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# Summary of 2009 Herring Acoustic Surveys in NAFO Divisions 4VWX

# Résumé des relevés acoustiques sur le hareng effectués en 2009 dans les divisions 4VWX de l'OPANO

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## ABSTRACT

Automated acoustic recording systems deployed on commercial fishing vessels have been used since 1997 to document the distribution and relative abundance of Atlantic herring from industry vessel surveys and fishing excursions in the Bay of Fundy and coastal Nova Scotia area within Northwest Atlantic Fisheries Organization (NAFO) divisions 4VWX. In 2009, regularly scheduled surveys at approximately 14 day intervals were again conducted on the main spawning components, and the spawning stock biomass for each component was estimated by summing these results. Five structured surveys were conducted in Scots Bay, two on Trinity Ledge, and seven on German Bank, with most following the established protocol. In most cases, these surveys provided good coverage of the spawning areas consistent with established protocols. Additional data from fishing nights in various areas were also examined but were not applied to the overall spawning stock biomass (SSB).

In 2009, biomass estimates increased for all survey areas in Scots Bay, Trinity Ledge and German Bank to 377,000t from 221,400t in 2008. The 2009 estimate for the overall area is about the same as that recorded in 2007 and remains below the long term average.

Biomass estimates from surveys of the coastal Nova Scotia spawning components for the Little Hope/Port Mouton, Halifax/Eastern Shore and Glace Bay areas were also examined. Four surveys were completed for Little Hope, five surveys for Halifax and three for the Glace Bay area. There were substantial increases in SSB recorded for Little Hope and Halifax areas while Glace Bay showed very little fish in the surveys completed.

## RÉSUMÉ

Les systèmes d'enregistrement acoustique automatisés installés à bord des bateaux de pêche commerciale sont utilisés depuis 1997 pour documenter la répartition et l'abondance relative du hareng, dans le cadre de relevés effectués par l'industrie ou d'excursions de pêche dans les eaux de la baie de Fundy et de la côte néo-écossaise qui font partie des divisions 4VWX de l'Organisation des pêches de l'Atlantique Nord-Ouest (OPANO). En 2009, les relevés usuels ont été de nouveau effectués à intervalles d'environ 14 jours parmi les grandes composantes de reproducteurs et la biomasse du stock de reproducteurs de chaque composante a été estimée d'après les résultats totaux des relevés. Cinq relevés structurés ont été réalisés dans la baie Scots, deux sur le récif de la Trinité et sept sur le banc German, la plupart en suivant le protocole établi. En règle générale, ces relevés ont permis de bien échantillonner les frayères selon les protocoles établis. Des données supplémentaires provenant d'une pêche nocturne dans diverses zones ont aussi été examinées, mais elles n'ont pas été appliquées à l'ensemble de la biomasse du stock de reproducteurs (BSR).

En 2009, la biomasse estimée a augmenté dans toutes les zones de relevé de la baie Scots, du récif de la Trinité et du banc German, se situant à 377 000 t alors qu'elle était de 221 400 t en 2008. L'estimation de 2009 pour l'ensemble des eaux considérées est à peu près la même que celle de 2007 et elle reste inférieure à la moyenne à long terme.

Les estimations de biomasse issues des relevés au sein des composantes de reproducteurs des eaux de la côte de la Nouvelle-Écosse dans les secteurs de Little Hope/Port Mouton, Halifax/côte est et Glace Bay ont aussi été examinées. Quatre relevés ont eu lieu dans le secteur de Little Hope, cinq dans celui d'Halifax et trois dans celui de Glace Bay. La BSR a connu des augmentations importantes dans les secteurs de Little Hope et d'Halifax, mais il y avait très peu de poissons dans les relevés réalisés dans le secteur de Glace Bay.

## INTRODUCTION

Since 1997, the spawning stock biomass (SSB) of NAFO divs. 4WX herring has been estimated using acoustic surveys conducted by the fishing industry (Melvin et al. 1998; Stephenson et al. 1998, Power and Melvin 2010). Each year, commercial fishing vessels equipped with calibrated acoustic logging systems undertake both scheduled and unscheduled surveys of herring aggregations on the spawning grounds. The data collected during these surveys serve two purposes. First, when necessary, the data can be analyzed in near real-time, and used as input for the "survey, assess, then fish" protocol, to apportion fishing effort on individual spawning grounds. Secondly, the estimates for individual spawning areas have been summed, under specific assumptions about elapsed time between surveys, to provide an annual index of the SSB for the assessment process. The development and implementation of the automatic acoustic systems represents a major improvement in quantifying fish biomass. Pre-1997 estimates relied on the experience of the observer to estimate the amount of fish from mapping surveys, and are considered qualitative only (Melvin et al. 2002a).

The use of commercial fishing vessels to survey and to estimate SSB was initially developed to provide additional protection of individual spawning components within a global total allowable catch (TAC) during a period (1994-95) of declining biomass. The original qualitative approach, commonly referred to as the "survey, assess, then fish" protocol, continues today, but now uses a quantitative acoustic methodology with a standard survey design (DFO 1997; Melvin and Power 1999; Melvin et al. 2004; Power and Melvin 2010) to provide an index of spawning biomass.

Several major improvements to our approach have been made in the areas of survey design and in the standardization of survey coverage to a point where they can be considered comparable from year to year (Melvin and Power 1999; Melvin et al. 2003, 2004; Power and Melvin 2010). The purpose of this document is to report and to summarize the NAFO divs. 4VWX stock assessment related survey data collected during the 2009 fishing and survey season.

## METHODS

Acoustic and mapping surveys using commercial fishing vessels have been employed to estimate the spawning stock biomass of individual components within the stock complex since 1999. The methods and procedures are well established and described in more detail in previous research documents (Melvin et al. 2004, Power and Melvin 2010).

Data from the 2009 fishing season were obtained during both standard fishing operations and regularly scheduled structured surveys. Structured surveys were either mapping and/or acoustic surveys (Melvin et al. 2001). In 2009, no major changes were made to the established protocol for either acoustic or mapping surveys.

The 22 surveys scheduled for 2009 were completed on or near the dates planned, and an additional 4 complete surveys were examined (Table 1). The additional surveys were completed in order to either increase coverage or to ensure that newly observed groups of fish were recorded, bringing the total number of structured surveys to 25. The total number of survey boat nights completed was 145, with 96 from vessels with acoustic recording systems and 49 from 'mapping' vessels without recording systems (Table 2).

In general, structured surveys were conducted in accordance with the protocol established in Melvin and Power (1999). When structured surveys were undertaken, participating vessels tended to follow standard protocol and there was usually good coverage of the defined spawning survey area.

A few exceptions to the normal protocols of survey design did take place and these are explained in more detail where they occur below.

**Data Quality Issues**

In the previous years the main areas of concern with the data included surveying protocols, provision and verification of the raw data and editing, and issues of noise and interference. Most of these issues have been resolved, but some, like not following survey protocols (i.e. doing a series of loops instead of parallel lines) when documenting fish aggregations on non-survey nights, continue to be a problem.

There is a well defined survey protocol for structured surveys and fishing night school documentation, but it was not always followed and remains an issue. In cases of fishing night surveys by purse seine vessels, there was very poor adherence to survey design with vessel captains rarely establishing a series of parallel transects to document the fish. Rather, the data provided was usually one of an unorganized search pattern common in fishing operations and was very difficult or impossible to analyze. It is important to follow the protocol (a series of stepped parallel lines) for surveying an aggregation or school of fish. Data collections inconsistent with established protocols were again given a low priority for analysis or were not processed.

A major portion of time is required to download, backup and edit the raw acoustic survey data files. In past years, Department of Fisheries and Oceans (DFO) staff completed this task and received all ‘original’ raw data files (unedited). More recently, these tasks have been split between the Herring Science Council (HSC) and DFO with the complete raw data received only at the end of the season. In the 2007 review, it was recommended that all raw data files be made available on a regular basis for review prior to finalizing the acoustic biomass estimates (Power and Melvin 2008). In the current year as well as in 2008, all raw data files were received and the data compared with the edited results before the final analysis was completed. The main reason for these comparisons is to check for target uncertainty, to distinguish fish from bottom and to examine interference/noise patterns. As a result of these examinations, some data problems were found and resolved by re-editing the data for some vessels and for specific surveys. In a few cases, the bottom was not completely removed or some non-herring species were apparent.

In previous years, vessel noise/interference was apparent for some of the raw data files examined. The solution for future analysis is to have raw data files made available and examined at regular intervals, and at the first sign of problem the source will be determined and corrected, if possible. In addition, the operational vessel speed should be determined for each vessel and surveying speed limited to this. In 2009, noise tests were again completed for each vessel as part of the calibration process, and recommended speed or vessel RPM levels were established. As a result of these efforts, the resulting raw data collected was found to have less background noise and was useable from all survey vessels.

### Length/Weight Relationship

Prior to 2001, the fish weight variable in the target strength (TS) equation (Table 3) was estimated using a length/weight relationship developed using combined average monthly data for each area. A correction factor of 1.02 was also applied to each length measurement to account for the shrinkage of fish due to freezing, prior to calculating the length/weight relationship (Hunt et al. 1986). This relationship was then used to estimate the weight of a fish for a given length. The time window used to select data appropriate for individual surveys has been narrowed slightly since 2001, to provide a more representative estimate of mean fish weight. Recent initiatives and continued collaboration with the processing plants have greatly improved sampling, such that it is now possible to obtain a significant number of detailed samples (length/weight data) within a 9-day window (4 days prior to or after each of the surveys). These data are used to develop a weight/length relationship specific to each acoustic survey (Table 3). The mean length of herring sampled during the night of the survey (or from landings of the previous night) and the calculated mean weight is then used to estimate target strength (TS) specific to each survey period. When samples were not available, target strength was estimated using values for an 'average spawning fish' at 28cm in length with adjustment for sounder frequency as required.

### Integration Calibration Factor

In 2003, an option to account for the non-square waveform observed in a ball calibration was incorporated into the HDPS software (Melvin, et al. 2004). This approach is used by several acoustic manufacturers when calibrating their echo sounders. The effect of including an integration calibration factor to estimate backscatter in the integration process varies depending on the vessel's acoustic hardware. The multiplier for the factor, which is applied to the standard calibration, typically lies between 0.4 and 1.6, with 1.0 equivalent to an ideal square wave and thus requires no adjustment.

Given that the inclusion of the integration calibration factor (ICF or CIF) is deemed to provide a more accurate estimate of biomass, it was recommended that all future analyses utilize the CIF to calculate absolute biomass (Melvin et al. 2004). However, when comparing observations from year to year, it was recommended that the comparisons be made between biomass estimates that exclude the adjustment, until a time series has been established with the CIF included. After several years, only the biomass estimate with the CIF will be needed.

Recalculation of the estimates for the earlier years from 1999 to 2002 using the CIF has been partially completed for 2001 and 2002 and these results were presented by S. Osborne at the 2008 RAP meeting. Further analysis for the 1999 and 2000 data is ongoing at which point all future analysis will be processed and reported with the use of the CIF exclusively.

The following analysis presents results using both methods of calculation (with and without the CIF). Until the revision including the CIF for all years is completed comparisons between years are made only with data calculated without the CIF. Unless otherwise noted, only biomass estimates without the CIF will be referred to when summarizing the data results.

### Acoustic Systems

In 2009, as in previous years, acoustic data were collected using automated logging systems aboard commercial fishing vessels during both standard fishing excursions and structured surveys. The systems, which were activated whenever the captain wished to document

observations, automatically saved all data to the system's hard drive. The data were downloaded at regular intervals prior to archiving, data editing and summary analysis.

A total of 18 automated acoustic logging systems (FEMTO model DE9320 or SIMRAD MODEL ES-60) were deployed on commercial fishing vessels in 2009. Systems from FEMTO Electronics were installed and calibrated aboard nine purse seine vessels, *Brunswick Provider, Canada 100, Dual Venture, Island Pride, Lady Janice, Lady Melissa, Lady Noreen, Secord,* and *Silver Harvester*. There were also three SIMRAD ES-60 acoustic systems calibrated and used on the purse seine vessels *Margaret Elizabeth, Morning Star* and the *Leroy & Barry*. There were six FEMTO systems on the inshore herring gillnet vessels *Bradley K, Knot Paid For, Miss Owls Head, Natasha Lee, Sea Quiz, SKJ* and the *Wet & Wild*.

**Structured Surveys**

Structured surveys are defined as those surveys that follow the standard protocol described by Melvin and Power (1999). Under this protocol, commercial vessels follow a series of randomly selected transects within a pre-defined area. The number of transects depends upon the number of vessels involved. Acoustic recording vessels are distributed throughout the survey area to provide representative coverage. The surveys conducted periodically throughout the spawning season are generally scheduled at 2-week intervals. These surveys play an important role in the understanding and perception of the 4WX herring stock. Sufficient flexibility is built into the process to allow for schedule changes and for investigation of areas of interest or uncertainty. Structured surveys were conducted on each of the major, and several of the minor, spawning grounds within 4WX, and additional recordings were made of both spawning and non-spawning aggregations during fishing night operations.

**Fishing Excursions**

Fishing nights are defined as those occasions when acoustic data are collected by fishing vessels equipped with automated acoustic logging systems during the search phase of a fishing excursion. These data, which often do not follow any formal survey design, provide information on the distribution and abundance of herring during non-survey nights. The data have also been used in the past to document large spawning aggregations not included in a survey and/or as a substitute for a survey, in the event that no other information is available. The approach to the activation of the systems has changed since the start of the program. During the early stages, fishing captains would turn their system on when they reached the fishing ground and off once they deployed their fishing gear. For the last few years, the majority of vessels have activated their systems only when they believed there was something worth recording. This has greatly reduced the amount of time required for archiving, editing and analyzing.

Analyses of acoustic data from non-survey nights were possible in previous years due to the provision of technical support from the Herring Science Council since 2002. Due to reductions in recent years, data from fishing nights were examined only where sufficient aggregations were surveyed and where established survey protocols were followed. Any fishing night estimate found to be higher than the nearest survey estimate for that spawning area and time period can be considered for the overall area estimates. In 2009 some fishing nights were examined but none were considered useful in the final analysis for the overall surveys.

## RESULTS

The spawning biomass for individual components of the 4WX herring stock complex in 2009 was estimated from industry collected data using multiple structured acoustic and mapping surveys on major spawning grounds (Figure 1). These surveys, when summed, provide an index of SSB and form the main foundation for evaluation of the stock status. The following text provides a summary of the 2009 observations and SSB estimates for each of the main spawning components within the stock complex.

### Bay of Fundy/SWNS Spawning Component

Biological Sampling for Maturity

The timing of surveys in relation to the residence time of spawning groups on the spawning grounds continues to be an issue of major concern. The current hypothesis for surveys on individual spawning grounds assumes that there is constant spawning on each ground over the season with individual spawning groups or waves continuously arriving, spawning and then leaving within 10 to 12 days (or less).

Sampling data for maturity supports the view of continuous spawning or waves with high proportions of ripe and running (Stage 6) fish observed over an extended period. The 10 to 12 day window between surveys also assumes that there will be no double counting and that the maturing (hard/Stage 5), as well as the spawning (Stage 6) fish in the samples will also have spawned and left before the next survey.

In previous years herring maturity data were obtained from 2 primary sources: “Herring Roe Analysis Sheet” data from the Scotia Garden Seafood processing plant quality control group and samples from the standard biological sampling program conducted by staff at the St. Andrews Biological Station (SABS). The “Roe Analysis Sheets” from Industry were supplied as available, usually on a daily basis during the spawning period and often with multiple samples from different boats. These are random samples of 50 to 100 fish with the males and females separated, and the individual gonads weighed into categories for use by the processing plant. From these data, the overall percent weights of mature, immature and spent females, as well as percent weight of the male gonads were determined. In 2009 there was no data provided in a timely manner by industry sources and so no analysis was completed.

The SABS biological samples provide data on individual fish for length, weight, sex, maturity stage, gonad weight and age. These samples are collected from various sources including research surveys, tagging trips and acoustic surveys, and from landings at various plants. For comparison with the industry categorization, a modification to the SABS lab procedure to weigh all gonad stages was implemented in 2003. SABS samples were combined for female fish by day and percent numbers and percent weight by the categories determined. The plant classification system of maturity must not be confused with the standardized ICES (International Council for the Exploration of the Sea) scientific scale of 1 to 8 (Parrish and Saville 1965), but the industry roe data can be compared with SABS data based on knowledge of the 2 methods. Analysis of the roe maturities was completed for the data available on an individual survey basis and is presented with the details for each survey area.

Spawning Ground Turnover Rates

The current acoustic survey method on spawning grounds is dependent on the assumption of periodic turnover of spawning fish on the spawning grounds. Acoustic surveys are required to

be separated by at least 10 to 14 days to allow for turnover and to prevent double counting (Power et al. 2002). This aspect of the assessment method was the subject of investigation in 2001 and of intensive sampling for maturity stage since that fishing season. The results and application to the acoustic surveys are summarized by Melvin et al. (2002b, 2003, 2004) Power et al. (2005, 2006, 2007, 2008) and by Power and Melvin (2010) and were used to assist in the evaluation of turnover timing and the inclusion or exclusion of specific acoustic surveys.

From 1998 to 2002, the Pelagics Research Council/Herring Science Council, in partnership with DFO, tagged herring on spawning grounds and on the major Nova Scotia over-wintering grounds. The information on tags returned from this study has been summarized by Waters and Clark (2005). Evidence from tagging experiments conducted in 1998 of ripe and running (spawning) herring showed that the residence time for most returns on the same grounds was less than 7-10 days; however, 25% of returns were captured on the same grounds after more than 10 days at large (Paul 1999). In contrast, a similar experiment in September 2001 on German Bank showed no recaptures after 9 days on the same grounds during the same spawning season (Power et al. 2002). This latter result was complicated by a large decrease in fishing effort (and thus returns) during the second week after tagging.

In response to a recommendation from the 2005 Regional Advisory Process (RAP), tags were applied to herring on the spawning grounds of Scots Bay and German Bank (Clark 2007). The results from the tag returns indicated that some tagged herring remained on the spawning grounds for at least 3 weeks after tagging and, in some cases, up to 5 to 6 weeks after tagging. Thus, acoustic surveys that were spaced at 2-week intervals were surveying some of the same fish twice or possibly even 3 times.

These results may have serious implications in how the acoustic surveys are evaluated and used to determine stock status. Some preliminary analysis has been completed comparing 3 different approaches for the interpretation of the acoustic biomass estimates in an absolute sense (Power et al. 2006). The results showed that caution is warranted when employing the cumulative biomass estimates as absolute in any of the survey areas. The results also indicated that some proportion of herring remain in the survey area even 3 weeks or longer. However, these adjustments do not change the overall trends over time but rather apply a scaling to the absolute amounts.

A framework assessment meeting in January 2007 determined that double counting does occur, but the extent has not been well determined (DFO 2007). However, it was still recommended to continue to do surveys at 10-14 day intervals to avoid double sampling. The timing/turnover issue was considered to be of highest importance for further study, which should include work on the duration of the maturation process, further tagging with more frequent intervals to estimate turnover rates and increased survey frequency to reflect maturity stage duration.

A new tagging experiment to investigate turnover was implemented in 2009 with daily tagging on German Bank from Aug. 18$^{th}$ to Sept. 30$^{th}$ with over 10,000 tags applied (Maxner et al. 2010). The results from this study found that although the majority of the tags were returned by the first three weeks after tagging, some remained on the spawning grounds for up to five weeks. This study is ongoing with tagging again planned for the German Bank area during the spawning period in 2010 and 2011.

## Acoustic Surveys

*Scots Bay*

The Scots Bay herring purse seine fishery has been an important component of the summer fishery with catches since 1987, ranging from 1,000 to 24,400t during the period of early July to late August-early September (Power et al 2010a, 2010b). The 2009 Scots Bay fishery was again restricted with a 5,000t cap due to the poor performance of the spawning component since 2005. Landings in 2009 were substantially reduced from 2008 with only 900t caught from July 12th to Aug. 11th (Power et al 2010b). Sampling was adequate with samples from most landings allowing detailed description of the size and maturity of fish captured (Figures 2, 3). Samples for gonad maturity showed mostly ripe and running (spawning) as well some maturing (Stage 5) stages (Figure 3). Some immature juvenile fish were also picked up from research bottom trawl samples collected in the area.

Five structured surveys were conducted during the 2009 spawning season in Scots Bay which is more than in previous years (Table 2). The surveys, which began about two weeks earlier than the surveys conducted in 2008, were separated by a minimum of 13 days and provided good coverage of the survey area.

*Scots Bay Acoustic Survey #1: June 27, 2009*

The first survey was conducted by three acoustic survey vessels with each vessel completing two lines for a total of 6 generally equally spaced lines (Appendix A1). There was some deviation from the lines to document off-track aggregations and vessels did not always return to the line point of departure (Figure 4). There were no samples available to document the size or maturity of fish and so standard target strength (TS) values were used.

Transects were divided into areas within the standard survey box (inbox) and outside the survey box (outbox) and estimates of the biomass were made (Appendix A1). The total surveyed biomass was 7,386t for the inbox area and 0t for the outbox area as calculated ‘without’ the Calibration Integration Factor (CIF) (Table 4). Estimates calculated ‘with’ the CIF are also provided in the tables for future reference but the final summary uses data without the CIF in order to provide a consistent time series.

The lack of sampling to confirm size and maturity and the fact that this survey was two weeks earlier than usual call into question the validity of using this result in the overall total.

*Scots Bay Acoustic Survey #2: July 11, 2009*

The second survey of the Scots Bay area in 2009 was conducted by six acoustic survey vessels with good coverage and 12 transects completed (Appendix A2). Transects/lines were generally spaced at 1 nautical miles (nm) intervals. There was some deviation from the lines to document off-track aggregations and vessels again did not always return to the line point of departure (Figure 5). One vessel used the wrong survey settings for the recording equipment (pulse duration was doubled from calibrated value) and an estimated correction factor of 3dB (50%) was used in the final analysis.

Sampling confirmed mature adult fish with a mixture of maturity stages with few in ripe and running condition (Figure 3). The size distribution from catches made following the survey had a mean length of 26cm with 10.9% smaller than 23cm which is the approximate size at 50% maturity (Figure 6). The biomass for this portion, less than 23cm, was calculated as 2,590t

(5% of the overall survey) but this amount was not discounted for the overall estimate. Length and weight data from both purse seine and bottom trawl sampled herring close to the survey time and location provided a good estimate of the length-weight relationship used to convert the total backscatter (Sa) from numbers to biomass (Figure 7).

Transects were divided into groups with 10 lines found within the standard survey box (inbox) and 2 lines outside the survey box (outbox) and estimates of the biomass were made using appropriate areas (Appendix A2). Using all the survey lines, the total surveyed biomass was 34,170t for the inbox area and 2,357t for the outbox area as calculated 'without' the Calibration Integration Factor (CIF) (Table 4).

*Scots Bay Acoustic Survey #3: July 25, 2009*

This survey was conducted by six acoustic survey vessels providing excellent survey coverage with 12 transects completed (Appendix A3). The lines were generally spaced at 1 nm intervals and there was little deviation from the lines to document off-track aggregations (Figure 8). One vessel again used the wrong survey settings for the recording equipment (pulse duration) and an estimated correction factor of 3dB (50%) was used in the analysis.

Sampling confirmed mature adult fish with a mixture of maturity stages with 50% in ripe and running condition (Figure 3). The size distribution from catches made following the survey had a mean length of 26.1cm with only 3.9% smaller than 23cm (Figure 9).

Transects were divided into groups with 8 lines within the standard survey box (inbox) and 4 lines outside the survey box (outbox) and estimates of the biomass were made using appropriate areas (Appendix A3). Using all the survey lines, the total surveyed biomass was 15,087t for the inbox area and 1,356t for the outbox area as calculated 'without' the Calibration Integration Factor (CIF) (Table 4).

*Scots Bay Acoustic Survey #4: August 8, 2009*

This survey was conducted by six acoustic survey vessels providing excellent survey coverage with 12 transects completed (Appendix A4). The lines were generally spaced at 1 nm intervals. There was significant deviation from the lines to document off-track aggregations and in some but not all cases, the vessels returned to their lines at the point of departure (Figure 10). One vessel again used the wrong survey settings for the recording equipment (pulse duration) and an estimated correction factor of 3dB (50%) was used in the analysis.

Sampling confirmed mature adult fish with a mixture of maturity stages with 67% in hard condition (Figure 3). The size distribution from catches made following the survey had a mean length of 26cm with only 0.3% smaller than 23cm (Figure 11).

Transects were divided into groups with 8 lines within the standard survey box (inbox) and 4 lines outside the survey box (outbox) and estimates of the biomass were made using appropriate areas (Appendix A4). Using all the survey lines, the total surveyed biomass was 10,797t for the inbox area and 1,342t for the outbox area as calculated 'without' the Calibration Integration Factor (CIF) (Table 4).

*Scots Bay Acoustic Survey #5: August 21, 2009*

The fifth and final survey for the 2009 season was conducted by five acoustic survey vessels providing good survey coverage with 10 transects completed (Appendix A5). There was

significant deviation from the lines to document off-track aggregations. In some but not all cases, the vessels returned to their lines at the point of departure (Figure 12). Very few spawning fish were seen although there was a substantial amount of small fish throughout the water column over much of the survey area. These small fish were removed from the transect files but were retained in the original edited files. There was no sampling to confirm the size or maturity of the fish recorded and so standard target strength (TS) values were used.

The transects were divided into groups with 8 lines within the standard survey box (inbox) and 2 lines outside the survey box (outbox) and estimates of the biomass were made using appropriate areas (Appendix A5). One line was also used to provide an estimate of a larger school encountered during the survey (Figure 13). The school alone provided a larger estimate of biomass than the survey lines and thus was substituted for the inbox biomass. Using all the survey lines the total surveyed biomass was only 203t (using the school as a substitute) for the inbox area and 40t for the outbox area as calculated 'without' the Calibration Integration Factor (CIF) (Table 4).

*Scots Bay Summary:*

In summary, the 2009 Scots Bay acoustic survey SSB estimate from the 5 structured surveys for the within survey box area (inbox) was 67,643t as calculated without the CIF and 81,645t with the CIF (Table 4). For 2009, the total biomass estimate for areas surveyed outside of the standard survey box in the Scots Bay area was 5,275t without the CIF and 6,112t with the CIF (Table 8). The lack of biological sampling and early timing of the first survey on June 27$^{th}$ call into question it's validity in the overall estimate but it remains included in the overall total for the area in 2009.

*German Bank*

The German Bank herring purse seine fishery has been a major component of the summer fishery with catches since 1985, ranging from 9,000 to 36,000t during the overall fishery period of early May to late October (Power et al., 2010b). Catches during the spawning period in 2008 were distributed quite differently from those of 2007 with only a single central area of spawning catch concentration in the upper middle part of the area (Power et al., 2010a). In 2009 catches of spawning herring were more widespread with localized groups seen in both the northern and southern portions of the standard survey area on German Bank (Power et al., 2010b).

Seven acoustic surveys were conducted on German Bank during the 2009 season between Aug. 12$^{th}$ and Oct. 20$^{th}$ covering the entire spawning period (Table 2). The 2009 surveys began about 10 days earlier than usual, so as not to miss spawning events, but also ended later than usual after the quota had been reached, with the final survey on Oct. 20$^{th}$. The data for the final survey was not available for the initial assessment review when this paper was first presented but those survey details are included in this report for completeness of all surveys.

The time interval between surveys ranged from 6 to 15 days, and a total of 51 vessel nights of surveying were completed for the German Bank area (Table 2). In addition to the acoustic recordings, visual observations from the sounder were recorded at 5 to 10 minute intervals on deck sheets for all vessels. Fish samples for maturity indicated that mature spawning herring (stages 5-6) dominated samples collected (Figure 14). Most samples close to surveys were dominated by ripe and running fish (Stage 6), except for the thirs survey on Sept. 8$^{th}$ which contained 41% hard mature (Stage 5) and 9% spent fish. As in previous years, length sampling was very extensive for this fishery with fish sampled from within the survey box found to be mostly larger than 23cm, which is the approximate size of 50% maturity for first spawning in this

stock (figures 15a, 15b). Pre-spawning herring of less than 23cm were infrequent in 2009 but were occasionally high indicating there was a mixture of juvenile and adult fish available on the grounds on some occasions.

*German Bank Acoustic Survey #1: August 12, 2009*

The first German Bank survey for 2009 was conducted by seven acoustic survey vessels with each vessel conducting two lines for a total of 14 transects completed, resulting in very good coverage of the survey area (Appendix A6) (Figure 16). The lines were generally spaced at 1km intervals. There was little deviation from the lines to document off-track aggregations but where there were deviations the vessels did not return to the track departure point to continue the line (Figure 16). There was 3km gap in survey line distribution as a result of an error in the survey plan used, but this did not affect the analysis as each transect is considered a random sample and the survey plan does not require even spacing of the survey lines.

Sampling confirmed mature adult fish with a mixture of maturity stages, including 95% in ripe and running (Stage 6) condition 2 days before the survey on Aug. 10$^{th}$ and only 50% in the same condition 3 days later (Figure 14). The size distribution from catches following the survey had a mean length of 27.3cm with 2.9% smaller than 23cm and 14% larger than 30cm (Figure 17).

All 14 transects were within the standard survey box (inbox) and estimates of the biomass were made using the appropriate overall area of 646km$^2$ (Appendix A6). Using all the survey lines, the total surveyed biomass was 69,431t for the inbox area as calculated 'without' the Calibration Integration Factor (CIF) (Table 5). This first survey for German Bank in 2009 was about 10 days earlier than usual, so as not to miss spawning events. It proved to be successful with spawning fish documented from both fishery sampling and the survey but should be carefully scrutinized when compared with other years which started later in the month of August.

*German Bank Acoustic Survey #2: August 25, 2009*

The second German Bank survey was conducted by nine acoustic survey vessels with each vessel conducting two lines for a total of 18 transects completed which resulted in superior coverage of the survey area (Appendix A7) (Figure 18). Two transects were outside of the survey box area and their data were analyzed separately for the 'outbox' area. The lines were generally spaced at 1km intervals. There was little deviation from the lines to document off-track aggregations but where there were deviations the vessels did not return to the track departure point to continue the line (Figure 18).

Sampling from the same day as the survey confirmed mature adult fish with 61% in ripe and running condition and 39% in pre-spawning (hard) condition (Figure 14). The size distribution from catches on the day of the survey had a mean length of 27.1cm with no fish smaller than 23cm and 11% larger than 30cm (Figure 19).

Transects were divided into groups with 16 lines within the standard survey box (inbox) and 2 lines outside the survey box (outbox) and estimates of the biomass were made using appropriate areas (Appendix A7). Using all the survey lines, the total survey biomass was 86,614t for the inbox area and 1,375t for the outbox area as calculated 'without' the Calibration Integration Factor (CIF) (Table 5).

*German Bank Acoustic Survey #3: September 8, 2009*

The third German Bank survey for 2009 was conducted by eight acoustic survey vessels with each vessel conducting two lines for a total of 16 transects completed which resulted in excellent coverage of the survey area (Appendix A8) (Figure 20). The lines were generally spaced at 1km intervals. There was only one deviation from the lines to document off-track aggregations and the vessel did not return to the track departure point to continue the line (Figure 20).

Sampling on the day of the survey confirmed mature adult fish with a mixture of maturity stages, including 41% in pre-spawning (hard) condition, 50% in ripe and running and 9% spent (Figure 14). The size distribution from catches on the same day had a mean length of 28.1cm with 0.4% smaller than 23cm and 21% larger than 30cm (Figure 21).

All 16 transects were within the standard survey box (inbox) and estimates of the biomass were made using the appropriate area of 646km$^2$ (Appendix A8). Using all the survey lines the total surveyed biomass was 29,941t for the inbox area as calculated 'without' the Calibration Integration Factor (CIF) (Table 5).

*German Bank Acoustic Survey #4: September 14, 2009*

This survey was conducted by seven acoustic survey vessels with a total of 8 transects completed which resulted in good coverage of the survey area (Appendix A9) (Figure 22). This survey was conducted only 6 days after the previous survey due to indications from the fishing fleet that the herring were more abundant than was seen on Sept. 8$^{th}$. The established survey design allows for surveys closer than 10 days apart which can then replace an existing survey but results in a new 10 day timing window beginning with the replacement survey.

Sampling on the days before and after the survey confirmed mature adult fish with 79-93% in ripe and running condition (Figure 14). The size distribution from catches on the day of the survey had a mean length of 26.5cm with 1% smaller than 23cm and 10% larger than 30cm (Figure 23).

The lines were generally spaced at 2 km intervals with one deviation from the lines to document an off-track aggregation. All 8 transects were within the standard survey box (inbox) and estimates of the biomass were made using the appropriate area of 646km$^2$ (Appendix A9).

Using all the survey lines the total surveyed biomass was 54,192t for the inbox area as calculated 'without' the Calibration Integration Factor (CIF) (Table 5). This estimate was substantially larger than the Sept.8$^{th}$ survey estimate and will replace it in the overall total. The time window to the next survey was now altered to re-start on Sept. 14$^{th}$.

*German Bank Acoustic Survey #5: September 24, 2009*

This survey was conducted by 8 acoustic survey vessels with a total of 10 transects completed which resulted in good coverage of the survey area (Appendix A10) (Figure 24). The lines were generally spaced at about 1.5km intervals with one deviation from the lines to document an off-track aggregation for which the vessel did return to the line at the point of departure. The Island Pride (IP) joined the survey about 3 hours after the survey start and ran a duplicate line very close to the *Leroy & Barry* line. These lines coincidentally saw far more fish than any of the other vessels in the survey. The results from the two lines were also virtually identical adding confidence to the results but having identical transects required removing one to prevent bias to

the final results. In this case, the IP line was removed because it was lacking its own navigation in the data file, with navigation substituted from deck sheets.

Sampling two days before the survey confirmed mature adult fish with 71% hard and 29% in ripe and running condition (Figure 14). The size distribution from catches on the day of the survey had a mean length of 26.3cm with 4% smaller than 23cm and 8% larger than 30cm (Figure 25). All 10 transects were within the standard survey box (inbox) and estimates of the biomass were made using only 9 transects (IP line excluded) with the appropriate area of 646km$^2$ (Appendix A10). Using 9 of the 10 available survey lines the total surveyed biomass was 39,828t for the inbox area as calculated 'without' the Calibration Integration Factor (CIF) (Table 5).

*German Bank Acoustic Survey #6: October 5, 2009*

This survey was conducted by 7 acoustic survey vessels with a total of 9 transects completed which resulted in good coverage of the survey area (Appendix A11) (Figure 26). Fish were recorded on only 2 of the 9 lines with the 2 areas of fish schools also estimated separately (Appendix A12). The lines were generally spaced at 1.5 km intervals with one deviation from the lines to document an off-track aggregation for which the vessel actually returned to the line at the exact point of departure (Figure 28).

Sampling 4 days before the survey on Oct. 1$^{st}$ confirmed mature adult fish with 11% hard and 87% in ripe and running condition (Figure 14). The size distribution from catches on the day of the survey had a mean length of 25.7cm with 10% smaller than 23cm and 4% larger than 30cm (Figure 27).

All 9 transects were within the standard survey box (inbox) and estimates of the biomass were made using all transects within the appropriate area of 646km$^2$ (Appendix A11). Using the 9 available survey lines, the total surveyed biomass was 58,648t for the inbox area as calculated 'without' the Calibration Integration Factor (CIF) (Table 5) (Appendix A11). A separate combined estimate for the 2 schools of fish gave a biomass of 54,553t (Figure 28) (Appendix A12). This provides additional confidence in the overall survey design with the estimate using random transects being within 7% of the schools only estimate.

*German Bank Acoustic Survey #7: Oct. 20, 2009*

The final survey on German Bank in 2009 was conducted on Oct. 20$^{th}$, 15 days after the previous survey. Five acoustic survey vessels participated with a total of 7 parallel transects completed, resulting in good coverage of the area (Appendix A13) (Figure 29). The lines were generally spaced at about 2km intervals with no deviation from the lines to document off-track aggregations.

There was no sampling to confirm the size or maturity of the fish recorded and so standard target strength (TS) values were used in the analysis. The lack of samples from the survey and the lack of any fishing in the area since Oct.7$^{th}$ is a serious deficiency in the use of this data as the size and condition of the fish surveyed is unknown.

All 7 transects were within the standard survey box (inbox) and estimates of the biomass were made with all transects within the appropriate area of 646km$^2$ (Appendix A10). Using all of the available survey lines the total surveyed biomass was 12,304t for the inbox area as calculated 'without' the Calibration Integration Factor (CIF) (Table 5).

The data for this final survey was not available for the initial assessment review when this paper was first presented during the RAP review; however, these survey details are included in this report for completeness of all surveys. The data from Oct. 20th is also not included in the overall biomass total for the German Bank area for 2009 because of the lack of sampling to confirm size or maturity of the fish encountered during the survey.

*German Bank Summary:*

In the previous year, 2008, the overall German Bank spawning stock biomass (without the integration factor) was estimated to be 201,700t from 4 structured surveys covering a period extending from Aug. 22nd to Oct. 6th. In 2009, the overall German Bank biomass was estimated to be 308,713t using 5 of 7 structured surveys covering a period extending from Aug. 12th to Oct. 20th (Sept. 8th survey replaced with that of Sept. 14th and the Oct. 20th survey was not included in the total).

Another issue which needs consideration is the overall timing of the earliest survey on Aug. 12th which was about 10 days earlier than the first survey in previous years. It is considered a valid survey of spawning fish but may not be strictly comparable to other years with a different range of start-end dates. The timing of surveys and how they are used for inter-year comparisons is also discussed further by Maxner et al. (2010) and will be considered when using the survey series as a whole.

As recommended at the RAP herring Framework meeting (January 2007), the use of a standard survey area was applied. This SSB estimate reflects only biomass estimated from within the survey box and may be used in inter-year comparisons for trends. The elapsed time between all surveys was greater than or within the 10-14 day guideline, and in this analysis, the turnover of spawning fish was assumed to be 100%. No adjustments were made to account for possible double counting of fish documented by previously conducted surveys.

*Spectacle Buoy*

The spring gillnet fishery for roe has occurred in recent years for a short period in June in the vicinity of Spectacle Buoy located just southwest of Yarmouth, Nova Scotia. The fishery is dependent upon the availability of fish and to some extent market conditions, and may or may not occur in any given year. In 2008, there was virtually no fishery with only one landing of 6t. Two acoustic surveys were undertaken in 2008 but very little fish was recorded. In previous years herring in this area were believed to have occurred in greater abundance in late May early June, and it is assumed the surveys had missed the majority of fish but there were no other signs or reports of herring in 2008.

In 2009 there was little fishing (less than 1t) and no survey activity in this area.

*Trinity Ledge*

In previous years, the surveying of spawning herring on Trinity Ledge has been considered to be less than optimal, and it is unlikely that biomass estimates accurately reflect the abundance of fish in this area (Power et al. 2007a). Improvements to the survey approach and adherence to the design protocols are required if the data are to reflect trends in abundance.

In 2008, three acoustic surveys were undertaken near the Trinity Ledge area on Aug. 2th, Sept. 22nd and Sept. 24th. For each acoustic survey the single recording vessel documented small areas of herring near the Ledge with biomass estimates of less than 500t. Summing the

survey biomass estimates for the two surveys which were separated by at least 10 days resulted in an overall total of only 270t (calculated without the CIF) or 520t with the CIF for the 2008 season. The 2008 total biomass of 270t was the lowest recorded since acoustic surveying began in 1998 (Table 6, Figure 30).

Catches were again very limited in 2009 with only 117t recorded between Sept. 1st to Sept. 11th (Table 6, Figure 30). In 2009, two surveys were conducted on Trinity Ledge on Aug. 25th and Sept. 8th with small areas or separate schools of fish documented in each case (Figure 31).

For the survey on Aug. 25th a single vessel conducted fine scale systematic parallel transect surveys. The lines were not predefined by a survey design but rather were conceived based on the best coverage of the two available aggregations (northern and southern). There were no samples for length frequency or biological sample for TS determination, thus standard values TS values were used with adjustment for sounder frequency. Using the 2 available schools sum the total surveyed biomass for the Aug. 25th survey was 313t as calculated 'without' the Calibration Integration Factor (CIF) (Table 7) (Appendix A14).

For the survey on Sept. 8th, the single vessel conducted fine scale systematic parallel transect surveys on the single available aggregation or school located. There again were no samples for length frequency or biological sample for TS determination, thus standard values TS values were used. Using the single available school, the total surveyed biomass for the Sept. 8th survey was 362t as calculated 'without' the Calibration Integration Factor (CIF) (Table 7) (Appendix A15).

The total overall survey biomass for Trinity Ledge in 2009 was 675t as calculated 'without' the Calibration Integration Factor (CIF) (Table 7). It is taken as the sum of the three schools surveyed in the two surveys which were separated by 13 days in time. The lack of biological sampling to confirm size and maturity as well as the very limited amount of surveying of the overall area continue to be a problem in assessing this group. Given the continued erosion of spawning biomass there still is cause for concern with this spawning group. Until biomass levels improve, very limited or no fishing should take place on the Trinity Ledge spawning ground. Surveys need to be continued to monitor the status of this spawning area which once supported a major portion of the overall stock catch.

*Browns Bank*

There was no survey activity on Browns Bank in 2008 or in 2009.

*Seal Island*

Historically, the spawning areas around Seal Island made a significant contribution to the biomass of the Bay of Fundy/SWNS stock complex. In recent years, the abundance of herring and the documentation of spawning fish in this area have been intermittent. In addition, little fishing has occurred in these shallow grounds, partly as a result of the deep purse seines that are now being employed, which are unsuitable for fishing these areas. There was no survey activity in the vicinity of Seal Island in 2008 or 2009.

## Bay of Fundy/SWNS Summary

The 2009 acoustic results are considered to provide a reasonable estimate of herring present at the time of surveying when conducted according to the survey design. A major source of uncertainty continues to be the assumption that the surveys are simply additive. If herring do not move on and off the spawning grounds in waves with a short period of time (days) between the waves, the estimate of total SSB will be significantly biased upward due to double counting. The issue of turn-over time and potential overlap (repeat counting) was evaluated at the RAP Framework review meetings in 2006/2007 (DFO 2007) and the 10-14 day time period between surveys was considered reasonable, but required further investigations. The latest investigation into turnover using tagging studies is presented by Maxner et al. (2010) summarizes the 2009 German Bank tagging experiment results.

Since 1997, biomass estimates determined from acoustic surveys have been used to evaluate the status of the Bay of Fundy/SWNS component of the 4WX herring stock complex. During this time, the approach for estimating SSB has evolved from a heavy reliance on distribution and abundance estimates from fishing excursions with a 10 day minimum elapsed time, to structured surveys scheduled at 2-week intervals. In 1999, spawning areas were defined and survey protocols were established to make the estimates more representative of the actual SSB rather than a minimum observed value. This was accomplished by undertaking a series of surveys that covered most of the spawning area on each of the spawning grounds during the defined spawning season.

In the absence of survey data, fishing excursion data may be substituted as appropriate. Regular monitoring of herring gonad development throughout the season, from both industry and DFO sampling, provided evidence that the fish surveyed were mature spawners, and that a turnover of spawning fish had occurred between each survey. The total observed biomass for the complex was obtained by summing the SSB estimate for each spawning ground. Given the changes in survey area that have occurred over time the estimated SSB for 1998 and 1999 should not be compared with those reported since then.

The estimation of biomass from acoustic backscatter relies on the relationship of TS to length measured under a variety of conditions (Foote 1987). The size and weight of herring from appropriate sample data have been applied, but there can still be considerable variance. Studies in controlled conditions in herring weirs (Melvin et al. 2000, 2001) resulted in absolute differences of 7 to 12% between the acoustic estimate and the biomass removed from the weir by seining. Work is ongoing in developing new TS relationships from ‘in situ’ studies of spawning fish on the spawning grounds and will be reported when completed (Melvin pers. comm.)

The spawning stock biomass for the Bay of Fundy/SWNS component of the 4WX herring stock complex in 2009 was determined from industry based acoustic surveys of the 3 major spawning components: Scots Bay, Trinity Ledge and German Bank. No structured surveys were conducted outside the main spawning areas, around Seal Island or in the vicinity of Browns Bank. Acoustic data from fishing nights were not included in the biomass estimate for any of the spawning components. No fishing and survey activity took place in the Spectacle Buoy area during the spring spawning period.

Since 1997, biomass estimates from industry based surveys have played a significant role in the evaluation of the 4WX herring stock abundance. For 2009, the majority of acoustic surveys in the Bay of Fundy/SWNS areas were well organized and provided good coverage of the

spawning grounds. The elapsed time between all surveys was within the 10-14 day guideline and turnover of spawning herring was assumed to be 100% for this analysis. The survey vessels generally completed the assigned transects, and automated recording systems were distributed throughout the fleet on survey nights. The set of surveys for the overall areas is considered to be comparable to others in the series since 1999. Biomass estimates from 1997 and 1998 are not considered comparable due to variation in the coverage area.

The SSB for Scots Bay which had been as high as 163,900t in 2001 first showed a major decline in 2005, likely due in part to the excessive catches of 2004 and 2005 (Power et al. 2010b). Recently, Scots Bay has shown an improvement increasing from 16,800 in 2005 to 45,700t in 2007 but was still well below the 1999-2008 average of 80,420t (Table 8) (Figure 32). In 2008 there was a substantial decline with an area estimate of 19,400, the lowest in the time series except for 2005. In 2009, the surveyed biomass increased substantially to 67,600t but still remains 16% below the 1999-2008 average. For 2009 there is some question about the inclusion of the first survey of 7,400t on June 27$^{th}$. The lack of sampling to confirm size and maturity and the fact that this survey was two weeks earlier than usual call into question the validity of using this result in the overall total. However, the overall 2009 SSB for Scots Bay remains substantially higher than all years since 2004 whether this survey is included or not.

