Outside	Lobster Bay Inside	Lobster Bay Outside	Port La Tour Inside	Port La Tour Outside	St.Mary's Bay Inside	St.Mary's Bay Outside	Average Overall Locations
Average BRIX	10.58	9.65	10.26	9.97	9.88	8.49	9.68	9.07	9.78
Ave Legal Counts Per Trap	8.32	6.41	13.92	14.68	7.06	2.80	9.95	9.38	11.74
Ave % Soft+Med	17.89%	23.16%	21.60%	21.20%	17.07%	41.32%	21.67%	24.31%	22.47%
Ave % Weaks	7.00%	9.54%	16.53%	13.07%	6.27%	15.20%	13.33%	11.72%	12.37%
Comparable Years	2020, 2013	2013	2018	2022	2020	2012	2022	2022	2022

4.1 BRIX Level Values

In 2023, Inside area average BRIX levels per sample tend to rise over the preseason sampling dates from early September to the end of sampling period in mid-November at average levels varying from a low of 7.62 mg/mL (Port La Tour in September) to over 12.31 mg/ml (Port La Tour in November). These average BRIX are indicative of average "Good" BRIX across all Inside locations and sampling dates in 2023. For Outside areas, average BRIX levels are more stable over the sampling dates. In Outside areas, average BRIX vary between low levels of 7 mg/mL (Port La Tour at end September) to 11.5 mg/mL (Yarmouth Bar in October-November).

In Figure 15, average BRIX values are shown for Lobster Bay and Port La Tour and include samples for both Inside and Outside areas and each of the indicated years 2020 to 2023. In the case of Lobster Bay (Figure 15a), overall average BRIX values are rising from 2020 to 2023. In 2023, Lobster Bay average BRIX values are 10.26 (Inside) and 9.97 (Outside) and contribute to the overall trend of somewhat

favorable Inside versus Outside BRIX in preseason sampling (Table 7). For Lobster Bay, these values remain below the higher average BRIX of the 2006 to 2013 period.

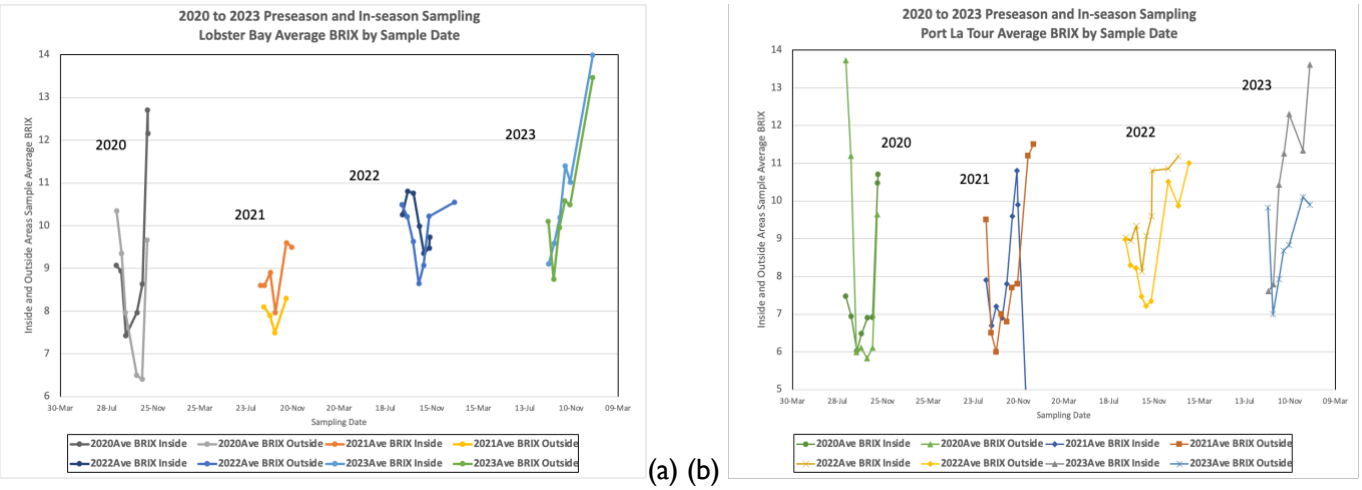


Figure 15. Preseason and In-season Sampling Average BRIX values by Sample Dates 2020-2024 for: (a) Lobster Bay inside and Outside Areas; and (b) Port La Tour Inside and Outside Areas

For Port La Tour (Figure 15b), overall average BRIX values are also rising annually from 2020 to 2023. In 2023, Port La Tour average BRIX values are 9.88 (Inside) and 8.49 (Outside) (Table 7). For Port La Tour, these values are improving, but remain slightly below the higher average BRIX of the 2006 to 2013 period from Port La Tour.

2023 preseason sampling results in LFAs 33 and 34 indicated that lobsters landed at the start of the 2023-2024 season in southwest Nova Scotia, appear to be of overall moderate (M) quality by comparison with the entire 2006 to 2022 preseason database. 2023 preseason samples average overall BRIX (Table 7) at the moderate level of 9.78 mg/mL, a 3% improvement in the overall BRIX average for 2022 (9.46 mg/mL).

4.2 Lobster Counts Per Trap

In 2023, total preseason and in-season landings (legal and sublegal, and male and female lobsters) over 57 sample dates were 24,038 lobsters. This represents a decrease of almost 30% versus last year's landings of 29,446 lobsters over 62 sample dates. The 2022 survey had an increase of 24% versus the 2021 preseason and in-season survey landings of 23,715 lobsters (2021 sample dates), and an increase of 23% over the 2020 preseason and in-season survey landings of 28,276 lobsters (2020 sample dates).

Previous surveys carried out different numbers of preseason sampling locations-dates. In 2023, 44 location-dates were sampled compared to 50 (2022), 51 (2021), and 52 (2020). Differences in the preseason sampling location-dates explain, in part, differences in total annual preseason survey lobster landings. To examine comparable differences in sampling counts of lobster, the measure of total (legal and sublegal) lobsters landed per sample are determined for each year 2020 to 2023. The results are summarized for selected locations in the figures below. Table 7 also presents the average legal sized landings of lobster counts per preseason trap in the 2023 samples for each location. Legal landings of

lobster counts per trap are also shown for each location and compared to historical years 2020-2022 in each of the 2023 preseason locations section below.

In the Figure 16, Inside and Outside total (legal and sublegal) counts are illustrated for Lobster Bay annually for each preseason sample over the years 2020 to 2023. Lobster Bay is unique in that there is a clear separation of males and females in the preseason samples' landings in the Inside area. With respect to legal lobster counts per sample (Table 7), Lobster Bay counts per trap for 2023 are comparable in the Inside area (13.91 lobsters/trap) and the Outside area (14.68 lobsters/trap). These relatively higher count statistics are consistent year-over-year in Lobster Bay compared to the other locations.

As for the interannual differences in total counts, 2023 may be considered to have slightly higher counts per trap than the 2020-2022 period in Lobster Bay. However, these differences are not statistically significant. The expectation is therefore that catches in the commercial fishery in 2023 will be similar to past catches in Lobster Bay, Inside and Outside areas based on the similarity of total counts and legal counts per trap over time.

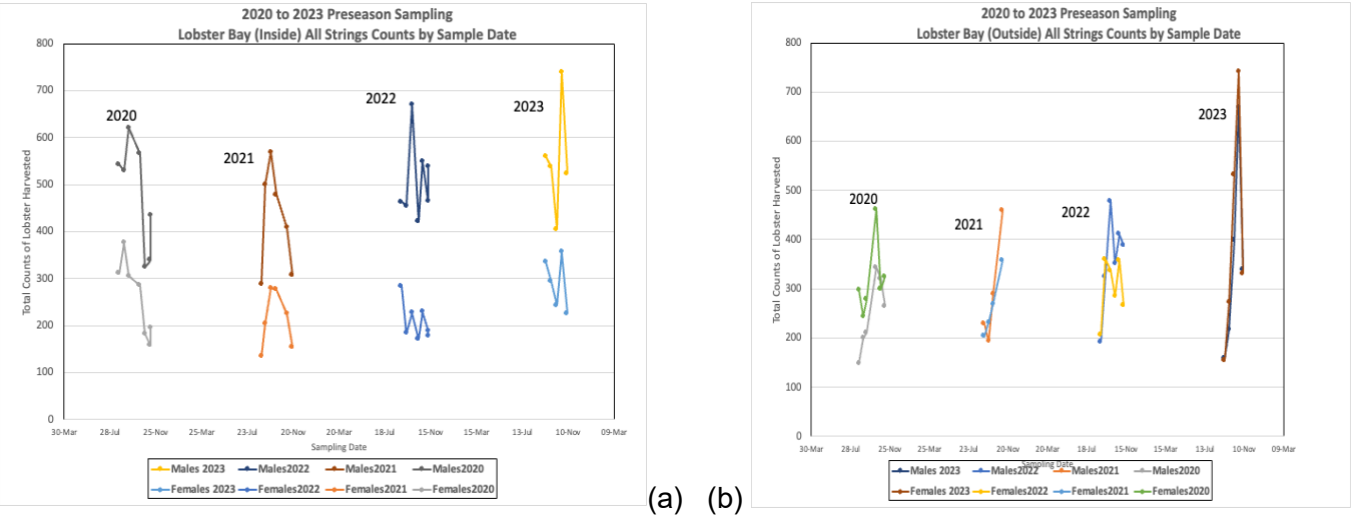
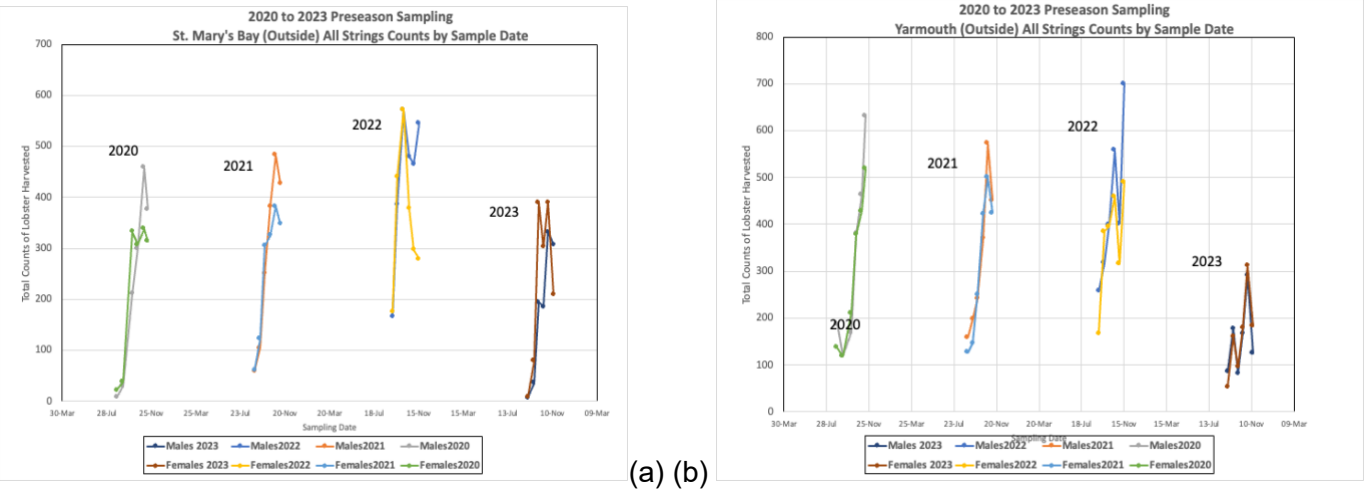


Figure 16. Lobster Bay Catch Counts per Trap 2020 to 2024: (a) Inside Sample Dates; (b) Outside Sample Dates

The figures below are provided for Outside areas of St. Mary's Bay and Yarmouth for 2020 to 2023. These figures illustrate clear differences between the 2023 Outside area counts by sex (legals and sublegals) and the comparable past years' results (2020-2022) for these two areas. Notably, St. Mary's Bay Outside appears to show a slight increase in counts per sample over the period 2020 to 2022 followed by a sharp decline in the 2023 total counts per sample of almost -50% compared to 2022 total counts per sample. For Yarmouth Outside, the average decline in total counts per sample in 2023 is -60% compared to the 2022 average total counts per sample as illustrated below.

In the case of these sharp year-over-year declines in landings per sample, the expectation is that catches in the commercial fishery in 2023 will be lower in the Outside areas of St. Mary's Bay and Yarmouth based on the total counts and legal counts per trap over the past years 2020-2022. In terms of counts per trap, over all 8 locations, average legal counts per trap in 2023 (9 legal sized counts per trap) are down

by 24% compared to 2022 values (11.83 legal sized counts per trap).

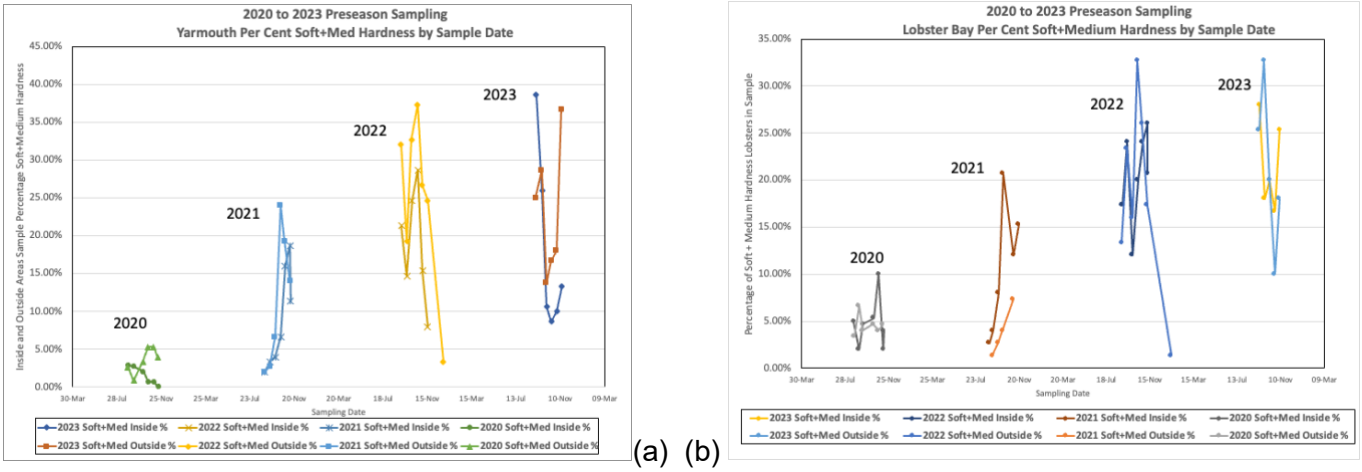


(a) (b)

Figure 17. St. Mary's Bay Catch Counts per Trap 2020 to 2024: (a) Inside Sample Dates; (b) Outside Sample Dates

4.3 Lobster Carapace Hardness in Samples

Lobster hardness measurements also shifted in the 2023 preseason in comparison to the 2022 to 2020 preseason survey results. The graphs below for Yarmouth (Inside and Outside) and Lobster Bay (Inside and Outside) compare the counts (in percentage of the 150 samples protocol) of the combined counts for "Soft" (Hardness scale=2) and "Medium" (Hardness scale=4) for the preseason survey dates over the 4-year reporting period, 2020 to 2023. Counts of soft and medium lobster increased from negligible amounts (5%) in 2020 to over 30% in the selected sampling dates in 2023 for both Yarmouth and Lobster Bay. These shifts in 2023 are evident in Port La Tour Inside and Outside areas but less so for St. Mary's Bay.



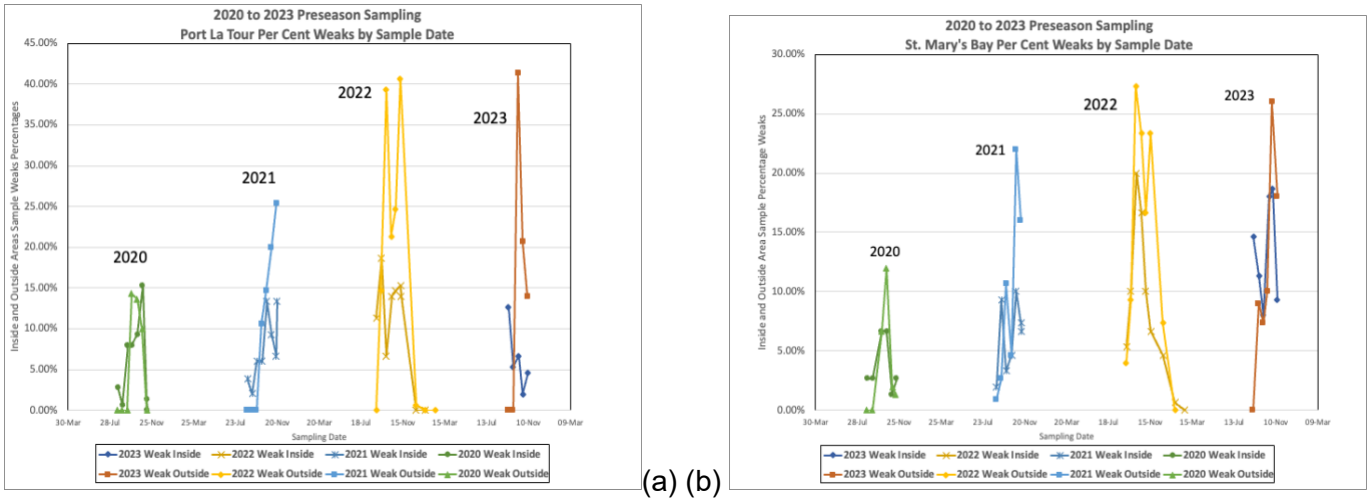
(a) (b)

Figure 18. (a) 2022-23 Yarmouth Per Cent Soft+Medium Hardness by Sample Dates; (b) 2022-23 Lobster Bay Per Cent Soft+Medium Hardness by Sample Dates

4.4 Percent Weak Lobsters in Samples

The percentage "weak" lobsters observed in 2023 preseason sampling was 12.37% weaks over all samples (Table 3). These observations are an improvement in the weaks statistics relative to the 2022 results and they approach the 2021 level of weak lobsters in the preseason samples. In 2023, weaks in the Inside locations averaged 10% per sample – an improvement over the 2022 value of 14.5%. Similarly, in 2023, weaks in the Outside locations averaged over 15% per sample – an improvement over the 2022 value of 18%. Lobster Bay and St. Mary's Bay (figure below) dominated the incidence of weaks (16% and 13% respectively in Inside areas, and 13% and 12% in Outside areas, respectively). These higher values are compared to the overall average of weaks in all areas of 12.37% in 2023 (Table 3). Yarmouth weaks are lower overall in Inside and Outside areas with averages (7% and 9.54% respectively, Table 4) below the overall mean of 12.37%.

The illustration for Port La Tour (Inside and Outside) in Figure 17 below depicts the dynamics of weaks from 2020 to 2023. It is typical of all areas that weaks percentages of samples tend to become more varied, i.e., wider, over time with gradual increases from lower 2020 values trending to higher percentage values in 2023.



(a) (b)

Figure 19. (a) 2022-23 Port La Tour Per Cent Weaks by Sample Dates; (b) 2022-23 St. Mary's Bay Per Cent Weaks by Sample Dates

Table 4 below summarizes the 2023 preseason samples results for: (1) average BRIX level values over all preseason samples by location; (2) average lobster counts per trap; (3) average lobster carapace 'soft' and 'medium' percentage values in location's samples; and (4) percent weak lobsters in the samples by location; and (5) each location's 2023 most closely comparable historical year(s) from the historical 2006-2022 database.

