

ANNEX V

ANALYSIS SUBCOMMITTEE

Report of Meeting 6-7 September 2000
Montréal, Québec

Attendees: P. Pepin (chair), E. Couture, J. Craig, K. Drinkwater, G. Harrison, G. Maillet, S. Narayanan, J. Plourde, J. Spry, M. Starr

Introduction

The first independent meeting of the Data Analysis Subcommittee (ASC) was held to provide a forum to address the standardization of analytical formats for the presentation of routine information collected as part of the Atlantic Zonal Monitoring Program (AZMP). ASC also considered the development of methods that provide a quantitative summary or distillation of the various data collected to parameterize the information into interpretable measures of changes in biological, chemical and physical oceanographic variables. Finally, the ASC considered further developments for the dissemination of information collected by the AZMP (Appendix A).

The following is intended to provide a summary of the general discussion that occurred during the meeting, the analytical approaches considered as useful for the presentation and interpretation of data collected as part of the AZMP, the conclusions about which methods are to be adopted on a Zonal basis, and highlight some of the items requiring action or further discussion for the activities of the subcommittee to be completed.

Standardization of Analytical Formats (Biological and chemical variables)

Among a number of objectives carried out as part of the routine assessment of the state of the ocean, the AZMP aims to provide all potential users of the information with a consistent and easily understandable presentation of the data collected as part of the activities in each region. It is with this goal in mind that members of the ASC consolidated the methods of presentation of the information listed below.

Two issues concerning the synthesis of observations were addressed during the meeting. In the first instance, variables such as chlorophyll and inorganic nutrient concentrations are often measured at a number of depths. However, reporting column integrated values can provide a measure of the total biomass present or the amount of available resources. There was general agreement that in the case of chlorophyll concentrations, integrating over the entire water column for which data are available would provide an accurate measure of the total biomass of phytoplankton under each unit area of ocean. Most of the biomass occurs within the confines of the mixed layer and the addition of samples below this level would not result in an erroneous representation of environmental conditions. There was considerable discussion about how to provide a measure of the integrated

amount of inorganic nutrients contained in the mixed layer. The group from the Maritimes region currently provides an integrated measure of nitrates contained in the top 50 m. The goal is to derive a quantity that represents changes in the balance between biological consumption and physical mixing. Their approach is based on the long term climatology of the region that shows that 50 m represents the depth below which the pool of inorganic nutrients is equal to wintertime surface values. Furthermore, 50 m also appears to be the depth to which biological consumption of inorganic nutrients appears to be confined. No such analysis of the seasonal variation in the depth structure of inorganic nutrient levels yet exists for other regions: **Action: each region to explore alternatives to the scheme used in the Maritime region and report their findings and recommendations at the November general AZMP meeting.**

The second issue of some concern dealt with the approach used to present interpolated 2-dimensional representations of variables. Contour plots are often used to show depth-dependent variations in concentrations (in relation to time or space) or to show aerial patterns in the distribution of a variable. To ensure that such diagrams are accurately interpreted, the committee agreed that **all plots should identify discrete sample locations and that large gaps be blanked out.** There was no agreement on which analytical tool provided the best representation of the fluctuations in a variable or how to measure the magnitude of the error associated with various interpolation schemes, despite several presentations on the subject. The issue can be of some importance because it is uncertain whether the spatial or temporal decorrelation scale is substantially less than the distance between stations or time between observations. There are some results currently available but further analyses or syntheses are required to establish the spatial and temporal scales of variation of the biological and chemical variables collected as part of the AZMP. In the interim, the committee agreed that it is each researcher's responsibility to determine the accuracy of each interpolate representation of the data.

The standardized approach for the display of information reached consensus based on a combination of presentation formats used in the various regions. There are still issues concerning details of the formats (e.g. display pallets) that will be worked out by members of the committee but the basics are displayed in appendix B. The appendix not only outlines the presentation formats but also the responsibility centers for the production of each variable as well as the contact in cases of products for Zonal use. **These approaches should be used in the preparation of information for presentation at advisory meetings (e.g. FOC), for display on the AZMP website managed by MEDS, as well as for the production of the annual AZMP data electronic report (see below).**

Beyond display, the mass of data collected under AZMP must be distilled into relevant parameters or indices that can serve in the interpretation of environmental and climatic relationships. Glen Harrison provided examples of two approaches that can serve to extract the essential patterns in the distribution of nutrients and phytoplankton (Appendix C). **The two approaches are simple and should be used routinely in all regions** for the distillation of information from the AZMP. The parameters derived from nutrient profiles can be estimated easily and **Glen will provide details of the fitting algorithms used to describe vertical chlorophyll distributions to contacts in each region.**