In 2005, the total spawning stock biomass observed on German Bank was one of the lowest recorded for this area at 211,000t. This represented a decrease of 150,000t from 2004, and was well below the average (Table 8) (Figure 32). The SSB in 2005 was based on estimates of biomass from only 3 structured surveys undertaken from Sept. 7$^{th}$ to Oct. 4$^{th}$. The 2006 surveys recorded a small increase while the 2007 biomass estimate for German Bank was 337,200t, a 36% increase, from 2006. The analysis for 2008 showed a substantial (40%) decrease in biomass (of 135,500t) to levels near the lowest observed for this area. In 2008, the overall spawning biomass for German Bank was 201,700t from 4 structured surveys from Aug. 22$^{nd}$ to Oct. 6$^{th}$ (Oct. 21$^{st}$ survey excluded) which was similar to the survey period in 2007.

In 2009, the overall German Bank biomass was estimated to be 308,713t from 5 structured surveys covering a period extending from Aug. 12$^{th}$ to Oct. 5$^{th}$ (Sept. 8$^{th}$ survey replaced with that of Sept. 14$^{th}$ and the Oct. 20$^{th}$ survey was excluded). The 2009 German Bank estimate of 308,700t represents an increase of 107,000t (or 53%) and is partially attributed to the strong incoming 2005 year-class at age 4.

For the Trinity Ledge and Spectacle Buoy areas, even with restrictions on catches, there has been an observed decline and a small amount of biomass recorded with surveys. Coverage of Trinity Ledge in 2009 was limited with two surveys completed. The single recording vessel tended to concentrate on a relatively small area where the schools of fish were located, with little searching of the entire spawning strata area of 100km$^2$. Trinity Ledge once supported a large spawning component and fishery within the 4WX stock complex. As such, given the fact that the observed biomass is still reduced, any fishing on Trinity Ledge must strictly adhere to the “survey, assess, then fish” protocol during the upcoming spawning season. This means that no fishing should occur until sufficient quantities of herring are observed to allow for removals. Alternatively, given the slow rate of recovery, consideration should also be given to complete closure until a significant increase in spawning biomass is observed.

In 2005, the total SSB for the Bay of Fundy/SWNS spawning complex was estimated to be 233,200t, the lowest level observed since acoustic surveys began in 1997 (Table 8) (Figure 33). Since 2005, the total SSB showed gradual increases with estimates of 282,600t in 2006 and 384,400t in 2007. However, in 2008 biomass estimates decreased for all survey areas in Scots

Bay, Trinity Ledge and German Bank to a new low of 221,400t. This represents a 42% decrease from 2007 and was the lowest recorded for the overall area since 1999.

In 2009 there were substantial increases in both Scots Bay and German Bank areas while Trinity Ledge remained at a low level. The overall spawning complex SSB for 2009 was 377,000t with an additional 6,700t surveyed outside of the standard survey areas. This amounts to a 155,600t (70%) increase in spawning biomass from the acoustic surveys. Despite this increase the 2009 estimate for the overall area remains below the long term average as it has since 2005. (Table 8, Figure 33).

**Coastal Nova Scotia Spawning Component**

The shallow inshore waters of the bays and inlets along the Atlantic coast of Nova Scotia support a number of herring spawning populations. Several documents describe reports of coastal spawning in 4VWX (Clark et al. 1999; Crawford 1979). Direct knowledge of these relatively small coastal populations is limited to a few areas where there are active commercial fisheries for roe on spawning grounds. A traditional fishery for lobster bait occurs in the spring and summer of the year. In the fall, commercial roe fisheries have been conducted in 3 areas of the Nova Scotia coastal stock component: Port Mouton/Little Hope, Halifax/Eastern Shore and Glace Bay. Surveys of the spawning grounds were undertaken using both the mapping and the structured acoustic survey approach, depending upon the area and the availability of a recording vessel.

The results for each spawning area presented below are calculated only 'with' the Calibration Integration Factor (CIF) which is considered to provide a more accurate representation of biomass. This method of calculation has been applied since 2003 and can now be used for the consistent calculation of 5 year averages which are used to establish beginning of year allocations for each area.

*Little Hope/Port Mouton*

The 2009 herring gillnet fishery in Little Hope/Port Mouton area began in early September and extended to October 26, 2009. The total catch was up substantially to 3,730t from 1,100t in 2008 with the majority of the catch occurring between Sept. 19th and Oct. 17th (Figure 34) (Power et al. 2010b). The catches occurred in 3 main areas off Port Mouton, near Liverpool and Port Medway (Figure 35). Overall, four acoustics surveys were conducted in the Little Hope/ Port Mouton area between Sept. 14th and Oct. 11th. All data were downloaded from the two boats with an acoustic recorder and, after editing to remove the bottom and non-herring targets, the acoustic files were cut into transects for each survey.

Given that the multi-panel gillnet was again not used to sample the acoustic targets in 2009, the standard TS of -35.96 for a 120 kHz system was used for all surveys in 2009 to estimate biomass from the backscatter. Length frequency and biological sample from the commercial catch were only used to confirm the size and maturity of herring in the area (figures 36, 37). The lack of good sampling for acoustic surveys in this area remains a problem that needs to be addressed. The use of standard TS likely underestimates the average size of herring surveyed with acoustics and may also underestimate the overall biomass.

*Little Hope Acoustic Survey #1 - September 14, 2009.*

The first survey in 2009 for the Little Hope spawning area was conducted by a single acoustic survey vessel as well as 9 vessels doing a mapping survey (figures 38, 39). The mapping

survey vessels used paper data sheets to record observations from their sounders. They covered more of the area than was covered by the acoustic survey vessel but did not find any additional aggregations (Figure 38). The single acoustic vessel conducted four separate fine scale systematic parallel transect surveys in 3 distinct areas (Figure 39). The lines were not predefined by a survey design but rather were conceived based on the best coverage of the aggregations using parallel lines closely spaced together.

No samples were collected for length frequency or maturity to confirm spawning condition and so biomass estimates are based on standard target strength for a 28cm fish. The size and maturity of herring from the commercial roe fishery in the area later confirmed the presence of spawning fish in the area. The total biomass from the four schools surveyed was estimated to be 13,021t as calculated 'with' the Calibration Integration Factor (CIF) (Table 9, Appendix A16).

*Little Hope Acoustic Survey #2 - September 26, 2009.*

The second herring acoustic survey in 2009 for the Little Hope spawning area was again conducted by a single acoustic survey vessel. The acoustic vessel conducted three separate fine scale systematic parallel transect surveys in 3 distinct areas (Figure 40). The fish were quite tight to bottom so results may vary among persons performing the data editing. The vessel saw significant aggregations of fish and had good overall coverage.

One transect (F209857) indicated a quite dense aggregation about 10 meters thick with the densest portion tight on bottom. This file was re-edited slightly and saved as a new file (F209957) producing a revised overall result which was only about 200t less than that initially produced. Because of incomplete and broken lines, the survey results could be drawn into question due to possible bias but, for this report, no such bias is assumed. Future surveys must be conducted with approximately equal length parallel lines starting from one end of the school and working to the other end of the school.

There was also a mapping survey by 10 gillnet vessels using paper data sheets to record observations from their sounders. They covered more of the area than was covered by the acoustic survey vessel but did not find any additional aggregations (Figure 41).

No samples were collected for length frequency or maturity to confirm spawning condition and so biomass estimates are based on standard target strength for a 28cm fish. The size and maturity of herring from the commercial roe fishery in the area later confirmed the presence of spawning fish (figure 37s, 38). The total biomass from the three schools surveyed was estimated to be 18,364t as calculated 'with' the Calibration Integration Factor (CIF) (Table 9, Appendix A17).

*Little Hope Acoustic Survey #3 – October 8, 2009.*

The third acoustic survey in 2009 for the Little Hope spawning area was conducted by two acoustic survey vessels. The vessels conducted four separate fine scale systematic parallel transect surveys with one boat working 1 large school in the east and the other doing 3 smaller schools to the west (Figure 42). The lines were not predefined by a survey design but rather were conceived based on the best coverage of the aggregations. The fish were also quite dispersed throughout the survey period. The speed of the vessels was good yielding a clear echogram but the electrical system of one vessel (SKJ) was injecting noise into the echogram which should be addressed.

No samples were collected for length frequency or maturity to confirm spawning condition and so biomass estimates are based on standard target strength for a 28cm fish. The size and maturity of herring from the commercial roe fishery in the area later confirmed the presence of spawning fish (Figure 36, 37).

The total biomass from the four schools surveyed was estimated to be 4,967t as calculated 'with' the Calibration Integration Factor (CIF) (Table 9, Appendix A18).

*Little Hope Acoustic Survey #4 - October 11, 2009.*

The fourth and final acoustic survey for the Little Hope spawning area was conducted by a single acoustic survey vessel. This survey was also part of a broad scale paper survey with 16 non-recording boats (Figure 43). The mapping survey used paper data sheets as usual to record observations from the sounders. The 16 boats covered more of the area than was covered by the single acoustic survey vessel and assisted the acoustic vessel in locating aggregations (Figure 43). The acoustic vessel conducted eight separate fine scale systematic parallel transect surveys over the entire area (Figure 44).

This survey was conducted only 3 days after the survey of Oct. 8$^{th}$ because of indications that there fish were more aggregated in spawning groups, with the intention that this survey might replace the one of Oct. 8$^{th}$. The lines were not predefined by a survey design but rather were conceived based on the best coverage of the aggregations. The speed of the vessel was good yielding a clear echogram. It may have been more practical to combine grids where possible to make one large grid (join S5 and S6 into one grid). By most measures, this was an excellent survey. No samples were collected for length frequency or maturity to confirm spawning condition and so biomass estimates are based on standard target strength for a 28cm fish. The size and maturity of herring from the commercial roe fishery in the area later confirmed the presence of spawning fish (figures 36, 37).

A new area just at the northern edge of the defined Little Hope Fishing Area near Cape LaHave was surveyed with two of the largest schools identified that night (S5, S6). This area is considered to be outside of the standard survey area and also was not part of the 2009 fishery and so is excluded from the overall totals (Table 9) (figures 35, 44).

The total biomass from the six schools surveyed and considered valid was estimated to be 5,203t as calculated 'with' the Calibration Integration Factor (CIF) (Table 9, Appendix A19). The results from this survey were slightly more than the survey result of 4,967t on Oct. 8$^{th}$ and thus replaced it in the overall results.

*Little Hope Summary:*

In 2009, four acoustic surveys were conducted in the Little Hope/Port Mouton spawning box over the traditional spawning period. The standard protocol for surveying spawning herring of allowing 10-14 days between surveys was followed in order to avoid double counting that may have remained from the previous surveys. One survey on Oct. 11$^{th}$ was repeated only 3 days after the survey of Oct. 8$^{th}$ because of indications that the fish were more aggregated in spawning groups. The Oct 11$^{th}$ survey also covered a new area just at the northern edge of the Fishing Area near Cape LaHave where two of the largest schools were surveyed that night (S5, S6) (Figure 44). This area is considered outside of the standard survey area and also was not part of the 2009 fishery and so is excluded from the overall total SSB for 2009.

Summing the biomass from all surveys/schools resulted in a total spawning biomass of 36,588t which was more than double that observed in 2008 and well above the long term average of 25,900t (Table 10). The spawning biomass in the Little Hope spawning box now appears to be higher than normal and much improved from the low in 2007 (Figure 45).

There remain several issues with survey methods and protocols for the Little Hope area which are to be addressed in the coming season. The first applies to survey methods when doing school surveys which require more rigor in completing equally spaced parallel lines which cover the entire school and beyond. The second issue applies to obtaining good multi-panel gillnet samples to determine better estimates of the size and maturities of the herring being surveyed. A third issue is the extent of the survey area and what should be considered valid as part of the overall biomass estimate for the season.

*Halifax/Eastern Shore Fishery and Surveys*

The 2009 herring gillnet fishery in the Eastern Shore fishing area began on Sept. 13th and ended on Oct. 26th with total landings of 5,885 which was over double that recorded in 2008. The increase was due to quota allocation increases during the season related to the improved biomass observed with in-season acoustic surveys. The fishery duration was similar to 2006 and 2007 with most catches occurring between Sept. 16th and Oct. 24th (Figure 46). Once again, this was primarily a herring roe fishery with catches reported from three main areas; near Halifax Harbour approaches, southwest of Jeddore Head and south of Ship Harbour. Catches were well distributed in the area but were less concentrated in the area south of Ship Harbour (Figure 47).

Surveys were completed in each of the primary fishing areas from Halifax Harbour to near Ship Harbour, N.S. on Sept. 16th, Sept. 24th, Oct 2nd, Oct. 9th and Oct. 20th (Figure 48). The data were downloaded from the two boats with acoustic recorders, *Bradley K* and *Miss Owls Head*. Additional data were examined from deck sheet recordings on Oct. 2nd with 14 vessels participating (Figure 49).

Sampling was very good in 2009 for all surveys with 5 multi-panel gillnet samples collected over the course of the season for determination of the full range of size and maturity of the acoustically surveyed fish. The maturity samples showed a high proportion of ripe and running (Stage 6) fish ranging from 87 to 100% at the time of each survey (Figure 50). Sampling for size using fishery nets with 2¾" mesh and multi-panel nets with mesh sizes of 1⅞", 2⅜", 2½" and 2¾" showed the presence of fish smaller than 30cm early in the season but less so after Oct. 10th (Figure 51).

*Halifax/Eastern Shore Acoustic Survey #1 - September 16, 2009.*

The first survey for the 2009 season was conducted by two acoustic survey vessels, the *Bradley K* (BK) and the *Miss Owls Head* (MOH) (Figure 52) (Appendix A20). The lines were not predefined by a survey design but rather were conceived based on the best coverage of the aggregations using equally spaced parallel lines. The two westerly school surveys were conducted flawlessly while the eastern school survey could have been improved with better spacing of lines (Figure 52). The westerly grids were conducted at the same time by the two different boats and so were not the same fish that had simply moved.

A multi-panel gillnet sample for the western schools area was taken and processed for both maturity stage and size (Figure 53). The overall size caught ranged from 25 to 35cm with 59% larger than 30cm. The multi-panel net with panel mesh sizes from 1⅞" to 2¾" primarily caught

fish in the 30 to 34cm sizes with a mean length of 31.2cm for the combined panels which was used for the calculation of target strength. Nearly all fish sampled (98%) were found to be in ripe and running spawning condition (Stage 6) (Figure 50).

Additional recording from Sept. 16th for the 'between schools area' was also processed with an estimate of 10,804t. There are several questions about this data including the validity of the total area being used, whether the track is biased toward schools of fish, and finally, whether these fish are pre-spawning (hard roe stage) which will show up in the future surveys and thus be double-counted (Figure 52, Table 11, Appendix A21). There were also no separate samples for these between-schools fish.

The total biomass from the three schools surveyed was estimated to be 24,302t as calculated 'with' the Calibration Integration Factor (CIF) (Table 11, Appendix A20). The between-school estimate will not be used in the overall total because these fish are likely dispersed pre-spawning fish that will be picked up in subsequent surveys on spawning school aggregations. Note also that there was no sample for the eastern school (S3) and that there were better additional surveys for this group in later surveys which were within the 10 day timing window.

*Halifax/Eastern Shore Acoustic Survey #2 - September 24, 2009.*

This survey was conducted only 8 days after the first survey by two acoustic survey vessels, the *Bradley K* (BK) and the *Miss Owls Head* (MOH). The vessels conducted a fine scale systematic parallel transect survey at the same time on a single aggregation with the MOH surveying the northern portion while the BK surveyed the southern portion of the school (Figure 54).

This was an excellent example of survey design for a school which was about 1.25 by 1.5km in size with an area of 2.0km$^2$. The lines were well spaced at about 100 to 200m apart but the presence of fish in the northern-most line shows that running one more line to the north to demonstrate that there were no more fish present might have been useful.

An example of a typical echogram taken for the entire transect B209800H indicates a quite dense aggregation about 10 meters thick with fish that are dense throughout and tight to bottom (Figure 55). Also of note is the dense layer near the bottom beginning at about half way through the aggregation showing up as the densest color in white. The average herring density for this transect was estimated as 17.0kg/m$^2$ which was the highest of the 10 lines completed (Appendix A22).

A multi-panel sample was collected and saved from this school alone (Figure 56). The multi-panel net primarily caught fish from 31 to 33cm in the panel mesh sizes 2½" and 2¾" although there were some smaller fish from 24 to 30cm caught by the smaller mesh panels. The mean length of 31.2cm for the combined panels was used for the calculation of target strength. Most fish sampled (87%) were found to be in ripe and running spawning condition (Stage 6) although some (13%) were still in hard roe condition (Stage 5) (Figure 50).

The total biomass from the single school surveyed on Sept. 24th was estimated to be 16,404t as calculated 'with' the Calibration Integration Factor (CIF) (Table 11, Appendix A22). Note that this school was separated from School #3 of the Sept. 16th survey by only 8 days and 5km in distance. Following standard protocols both of these school estimates cannot be used in the overall estimate and so the smaller earlier survey estimate was not included.

*Halifax/Eastern Shore Acoustic Survey #3 – October 2, 2009.*

This third survey was conducted 8 days after the second survey by two acoustic survey vessels with two fine scale systematic parallel transect surveys completed on two schools of herring as well as lines between the schools (Figure 57)(Appendix A23). The lines were not predefined by a survey design but rather were conceived based on the best coverage of the aggregations. The western school (#1) was well surveyed by the *Bradley K* with 8 transects completed over the 1.7km$^2$ area. This school was only 3km in distance from the location surveyed 8 days earlier on Sept. 24$^{th}$. The eastern school (#2) was well surveyed by the *Miss Owls Head* with 6 transects completed over the 1.4km$^2$ area. This second school was located in a new area for 2009 approximately 25km from the first school.

The fine scale surveys by the vessels with acoustic recording equipment were also part of a broader scale mapping survey by 14 additional gillnet vessels using paper data sheets to record observations from their sounders (Figure 49). The mapping boats covered more of the area than was covered by the acoustic survey vessels including some outside of the Eastern Shore Fishing Area but they did not identify any additional aggregations for surveying by the acoustic boats.

A multi-panel sample was collected and saved from the western school #1 (Figure 58). The multi-panel net primarily caught fish from 31 to 33cm in the panel mesh sizes 2½" and 2¾" although there were some smaller fish from 25 to 30cm caught by the smaller mesh panels. The mean length of 31.2cm for the combined panels was used for the calculation of target strength. Most fish sampled (95%) were found to be in ripe and running spawning condition (Stage 6) although a few (5%) were still in hard roe condition (Stage 5) (Figure 50).

The biomass from the western school and eastern schools was estimated to be 7,248t and 2,354t respectively as calculated 'with' the Calibration Integration Factor (CIF) (Table 11, Appendix A23). The western school was not used in the final overall total because it was too close in time and space to the survey on Sept. 24$^{th}$. The eastern school was also not used because a subsequent survey on Oct. 9$^{th}$ was found to be larger in total biomass and thus replaced the second eastern school estimate.

*Halifax/Eastern Shore Acoustic Survey #4 - October 9, 2009.*

The fourth survey was conducted 8 days after the third survey by two acoustic survey vessels with two fine scale systematic parallel transect surveys completed on two very closely located schools of herring (Figure 59)(Appendix A24). The lines were not predefined by a survey design but rather were conceived based on the best coverage of the aggregations. The two schools were very close together so there is some concern of double counting. The southern most school was surveyed at 0100 and the northern most school was surveyed at 0200. There is some anecdotal fishing information that the southern school remained stationary while the northern school was surveyed. The eastern school (#1) was surveyed by the *Bradley K* with 8 transects completed over the 1.5km$^2$ area. This school was located only about 0.5km east from the second western school (#2) surveyed by the MOH with 4 transects completed over the 0.5km$^2$ area. The second school was only 0.5km in distance from a school surveyed 8 days earlier on Oct. 2$^{nd}$ (Oct2_School2). A better survey design might have included the area for both schools into a single combined survey.

Multi-panel samples were collected and saved for each of the two school areas (figures 60, 61). The sample from School #1 had a weighted mean length of 31.6cm while the sample from School #2 was 0.7cm smaller at 30.9cm. The multi-panel nets primarily caught fish from 30 to

33cm in the panel mesh sizes 2½" and 2¾" although there were some smaller fish from 26 to 30cm caught by the smaller mesh panels. The mean lengths for the samples were used for the calculation of target strength for the specific schools. Most fish sampled (92%) were found to be in ripe and running spawning condition (Stage 6) although a few (6%) were still in hard roe condition (Stage 5) and some were spent (2% Stage7) (Figure 50).

The biomass for the schools combined was estimated to be 7,957t as calculated 'with' the Calibration Integration Factor (CIF) (Table 11, Appendix A24). This new combined estimate replaced the second school estimate of 2,354t from the Oct. 2nd survey.

*Halifax/Eastern Shore Acoustic Survey #5 - October 21, 2009.*

The fifth and final survey was conducted 11 days after the fourth survey by a single acoustic survey vessel in the Big Shoal area which is located southeast of Halifax approaches. The survey design was good with two fine scale systematic parallel transect surveys completed on two closely located schools of herring (Figure 62) (Appendix A25). The northern most school was surveyed at 0445 and the southern most school was surveyed at 0530. There is some anecdotal fishing information that the southern school remained stationary while the northern school was surveyed and there is evidence in the data to suggest that the northern school is moving to the west and the southern school is moving to the east. It is unlikely that this resulted in double counting but does indicate that the two schools may be in the process of combining.

A multi-panel sample collected fish from 30 to 33cm in the panel mesh sizes 2½" and 2¾" (Figure 63). There were no fish caught in the smallest mesh panel while fish from 29 to 30cm were caught by the 2⅜" mesh panel. The mean length of 31.5cm for the combined panels was used for the calculation of target strength for both schools surveyed. All fish sampled (100%) were found to be in ripe and running spawning condition (Stage 6) (Figure 50).

The biomass from the two schools combined was estimated to be 10,300t as calculated 'with' the Calibration Integration Factor (CIF) and was used in the overall total for the area (Table 11, Appendix A25).

*Halifax/Eastern Shore Acoustic Survey Summary for 2009.*

The 2009 acoustic surveys in the Halifax/Eastern Shore provided excellent coverage of the various herring spawning locations in the area. These surveys were also exceptional in the use of a multi-panel gillnet to collect representative samples of herring being surveyed on each of the survey nights which were then used to better estimate TS. The total spawning biomass for the Eastern Shore area for 2009 was taken as the sum of the Sept. 16th, Sept. 24th, Oct. 9th, and Oct. 21st surveys where there was not an overlap in either the 10 day time window or location (Table 11). The overall estimate of 54,236t as calculated 'with' the Calibration Integration Factor, is nearly double that recorded for 2008 and well above the long term average of 37,440t (Table 10) (Figure 64).

The results are considered to provide a reasonable estimate of herring present at the time of surveying. A major concern or source of uncertainty is the assumption that the surveys are simply cumulative. If herring do not move 'on to' and 'off of' the spawning grounds in waves the estimate of total SSB will be significantly biased upward due to double counting. Another major issue, which was addressed at the 2007 Herring Framework review, is the use of these estimates as absolute measures of biomass due to the many uncertainties, especially with target strength.

*Glace Bay Fishery and Surveys*

Survey coverage for the Glace Bay area was poor in 2009 with three surveys attempted on July 27th, Sept. 12th and Oct. 2nd. There was no spawning fishery in the area due to a lack of markets and the lack of fishing activity may have prevented the opportunity for other boats to participate in the searching and survey activities.

*Glace Bay Acoustic Survey #1 – July 27, 2009.*

This survey was conducted by a single acoustic survey vessel *Natasha Lee* which conducted one broad scale systematic parallel transect survey in the Red Ground area (Figure 65). The lines were not predefined by a survey design but rather were conceived based on the best coverage of the aggregations and very few fish were located. Future surveys should be conducted with approximately equal length parallel lines starting from one end of the school and working to the other end of the school. The speed should be kept at or below 6 knots while surveying for this vessel since there is considerable noise from the electrical system that should be addressed.

There were no samples for size or maturity of herring and this time period was outside the normal known spawning time for herring in this location.

The biomass for the overall survey area was estimated to be 726t as calculated 'with' the Calibration Integration Factor (CIF) (Table 12, Appendix A26). There is large uncertainty as to the target species recorded which did not 'look' like typical herring schools and because of the survey timing in late July before the usual fall spawning period that typically begins in September.

*Glace Bay Acoustic Survey #2 – September 12, 2009.*

This survey was conducted by a single acoustic survey vessel *Natasha Lee* which conducted a broad scale systematic parallel transect survey in the Glace Bay grounds area (Figure 65). No fish were found in the survey area.

There was a small school near the mouth of the Glace Bay Harbour but this area was not surveyed effectively. This aggregation could have been about 300 tons but as it was not part of the prearranged survey, coverage was quite poor and therefore the results are not used. There were no samples for size or maturity.

The biomass for this survey was estimated to be 0t (Table 12, Appendix A27).

*Glace Bay Acoustic Survey #3 - October 2, 2009.*

This final survey was conducted by a single acoustic survey vessel *Natasha Lee* which conducted a broad scale systematic parallel transect survey near the Big Shoal area (Figure 65). An area of about 4km$^2$ was surveyed with a total of 6 equally spaced transects but the fish which appeared to be herring (density and distribution in the water column) were very thinly aggregated. The biomass for the overall survey was estimated to be 94t as calculated 'with' the Calibration Integration Factor (CIF) (Table 12, Appendix A28).

*Glace Bay Acoustic Survey Summary for 2009.*

Survey coverage for the Glace Bay area was poor in 2009 with one survey completed too early in the season with unknown species recorded, a second survey with no fish located and a third survey with only 94t estimated (tables 10, 12) (Figure 66). There were no biological samples collected and there was also no fishery for the area in 2009. Improvements in the timing, location and amount of survey effort are required in the future for this area.

**Offshore Scotian Shelf Component**

Fleet activity/catch in the spring/early summer fishery on the offshore banks of the Scotian Shelf has varied between 1,000 and 20,000t since 1996 with landings of 5,263t in 2005. Acoustic recorders were activated on a few occasions, but insufficient quantities of fish were observed to warrant analysis. Consequently, no acoustic biomass estimates were available from the Scotian Shelf. There continues to be a lack of herring research on the Scotian Shelf in the fall using a research vessel like the *CCGS Alfred Needler* to investigate possible spawning activity in the offshore areas.

No acoustic survey data was available for analysis from the outer Scotian Shelf banks in 2009.

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Table 1. Summary of the number of surveys scheduled and number undertaken in 2009 with the number of fishing nights examined in the estimation of spawning stock biomass in the 4VWX stock and coastal component complexes.

| Spawning Ground | Surveys Scheduled | Surveys Completed | Fishing Nights |
|---|---|---|---|
| Scots Bay | 4 | 5 | 0 |
| German Bank | 5 | 7 | 0 |
| Spectacle Buoy | 2 | 0 | 0 |
| Trinity Ledge | 2 | 2 | 0 |
| Browns Bank | 0 | 0 | 0 |
| Seal Island | 0 | 0 | 0 |
| Little Hope | 3 | 4 | 0 |
| Eastern Shore | 3 | 5 | 0 |
| Glace Bay | 3 | 3 | 0 |
| Total | 22 | 26 | 0 |

Table 2. Summary of completed herring acoustic surveys undertaken in 2009 with interval (days) between surveys on the same grounds, number of boats with acoustic systems and the number of mapping boats (without acoustic systems using deck sheets only).

| No. | Survey Date | Location of survey | Interval (days) | Acoutic Boats | Mapping Boats | Total No. Boats |
|---|---|---|---|---|---|---|
| 1 | 27-Jun-09 | Scots Bay #1 | 0 | 3 | 0 | 3 |
| 2 | 11-Jul-09 | Scots Bay #2 | 14 | 6 | 0 | 6 |
| 3 | 25-Jul-09 | Scots Bay #3 | 14 | 6 | 0 | 6 |
| 4 | 08-Aug-09 | Scots Bay #4 | 13 | 6 | 0 | 6 |
| 5 | 21-Aug-09 | Scots Bay #5 | 13 | 5 | 0 | 5 |
| 6 | 12-Aug-09 | German Bank #1 | 0 | 7 | 0 | 7 |
| 7 | 25-Aug-09 | German Bank #2 | 13 | 9 | 0 | 9 |
| 8 | 08-Sep-09 | German Bank #3 | 13 | 8 | 0 | 8 |
| 9 | 14-Sep-09 | German Bank #4 | 6 | 7 | 0 | 7 |
| 10 | 24-Sep-09 | German Bank #5 | 10 | 8 | 0 | 8 |
| 11 | 05-Oct-09 | German Bank #6 | 11 | 7 | 0 | 7 |
| 12 | 20-Oct-09 | German Bank #7 | 15 | 5 | 0 | 5 |
| 13 | 25-Aug-09 | Trinity Ledge #1 | 0 | 1 | 0 | 1 |
| 14 | 08-Sep-09 | Trinity Ledge #2 | 13 | 1 | 0 | 1 |
| 15 | 14-Sep-09 | Little Hope #1 | 0 | 1 | 9 | 10 |
| 16 | 26-Sep-09 | Little Hope #2 | 12 | 1 | 10 | 11 |
| 17 | 08-Oct-09 | Little Hope #3 | 12 | 2 | 0 | 2 |
| 18 | 11-Oct-09 | Little Hope #4 | 3 | 1 | 16 | 17 |
| 19 | 16-Sep-09 | Eastern Shore #1 | 0 | 2 | 0 | 2 |
| 20 | 24-Sep-09 | Eastern Shore #2 | 8 | 2 | 0 | 2 |
| 21 | 02-Oct-09 | Eastern Shore #3 | 8 | 2 | 14 | 16 |
| 22 | 10-Oct-09 | Eastern Shore #4 | 8 | 2 | 0 | 2 |
| 23 | 21-Oct-09 | Eastern Shore #5 | 11 | 1 | 0 | 1 |
| 24 | 21-Jul-09 | Glace Bay #1 | 0 | 1 | 0 | 1 |
| 25 | 14-Sep-09 | Glace Bay #2 | 53 | 1 | 0 | 1 |
| 26 | 02-Oct-09 | Glace Bay #3 | 18 | 1 | 0 | 1 |
| | Total number of survey boat nights | | | 96 | 49 | 145 |

Table 3. Summary of fish sampled by survey date and location with target strength estimate from samples, and target strength estimate for a 28cm herring using the length/weight equation.

| Date of Survey | Location of survey | Interval (days) | Number Samples | Number Measured Fish | Number Len/Wt Fish | Mean Length (mm) | Mean Weight (gm) | Target Strength dB/kg | Wt 28 cm Fish (gm) | TS 28 cm Fish dB/kg |
|---|---|---|---|---|---|---|---|---|---|---|
| 27-Jun-09 | Scots Bay #1 | 0 | 0 | 0 | 0 | 280 | 180 | -35.500 | 180 | -35.500 |
| 11-Jul-09 | Scots Bay #2 | 14 | 4 | 532 | 208 | 260.0 | 139 | -35.024 | 178 | -35.457 |
| 25-Jul-09 | Scots Bay #3 | 14 | 2 | 336 | 32 | 262 | 142 | -35.080 | 183 | -35.592 |
| 08-Aug-09 | Scots Bay #4 | 13 | 3 | 345 | 49 | 260 | 136 | -34.957 | 183 | -35.582 |
| 21-Aug-09 | Scots Bay #5 | 13 | 0 | 0 | 0 | 280 | 180 | -35.500 | 180 | -35.500 |
| 12-Aug-09 | German Bank #1 | 0 | 7 | 1085 | 65 | 273 | 170 | -35.487 | 187 | -35.667 |
| 25-Aug-09 | German Bank #2 | 13 | 5 | 674 | 63 | 271 | 165 | -35.409 | 184 | -35.610 |
| 08-Sep-09 | German Bank #3 | 13 | 7 | 937 | 191 | 281 | 182 | -35.542 | 181 | -35.528 |
| 14-Sep-09 | German Bank #4 | 6 | 7 | 926 | 120 | 265 | 153 | -35.286 | 184 | -35.607 |
| 24-Sep-09 | German Bank #5 | 10 | 6 | 867 | 68 | 263 | 143 | -35.045 | 178 | -35.471 |
| 05-Oct-09 | German Bank #6 | 11 | 3 | 537 | 47 | 257 | 132 | -34.894 | 173 | -35.338 |
| 20-Oct-09 | German Bank #7 | 15 | 0 | 0 | 0 | 280 | 180 | -35.500 | 180 | -35.500 |
| 25-Aug-09 | Trinity Ledge #1 | 0 | 0 | 0 | 0 | 280 | 180 | -35.500 | 180 | -35.500 |
| 08-Sep-09 | Trinity Ledge #2 | 13 | 0 | 0 | 0 | 280 | 180 | -35.500 | 180 | -35.500 |
| 14-Sep-09 | Little Hope #1 | 0 | 0 | 0 | 0 | 280 | 180 | -35.500 | 180 | -35.500 |
| 26-Sep-09 | Little Hope #2 | 12 | 0 | 0 | 0 | 280 | 180 | -35.500 | 180 | -35.500 |
| 08-Oct-09 | Little Hope #3 | 12 | 0 | 0 | 0 | 280 | 180 | -35.500 | 180 | -35.500 |
| 11-Oct-09 | Little Hope #4 | 3 | 0 | 0 | 0 | 280 | 180 | -35.500 | 180 | -35.500 |
| 16-Sep-09 | Eastern Shore #1 | 0 | 1 | 146 | 98 | 312 | 253 | -36.047 | 179 | -35.478 |
| 24-Sep-09 | Eastern Shore #2 | 8 | 1 | 103 | 98 | 311 | 251 | -36.026 | 179 | -35.478 |
| 02-Oct-09 | Eastern Shore #3 | 8 | 1 | 101 | 105 | 312 | 246 | -35.935 | 176 | -35.402 |
| 10-Oct-09 | Eastern Shore #4 | 8 | 2 | 254 | 105 | 316 | 257 | -35.997 | 176 | -35.402 |
| 21-Oct-09 | Eastern Shore #5 | 11 | 1 | 117 | 105 | 315 | 254 | -35.982 | 176 | -35.402 |
| 21-Jul-09 | Glace Bay #1 | 0 | 0 | 0 | 0 | 280 | 180 | -35.500 | 180 | -35.500 |
| 14-Sep-09 | Glace Bay #2 | 53 | 0 | 0 | 0 | 280 | 180 | -35.500 | 180 | -35.500 |
| 02-Oct-09 | Glace Bay #3 | 18 | 0 | 0 | 0 | 280 | 180 | -35.500 | 180 | -35.500 |

Note - shaded cells represent standard values used for 38kHz system when no sampling was available. Further adjustments also made for frequency of systems used.

Table 4. Summary of the 2009 Scots Bay spawning ground acoustic survey data and associated biomass estimates for the standard survey box area (inbox) and for outside the survey box (outbox). The total SSB for the spawning component was obtained for each grouping by summing the biomass estimates.

a - without calibration integration factor; as presented since 1997

| Location/ Type | Date | Target Strength (dB/kg) | Area ($km^2$) | Weighted Sa ($dB/m^2$) | Density ($kg/m^2$) | Biomass (t) | Standard Error (t) | SE % |
|---|---|---|---|---|---|---|---|---|
| Scots Bay (inbox) | 27-Jun-09 | -35.77 | 636 | -55.12 | 0.012 | 7,386 | 7,322 | 99% |
| | 11-Jul-09 | -35.03 | 636 | -47.73 | 0.054 | 34,170 | 12,136 | 36% |
| | 25-Jul-09 | -35.14 | 636 | -51.39 | 0.024 | 15,087 | 11,606 | 77% |
| | 08-Aug-09 | -34.56 | 636 | -52.26 | 0.017 | 10,797 | 5,363 | 50% |
| | 21-Aug-09 | -35.77 | 1.9 | -45.48 | 0.107 | 203 | 0 | 0% |
| Scots Bay total for standard survey area (inbox) | | | | | | 67,643 | 19,088 | 28% |
| Scots Bay (outbox) | 27-Jun-09 | -35.77 | 90 | -1035.37 | 0.000 | 0 | 0 | 0% |
| | 11-Jul-09 | -35.02 | 80 | -50.01 | 0.032 | 2,537 | 1,911 | 75% |
| | 25-Jul-09 | -35.26 | 180 | -56.49 | 0.008 | 1,356 | 661 | 49% |
| | 08-Aug-09 | -34.96 | 164 | -55.83 | 0.008 | 1,342 | 1,276 | 95% |
| | 21-Aug-09 | -35.50 | 100 | -69.44 | 0.000 | 40 | 40 | 100% |
| Scots Bay total for non-standard survey area (outbox) | | | | | | 5,275 | 2,391 | 45% |
| Scots Bay overall total all survey areas | | | | | | 72,918 | 19,237 | 26% |

b - with integration factor as introduced in 2003

| Location/ Type | Date | Target Strength (dB/kg) | Area ($km^2$) | Weighted Sa ($dB/m^2$) | Density ($kg/m^2$) | Biomass (t) | Standard Error (t) | SE % |
|---|---|---|---|---|---|---|---|---|
| Scots Bay (inbox) | 27-Jun-09 | -35.77 | 636 | -55.03 | 0.012 | 7,542 | 7,452 | 99% |
| | 11-Jul-09 | -35.03 | 636 | -46.73 | 0.068 | 42,931 | 15,430 | 36% |
| | 25-Jul-09 | -35.13 | 636 | -50.67 | 0.028 | 17,761 | 14,005 | 79% |
| | 08-Aug-09 | -34.60 | 636 | -51.43 | 0.021 | 13,204 | 7,213 | 55% |
| | 21-Aug-09 | -35.77 | 1.9 | -45.40 | 0.109 | 207 | 0 | 0% |
| Scots Bay total for standard survey area (inbox) | | | | | | 81,645 | 23,276 | 29% |
| Scots Bay (outbox) | 27-Jun-09 | -35.77 | 90 | -1035.37 | 0.000 | 0 | 0 | 0% |
| | 11-Jul-09 | -35.02 | 80 | -49.56 | 0.035 | 2,813 | 2,120 | 75% |
| | 25-Jul-09 | -35.26 | 180 | -55.84 | 0.009 | 1,577 | 753 | 48% |
| | 08-Aug-09 | -34.96 | 164 | -54.87 | 0.010 | 1,673 | 1,591 | 95% |
| | 21-Aug-09 | -35.50 | 100 | -68.60 | 0.001 | 49 | 48 | 98% |
| Scots Bay total for non-standard survey area (outbox) | | | | | | 6,112 | 2,756 | 45% |
| Scots Bay overall total all survey areas | | | | | | 87,757 | 23,439 | 27% |

Table 5. Summary of the 2009 German Bank spawning ground acoustic survey results and SSB biomass estimates. The shaded rows represent survey data which were not included in the overall totals.

a - without integration factor; as presented since 1997

| Location/ Type | Date | Target Strength (dB/kg) | Area ($km^2$) | Weighted Sa ($dB/m^2$) | Density ($kg/m^2$) | Biomass (t) | Standard Error (t) | SE % |
|---|---|---|---|---|---|---|---|---|
| German Bank (inbox) | 12-Aug-09 | -35.50 | 646 | -45.18 | 0.108 | 69,431 | 31,075 | 45% |
| | 25-Aug-09 | -35.42 | 646 | -44.14 | 0.134 | 86,614 | 18,784 | 22% |
| (excluded Sept. 8) | 08-Sep-09 | -35.59 | 646 | -48.93 | 0.046 | 29,941 | 8,530 | 28% |
| | 14-Sep-09 | -35.29 | 646 | -46.05 | 0.084 | 54,192 | 36,094 | 67% |
| | 24-Sep-09 | -35.05 | 646 | -47.15 | 0.062 | 39,828 | 27,955 | 70% |
| | 05-Oct-09 | -34.89 | 646 | -45.31 | 0.091 | 58,648 | 43,646 | 74% |
| (excluded Oct. 20) | 20-Oct-09 | -35.60 | 646 | -52.81 | 0.019 | 12,304 | 3,088 | 25% |
| German Bank inbox total (excluds Sept. 8 survey) | | | | | | 308,713 | 72,854 | 24% |
| German Bank (outbox) | 25-Aug-09 | -35.41 | 90 | -53.57 | 0.015 | 1,375 | 419 | 30% |
| German Bank outbox total | | | | | | 1,375 | 419 | 30% |
| German Bank overall total all areas | | | | | | 310,088 | 72,855 | 23% |

b - with integration factor as introduced in 2003

| Location/ Type | Date | Target Strength (dB/kg) | Area ($km^2$) | Weighted Sa ($dB/m^2$) | Density ($kg/m^2$) | Biomass (t) | Standard Error (t) | SE % |
|---|---|---|---|---|---|---|---|---|
| German Bank | 12-Aug-09 | -35.50 | 646 | -44.05 | 0.140 | 90,118 | 38,930 | 43% |
| | 25-Aug-09 | -35.42 | 646 | -42.93 | 0.177 | 114,610 | 25,489 | 22% |
| (excluded Sept. 8) | 08-Sep-09 | -35.59 | 646 | -47.95 | 0.058 | 37,522 | 10,885 | 29% |
| | 14-Sep-09 | -35.29 | 646 | -44.94 | 0.108 | 70,024 | 47,174 | 67% |
| | 24-Sep-09 | -35.05 | 646 | -46.23 | 0.076 | 49,292 | 33,746 | 68% |
| | 05-Oct-09 | -34.89 | 646 | -44.44 | 0.111 | 71,809 | 53,028 | 74% |
| (excluded Oct. 20) | 20-Oct-09 | -35.60 | 646 | -51.89 | 0.024 | 15,195 | 3,728 | 25% |
| German Bank inbox total (excludes Sept. 8 survey) | | | | | | 395,853 | 91,331 | 23% |
| German Bank (outbox) | 25-Aug-09 | -35.41 | 90 | -52.55 | 0.019 | 1,737 | 529 | 30% |
| German Bank outbox total | | | | | | 1,737 | 529 | 30% |
| German Bank overall total all areas | | | | | | 397,590 | 91,333 | 23% |

Table 6. Catches (t), acoustic survey biomass (t) and exploitation (Catch/SSB) for the Trinity Ledge herring fishery from 1998 to 2009. Survey biomass calculated without CIF.

| Fishery Start Day | Fishery End Day | Catch t | Survey Biomass t | Exploitation Catch/SSB |
|---|---|---|---|---|
| 24-Aug-98 | 21-Sep-98 | 1,668 | | |
| 12-Aug-99 | 15-Sep-99 | 1,257 | 3,885 | 32% |
| 30-Aug-00 | 12-Sep-00 | 734 | 621 | 118% |
| 21-Aug-01 | 26-Sep-01 | 1,012 | 14,797 | 7% |
| 02-Sep-02 | 30-Sep-02 | 256 | 8,096 | 3% |
| 21-Aug-03 | 18-Sep-03 | 369 | 14,512 | 3% |
| 02-Sep-04 | 15-Sep-04 | 225 | 6,511 | 3% |
| 05-Sep-05 | 20-Sep-05 | 447 | 5,071 | 9% |
| 23-Aug-06 | 21-Sep-06 | 717 | 8,486 | 8% |
| 27-Aug-07 | 20-Sep-07 | 1,091 | 1,357 | 80% |
| 21-Aug-08 | 25-Sep-08 | 7 | 273 | 3% |
| 01-Sep-09 | 11-Sep-09 | 117 | 675 | 17% |
| Average | | 658 | 5,844 | 11% |

Table 7. Biomass estimation for the overall 2009 Trinity Ledge acoustic surveys.

a - without calibration integration factor; as presented since 1997

| Location/ Type | Date | Mean Length (mm) | Target Strength (dB/kg) | Area ($km^2$) | Weighted Sa ($dB/m^2$) | Density ($kg/m^2$) | Biomass (t) | Standard Error (t) | SE % |
|---|---|---|---|---|---|---|---|---|---|
| Trinity Ledge-S1 | 25-Aug-09 | 280 | -36.0 | 1.0 | -44.1 | 0.152 | 144 | 125 | 87% |
| Trinity Ledge-S2 | 25-Aug-09 | 280 | -36.0 | 0.2 | -36.2 | 0.941 | 169 | 160 | 95% |
| Trinity Ledge-S1 | 8-Sep-09 | 280 | -36.0 | 0.2 | -32.4 | 2.264 | 362 | 85 | 23% |
| Trinity Ledge total for 2009 | | | | | | | 675 | 220 | 33% |

b - with calibration integration factor (as calculated since 2003)

| Location/ Type | Date | Mean Length (mm) | Target Strength (dB/kg) | Area ($km^2$) | Weighted Sa ($dB/m^2$) | Density ($kg/m^2$) | Biomass (t) | Standard Error (t) | SE % |
|---|---|---|---|---|---|---|---|---|---|
| Trinity Ledge-S1 | 25-Aug-09 | 280 | -36.0 | 1.0 | -40.5 | 0.354 | 336 | 292 | 87% |
| Trinity Ledge-S2 | 25-Aug-09 | 280 | -36.0 | 0.2 | -32.5 | 2.193 | 395 | 374 | 95% |
| Trinity Ledge-S1 | 8-Sep-09 | 280 | -36.0 | 0.2 | -28.7 | 5.273 | 844 | 199 | 24% |
| Trinity Ledge total for 2009 | | | | | | | 1,575 | 515 | 33% |

Table 8. Summary of the minimum observed spawning stock biomass for each of the surveyed spawning grounds in the Bay of Fundy/SWNS component of the 4WX stock complex. Total SSB rounded to nearest 100t and all data calculated without the integration calibration factor.

| **Location/Year** | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | Average 1999-2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scots Bay (inbox) | 41,000 | 106,300 | 163,900 | 141,000 | 133,900 | 107,600 | 16,800 | 28,600 | 45,700 | 19,400 | 67,600 | 80,420 |
| Trinity Ledge | 3,900 | 600 | 14,800 | 8,100 | 14,500 | 6,500 | 5,100 | 8,500 | 1,400 | 300 | 700 | 6,370 |
| German Bank (inbox) | 460,800 | 356,400 | 190,500 | 393,100 | 343,500 | 367,600 | 211,000 | 245,500 | 337,200 | 201,700 | 308,700 | 310,730 |
| Spec Buoy (spring) | 0 | 0 | 1,100 | | 1,400 | n/s | 300 | n/s | 100 | 0 | n/s | 414 |
| Spec Buoy (fall) | | | 87,500 | | | | | | | | | 87,500 |
| Sub-Total | 505,700 | 463,300 | 457,800 | 542,200 | 493,300 | 481,700 | 233,200 | 282,600 | 384,400 | 221,400 | 377,000 | 485,434 |
| Scots Bay (outbox) | | | | | | | | | | | 5,300 | |
| German Bank (outbox) | | | | | | | | 4,100 | 2,820 | 1,700 | 1,400 | 2,873 |
| Seal Island | | | 3,300 | 1,200 | 12,200 | | | 8,100 | | | | 6,200 |
| Browns Bank | | | 45,800 | | | | | 6,100 | | | | 25,950 |
| Total | 505,700 | 463,300 | 506,900 | 543,400 | 505,400 | 481,700 | 233,200 | 300,900 | 387,220 | 223,100 | 383,700 | 415,082 |

Table 9. 2009 herring acoustic surveys for Little Hope/Port Mouton (using standard TS with CIF) (no samples available).

| Survey Date | Stratum or school | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|---|
| 14-Sep-2009 | School_1 | -35.95 | 2.75 | -33.39 | 1.801 | 4,954 | 2623 | 53 |
| | School_2 | -35.95 | 1.98 | -31.25 | 2.952 | 5,844 | 2702 | 46 |
| | School_3 | -35.95 | 0.19 | -29.73 | 4.187 | 795 | 214 | 27 |
| | School_4 | -35.95 | 0.27 | -28.72 | 5.287 | 1,428 | 655 | 46 |
| | Survey Total or mean | -35.95 | 5.19 | -31.95 | 2.509 | 13,021 | 3,828 | 29% |
| 26-Sep-2009 | West_School_1 | -35.95 | 6.82 | -38.85 | 0.513 | 3,499 | 674 | 19 |
| | Middle_School_2 | -35.95 | 4.42 | -44.98 | 0.125 | 552 | 114 | 21 |
| | East_School_3 | -35.95 | 2.25 | -27.91 | 6.361 | 14,313 | 4080 | 29 |
| | Survey Total or mean | -35.95 | 13.49 | -34.61 | 1.361 | 18,364 | 4,137 | 23% |
| 08-Oct-2009 | School_1 | -35.95 | 6.75 | -42.25 | 0.235 | 1,583 | 551 | 35 |
| | School_2 | -35.95 | 11.83 | -43.79 | 0.164 | 1,943 | 392 | 20 |
| | School_3 | -35.95 | 1.71 | -37.05 | 0.776 | 1,327 | 196 | 15 |
| | School_4 | -35.95 | 1.2 | -46.18 | 0.095 | 114 | 17 | 15 |
| | Survey Total or mean | -35.95 | 21.49 | -42.31 | 0.231 | 4,967 | 704 | 14% |
| 11-Oct-2009 | School_1 | -35.95 | 1.57 | -38.77 | 0.522 | 819 | 243 | 30 |
| | School_2 | -35.95 | 0.23 | -27.96 | 6.297 | 1,448 | 809 | 56 |
| | School_3 | -35.95 | 1.68 | -38.84 | 0.514 | 864 | 150 | 17 |
| | School_4 | -35.95 | 0.14 | -35.47 | 1.117 | 156 | 66 | 42 |
| | School_5 | -35.95 | 0.98 | -30.86 | 3.228 | 3,163 | 511 | 16 |
| | School_6 | -35.95 | 1.38 | -30.62 | 3.409 | 4,705 | 1683 | 36 |
| | School_7 | -35.95 | 0.25 | -32.20 | 2.369 | 592 | 297 | 50 |
| | School_8 | -35.95 | 0.26 | -28.88 | 5.091 | 1,324 | 498 | 38 |
| | Survey Total or mean | -35.95 | 4.13 | -32.91 | 2.014 | 5,203 | 1,038 | 20% |
| **Overall Total** | | **-35.95** | **22.81** | | **1.604** | **36,588** | **5,774** | **16%** |

Note - Oct. 8, 2009 survey not used in 'Overall' as it was replaced by the larger Oct. 11 survey.
Note 2- School 5 & 6, at north edge of survey box, no sample, no fishing, different group of fish.