4.5 Summary of 2023 Predictors

For the start of the commercial season (end-November to mid-December 2023) predictors are provided for preseason samples for all 8 locations as follows: (1) average BRIX level values; (2) average lobster counts (legal sized) per trap; (3) average lobster carapace hardness scales for 'Soft' plus 'Medium' percentage values; and (4) average percent weak lobsters. The logic for establishing the list of predictors is based on the extension of the observed 2023 preseason samples' results into the start of the commercial season for 2023-2024. From the start of the commercial season, lobsters prepare to move from the post-moult stage to the pre-moult stage over the winter of 2023-2024. The pre-moult stage is characterized by hardening of lobster shells and lower incidence of lobsters with soft and medium scale carapaces, and lower incidences of otherwise weak lobsters. Estimates of these predictors into December 2023 anticipate the rate of improvement of lobster quality status overall. The estimate of counts per trap takes into account the increased catchability of lobsters as well as the draw down in catchable lobster abundance in each location following the initial start of season fishing effort intensity. As evidenced from the data, the participation of the commercial fleet immediately after the season opens results in fishing effort that leads to a precipitous decline in catch counts of lobster per trap in all locations into the New Year (January) period. Table 5 below presents the estimated predictor values to mid-December based on the above assumptions.

Table 8. 2023 Preseason Sampling Predictors to mid-December 2023

Locations: / Predictors	Yarmouth Inside	Yarmouth Outside	Lobster Bay Inside	Lobster Bay Outside	Port La Tour Inside	Port La Tour Outside	St.Mary's Bay Inside	St.Mary's Bay Outside
Average BRIX (mg/mL)	10	9.5	11	10.5	10.5	8.5	10	9.5
Ave Legal Counts Per Trap	5	5	6	5	4	4	5	6
Ave % Soft+Med	10%	15%	15%	15%	10%	20%	10%	10%
Ave % Weaks	5%	8%	15%	12%	5%	10%	5%	10%

The predictor values in Table 5 are presented here to test the ability of the preseason summary report (Mattock, Mulock, and Lane 2023) in mirroring the results at the start of the commercial fishery. It is anticipated that feedback from industry about the viability of these predictors will assist in improving these predictor results based on the preseason sampling program. Overall in 2023, BRIX levels across all locations are expected to remain high as lobster proceed from post moult to pre-moult status. There is concern – especially in Outside areas – for a decline in commercial catch rates, as indicated by the comparable fall in counts per trap over the sampling period especially in St. Mary's Bay and Yarmouth Bar where catches may be expected to drop by as much as 30% relative to previous years. Consistent with rising BRIX and the eventual improvement in the status of lobster quality on LFA33 and 34, the percent weaks and soft and medium lobster is expected to fall over all locations into Dec 2023.

5 Analysis of Preseason Sampling Data in 2023

The at-sea sampling summary report for 2023 was compiled as the 'Lobster Quality Preseason Sampling Program–Southwest Nova Scotia LFA33 & LFA34, Preseason Summary Report' (Mattock, Mulock, and Lane 2023) and distributed by Coldwater Lobster Association to the lobster industry and government funders on November 24, 2023. This report contains information on the proportion of soft shell as well as the proportion of low blood protein lobsters for each of the identified sampling areas in the survey.

The 2023 preseason sampling results in LFAs 33 and 34 indicated that lobsters landed at the start of the 2023-2024 season in southwest Nova Scotia, were of overall of Moderate (M) quality (see also Table 6, Section 2.4 above). 2023 preseason samples mean overall BRIX is higher than the past 3 years but remains at a 'Moderate' (M) overall level of 10.07 units/ml (versus 9.46 (2022), 8.4 (2021) and 8.37 (2020)). Preseason results vary by location. Other observations from the preseason summary report include:

- During the early preseason sampling periods (September), sample results, especially Outside subareas show elevated BRIX with no "Poor" observations (below 6) in any sample. Average BRIX values then tend to decline/dip to early October and then increase moderately toward the end of the sampling period in mid-November.

- In 2023-24, weaks in the Inside locations averaged 10% per sample. Weaks in the Outside locations averaged over 12.5% per sample. Lobster Bay dominated the incidence of weaks in the Inside (average 14%) and Port La Tour dominated the Outside areas (average 13%), compared to the overall average of weaks in all areas of 11.2% (2023-24) (versus 13.3% in 2022-23 10.1%(2021-22) and 5.4%(2020-21)).

- Overall lobster hardness measurements also shifted in the 2023 preseason in comparison to the 2022 to 2020 preseason survey results. Counts of Soft+Medium lobsters in samples increased from negligible amounts of 2.5% (in 2020-21) to 8.9% (in 2021-22) to 20.7% (in 2022-23) to 21.3% in 2023-24. These shifts are evident in all areas in 2023, notably Yarmouth (max approaching 40%), and Lobster Bay (max approaching 35%) (Figure 18 above.)

Sample results by BRIX category are shown for each of the 8 sampling locations in Section 5.2. These results present:

(A) BRIX category series trend for the 2023 preseason and 2023-24 in-season samples;
(B) comparable BRIX category preseason sampling 3-4 weeks before the start of the commercial season for years 2012 to 2023;
(C) lobster (legal-sized) counts per trap for each preseason and in-season samples in 2023-24 compared to comparable results in 2020 to 2022.

The trends are described and predictions for the 2023 start-of-season are presented. It is acknowledged that years when preseason BRIX has been observed to be high, e.g., 2012 and 2013, catch per trap was relatively lower. Conversely, seasons of relatively lower preseason BRIX (2015, 2017) have resulted in relatively higher catches per trap.

5.1 Blood Protein (BRIX) Categories

The BRIX analyses compare sample annual data of past years with the preseason and in-season sample data of the current year and looks for observations of the best match of a past year with the current year's sampling observations. The most closely matched historical year then becomes the basis for predicting the status and quality of lobster at the start of the current commercial fishery. For example, consider Figure 20 for Yarmouth Outside 2012-2018, from sampled data 3-4 weeks before the start of the respective season. The indication from these results is that 2016 is a low-quality year in a series of declining quality beginning in 2012. Since 2012, the poor BRIX values (Red category) are seen to be increasing from a low of 2.4% (2012) to a high of 31.4% (2016). Similarly, the extent of the high-quality BRIX values (Green category) decreases from a high of 75% (2012) to a low of 22% (2016).

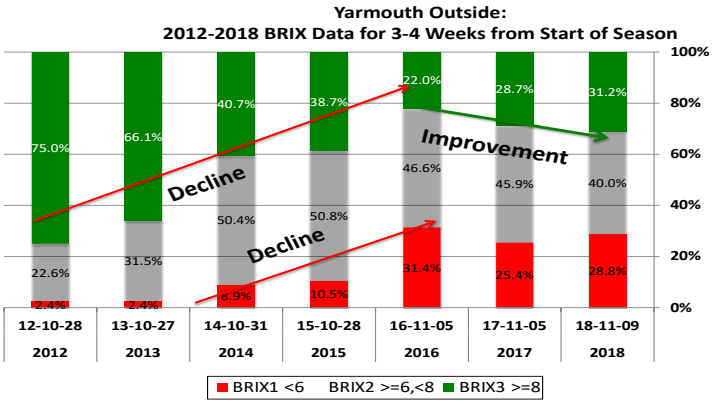


Figure 20. Example: Yarmouth Outside BRIX Categories for 3-4 weeks prior to season start 2012-2018

From Figure 20 and since 2016, preseason quality indicators have shown improvement. The 2016 low of BRIX values in the high category (Green) of 22% rises again from 28.7% (2017) to 31.2% (2018). Similarly, but less dramatically, the poor BRIX category (Red) falls from 31.4% in 2016 to 25.4% in 2017 with a similar value in 2018 of 28.8%. Based on this graphic, there may be expectation – assuming the annual trend since 2016 continues for Yarmouth Outside – that the 2019-2020 preseason season will mark improved quality over the lows of 2016 with marginal improvement over 2017 and 2018. (In fact, the 2019 preseason samples yielded high BRIX values (Green) of only 18%, and low BRIX values (Red) of 7.3% for an overall average BRIX of 7.2–a decline of -11% versus the 2018-2019 average BRIX of 8.1. This result may indicate that in Yarmouth in 2019, the quality improvement had stalled.)

5.2 Site Results and Predictions

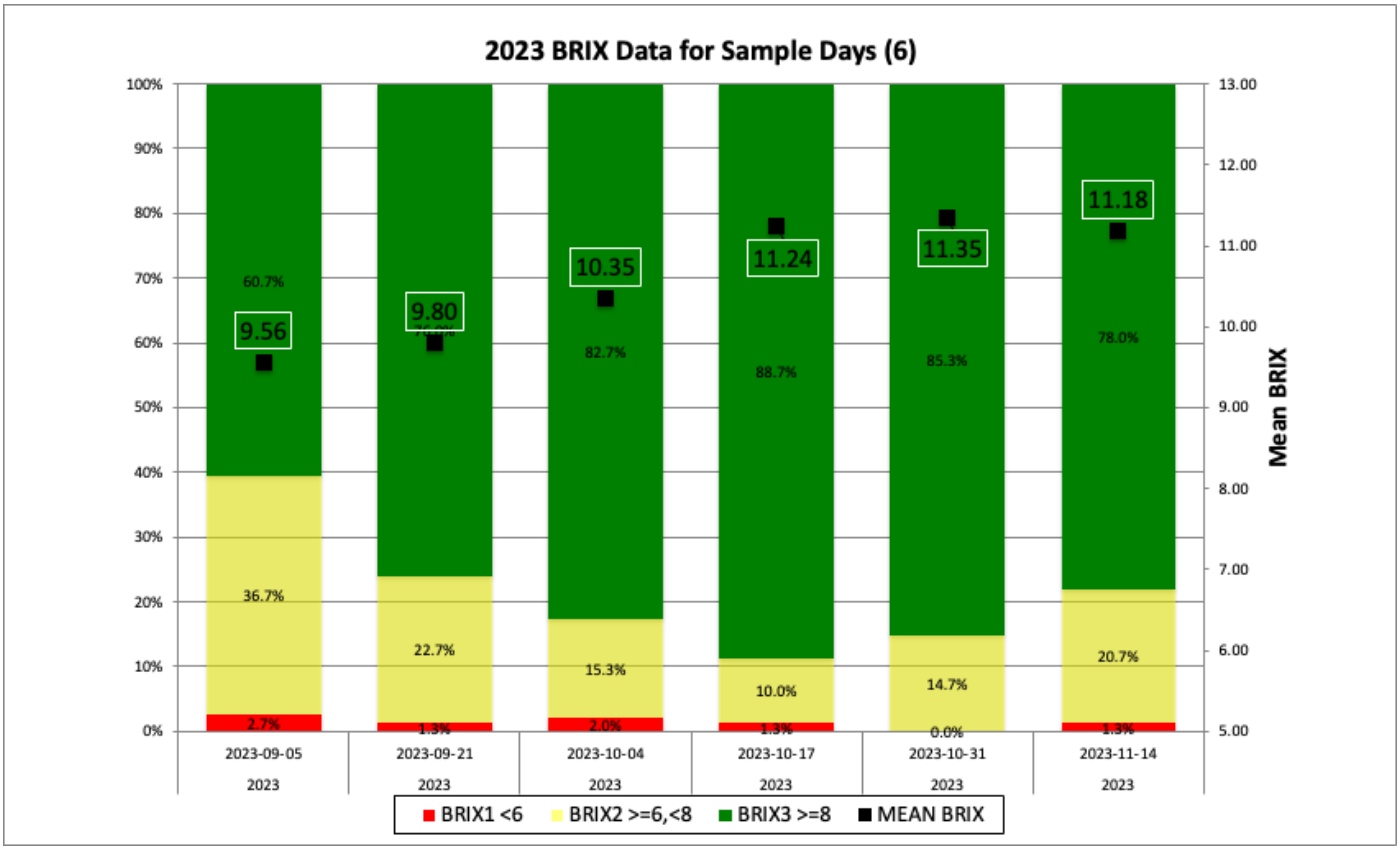
Start of season lobster quality predictions are based on the analyses described in Sections 5.1 above. Appendix C - Preseason Sampling Summaries presents the summary (text) for each of the 8 location-areas as previously provided in the 'Lobster Quality 2022 Preseason Sampling Program, Southwest Nova Scotia LFA33 & LFA34: Preseason Summary Report' (Mattock, Mulock, and Lane 2023). The following pages present the breakdown of the 2023-24 preseason and include added in-season results. The preseason results were provided to industry collaborators on November 24, 2023 prior to the start of the 2023-2024 commercial season.

5.2.1 YARMOUTH INSIDE

2023 SUMMARY OF RESULTS

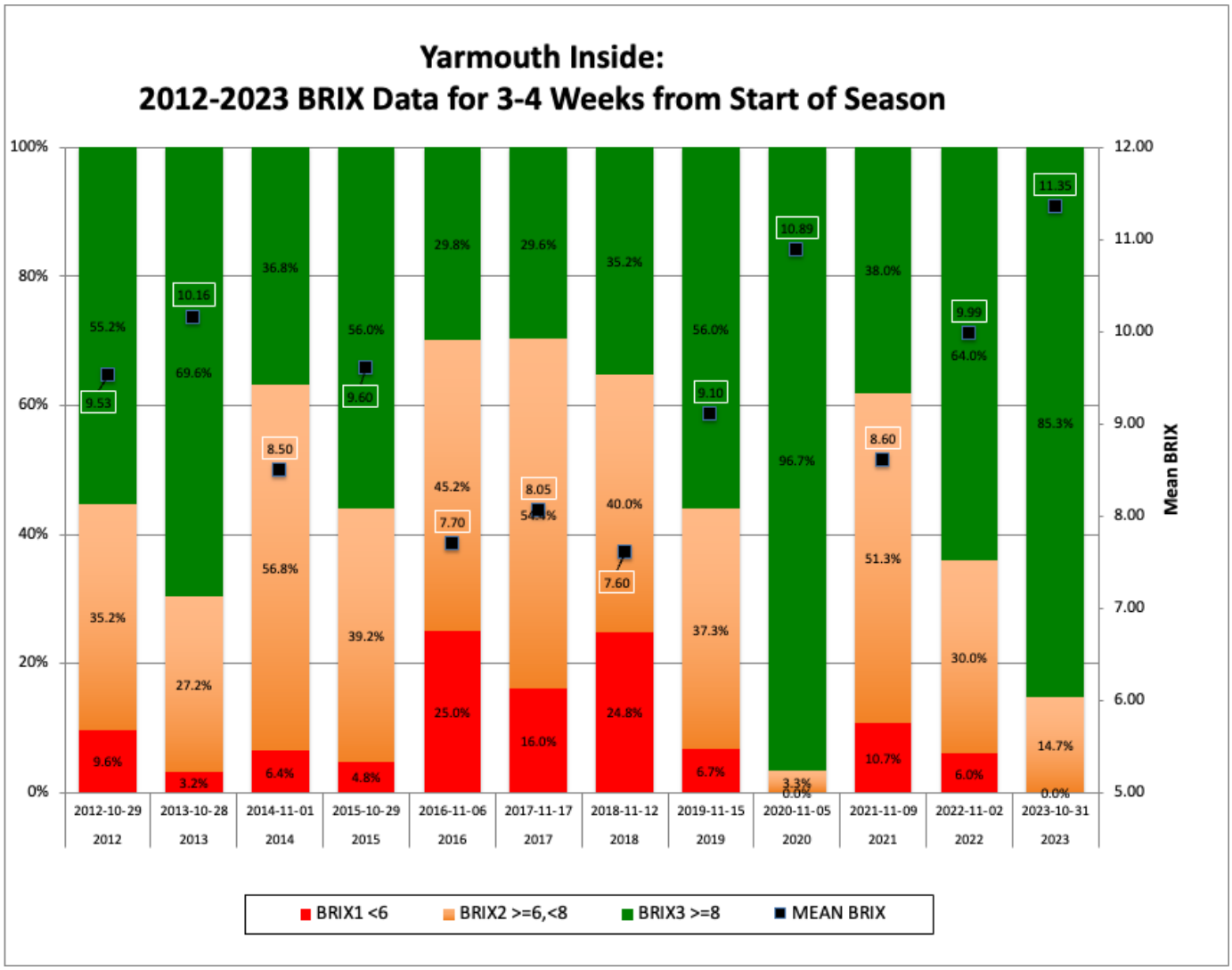
(A) BLOOD PROTEIN (BRIX) CATEGORIES–2023 SAMPLES

In the figure below, 2023 preseason survey results for 6 sample sites in Yarmouth Inside show a steady rise in average BRIX from early-September to late-October samples. After October, approximately 80% of each sample attained “Good” levels of BRIX (≥8 mg/mL). The proportion of “Poor” lobsters (BRIX<6 mg/mL) sampled in Yarmouth Inside remains below 3% of all samples in 2023. Average BRIX level values for samples in 2023 (10.6 mg/mL) were slightly above (approximately +10%) values for 2020 through 2022.



(B) BLOOD PROTEIN (BRIX) CATEGORIES – ANNUAL SAMPLES 3-4 WEEKS BEFORE SEASON START

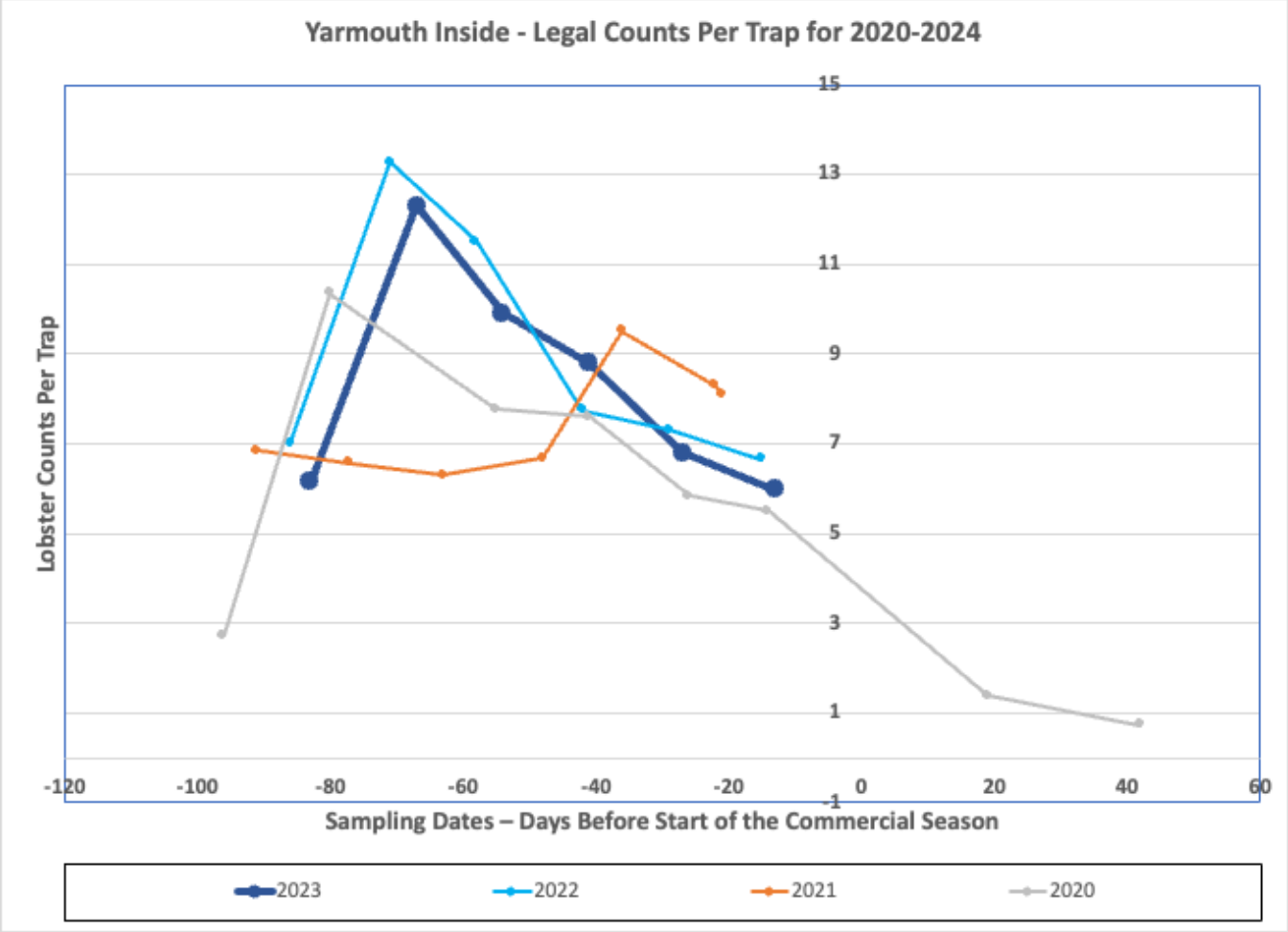
From the figure below, annual samples 3-4 weeks from the start of each commercial harvest season opening are variable across the series from 2012 to 2023 for Yarmouth Inside. The 2023 sample (October 31) has the highest BRIX average (11.35 mg/mL) in the series. The October 31, 2023 sample is comparable to the November 5, 2020 sample, the second highest BRIX mean in the series, with comparable BRIX category values.