Other indices include the ratio of diatoms-to-dinoflagellates to assess the pattern of variation in phytoplankton community structure, the ratio of large-to-small copepods (e.g. *Calanus* sp. + *Metridia* sp. vs all other copepods) for a comparable measure of copepod diversity. A more general index of species diversity is the Shannon's entropy index that is commonly used as a measure of community diversity. Although the ASC agreed that this index can be used as an index of changes in ecosystem structure, one must be careful that comparisons are based on the a constant level of taxonomic identification since not all organisms are routinely identified the similar taxonomic levels. **Regions should investigate what approaches are to be used in calculating this index.**

With respect to community structure, the ASC identified that Maritimes region was using an integrated sample (10-50 m) in their analysis of phytoplankton community structure whereas both the Newfoundland and Quebec regions were using samples from a fixed depth (10 m). **Although all groups agreed that presentations at the 2001 FOC would be based on the analysis of samples taken at the single common depth, Glen Harrison agreed to conduct an analysis of existing data from Maritimes region to determine whether the patterns of variations in species diversity might be dependent on the depth(s) used in for sampling.** There were also questions about what temporal sampling frequency might be needed to detect major changes in taxonomic composition of phytoplankton, or overall changes in phytoplankton biomass (e.g. chlorophyll), while ensure that aliasing of the results is kept at minimal levels. To address this issue, **Michel Starr agreed to provide the zonal group with an assessment of the influence of biweekly sampling frequency on different variables collected at fixed stations based on an analysis of the Rimouski station sampled weekly by IML.**

The issue of sampling frequency, whether in space or time, was often raised as a point of discussion during the meeting. It is recognized that much the level of information needed to identify the necessary level of sampling for some variables collected by AZMP was not available when the initial project was developed. However, a number of monitoring and research initiatives may have further information necessary to identify the most appropriate level of sampling required to accurately describe changes in oceanographic conditions. **Members of the ASC should review information concerning the need for high-resolution sampling of variables such as chlorophyll using both the literature (e.g. work by Platt and Denman in the early 70s; a recent paper on the use of ships-of-opportunity ICES J.Mar.Sci. 55: 697-704) as well as with information gained from a pilot study using a 2-month deployment of the Seahorse® system at Halifax Station 2 (Glen Harrison).**

Glen provided an update to SeaWifs web site and mentioned reprocessing of all ocean color data is underway. This has resulted in substantial changes to the chlorophyll data. Reprocessed data now designated as OC4. The reprocessing is not yet complete but it is anticipated that all images will have be passed through the new algorithms by the end of the calendar year. Products will include biweekly composites of ocean color and AVHRR data for western North Atlantic. Data can be extracted from FTP site. In addition, a number of computations will be performed for the fixed boxes identified by each region.

Additional information requested will include basic statistics (means, standard deviation) for box area and pixel density. It was noted that IML will assume responsibility for AVHRR and Pierre Larouche is to provide time line for transfer.

Glen briefly discussed the work by Doug Sameoto in which he compares data between E- and Z-lines, and climatological means with annual data. Brian Petrie is exploring large-scale patterns in community structure from CPR database. Mary Kennedy is to inform contact ASC members in each region (IML: M. Harvey; NF: P. Pepin) of periodic updates of CPR data. Doug Sameoto is to inquire about obtaining raw numbers instead of binned CPR data and provide report to zonal group.

Additions to the analysis and presentation of physical oceanographic data

Ken Drinkwater presented additions and changes to the presentation of physical oceanographic data:

- There will be routine presentation of near-bottom temperature for the Gulf of St. Lawrence and the anomalies from the long-term mean, as is routinely done for the Scotian Shelf and Newfoundland Shelf;
- There will be a climatology of temperature, salinity and sigma-t for Halifax Station 2 derived in the same manner as has been carried out in the Newfoundland region;
- There will be a standardized approach for the presentation of data from sections;
- There will be further standardization of the environmental scorecard. Further discussion of this topic for biological and chemical variables should be reopened during the November meeting of the AZMP.

Ken also indicated that the wind field data for entire N. Atlantic is being processed in bins of 1 degree of longitude and 0.5 degrees of latitude.

For the current assessment year (FOC 2001), anomalies in physical conditions will be provided relative to the long-term average for the period 1961-90. However, starting in 2002, the long-term average will be based on the period of 1971-2000, in accordance with standard meteorological practice. Ken Drinkwater and Eugene Colbourne are to provide a summary document that will highlight possible changes in the interpretation of anomalies as a result of changes in the period over which the long-term average is calculated.

Joe Craig provided an update on alternative methods for estimation of stratification / density indices using MATLAB routines he developed. It was noted that depth at maximum gradient could be influenced by other processes (e.g. internal waves) and that care should be taken in the interpretation of fluctuations. It was suggested that relationships of chlorophyll maximum layer depth with stratification calculations should be explored by NF region and results provided to zonal group at a later date

Eugene Colbourne's work on geostrophic calculations of currents along standard oceanographic transects was presented in his absence. It was noted that although many

years of data exist, noise levels are high which presents problems with inter-annual comparisons of the data. However, it was agreed that the conditions on the Newfoundland Shelf do provide an adequate environment for comparison of seasonal and inter-annual patterns of variation as a routine part of the presentation to FOC and other environmental assessments. Ken Drinkwater indicated that he does not believe that currents are sufficiently strong on the Scotian Shelf to allow accurate calculations of geostrophic flows in that region.