Table 10. Landings, acoustic survey SSB and exploitation estimates by spawning area for coastal Nova Scotia with 5 year and overall averages.

**a - Landings by spawning area along coastal Nova Scotia with 5 year and overall averages**

| Landings (t) | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | Average Catch Last 5 yr. | Average Catch All Years |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Little Hope/Port Mouton** | | 490 | 1,170 | 2,919 | 2,043 | 2,904 | 3,982 | 4,526 | 1,267 | 2,239 | 3,133 | 1,506 | 1,108 | 3,731 | 2,343 | 2,386 |
| **Halifax/Eastern Shore** | 1,280 | 1,520 | 1,100 | 1,628 | 1,350 | 1,898 | 3,334 | 2,727 | 4,176 | 3,446 | 3,348 | 3,727 | 2,381 | 6,045 | 3,789 | 2,711 |
| **Glace Bay** | | 170 | 1,730 | 1,040 | 834 | 1,204 | 3,058 | 1,905 | 1,481 | 626 | 85 | 7 | 12 | 4 | 147 | 935 |
| **Bras d'Or Lakes** | 170 | 160 | 120 | 31 | 56 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| **Total** | 1,450 | 2,340 | 4,120 | 5,618 | 4,283 | 6,006 | 10,375 | 9,162 | 6,924 | 6,311 | 6,566 | 5,240 | 3,500 | 9,780 | 6,279 | 5,834 |

**b - Acoustic SSB for coastal Nova Scotia with 5 year and overall averages (with CIF since 2003; w/o CIF pre-2003)**

| Survey SSB (t) | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 10% SSB Average Last 5 yr | 10% SSB Average All years |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Little Hope/Port Mouton** | | | 14,100 | 15,800 | 5,200 | 21,300 | 56,000 | **53,100** | 22,500 | 44,700 | 24,100 | 2,800 | 14,500 | 36,588 | 2,454 | 2,589 |
| **Halifax/Eastern Shore** | | | 8,300 | 20,200 | **10,900** | 16,700 | **41,500** | 92,600 | 28,400 | 36,950 | 68,900 | 28,300 | 30,300 | 54,236 | 4,374 | 3,644 |
| **Glace Bay** | | | | 2,000 | | 21,200 | 7,700 | 31,500 | | 3,180 | n/s | 240 | 500 | 94 | 100 | 830 |
| **Bras d'Or Lakes** | | | | 530 | 70 | n/s | n/s | n/s | n/s | n/s | n/s | n/s | n/s | n/s | n/s | 30 |

Note 1: shaded cells include mapping surveys; bold cells include mapping and acoustic surveys.
Note 2: data prior to 2003 calculated with the Calibration Integration Factor (CIF) are not available. Pre-2003 is w/o CIF.

**c - Exploitation estimates for spawning components along coastal Nova Scotia with 5 year and overall averages (with CIF)**

| Survey SSB (t) with CIF | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 10% SSB Average Last 5 yr | 10% SSB Average All years |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Little Hope/Port Mouton** | | | | | | | | **9%** | 6% | 5% | 13% | 54% | 8% | 10% | 18% | 15% |
| **Halifax/Eastern Shore** | | | | | | | | 3% | 15% | 9% | 5% | 13% | 8% | 11% | 9% | 9% |
| **Glace Bay** | | | | | | | | 6% | | 20% | | 3% | 2% | 4% | 7% | 7% |
| **Bras d'Or Lakes** | | | | | | | | | | | | | | | | |

Note: shaded cells include mapping surveys; bold cells include mapping and acoustic surveys, yellow cells w/o CIF.

Table 11. 2009 Halifax/Eastern Shore herring acoustic survey results (CIF with multi-panel samples used for mean size and TS)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (kmý) | Weighted Mean Sa (/mý) | Biomass Density (kg/mý) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Sept 16_BK_School_1 | -36.49 | 5.0 | -40.18 | 0.428 | 2,139 | 319 | 15 |
| Sept 16_MOH_School_2 | -36.49 | 1.9 | -26.87 | 9.177 | 17,436 | 3,071 | 18 |
| Sept 16_MOH_School_3* | -36.49 | 0.6 | -27.53 | 7.878 | 4,727 | 792 | 17 |
| Sept_16 _Between_schools ^ | -36.49 | 170.0 | -48.46 | 0.064 | 10,804 | 1,757 | 16 |
| Sept 24_School_1 | -36.49 | 2.0 | -27.26 | 8.369 | 16,404 | 3,303 | 20 |
| Oct 2_BK_School_1* | -36.38 | 1.7 | -30.14 | 4.214 | 7,248 | 2,711 | 37 |
| Oct 2_MOH_School_2 * | -36.38 | 1.4 | -34.00 | 1.731 | 2,354 | 541 | 23 |
| Oct 9_BK_School_1 | -36.33 | 1.0 | -29.82 | 4.482 | 4,482 | 1,619 | 36 |
| Oct 9_MOH_School_2 * | -36.44 | 0.5 | -28.02 | 6.950 | 3,475 | 1,101 | 32 |
| Oct 21_School_1 | -36.44 | 0.8 | -27.24 | 8.316 | 6,486 | 2,246 | 35 |
| Oct 21_School_2 | -36.44 | 1.0 | -30.58 | 3.853 | 3,814 | 1,100 | 29 |
| Initial All Surveys (see notes) | -36.44 | 185.8 | -40.14 | 0.427 | 79,369 | 6,472 | 8% |
| Final All Surveys (see notes) | -36.44 | 14.5 | -29.83 | 4.582 | 54,236 | 5,525 | 10% |

Notes: reasons for excluding schools or surveys are as follows:
^ Between schools not included in overall total as fish may appear in subsequent survey schools
* Sept. 16 school #3 near same location and replaced by Sept. 24 survey
* Oct. 2 school #1 near same location and replaced by Sept. 24 survey
* Oct. 2 school #2 near same location and replaced by Oct. 9 survey

Table 12. 2009 herring acoustic surveys for Glace Bay (using standard TS with CIF) (no samples available).

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| GlaceBay_July_27* | -35.95 | 50.0 | -54.33 | 0.015 | 726 | 318 | 44 |
| GlaceBay_Sept_12 | -35.5 | 33.0 | -1027.21 | 0.000 | - | - | 3 |
| GlaceBay_Oct_2 | -35.95 | 4.3 | -52.53 | 0.022 | 94 | 65 | 69 |
| Totals/mean | -35.95 | 87.3 | -53.43 | 0.012 | 820 | 325 | 40% |

* July 27 survey not used because outside usual spawning period and targets were not 'herring-like'

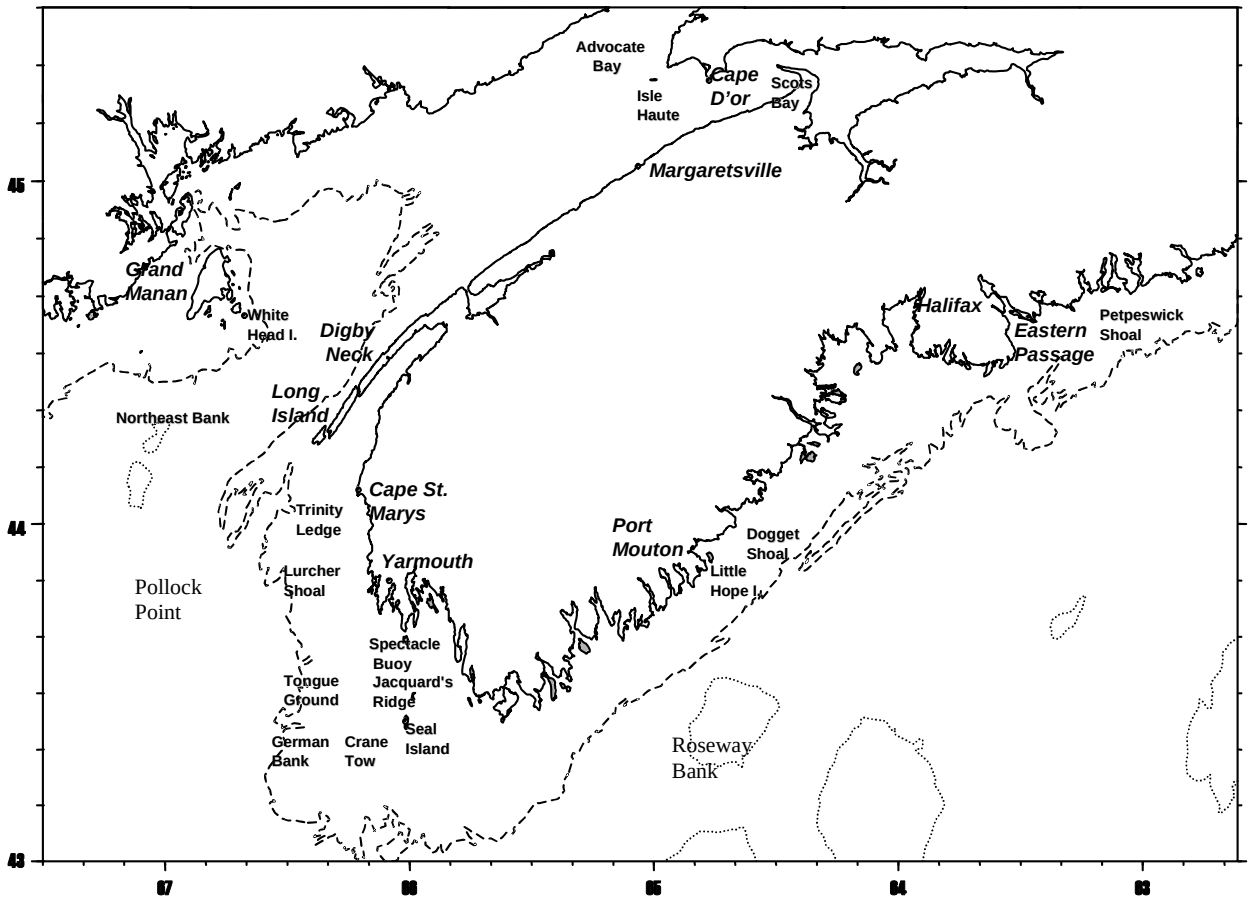


Figure 1. Map of the major spawning areas within the 4WX herring stock complex

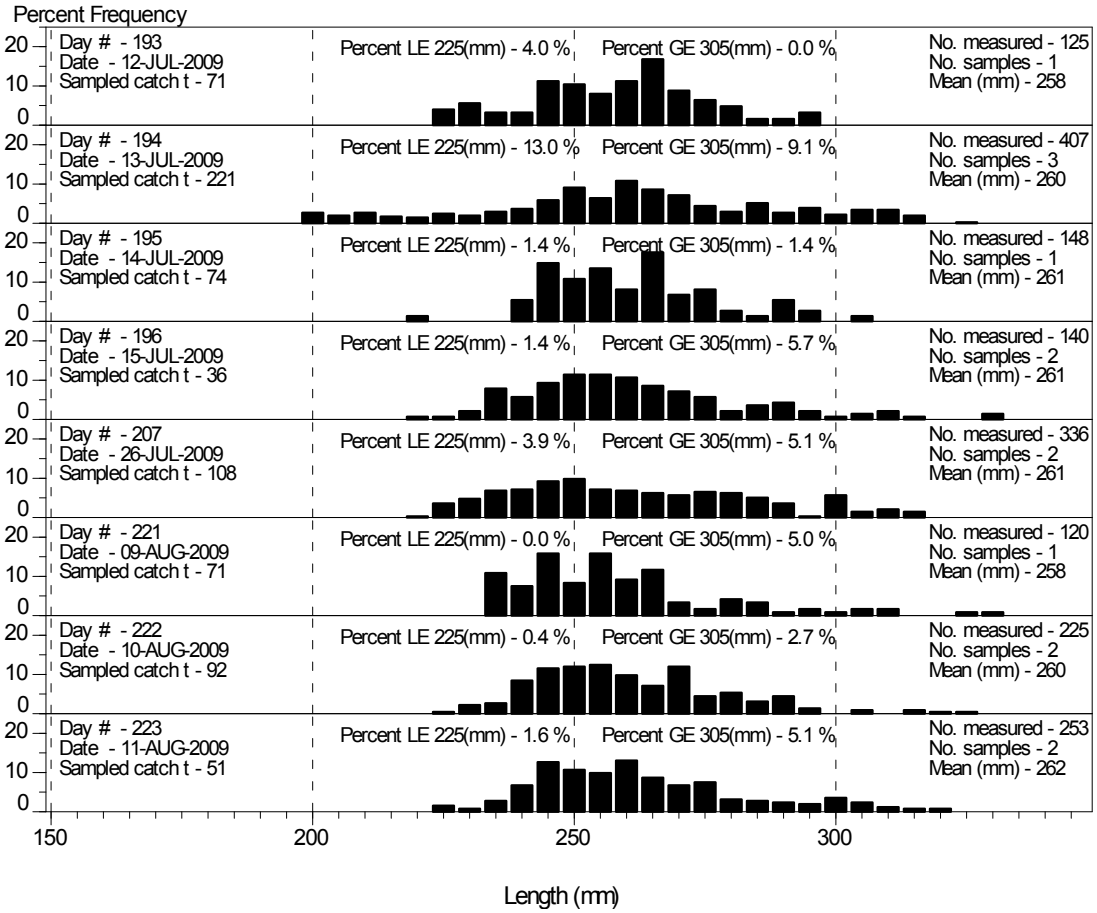


Figure 2. 2009 Scots Bay daily herring length frequency samples collected from landings with proportions <23cm and >30cm.

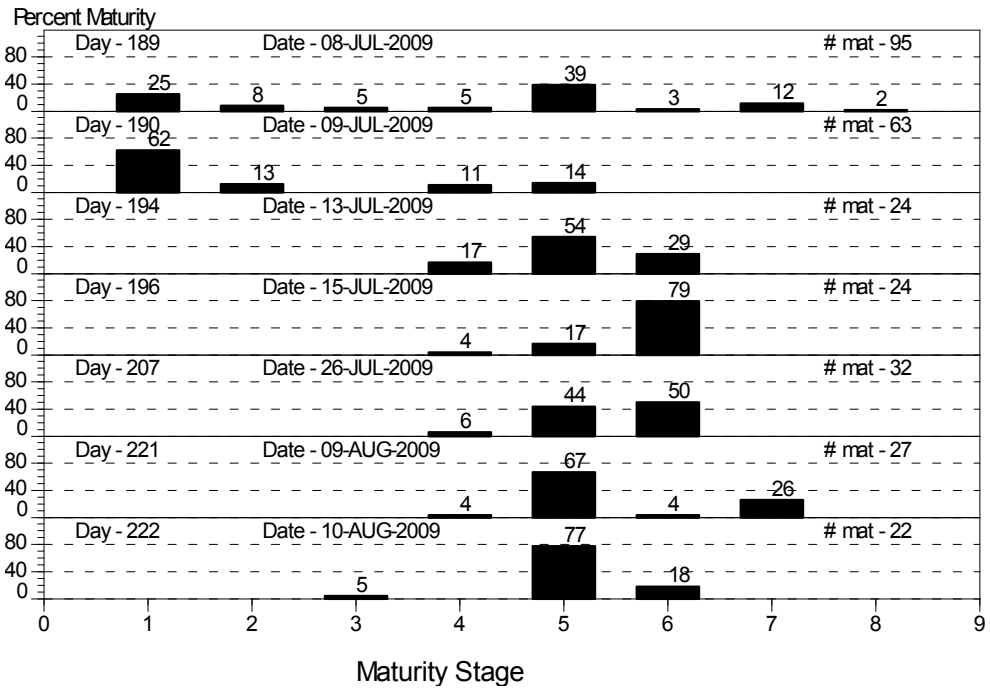


Figure 3. Daily herring maturity samples collected from Scots Bay landings in 2009. (Staging codes 1-2=immature; 3-4-5=maturing/hard; 6=ripe and running; 7=spent; 8=recovering).

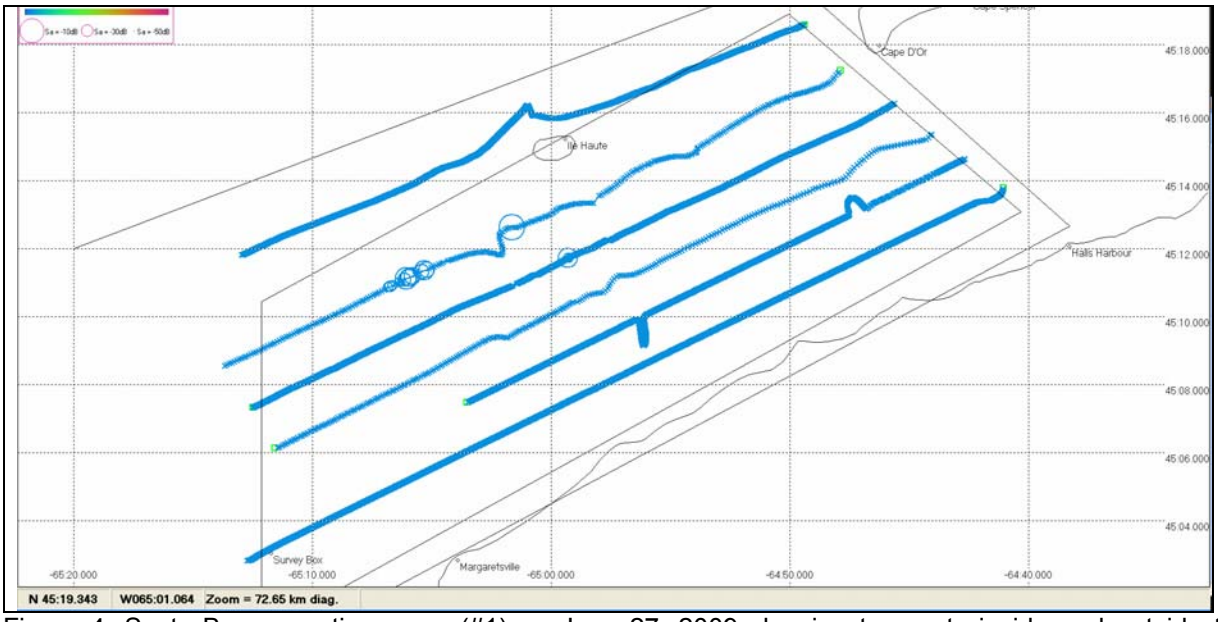


Figure 4. Scots Bay acoustic survey (#1) on June 27, 2009 showing transects inside and outside the standard survey area as well as deviations from the main survey lines to document fish near the lines.

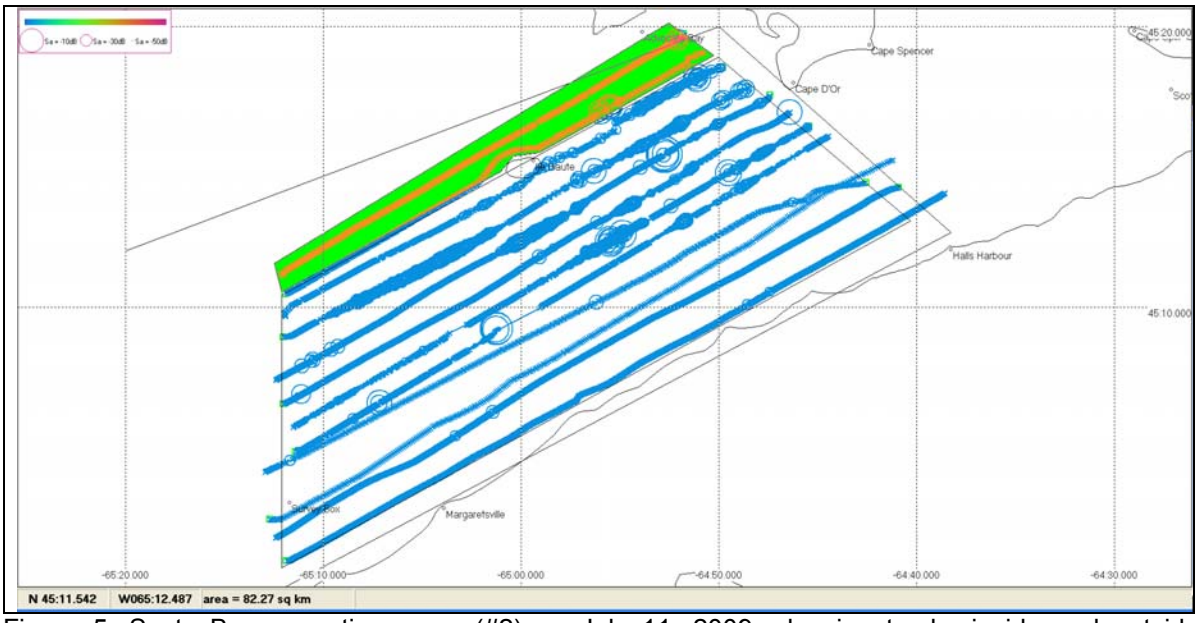


Figure 5. Scots Bay acoustic survey (#2) on July 11, 2009, showing tracks inside and outside the standard survey area with area outside the box estimated as 80km$^2$.

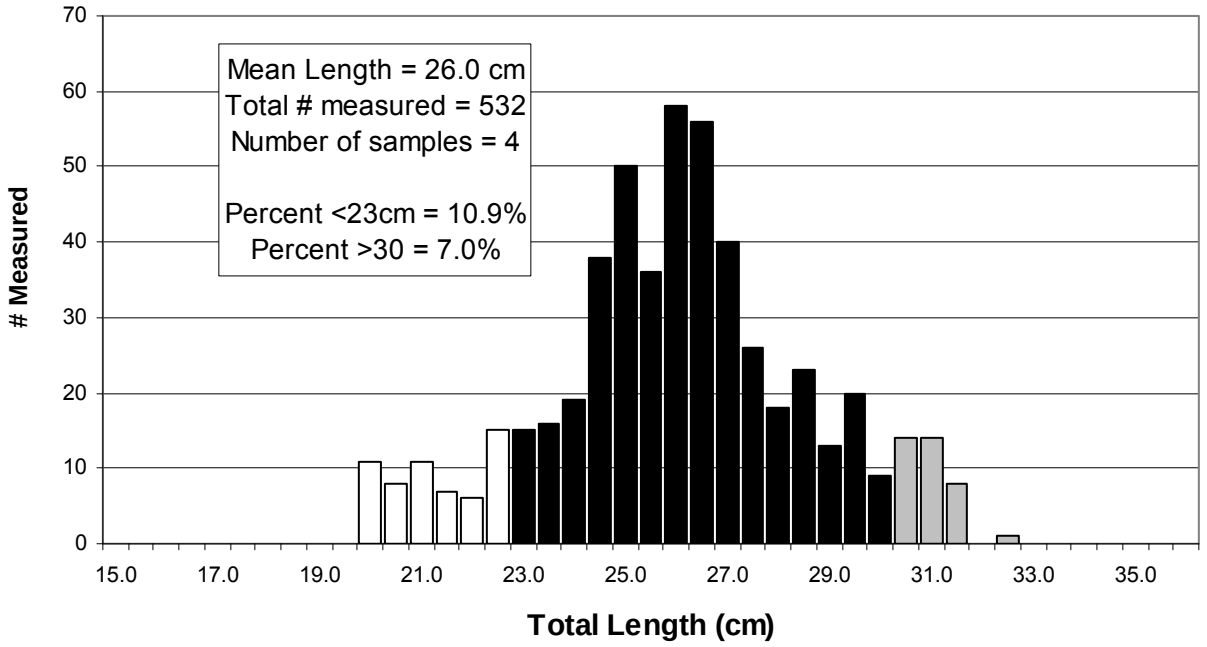


Figure 6. Length distribution for Scots Bay survey (#2) on July 11, 2009, from sampling on July 12-13 (nearest landing dates) with proportions <23 and >30cm. Bars are shaded white for sizes less than 23cm and grey for sizes greater than 30cm.

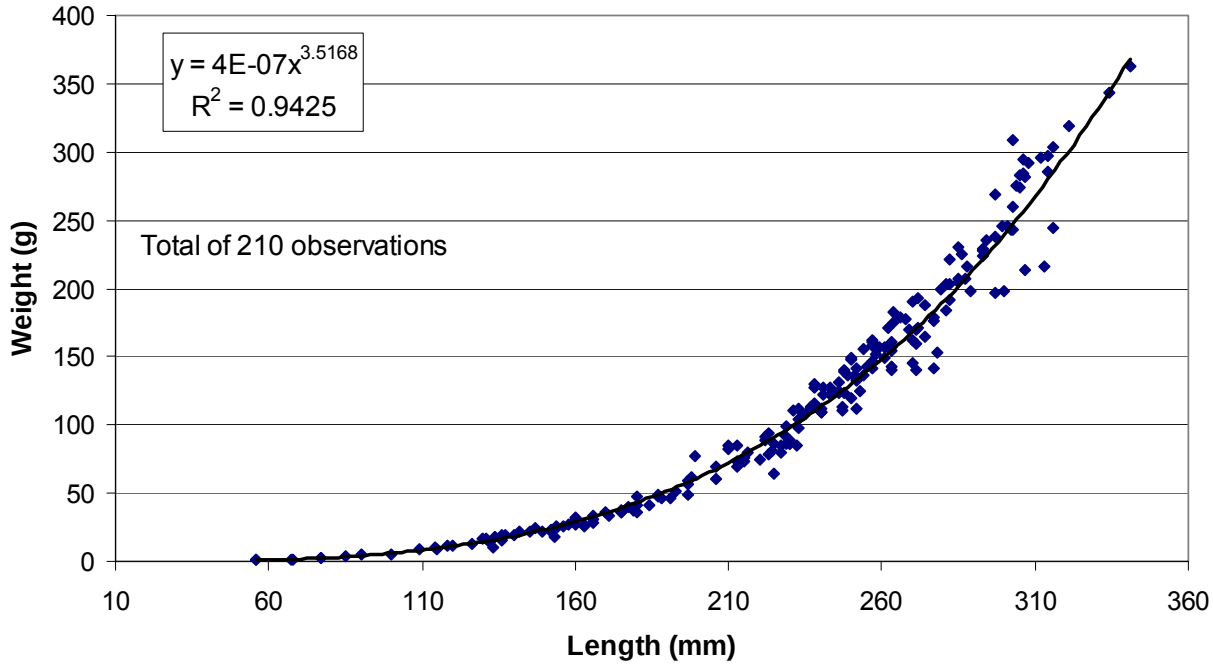


Figure 7. Length-weight relationship for Scots Bay survey (#2) on July 11, 2009, from sampling on July 8-15 by both industry purse seine and research bottom trawl gear types.

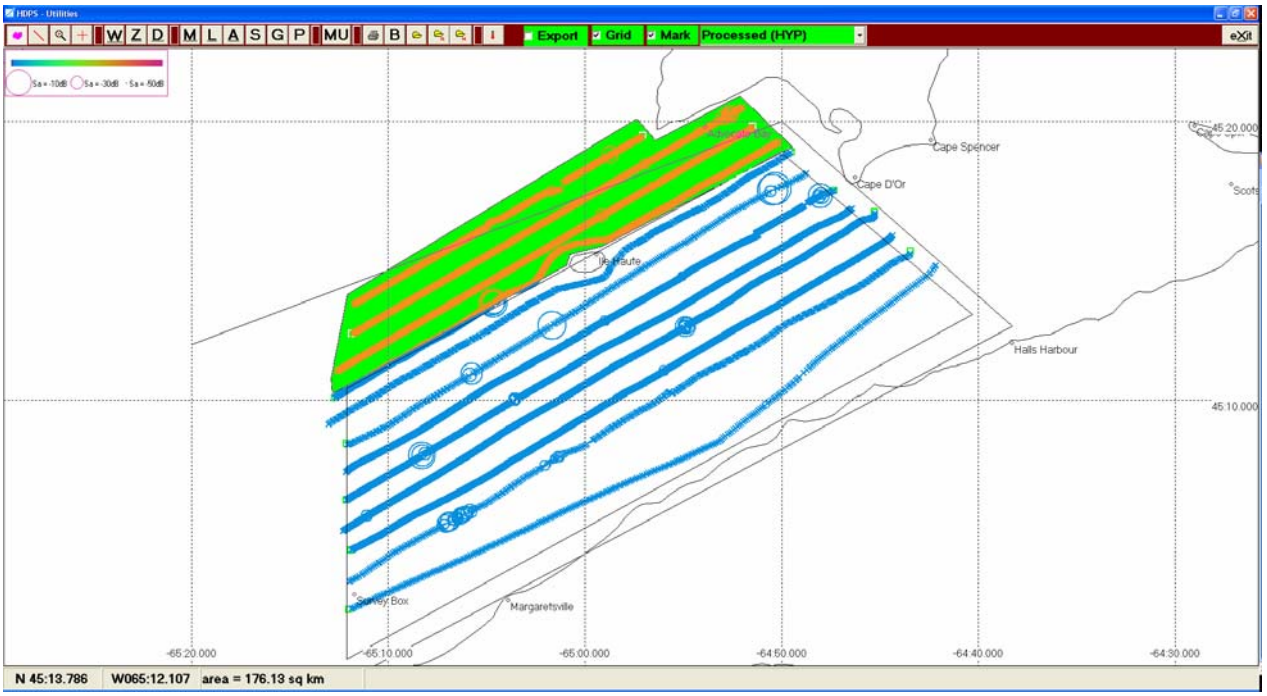


Figure 8. Scots Bay acoustic survey (#3) on July 25, 2009, showing transects inside and outside the standard survey area with area outside the box estimated as 180 km$^2$.

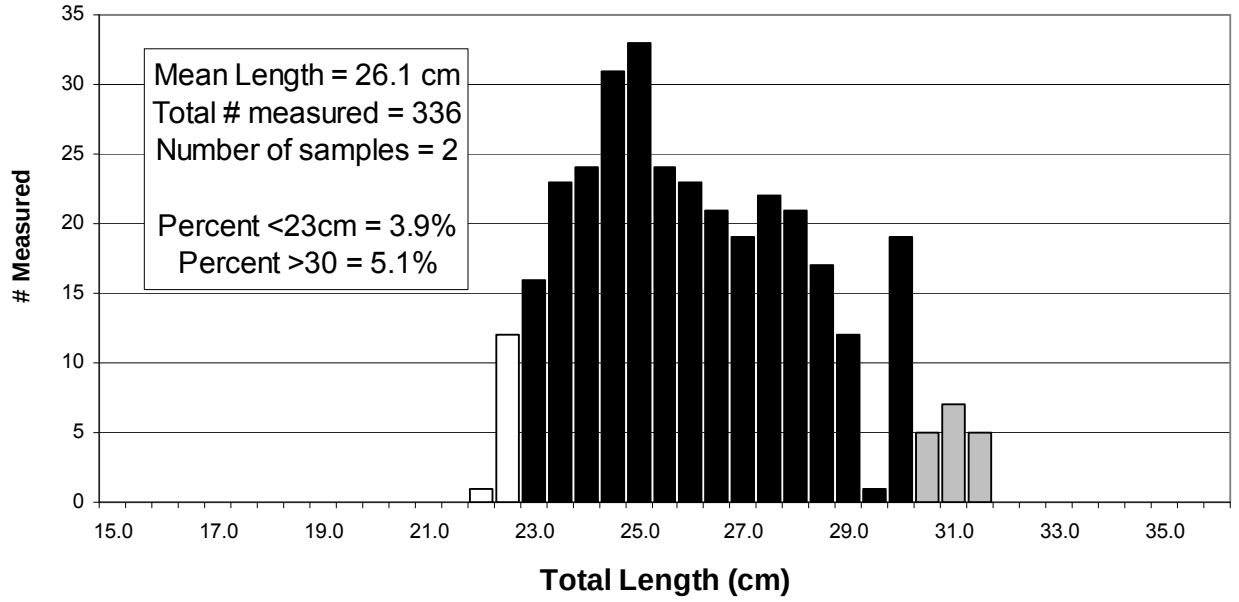


Figure 9. Length distribution for Scots Bay survey (#3) on July 25, 2009 from sampling on July 26 with proportions <23 and >30cm. Bars are shaded white for sizes less than 23cm and grey for sizes greater than 30cm.

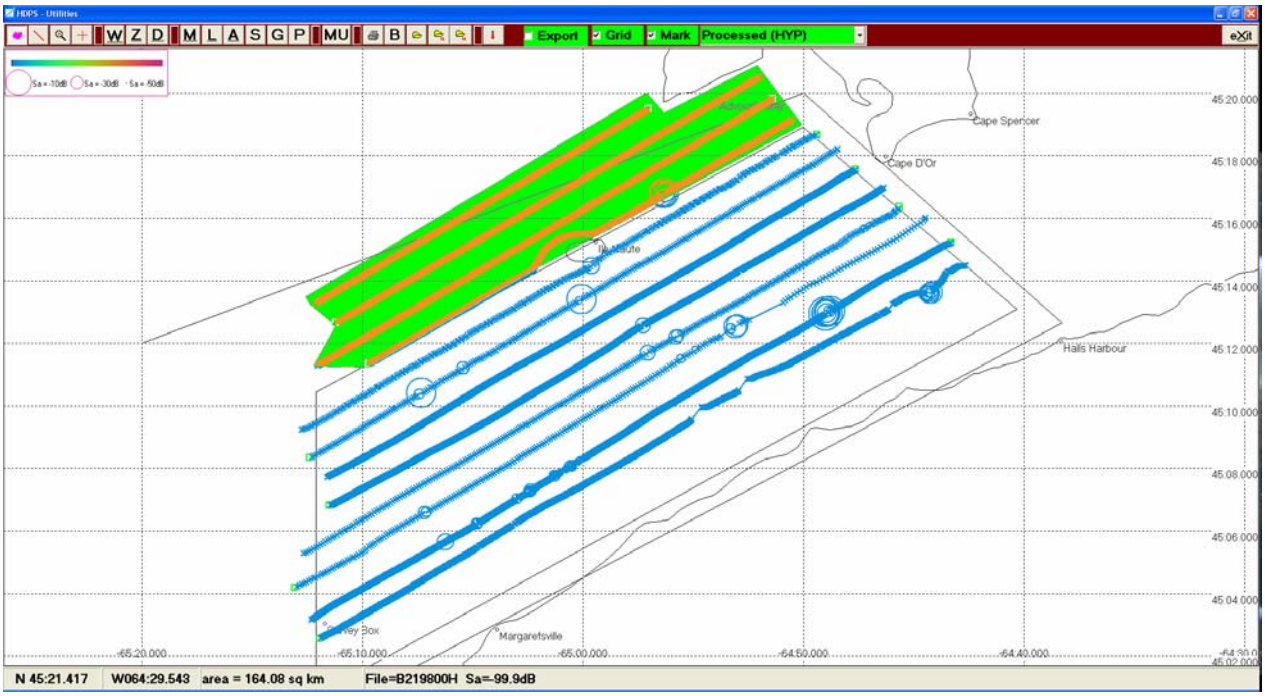


Figure 10. Scots Bay acoustic survey (#4) on Aug. 8, 2009, showing transects inside and outside the standard survey area with area outside the box estimated as 164km$^2$.

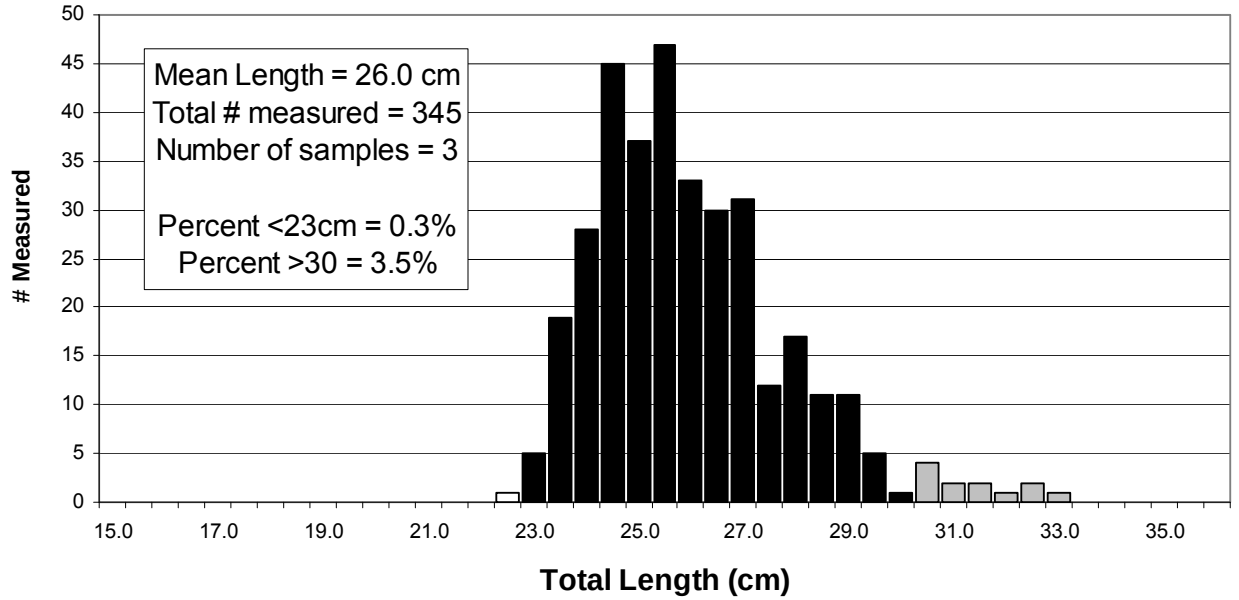


Figure 11. Length distribution for Scots Bay survey (#4) on Aug. 8, 2009, from sampling on Aug. 9-10$^{th}$ with proportions <23 and >30cm. Bars are shaded white for sizes less than 23cm and grey for sizes greater than 30cm.

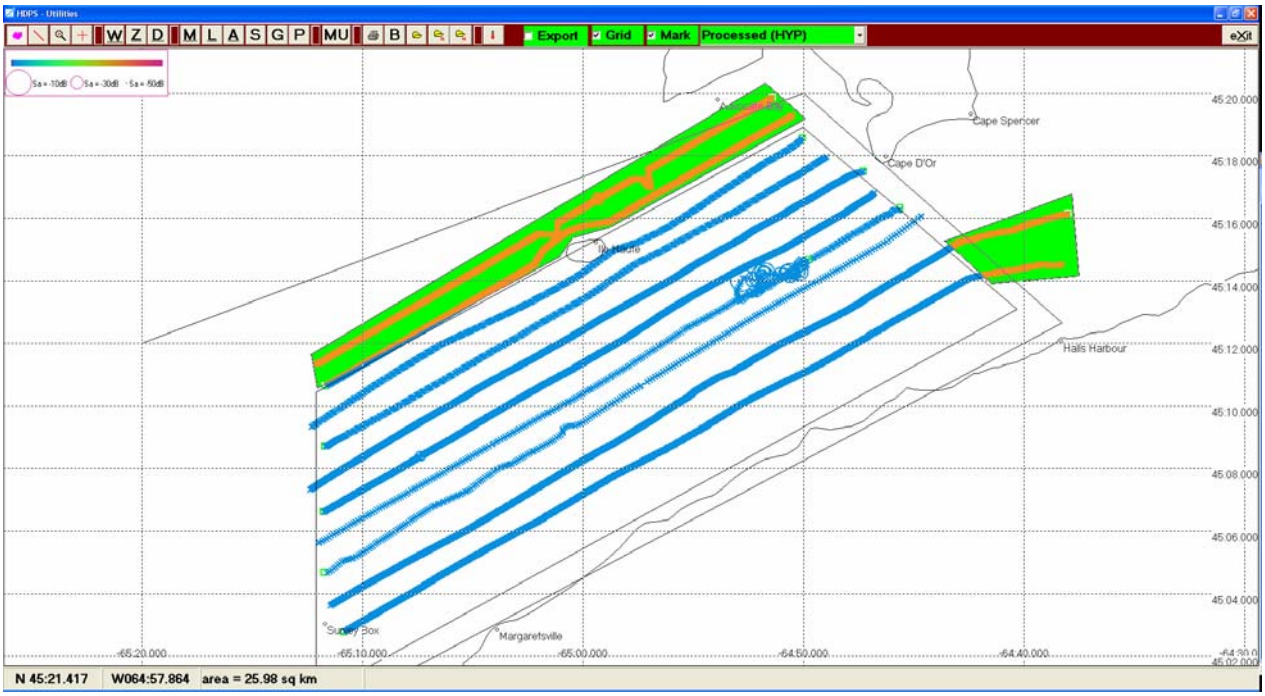


Figure 12. Scots Bay acoustic survey (#5) on Aug. 21, 2009, showing transects inside and outside the standard survey area with area outside the box estimated as 80+25=105km$^2$.