Another comparable year to 2023 is 2013 – third highest BRIX mean in the series. 2013 is the final year of the higher BRIX regime (2006-2013) after which overall BRIX levels across the 8 locations remain in a lower BRIX regime (since 2014).

(C) Counts (legal-sized) per trap for 2023 samples

In the figure below, the counts per trap of lobsters (male and female) of legal-sized (82.5 mm or greater) lobsters that occurred in the survey samples dates in 2023 (thick dark blue line) are compared to past years' samples (2020-2022). The counts for Yarmouth Inside are comparable to past years' counts. With the exception of 2021, the time series of counts over the preseason in Yarmouth Inside exhibit a rise to end-September and then fall (by 50%) to the end of the sampling period (mid-November). As evidenced by the 2020 in-season sampling in the figure below, commercial catch rates are expected to fall precipitously after the beginning of the commercial season as legal sized lobster abundance is extracted.

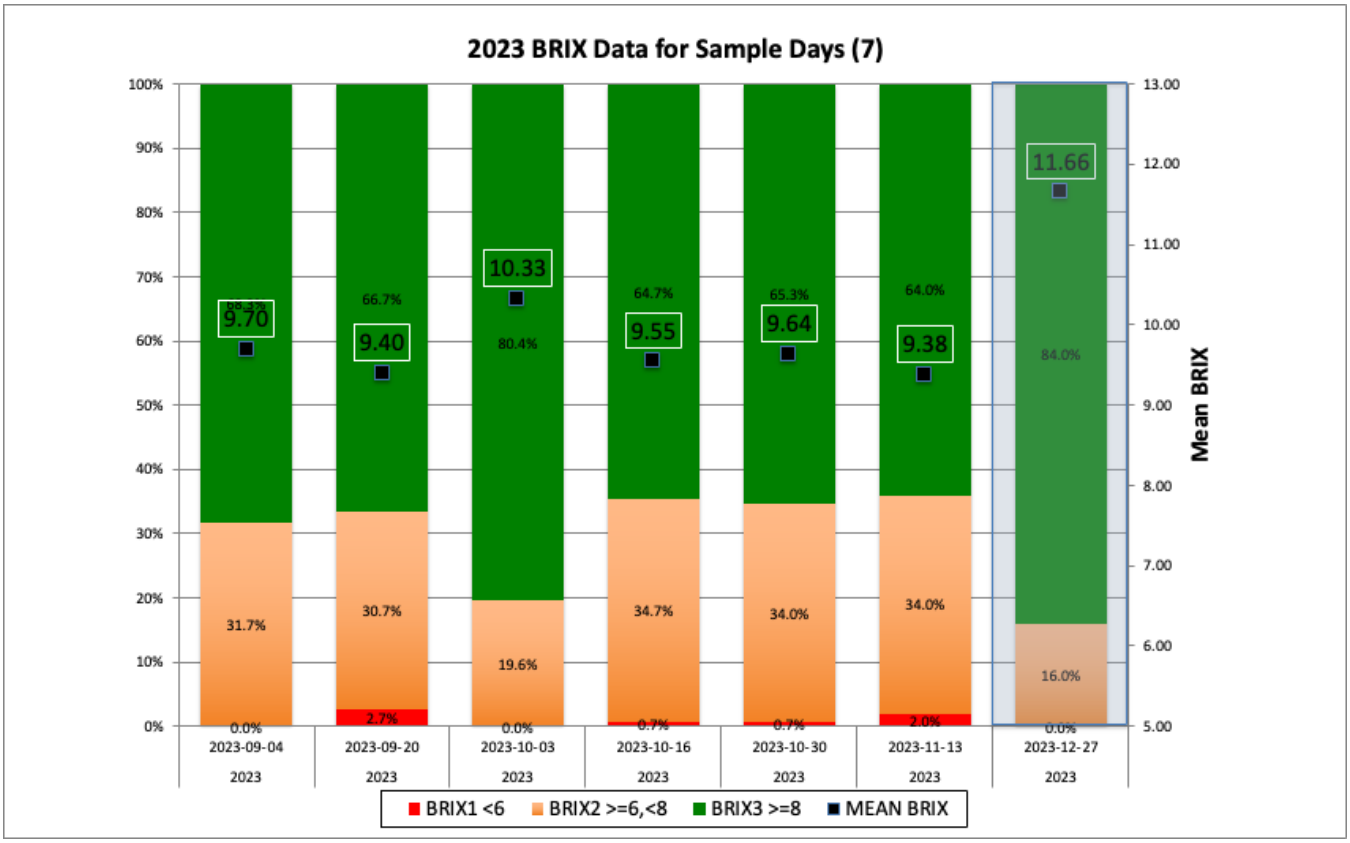


Counts of weak lobsters in the 2023 Yarmouth Inside samples were slightly below past years (2021-2022) values averaging 7% per sample versus 10% (2021). The average percentage of Soft and Medium lobsters per sample (18%) fell slightly compared to 2022 (19%) but were twice that of 2021 (9%).

5.2.2 YARMOUTH OUTSIDE

2023 SUMMARY OF RESULTS

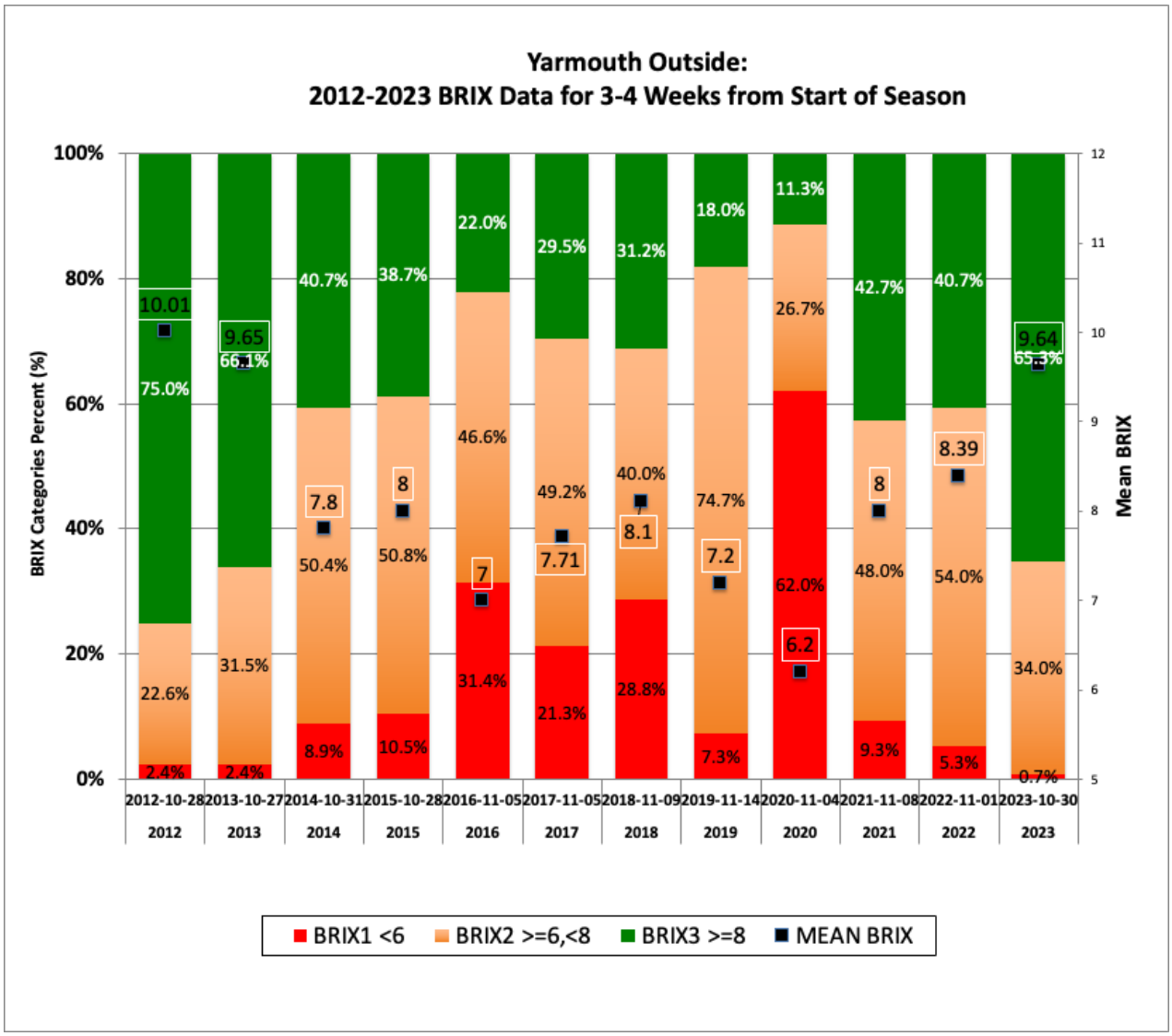
(A) Blood Protein (BRIX) Categories–2023 Samples



The 6 preseason samples in 2023 for Yarmouth Outside show a relatively constant average BRIX between values of 9.38 mg/mL (November 13) and 10.33 mg/mL (October 3). Throughout sampling, the percentage of "Good" category lobsters (BRIX≥8) varied between 64% (November 13) and 80% (October 3). "Poor" BRIX category lobsters (BRIX<6) were rare throughout with sample with percentages below 3% in all samples. Average BRIX level values for samples in 2023 (9.97 mg/mL) exceeded values for 2020 through 2022 (9.0) in Yarmouth Outside. As expected, the single in-season sample in Yarmouth Outside of December 27, 2023 shows increased average BRIX level and higher "Good" category lobsters.

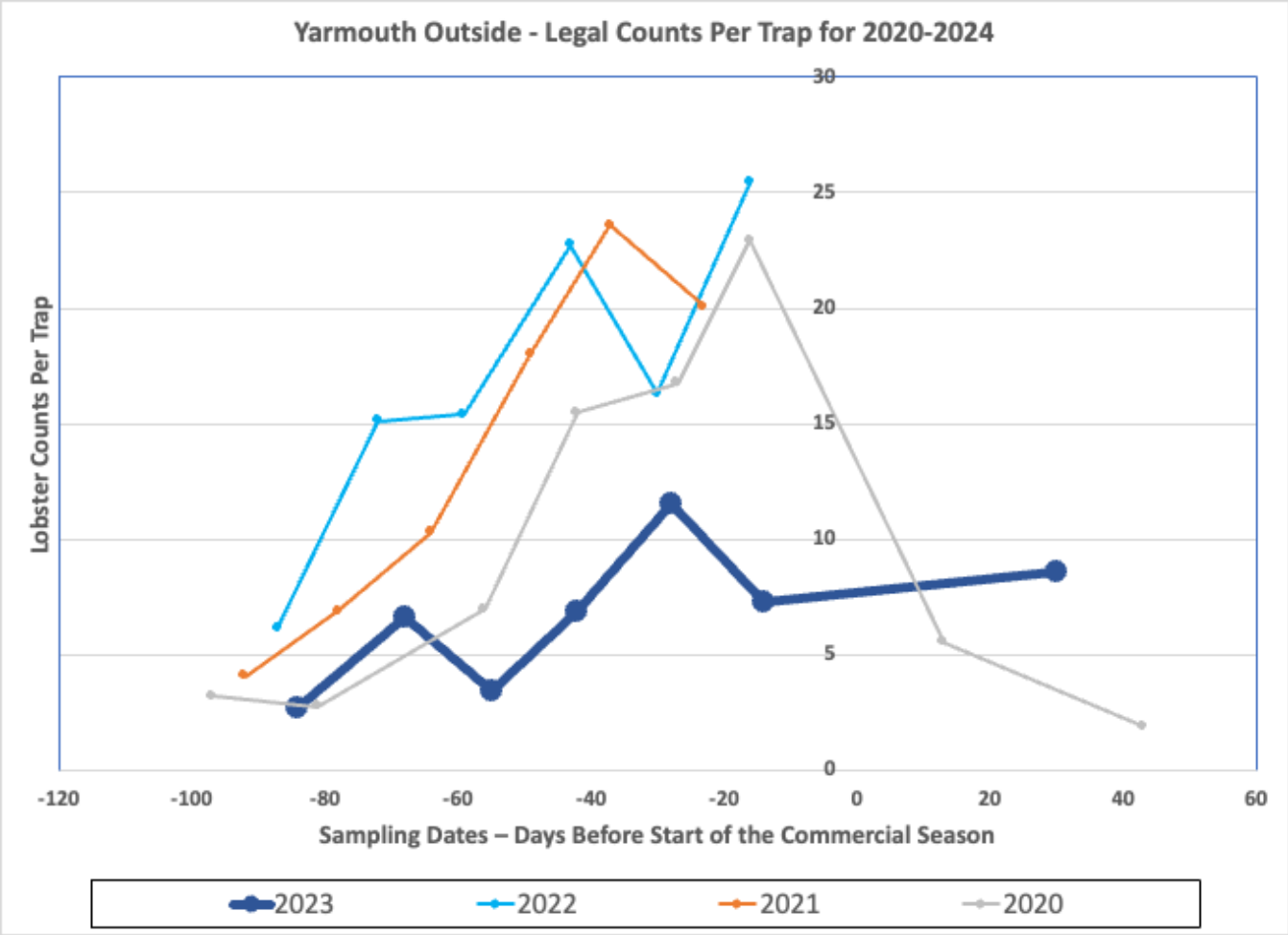
(B) BLOOD PROTEIN (BRIX) CATEGORIES – ANNUAL SAMPLES 3-4 WEEKS BEFORE SEASON START

From the figure below, annual samples 3-4 weeks from the start of each commercial harvest season opening are variable across the series from 2012 to 2023 for Yarmouth Outside. The average BRIX for the 2023 sample of October 30 is the third largest in the series and its BRIX categories are directly comparable to 2013. There is a negligible proportion of "Poor" quality lobster (BRIX<6) in the 2023 sample of October 30. As noted above, 2013 is the final year of the higher BRIX regime (2006-2013) after which overall BRIX levels across the 8 locations remain in a lower BRIX regime (since 2014).



(C) Counts (legal-sized) per trap for 2023 samples

In the figure below, the counts per trap of lobsters (male and female) of legal-sized (82.5 mm or greater) that occurred in the survey samples dates in 2023 are compared to past years' samples (2020-2022). The 2023 counts for Yarmouth Outside (thick dark blue line) are considerably lower than the past years' counts by more than 50% for comparable sample date timing. As for the Yarmouth Inside counts per trap, the time series of counts per trap over the preseason in Yarmouth Outside exhibit a rise from the September samples until end October when counts per trap begin the characteristic decline at the end of the sampling period (mid-November). As evidenced again by the 2020 in-season sampling in the figure below, commercial catch rates are expected to fall off even more at the beginning of the commercial season as legal sized lobster abundance is extracted.



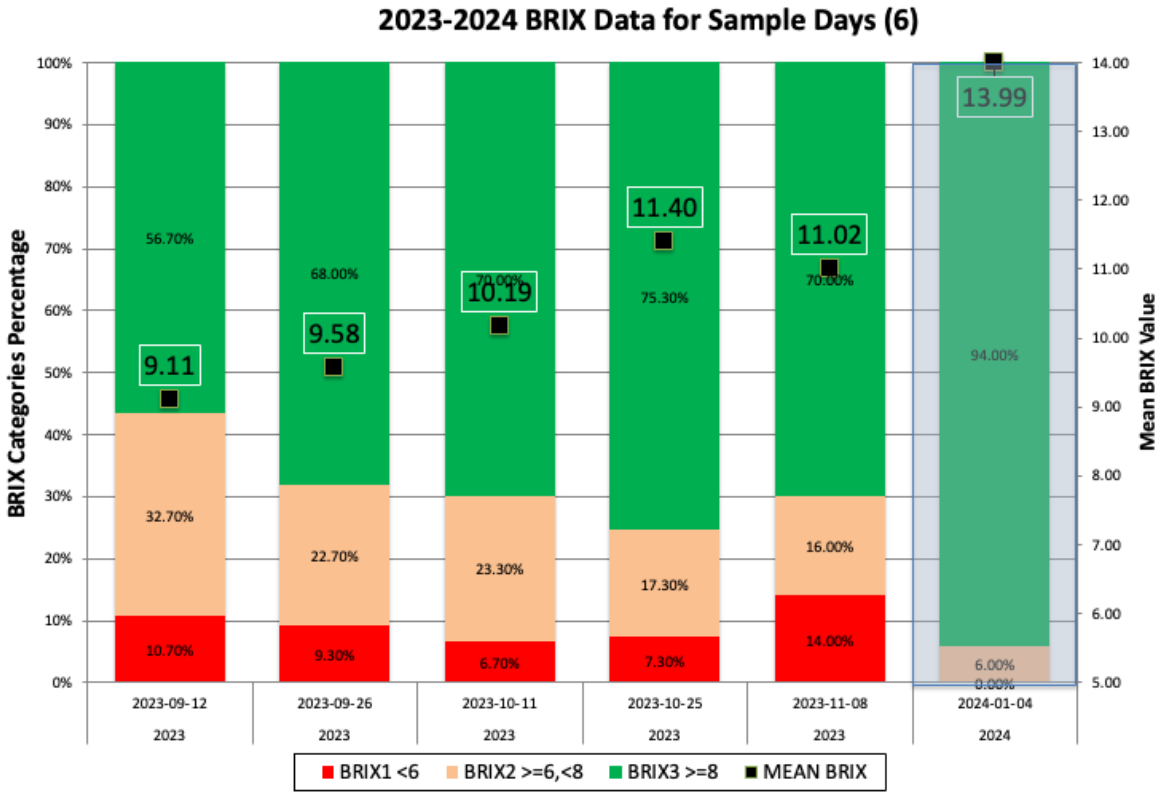
Counts of weak lobsters in the 2023 Yarmouth Outside samples were well below 2022-2021 values averaging 9.54% per sample versus 16-18% (in 2022 and 2021, respectively). The average weaks percentage for 2023 is slightly above the 2020 weaks percent of 8.34%. In 2023, the average percentage of Soft and Medium lobsters per sample (23%) fell compared to 2022 (29%) but were twice that of 2021 (11%) and still 7 times higher than the 2020 weaks percentage of 3.6%.