Eugene's work also highlighted differences in the cross shelf patterns of oxygen and fluorescence when calibrated and uncalibrated data are used to derive the cross-sectional contour plots. His results indicated that the nature of the variation in the calibration curve may vary spatially. This highlighted the continuing need for properly calibrated methods before displaying data. However, Jeff Spry indicated that Maritimes region obtained good success using oxygen probe system and were going to eliminate the routine use of Winkler titrations for field calibrations of oxygen probes. The approach is to be further tested and evaluated during the upcoming fall 2000 cruise. However, it was felt that the differences in approaches should be reconciled. **Peter Strain and Eugene Colbourne are to report to the AZMP with clarification on oxygen calibration protocols that are to be used in the routine collection of data.**

AZMP Website

Estelle Couture provided an update on current status of AZMP website and future developments. Overall the development of the website is coming along well, and MEDS has allocated additional support to maintain the development at a required pace. The group discussed the content and the format of the website at length to ensure that data processing and quality control procedures are consistent across the regions and all standard products resulting from the program from all regions will have a common look and feel. This would require that all regions implement the same algorithm for any given data type, for not only quality control, and preliminary processing but for plotting them as well. In other words, all plots downloaded from the website or extracted from the SSR will be identical in format.

Changes to be made to the graphs on the website include:

- For the waterfall plots, change the time axis to 'day of the year'
- Add units to the station plots of chlorophyll data.
- Station locations are to be included in the contour plots
- Contour plots colours to be consistent across the regions.
- Electronic fluorescence plots or data should have no units since these are uncalibrated. Website description of the data should indicate that.
- Put a disclaimer on the website for the fluorescence contours.

In addition, the following actions by members of the AZMP should be carried out:

- Each region should verify that the station locations on the website are accurate and are consistent with those in their own publications.
- Each region to check the climate indices on the site and provide a modified list (if required) along with the data. Ice cover for example is not on the site. After discussion it was decided that ice cover should be removed from the site. For climate indices, short descriptions are required. Regions to provide the descriptions for the indices for their regions.
- Up until now, no biological data are presented on the web. It was decided that as a start, the relative abundance of major categories and the total abundance will be put on the website. Each region is to send the plots for 1999 to MEDS. At this time, no timeline was identified but it is hoped that all regions will provide this information by the end of this calendar year.
- The 'Documents' folder should contain the basic information on the program and the results and publications. This will include: the original proposal, Res. Docs., primaries, and any descriptive articles that may be produced for information purposes. All regions are required to forward a complete listing of documents relevant to AZMP activities and results.
- The WG reports, annual reports and project plans, etc., should be on the INTRANET site.
- All groups to verify data inventories listed on AZMP website and provide updates twice per year.
- MEDS to provide updated plots to Zonal working groups for final approval for display presentation.

Following a discussion on the consistency of station and line occupations, particularly in the Gulf, it was recommended that:

- **J. Plourde (IML) and K. Drinkwater and B. Petrie (BIO)** review the location of the Shediac Valley site, Cabot Strait and other Gulf sections and advise on perhaps moving the various sampling locations a little so that they will fit in with the fisheries survey pattern in the Gulf, thus facilitating the use of longer time series.

AZMP General Report

Ken Drinkwater presented the rationale and possible format, developed in collaboration with Brian Petrie, for a AZMP general annual report. The overall format should be along the lines of a glossy document, approximately 20-30 pages in length. The idea was originally put forward by Brian last year during the AZMP annual meeting, however, no progress was made. The overall objective of this report is to provide a general summary of activities, progress and plans of the AZMP that can be understood by non-experts in the field. This should differ from advisory documents, primary publications and data reports by ensuring that the report be written in laymen's terms. It was agreed that it is important to produce this to provide an overview of the program and the key results and publications that emerged from it. It was also agreed that the report should be bilingual. The following actions will be undertaken:

- **Ken Drinkwater** to take the responsibility of coordinating the report, if timely and relevant input are provided by the scientific team.
- **Pierre Pepin** to communicate with J-C Therriault, the Chair of AZMP for his comments on the format and content of the report.
- **J-C Therriault** to contact Ottawa for possible funding to cover the production cost of the report.

A detailed outline of the report appears in Appendix D.