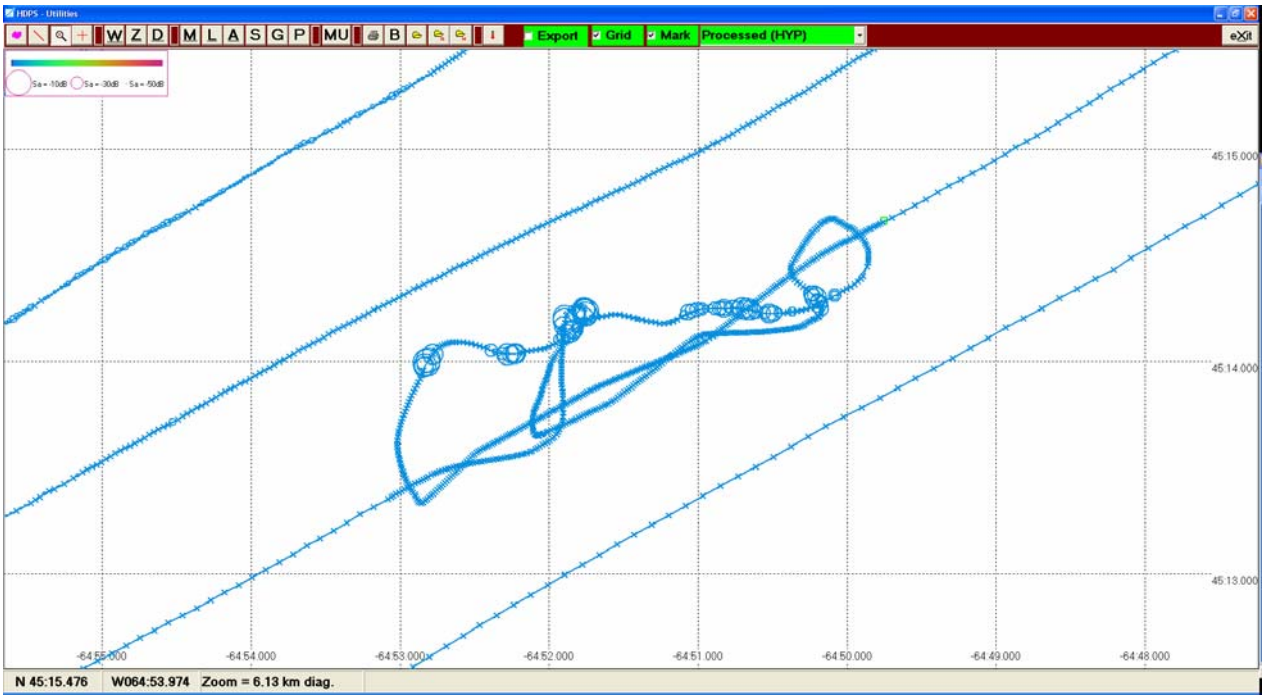


Figure 13. Scots Bay acoustic survey (#5) on Aug. 21, 2009, with lines completed on school.

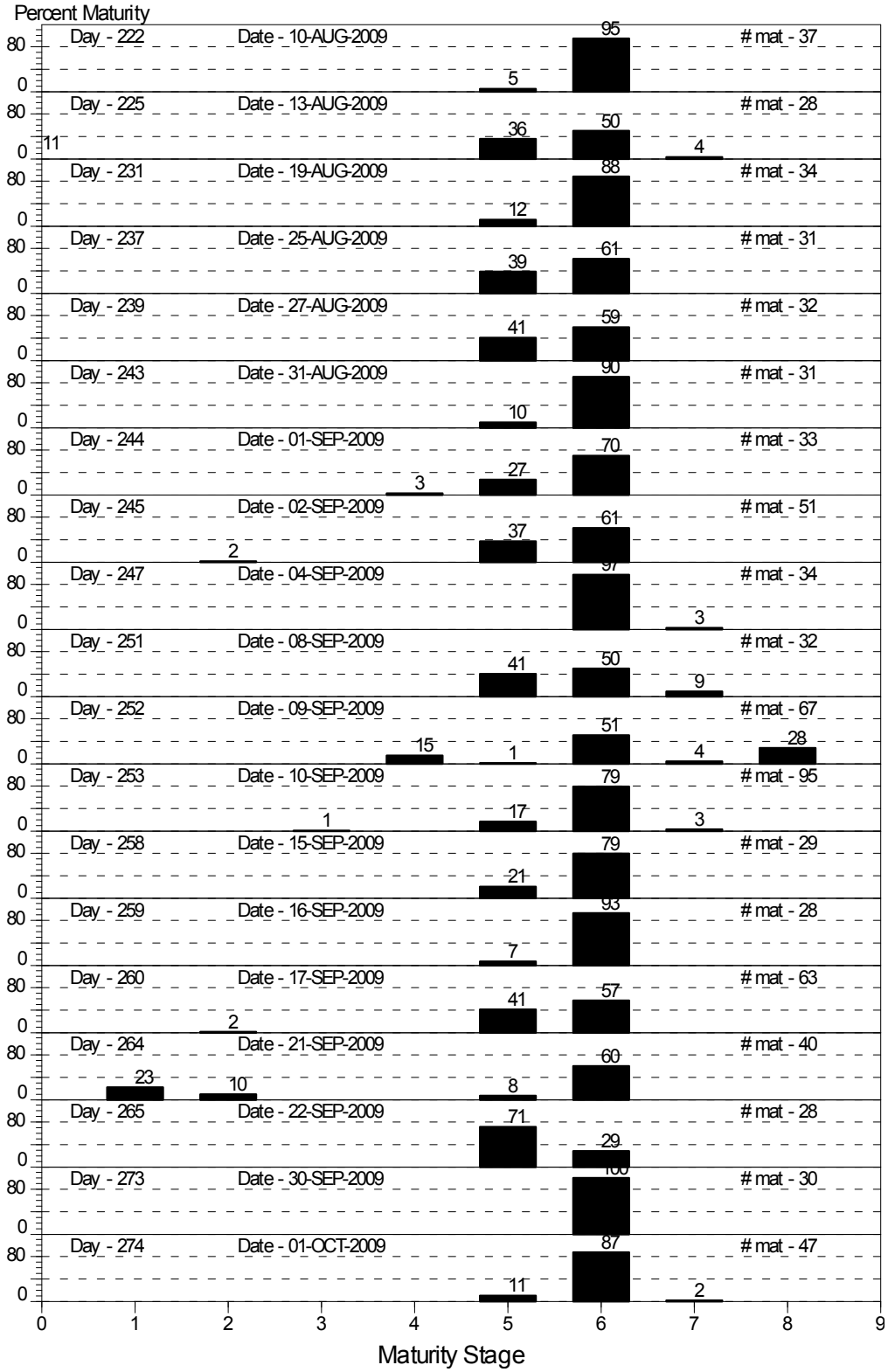


Figure 14. Daily herring maturity samples collected from German Bank survey box area in 2009. (Staging codes 1-2=immature; 3-4-5=maturing/hard; 6=ripe and running; 7=spent; 8=recovering).

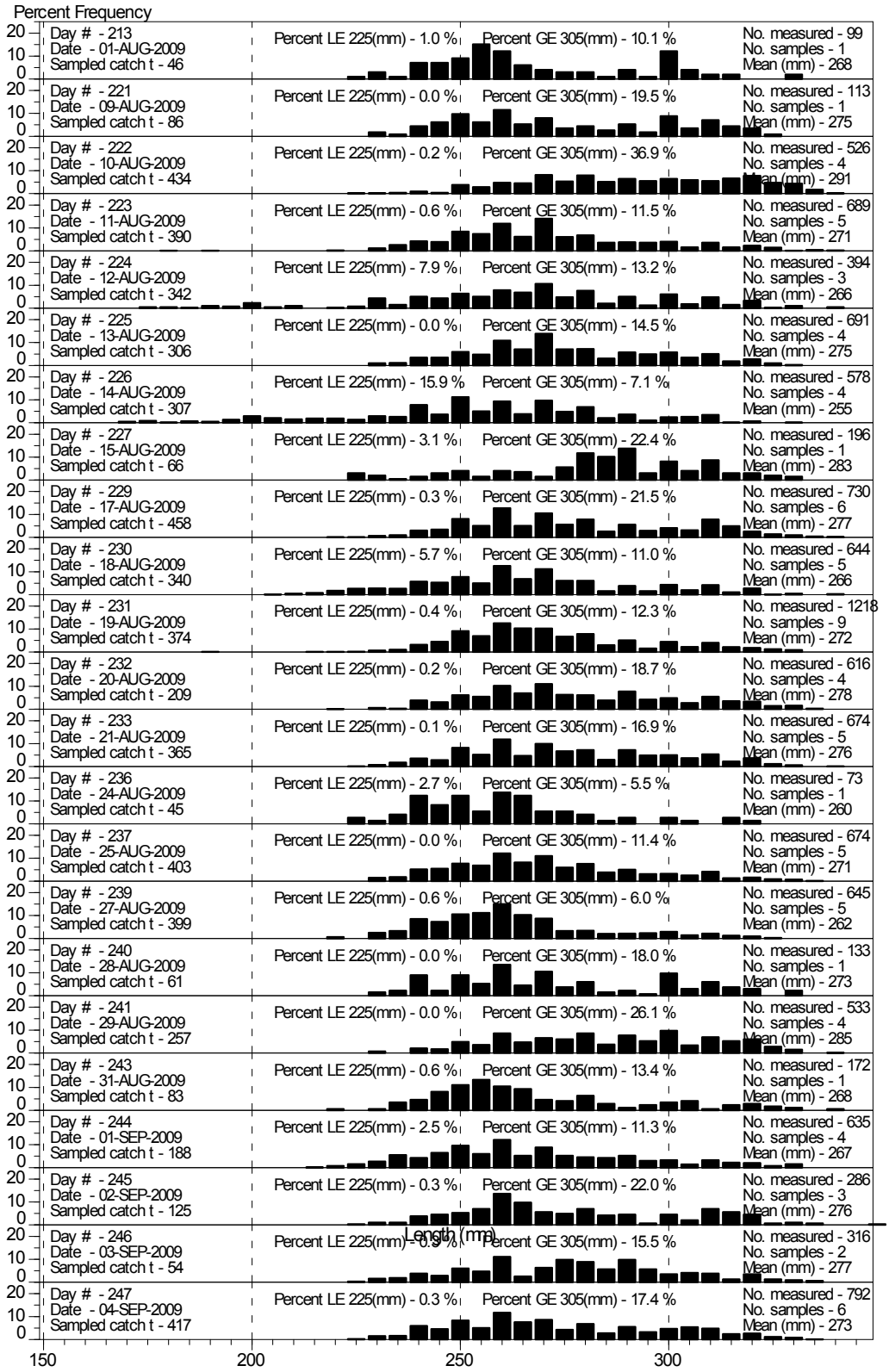


Figure 15a. Daily herring length frequency samples collected from 2009 German Bank survey box area for period from Aug. 1 to Sept. 4, 2009, with proportions <23cm and >30cm.

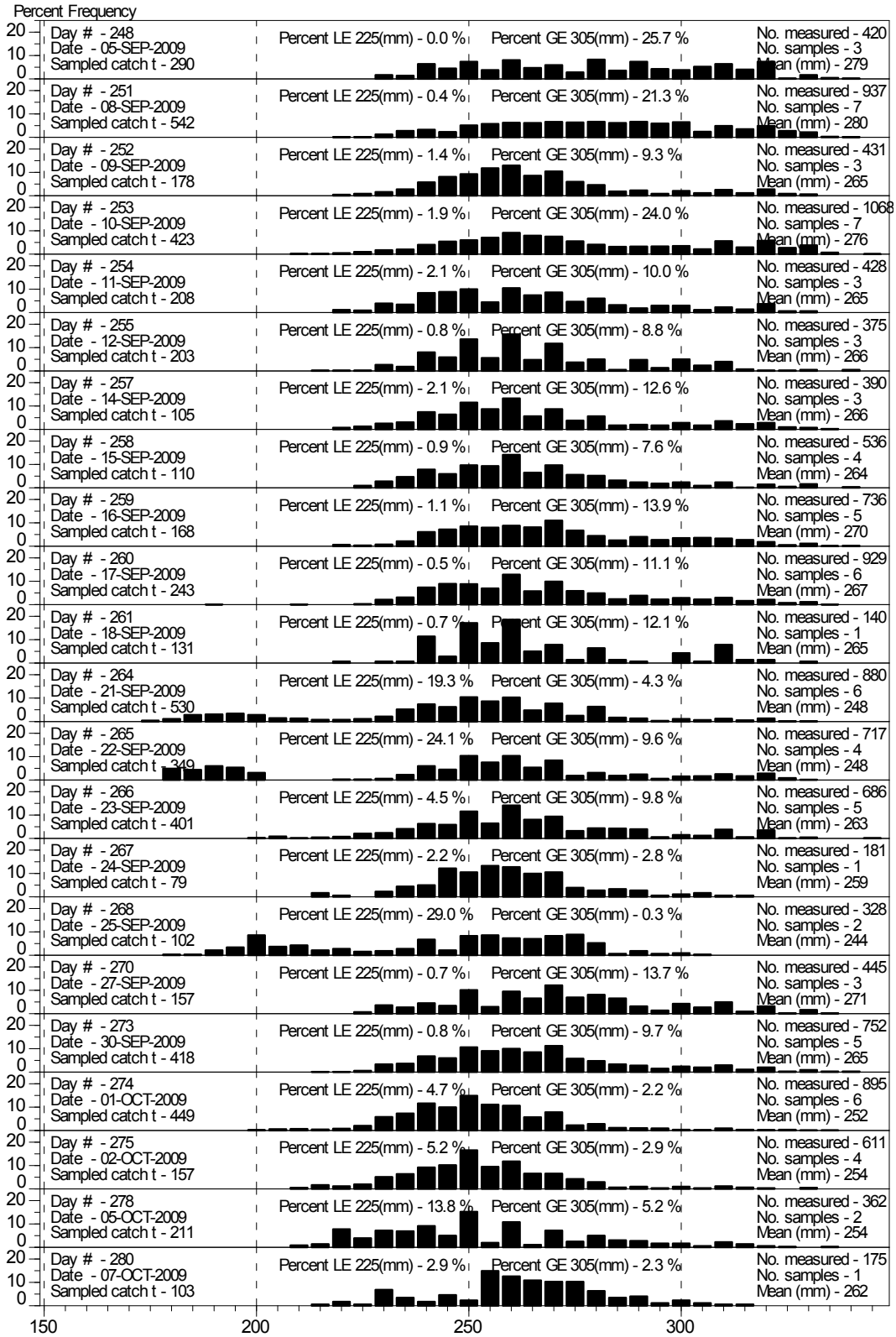


Figure 15b. Daily herring length frequency samples collected from 2009 German Bank survey box area for period from Sept. 5 to Oct. 7, 2009, with proportions <23cm and >30cm.

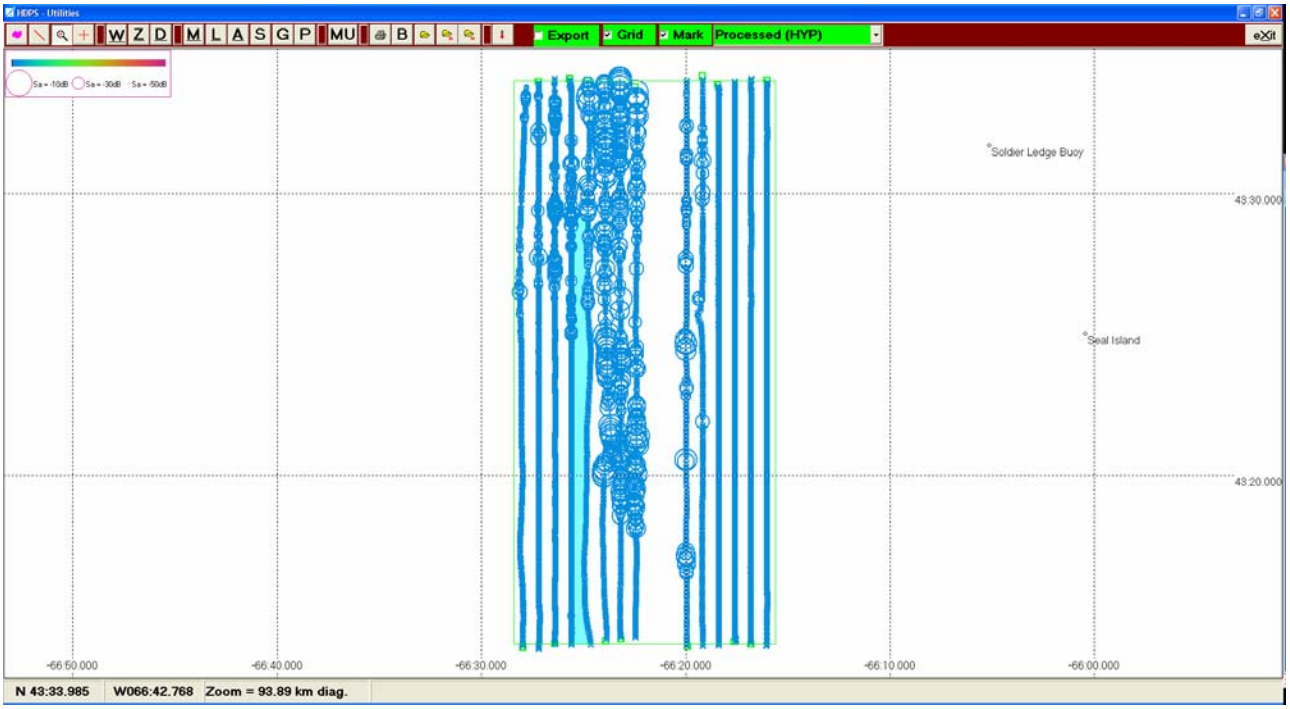


Figure 16. German Bank acoustic survey (#1) on August 12, 2009, with transects showing location and backscatter (Sa) in the main survey box (highlighted area). Gap in line distribution was a result of an error in the survey plan.

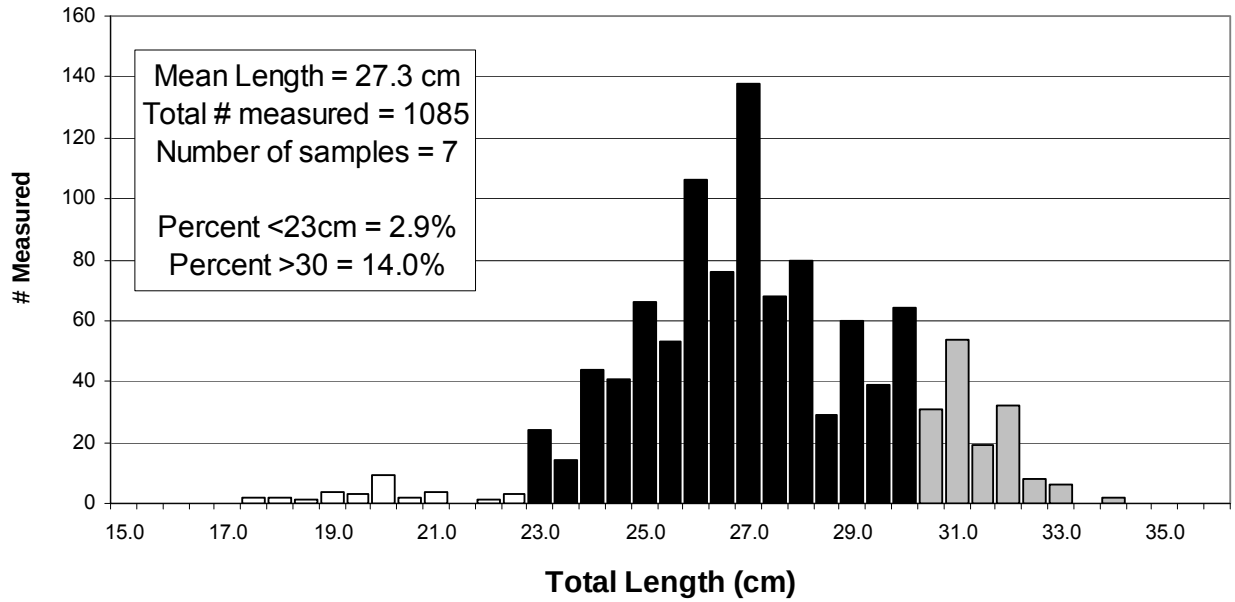


Figure 17. Length distribution used for calculation of target strength for the German Bank acoustic survey (#1) on Aug. 12, 2009, from sampling on Aug. 12-13$^{th}$ with proportions <23 and >30cm.

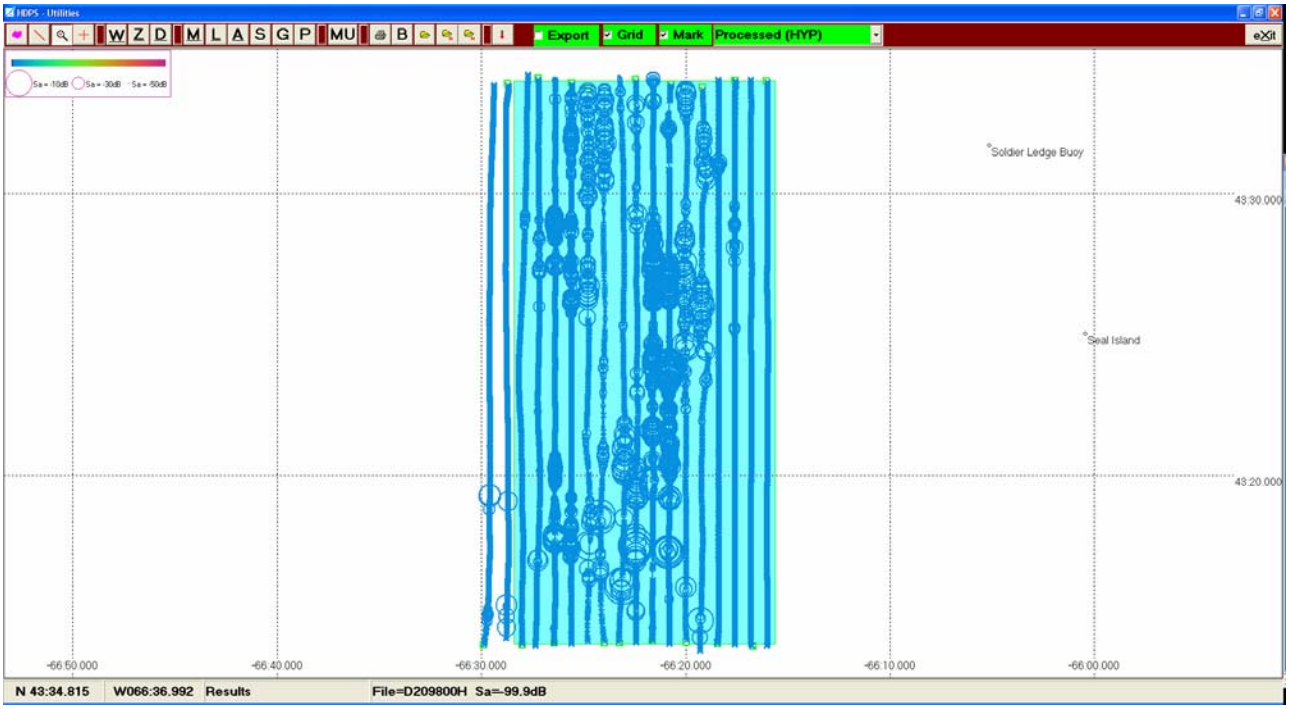


Figure 18. German Bank acoustic survey (#2) on August 25, 2009, showing location and backscatter (Sa) for transects in the survey box. Note 2 transects outside the survey box on the western edge.

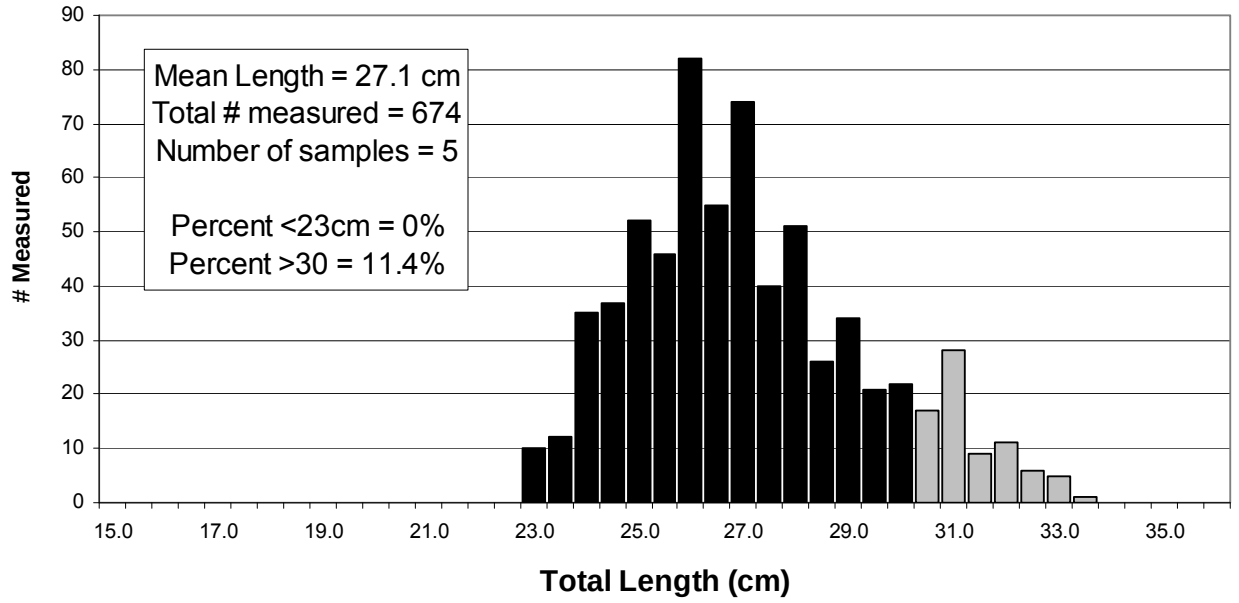


Figure 19. Length distribution used for calculation of target strength for the German Bank acoustic survey (#2) on August 25, 2009, from sampling on Aug. 25th with proportions <23 and >30cm.

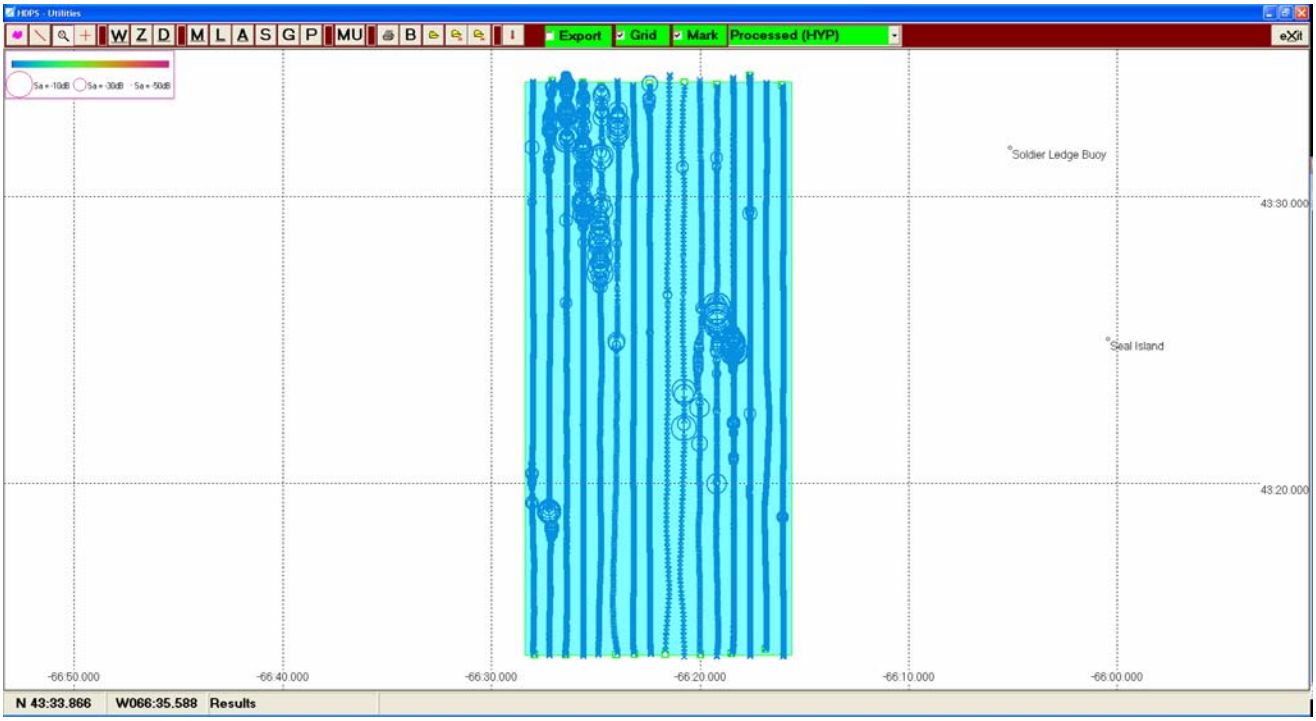


Figure 20. German Bank acoustic survey (#3) on Sept. 8, 2009, showing location and backscatter (Sa) for transects in the survey box.

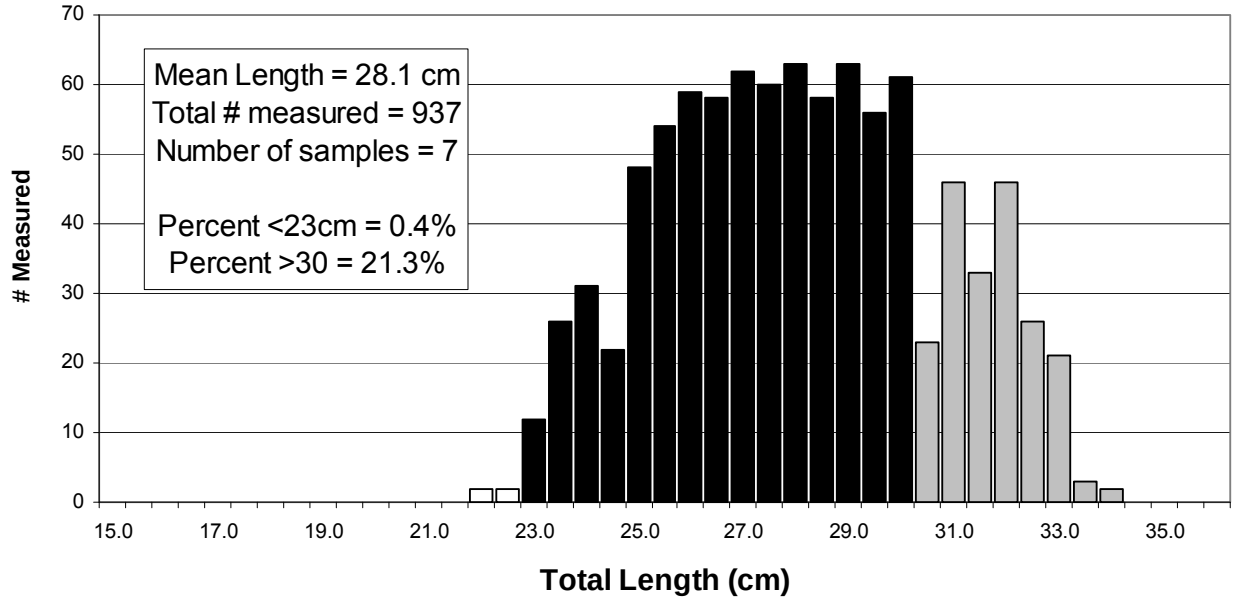


Figure 21. Length distribution used for calculation of target strength for the German Bank acoustic survey (#3) on Sept. 8, 2009, from sampling on Sept. 8th with proportions <23 and >30cm.

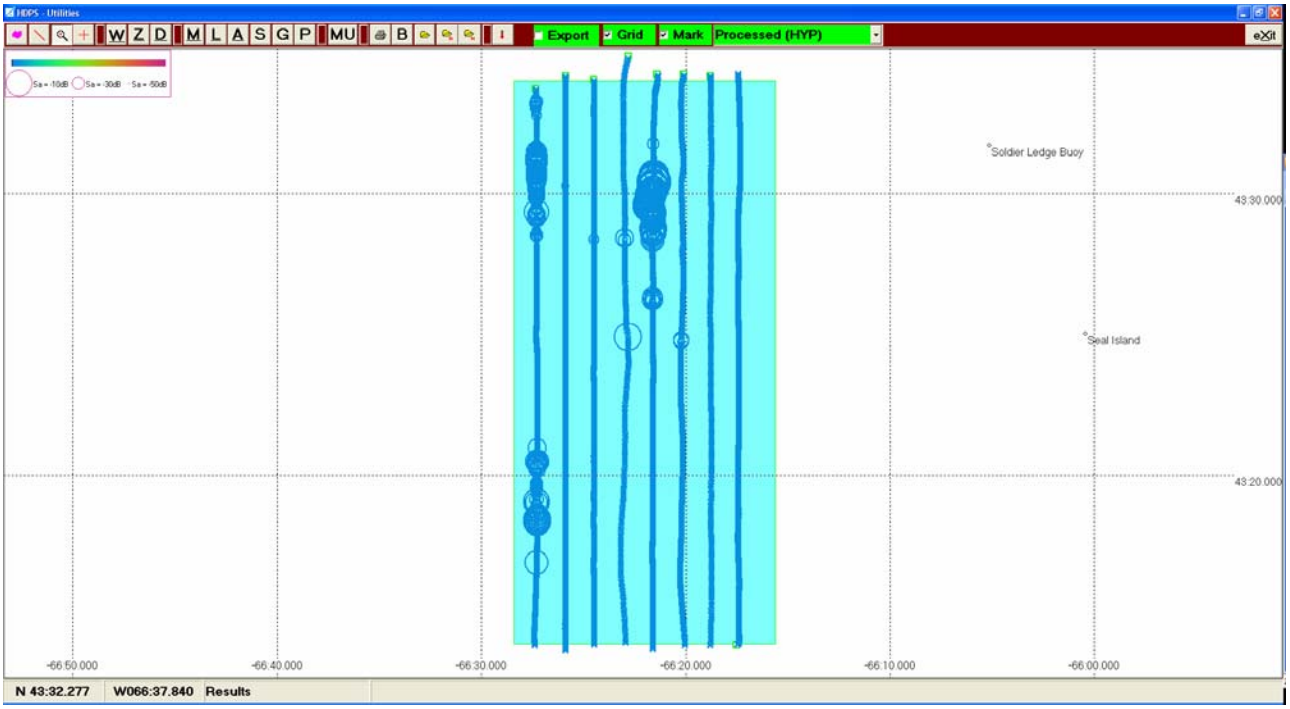


Figure 22. German Bank acoustic survey (#4) on Sept. 14, 2009, showing location and backscatter (Sa) for transects in the survey box. Note survey repeated only 6 days after previous survey at suggestion from fishing fleet.

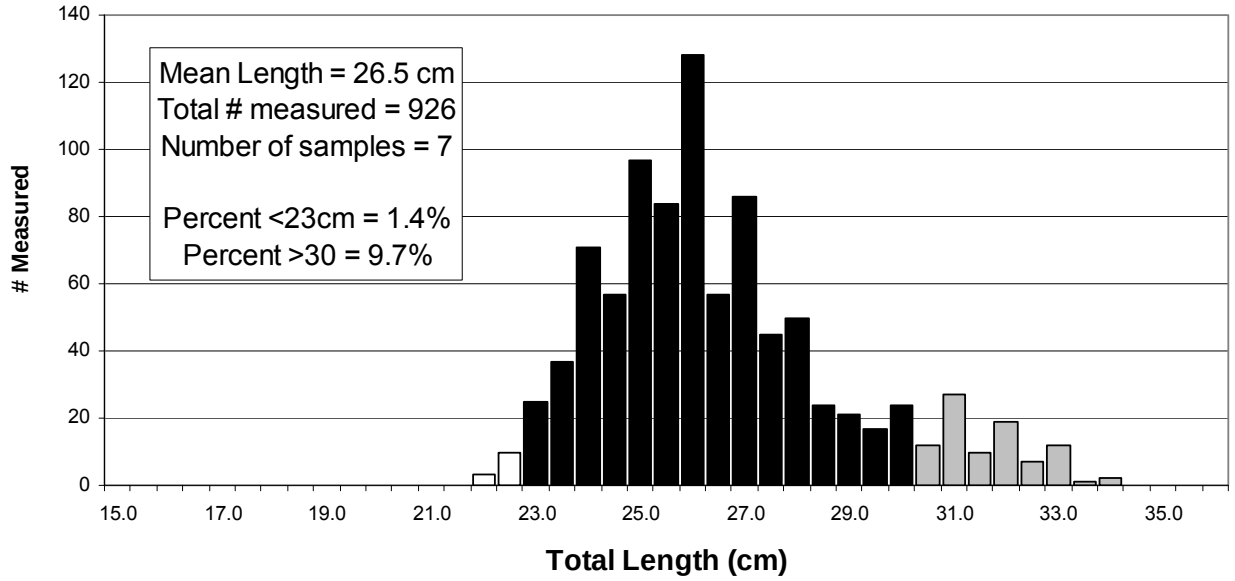


Figure 23. Length distribution used for calculation of target strength for the German Bank acoustic survey (#4) on Sept. 14, 2009, from sampling on Sept. 14-15$^{th}$ with proportions <23 and >30cm.

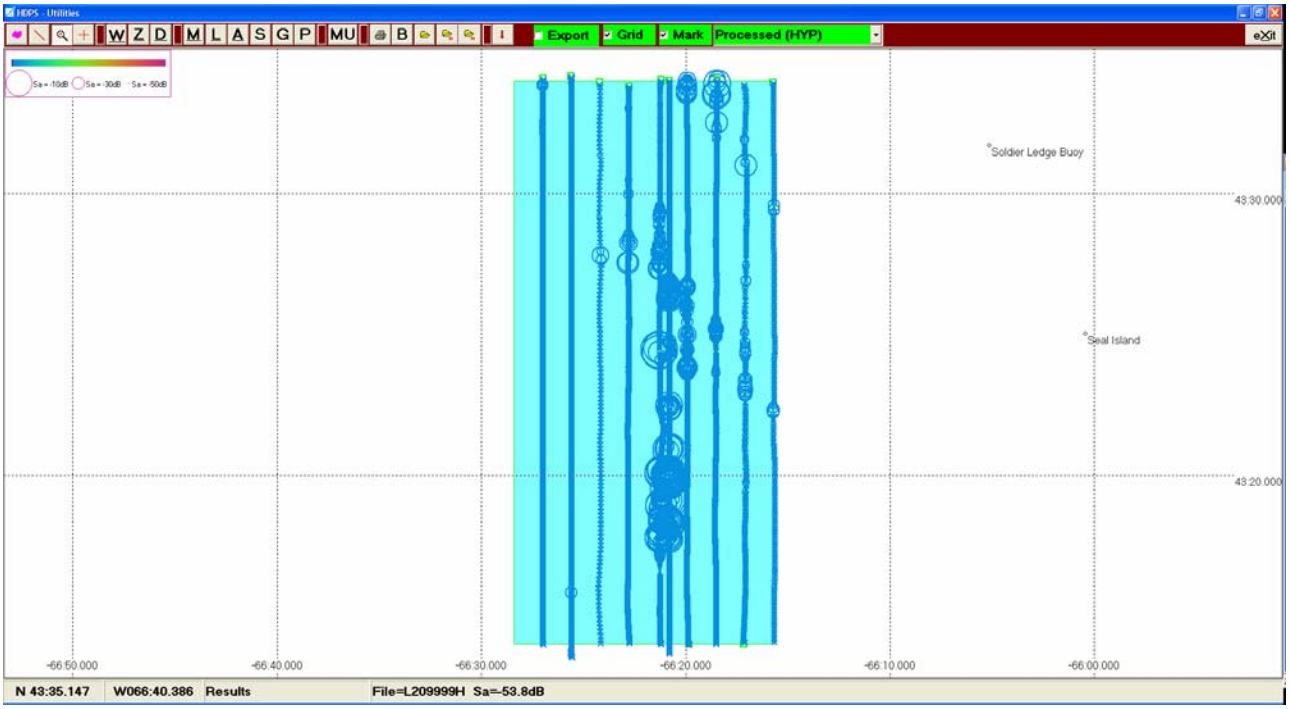


Figure 24. German Bank acoustic survey (#5) on Sept. 24, 2009, showing location and backscatter (Sa) for transects in the survey box.

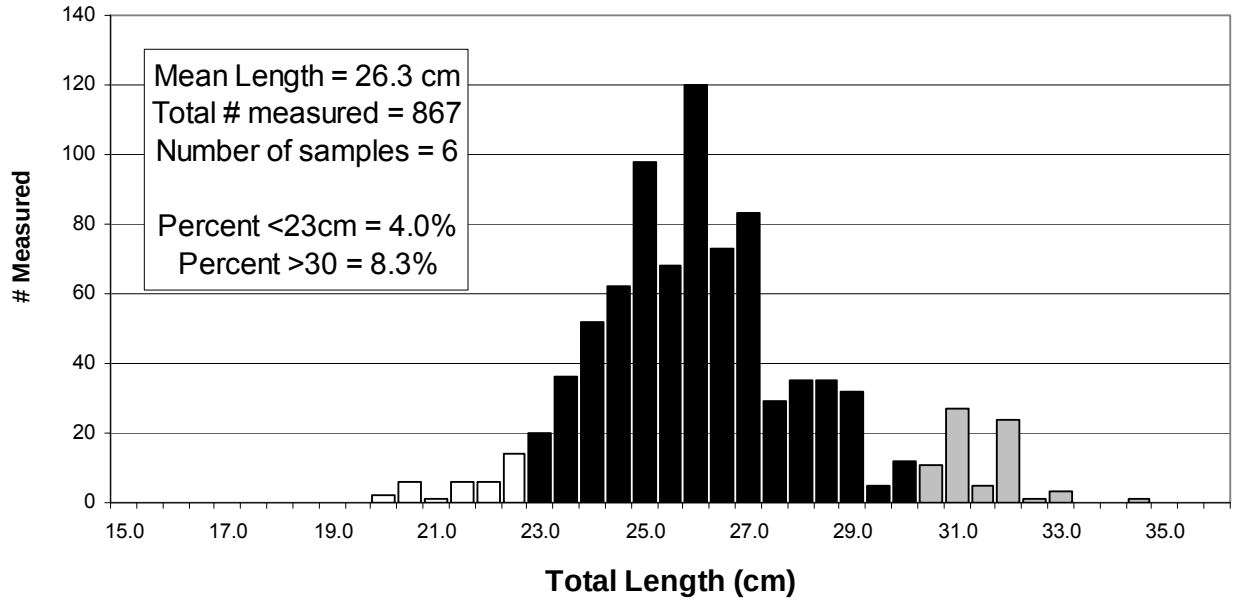


Figure 25. Length distribution used for calculation of target strength for the German Bank acoustic survey (#5) on Sept. 24, 2009, from sampling on Sept. 23-24$^{th}$ with proportions <23 and >30cm.

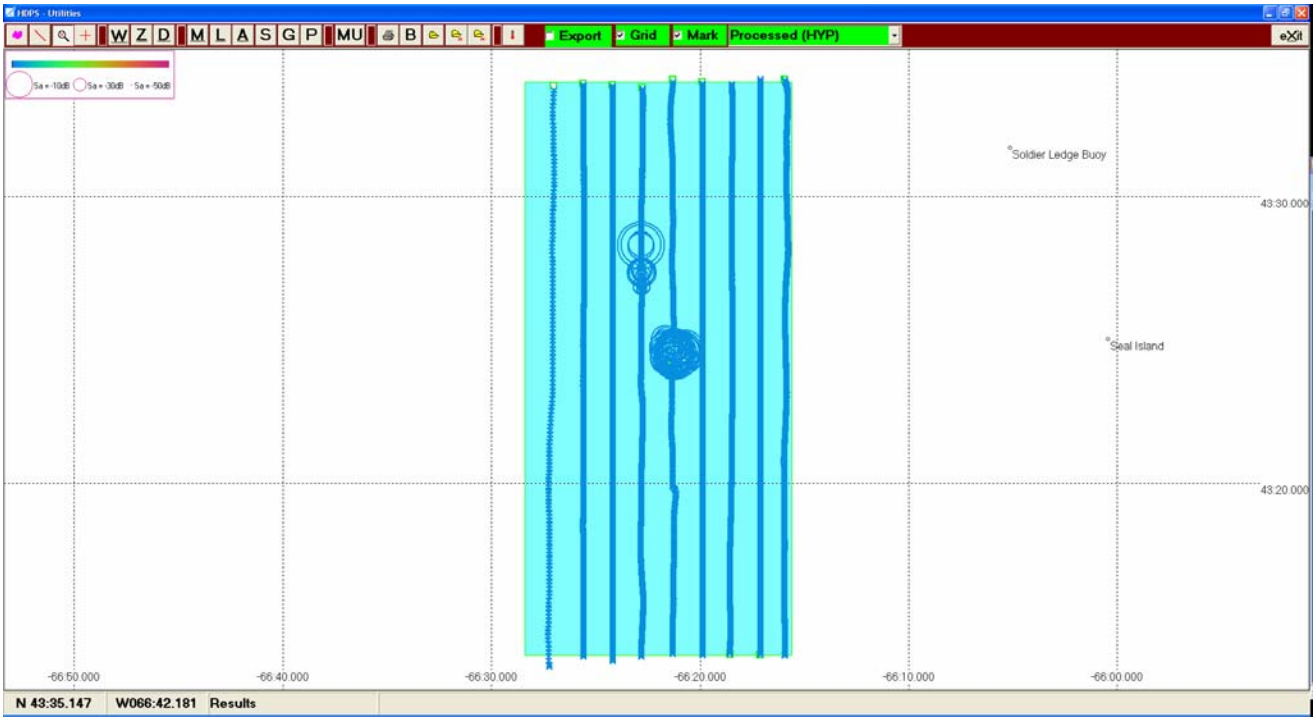


Figure 26. German Bank acoustic survey (#6) on October 5, 2009, showing location and backscatter (Sa) for transects in the survey box.