5.2.3 LOBSTER BAY INSIDE

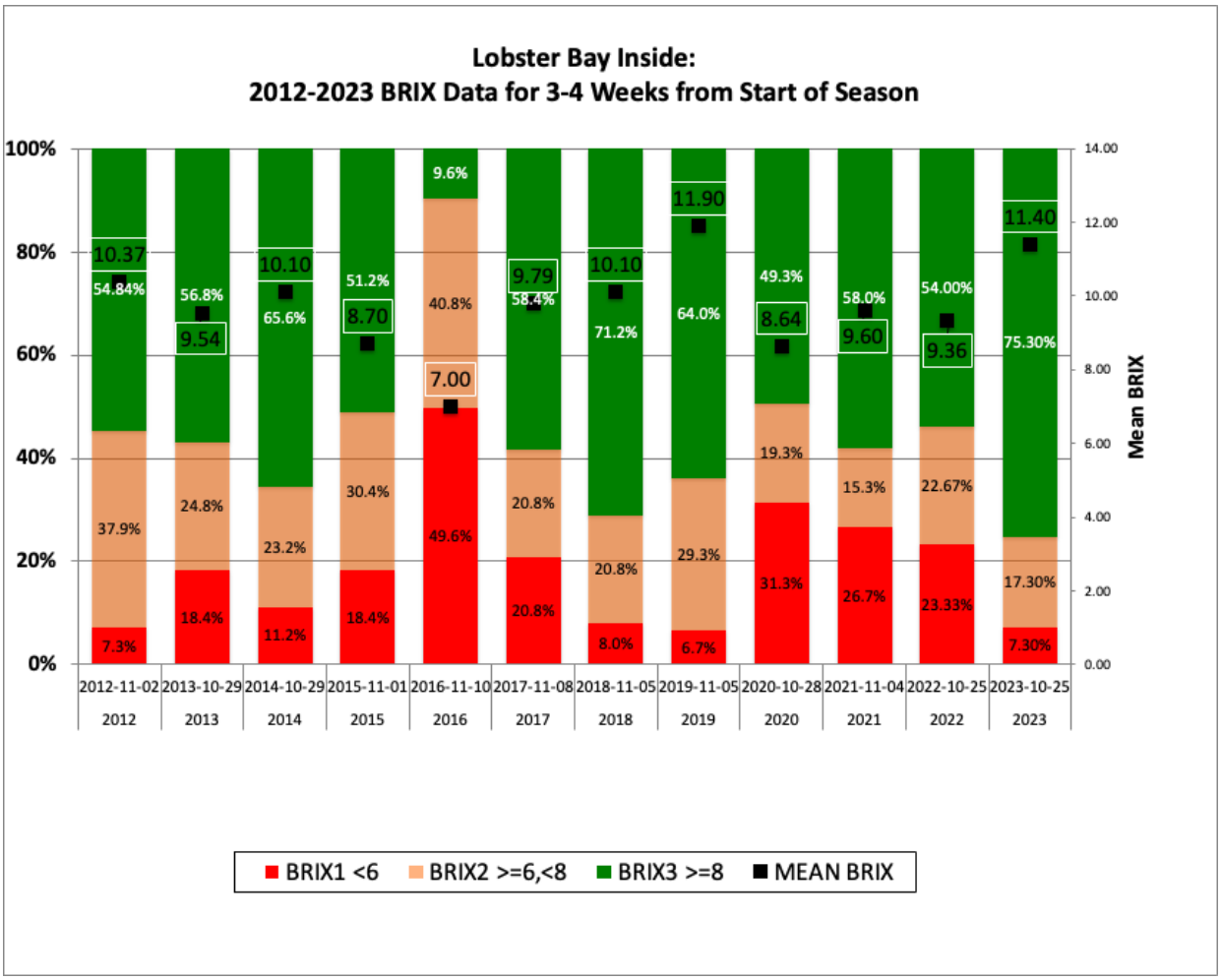
2023 SUMMARY OF RESULTS

(A)BLOOD PROTEIN (BRIX) CATEGORIES–2023 SAMPLES

In the figure below, 2023 preseason survey results for 5 sample sites in Lobster Bay Inside show a rise in average BRIX from 9.11 mg/mL in early-September to 11.4 mg/mL by late-October. A slight decline in the preseason ending sample average BRIX (11.02) is observed in the November 8 sample. Approximately 70% of samples attained “Good” levels of BRIX (≥8 mg/mL).



The proportion of “Poor” lobsters (BRIX<6 mg/mL) sampled in Lobster Bay Inside in 2023 averaged just below 10% across all 5 samples with the largest in the final preseason sample of November 8 (14%). Average BRIX level values for samples in 2023 (10.3 mg/mL) were similar to above average BRIX values for 2022 (10), 2021 (8.9) and 2020 (9.6).



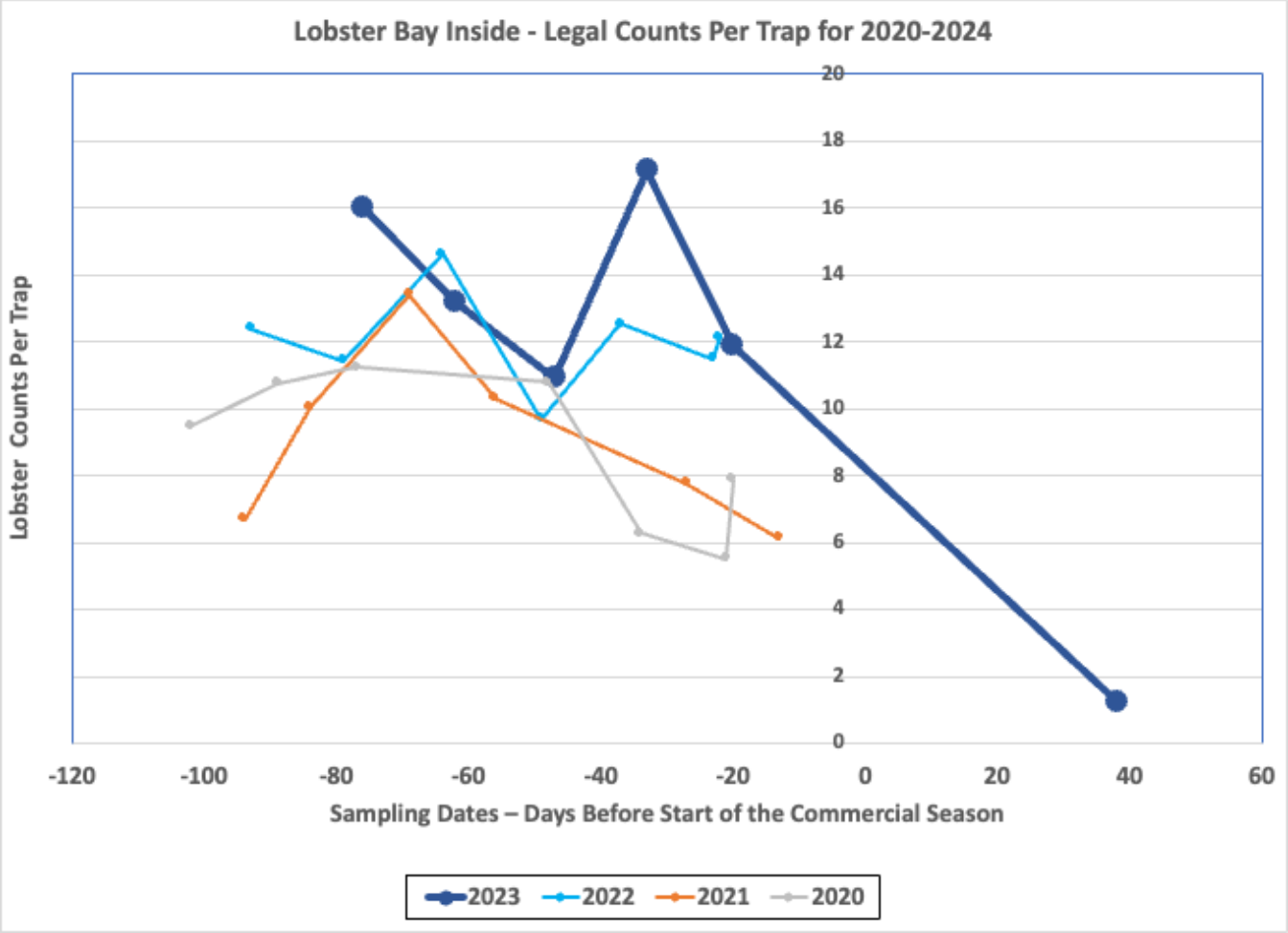
(B) BLOOD PROTEIN (BRIX) CATEGORIES – ANNUAL SAMPLES 3-4 WEEKS BEFORE SEASON START

From the figure above, annual samples 3-4 weeks from the start of each commercial harvest season opening are somewhat variable across the series from 2012 to 2023 for Lobster Bay Inside. The 2023 sample (October 25) has the second highest BRIX average (11.4 mg/mL) in the series behind the 2019 average BRIX of 11.9 mg/mL. The October 25, 2023 sample is directly comparable to the November 5, 2018 sample but with an elevated average BRIX value (11.4 versus 10.1 mg/mL).

(C) Counts (legal-sized) per trap for 2023 samples

In the figure below, the counts per trap of lobsters (male and female) of legal-sized (82.5 mm or greater) that occurred in the survey samples dates in 2023 (thick dark blue line) are compared to past years' samples (2020-2022). The counts for Lobster Bay Inside sampling are generally highest among the 4 Inside locations surveyed in LFAs33 and 34. In 2023, Lobster Bay Inside counts are slightly higher by comparison to past years' counts at similar sampling dates. For Lobster Bay Inside, the time series of counts per trap over the preseason remain relatively stable from September through November with average counts varying between 8 and 14 lobsters per trap. The highest counts per trap (17 lobsters per trap) in the October 25 sample are predominantly males and appear to represent a change from the pattern of decline in past years after the early October samples. The evidence from the figure below is

that commercial catch rates are expected to fall precipitously in Lobster Bay Inside after the beginning of the commercial season as legal sized lobster abundance is extracted (e.g., January 4 in-season sample fall to less than 2 lobsters per trap).



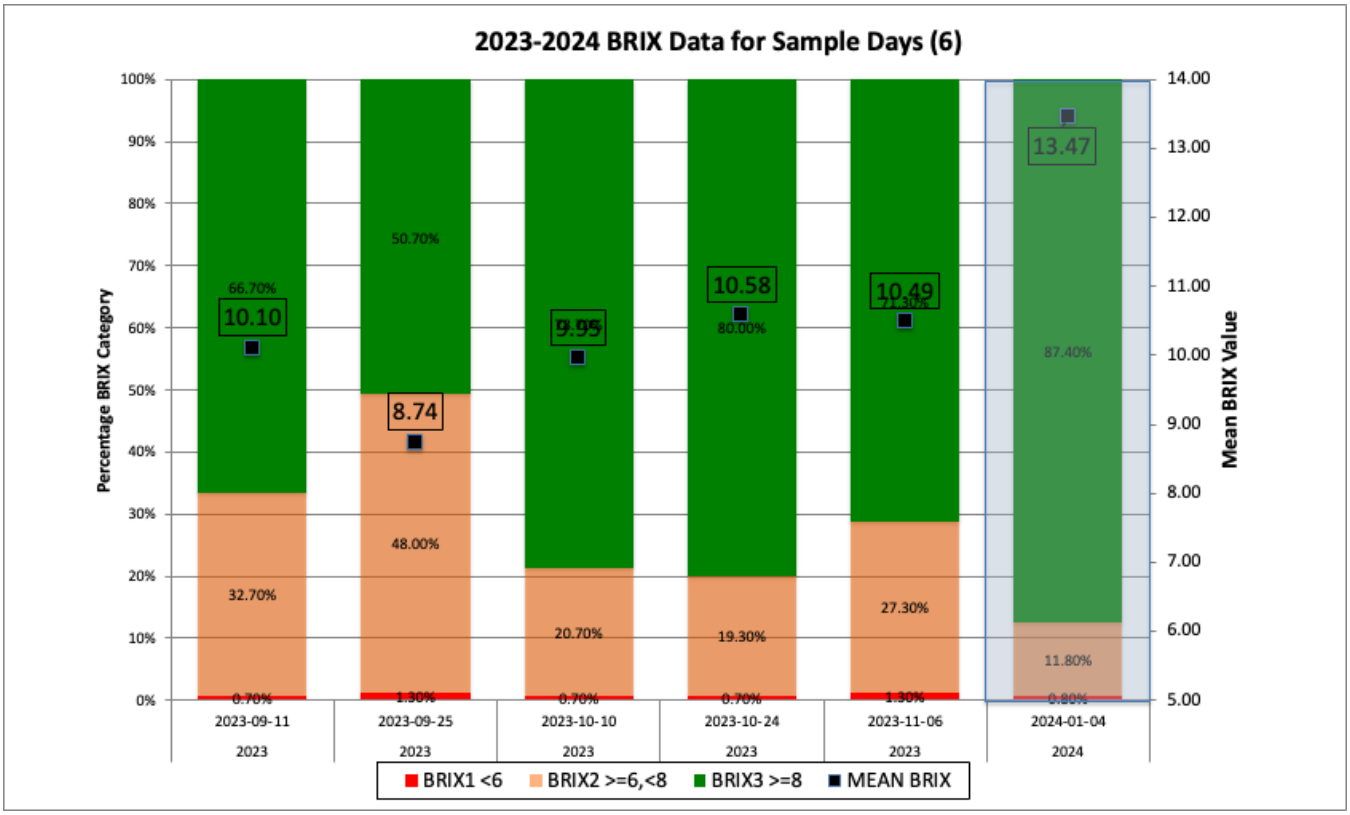
Counts of weak lobsters in the 2023 Lobster Bay Inside samples were slightly below past years (2021-2022) values averaging 16.5% per sample versus 21% in 2022. The percent of weak lobsters in Lobster Bay Inside in 2020 (9.8%) was almost half of the 2023 value. The average percentage of Soft and Medium lobsters per sample in Lobster Bay Inside (21.6%) is comparable to the 2022 value (20.6%) but were twice that of the 2021 value (10.4%).

5.2.4 LOBSTER BAY OUTSIDE

2023 SUMMARY OF RESULTS

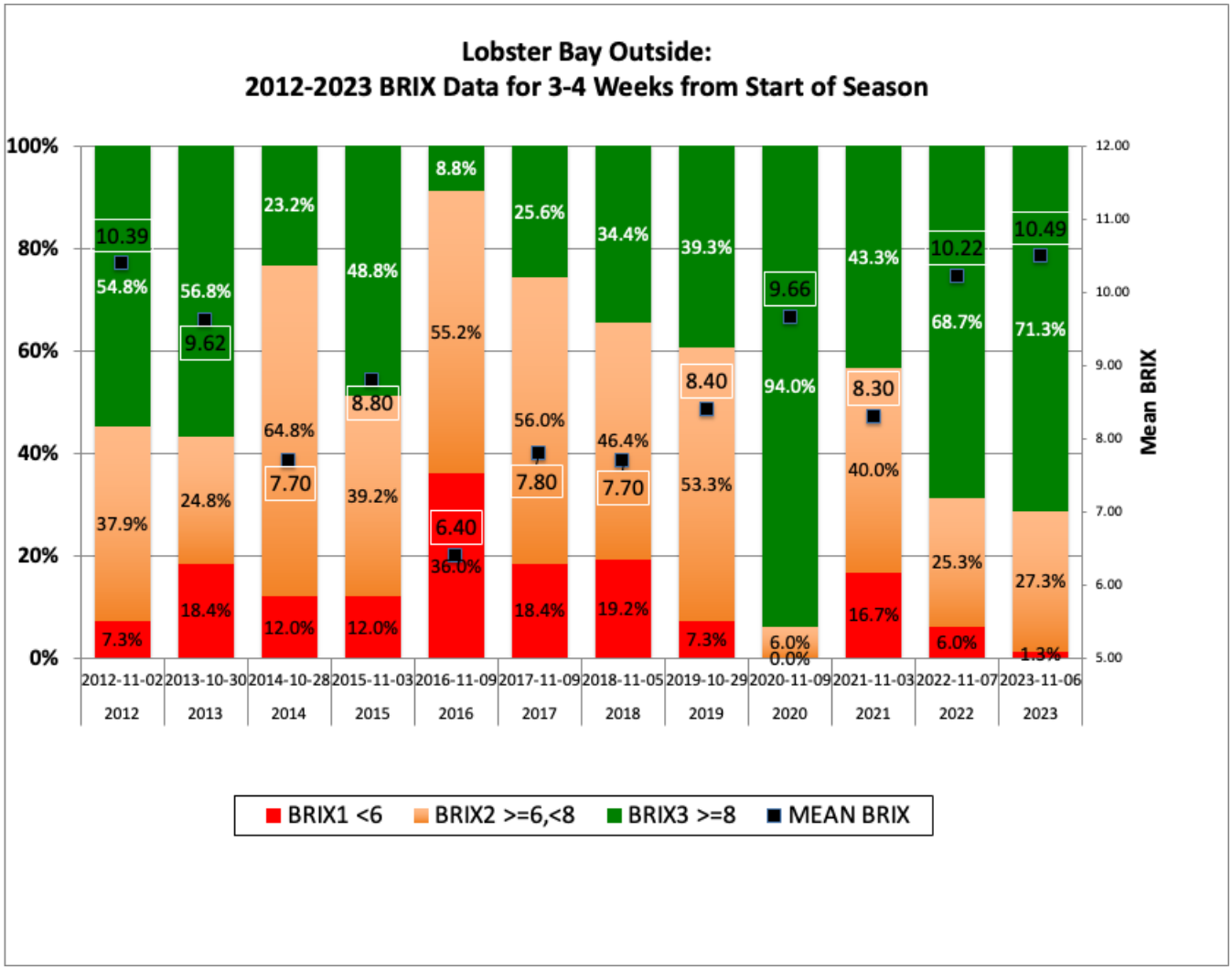
(A)BLOOD PROTEIN (BRIX) CATEGORIES–2023 SAMPLES

In the figure below, 2023 preseason survey results for 5 sample sites in Lobster Bay Outside show a constant average BRIX varying from 10.1 mg/mL in early-September to 10.5 mg/mL by early November. The sole exception is lower average BRIX (8.74) of the September 25 sample. Approximately 70% of samples attained “Good” levels of BRIX (≥8 mg/mL) and incidences of “Poor” lobsters in samples were very low – less than 2% in all samples.



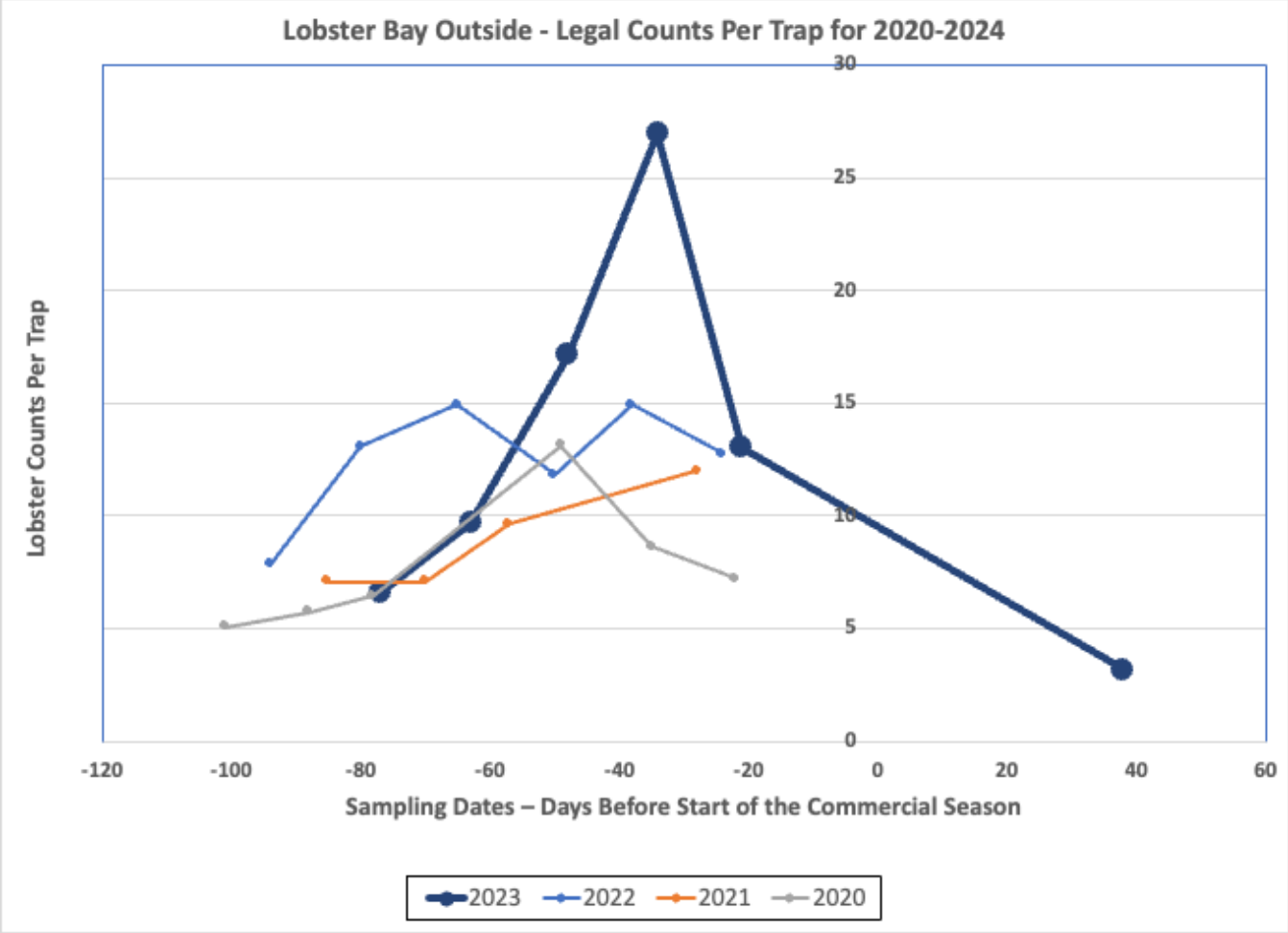
(B) BLOOD PROTEIN (BRIX) CATEGORIES – ANNUAL SAMPLES 3-4 WEEKS BEFORE SEASON START

From the figure below, annual samples 3-4 weeks from the start of each commercial harvest season opening are variable across the series from 2012 to 2023 for Lobster Bay Outside. The 2023 sample (November 6) has the highest BRIX average (10.49 mg/mL) in the series. The November 6, 2023 sample is comparable to the November 7, 2022 sample with similar average BRIX value and like BRIX category levels.