AZMP Data Report

It was recognized that AZMP produces considerably more information than what is presented in the FOC reports, SSRs and annual reports. The group felt that an annual data report which summarizes these data along with information on cruises, methods, data quality, etc. is absolutely necessary to ensure the long-term security of the data and the associated meta-data. However, because such a report will have to contain a large number of pages to cover all fixed stations and sections, the production cost will be significant if printed reports are generated. The group decided on the option of a data report on CD each year. The action items are:

- **P. Pepin** to take the lead on producing the report using the format as outlined at the meeting.
- Include all data up to the end of 1999 for this year's report and for subsequent years, use only one year's of data.
- **MEDS** will assume the responsibility for producing and distributing the CD and assist with the data report.
- All data associated with the data report will be on the website.

Other matters arising

J.-C. Therriault asked the ASC to undertake a preliminary discussion concerning the value of an additional fixed station in the northeast Gulf of St. Lawrence (GSL). Glen Harrison provided information from a publication by Y. DeLaFontaine published in 1991 on food web structure in the GSL region. It is recognized that there is a considerable lack of information concerning this portion of the GSL. However, an alternate location for a fixed station, off the coast of Labrador near the Hamilton Bank region, was suggested by the ASC group, where there is a similar lack of knowledge and where analysis of SeaWiFS data suggest that there may be substantial differences in the seasonal dynamics of production. There was insufficient information at the time of this meeting to provide a strong recommendation to the AZMP concerning which site would be most informative. There are also concerns about the logistic problems associated with sampling sites that are not easily accessible by Science Branch personnel. Further information and analysis concerning the potential value of each site as a fixed station (thus providing a time series) should be presented at the November meeting of AZMP.

There were two methodological issues brought up for preliminary discussion. First, there has been a proposal to alter the current zooplankton collection protocol so that the

maximum sampling depth be changed from the current 300m to 500m. The rationale is that current practice does not provide an adequate measure of abundance of over-wintering *Calanus* sp. in deeper waters. No data was provided at this meeting but analyses by **E. Head, L. Harris and A. Herman** detailing issues of sampling accuracy and efficiency will be presented at the November meeting of AZMP. Members from IML and NAFC are also asked to review any available data that can help address this issue. All members agreed to conform to the current protocol until such time that changes should be implemented.

Gary Maillet discussed results of comparisons of chl *a* determinations between the newly updated fluorometric method (Welschmeyer 1994: Limnol. Oceanogr. 39: 1985-1192) and traditional acidification method. Results from the NF indicated that in most cases chl *a* determinations are in good agreement, although instances were observed when profiles disagreed by 3-fold levels. A systematic shift was observed between the two methods; the updated method normally predicted slightly higher levels of chlorophyll *a* when levels exceed 3 µg/L, but diverged when concentrations were greater than 3 µg/L. The divergence increased linearly with further increase in chlorophyll *a* to levels near 15 µg/L. Causes for this discrepancy include the presence of other interfering chlorophyll molecules (including chlorophyll *b* and *c*) as well as other accessory pigments. The NF region has begun collection of HPLC samples in attempt to ascertain the probable cause for differences observed between the two methods. Recommendations regarding the use of both methods will be provided at a later date.

Glen Harrison raised the issue of the lack of a representative from the fisheries science community on the AZMP. It was noted that such a representative would strengthen the group and provide further ideas for linkages of environmental and biological data collected by the zonal working groups. A number of individuals with potential interest were identified but it was felt that the issue should be discussed further at the November meeting of the AZMP before action is taken or invitations are put forth.

The ASC raised the need to begin consideration of modeling efforts as part of the AZMP activities. **P. Pepin** is to initiate discussions with Geoff Evans (NF) and Alain Vezina (BIO) for preparation of possible modeling presentation for March 2001 FOC meeting.

Conclusion

TO BE FILLED IN ONCE EVERYONE HAS AGREED ON THE ACCURACY OF THE REPORT.

Appendix A

Agenda – Analysis Subcommittee AZMP

September 6-7, 2000

Room Gauging A, Crowne Plaza Hotel, Montreal

Wednesday, September 6, 2000

9:00 Objectives & Tasks,
Identification of presentations and other business

Biological and Chemical Data from fixed stations and transects
(P. Pepin, G. Harrison, G. Maillet, M. Starr)

Issues to be addressed include:

- Presentation and data formats for next FOC – standardizing among regions. Do we want to separate the presentations of common and regional contributions?
- The value and interpretation of (column) integrated measurements
- How much information is needed to develop a climatological average from which “anomalies” can be discussed?
- Standards for interpolation schemes. Are existing adequate to determine scale of biological properties?
- Assessment methods for the analysis of community structure. We should also consider the level of detail needed in the analysis of phyto- and zooplankton samples)

10:30 Break

10:50 Resume discussion of Biological and Chemical Data from fixed stations and transects

12:30 – 13:30 Lunch

13:30 Conclude discussion of Biological and Chemical Data from fixed stations and transects

14:30 Break

14:45 Additions and changes to the presentation of Physical Oceanographic Data
(K. Drinkwater, J. Craig)

Initiate discussion of methods to link Biological, Chemical and Physical Data

Thursday, September 7, 2000

9:00 AZMP Website (E. Couture)

Identifying products for display.
Establishing timelines and responsibilities for providing graphics and data to MEDS.