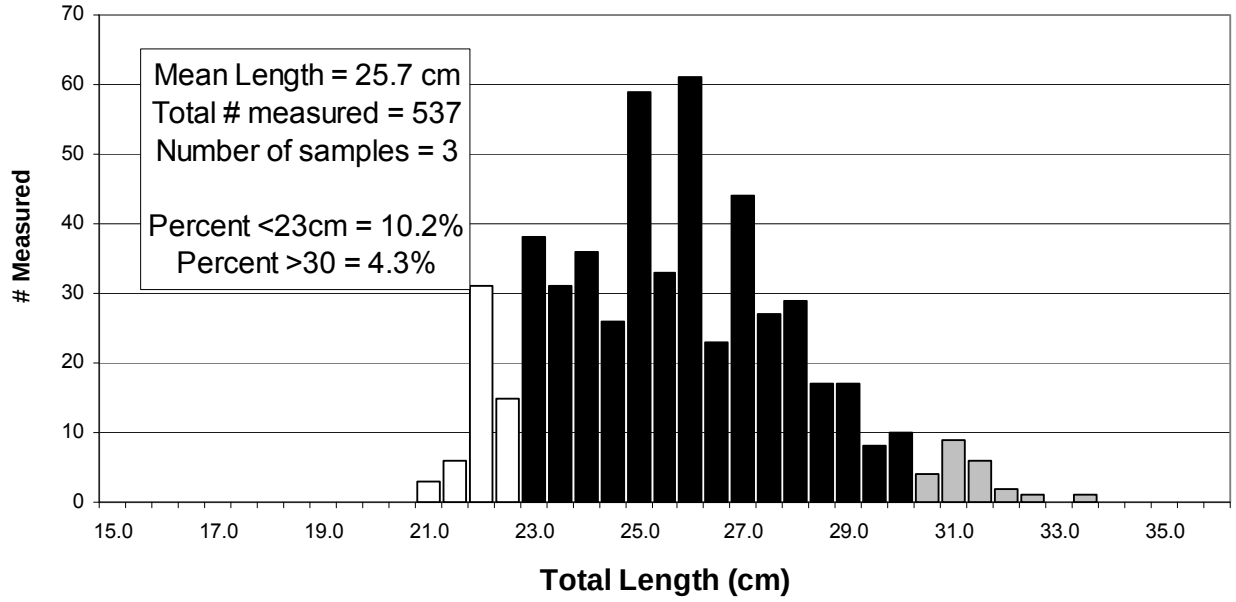


Figure 27. Length distribution used for calculation of target strength for the German Bank acoustic survey (#6) on Oct. 5, 2009, from sampling on Oct. 5-7$^{th}$ with proportions <23 and >30cm.

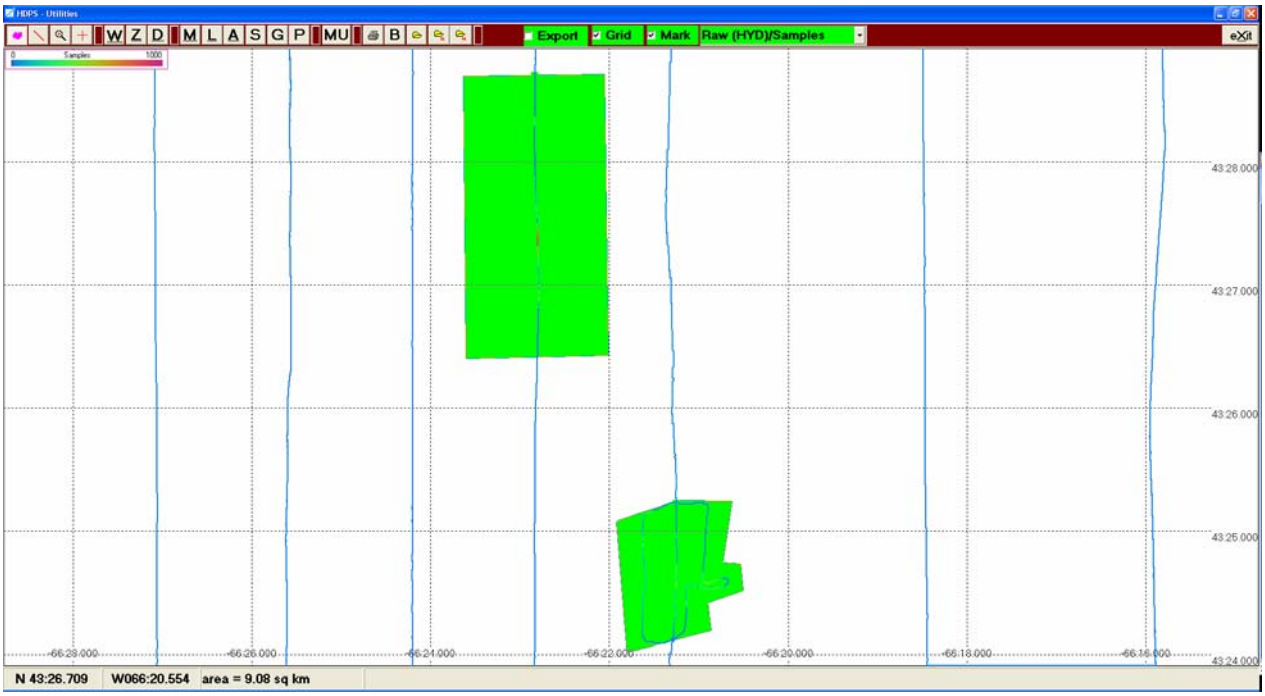


Figure 28. German Bank acoustic survey (#6) on Oct. 5, 2009 with area estimates of 9.08 and 3.25km² for the two areas/schools of fish encountered.

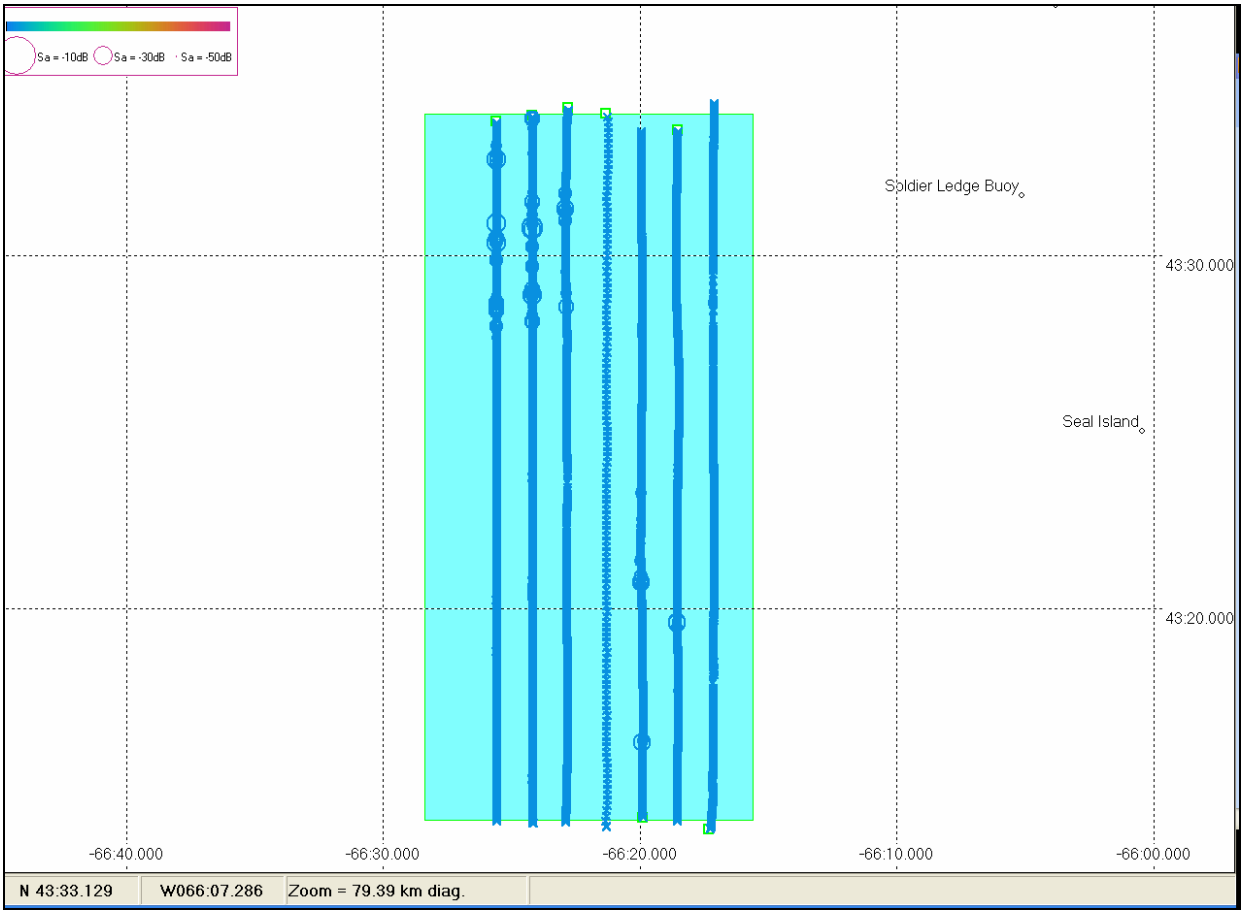


Figure 29. German Bank acoustic survey (#7) on October 20, 2009, showing location and backscatter (Sa) for transects in the survey box.

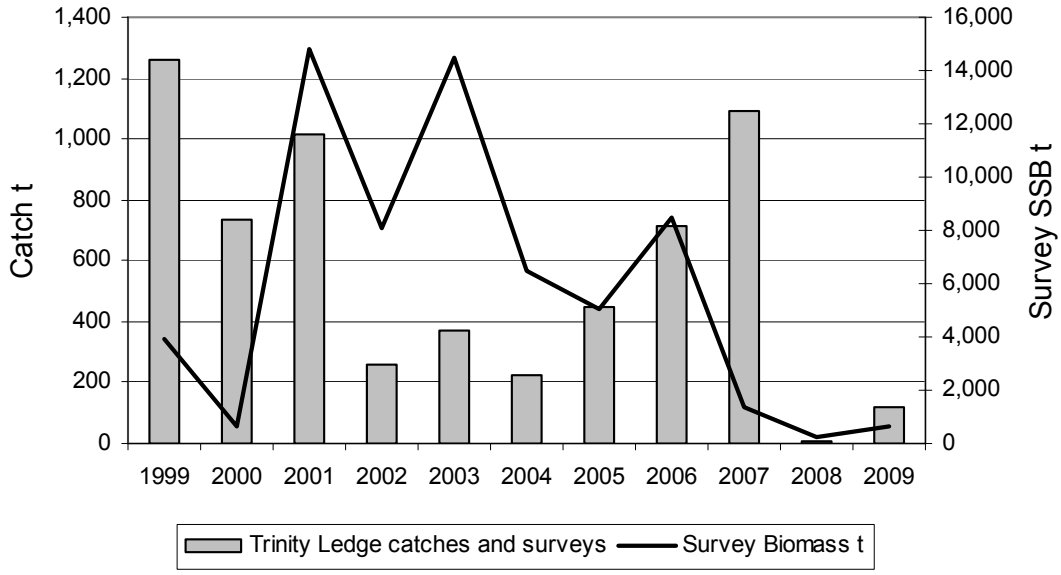


Figure 30. Trinity Ledge herring catches and acoustic survey biomass estimates from 1999 to 2009. All acoustic estimates were calculated without the CIF.

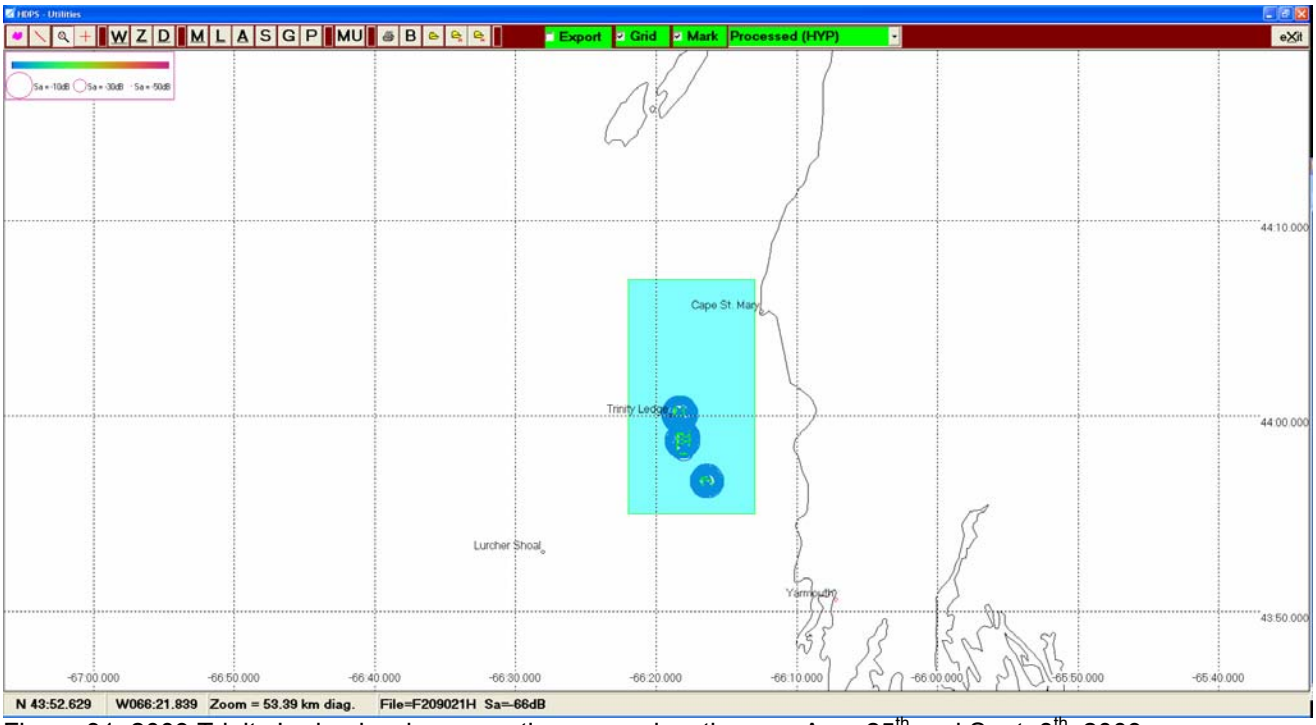


Figure 31. 2009 Trinity Ledge herring acoustic surveys locations on Aug. 25th and Sept. 8th, 2009.

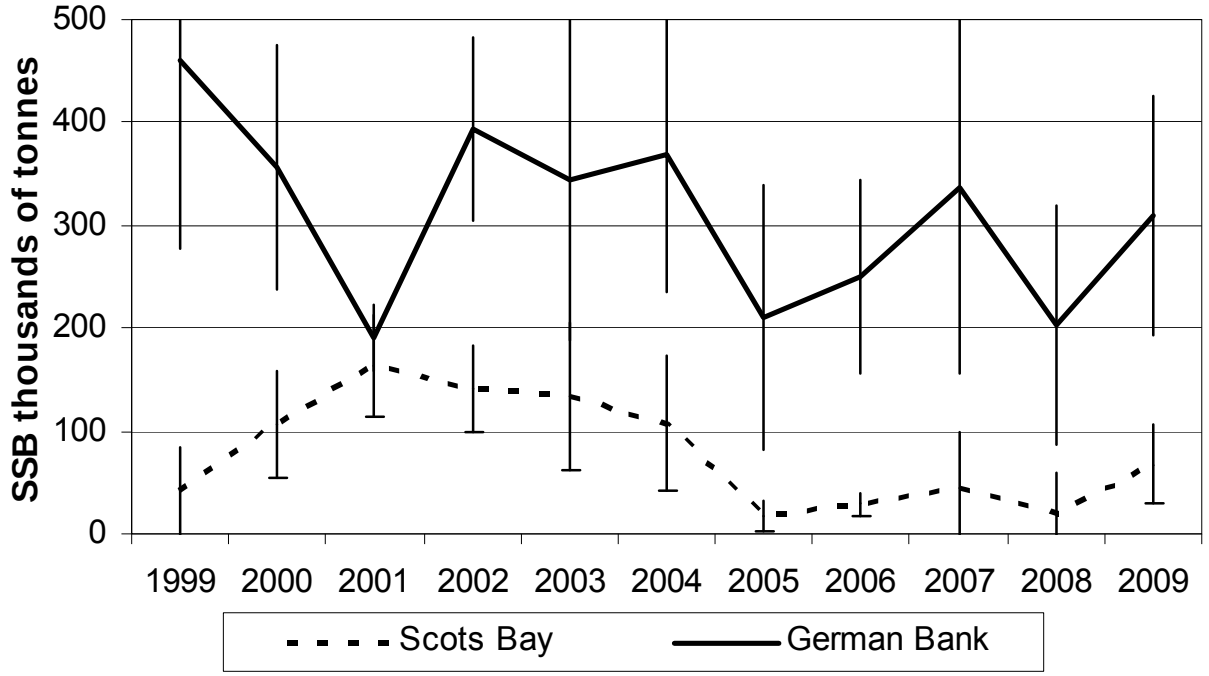


Figure 32. Trends in herring spawning stock biomass from acoustic surveys in Scots Bay and German Bank areas with 95% confidence intervals (equivalent to 2 times SE).

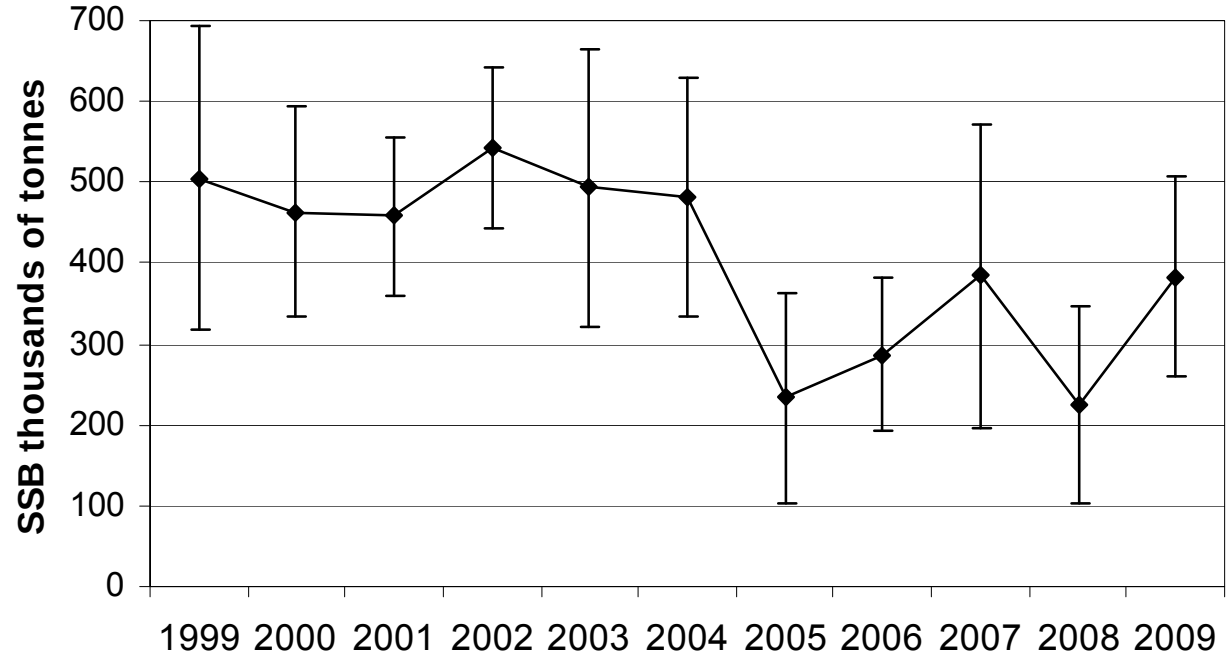


Figure 33. Trends in herring spawning stock biomass from acoustic surveys for the combined SWNS areas with 95% confidence intervals (equivalent to 2 times SE).

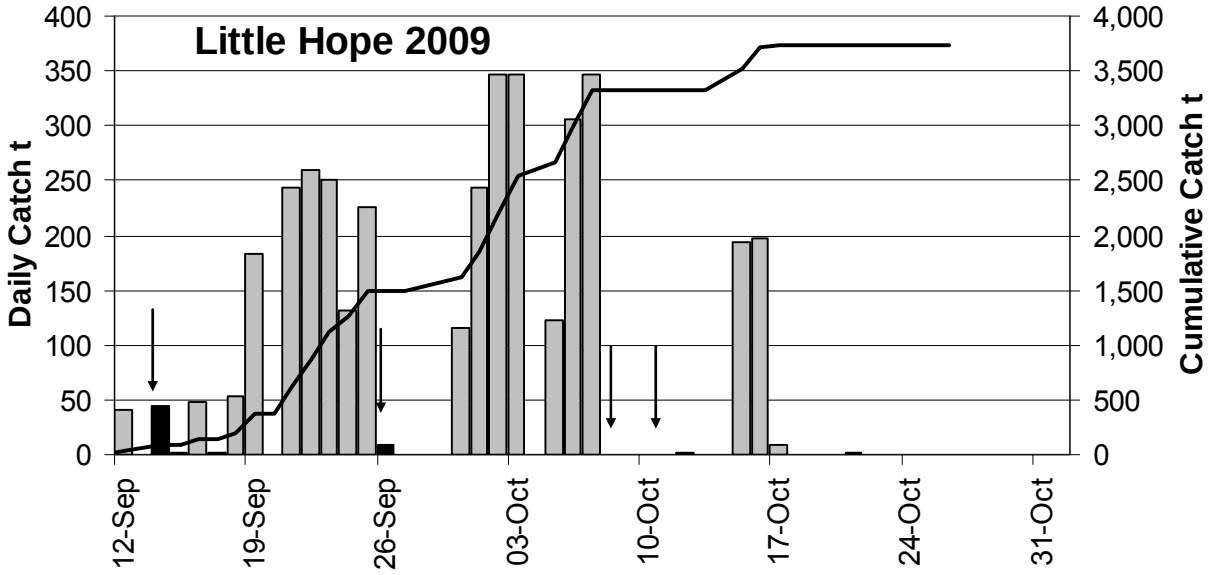


Figure 34. Daily and cumulative catch for the 2009 Little Hope/Port Mouton herring gillnet fishery. Survey dates are identified by black columns and arrows indicating survey date.

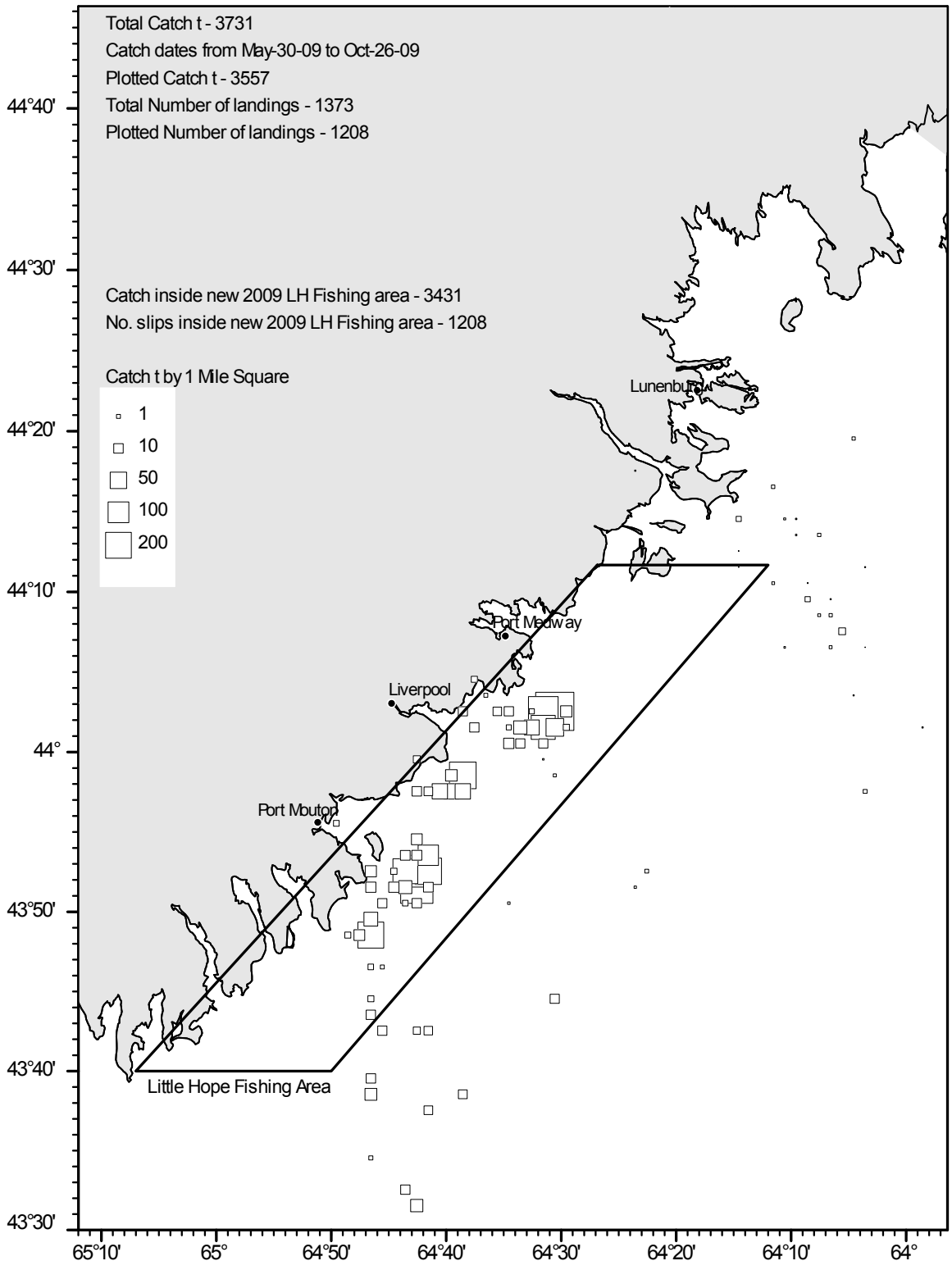


Figure 35. 2009 fishery herring gillnet catch distribution for Little Hope/Port Mouton area.

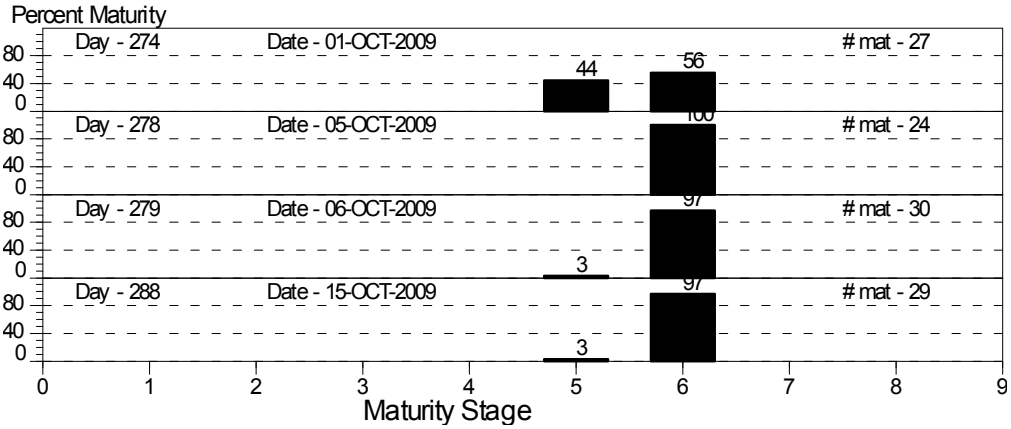


Figure 36. 2009 Port Mouton/Little Hope maturity sample data for gillnet gear types from commercial landings.

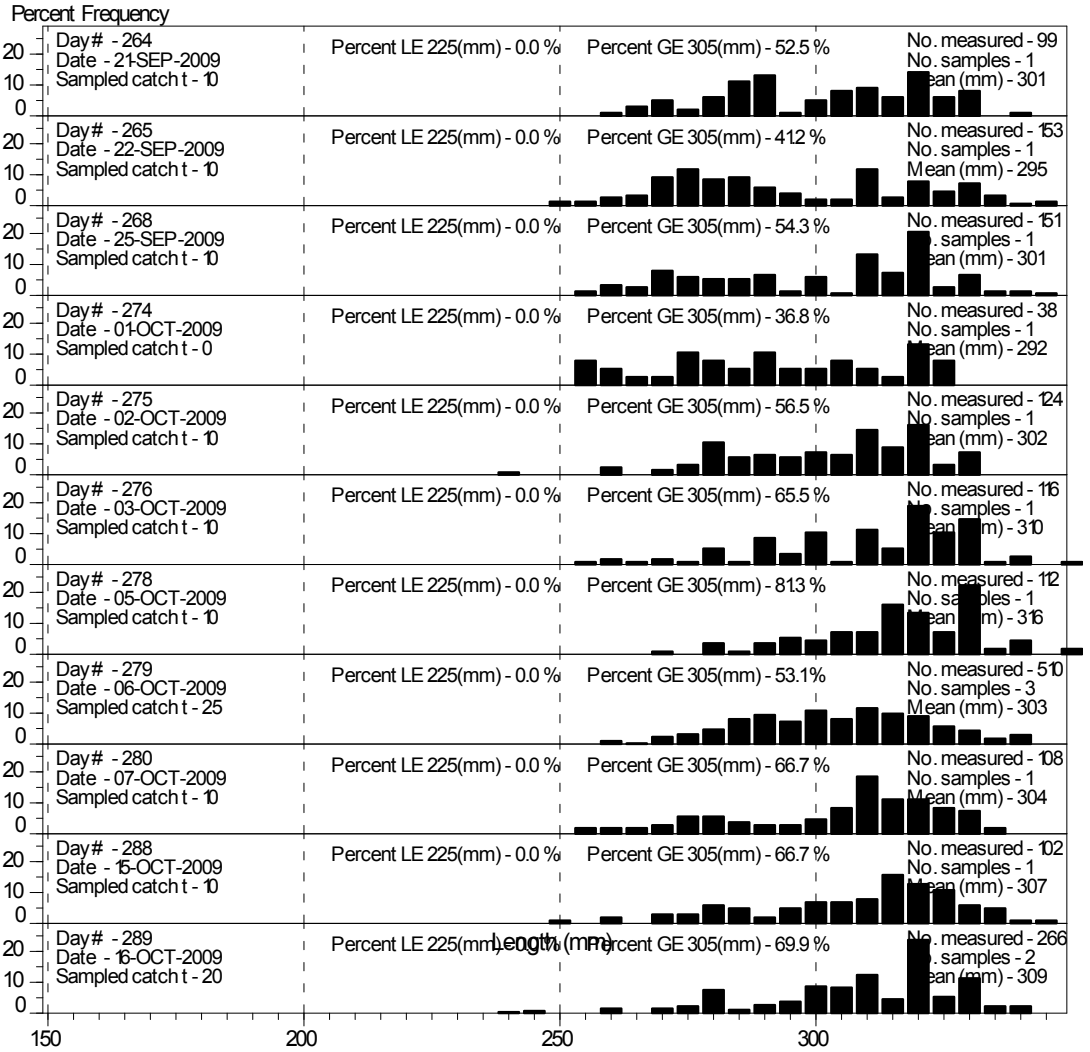


Figure 37. 2009 Port Mouton/Little Hope daily length frequency sampling from commercial landings by gillnet gear.

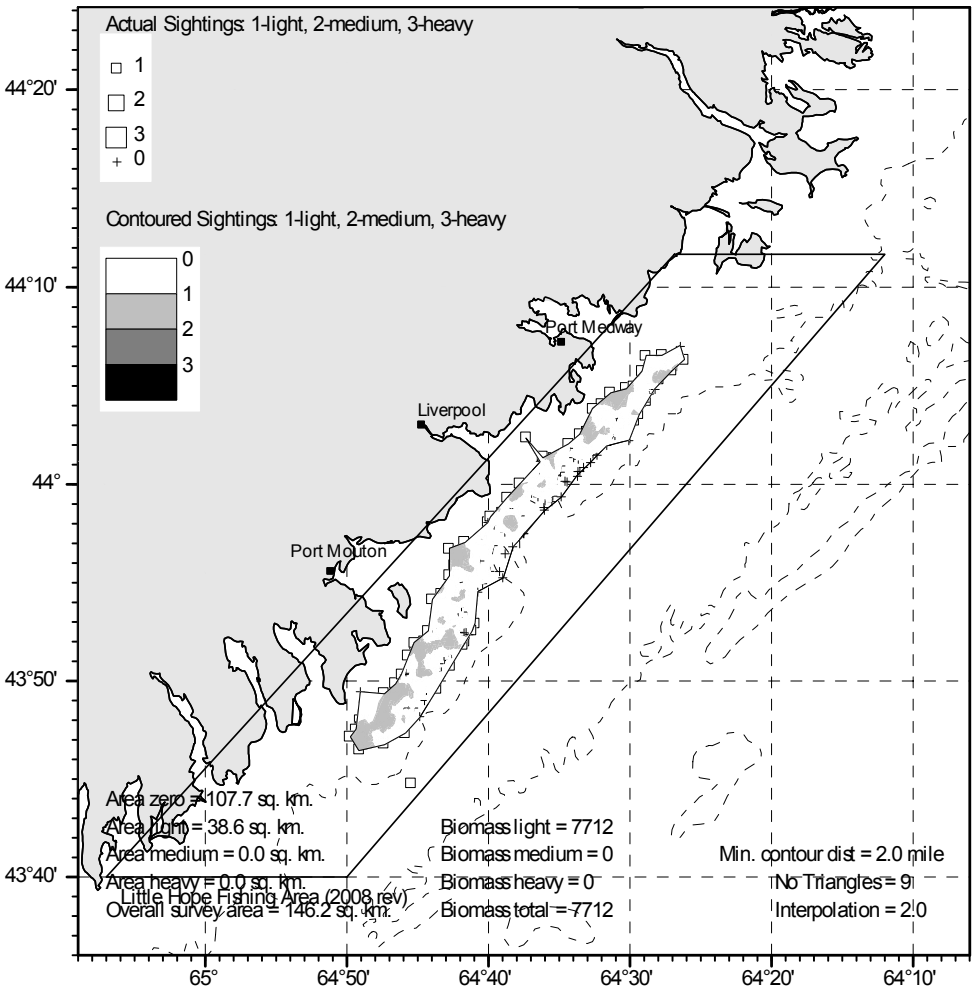


Figure 38. Mapping survey with contouring for Little Hope/Port Mouton area for Sept 14, 2009.

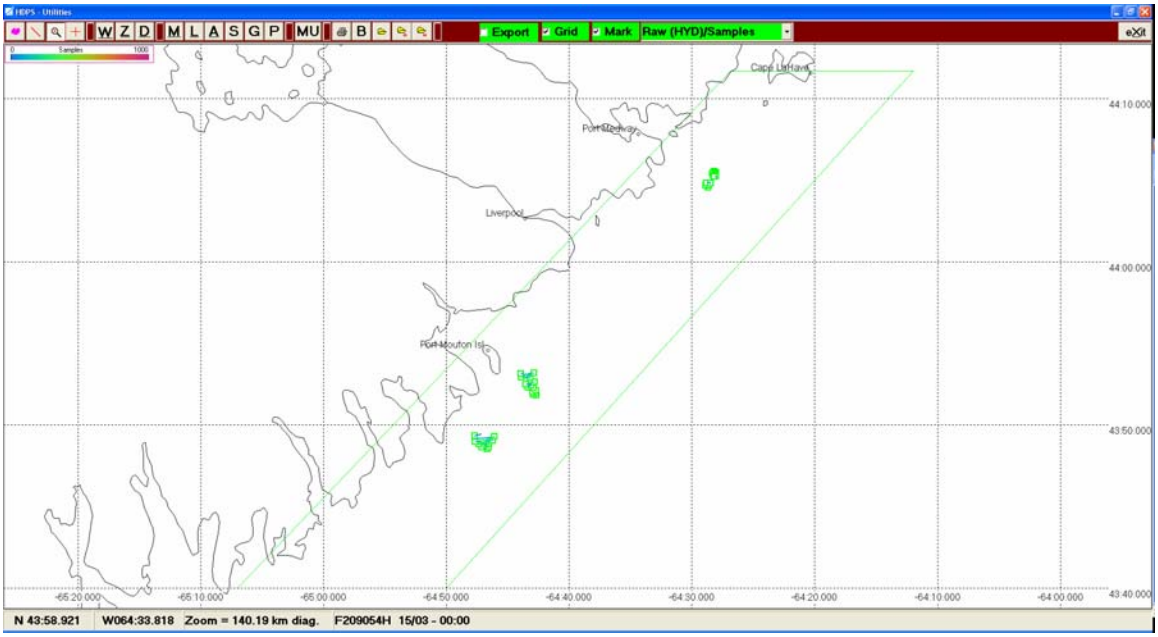


Figure 39. Little Hope/Port Mouton herring gillnet survey for Sept 14, 2009.

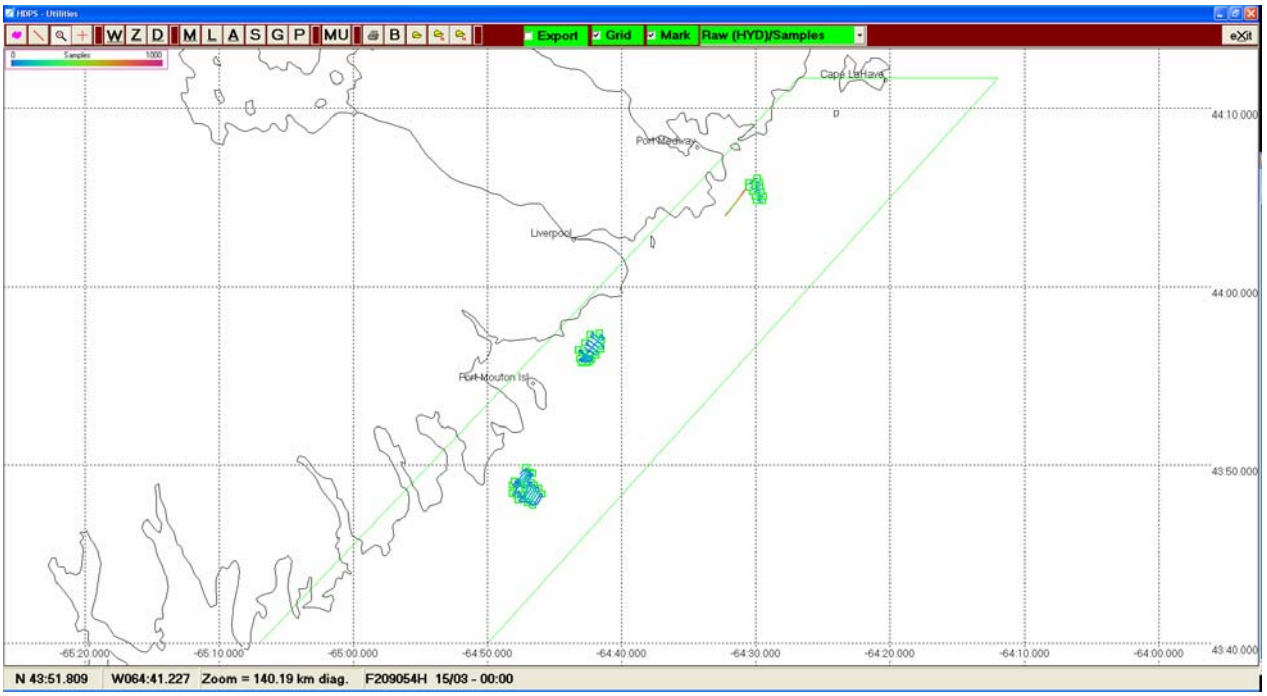


Figure 40. Little Hope/Port Mouton herring gillnet survey for Sept 26, 2009.

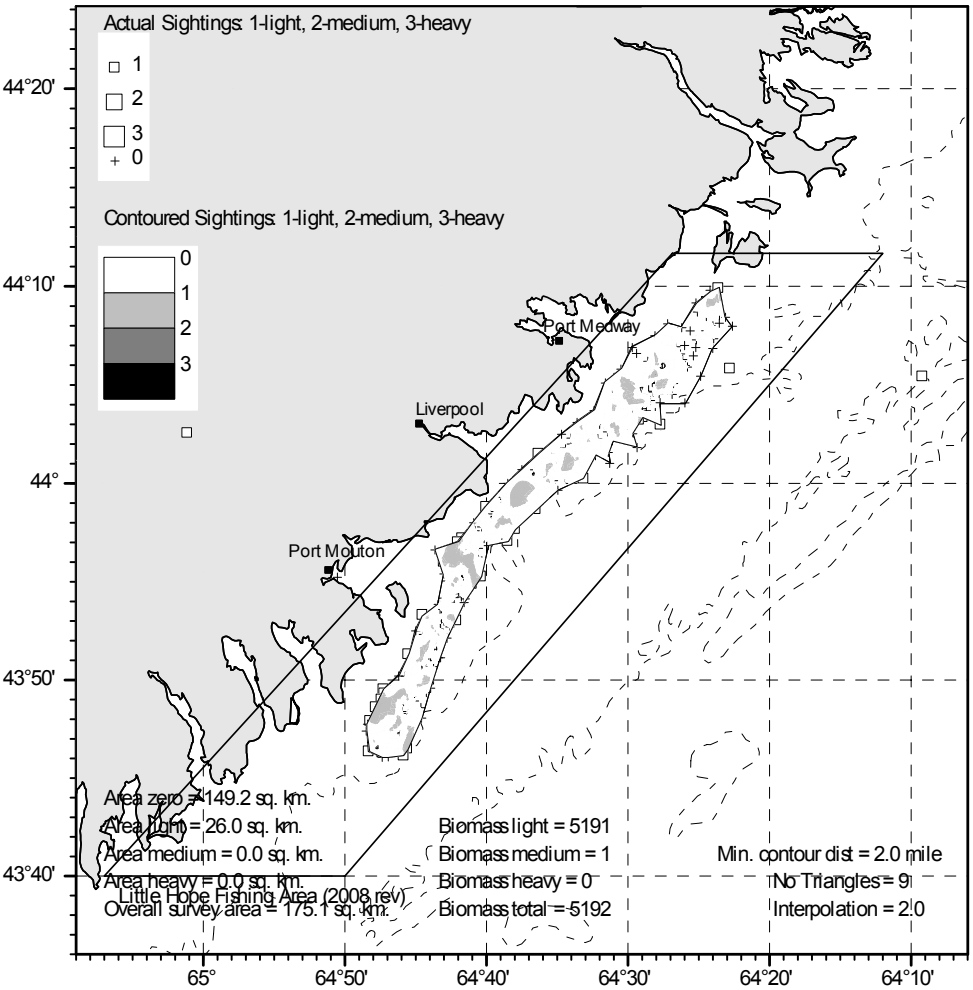


Figure 41. Mapping survey with contouring for Little Hope/Port Mouton area for Sept 26, 2009.

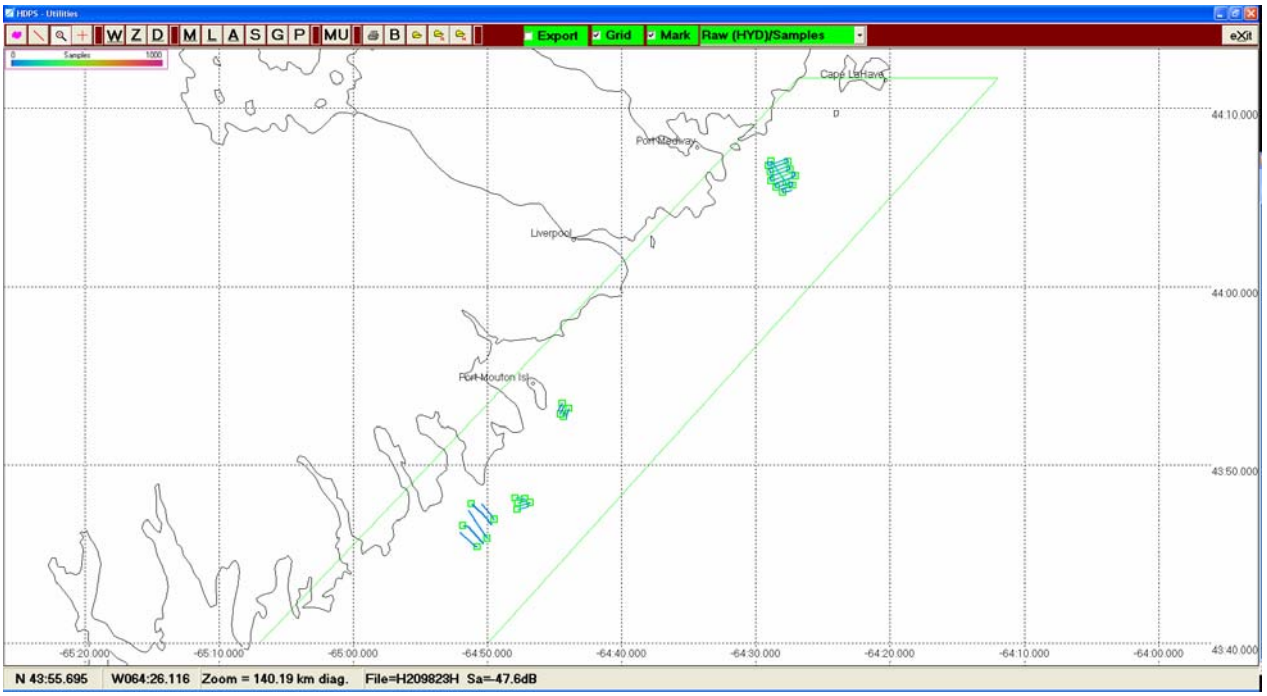


Figure 42. Little Hope/Port Mouton herring gillnet surveys for Oct. 8, 2009.