(C) Counts (legal-sized) per trap for 2023 samples

In the figure below, the counts per trap of lobsters (male and female) of legal-sized (82.5 mm or greater) that occurred in the survey samples dates in 2023 (thick dark blue line) are compared to past years' samples (2020-2022). The counts per trap for Lobster Bay Outside sampling are generally highest among the 4 Outside area locations in LFAs33 and 34. In 2023, Lobster Bay Outside counts are comparable to past years' counts at similar sampling dates with the exception of the spike in counts for the October 24 sample. The highest counts per trap (27 lobsters per trap) in the October 24 sample are equally males and females. The evidence from the figure below is that Lobster Bay Outside counts per trap return to level (approximately 13 lobsters per trap) at the November 6 sample. Commercial catch rates are expected to fall precipitously in Lobster Bay Outside after the beginning of the commercial season as legal sized lobster abundance is extracted – as evidenced by the single in-season sample of January 4, 2024 (<5 lobster per trap) in Lobster Bay Outside.



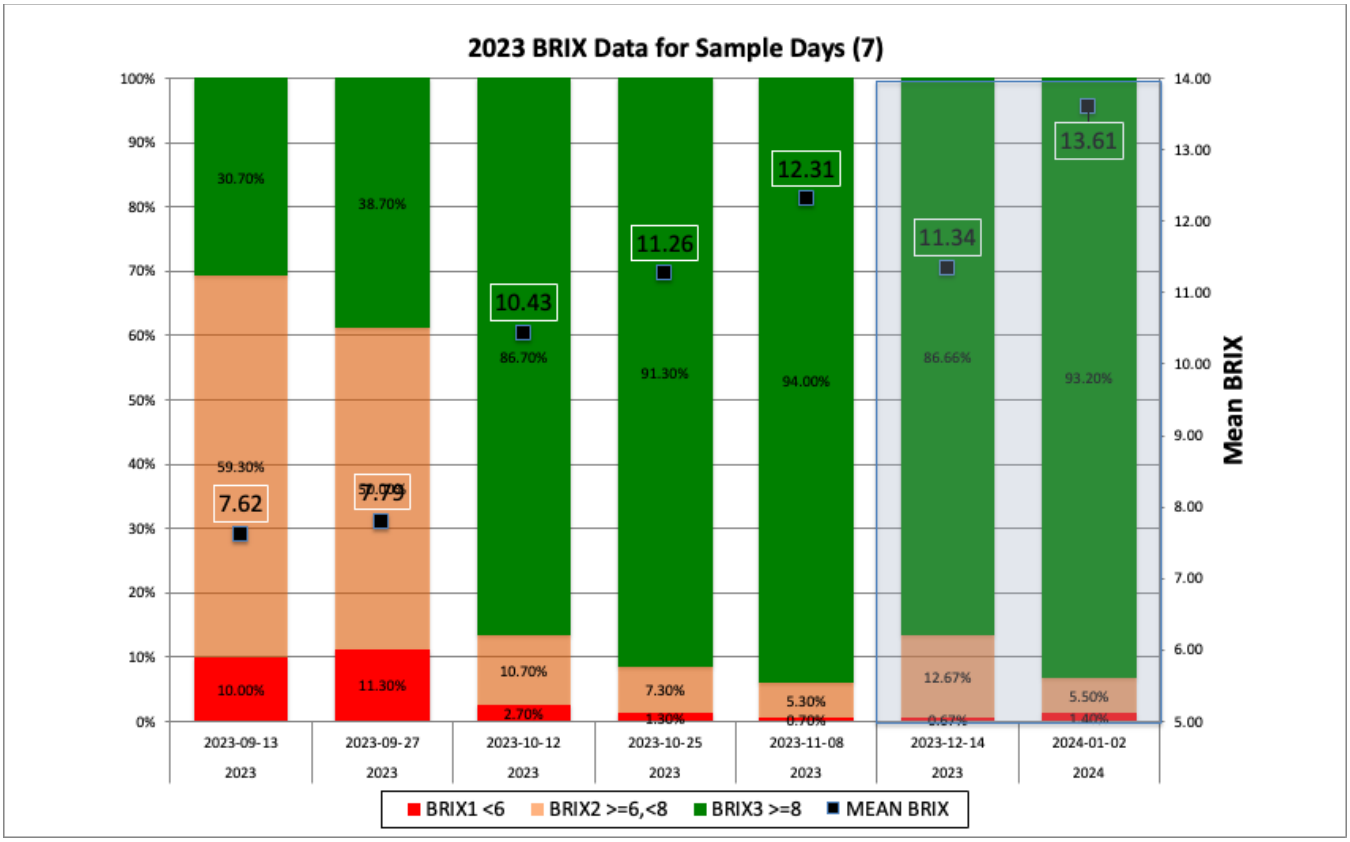
Counts of weak lobsters in the 2023 Lobster Bay Outside samples (13%) are similar to 2022 and 2021 values (13% and 18% respectively). The percent of weak lobsters in Lobster Bay Outside in 2020 was only 10%. The average percentage of Soft and Medium lobsters per sample in Lobster Bay Outside (21.2%) is identical to the 2022 value (21.4%) but considerably more than the 2021 and 2020 percent soft and weak values in Lobster Bay Outside (3.8% and 4,6% respectively).

5.2.5 PORT LA TOUR INSIDE

2023 SUMMARY OF RESULTS

(A)BLOOD PROTEIN (BRIX) CATEGORIES–2023 SAMPLES

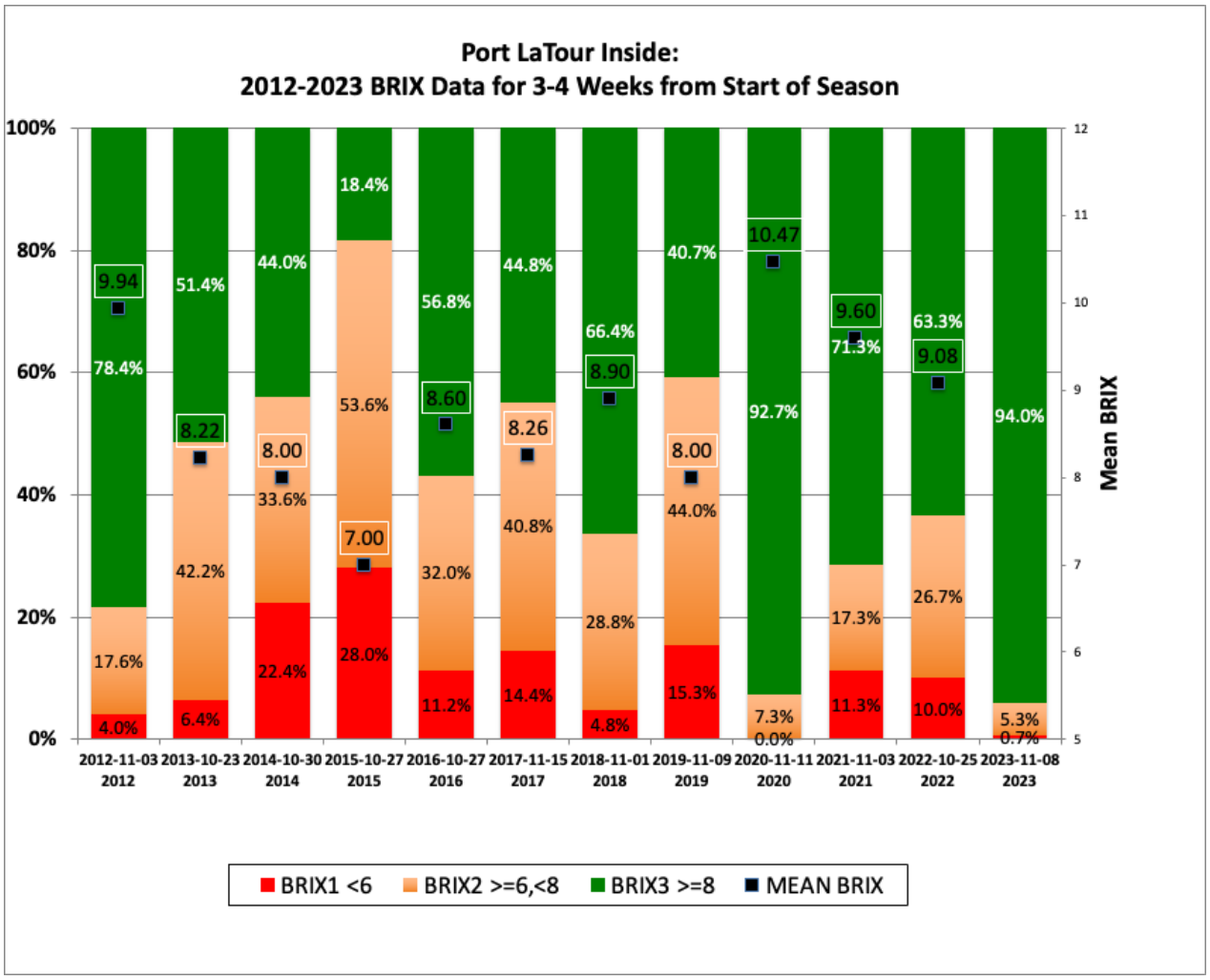
In the figure below, 2023 preseason survey results for 5 sample sites in Port La Tour Inside show a rise in average BRIX from early-September (7.62 mg/mL) to the high of early-November samples (12.31 mg/mL). After September, 85% or more of each sample attained “Good” levels of BRIX (≥8 mg/mL).



Similarly, the proportion of “Poor” lobsters (BRIX<6 mg/mL) sampled in Port La Tour Inside after September falls below 3% for all subsequent samples in 2023. Average BRIX level values for samples in 2023 (9.9 mg/mL) were the highest among 2020-2023 calculated values. The two in-season samples (December 14, 2023 and January 2, 2024) continue the series from the end of the preseason sampling with higher relative average BRIX values.

(B) BLOOD PROTEIN (BRIX) CATEGORIES – ANNUAL SAMPLES 3-4 WEEKS BEFORE SEASON START

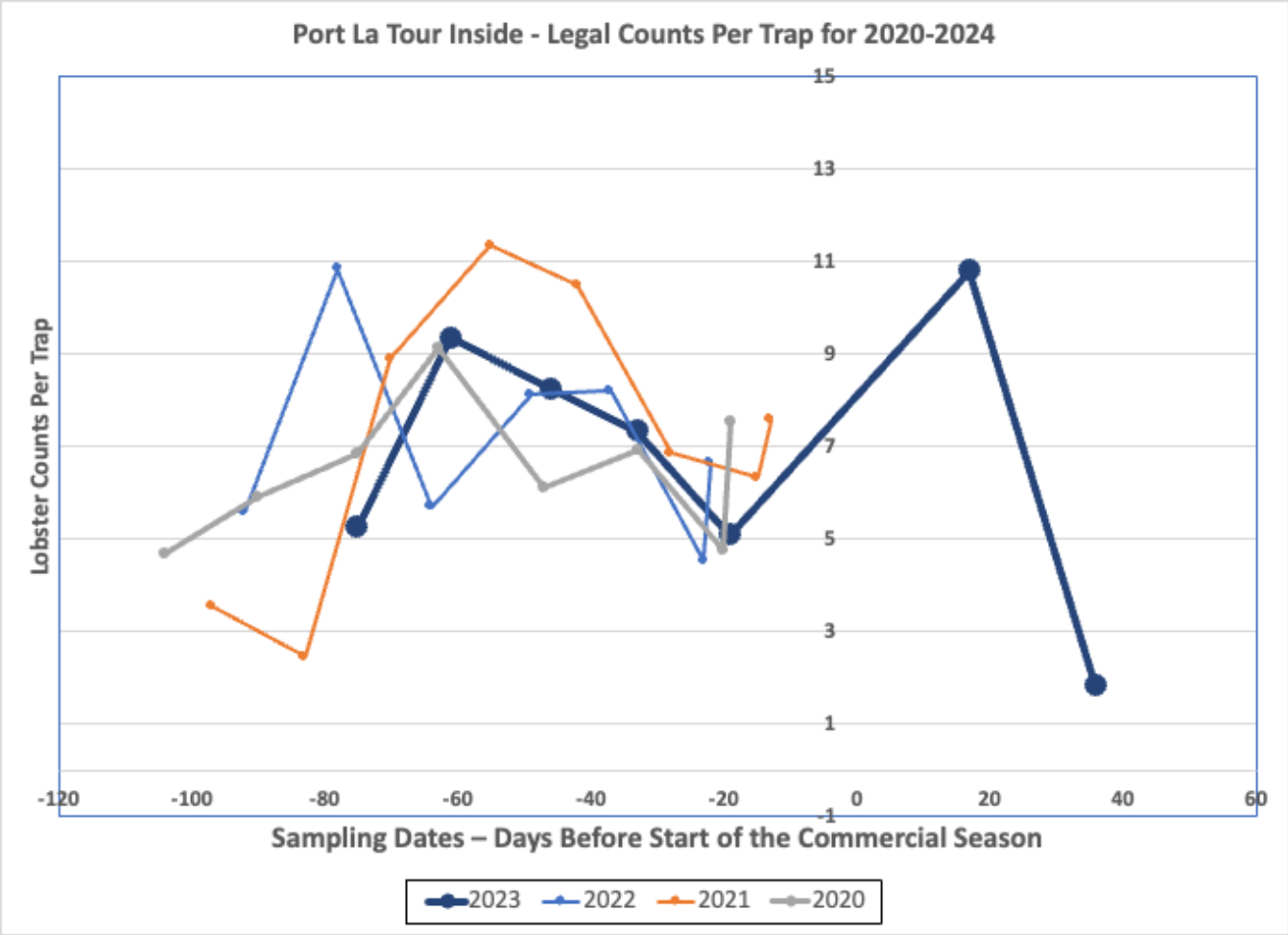
From the figure below, annual samples 3-4 weeks from the start of each commercial harvest season opening are variable across the series from 2012 to 2023 for Port La Tour Inside. The 2023 sample (November 8) has the highest BRIX average (12.31 mg/mL – off scale; see also the figure above) in the series. The November 8, 2023 sample is directly comparable to the November 11, 2020 sample but with an elevated average BRIX value (12.31 versus 10.47 mg/mL).



(C) Counts (legal-sized) per trap for 2023 samples

In the figure below, the counts per trap of lobsters (male and female) of legal-sized (82.5 mm or greater) that occurred in the survey samples dates in 2023 (thick dark blue line) are compared to past years' samples (2020-2022) for Port La Tour Inside. In 2023, Port La Tour Inside counts are directly comparable to past years' counts at similar sampling dates. The time series of counts over the preseason in Port La Tour Inside exhibit an initial rise to end-September and then fall (by 50%) to the end of the sampling period (mid-November).

As evidenced from the figure below, commercial catch rates rise (to 11 legal counts per trap) for the December 14, 2023 in-season sample and then fall precipitously to 2 legal counts per trap for the January 2, 2024 in-season sample as legal sized lobster abundance is extracted.



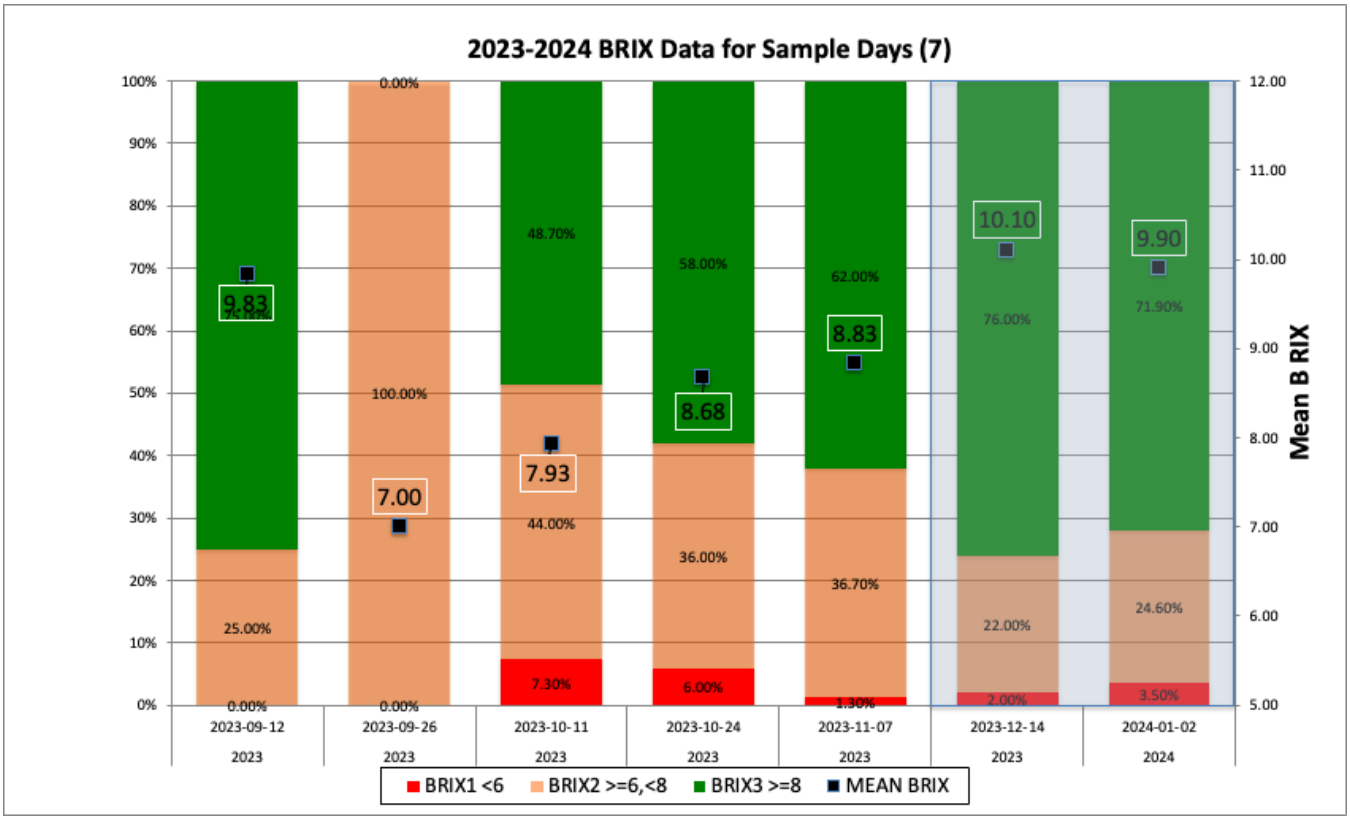
Counts of weak lobsters in the 2023 Port La Tour Inside samples were below the 2022 values averaging 6.3% per sample versus 13.5% in 2022 and closer to the 2021 and 2020 weak percents (7.6% and 5.7% respectively). The average percentage of Soft and Medium lobsters per sample (17%) also fell compared to 2022 (27%) but were higher than the 2021 and 2020 percentage values of only 4%.