10:15 Break

10:30 Data Products from AZMP

Beyond the provision of advice to FOC, it has been proposed that AZMP produce [1] a data report of all information collected by or in collaboration with the program; and [2] an annual “glossy style” report that focussed on the past year’s effort and coming activities to be provided for the information of managers, directors, and individuals who could benefit from enlightenment of what we do.

We need to identify formats and assign responsibility for the development and production.

12:30 – 13:30 Lunch

13:30 Data collection protocols: new methods, concerns and issues arising.

Establishment of a fixed station in the Northern Gulf (on behalf of J.C. Therriault)
Chlorophyll estimation (G. Maillet)
Zooplankton collection protocol.

14:30 Break

14:45 Complete discussion of methods to link Biological, Chemical and Physical Data.

Appendix B

Responsibility centers for analysis:

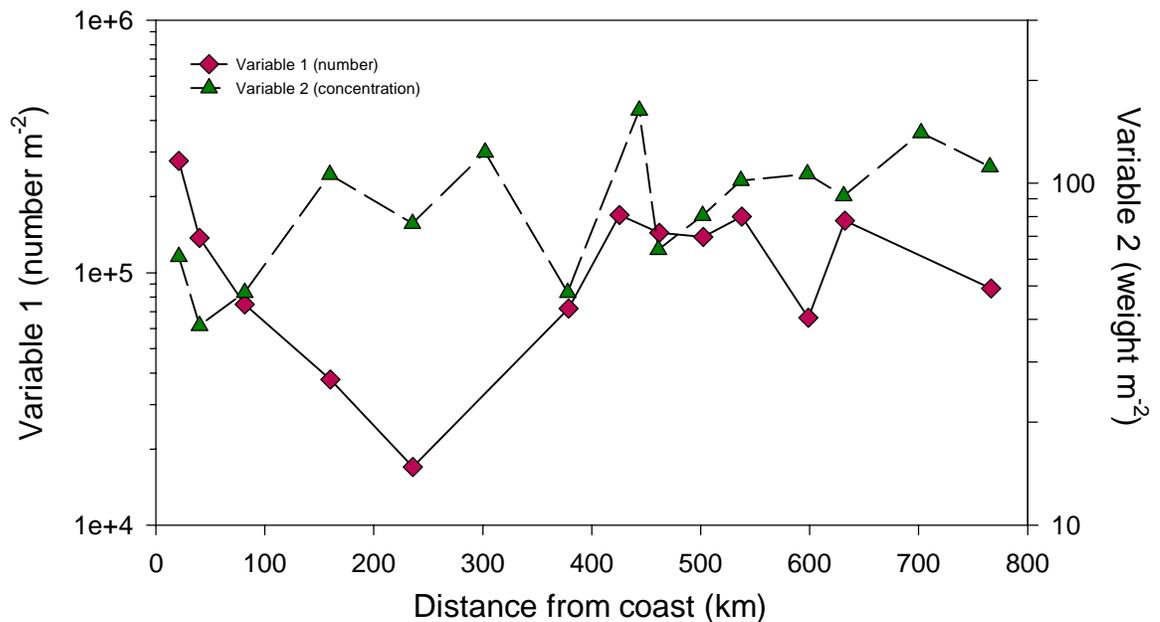
Variable	Presentation	Responsibility
Light	Line plot	By region
Nutrients	Contour diagrams Partial column integrated concentration (<i>depth to be explored</i>)	By region
Chlorophyll	Contour diagrams Integrated concentration (time series: line plot; spatial dist.: expanding symbol)	By region
Phytoplankton	Total abundance (time series: line plot; transects.: expanding symbols) Taxonomic composition (time series: filled bar or line plot) Diatom-dinoflagellate ratio	By region
Zooplankton	Total abundance (time series: line plot; transects.: expanding symbols) Taxonomic composition (time series: filled bar or line plot) Ratio of large to small species	By region
CPR	Greenness – Monthly levels by region Phytoplankton – Monthly total abundance + major taxa by region Zooplankton – Monthly total abundance + major taxa by region Line plots or expanding symbol plots	Doug Sameoto
Satellite imagery	Bi-weekly statistics (mean, standard deviation, # observations) for selected subregions. SeaWIFS (BIO) and AVHRR;	Seawifs: G. Harrison AVHRR: P. Larouche ARE THERE OTHERS?
Groundfish Surveys (Maritime) [summer and fall]	Surface and bottom nutrients [:M] and chlorophyll [:g L ⁻¹]; Integrated zooplankton abundance [mg dry wt m ⁻²] and species composition of major taxa [numbers m ⁻²]	Jeff Spry
Zooplankton Survey – Estuary	Integrated zooplankton abundance [mg dry wt m ⁻²] and species	M. Harvey

(Laurentian)	composition of major taxa [numbers m^{-2}]	
Zooplankton from Mackerel Egg Survey – Gulf (Laurentian)	Integrated zooplankton abundance [mg dry wt m^{-2}] and species composition of major taxa [numbers m^{-2}]	M. Harvey

Line plots:

Variables such as secchi depth, integrated nutrient concentrations (e.g. 0-50 m), other integrated indices as well as derived parameters should be displayed as temporal or spatial series using line plots (see below). Note that abundance measurements of the different plankton groups are more effectively displayed using maps (see below).