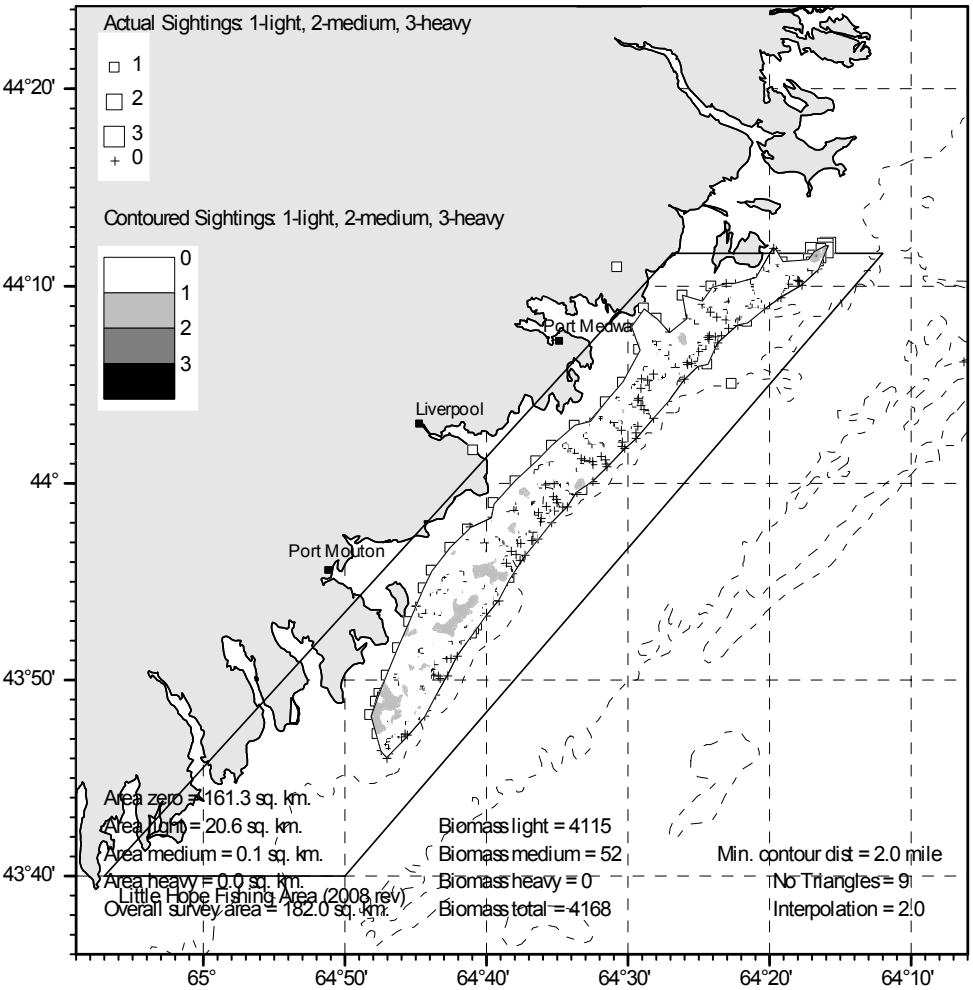


Figure 43. Mapping survey with contouring for Little Hope/Port Mouton area for Oct. 11, 2009.

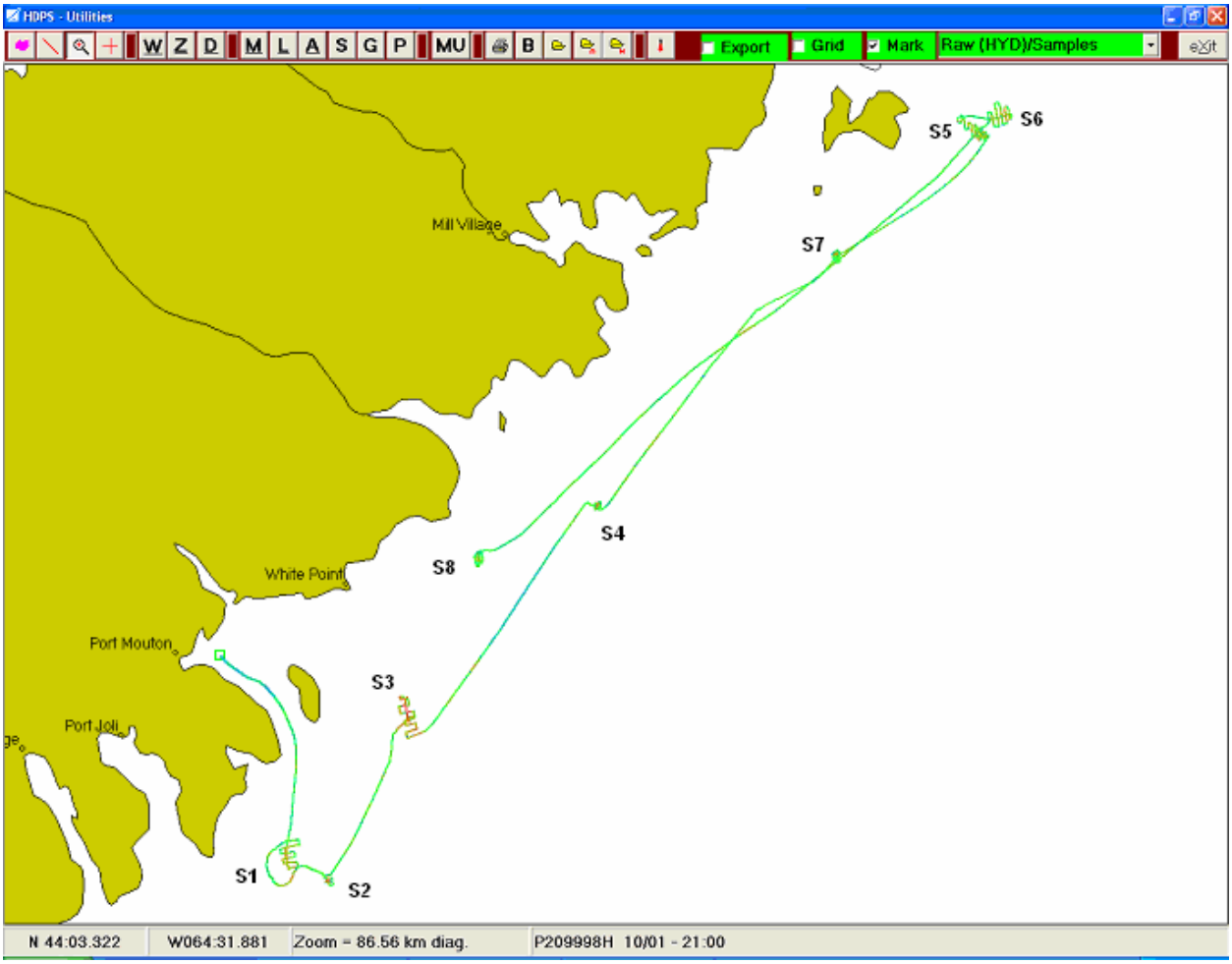


Figure 44. Little Hope/Port Mouton herring gillnet survey for Oct. 11, 2009.

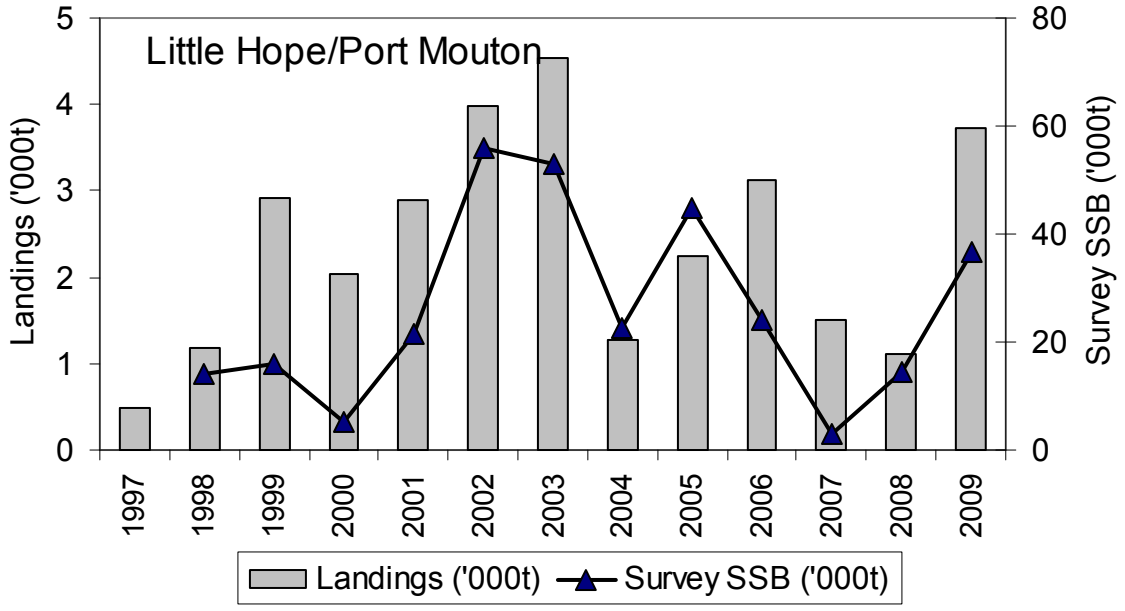


Figure 45. Little Hope/Port Mouton herring catches and acoustic survey biomass estimates from 1997 to 2009. (Acoustic survey SSB 1998-2002 without the CIF; 2003-2009 with the CIF).

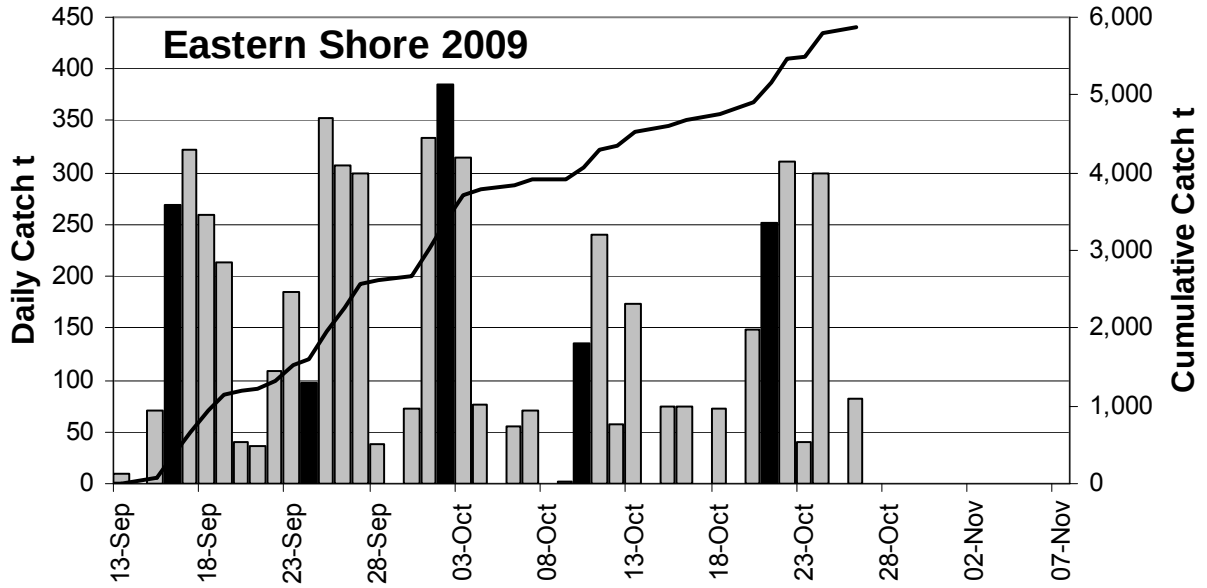


Figure 46. Daily and cumulative catch for the 2009 Halifax/Eastern Shore herring gillnet fishery. Survey dates are identified by black columns indicating survey date.

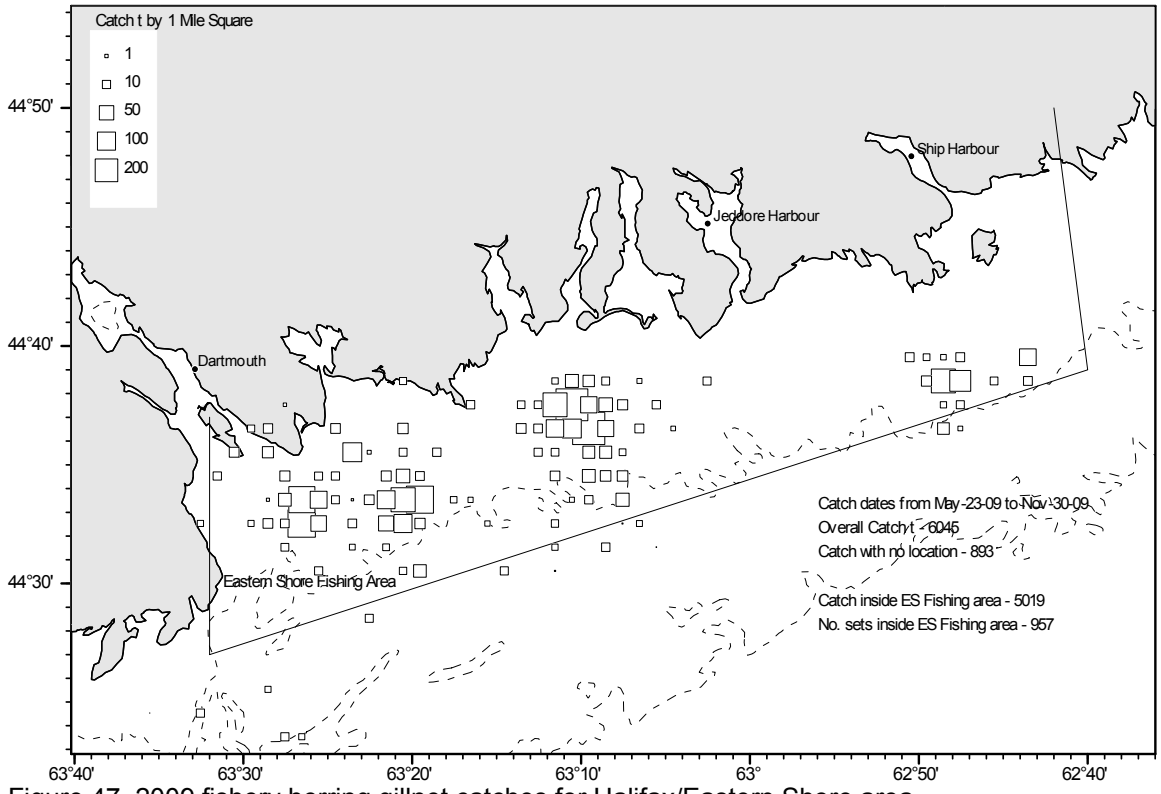


Figure 47. 2009 fishery herring gillnet catches for Halifax/Eastern Shore area.

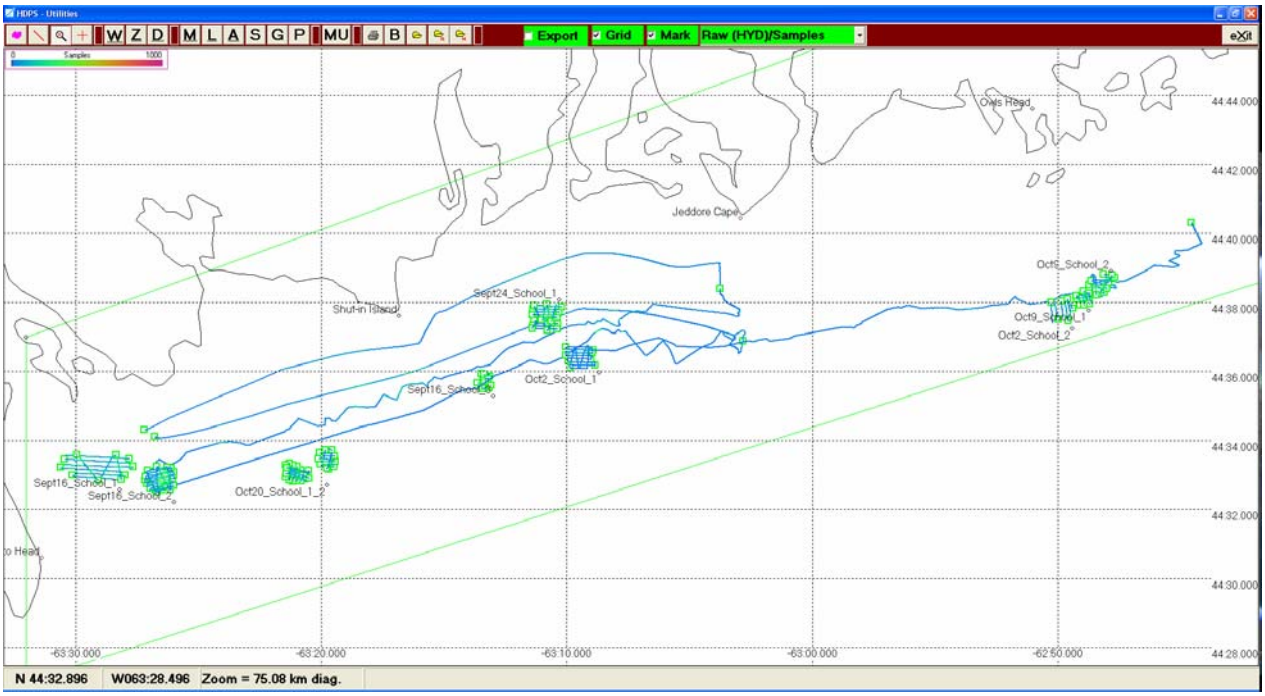


Figure 48. Halifax/Eastern Shore herring gillnet surveys for the entire 2009 season.

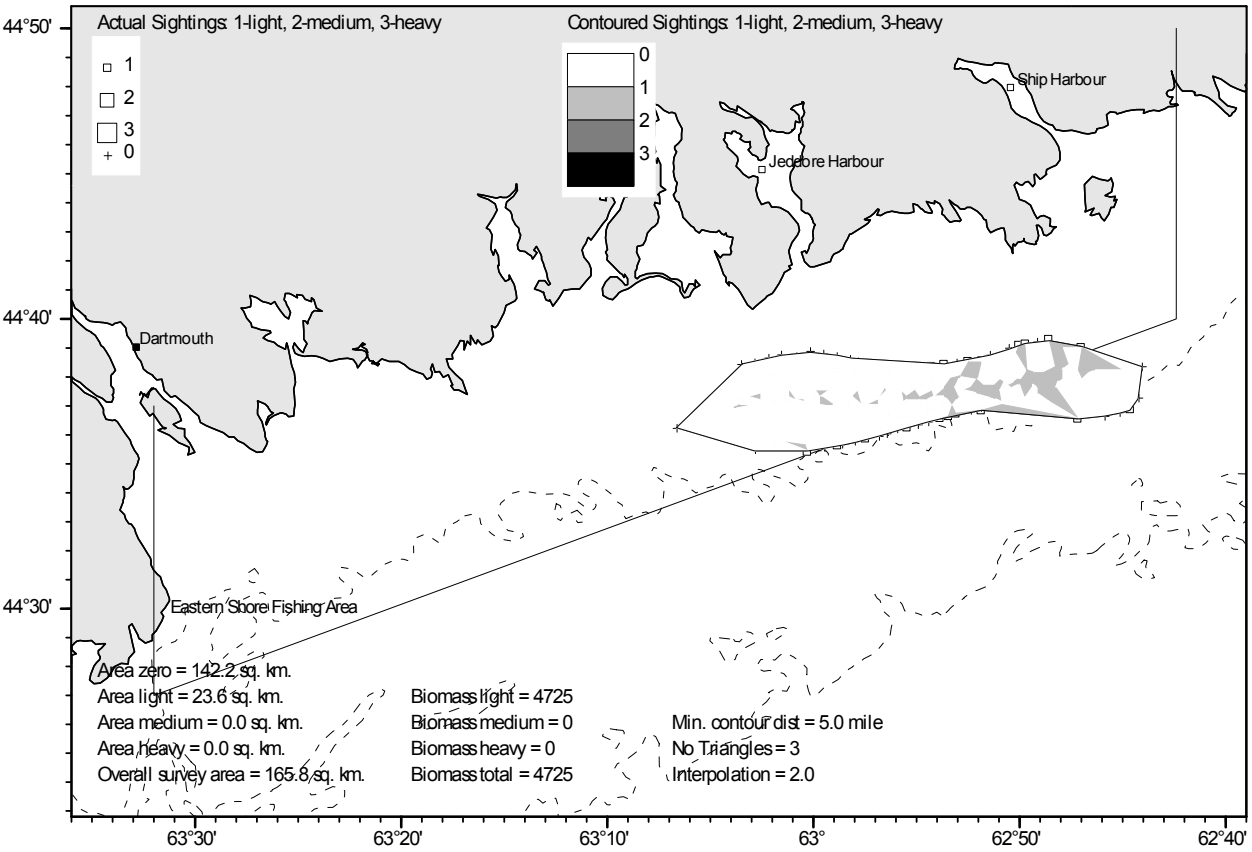


Figure 49. Mapping survey with contouring for Halifax/Eastern Shore area on Oct. 2, 2009.

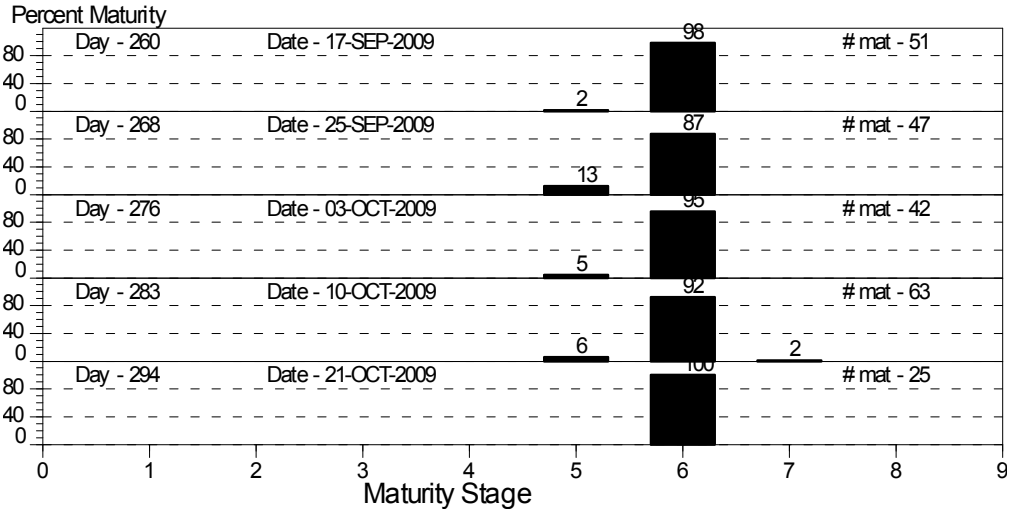


Figure 50. 2009 Halifax/Eastern Shore maturity sample data for gillnet gear types.

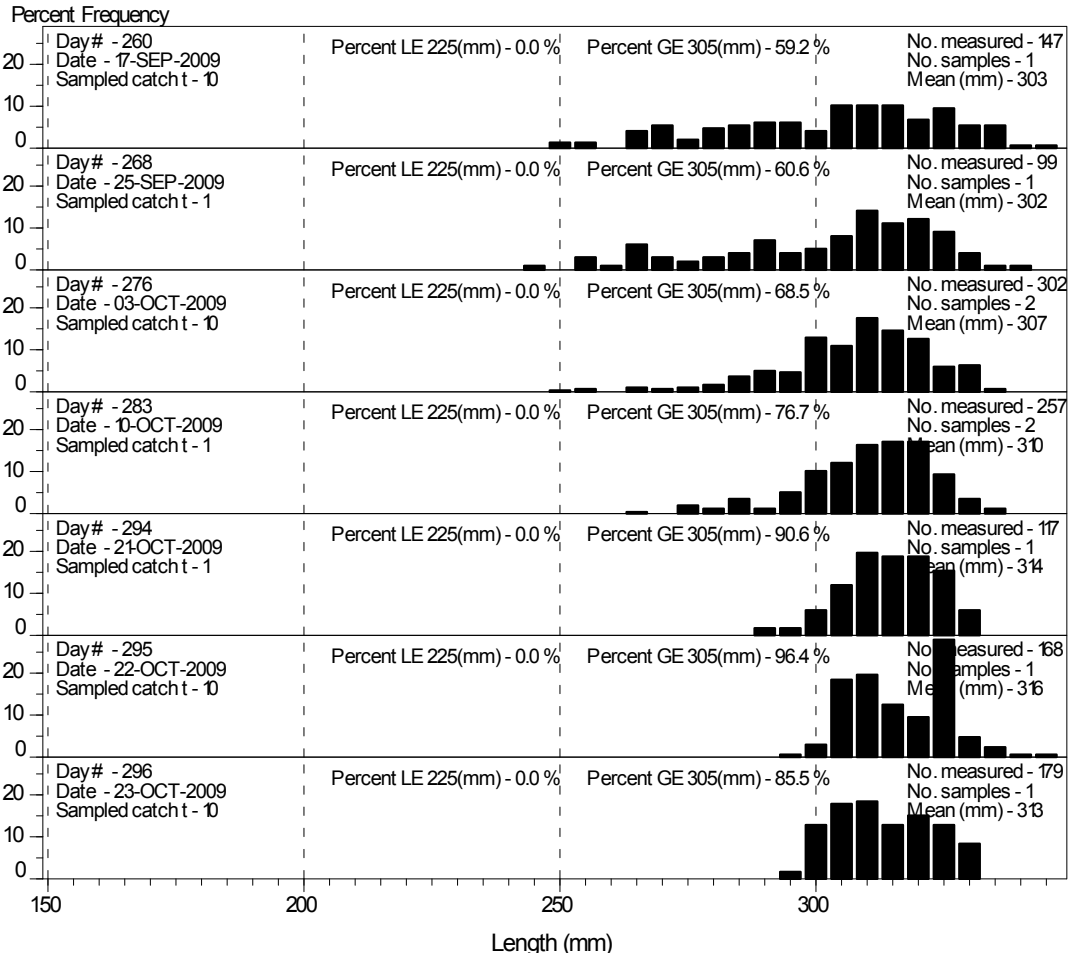


Figure 51. 2009 Halifax/Eastern Shore daily length frequency sampling from gillnet gear using either multi-panel or commercial gillnet with 2¾" mesh.

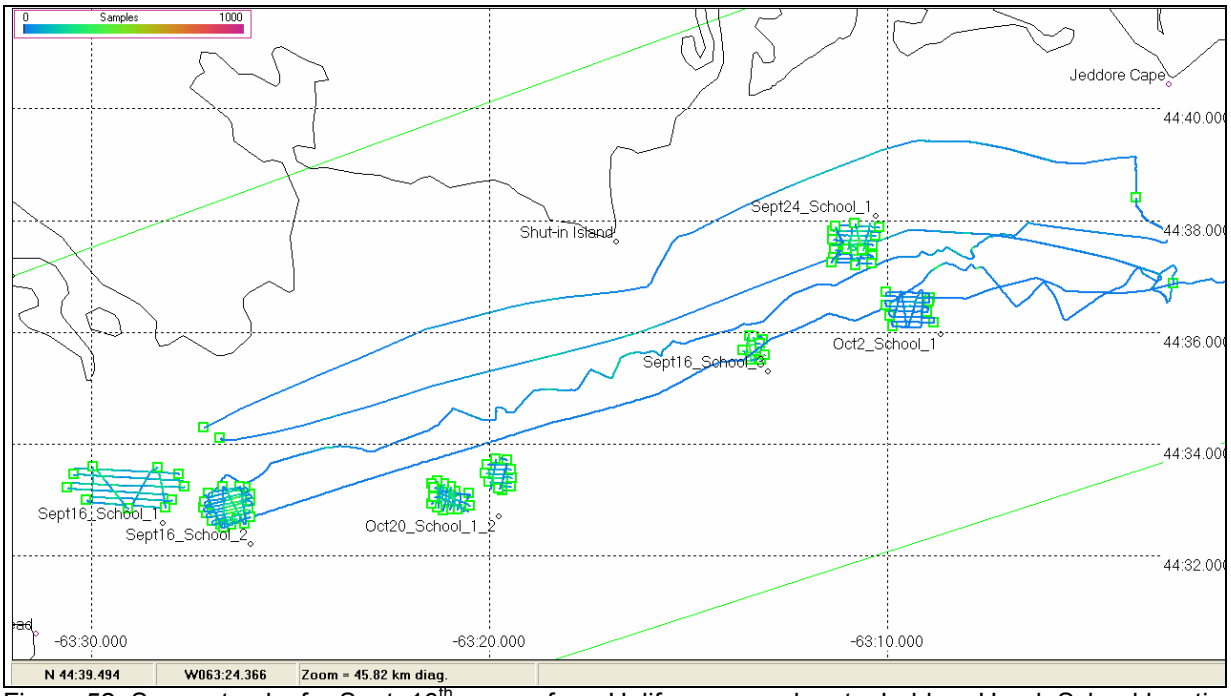


Figure 52. Survey tracks for Sept. 16th survey from Halifax approaches to Jeddore Head. School locations and tracks for subsequent surveys are also shown.

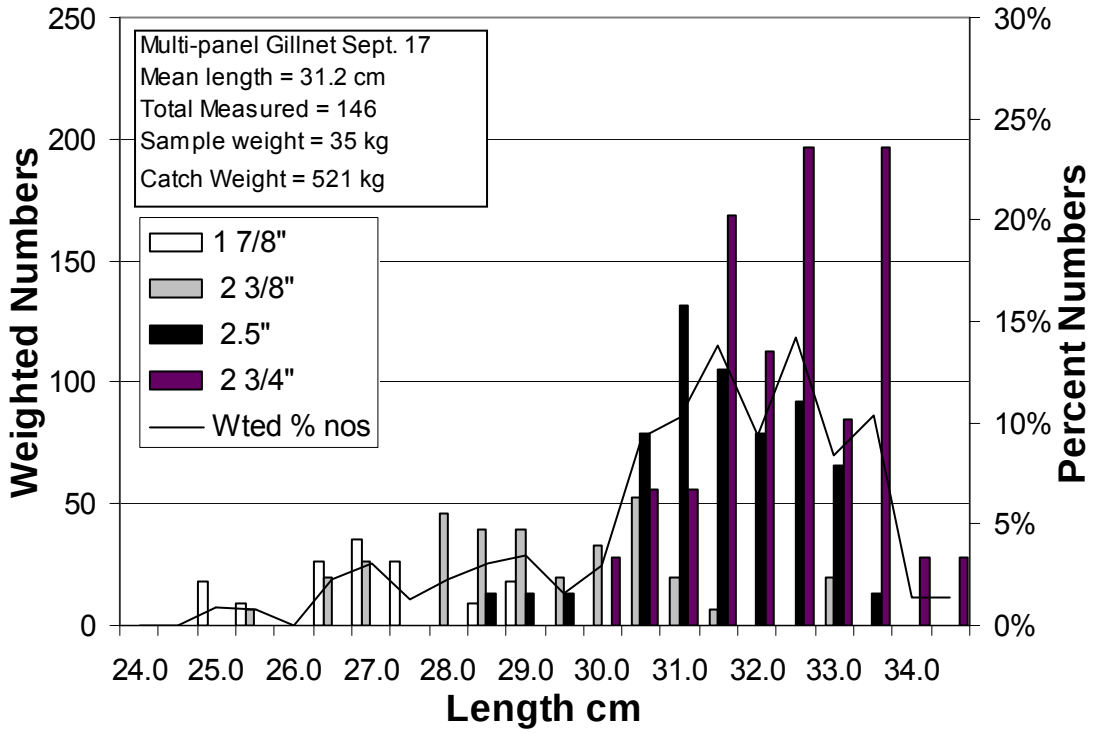


Figure 53. Multi-panel herring gillnet sample collected on Sept. 17, 2009, for Halifax/Eastern Shore survey #1 on Sept. 16, 2009 (from the western schools area).

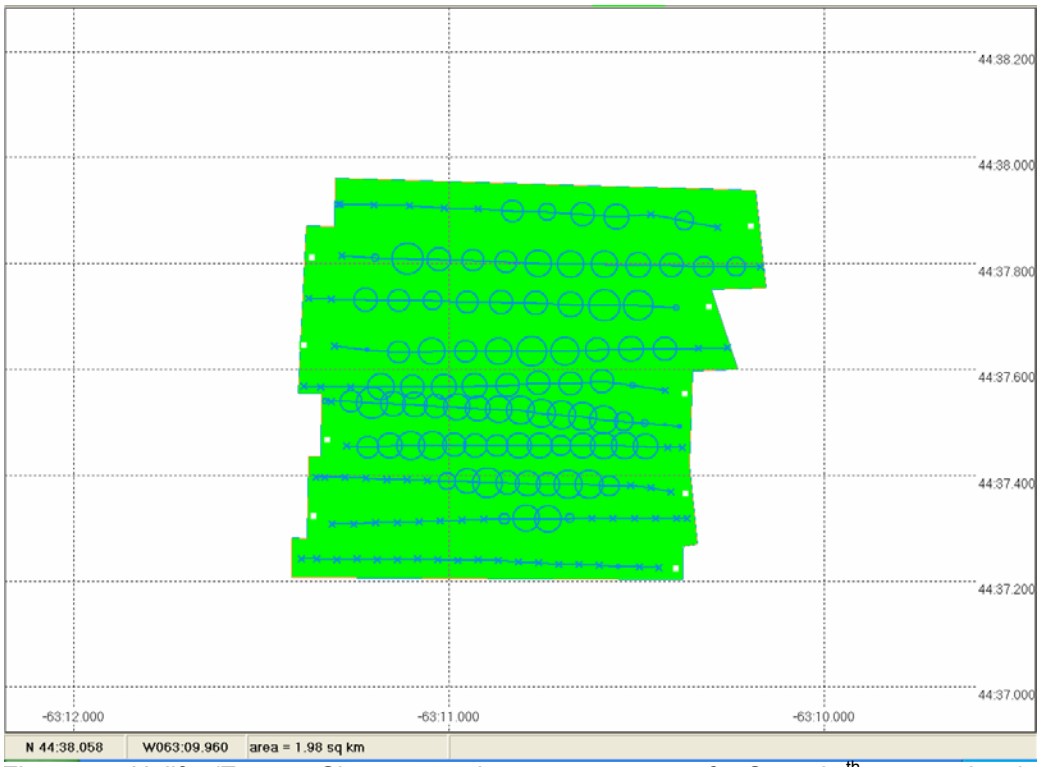


Figure 54. Halifax/Eastern Shore acoustic survey transects for Sept. 24th survey showing average density and distribution of fish encountered and the area estimation of 1.98km$^2$.

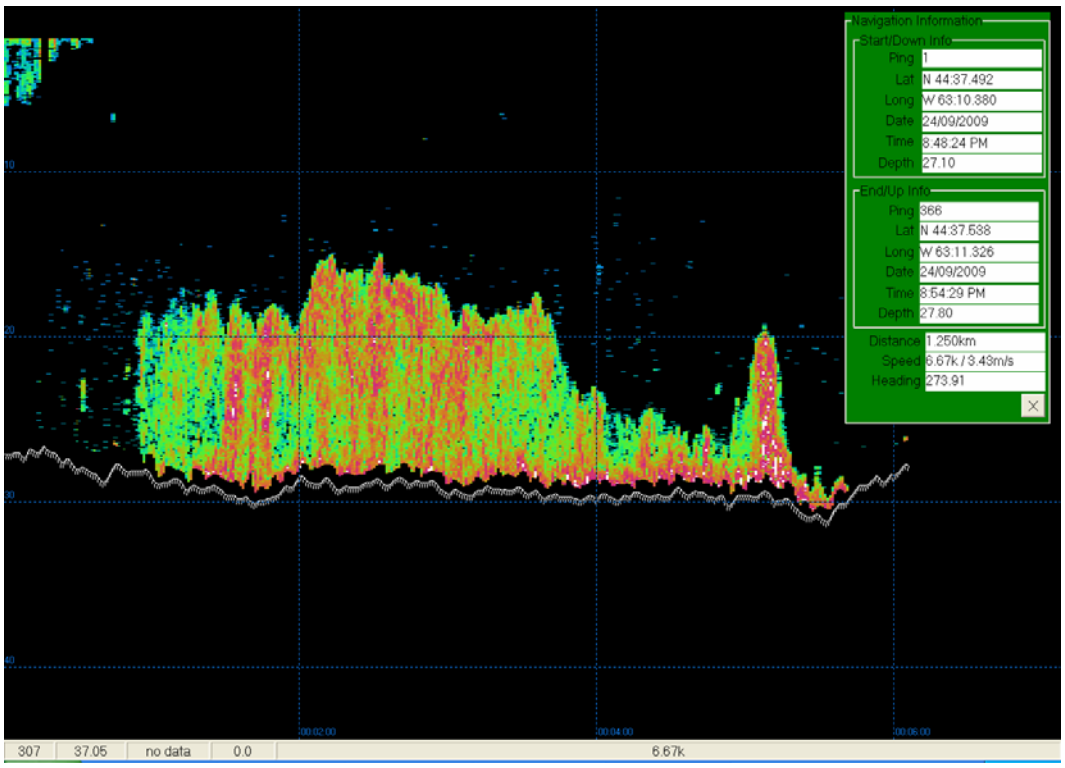


Figure 55. Echogram for entire transect B209800 from the acoustic survey on Sept. 24, 2009.

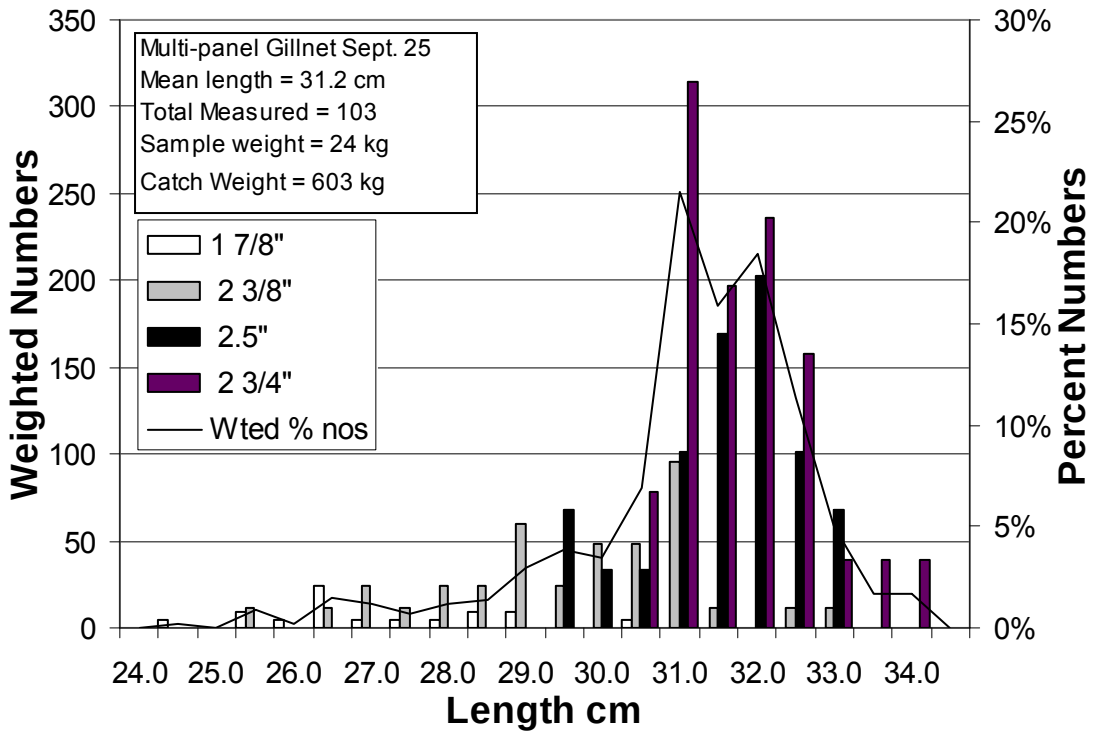


Figure 56. Multi-panel herring gillnet sample collected on Sept. 25, 2009, for Halifax/Eastern Shore survey #2 on Sept. 25, 2009.

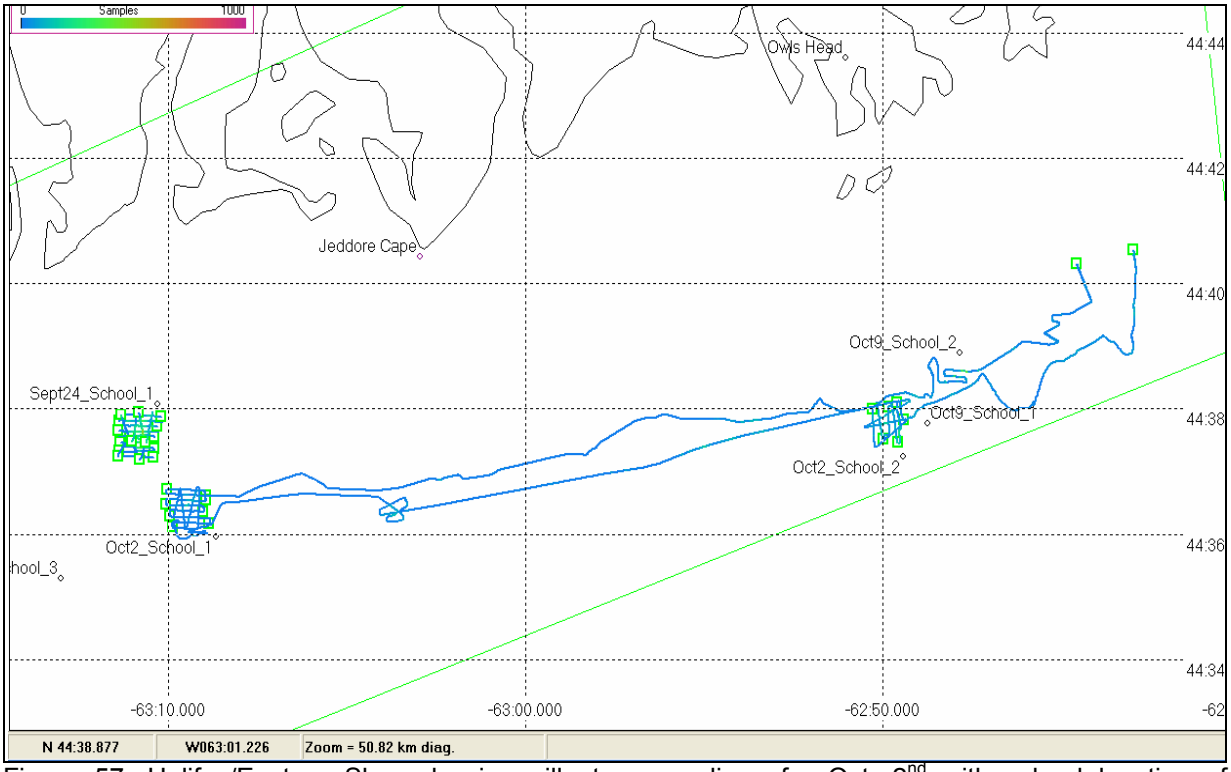


Figure 57. Halifax/Eastern Shore herring gillnet survey lines for Oct. 2nd with school locations for Sept. 24th and Oct. 9th surveys.

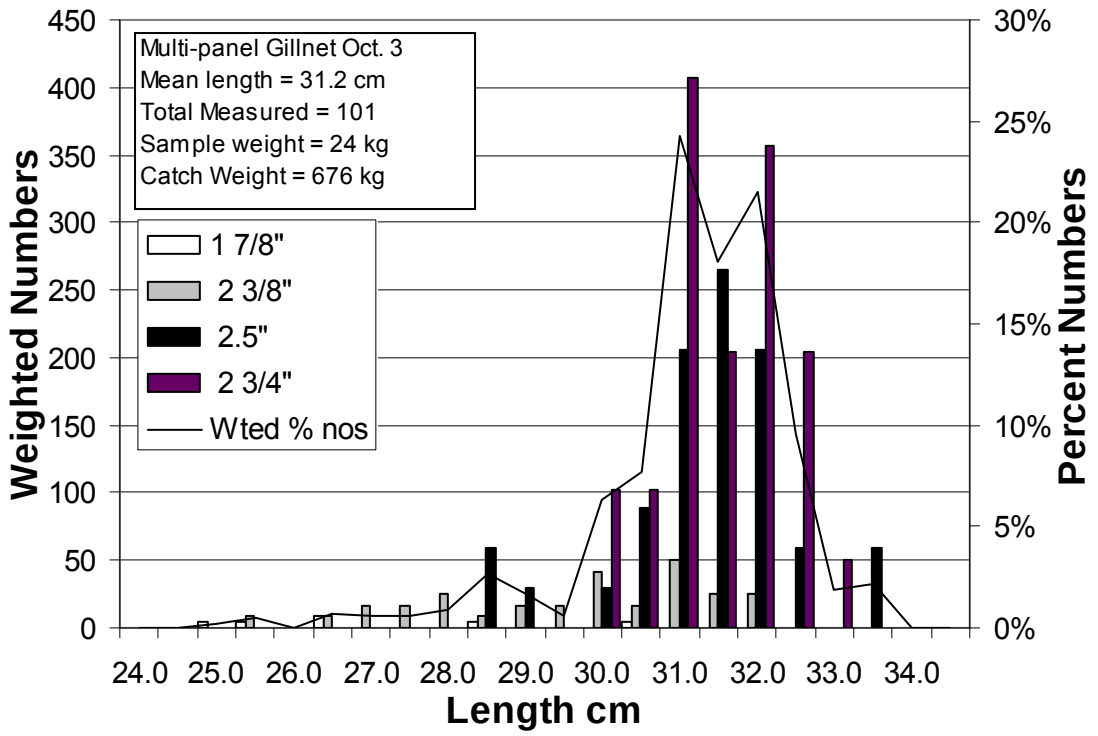


Figure 58. Multi-panel herring gillnet sample collected on Oct. 3, 2009, for Halifax/Eastern Shore survey #3 on Oct. 2, 2009, by the *Bradley K* for the western school (#1).