5.2.6 PORT LA TOUR OUTSIDE

2023 SUMMARY OF RESULTS

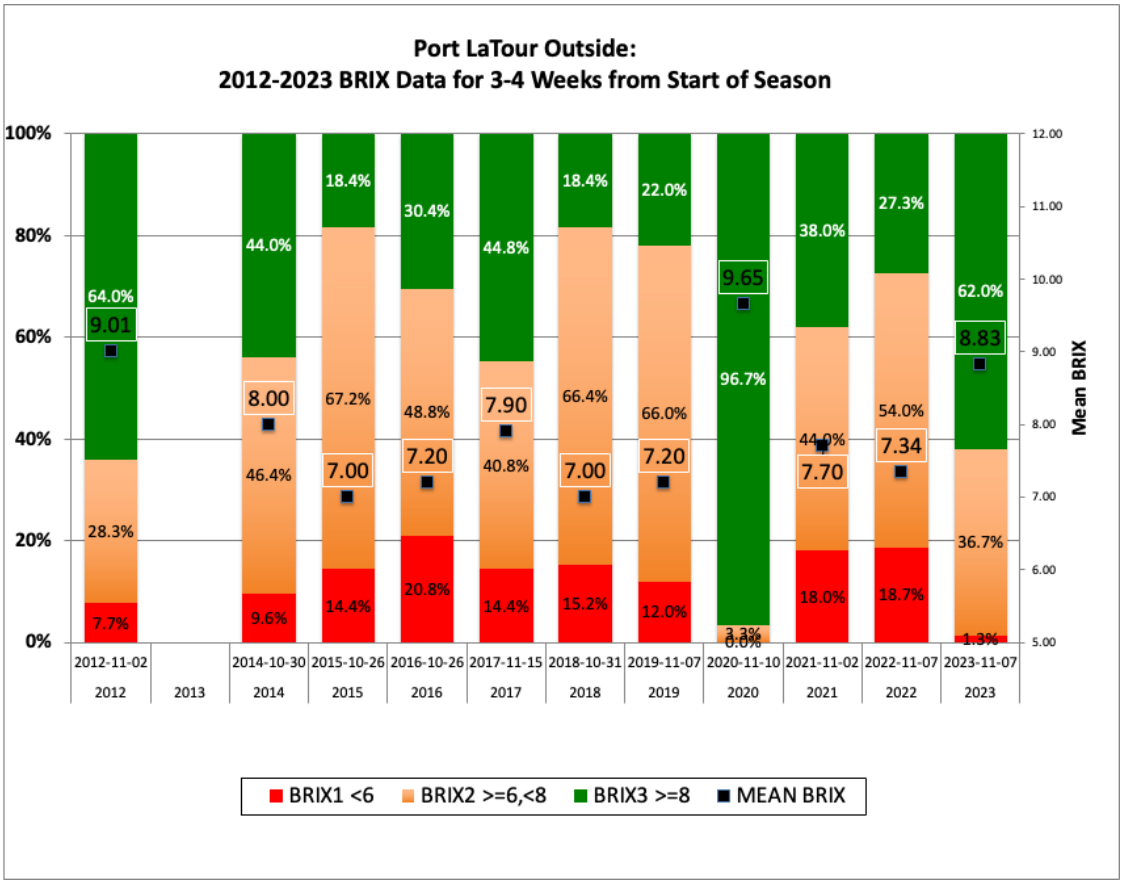
(A)BLOOD PROTEIN (BRIX) CATEGORIES–2023 SAMPLES

In the figure below, 2023 preseason survey results for 5 sample sites in Port La Tour Outside show a variable average BRIX ranging from a low of 7 mg/mL in late-September to a high of 9.83 mg/mL in early September's first sample of the 2023 preseason period. Average BRIX values actually increase after the late-September sample low, climbing to an average BRIX of 8.83 mg/mL by the end of the sampling period (November 7). For Port La Tour Outside, the September samples contain very few sampled lobsters far below the protocol of 150 lobsters to sample. Thus, only 4 and 1 lobster were sampled respectively in the September samples in Port La Tour Outside due to the (historical) inability to catch in this location early in the survey. Ignoring the September samples in Port La Tour Outside in 2023, we note that the trend of the BRIX level categories is to grow the "Good" levels of BRIX (≥8 mg/mL) (from 48% to 62%) and decrease the incidences of "Poor" lobsters in samples to the end of the sampling period (from 7.3% to 1.3%). Averagew BRIX levels (10 units/ml) for the 2 in-season samples are elevated relative to the earlier samples, as expected, as lobster move into premoult status.



(B) BLOOD PROTEIN (BRIX) CATEGORIES – ANNUAL SAMPLES 3-4 WEEKS BEFORE SEASON START

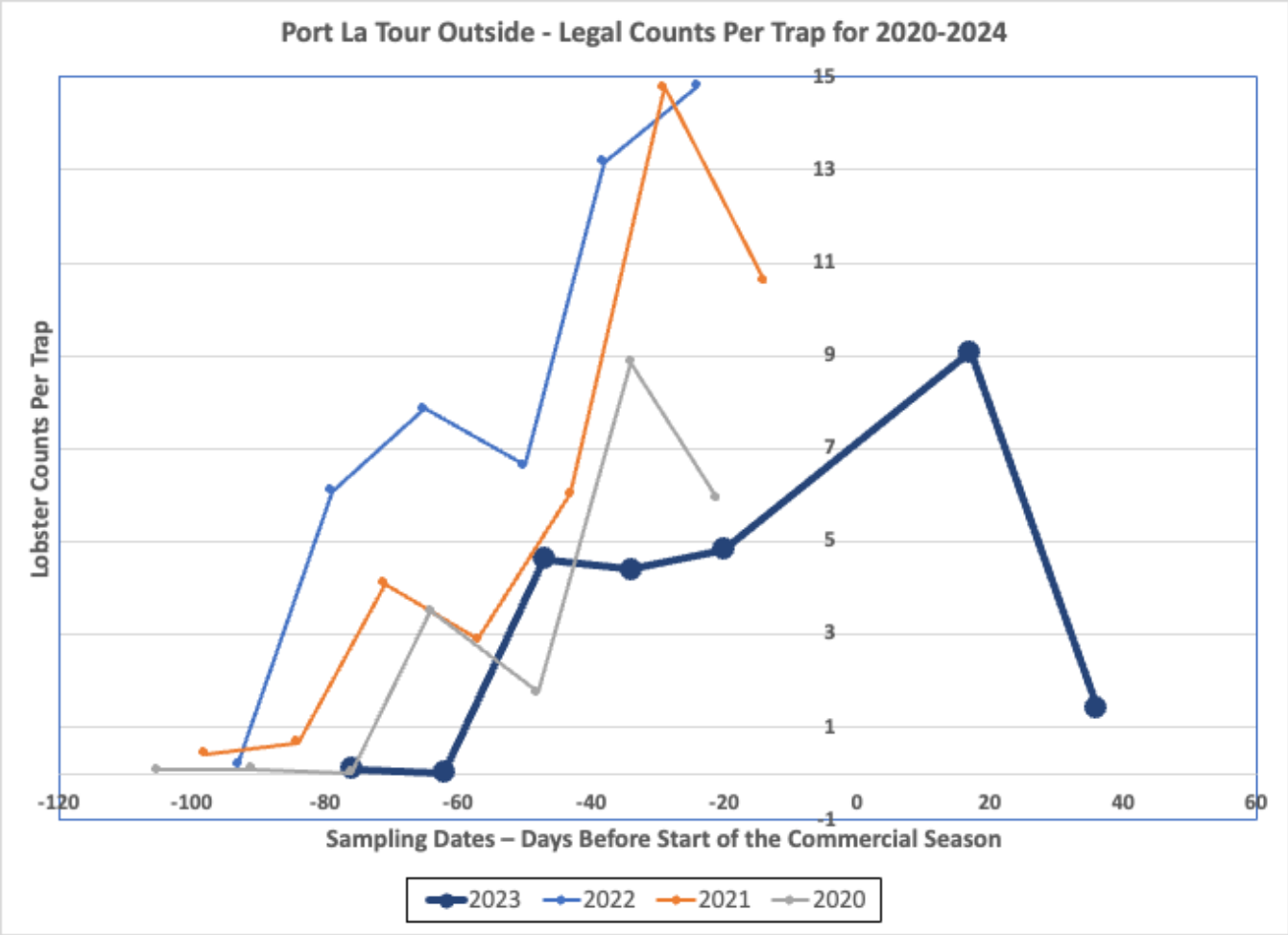
From the figure below, annual samples 3-4 weeks from the start of each commercial harvest season opening are highly variable across the series from 2012 to 2023 for Port La Tour Outside. The 2023 sample (November 7) has the third highest BRIX average (8.83 mg/mL) in the series. The November 7, 2023 sample is comparable to the November 2, 2012 sample with similar average BRIX value (9 mg/mL) and like BRIX category levels.



(C) Counts (legal-sized) per trap for 2023 samples

In the figure below, the counts per trap of lobsters (male and female) of legal-sized (82.5 mm or greater) that occurred in the survey samples dates in 2023 (thick dark blue line) are compared to past years' samples (2020-2022) for Port La Tour Outside. In 2023, Port La Tour Outside counts are among the lowest in comparison to past years' counts at similar sampling dates. The time series of counts over the preseason in Port La Tour Outside exhibit a slow rise to mid-October and a leveling off at counts per trap that are approximately 50% below those of 2020-2022 to the end of the sampling period (mid-November). As evidenced the figure below, commercial catch rates are expected to fall precipitously after the beginning of the commercial season as legal sized lobster abundance is extracted.

In 2023, the in-season samples show a rise (to 9) in average legal counts per trap in the December 24, 2023 sample and then a falling off, as expected. into January (less than 2 legal counts per trap). Based on past years, it appears the peaking of average counts per trap in December 2023 is later than the past years when the peaks had occurred in Novermber.



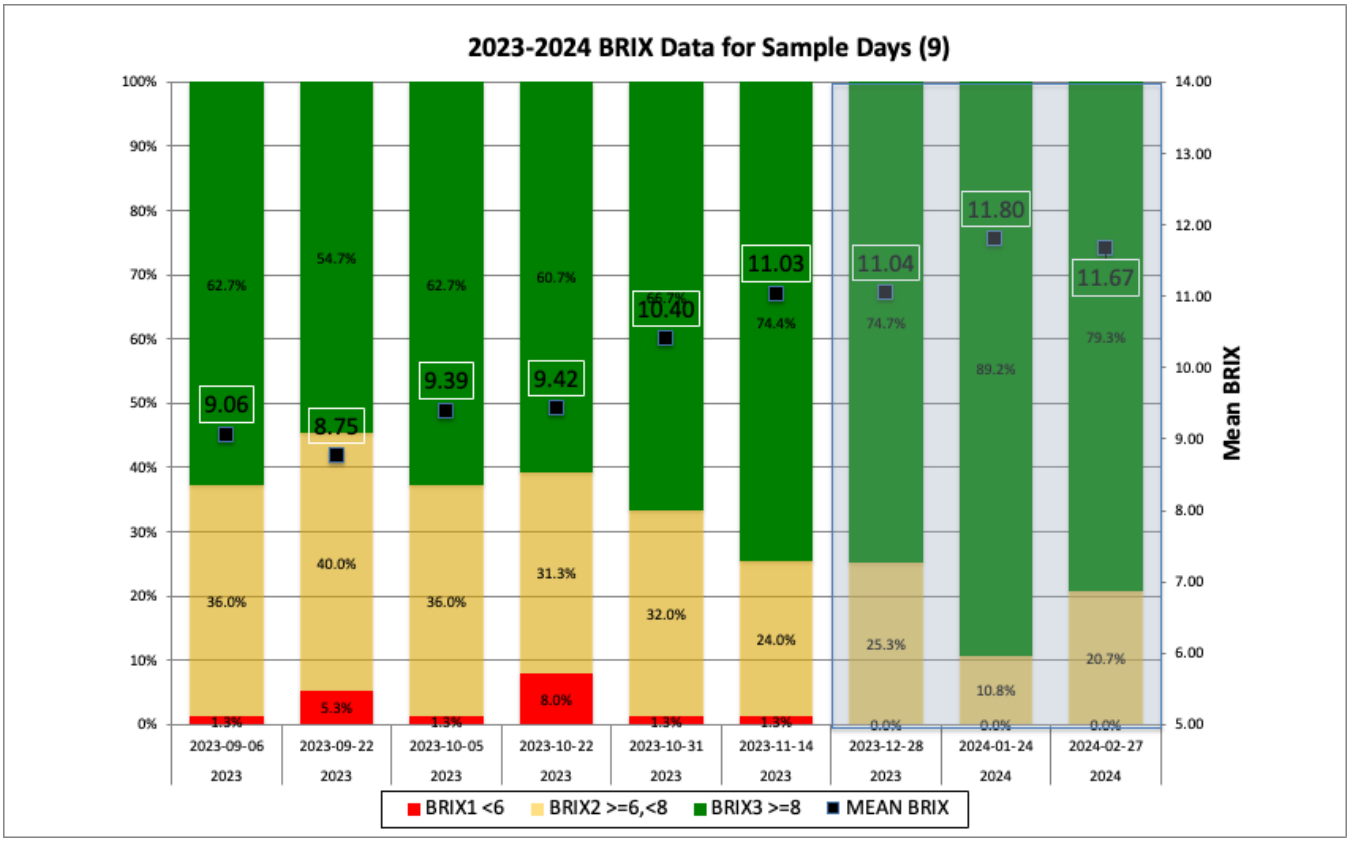
Counts of weak lobsters in the 2023 Port La Tour Inside samples were below the 2022 values averaging 15.2% per sample versus 23.4% in 2022. Percent weaks in 2021 and 2020 were 10% and 5% respectively. The average percentage of Soft and Medium lobsters per sample were high in Port La Tour Outside (50%) and similar to 2022 (44%). 2021 and 2020 percent values for soft and medium were both less than 17%.

5.2.7 ST. MARY'S BAY INSIDE

2023 SUMMARY OF RESULTS

(A)BLOOD PROTEIN (BRIX) CATEGORIES–2023 SAMPLES

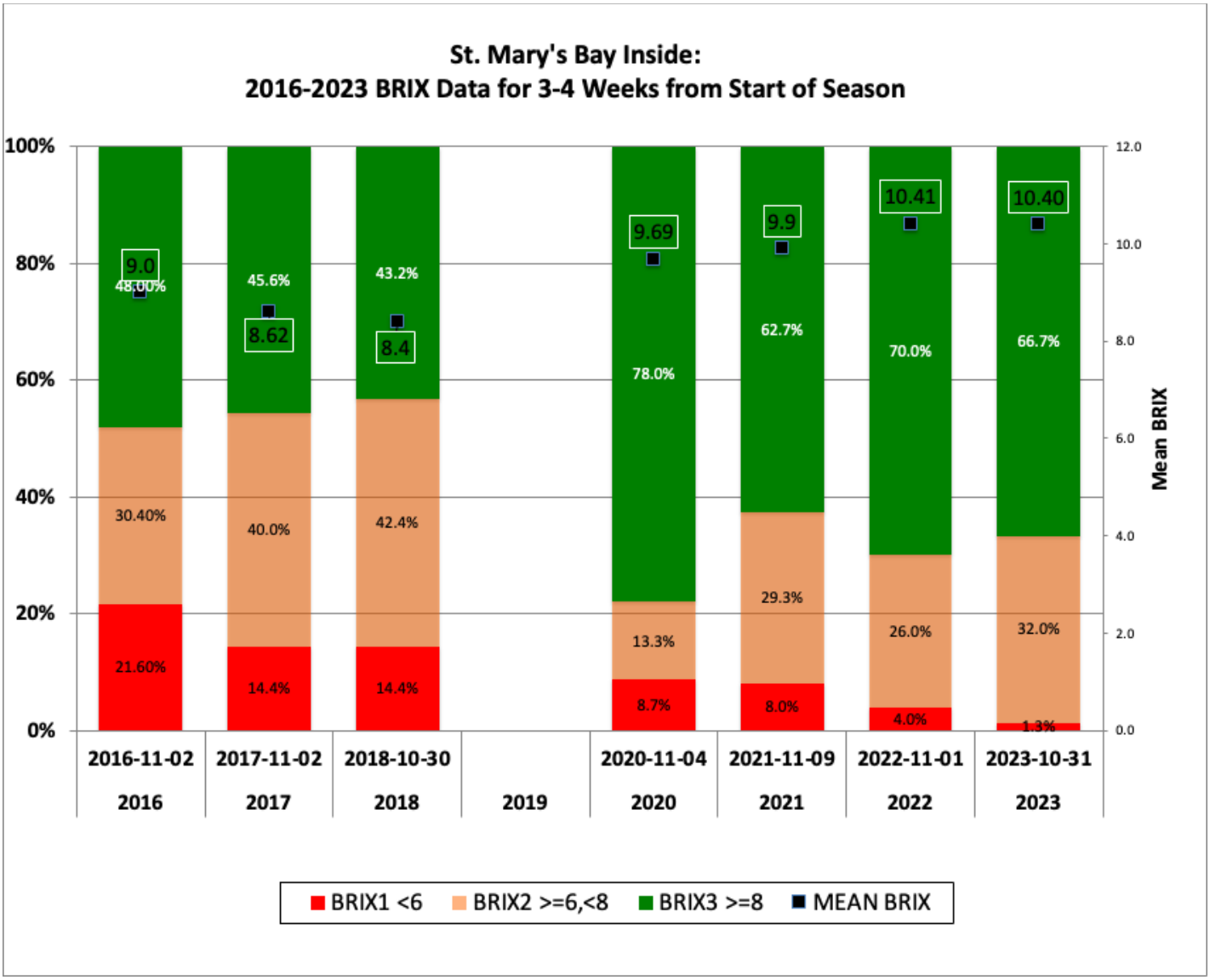
In the figure below, 2023 preseason survey results for 6 sample sites in St. Mary's Bay Inside show a gradual rise in average BRIX from the September samples (9.06 and 8.75 mg/mL) to the mid-November sample (11.03 mg/mL). BRIX category levels remained relatively constant with samples attaining 60-75% "Good" levels for BRIX (≥8 mg/mL). The proportion of "Poor" lobsters (BRIX<6 mg/mL) sampled in St. Mary's Bay Inside did not exceed 10% throughout the sampling period. Average BRIX level values for samples in 2023 (9.7 mg/mL) were comparable to 2022 values (9.95) and above values for 2021 (9.2) through 2020 (8.4). The 3 in-season BRIX distributions all have higher average BRIX values than the late preseason peak (11 units/ml) with lower "Medium" and zero percent "Poor" category lobsters.