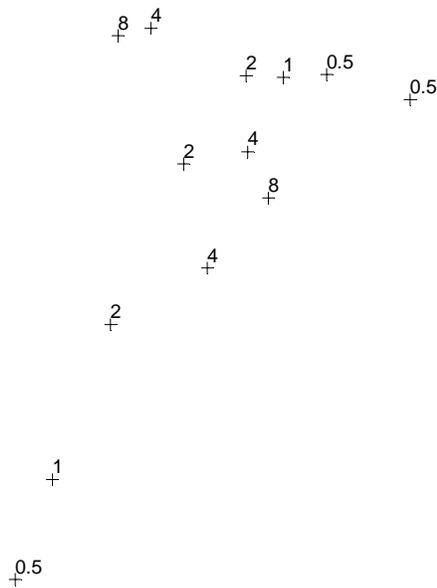
- Axes should be clearly labeled: time series should have either monthly indicators (text) or use Day of Year (which is preferred). Spatial series along transects should be based on distance from the coast;
- Collection points/times should be clearly shown by a symbol. A break in a line may be difficult to identify and is therefore inadequate;
- Units of measure of the dependent variable should be clearly indicated (units m^{-2});
- multiple lines should be identified with appropriate labels or legends



Contour plots:

Variables with depth resolved information, such as data from bottle/rosette/CTD casts (e.g. chlorophyll, nutrients, fluorescence) should be displayed using contour diagrams. The ASC has not resolved which algorithms are best suited to the display of such information. In particular, issues about grid resolution need further study as do the accuracy of the differing interpolation schemes. Recommendations for display are:

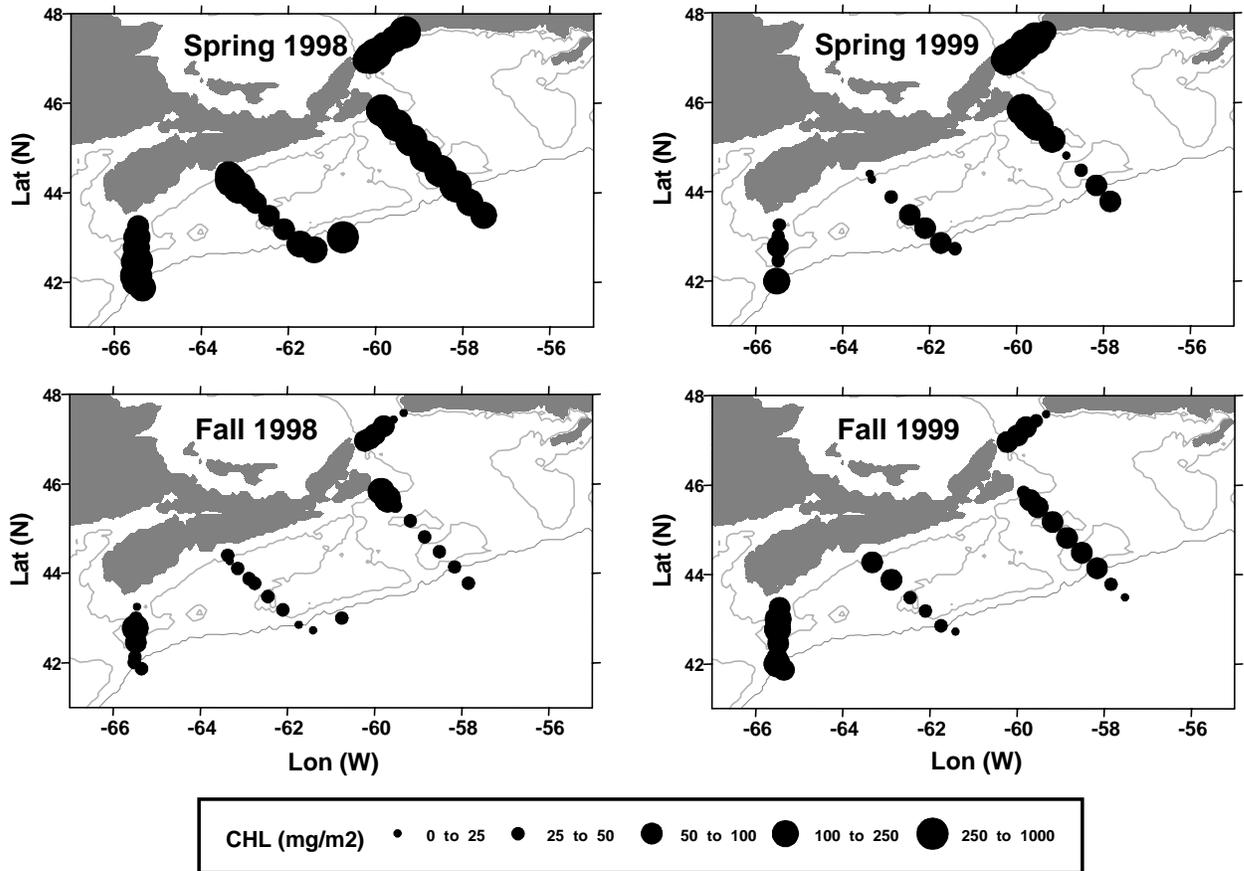
- Collection locations (depth/time/distance) should appear on each contour plot to show the density of information on which the interpolation is based;
- Contour lines should be used to make color schemes more easily interpreted;
- Large gaps in data should be clearly identified;
- The suggested color palette (at least for now is MATLAB jet);