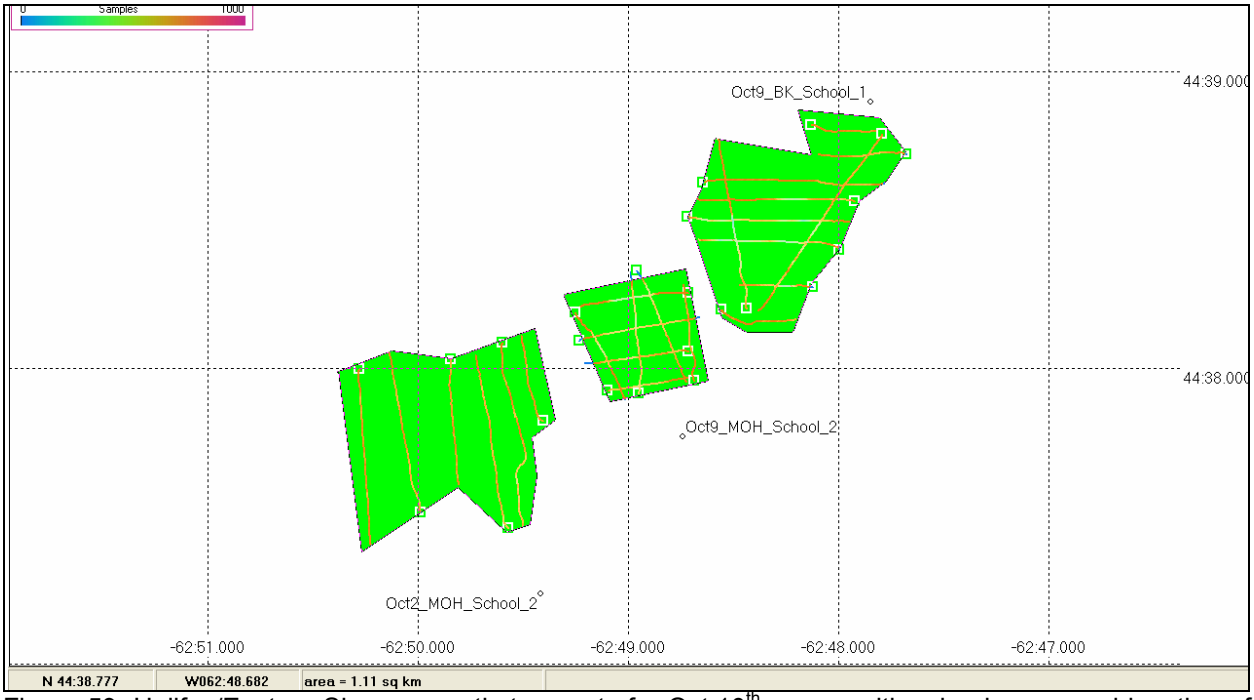


Figure 59. Halifax/Eastern Shore acoustic transects for Oct.10th survey with school areas and location of the western school from the Oct. 2nd survey.

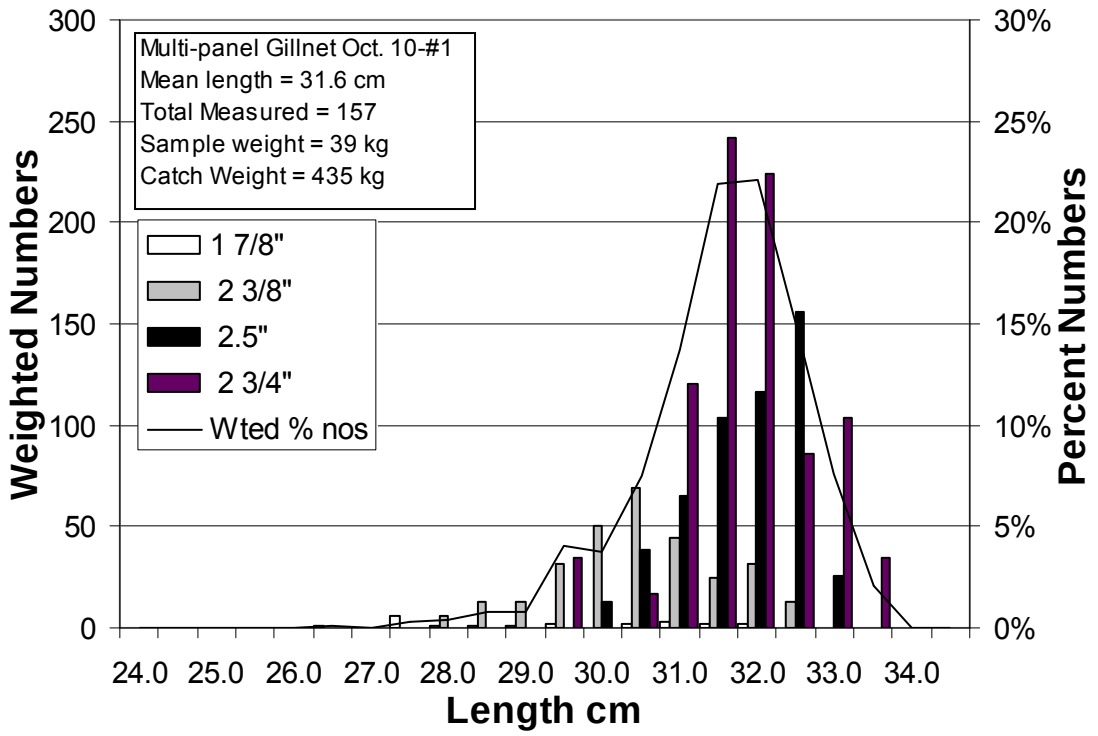


Figure 60. Multi-panel herring gillnet sample collected on Oct. 10, 2009, for Halifax/Eastern Shore survey #4 (sample 1 of 2 collected by *Miss Owls Head* for school #2)

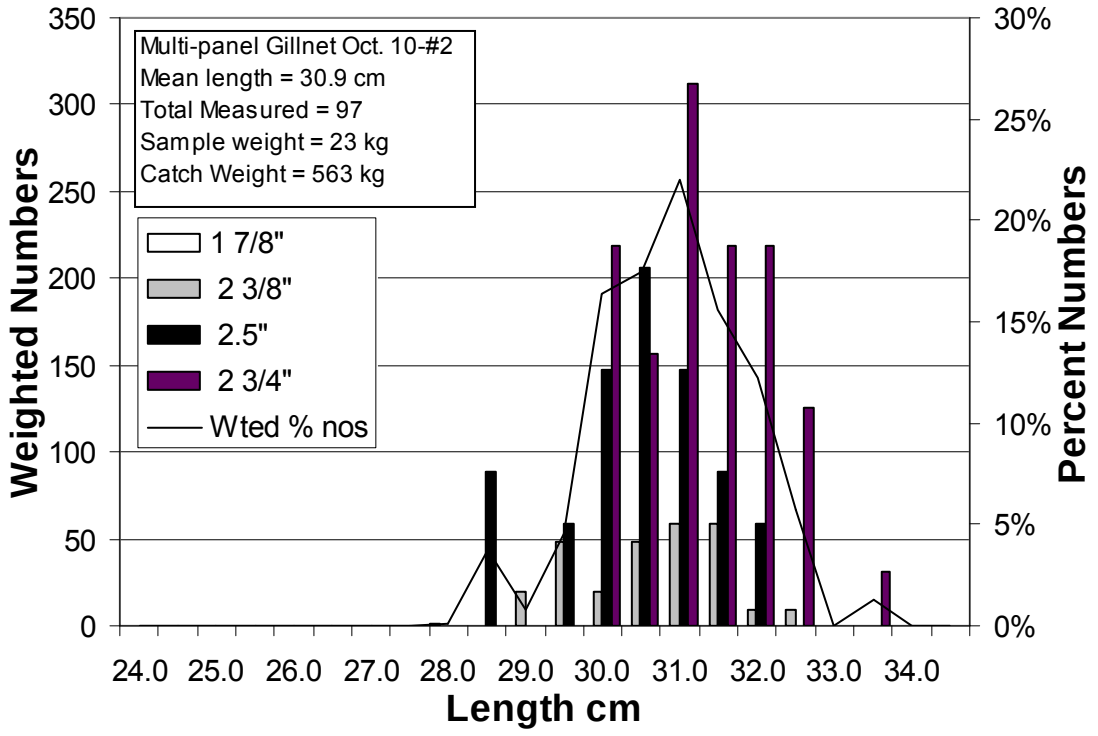


Figure 61. Multi-panel herring gillnet sample collected on Oct. 10, 2009, for Halifax/Eastern Shore survey #4 (sample 2 of 2 collected by *Bradley K* for school #1)

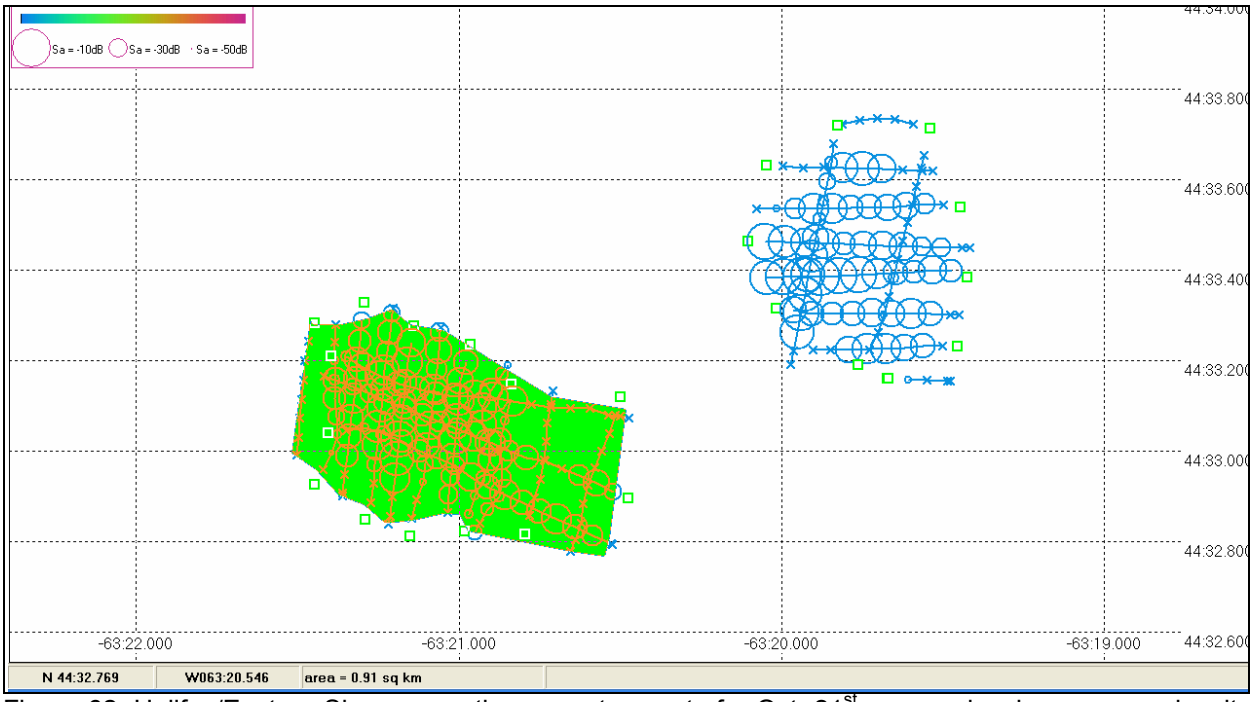


Figure 62. Halifax/Eastern Shore acoustic survey transects for Oct. 21st survey showing average density and distribution of fish encountered and the area estimation of 0.91km$^2$ for the western school.

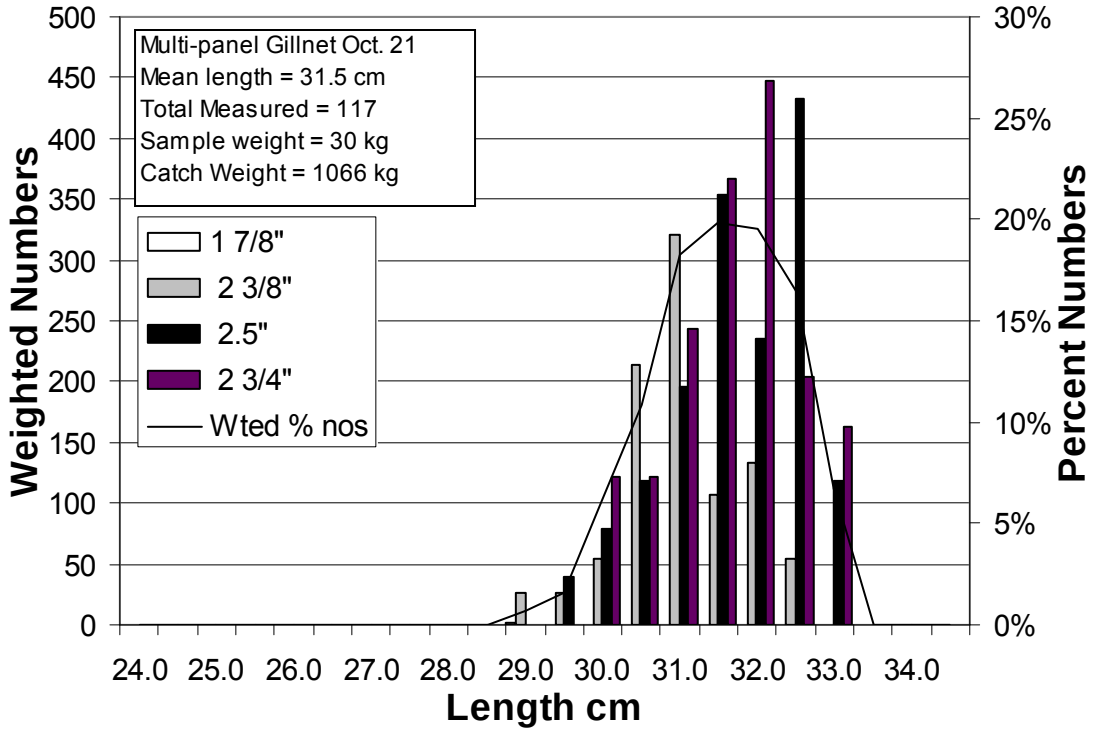


Figure 63. Multi-panel herring gillnet sample collected on Oct. 21, 2009, for Halifax/Eastern Shore survey #5.

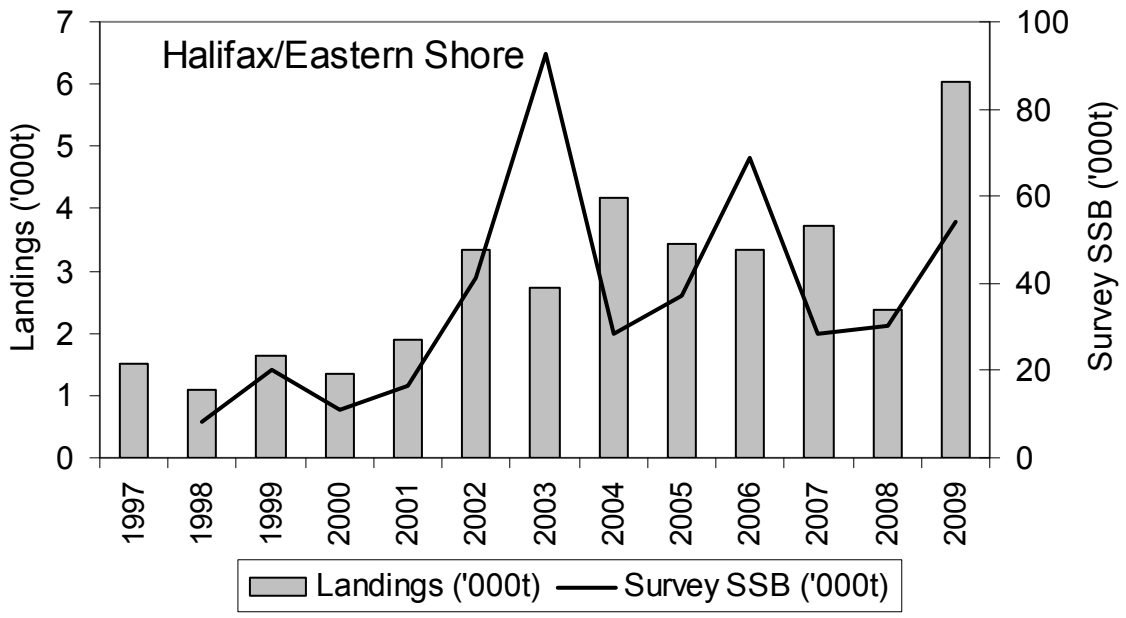


Figure 64. Halifax/Eastern Shore herring catches and acoustic survey biomass estimates from 1997 to 2009. (Acoustic survey SSB 1998-2002 without the CIF; 2003-2009 with the CIF).

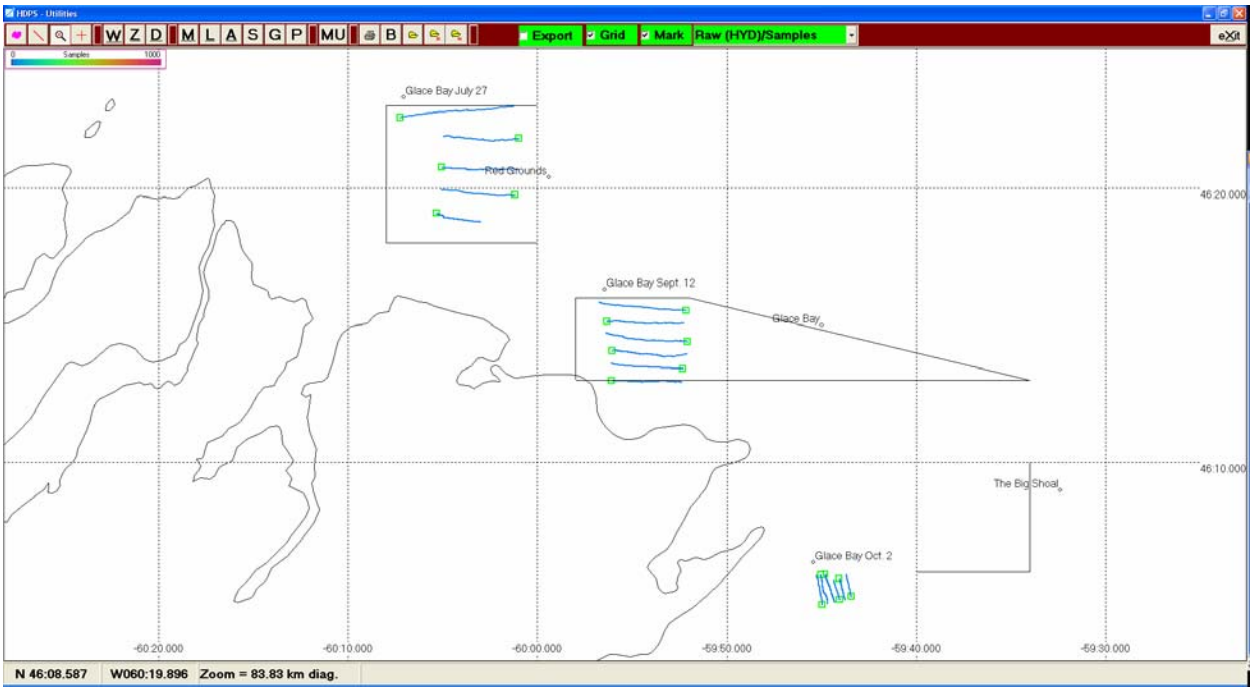


Figure 65. Glace Bay herring gillnet surveys for July 27th, Sept. 12th and Oct. 2nd 2009.

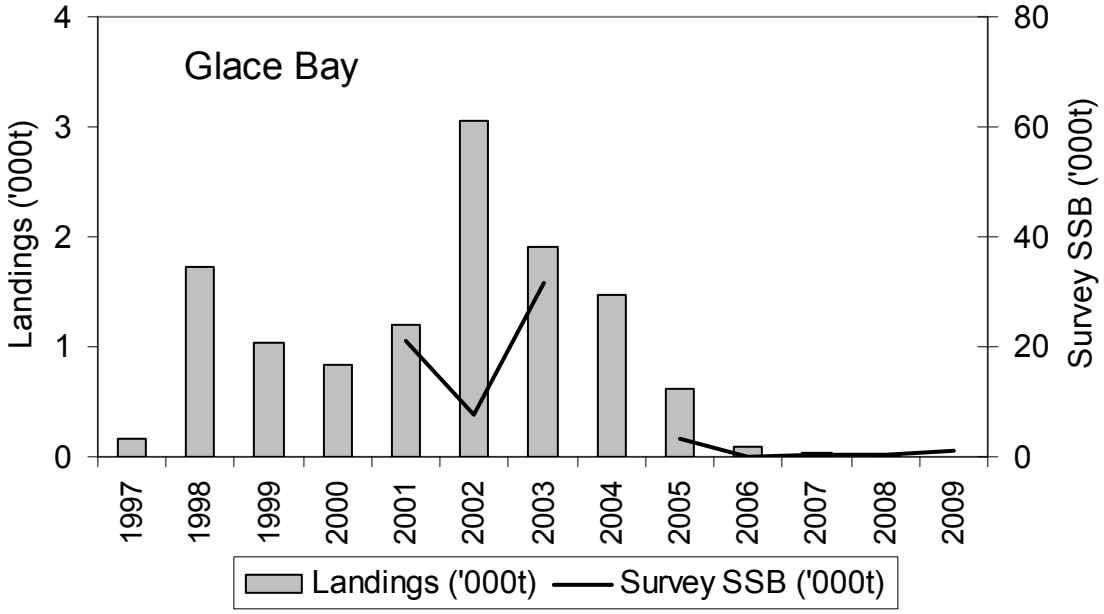


Figure 66. Glace Bay herring catches and acoustic survey biomass estimates from 1997 to 2009. (Acoustic survey SSB 1998-2002 without the CIF; 2003-2009 with the CIF).

## APPENDIX A: Acoustic transect summary details by survey.

Table A1. Results for Scots Bay herring acoustic survey (#1) on June 27, 2009, for the overall area (inbox) as well as lines completed outside the survey area (outbox).

A - Scots Bay June 27, 2009 estimates by area without CIF (no samples, standard TS with frequency adjust)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Systematic_27june09_inbox | -35.77 | 636 | -55.116 | 0.0116 | 7386 | 7322 | 99 |
| Systematic_27june09_outbox | -35.77 | 90 | -1035.367 | 0 | 0 | 0 | 0 |
| Total | | 726 | -55.691 | 0.0102 | 7386 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Systematic_27june09_inbox | B219800H | 38.984 | -35.77 | -64.323 | 0.0014 | |
| | C219800H | 40.299 | -35.77 | -1036.053 | 0 | |
| | C219801H | 38.926 | -35.77 | -48.14 | 0.0579 | |
| | M209800H | 34.218 | -35.5 | -1035.342 | 0 | |
| | M209801H | 46.295 | -35.5 | -1036.655 | 0 | |
| Systematic_27june09_outbox | B219801H | 34.411 | -35.77 | -1035.367 | 0 | |

B - Scots Bay June 27, 2009 estimates by area with CIF (no samples, standard TS with frequency adjust)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Systematic_27june09_inbox | -35.77 | 636 | -55.025 | 0.0119 | 7542 | 7452 | 99 |
| Systematic_27june09_outbox | -35.77 | 90 | -1035.367 | 0 | 0 | 0 | 0 |
| Total | | 726 | -55.6 | 0.0104 | 7542 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Systematic_27june09_inbox | B219800H | 38.984 | -35.77 | -63.785 | 0.0016 | |
| | C219800H | 40.299 | -35.77 | -1036.053 | 0 | |
| | C219801H | 38.926 | -35.77 | -48.06 | 0.059 | |
| | M209800H | 34.218 | -35.5 | -1035.342 | 0 | |
| | M209801H | 46.295 | -35.5 | -1036.655 | 0 | |
| Systematic_27june09_outbox | B219801H | 34.411 | -35.77 | -1035.367 | 0 | |

Table A2. Results for Scots Bay herring acoustic survey (#2) area on July 11, 2009, for the overall survey area (inbox), as well as lines completed outside the survey area (outbox).

A - Scots Bay July 11, 2009 estimates by area without CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Scots_11july2009_inbox | -35.03 | 636 | -47.726 | 0.0537 | 34170 | 12136 | 36 |
| Scots_11july2009_outbox | -35.02 | 80 | -50.012 | 0.0317 | 2537 | 1911 | 75 |
| Total | | 716 | -47.929 | 0.0513 | 36707 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Scots_11july2009_inbox | B219800H | 49.958 | -35.29 | -64.887 | 0.0011 | |
| | B219801H | 47.382 | -35.29 | -65.892 | 0.0009 | |
| | C219800H | 47.788 | -35.29 | -69.786 | 0.0004 | |
| | C219801H | 44.335 | -35.29 | -58.322 | 0.005 | |
| | M209800H | 41.066 | -35.02 | -45.793 | 0.0838 | |
| | M209801H | 39.728 | -35.02 | -44.857 | 0.1039 | |
| | M229800H | 34.895 | -35.02 | -43.076 | 0.1566 | |
| | M229801H | 33.865 | -35.02 | -46.237 | 0.0756 | |
| | S209800H | 38.66 | -35.02 | -50.302 | 0.0297 | |
| | S209801H | 37.753 | -35.02 | -43.597 | 0.1389 | |
| Scots_11july2009_outbox | D209800H | 32.309 | -35.02 | -47.608 | 0.0552 | |
| | D209801H | 31.128 | -35.02 | -56.346 | 0.0074 | |

B - Scots Bay July 11, 2009 estimates by area with CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Scots_11july2009_inbox | -35.03 | 636 | -46.734 | 0.0675 | 42931 | 15430 | 36 |
| Scots_11july2009_outbox | -35.02 | 80 | -49.563 | 0.0352 | 2813 | 2120 | 75 |
| Total | | 716 | -46.973 | 0.0639 | 45744 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Scots_11july2009_inbox | B219800H | 49.958 | -35.29 | -64.35 | 0.0012 | |
| | B219801H | 47.382 | -35.29 | -65.355 | 0.001 | |
| | C219800H | 47.788 | -35.29 | -69.706 | 0.0004 | |
| | C219801H | 44.335 | -35.29 | -58.243 | 0.0051 | |
| | M209800H | 41.066 | -35.02 | -44.959 | 0.1015 | |
| | M209801H | 39.728 | -35.02 | -44.023 | 0.1259 | |
| | M229800H | 34.895 | -35.02 | -42.062 | 0.1978 | |
| | M229801H | 33.865 | -35.02 | -45.223 | 0.0955 | |
| | S209800H | 38.66 | -35.02 | -49.124 | 0.0389 | |
| | S209801H | 37.753 | -35.02 | -42.418 | 0.1822 | |
| Scots_11july2009_outbox | D209800H | 32.309 | -35.02 | -47.159 | 0.0612 | |
| | D209801H | 31.128 | -35.02 | -55.897 | 0.0082 | |

Table A3. Results for Scots Bay herring acoustic survey (#3) on July 25, 2009, for the overall survey area (inbox) and for areas outside the standard survey area (outbox).

a - Scots Bay July 25, 2009 split areas estimate without CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Scots_25july2009_inbox | -35.14 | 636 | -51.386 | 0.0237 | 15087 | 11606 | 77 |
| Scots_25july2009_outbox | -35.26 | 180 | -56.494 | 0.0075 | 1356 | 661 | 49 |
| Total | | 816 | -52.105 | 0.0202 | 16443 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Scots_25july2009_inbox | B219800H | 41.685 | -35.35 | -70.191 | 0.0003 | |
| | B219801H | 41.546 | -35.35 | -60.125 | 0.0033 | |
| | C219800H | 45.585 | -35.35 | -68.208 | 0.0005 | |
| | C219801H | 43.51 | -35.35 | -49.906 | 0.035 | |
| | S209800H | 38.786 | -35.08 | -55.22 | 0.0097 | |
| | S209801H | 37.859 | -35.08 | -57.868 | 0.0053 | |
| | L209800H | 35.567 | -35.08 | -43.319 | 0.15 | |
| | L209801H | 36.149 | -35.08 | -1035.581 | 0 | |
| Scots_25july2009_outbox | K209800H | 34.526 | -35.35 | -52.989 | 0.0172 | |
| | K209801H | 32.166 | -35.35 | -64.893 | 0.0011 | |
| | M209800H | 29.971 | -35.08 | -56.465 | 0.0073 | |
| | M209801H | 22.435 | -35.08 | -61.622 | 0.0022 | |

B - Scots Bay July 25, 2009 split areas estimate with CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Scots_25july2009_inbox | -35.13 | 636 | -50.67 | 0.0279 | 17761 | 14005 | 79 |
| Scots_25july2009_outbox | -35.26 | 180 | -55.835 | 0.0088 | 1577 | 753 | 48 |
| Total | | 816 | -51.394 | 0.0237 | 19338 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Scots_25july2009_inbox | B219800H | 41.685 | -35.35 | -69.653 | 0.0004 | |
| | B219801H | 41.546 | -35.35 | -59.587 | 0.0038 | |
| | C219800H | 45.585 | -35.35 | -68.129 | 0.0005 | |
| | C219801H | 43.51 | -35.35 | -49.827 | 0.0356 | |
| | S209800H | 38.786 | -35.08 | -54.042 | 0.0127 | |
| | S209801H | 37.859 | -35.08 | -56.69 | 0.0069 | |
| | L209800H | 35.567 | -35.08 | -42.491 | 0.1815 | |
| | L209801H | 36.149 | -35.08 | -1035.581 | 0 | |
| Scots_25july2009_outbox | K209800H | 34.526 | -35.35 | -52.411 | 0.0197 | |
| | K209801H | 32.166 | -35.35 | -64.316 | 0.0013 | |
| | M209800H | 29.971 | -35.08 | -55.631 | 0.0088 | |
| | M209801H | 22.435 | -35.08 | -60.789 | 0.0027 | |

Table A4. Results for Scots Bay herring acoustic survey (#4) on Aug. 8, 2009, for the overall survey area (inbox) and for areas outside the standard survey area (outbox).

A - Scots Bay Aug. 8, 2009 split areas estimate without CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Scots_08aug2009_inbox | -34.56 | 636 | -52.263 | 0.017 | 10797 | 5363 | 50 |
| Scots_08aug2009_outbox | -34.96 | 164 | -55.827 | 0.0082 | 1342 | 1276 | 95 |
| Total | | 800 | -52.792 | 0.0152 | 12139 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Scots_08aug2009_inbox | B219800H_ | 44.939 | -34.22 | -56.173 | 0.0064 | |
| | B219801H_ | 44.134 | -34.22 | -48.948 | 0.0337 | |
| | C219800H_ | 43.424 | -34.22 | -51.381 | 0.0192 | |
| | C219801H_ | 40.89 | -34.22 | -57.47 | 0.0047 | |
| | S209800H_ | 37.869 | -34.96 | -64.894 | 0.001 | |
| | S209801H_ | 36.264 | -34.96 | -78.417 | 0 | |
| | S219800H_ | 36.252 | -34.96 | -46.584 | 0.0687 | |
| | S219801H_ | 35.326 | -34.96 | -61.253 | 0.0023 | |
| Scots_08aug2009_outbox | M209800H_ | 29.048 | -34.96 | -1034.631 | 0 | |
| | M209801H_ | 22.815 | -34.96 | -72.574 | 0.0002 | |
| | N209800H_ | 29.283 | -34.96 | -50.014 | 0.0312 | |
| | N209801H_ | 31.333 | -34.96 | -75.526 | 0.0001 | |

B - Scots Bay Aug. 8, 2009 split areas estimate with CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Scots_08aug2009_inbox | -34.6 | 636 | -51.43 | 0.0208 | 13204 | 7213 | 55 |
| Scots_08aug2009_outbox | -34.96 | 164 | -54.87 | 0.0102 | 1673 | 1591 | 95 |
| Total | | 800 | -51.947 | 0.0186 | 14877 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Scots_08aug2009_inbox | B219800H_ | 44.939 | -34.22 | -55.635 | 0.0072 | |
| | B219801H_ | 44.134 | -34.22 | -48.41 | 0.0381 | |
| | C219800H_ | 43.424 | -34.22 | -51.302 | 0.0196 | |
| | C219801H_ | 40.89 | -34.22 | -57.391 | 0.0048 | |
| | S209800H_ | 37.869 | -34.96 | -63.716 | 0.0013 | |
| | S209801H_ | 36.264 | -34.96 | -77.239 | 0.0001 | |
| | S219800H_ | 36.252 | -34.96 | -45.23 | 0.0939 | |
| | S219801H_ | 35.326 | -34.96 | -59.899 | 0.0032 | |
| Scots_08aug2009_outbox | M209800H_ | 29.048 | -34.96 | -1034.631 | 0 | |
| | M209801H_ | 22.815 | -34.96 | -71.74 | 0.0002 | |
| | N209800H_ | 29.283 | -34.96 | -49.056 | 0.0389 | |
| | N209801H_ | 31.333 | -34.96 | -74.568 | 0.0001 | |

Table A5. Results for Scots Bay herring acoustic survey (#5) on Aug. 21, 2009, for the overall survey area (inbox) and for areas outside the standard survey area (outbox).

A - Scots Bay Aug. 21, 2009 estimates by area without CIF (no samples, standard TS with frequency adjustment)
use school instead of inbox

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Scots_21aug2009_inbox | -35.59 | 636 | -76.234 | 0.0001 | 55 | 36 | 66 |
| Scots_21aug2009_outbox | -35.5 | 100 | -69.436 | 0.0004 | 40 | 40 | 99 |
| Scots_21aug2009_school | -35.77 | 1.9 | -45.475 | 0.1069 | 203 | 0 | 0 |
| Total | | 737.9 | -69.629 | 0.0004 | 243 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Scots_21aug2009_inbox | B219800H | 48.235 | -35.77 | -73.836 | 0.0002 | NONE |
| | B219801H | 49.969 | -35.77 | -1036.987 | 0 | |
| | C219800H | 41.479 | -35.77 | -79.256 | 0 | |
| | C219801H | 39.906 | -35.77 | -1036.01 | 0 | |
| | P209800H | 34.311 | -35.77 | -1035.354 | 0 | |
| | P209801H | 33.844 | -35.77 | -85.013 | 0 | |
| | S209800H | 37.748 | -35.5 | -68.833 | 0.0005 | |
| | S209801H | 37.894 | -35.5 | -83.614 | 0 | |
| Scots_21aug2009_outbox | M209800H | 32.209 | -35.5 | -1035.08 | 0 | |
| | M209801H | 33.112 | -35.5 | -66.485 | 0.0008 | |
| Scots_21aug2009_school | C219900H | 18.793 | -35.77 | -45.475 | 0.1069 | |

B - Scots Bay Aug. 21, 2009 estimates by area with CIF (no samples, standard TS with frequency adjustment)
use school instead of inbox

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Scots_21aug2009_inbox | -35.58 | 636 | -75.283 | 0.0001 | 68 | 47 | 70 |
| Scots_21aug2009_outbox | -35.5 | 100 | -68.602 | 0.0005 | 49 | 48 | 99 |
| Scots_21aug2009_school | -35.77 | 1.9 | -45.403 | 0.1087 | 207 | 0 | 0 |
| Total | | 737.9 | -69.265 | 0.0004 | 256 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Scots_21aug2009_inbox | B219800H | 48.235 | -35.77 | -73.298 | 0.0002 | NONE |
| | B219801H | 49.969 | -35.77 | -1036.987 | 0 | |
| | C219800H | 41.479 | -35.77 | -79.176 | 0 | |
| | C219801H | 39.906 | -35.77 | -1036.01 | 0 | |
| | P209800H | 34.311 | -35.77 | -1035.354 | 0 | |
| | P209801H | 33.844 | -35.77 | -84.192 | 0 | |
| | S209800H | 37.748 | -35.5 | -67.655 | 0.0006 | |
| | S209801H | 37.894 | -35.5 | -82.435 | 0 | |
| Scots_21aug2009_outbox | M209800H | 32.209 | -35.5 | -1035.08 | 0 | |
| | M209801H | 33.112 | -35.5 | -65.651 | 0.001 | |
| Scots_21aug2009_school | C219900H | 18.899 | -35.77 | -45.403 | 0.1087 | |

Table A6. Results for German Bank herring acoustic survey (#1) on Aug. 12, 2009, for the overall survey area (inbox).

A - German Bank Aug. 12, 2009 final run without CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_12aug2009 | -35.5 | 646 | -45.183 | 0.1075 | 69431 | 31075 | 45 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_12aug2009 | D209800H_ | 37.227 | -35.49 | -68.526 | 0.0005 | NONE |
| | D209801H_ | 37.295 | -35.49 | -67.762 | 0.0006 | |
| | I209800H_2 | 36.244 | -35.49 | -41.577 | 0.246 | |
| | I209801H_2 | 36.925 | -35.49 | -41.338 | 0.2599 | |
| | K209800H_ | 36.947 | -35.75 | -65.317 | 0.0011 | |
| | K209801H_ | 36.968 | -35.75 | -63.123 | 0.0018 | |
| | L209800H_ | 37.223 | -35.49 | -44.969 | 0.1127 | |
| | L209801H_ | 37.145 | -35.49 | -37.308 | 0.6575 | |
| | N209800H_ | 37.256 | -35.49 | -50.099 | 0.0346 | |
| | N209801H_ | 37.276 | -35.49 | -48.799 | 0.0466 | |
| | P209800H_ | 37.332 | -35.75 | -51.736 | 0.0252 | |
| | P209801H_ | 36.915 | -35.75 | -51.824 | 0.0247 | |
| | S219800H_ | 37.75 | -35.49 | -51.943 | 0.0226 | |
| | S219801H_ | 37.369 | -35.49 | -46.651 | 0.0765 | |

B - German Bank Aug. 12, 2009 final run with CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_12aug2009 | -35.5 | 646 | -44.05 | 0.1395 | 90118 | 38930 | 43 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_12aug2009 | D209800H_ | 37.227 | -35.49 | -68.076 | 0.0006 | NONE |
| | D209801H_ | 37.295 | -35.49 | -67.313 | 0.0007 | |
| | I209800H_2 | 36.244 | -35.49 | -39.997 | 0.354 | |
| | I209801H_2 | 36.925 | -35.49 | -39.758 | 0.374 | |
| | K209800H_ | 36.947 | -35.75 | -64.739 | 0.0013 | |
| | K209801H_ | 36.968 | -35.75 | -62.545 | 0.0021 | |
| | L209800H_ | 37.223 | -35.49 | -44.141 | 0.1363 | |
| | L209801H_ | 37.145 | -35.49 | -36.48 | 0.7957 | |
| | N209800H_ | 37.256 | -35.49 | -49.141 | 0.0431 | |
| | N209801H_ | 37.276 | -35.49 | -47.841 | 0.0582 | |
| | P209800H_ | 37.332 | -35.75 | -50.915 | 0.0305 | |
| | P209801H_ | 36.915 | -35.75 | -51.003 | 0.0298 | |
| | S219800H_ | 37.75 | -35.49 | -50.588 | 0.0309 | |
| | S219801H_ | 37.369 | -35.49 | -45.296 | 0.1045 | |

Table A7. Results for German Bank herring acoustic survey (#2) on Aug. 25, 2009, for the overall survey area (inbox) and for areas outside the standard survey area (outbox).

A - German Bank Aug. 25, 2009 final run without CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_2009_08_25_inbox | -35.42 | 646 | -44.142 | 0.1341 | 86614 | 18784 | 22 |
| German_2009_08_25_outbox | -35.41 | 90 | -53.568 | 0.0153 | 1375 | 419 | 30 |
| | | 736 | -44.64 | 0.1196 | 87989 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_2009_08_25_inbox | D209800H | 37.203 | -35.41 | -80.414 | 0 | NONE |
| | D209801H | 37.409 | -35.41 | -95.792 | 0 | |
| | I209800H | 37.069 | -35.41 | -40.664 | 0.2982 | |
| | I209801H | 37.348 | -35.41 | -41.362 | 0.254 | |
| | K209800H | 37.216 | -35.67 | -54.185 | 0.0141 | |
| | K209801H | 37.29 | -35.67 | -57.491 | 0.0066 | |
| | L209800H | 36.45 | -35.41 | -41.574 | 0.2418 | |
| | L209801H | 36.51 | -35.41 | -42.005 | 0.219 | |
| | N209800H | 36.966 | -35.41 | -46.281 | 0.0818 | |
| | N209801H | 37.139 | -35.41 | -45.386 | 0.1005 | |
| | P209800H | 37.369 | -35.67 | -51.504 | 0.0261 | |
| | P209801H | 37.594 | -35.67 | -55.613 | 0.0101 | |
| | S209800H | 36.91 | -35.41 | -40.514 | 0.3087 | |
| | S209801H | 37.065 | -35.41 | -41.776 | 0.2308 | |
| | S219800H | 37.347 | -35.41 | -43.412 | 0.1584 | |
| | S219801H | 36.622 | -35.41 | -42.308 | 0.2042 | |
| German_2009_08_25_outbox | M229800H | 36.555 | -35.41 | -55.155 | 0.0106 | |
| | M229801H | 36.971 | -35.41 | -52.419 | 0.0199 | |

B - German Bank Aug. 25, 2009 final run with CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_2009_08_25_inbox | -35.42 | 646 | -42.925 | 0.1774 | 114610 | 25489 | 22 |
| German_2009_08_25_outbox | -35.41 | 90 | -52.554 | 0.0193 | 1737 | 529 | 30 |
| | | 736 | -43.426 | 0.1581 | 116347 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_2009_08_25_inbox | D209800H | 37.203 | -35.41 | -79.965 | 0 | NONE |
| | D209801H | 37.409 | -35.41 | -95.342 | 0 | |
| | I209800H | 37.069 | -35.41 | -39.084 | 0.429 | |
| | I209801H | 37.348 | -35.41 | -39.781 | 0.3654 | |
| | K209800H | 37.216 | -35.67 | -53.608 | 0.0161 | |
| | K209801H | 37.29 | -35.67 | -56.913 | 0.0075 | |
| | L209800H | 36.45 | -35.41 | -40.746 | 0.2926 | |
| | L209801H | 36.51 | -35.41 | -41.177 | 0.265 | |
| | N209800H | 36.966 | -35.41 | -45.324 | 0.102 | |
| | N209801H | 37.139 | -35.41 | -44.428 | 0.1253 | |
| | P209800H | 37.369 | -35.67 | -50.682 | 0.0316 | |
| | P209801H | 37.594 | -35.67 | -54.792 | 0.0123 | |
| | S209800H | 36.91 | -35.41 | -39.336 | 0.4049 | |
| | S209801H | 37.065 | -35.41 | -40.598 | 0.3027 | |
| | S219800H | 37.347 | -35.41 | -42.057 | 0.2164 | |
| | S219801H | 36.622 | -35.41 | -40.954 | 0.2789 | |
| German_2009_08_25_outbox | M229800H | 36.555 | -35.41 | -54.141 | 0.0134 | |
| | M229801H | 36.971 | -35.41 | -51.405 | 0.0251 | |

Table A8. Results for German Bank herring acoustic survey (#3) on Sept. 8, 2009, for the overall survey area (inbox).

A - German Bank Sept. 8, 2009 final run without CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_2009_09_08 | -35.59 | 646 | -48.933 | 0.0463 | 29941 | 8530 | 28 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_2009_09_08 | D209800H | 36.915 | -35.54 | -56.993 | 0.0072 | NONE |
| | D209801H | 36.858 | -35.54 | -64.459 | 0.0013 | |
| | K209800H | 37.656 | -35.81 | -58.215 | 0.0057 | |
| | K209801H | 37.361 | -35.81 | -47.186 | 0.0728 | |
| | L209800H | 36.972 | -35.54 | -43.216 | 0.1708 | |
| | L209801H | 37.238 | -35.54 | -47.1 | 0.0699 | |
| | M229800H | 36.97 | -35.54 | -60.086 | 0.0035 | |
| | M229801H | 36.76 | -35.54 | -61.474 | 0.0026 | |
| | N209800H | 37.097 | -35.54 | -47.939 | 0.0576 | |
| | N209801H | 37.47 | -35.54 | -49.158 | 0.0435 | |
| | P209800H | 37.186 | -35.81 | -48.068 | 0.0594 | |
| | P209801H | 37.505 | -35.81 | -56.571 | 0.0084 | |
| | S209800H | 37.181 | -35.54 | -49.051 | 0.0446 | |
| | S209801H | 37.182 | -35.54 | -55.536 | 0.01 | |
| | S219800H | 37.006 | -35.54 | -43.532 | 0.1588 | |
| | S219801H | 37.323 | -35.54 | -51.364 | 0.0262 | |

B - German Bank Sept. 8, 2009 final run with CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_2009_09_08 | -35.59 | 646 | -47.949 | 0.0581 | 37522 | 10885 | 29 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_2009_09_08 | D209800H | 36.915 | -35.54 | -56.544 | 0.0079 | NONE |
| | D209801H | 36.858 | -35.54 | -64.009 | 0.0014 | |
| | K209800H | 37.656 | -35.81 | -57.637 | 0.0066 | |
| | K209801H | 37.361 | -35.81 | -46.608 | 0.0832 | |
| | L209800H | 36.972 | -35.54 | -42.388 | 0.2067 | |
| | L209801H | 37.238 | -35.54 | -46.272 | 0.0845 | |
| | M229800H | 36.97 | -35.54 | -59.072 | 0.0044 | |
| | M229801H | 36.76 | -35.54 | -60.46 | 0.0032 | |
| | N209800H | 37.097 | -35.54 | -46.982 | 0.0718 | |
| | N209801H | 37.47 | -35.54 | -48.2 | 0.0542 | |
| | P209800H | 37.186 | -35.81 | -47.247 | 0.0718 | |
| | P209801H | 37.505 | -35.81 | -55.75 | 0.0101 | |
| | S209800H | 37.181 | -35.54 | -47.873 | 0.0585 | |
| | S209801H | 37.182 | -35.54 | -54.358 | 0.0131 | |
| | S219800H | 37.006 | -35.54 | -42.178 | 0.217 | |
| | S219801H | 37.323 | -35.54 | -50.01 | 0.0357 | |

Table A9. Results for German Bank herring acoustic survey (#4) on Sept. 14, 2009, for the overall survey area (inbox).