(B) BLOOD PROTEIN (BRIX) CATEGORIES – ANNUAL SAMPLES 3-4 WEEKS BEFORE SEASON START

From the figure below, annual samples 3-4 weeks from the start of each commercial harvest season opening are somewhat variable across the series from 2016 to 2023 for Yarmouth Inside. The 2023 sample (October 31) has the highest BRIX average (10.4 mg/mL) in the series (roughly equivalent to the

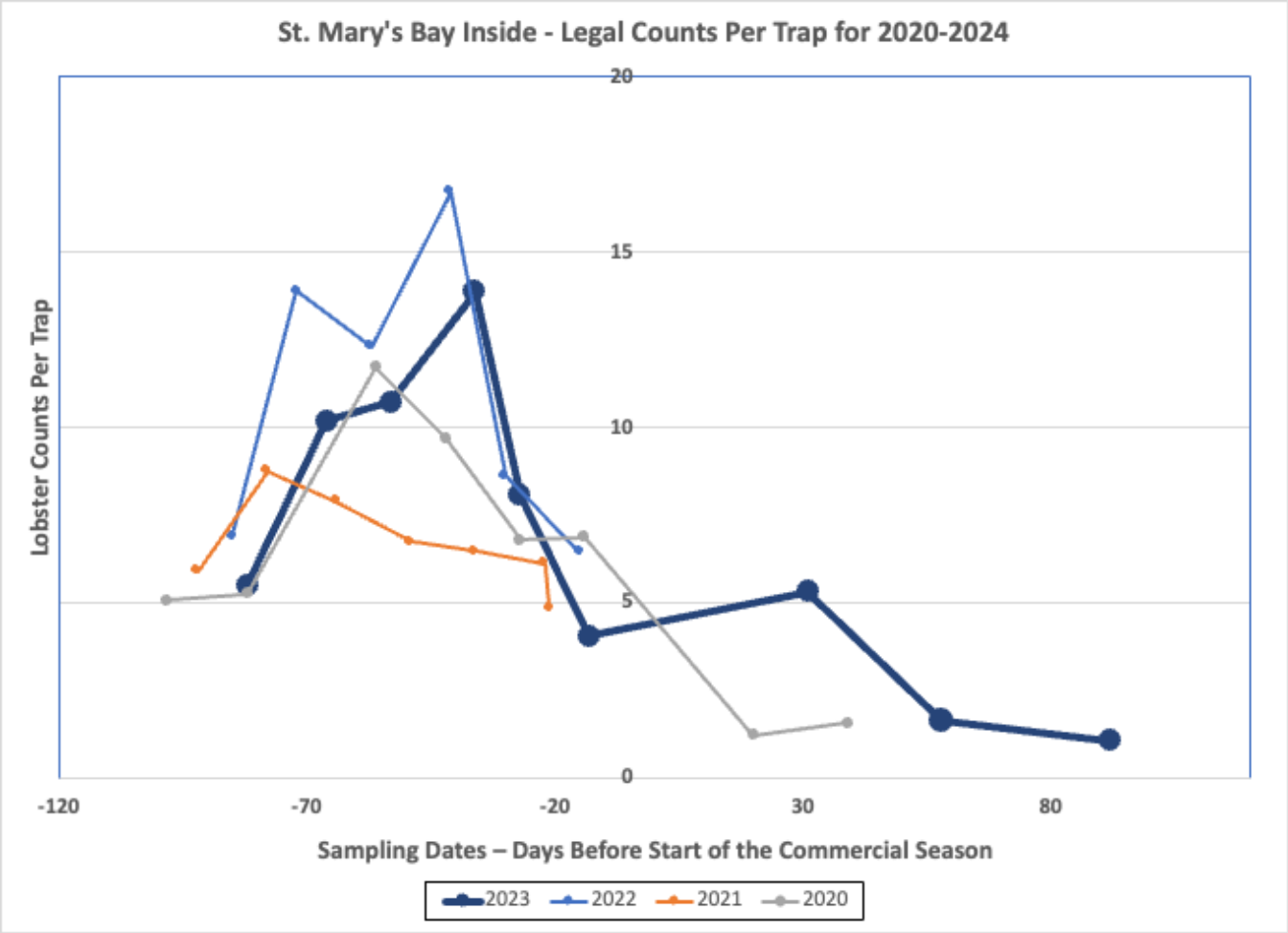
average BRIX of the November 1, 2022 sample at 10.41). The October 31, 2023 sample is also directly comparable to the November 1, 2022 sample.



(C) Counts (legal-sized) per trap for 2023 samples

In the figure below, the counts per trap of lobsters (male and female) of legal-sized (82.5 mm or greater) that occurred in the survey samples dates in 2023 (thick dark blue line) are compared to past years' samples (2020-2022). The counts for St. Mary's Bay Inside are comparable to past years' counts. The characteristic time series of counts over the preseason in St. Mary's Bay Inside exhibit a rise toward end-October and then a fall (by 50+%) to the end of the sampling period (mid-November).

As evidenced by the 2023 and the 2020 in-season samples in the figure below, commercial catch rates fall precipitously after the beginning of the commercial season as legal sized lobster abundance is extracted.



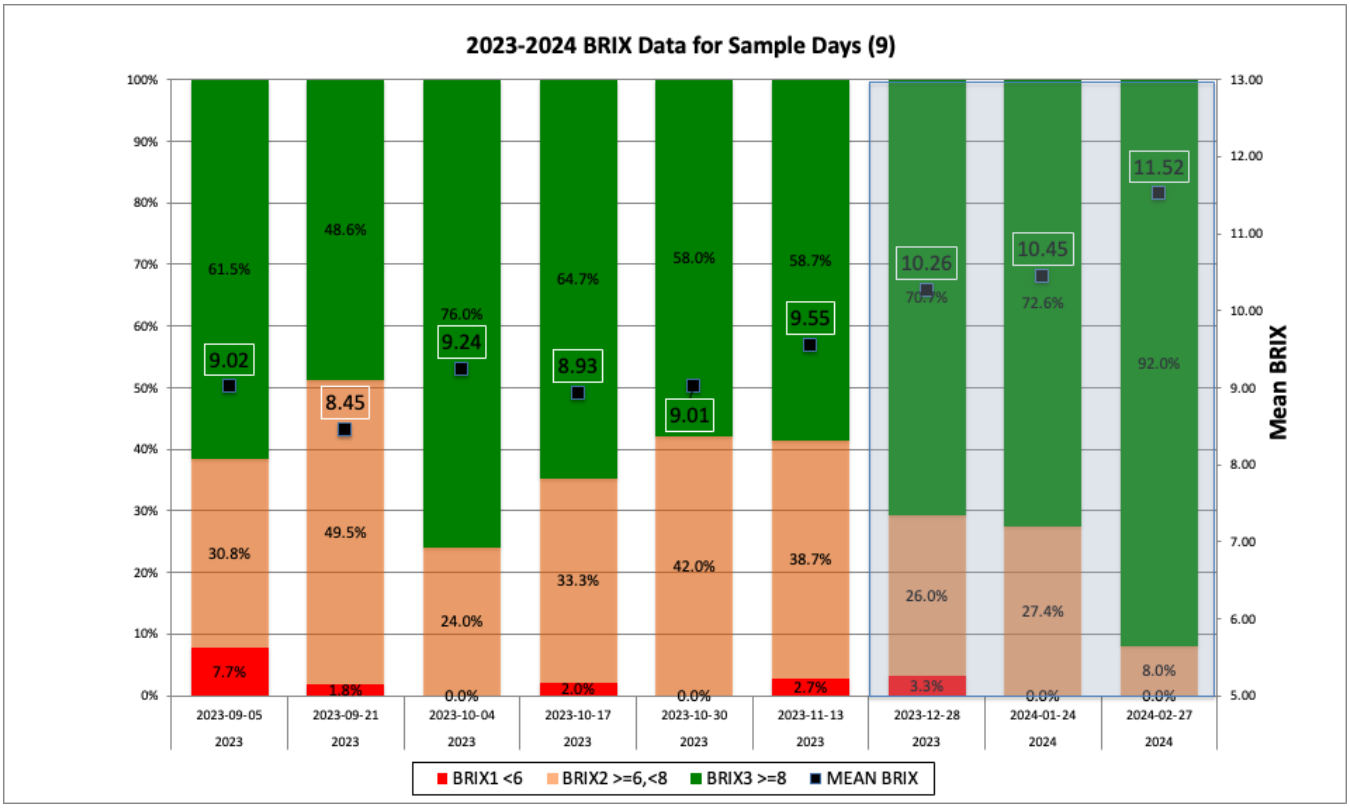
Counts of weak lobsters in the 2023 St. Mary's Bay Inside samples (13.3%) were comparable to 2022 values (11.4%) but greater than the past years (2020-2021) values for weak percent in samples of 6% and 4% respectively. The average percentage of Soft and Medium lobsters per sample (22%) fell slightly compared to 2022 (23%) but were well above the almost negligible 2021 (5%) and 2020 (1%) percents for soft and medium lobsters in the samples.

5.2.8 ST. MARY'S BAY OUTSIDE

2023 SUMMARY OF RESULTS

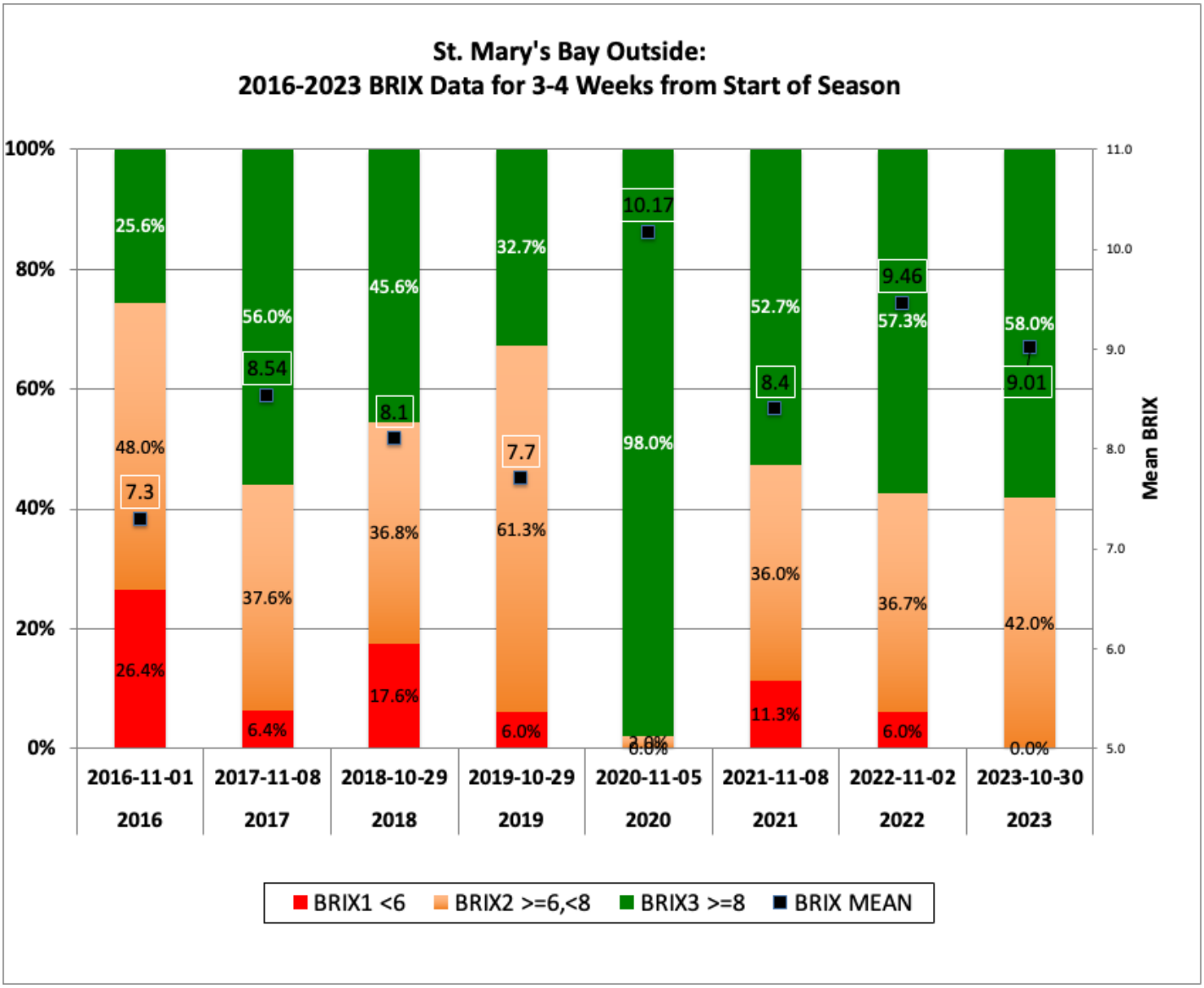
(A)BLOOD PROTEIN (BRIX) CATEGORIES–2023 SAMPLES

In the figure below, 2023 preseason survey results for 6 sample sites in St. Mary's Bay Outside show a relatively constant average BRIX ranging from a low of 8.45 mg/mL (September 21 sample) to the high of 9.55 mg/mL at the ending mid-November sample. BRIX category levels also remained relatively constant with samples attaining 49-76% "Good" levels for BRIX (≥8 mg/mL) throughout the sampling period. The proportion of "Poor" lobsters (BRIX<6 mg/mL) sampled in St. Mary's Bay Outside did not exceed 8% for all samples. Average BRIX level values for samples in 2023 (9.1 mg/mL) were comparable to 2022 values (9.21) and above values for 2021 (8.4) through 2020 (8.65). As for St. Mary's Bay Inside, the in-season samples exhibit rising average BRIX values and high proportions of "Good" category lobsters per sample and lower proportions of "Medium" and "Poor" lobsters.



(B) BLOOD PROTEIN (BRIX) CATEGORIES – ANNUAL SAMPLES 3-4 WEEKS BEFORE SEASON START

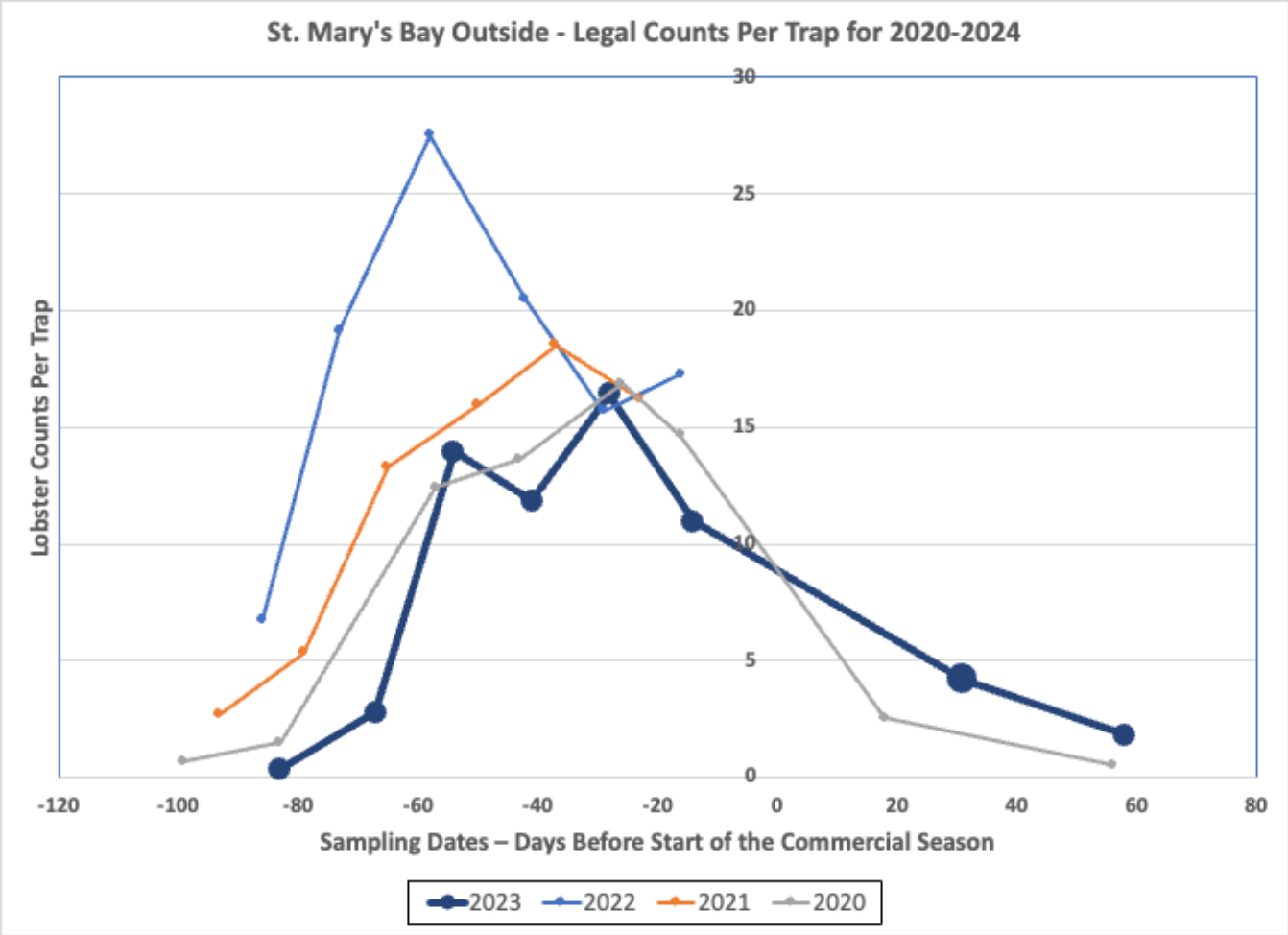
From the figure below, annual samples 3-4 weeks from the start of each commercial harvest season opening are somewhat variable across the series from 2016 to 2023 for St. Mary's Bay Outside. The 2023 sample (October 30) has the third highest BRIX average (9.01 mg/mL) in the series. The October 30, 2023 sample is also directly comparable to the November 2, 2022 sample with similar BRIX category levels but elevated average BRIX (9.46 mg/mL) in the 2022 sample.



(C) Counts (legal-sized) per trap for 2023 samples

In the figure below, the counts per trap of lobsters (male and female) of legal-sized (82.5 mm or greater) that occurred in the survey samples dates in 2023 (thick dark blue line) are compared to past years' samples (2020-2022). The counts for St. Mary's Bay Outside are, for the most part, lower than previous years' counts. The 2023 counts do exhibit the characteristic time series of counts over the preseason showing an initial rise toward end-October and then a fall to the end of the sampling period (mid-November).

As evidenced by the 2023 and the 2020 in-season sampling for St. Mary's Bay Outside in the figure below, commercial catch rates all precipitously after the beginning of the commercial season as legal sized lobster abundance is extracted.



Counts of weak lobsters in the 2023 St. Mary's Bay Outside samples (11.7%) were below 2022 values (17.3%) but greater than the past years (2020-2021) values for weak percent in samples of 9.5% and 3.7% respectively. The average percentage of Soft and Medium lobsters per sample (24.5%) rose slightly compared to 2022 (21.3%) but were well above the 2021

6 In-season Sampling Data in 2023-2024

The 2023-2024 sampling program included 13 sampling location-dates that took place after the beginning of the commercial lobster fishing season (November 26, 2023 in LFA33, December 2, 2023 in LFA34). These samples were carried out in 7 days during the last half of December 2023 (14th, 27th, and 28th), January 2024 (2nd, 4th, and 24th), and February 2024 (27th).

6.1 In-season Sampling Data

In-season samples took place in Inside areas of Port La Tour, and St. Mary's Bay, and all Outside areas of Lobster Bay, Port La Tour, Yarmouth, and St. Mary's Bay as summarized in Table 9. As per the sampling protocol, in-season samples were comprised of 150 legal-sized lobsters per location-date if available. It is noted that of the 13 in-season sampling location-dates, 8 of these were not able to sample the 150 legal-sized lobsters as per the protocol (Table 9).