Expanding symbol plots:

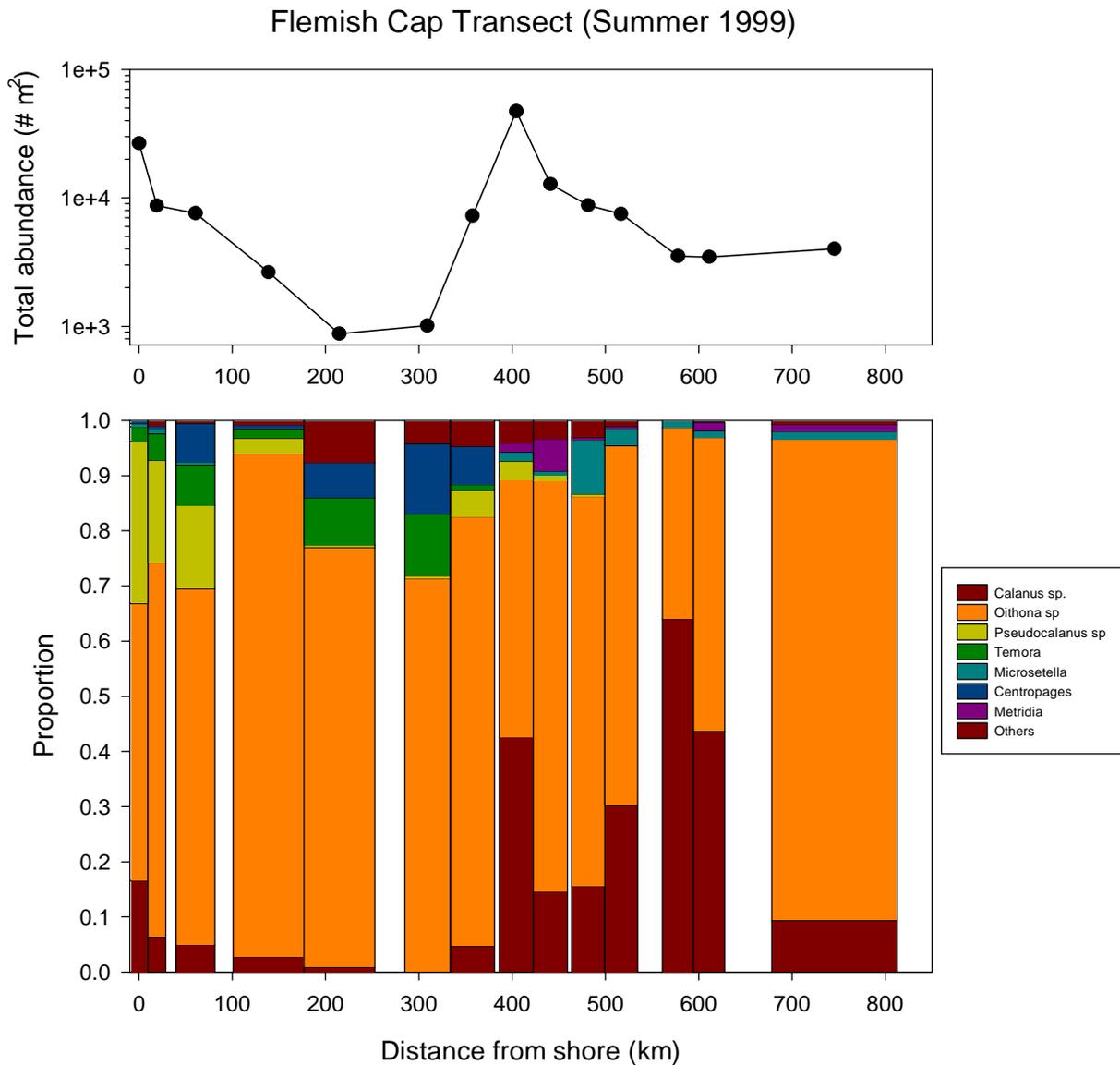
An example taken from the Stock Status Report for Maritimes is shown below. The ASC agreed that such figures were the most effective method of presenting the spatial distribution of organisms (phytoplankton and zooplankton) from integrated samples.