A - German Bank Sept. 14, 2009 final run without CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_2009_09_14 | -35.29 | 646 | -46.052 | 0.0839 | 54192 | 36094 | 67 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_2009_09_14 | K209999H | 37.862 | -35.55 | -60.266 | 0.0034 | NONE |
| | L209999H | 38.705 | -35.29 | -51.21 | 0.0256 | |
| | N209999H | 37.188 | -35.29 | -61.004 | 0.0027 | |
| | P209999H | 37.643 | -35.55 | -59.654 | 0.0039 | |
| | M229999H | 36.625 | -35.29 | -42.337 | 0.1972 | |
| | S209800H | 38.023 | -35.29 | -38.874 | 0.4377 | |
| | S209801H | 37.677 | -35.29 | -72.665 | 0.0002 | |

B - German Bank Sept. 14, 2009 final run with CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_2009_09_14 | -35.29 | 646 | -44.938 | 0.1084 | 70024 | 47174 | 67 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_2009_09_14 | K209999H | 37.862 | -35.55 | -59.689 | 0.0039 | NONE |
| | L209999H | 38.705 | -35.29 | -50.382 | 0.0309 | |
| | N209999H | 37.188 | -35.29 | -60.047 | 0.0033 | |
| | P209999H | 37.643 | -35.55 | -58.833 | 0.0047 | |
| | M229999H | 36.625 | -35.29 | -41.323 | 0.2491 | |
| | S209800H | 38.023 | -35.29 | -37.696 | 0.5742 | |
| | S209801H | 37.677 | -35.29 | -71.486 | 0.0002 | |
| | S219999H | 37.533 | -35.29 | -64.201 | 0.0013 | |

Table A10. Results for German Bank herring acoustic survey (#5) on Sept. 24, 2009, for the overall survey area (inbox).

A - German Bank Sept. 24, 2009 final run without CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_2009_09_24_with_lb | -35.05 | 646 | -47.152 | 0.0617 | 39828 | 27955 | 70 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_2009_09_24_with_lb | K209800H | 38.258 | -35.31 | -62.78 | 0.0018 | |
| | L209800H | 37.289 | -35.04 | -38.968 | 0.4053 | |
| | M229800H | 36.689 | -35.04 | -55.18 | 0.0097 | |
| | N209800H | 37.26 | -35.04 | -61.38 | 0.0023 | |
| | P209800H | 36.979 | -35.31 | -54.284 | 0.0127 | |
| | S209800H | 37.17 | -35.04 | -49.626 | 0.0348 | |
| | S209801H | 37.402 | -35.04 | -48.721 | 0.0429 | |
| | S219800H | 36.839 | -35.04 | -55.826 | 0.0084 | |
| | S219801H | 36.951 | -35.04 | -49.433 | 0.0364 | |

B - German Bank Sept. 24, 2009 final run with CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_2009_09_24_with_lb | -35.05 | 646 | -46.226 | 0.0763 | 49292 | 33746 | 68 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_2009_09_24_with_lb | K209800H | 38.258 | -35.31 | -62.202 | 0.002 | |
| | L209800H | 37.289 | -35.04 | -38.139 | 0.4904 | |
| | M229800H | 36.689 | -35.04 | -54.165 | 0.0122 | |
| | N209800H | 37.26 | -35.04 | -60.423 | 0.0029 | |
| | P209800H | 36.979 | -35.31 | -53.463 | 0.0153 | |
| | S209800H | 37.17 | -35.04 | -48.448 | 0.0457 | |
| | S209801H | 37.402 | -35.04 | -47.542 | 0.0563 | |
| | S219800H | 36.839 | -35.04 | -54.471 | 0.0114 | |
| | S219801H | 36.951 | -35.04 | -48.079 | 0.0497 | |

Table A11. Results for German Bank herring acoustic survey (#6) on Oct. 5, 2009, for the overall survey area (inbox).

A - German Bank Oct. 5, 2009 final run without CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_2009_10_05 | -34.89 | 646 | -45.314 | 0.0908 | 58648 | 43646 | 74 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_2009_10_05 | I209800H | 37.054 | -34.89 | -1035.688 | 0 | NONE |
| | I209801H | 37.266 | -34.89 | -1035.713 | 0 | |
| | K209800H | 37.335 | -35.16 | -1035.721 | 0 | |
| | L209800H | 37.283 | -34.89 | -37.154 | 0.5944 | |
| | M229800H | 36.828 | -34.89 | -41.413 | 0.2229 | |
| | N209800H | 37.038 | -34.89 | -75.304 | 0.0001 | |
| | P209800H | 37.613 | -35.16 | -72.227 | 0.0002 | |
| | S209800H | 37.288 | -34.89 | -76.265 | 0.0001 | |
| | S209801H | 36.947 | -34.89 | -86.906 | 0 | |

B - German Bank Oct. 5, 2009 final run with CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_2009_10_05 | -34.89 | 646 | -44.435 | 0.1112 | 71809 | 53028 | 74 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_2009_10_05 | I209800H | 37.054 | -34.89 | -1035.688 | 0 | NONE |
| | I209801H | 37.266 | -34.89 | -1035.713 | 0 | |
| | K209800H | 37.335 | -35.16 | -1035.721 | 0 | |
| | L209800H | 37.283 | -34.89 | -36.325 | 0.7192 | |
| | M229800H | 36.828 | -34.89 | -40.399 | 0.2815 | |
| | N209800H | 37.038 | -34.89 | -74.346 | 0.0001 | |
| | P209800H | 37.613 | -35.16 | -71.405 | 0.0002 | |
| | S209800H | 37.288 | -34.89 | -75.087 | 0.0001 | |
| | S209801H | 36.947 | -34.89 | -85.728 | 0 | |

Table A12. Results for German Bank herring acoustic survey (#6) on Oct. 5, 2009, for the school estimates only.

A - German Bank Oct. 5, 2009 schools only without CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_2009_10_05_school_ | -34.89 | 3.25 | -24.338 | 11.3662 | 36940 | 9034 | 24 |
| German_2009_10_05_school_ | -34.89 | 9 | -31.978 | 1.957 | 17613 | 0 | 0 |
| | | 12.25 | | | 54553 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_2009_10_05_school_ | L209900H | 1.89 | -34.89 | -27.492 | 5.4979 | |
| | L209901H | 2.049 | -34.89 | -24.353 | 11.3265 | |
| | L209902H | 3.032 | -34.89 | -23.118 | 15.0505 | |
| German_2009_10_05_school_ | M229700H | 4.193 | -34.89 | -31.978 | 1.957 | |

B - German Bank Oct. 5, 2009 schools only with CIF (sample TS with frequency adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_2009_10_05_school_ | -34.89 | 3.25 | -23.51 | 13.7541 | 44701 | 10932 | 24 |
| German_2009_10_05_school_ | -34.89 | 9 | -30.964 | 2.4717 | 22245 | 0 | 0 |
| | | 12.25 | | | 66946 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_2009_10_05_school_ | L209900H | 1.89 | -34.89 | -26.664 | 6.6529 | |
| | L209901H | 2.049 | -34.89 | -23.525 | 13.7061 | |
| | L209902H | 3.032 | -34.89 | -22.29 | 18.2124 | |
| German_2009_10_05_school_ | M229700H | 4.193 | -34.89 | -30.964 | 2.4717 | |

Table A13. Results for German Bank herring acoustic survey (#7) on Oct. 20, 2009, for the overall survey area (inbox).

A -German Bank Oct. 20,2009 estimate without CIF (no samples, std TS with freq adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_2009_10_20 | -35.6 | 646 | -52.807 | 0.019 | 12304 | 3088 | 25 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_2009_10_20 | K209800H | 36.787 | -35.76 | -50.85 | 0.031 | NONE |
| | M229800H | 37.497 | -35.5 | -52.252 | 0.0211 | |
| | M229801H | 38.188 | -35.5 | -50.941 | 0.0286 | |
| | N209800H | 37.176 | -35.61 | -50.382 | 0.0333 | |
| | P209800H | 37.464 | -35.76 | -60.291 | 0.0035 | |
| | S209800H | 36.261 | -35.61 | -58.788 | 0.0048 | |
| | S209801H | 36.034 | -35.61 | -55.452 | 0.0104 | |

B - German Bank Oct. 20, 2009 estimate with CIF (std TS with freq adjustment)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| German_2009_10_20 | -35.6 | 646 | -51.886 | 0.0235 | 15195 | 3728 | 25 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| German_2009_10_20 | K209800H | 36.787 | -35.76 | -50.273 | 0.0354 | NONE |
| | M229800H | 37.497 | -35.5 | -51.238 | 0.0267 | |
| | M229801H | 38.188 | -35.5 | -49.927 | 0.0361 | |
| | N209800H | 37.176 | -35.61 | -49.424 | 0.0415 | |
| | P209800H | 37.464 | -35.76 | -59.469 | 0.0043 | |
| | S209800H | 36.261 | -35.61 | -57.61 | 0.0063 | |
| | S209801H | 36.034 | -35.61 | -54.274 | 0.0136 | |

Table A14. Results for Trinity Ledge herring acoustic survey (#1) on Aug. 25, 2009, with two schools surveyed.

A. Trinity Ledge, Aug. 25, 2009 schools only, without CIF, TS adjusted for frequency (no samples)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Trinity_25082009_north | -35.95 | 0.95 | -44.137 | 0.1518 | 144 | 125 | 87 |
| Trinity_25082009_south | -35.95 | 0.18 | -36.212 | 0.9413 | 169 | 160 | 95 |
| Total or mean | -35.95 | 1.13 | -41.515 | 0.2776 | 313 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Trinity_25082009_north | F209800H | 0.482 | -35.95 | -69.926 | 0.0004 | NONE |
| | F209801H | 0.59 | -35.95 | -69.267 | 0.0005 | |
| | F209802H | 0.622 | -35.95 | -36.292 | 0.924 | |
| | F209803H | 0.608 | -35.95 | -62.994 | 0.002 | |
| | F209804H | 0.575 | -35.95 | -61.644 | 0.0027 | |
| | F209805H | 0.565 | -35.95 | -71.157 | 0.0003 | |
| | F209806H | 0.37 | -35.95 | -70.563 | 0.0003 | |
| Trinity_25082009_south | F209900H | 0.343 | -35.95 | -33.434 | 1.7842 | |
| | F209901H | 0.307 | -35.95 | -66.067 | 0.001 | |

B. Trinity Ledge, Aug. 25, 2009 schools only, with CIF, TS adjusted for frequency (no samples)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Trinity_25082009_north | -35.95 | 0.95 | -40.464 | 0.3536 | 336 | 292 | 87 |
| Trinity_25082009_south | -35.95 | 0.18 | -32.539 | 2.1928 | 395 | 374 | 95 |
| Total or mean | -35.95 | 1.13 | -37.843 | 0.6466 | 731 | | |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Trinity_25082009_north | F209800H | 0.482 | -35.95 | -66.253 | 0.0009 | NONE |
| | F209801H | 0.59 | -35.95 | -65.594 | 0.0011 | |
| | F209802H | 0.622 | -35.95 | -32.62 | 2.1524 | |
| | F209803H | 0.608 | -35.95 | -59.321 | 0.0046 | |
| | F209804H | 0.575 | -35.95 | -57.972 | 0.0063 | |
| | F209805H | 0.565 | -35.95 | -67.485 | 0.0007 | |
| | F209806H | 0.37 | -35.95 | -66.89 | 0.0008 | |
| Trinity_25082009_south | F209900H | 0.343 | -35.95 | -29.762 | 4.1564 | |
| | F209901H | 0.307 | -35.95 | -62.395 | 0.0023 | |

Table A15. Results for Trinity Ledge herring acoustic survey (#2) on Sept. 8, 2009, with one school surveyed.

A. Trinity Ledge, Sept. 8, 2009 school only, without CIF, TS adjusted for frequency (no samples)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Trinity_2009_09_08 | -35.95 | 0.16 | -32.401 | 2.2636 | 362 | 85 | 24 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Trinity_2009_09_08 | F209800H | 0.251 | -35.95 | -31.368 | 2.8714 | NONE |
| | F209801H | 0.262 | -35.95 | -30.336 | 3.6414 | |
| | F209802H | 0.287 | -35.95 | -32.734 | 2.0964 | |
| | F209803H | 0.305 | -35.95 | -31.058 | 3.0841 | |
| | F209804H | 0.274 | -35.95 | -31.988 | 2.4896 | |
| | F209805H | 0.192 | -35.95 | -42.176 | 0.2384 | |
| | F209806H | 0.171 | -35.95 | -1012.341 | 0 | |

B. Trinity Ledge, Sept. 8, 2009 school only, with CIF, TS adjusted for frequency (no samples)

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Trinity_2009_09_08 | -35.95 | 0.16 | -28.728 | 5.273 | 844 | 199 | 24 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Trinity_2009_09_08 | F209800H | 0.251 | -35.95 | -27.695 | 6.689 | NONE |
| | F209801H | 0.262 | -35.95 | -26.664 | 8.4826 | |
| | F209802H | 0.287 | -35.95 | -29.062 | 4.8836 | |
| | F209803H | 0.305 | -35.95 | -27.385 | 7.1845 | |
| | F209804H | 0.274 | -35.95 | -28.315 | 5.7996 | |
| | F209805H | 0.192 | -35.95 | -38.503 | 0.5554 | |
| | F209806H | 0.171 | -35.95 | -1012.341 | 0 | |

Table A16. Transect summary results for Little Hope/Port Mouton herring acoustic survey (#1) on Sept. 14, 2009, as calculated with the CIF and standard target strength values adjusted for frequency (no survey samples available).

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Westmost | -35.95 | 2.75 | -33.393 | 1.8014 | 4954 | 2623 | 53 |
| East_of_westmost | -35.95 | 1.98 | -31.249 | 2.9515 | 5844 | 2702 | 46 |
| Eastmost | -35.95 | 0.19 | -29.73 | 4.1865 | 795 | 214 | 27 |
| West_of_eastmost | -35.95 | 0.27 | -28.717 | 5.2872 | 1428 | 655 | 46 |
| Total or mean | -35.95 | 5.19 | -31.954 | 2.5088 | 13021 | 3,828 | 29% |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Westmost | F209800H | 0.214 | -35.95 | -27.994 | 6.244 | NONE |
| | F209801H | 0.722 | -35.95 | -31.681 | 2.6718 | |
| | F209802H | 0.87 | -35.95 | -29.313 | 4.6086 | |
| | F209803H | 1.107 | -35.95 | -27.062 | 7.7387 | |
| | F209804H | 1.567 | -35.95 | -35.603 | 1.0828 | |
| | F209805H | 1.877 | -35.95 | -37.078 | 0.7712 | |
| | F209806H | 2.188 | -35.95 | -37.68 | 0.6713 | |
| | F209807H | 2.319 | -35.95 | -44.358 | 0.1442 | |
| | F209808H | 0.704 | -35.95 | -47.533 | 0.0694 | |
| East_of_westmost | F209810H | 0.295 | -35.95 | -29.671 | 4.2447 | |
| | F209811H | 0.232 | -35.95 | -27.775 | 6.567 | |
| | F209812H | 0.316 | -35.95 | -23.747 | 16.6019 | |
| | F209813H | 0.38 | -35.95 | -29.514 | 4.4008 | |
| | F209814H | 0.345 | -35.95 | -54.299 | 0.0146 | |
| | F209815H | 0.504 | -35.95 | -24.989 | 12.4733 | |
| | F209816H | 0.326 | -35.95 | -48.39 | 0.057 | |
| | F209817H | 0.589 | -35.95 | -51.105 | 0.0305 | |
| | F209818H | 1.008 | -35.95 | -30.691 | 3.3557 | |
| | F209819H | 0.362 | -35.95 | -36.278 | 0.9271 | |
| | F209820H | 0.91 | -35.95 | -29.278 | 4.6465 | |
| | F209821H | 1.37 | -35.95 | -40.541 | 0.3473 | |
| | F209822H | 1.38 | -35.95 | -46.643 | 0.0852 | |
| | F209823H | 0.309 | -35.95 | -49.671 | 0.0424 | |
| Eastmost | F209830H | 0.211 | -35.95 | -50.172 | 0.0378 | |
| | F209831H | 0.283 | -35.95 | -27.427 | 7.1147 | |
| | F209832H | 0.298 | -35.95 | -25.914 | 10.0811 | |
| | F209833H | 0.37 | -35.95 | -28.533 | 5.5155 | |
| | F209834H | 0.351 | -35.95 | -29.611 | 4.3034 | |
| | F209835H | 0.185 | -35.95 | -30.265 | 3.7013 | |
| | F209836H | 0.266 | -35.95 | -34.174 | 1.5048 | |
| | F209837H | 0.256 | -35.95 | -33.382 | 1.806 | |
| | F209838H | 0.2 | -35.95 | -49.006 | 0.0495 | |
| West_of_eastmost | F209840H | 0.336 | -35.95 | -29.828 | 4.0938 | |
| | F209841H | 0.362 | -35.95 | -25.408 | 11.3268 | |
| | F209842H | 0.333 | -35.95 | -25.592 | 10.8566 | |
| | F209843H | 0.421 | -35.95 | -58.112 | 0.0061 | |
| | F209844H | 0.308 | -35.95 | -37.51 | 0.6981 | |

Table A17. Transect summary results for Little Hope/Port Mouton herring acoustic survey (#2) on Sept. 26, 2009, as calculated with the CIF and standard target strength values adjusted for frequency (no survey samples available).

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| West_school | -35.95 | 6.82 | -38.846 | 0.5131 | 3499 | 674 | 19 |
| Middle_school | -35.95 | 4.42 | -44.979 | 0.125 | 552 | 114 | 21 |
| East_school_v2 | -35.95 | 2.25 | -27.913 | 6.3612 | 14313 | 4080 | 29 |
| Totals | | 13.49 | -34.608 | 1.3613 | 18364 | 4,137 | 23% |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| West_school | F209800H | 1.673 | -35.95 | -43.147 | 0.1906 | NONE |
| | F209801H | 1.736 | -35.95 | -41.586 | 0.273 | |
| | F209802H | 1.725 | -35.95 | -35.463 | 1.1181 | |
| | F209803H | 1.741 | -35.95 | -35.283 | 1.1654 | |
| | F209804H | 0.927 | -35.95 | -38.16 | 0.6009 | |
| | F209805H | 1.863 | -35.95 | -36.191 | 0.9456 | |
| | F209806H | 1.813 | -35.95 | -34.701 | 1.3326 | |
| | F209807H | 1.862 | -35.95 | -36.142 | 0.9562 | |
| | F209808H | 1.844 | -35.95 | -40.349 | 0.363 | |
| | F209809H | 1.864 | -35.95 | -40.921 | 0.3182 | |
| | F209810H | 1.507 | -35.95 | -49.956 | 0.0397 | |
| | F209811H | 1.149 | -35.95 | -62.889 | 0.002 | |
| | F209812H | 0.693 | -35.95 | -38.085 | 0.6114 | |
| | F209813H | 0.346 | -35.95 | -37.97 | 0.6277 | |
| | F209814H | 0.421 | -35.95 | -41.615 | 0.2712 | |
| | F209815H | 0.684 | -35.95 | -45.744 | 0.1048 | |
| | F209816H | 0.944 | -35.95 | -54.148 | 0.0151 | |
| | F209817H | 0.445 | -35.95 | -53.89 | 0.0161 | |
| | F209818H | 2.242 | -35.95 | -50.188 | 0.0377 | |
| | F209819H | 0.881 | -35.95 | -66.891 | 0.0008 | |
| Middle_school | F209830H | 0.599 | -35.95 | -45.807 | 0.1033 | |
| | F209831H | 0.869 | -35.95 | -41.429 | 0.2831 | |
| | F209832H | 1.61 | -35.95 | -43.363 | 0.1813 | |
| | F209833H | 1.677 | -35.95 | -46.487 | 0.0883 | |
| | F209834H | 0.905 | -35.95 | -46.129 | 0.0959 | |
| | F209835H | 0.703 | -35.95 | -48.859 | 0.0512 | |
| | F209836H | 0.754 | -35.95 | -54.605 | 0.0136 | |
| | F209837H | 0.355 | -35.95 | -51.727 | 0.0264 | |
| | F209838H | 0.408 | -35.95 | -91.516 | 0 | |
| | F209839H | 0.559 | -35.95 | -41.731 | 0.264 | |
| | F209840H | 1.184 | -35.95 | -43.228 | 0.1871 | |
| | F209841H | 1.759 | -35.95 | -44.971 | 0.1252 | |
| | F209842H | 1.611 | -35.95 | -41.486 | 0.2794 | |
| | F209843H | 1.579 | -35.95 | -49.977 | 0.0395 | |
| | F209844H | 1.482 | -35.95 | -56.068 | 0.0097 | |
| East_school_v2 | F209850H | 0.614 | -35.95 | -34.238 | 1.4824 | |
| | F209851H | 0.765 | -35.95 | -35.575 | 1.0897 | |
| | F209852H | 0.742 | -35.95 | -32.237 | 2.3501 | |
| | F209853H | 0.679 | -35.95 | -36.724 | 0.8363 | |
| | F209854H | 0.829 | -35.95 | -26.022 | 9.8301 | |
| | F209855H | 0.8 | -35.95 | -24.324 | 14.5346 | |
| | F209856H | 0.971 | -35.95 | -29.489 | 4.4244 | |
| | F209957H | 1.033 | -35.95 | -24.099 | 15.3077 | |
| | F209858H | 1 | -35.95 | -25.332 | 11.5249 | |
| | F209859H | 0.93 | -35.95 | -87.256 | 0 | |
| | F209860H | 0.356 | -35.95 | -94.416 | 0 | |

Table A18. Transect summary results for Little Hope/Port Mouton herring acoustic survey (#3) on Oct.8, 2009, as calculated with the CIF and standard target strength values adjusted for frequency (no survey samples available).

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Littlehop2_2009_10_08_s1 | -35.95 | 6.75 | -42.245 | 0.2346 | 1583 | 551 | 35 |
| Littlehop2_2009_10_08_s2 | -35.95 | 11.83 | -43.792 | 0.1643 | 1943 | 392 | 20 |
| Littlehop2_2009_10_08_s3 | -35.95 | 1.71 | -37.048 | 0.7762 | 1327 | 196 | 15 |
| Littlehop2_2009_10_08_s4 | -35.95 | 1.2 | -46.177 | 0.0949 | 114 | 17 | 15 |
| | | 21.49 | -42.309 | 0.2312 | 4967 | 704 | 14% |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Littlehop2_2009_10_08_s1 | F209800H | 0.462 | -35.95 | -56.615 | 0.0086 | NONE |
| | F209801H | 1.958 | -35.95 | -48.632 | 0.0539 | |
| | F209802H | 2.018 | -35.95 | -47.393 | 0.0717 | |
| | F209803H | 1.941 | -35.95 | -44.526 | 0.1388 | |
| | F209804H | 2.154 | -35.95 | -37.93 | 0.6335 | |
| | F209805H | 2.413 | -35.95 | -37.523 | 0.6958 | |
| | F209806H | 2.205 | -35.95 | -45.394 | 0.1136 | |
| | F209807H | 1.666 | -35.95 | -49.115 | 0.0482 | |
| | F209808H | 1.152 | -35.95 | -54.63 | 0.0135 | |
| | F209809H | 0.864 | -35.95 | -49.891 | 0.0403 | |
| Littlehop2_2009_10_08_s2 | H209800H | 2.293 | -35.95 | -44.682 | 0.1338 | |
| | H209801H | 2.903 | -35.95 | -42.485 | 0.222 | |
| | H209802H | 3.534 | -35.95 | -42.083 | 0.2435 | |
| | H209803H | 2.916 | -35.95 | -46.125 | 0.096 | |
| | H209804H | 2.107 | -35.95 | -46.941 | 0.0796 | |
| Littlehop2_2009_10_08_s3 | H209810H | 0.935 | -35.95 | -36.998 | 0.7853 | |
| | H209811H | 0.876 | -35.95 | -38.975 | 0.498 | |
| | H209812H | 1.206 | -35.95 | -35.254 | 1.1733 | |
| | H209813H | 1.449 | -35.95 | -37.29 | 0.7342 | |
| | H209814H | 1.127 | -35.95 | -38.065 | 0.6142 | |
| Littlehop2_2009_10_08_s4 | H209820H | 1.117 | -35.95 | -44.93 | 0.1264 | |
| | H209821H | 0.969 | -35.95 | -46.551 | 0.087 | |
| | H209822H | 1.072 | -35.95 | -46.03 | 0.0981 | |
| | H209823H | 0.883 | -35.95 | -48.201 | 0.0595 | |

Table A19. Transect summary results for Little Hope/Port Mouton herring acoustic survey (#4) on Oct. 11, 2009, as calculated with the CIF and standard target strength values adjusted for frequency (no survey samples available).

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Littlehope_2009_10_11_s1 | -35.95 | 1.57 | -38.774 | 0.5217 | 819 | 243 | 30 |
| Littlehope_2009_10_11_s2 | -35.95 | 0.23 | -27.957 | 6.2972 | 1448 | 809 | 56 |
| Littlehope_2009_10_11_s3 | -35.95 | 1.68 | -38.838 | 0.514 | 864 | 150 | 17 |
| Littlehope_2009_10_11_s4 | -35.95 | 0.14 | -35.469 | 1.1166 | 156 | 66 | 42 |
| Littlehope_2009_10_11_s5 | -35.95 | 0.98 | -30.859 | 3.2275 | 3163 | 511 | 16 |
| Littlehope_2009_10_11_s6 | -35.95 | 1.38 | -30.621 | 3.4093 | 4705 | 1683 | 36 |
| Littlehope_2009_10_11_s7 | -35.95 | 0.25 | -32.202 | 2.3694 | 592 | 297 | 50 |
| Littlehope_2009_10_11_s8 | -35.95 | 0.26 | -28.88 | 5.0911 | 1324 | 498 | 38 |
| Totals w/o school 5 & 6 | -35.95 | 4.13 | -32.91 | 2.014 | 5,203 | 1,038 | 20% |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Littlehope_2009_10_11_s1 | F209800H | 0.655 | -35.95 | -39.284 | 0.4639 | NONE |
| | F209801H | 0.775 | -35.95 | -39.148 | 0.4786 | |
| | F209802H | 0.737 | -35.95 | -36.239 | 0.9351 | |
| | F209803H | 0.803 | -35.95 | -41.883 | 0.255 | |
| | F209804H | 1.159 | -35.95 | -36.098 | 0.9661 | |
| | F209805H | 1.024 | -35.95 | -1020.1 | 0 | |
| Littlehope_2009_10_11_s2 | F209806H | 0.436 | -35.95 | -25.897 | 10.1185 | |
| | F209807H | 0.39 | -35.95 | -24.398 | 14.289 | |
| | F209808H | 0.453 | -35.95 | -37.066 | 0.7731 | |
| | F209809H | 0.363 | -35.95 | -68.071 | 0.0006 | |
| Littlehope_2009_10_11_s3 | F209810H | 0.292 | -35.95 | -46.619 | 0.0857 | |
| | F209811H | 0.436 | -35.95 | -37.179 | 0.7532 | |
| | F209812H | 0.619 | -35.95 | -37.197 | 0.7501 | |
| | F209813H | 0.787 | -35.95 | -38.243 | 0.5895 | |
| | F209814H | 0.648 | -35.95 | -38.245 | 0.5892 | |
| | F209815H | 0.539 | -35.95 | -40.892 | 0.3204 | |
| | F209816H | 0.658 | -35.95 | -37.983 | 0.6259 | |
| | F209817H | 0.676 | -35.95 | -42.651 | 0.2136 | |
| Littlehope_2009_10_11_s4 | F209818H | 0.294 | -35.95 | -34.284 | 1.4669 | |
| | F209819H | 0.281 | -35.95 | -32.474 | 2.2254 | |
| | F209820H | 0.365 | -35.95 | -36.892 | 0.8046 | |
| | F209821H | 0.27 | -35.95 | -1014.31 | 0 | |
| Littlehope_2009_10_11_s5 | F209822H | 0.376 | -35.95 | -33.588 | 1.7219 | |
| | F209823H | 0.429 | -35.95 | -32.066 | 2.4445 | |
| | F209824H | 0.73 | -35.95 | -34.665 | 1.3436 | |
| | F209825H | 0.721 | -35.95 | -32.261 | 2.3372 | |
| | F209826H | 0.867 | -35.95 | -30.877 | 3.2144 | |
| | F209827H | 0.667 | -35.95 | -33.162 | 1.8992 | |
| | F209828H | 0.663 | -35.95 | -28.488 | 5.5714 | |
| | F209829H | 0.35 | -35.95 | -28.389 | 5.6998 | |
| | F209830H | 0.648 | -35.95 | -30.79 | 3.2794 | |
| | F209831H | 0.465 | -35.95 | -29.812 | 4.1075 | |
| | F209832H | 0.318 | -35.95 | -28.006 | 6.2257 | |
| Littlehope_2009_10_11_s6 | F209833H | 0.717 | -35.95 | -31.181 | 2.9972 | |
| | F209834H | 0.926 | -35.95 | -26.504 | 8.7993 | |
| | F209835H | 1.304 | -35.95 | -31.231 | 2.9626 | |
| | F209836H | 1.31 | -35.95 | -31.233 | 2.9612 | |
| | F209837H | 0.887 | -35.95 | -34.161 | 1.5089 | |
| | F209838H | 0.539 | -35.95 | -1017.32 | 0 | |
| Littlehope_2009_10_11_s7 | F209839H | 0.231 | -35.95 | -1013.64 | 0 | |
| | F209840H | 0.164 | -35.95 | -1012.14 | 0 | |
| | F209841H | 0.386 | -35.95 | -29.502 | 4.4119 | |
| | F209842H | 0.419 | -35.95 | -27.79 | 6.5439 | |
| | F209843H | 0.376 | -35.95 | -1015.75 | 0 | |
| | F209844H | 0.3 | -35.95 | -1014.77 | 0 | |
| Littlehope_2009_10_11_s8 | F209845H | 0.156 | -35.95 | -1011.93 | 0 | |
| | F209846H | 0.421 | -35.95 | -26.749 | 8.315 | |
| | F209847H | 0.461 | -35.95 | -27.889 | 6.3958 | |
| | F209848H | 0.426 | -35.95 | -25.887 | 10.142 | |
| | F209849H | 0.342 | -35.95 | -1015.34 | 0 | |
| | F209850H | 0.309 | -35.95 | -1014.9 | 0 | |

Table A20. Transect summary for Halifax/Eastern Shore herring acoustic survey (#1) on Sept. 16, 2009, for main schools only as calculated with the CIF and target strength values from multi-panel net sample from Sept. 17th adjusted for frequency.

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Esfpa_2009_09_16_bk | -36.49 | 5 | -40.182 | 0.4278 | 2139 | 319 | 15 |
| Esfpa_2009_09_16_moh_west | -36.49 | 1.9 | -26.868 | 9.1769 | 17436 | 3071 | 18 |
| Esfpa_2009_09_16_moh_east | -36.49 | 0.6 | -27.531 | 7.878 | 4727 | 792 | 17 |
| Total of 3 schools | -36.49 | 7.5 | -31.389 | 3.2403 | 24302 | 3,187 | 13% |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Esfpa_2009_09_16_bk | B209800H | 3.487 | -36.49 | -40.853 | 0.3666 | NONE |
| | B209801H | 3.644 | -36.49 | -42.408 | 0.2563 | |
| | B209802H | 3.912 | -36.49 | -37.441 | 0.8043 | |
| | B209803H | 3.451 | -36.49 | -42.064 | 0.2774 | |
| | B209804H | 2.884 | -36.49 | -40.382 | 0.4086 | |
| | B209805H | 2.659 | -36.49 | -42.975 | 0.2249 | |
| | B209806H | 1.381 | -36.49 | -40.182 | 0.4278 | |
| | B209807H | 1.704 | -36.49 | -40.091 | 0.437 | |
| | B209808H | 1.823 | -36.49 | -37.669 | 0.7632 | |
| | B209809H | 1.213 | -36.49 | -41.63 | 0.3066 | |
| Esfpa_2009_09_16_moh_west | M219800H | 0.335 | -36.49 | -45.845 | 0.1162 | |
| | M219801H | 0.566 | -36.49 | -37.305 | 0.8298 | |
| | M219802H | 0.824 | -36.49 | -28.89 | 5.7609 | |
| | M219803H | 1.263 | -36.49 | -29.128 | 5.4532 | |
| | M219804H | 1.37 | -36.49 | -24.529 | 15.7241 | |
| | M219805H | 1.537 | -36.49 | -26.474 | 10.0487 | |
| | M219806H | 1.559 | -36.49 | -23.527 | 19.8079 | |
| | M219807H | 1.581 | -36.49 | -25.636 | 12.187 | |
| | M219808H | 1.558 | -36.49 | -25.835 | 11.6414 | |
| | M219809H | 1.456 | -36.49 | -28.374 | 6.4878 | |
| | M219810H | 1.302 | -36.49 | -28.154 | 6.8247 | |
| | M219811H | 1.04 | -36.49 | -42.346 | 0.2599 | |
| | M219812H | 1.234 | -36.49 | -34.347 | 1.64 | |
| | M219813H | 1.467 | -36.49 | -25.047 | 13.9562 | |
| | M219814H | 1.372 | -36.49 | -24.418 | 16.1337 | |
| | M219815H | 1.237 | -36.49 | -46.194 | 0.1072 | |
| Esfpa_2009_09_16_moh_east | M219820H | 0.691 | -36.49 | -28.584 | 6.1818 | |
| | M219821H | 0.874 | -36.49 | -26.958 | 8.9883 | |
| | M219822H | 0.781 | -36.49 | -25.77 | 11.8169 | |
| | M219823H | 0.789 | -36.49 | -26.274 | 10.522 | |
| | M219824H | 0.534 | -36.49 | -56.317 | 0.0104 | |
| | M219825H | 0.581 | -36.49 | -28.994 | 5.6249 | |
| | M219826H | 0.733 | -36.49 | -28.261 | 6.6595 | |
| | M219827H | 0.725 | -36.49 | -26.548 | 9.8778 | |

Table A21. Transect summary for Halifax/Eastern Shore herring acoustic survey (#1) on Sept. 16, 2009, for between school areas as calculated with the CIF and target strength values from multi-panel net sample from Sept. 17th adjusted for frequency.

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Between_schools_uncut | -36.49 | 170 | -48.472 | 0.0634 | 10784 | 2647 | 25 |
| Between_schools_cut | -36.49 | 170 | -48.464 | 0.0636 | 10804 | 1757 | 16 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Between_schools_uncut | B209900H | 73.685 | -36.49 | -47.538 | 0.0787 | |
| | M219900H | 70.424 | -36.49 | -49.727 | 0.0475 | |
| Between_schools_cut | M219901H | 34.559 | -36.49 | -49.424 | 0.0509 | |
| | M219902H | 35.842 | -36.49 | -50.021 | 0.0444 | |
| | B209901H | 34.741 | -36.49 | -46.921 | 0.0907 | |
| | B209902H | 38.924 | -36.49 | -48.158 | 0.0682 | |

Table A22. Transect summary for Halifax/Eastern Shore herring acoustic survey (#2) on Sept. 24, 2009, for main schools only as calculated with the CIF and target strength values from multi-panel net sample from Sept. 25th adjusted for frequency.

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Esfpa_2009_09_24 | -36.49 | 1.96 | -27.258 | 8.3693 | 16404 | 3303 | 20 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Esfpa_2009_09_24 | B209800H | 1.255 | -36.49 | -24.17 | 17.0419 | NONE |
| | B209801H | 1.248 | -36.49 | -26.113 | 10.8938 | |
| | B209802H | 1.304 | -36.49 | -27.739 | 7.492 | |
| | B209803H | 1.315 | -36.49 | -32.472 | 2.5195 | |
| | B209804H | 1.319 | -36.49 | -55.326 | 0.0131 | |
| | M219800H | 1.347 | -36.49 | -27.712 | 7.539 | |
| | M219801H | 1.487 | -36.49 | -25.657 | 12.0997 | |
| | M219802H | 1.411 | -36.49 | -25.843 | 11.5924 | |
| | M219803H | 1.576 | -36.49 | -25.805 | 11.6946 | |
| | M219804H | 1.459 | -36.49 | -32.312 | 2.6141 | |

Table A23. Transect summary for Halifax/Eastern Shore herring acoustic survey (#3) on Oct. 2, 2009, for main schools only as calculated with the CIF and target strength values from multipanel net sample from Oct. 3rd adjusted for frequency.

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Oct 2_BK_School_1 | -36.38 | 1.72 | -30.135 | 4.2141 | 7248 | 2711 | 37 |
| Oct 2_MOH_School_2 * | -36.38 | 1.36 | -33.999 | 1.7308 | 2354 | 541 | 23 |
| Total (*only use BK school in final) | -36.38 | 3.08 | -31.444 | 3.1176 | 9602 | 2,764 | 29% |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Oct 2_BK_School_1 | B209800H | 1.442 | -36.38 | -28.73 | 5.8237 | NONE |
| | B209801H | 1.387 | -36.38 | -29.885 | 4.4636 | |
| | B209802H | 1.453 | -36.38 | -26.575 | 9.5646 | |
| | B209803H | 1.414 | -36.38 | -26.05 | 10.7942 | |
| | B209804H | 1.228 | -36.38 | -60.642 | 0.0037 | |
| | B209805H | 1.445 | -36.38 | -38.359 | 0.6343 | |
| | B209806H | 1.36 | -36.38 | -47.291 | 0.0811 | |
| | B209807H | 0.901 | -36.38 | -53.668 | 0.0187 | |
| Oct 2_MOH_School_2 * | M219800H | 0.572 | -36.38 | -36.449 | 0.9848 | |
| | M219801H | 1.197 | -36.38 | -39.373 | 0.5022 | |
| | M219802H | 1.116 | -36.38 | -35.143 | 1.3303 | |
| | M219803H | 0.798 | -36.38 | -32.02 | 2.7302 | |
| | M219804H | 1.033 | -36.38 | -31.706 | 2.9347 | |
| | M219805H | 1.114 | -36.38 | -33.366 | 2.0027 | |

Table A24. Transect summary for Halifax/Eastern Shore herring acoustic survey (#4) on Oct. 9, 2009, for main schools only as calculated with the CIF and target strength values from multi-panel net sample from Oct. 10th adjusted for frequency.

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Oct 9_BK_School_1 | -36.33 | 1 | -29.819 | 4.482 | 4482 | 1619 | 36 |
| Oct 9_MOH_School_2 * | -36.44 | 0.5 | -28.02 | 6.9503 | 3475 | 1101 | 32 |
| Totals | | 1.5 | -29.133 | 5.3048 | 7957 | 1,958 | 25% |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Oct 9_BK_School_1 | B209800H | 0.495 | -36.33 | -49.888 | 0.0441 | NONE |
| | B209801H | 0.469 | -36.33 | -38.609 | 0.5922 | |
| | B209802H | 0.9 | -36.33 | -25.962 | 10.8949 | |
| | B209803H | 1.019 | -36.33 | -26.245 | 10.2081 | |
| | B209804H | 1 | -36.33 | -29.622 | 4.6905 | |
| | B209805H | 1.144 | -36.33 | -35.178 | 1.305 | |
| | B209806H | 0.562 | -36.33 | -38.631 | 0.5892 | |
| | B209807H | 0.443 | -36.33 | -51.422 | 0.031 | |
| Oct 9_MOH_School_2 * | M219800H | 0.551 | -36.44 | -29.601 | 4.8291 | |
| | M219801H | 0.667 | -36.44 | -28.889 | 5.6904 | |
| | M219802H | 0.771 | -36.44 | -25.275 | 13.0774 | |
| | M219803H | 0.703 | -36.44 | -31.534 | 3.0947 | |

* Oct. 9 survey of school in same location replaced Oct. 2_School_2 survey

Table A25. Transect summary for Halifax/Eastern Shore herring acoustic survey (#5) on Oct. 21, 2009, for main schools only as calculated with the CIF and target strength values from multi-panel net sample from Oct. 21st adjusted for frequency.

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| Oct 21_School_1 | -36.44 | 0.78 | -27.236 | 8.316 | 6486 | 2246 | 35 |
| Oct 21_School_2 | -36.44 | 0.99 | -30.577 | 3.8528 | 3814 | 1100 | 29 |
| Totals | -36.44 | 1.77 | -28.786 | 5.8197 | 10300 | 2,501 | 24% |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| Oct 21_School_1 | B209800H | 0.255 | -36.44 | -46.77 | 0.0926 | NONE |
| | B209801H | 0.593 | -36.44 | -28.935 | 5.6231 | |
| | B209802H | 0.748 | -36.44 | -29.249 | 5.2307 | |
| | B209803H | 0.829 | -36.44 | -22.334 | 25.7081 | |
| | B209804H | 0.905 | -36.44 | -27.103 | 8.5746 | |
| | B209805H | 0.838 | -36.44 | -30.108 | 4.2927 | |
| | B209806H | 0.68 | -36.44 | -29.193 | 5.2996 | |
| | B209807H | 0.388 | -36.44 | -71.356 | 0.0003 | |
| Oct 21_School_2 | B209810H | 0.666 | -36.44 | -67.133 | 0.0009 | |
| | B209811H | 0.599 | -36.44 | -58.275 | 0.0065 | |
| | B209812H | 0.645 | -36.44 | -35.928 | 1.1238 | |
| | B209813H | 0.735 | -36.44 | -31.152 | 3.3749 | |
| | B209814H | 0.698 | -36.44 | -27.989 | 6.9925 | |
| | B209815H | 0.87 | -36.44 | -30.291 | 4.1154 | |
| | B209816H | 0.817 | -36.44 | -25.748 | 11.713 | |
| | B209817H | 0.878 | -36.44 | -28.531 | 6.1717 | |
| | B209818H | 0.796 | -36.44 | -30.438 | 3.9787 | |
| | B209819H | 0.677 | -36.44 | -36.199 | 1.0559 | |
| | B209820H | 0.546 | -36.44 | -66.171 | 0.0011 | |

Table A26. Transect summary results for Glace Bay herring acoustic survey (#1) on July 27, 2009, as calculated with the CIF and standard target strength values adjusted for frequency (no survey samples available).

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| GlaceBay_July_27 | -35.95 | 50 | -54.327 | 0.0145 | 726 | 318 | 44 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| GlaceBay_July_27 | N219800H | 7.766 | -35.95 | -50.941 | 0.0317 | NONE |
| | N219801H | 5.235 | -35.95 | -67.516 | 0.0007 | |
| | N219802H | 5.296 | -35.95 | -73.842 | 0.0002 | |
| | N219803H | 5.081 | -35.95 | -52.377 | 0.0228 | |
| | N219804H | 3.109 | -35.95 | -58.195 | 0.006 | |

Table A27. Transect summary results for Glace Bay herring acoustic survey (#2) on Sept. 12, 2009, as calculated with the CIF and standard target strength values adjusted for frequency (no survey samples available).

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| GlaceBay_Sept_12 | -35.5 | 33 | -1027.214 | 0 | 0 | 0 | 3 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| GlaceBay_Sept_12 | N219800H | 4.764 | -35.5 | -1026.78 | 0 | NONE |
| | N219801H | 4.921 | -35.5 | -1026.921 | 0 | |
| | N219802H | 5.106 | -35.5 | -1027.081 | 0 | |
| | N219803H | 5.636 | -35.5 | -1027.51 | 0 | |
| | N219804H | 5.199 | -35.5 | -1027.159 | 0 | |
| | N219805H | 5.962 | -35.5 | -1027.754 | 0 | |

Table A28. Transect summary results for Glace Bay herring acoustic survey (#3) on Oct. 2, 2009, as calculated with the CIF and standard target strength values adjusted for frequency (no survey samples available).

| Stratum Layer 1 | Average TS (dB/kg) | Stratum Area (km2) | Weighted Mean Sa (/m2) | Biomass Density (kg/m2) | Strata Biomass (tons) | Standard Error (tons) | Standard Error (%) |
|---|---|---|---|---|---|---|---|
| GlaceBay_Oct_2 | -35.95 | 4.3 | -52.529 | 0.022 | 94 | 65 | 69 |

| Stratum Layer 1 | Transect Number | Transect Length (km) | Target Strength (dB/kg) | Average Sa (/m2) | Biomass Density (kg/m2) | Set Number |
|---|---|---|---|---|---|---|
| GlaceBay_Oct_2 | N219800H | 2.015 | -35.95 | -51.451 | 0.0282 | NONE |
| | N219801H | 1.382 | -35.95 | -46.115 | 0.0962 | |
| | N219802H | 1.45 | -35.95 | -1021.612 | 0 | |
| | N219803H | 1.559 | -35.95 | -62.73 | 0.0021 | |
| | N219804H | 2.053 | -35.95 | -1023.124 | 0 | |
| | N219805H | 2.127 | -35.95 | -53.248 | 0.0186 | |