Table 9. Summary of 2023-24 In-season Sampling Data

Sampling Location	Samples Subarea	Sampling Dates	Counts# Harvested	Total Samples	Sample Ave BRIX	% Change Ave BRIX*	Sample % Soft	Sample % Weak
Lobster Bay	Inside	04-Jan	134	50	13.99	+33%	0.00%	4.00%
LFA34	Outside	04-Jan	287	127	13.47	+51%	2.36%	6.30%
Port La Tour LFA 33	Inside	14-Dec	543	150	11.34	+9%	0.00%	5.33%
		02-Jan	137	73	13.61	+31%	0.00%	0.00%
	Outside	14-Dec	476	150	10.10	+13%	2.67%	9.33%
		02-Jan	84	57	9.90	+10%	1.75%	7.02%
St. Mary's Bay LFA 34	Inside	28-Dec	437	150	11.04	+10%	1.33%	8.00%
		24-Jan	168	65	11.80	+18%	0.00%	9.23%
		27-Feb	40	29	11.67	+16%	0.00%	0.00%
	Outside	28-Dec	318	150	10.26	+8%	4.00%	3.33%
		24-Jan	186	73	10.45	+10%	1.37%	8.22%
		27-Feb	123	50	11.52	+22%	0.00%	0.00%
Yarmouth LFA 34	Outside	27-Dec	450	150	11.66	+17%	2.00%	5.33%
	7 sub-areas^	**13 Sample Dates**	**Total# Lobsters Harvested**	**Lobsters Sampled**	**Average BRIX**	**Ave %BRIX Change***	**Overall % Soft**	**Overall % Weak**
	IN-SEASON TOTALS		**3,383**	**1,274**	**11.44**	**+19%**	**1.57%**	**5.73%**

^Zero In-season samples were taken in Yarmouth (Inside) in 2023-2024.
*Average BRIX % change compares average preseason BRIX means by location with average in-season BRIX means.
#Counts Harvested totals include legal and sublegal lobsters.

In-season samples consistently show improved overall BRIX indicators over all areas with means exceeding 9.9 units/ml in all in-season sampling dates and overall in-season 2023-24 BRIX mean of 11.44 (Table 9) versus overall preseason and in-season BRIX mean of 10.07 units/ml (Table 3). In-season samples also showed lower %Soft and %Weak values respectively of 1.57% and 5.73% on 1,274 samples (Table 9) versus preseason %Soft and %Weak values of 3.03% and 12.37% respectively on 6,071 preseason samples – a decrease of 50% in %Soft/%Weak values from preseason to in-season samples (Table 3).

The following section compares the in-season BRIX distribution category results for the preseason samples by locations and inside/outside areas for the 12 in-season sample location-dates.

6.2 Preseason and In-season Comparison

The preseason and in-season sample results for the BRIX indicators for each location-area compare the corresponding preseason samples for a given location with the in-season samples. An examination of the performance results of the preseason prediction indicators of Table 8 is provided in Table 10.

6.2.1 Lobster Bay In-season Results

There were 7 total sampling periods for Lobster Bay Outside including 1 in-season sample date (January 4, 2024), 1 month after the start of the commercial season on December 2, 2023 (in LFA34). The mean BRIX category time series generally increased from the September 2023 sample dates in Lobster Bay Inside and Outside from a low BRIX mean of less than 9 units/ml improving to 11 units/ml by the end of preseason sampling (November 7). The single in-season sample of January 4, 2024 in both Inside and Outside subareas of Lobster Bay saw an increase in mean BRIX to the highest mean BRIX in the sampling series to nearly 14 units/ml. Average BRIX levels as expected to improve as the winter season progresses and lobsters become fully-meated while moving from post-moult into the pre-moult period. Thus, for Lobster Bay Inside and Outside, by end January 2024, lobsters are predominantly (80%+) of high quality and considered acceptable for long-term storage and all markets.

6.2.2 Port La Tour In-season Results

There were 14 total sampling periods for Port La Tour Inside and Outside including two in-season sampling dates at December 14, 2023 and January 2, 2024 in each subarea. The mean BRIX time series over the preseason sampling period increased from the low of 7.6 units/ml (September 13, 2023) and a high of 12.3 units/ml (November 8, 2023).

The two in-season samples in Port LA Tour Inside continued the higher mean BRIX values of 11.3 (December) to 13.6 units/ml (January). Average BRIX levels as expected to improve as the winter season progresses and lobsters become fully-meated while moving from post-moult into the pre-moult period. For Port La Tour Inside by end January 2024 lobsters are 70%+ considered to be of high quality and acceptable for long-term storage and all markets. For Port La Tour Outside, average BRIX levels are below those of the Inside areas but follow a similar pattern. The two in-season samples in Port LA Tour Outside have higher mean BRIX values of 10 units/ml (December and January). For Port La Tour Outside

by end January 2024 lobsters are 70%+ considered to be of high quality and acceptable for long-term storage and all markets.

6.2.3 St. Mary's Bay In-season Results

There are 9 total sampling periods for each of St. Mary's Bay Inside and Outside including three in-season same day sampling dates (December 28, 2023, January 24, 2024, and February 72, 2024) in each subarea. The mean BRIX time series over the preseason period showed similar trends Inside and Outside with an initial decline to early October followed by a gradual but steady improvement in mean BRIX values from under 9 units/ml (October) to just under 12 by the end of the in-season sampling period at end February 2024.

Once again, it is understood that BRIX levels are expected to improve as the lobster season progresses, and lobster becomes fully-meated as they move from post-moult into the pre-moult period of the coming year. Thus, for St. Mary's Bay Inside and Outside, by January 2024, lobsters are 80%+ of high quality and considered acceptable for long-term storage and all markets.

6.2.4 Yarmouth In-season Results

There are a total of 13 sampling periods for Yarmouth Inside and Outside including a single in-season sample date in the Outside subarea on December 27, 2023. The mean BRIX time series patterns were relatively stable over the preseason 10 units/ml from September (9.7) through November 2023 (11) samples.

The single in-season sample in the Outside subarea shows the highest mean BRIX (11.6) of the time series. Yarmouth Outside mean BRIX levels are expected to improve into the season, as lobsters become more fully-meated while they may be considered moving from post-moult into the pre-moult period of the coming calendar year, 2024. By the New Year 2024, lobsters are approximately 70% of high quality and considered acceptable for long-term storage and for all markets.

6.2.5 Preseason Predictions versus In-season Results

The total of 13 in-season sampling periods provide a check on the preseason lobster quality indicators and predictors (Table 8) as presented in the Lobster Quality 2023 Preseason Sampling Program: Preseason Summary Report (Mattock, Mulock and Lane 2023). Table 10 provides the Table 8 lobster quality predictors by location compared to the observations of the in-season sampling results.

The results indicate that the preseason predictors tend to underestimate the average BRIX sample values across all locations and Inside and Outside subareas. As stated previously, it is anticipated that lobster BRIX values increase as lobsters move through the winter from the post-moult stage in 2023 to pre-moult in 2024. The incidence of the January 2024 in-season samples suggest that the BRIX predictors were more relevant to earlier in-season samples, e.g., December only.

Table 10. 2023 Preseason Sampling Predictors Performance vs In-season Sampling

Locations: / Predictors:	Yarmouth Inside*	Yarmouth Outside	Lobster Bay Inside	Lobster Bay Outside	Port La Tour Inside	Port La Tour Outside	St.Mary's Bay Inside	St.Mary's Bay Outside
In-Season Samples (Dates^)	0	150(1)	200(2)	277(2)	223(2)	207(2)	215(2)	223(2)
Average BRIX (mg/mL)	**10**	**9.5**	**11**	**10.5**	**10.5**	**8.5**	**10**	**9.5**
In-season Obs Average BRIX	X	11.7	11.8	11.9	12.1	10.0	11.3	10.3
Ave Legal Counts Per Trap	**5**	**5**	**6**	**5**	**4**	**4**	**5**	**6**
In-season Obs Ave Legal Counts	X	8.6	6.6	8.1	6.3	5.2	3.4	3.0
Ave % Soft+Med	**10%**	**15%**	**15%**	**15%**	**10%**	**20%**	**10%**	**10%**
In-season Obs Ave % Soft+Med	X	15.3%	21%	14.8%	12%	30.4%	16.3%	14.8%
Ave % Weaks	**5%**	**8%**	**15%**	**12%**	**5%**	**10%**	**5%**	**10%**
In-season Obs Ave % Weaks	X	5.3%	19%	14.4%	3.5%	8.7%	8.4%	4.9%

*Yarmouth Inside recorded zero in-season sampling in 2023-24.
^In-season sample dates include December 2023 and January 2024 dates only (February dates excluded).
Notes: Table 8 predictor values are denoted in **red text**; green cells denote in-season observations that exceed the corresponding predictor value; blue cells denote in-season observations that are less than the corresponding predictor value.

Average percentage Soft plus Medium hardness levels predictors were also underestimated, especially in Inside areas. These diminished hardness results are not consistent with the anticipated hardening of lobsters' carapace as lobsters move through the winter from the post-moult stage in 2023 to pre-moult in 2024 and are indicative of lobsters of reduced quality for shipping and storage.

Average legal counts (i.e., catch predictions) vary slightly with overestimates in St. Mary's Bay where it is reported and observed that catch rates have fallen during the commercial fishery in 2023-2024 (Travis 2024, Withers 2024). In other Outside areas (Yarmouth, Lobster Bay, and Port La Tour), the predictors have underestimated the actual catch counts observed in the in-season samples which implies that preseason counts per trap (Figures 7 and 11) did not continue into the in-season period. The implication of overestimating in St. Mary's Bay implies that actual commercial catches there may be declining in 2023-24 by as much as 50% in this area overall. Similarly, underestimates in the other areas (Yarmouth and Port La Tour) suggests that actual catches may be as much as 30-70% higher than first expected.

Finally, predictors for the percentage of weak lobsters in the in-season samples vary. In Outside areas, it appears that weaks are overestimated by the predictors and actual weaks are less than expected. However, in the Inside areas of Lobster Bay and St. Mary's Bay, actual weak percentages exceed the predicted values. Overall, it appears that the predictors may be considered as reasonable estimates of early commercial season observations of lobster status indicators by subarea.

7 Discussion

The objective of this report is to present all information from the 2023-24 preseason and in-season sampling program–in a concise a manner as possible–for the benefit of the lobster sector in Nova Scotia. The extent of the expansive sampling program dataset and the variety of the rich information therein makes this a challenging task. This challenge is met by following strictly the sampling protocol (described above) each year of the sampling program so that observations are substantiated, validated and, where necessary, verified so that they are comparable across years as well as by sampled location. Following the protocol is at once a requirement for good data collection (leading to validated data analyses) as well as a goodwill protector against biased observations. We are confident that the 2023-24 dataset contribute unbiased observations on lobster in LFAs33 and 34 as per the full 2006-2024 dataset.

It is also important to note what this dataset does not do. The lobster data collected are samples taken from 8 defined subareas of LFAs 33 and 34. As such, these data provide representative information about lobster quality indicators in these specific subareas. The data do not represent the entire LFAs as a whole and do not pretend to summarize lobster status for the broader LFAs. This is the reason why designated subareas are established– they represent integrated parts of the whole of the LFA that permit repeated observation and longitudinal analyses that characterize good data. For example, the single representative data for the subarea of Port La Tour in LFA33 cannot be expected to be representative of actual results of lobster quality across the entire expanse of LFA33 since it is well-known that key components of LFA33 (such as around the Halifax area) are not included in the dataset. Rather, Port La Tour provides an integrated location in a separate jurisdiction that enables comparison with the other areas of the database that happen to be in LFA34 – St. Mary's Bay, Lobster Bay, and Yarmouth Bar. Similarly, these LFA34 subareas sampled in the dataset may not be considered representative of the entire LFA34.

Given the rich – and variable – observations of the sampling dataset from this report, we may anticipate that other lobster quality observations from these same LFAs may nevertheless differ from the results observed and presented here. In such a case, we caution the need to substantiate all observations and adhere to the same protocols as the dataset presented here so that the observations may be directly comparable. In situations where observations follow a different protocol or adopt different approaches to collecting data, then we understand that effort needs to be made to align the different data collection protocols so that the results may be justly comparative.

Since 2006, there have been some years of excellent quality (2012, 2013) and others of poorer and deteriorating quality (2015, 2016) as measured by the distribution of BRIX values from the preseason samples. Our ability to discriminate each year's sample using the same protocol standards improves as we collect and consider more years of historical data. The objective of the preseason and in-season sampling program by location is to carry out a structured, statistical analysis of year-over-year comparisons to gauge the early season prediction of lobster quality by fishing areas. This information, we believe, is of benefit to Nova Scotia harvesters, processors, and decision makers looking to prepare inventories for live and processed markets that yield most value to the lobster sector. The following discussion considers the outlook for the preseason and in-season lobster sampling program in LFAs33&34 and presents issues for continuous improvement of this report for the benefit of the lobster industry for the coming commercial seasons.

7.1 Annual Lobster Quality and Landings Comparison

In the 2020-2021 final report (Mattock, Mulock, and Lane 2021a), it was reported that there was a negative correlation between LFA34 seasonal landings and Overall Average BRIX for all 8 sampling areas, i.e., it was conjectured that as overall quality (measured by BRIX levels) degrades, total seasonal catches appear to increase (e.g., 2015-16 – year of highest catches and low quality) and vice versa (as lobster quality (BRIX levels) increases, catches fall – e.g., 2012-13 – year of low relative catches but high quality lobster).

It was also reported in the 2021-2022 final report (Mattock, Mulock, and Lane 2022a) that overall predictions of lobster quality and lobster landings in LFAs 33 and 34 can be seen as an independent time series that moves annually according to detectible and comparable trends. We caution that a strict time series analysis approach may ignore exogenous factors that clearly affect lobster fishing effort (i.e., numbers of trap hauls) and subsequent landings independent of lobster quality, e.g., fishing effort, weather conditions, access and allocation disputes, shore prices, lobster inventory and catchability, international markets, as well as global socioeconomic conditions (i.e., global public health issues in a pandemic, or economic fluctuations).

Again this year, this final report does not report on commercial landings compared to the preseason and in-season lobster sampling for quality as determined primarily by BRIX values. Further research on the dynamic determinants of lobster effort and catches by LFA – including predicted and perceived quality – is currently ongoing in order to prepare a sufficient analysis of the potential impacts of perceived quality on catch and effort for lobster. Future final reports of the preseason and in-season sampling program will seek to define quality rankings and grading definitions in further detail based on the historical and the current BRIX observations.

7.2 Decision Opportunities

The ability to compare historical data by selected sites may allow industry to consider options about when and where to harvest higher quality lobster. For example, industry may consider setting harvesting openings, e.g., if the prediction on quality expects harvests with low BRIX (and corresponding lower meat percentage levels), and high offloading losses, or lower lobster catchability, then it may be preferable to shift harvesting to alternative locations (e.g., Inside areas being preferred temporarily to Outside areas) that may have better than expected BRIX performance and catch rates to enable storage and shipment of higher valued quality product. Alternatively, lower BRIX levels may trigger industry decisions to move product from storage and shipment for live markets into processed product until BRIX levels improve.

These options can be evaluated in advance and based on modelling of the historical annual lobster BRIX observations into the commercial season combined with price trends and dynamic behaviour, e.g., based on inventory levels, in order to help lobster harvesters and the industry to make decisions on where and when to fish to improve harvest quality and overall value to the lobster sector over the course of the commercial seasons.

Future full reports will endeavour to model the value implications of alternative decisions that may be a consequence of the observed BRIX profiles of the preseason sampling program.

7.3 Lobster Abundance Considerations

Recent US lobster fishery regulations changes have raised attention to the status of lobsters recruiting to the commercial fishery along the New England shore and into the Gulf of Maine. The implications of a January 2025 revised minimum size from 82.5mm to 84mm carapace measure will undoubtedly have repercussions on Canadian lobster fisheries and, in particular, lobster commercial fishing in LFAs33 and 34 – the focus of this report. Initial feedback suggest that without adopting likewise minimum size restrictions, estimates of up to 20% shipments of Canadian lobster to the United States may face rejection from US markets.

More importantly, the reasons given for why the Americans are anxious to apply new regulations ought to be of concern. The recent University of Maine Lobster Institute Town Hall held in Moncton at the end of January 2024 addressed the American concerns that lobster egg production may be declining, e.g., due to disease or other impacts, and/or lobster recruitment may be hindered, e.g., by increased juvenile lobster predation. These factors would affect the availability of catchable market lobster available for the fisheries. US fishery evidence was presented at the meeting regarding the sharp fall in catches of “tinkers” (sublegal lobster) in the commercial fishery coupled with the year-over-year decline in commercial catches since 2015.

The Lobster Quality Centre is in the process of reviewing these data toward framing research on determining lobster abundance estimates based on observed lobster catch per unit effort, i.e., catch per trap or CPT. The idea consists of using (1) preseason sampling data on lobster counts per trap by location (as reported in this report) and (2) commercial (logbook) data on catch weight and trap hauls (Fisheries and Oceans Canada 2022) to develop an estimate of commercial catchable biomass and expected catch per trap over the season in LFA34 subareas.

The analysis applies our knowledge of lobster moult dynamics (Factor 1995) to determine expected moult and lobster catchability. Data observations from the sampling program (dataset for this report) are matched with counts per sampling trap with data by subareas. Together, the moult schedule, lobster catchability, and observed catch data enable an annual estimate of lobster Catch Per Trap (CPT) over the year by subarea. Assuming catchability coefficients by area (based on sampling data protocols results) an estimate of an index of catchable biomass may be determined. A Lobster Quality Centre Working Paper is currently in progress to explore these concepts. Additionally, the Lobster Quality Centre is currently exploring potential impacts on lobster of egg production, recruitment, warming temperatures and the incidence and impacts of culls in the commercial fishery. This extensive work involves consideration of the impact of predation (e.g., including grey seals) on juvenile lobster stocks.

7.4 Future Preseason Sampling Survey Outlook

Future preseason sampling surveys will continue to follow the traditional ALMQ protocols toward maintaining the integrity of the longitudinal database – one of the world’s longest marine scientific databases. This continuation seeks to ensure the availability to industry of annual LFA 33 and 34 information on the status of lobster quality including individual lobster statistics, lobster harvests by location-area samples, lobster sample counts, moult stages (pleopod analyses), and hardness scale analyses.

Finally, future reports and research initiatives will seek:

- to establish and apply a lobster grading function consistent with industry grading schemes (Lane et al 2023, update in progress);
- to initiate a consistent program of temperature data collection and/or temperature modelling analyses (e.g., regression of surface temperatures to estimate bottom temperatures) associated with the changing marine climate, and the potential for creating conditions that may lead to increased incidences of epizootic shell disease (ESD);
- to develop a specific Quality Indicator time series for each location and inside-outside area that combines lobster landings, BRIX, and other quality measures across the subareas of LFA34;
- to develop statistical analyses using the information in the entire ALMQ database 2006-2022 to discriminate years into quality categories for direct comparison and future analysis and prediction;
- to develop a dynamic BRIX level model for the 8 locations in order to track sample BRIX level changes over the 2023 preseason sampling period and to prepare a forecast of (i) BRIX level distributions and (ii) average BRIX estimates for the start of the commercial season at end November 2023 to be presented in the Preseason Summary of the 2023-24 commercial season;
- to develop, beginning in 2023 a prediction score based on industry feedback at the start of the season to evaluate the performance of the preseason summary report predictions compared to actual results at the start of the LFA33 and 34 commercial seasons; and, finally,
- to match lobster quality analyses with ongoing feedback from industry as to the usefulness of the information for improved industry value and decision making.
- to develop a lobster Catch (kg) Per Trap (CPT) analysis based on commercial and sampling data and link to indices of catchable lobster biomass by subarea.
- to develop a funding plan for the continuation of the extended ALMQ into 2024 and beyond including promoting this continued work with the LQC Advisory Board, the Department of Fisheries and Aquaculture of the Province of Nova Scotia, and Fisheries and Oceans Canada and to maintain our working relationship between Coldwater Lobster Association and the Lobster Quality Centre, Université Sainte-Anne.

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