Phytoplankton Biomass



Zooplankton/Phytoplankton Taxonomic Composition

The scheme adopted to show the taxonomic composition of zooplankton was based on the presentation by M. Harvey at the 2000 FOC meeting. The relative taxonomic contribution of a specific group at each station, or as part of a time series, is to be illustrated using filled bars scaled to a total of 100% (or 1 as in the case of the graph below). It is recommended that similar methods be used to illustrate major taxonomic groupings, species composition within groups (e.g. copepods), and stages within species. An overall perspective is to be provided in the line-and-symbol plot that shows overall abundance of the group, in relation to time or space.



Appendix C

Glen Harrison provided a summary of the chemical and biological data displays employed by Maritimes at the FOC 2000 meeting and in generating the regional SSR. He indicated that the AZMP needs to consider 3 levels of data analysis in developing an assessment of the state of the zonal marine environment; data display, distillation and interpretation.

The first example was a description of three important properties that can be derived from a nutrient profile: (1) the mixed-layer depth, (2) the average nutrient concentration in the mixed-layer, and (3) the nutrient gradient below the mixed-layer (Fig. C1). The mixed-layer depth would be defined operationally as the depth over which the nutrient concentrations were “invariant” by some accepted definition, e.g. ± 0.01 mmol/m³ when concentrations are low (<1 mmol/m³) or $\pm 10\%$ when concentrations are high (>1 mmol/m³). The mixed-layer nutrient concentration would then be the average of the measurements taken within that zone. The nutrient gradient would be determined just below the mixed-layer or at some arbitrary depth horizon, e.g. 50 m, but the former would probably be the best representation. The depth of the mixed-layer (1) would be useful and trying to explain the vertical structure of biological properties like the subsurface chlorophyll maximum, the mixed-layer nutrient concentration (2) could be used in determining seasonal biological consumption of nutrients, i.e. winter to summer decrease in concentration and the nutrient gradient (3) could be used to estimate the delivery of nutrients to the mixed-layer by mixing processes (this would require also an estimate of vertical eddy diffusivity). Extraction of these “parameters” at the fixed station on the Halifax Line (Stn 2) in 1999 showed some interesting seasonal variations (Fig. C2).

Some discussion also focussed on the depth of integration for nutrient and biological properties. For chlorophyll, the suggestion was made to integrate to at least 100m to insure the result were representative of the entire water column (most of the chlorophyll in shelf waters will usually be found in the upper 50 m but significant quantities can be found at depth following blooms). Integration depth for nutrients is more problematic. The goal is to derive a quantity that represents the depth zone where nutrient concentration changes reflect the balance between biological consumption and physical mixing. In Maritimes region, an integration depth of 50 m has been employed thus far since this is the depth zone over which biological consumption appears to be largely confined. Based on analysis of the region’s nutrient climatology, this depth also approximates *the maximum depth* at which nutrient concentrations equal to wintertime surface values (Fig. C3). A suggestion was also made to integrate based on optical depth (i.e. the 1% surface light penetration depth). Each region is to explore alternatives and report their findings and recommendations at the November general AZMP meeting.

In the same manner that nutrient vertical profiles can be “parameterized”, the vertical structure of phytoplankton biomass (chlorophyll a) can be characterized using a shifted Gaussian formulation (Fig. C4; Platt et al. 1988).

$$B(z) = B_0 + \frac{h}{\sigma\sqrt{2\pi}} \exp\left[-\frac{(z-z_m)^2}{2\sigma^2}\right]$$

Four useful properties of the chlorophyll structure are described: (1) the background concentration, (2) the depth of the maximum, (3) the size (vertical extent) of the maximum and (4) the magnitude of the maximum compared to the background concentration. Examples of the “goodness of fit” were shown. Profiles from the fixed-station on the Halifax line (Stn 2) in 1999 showed that the maximum depth and magnitude of the subsurface chlorophyll max coincided with the spring and summer blooms periods (Fig. C5). Gaussian parameters have been derived for ~1600 chlorophyll profiles constituting the Scotian Shelf archive and climatological monthly means have been calculated. Regional differences are apparent in the depth and magnitude of the chlorophyll maximum but the overall seasonal patterns are similar among regions (Fig. C6).

References:

Platt, T. S. Sathyendranath, C.M. Caverhill and M.R. Lewis. 1988. Ocean primary production and available light: further algorithms for remote sensing. *Deep-Sea Res.* 35(6): 855-879.

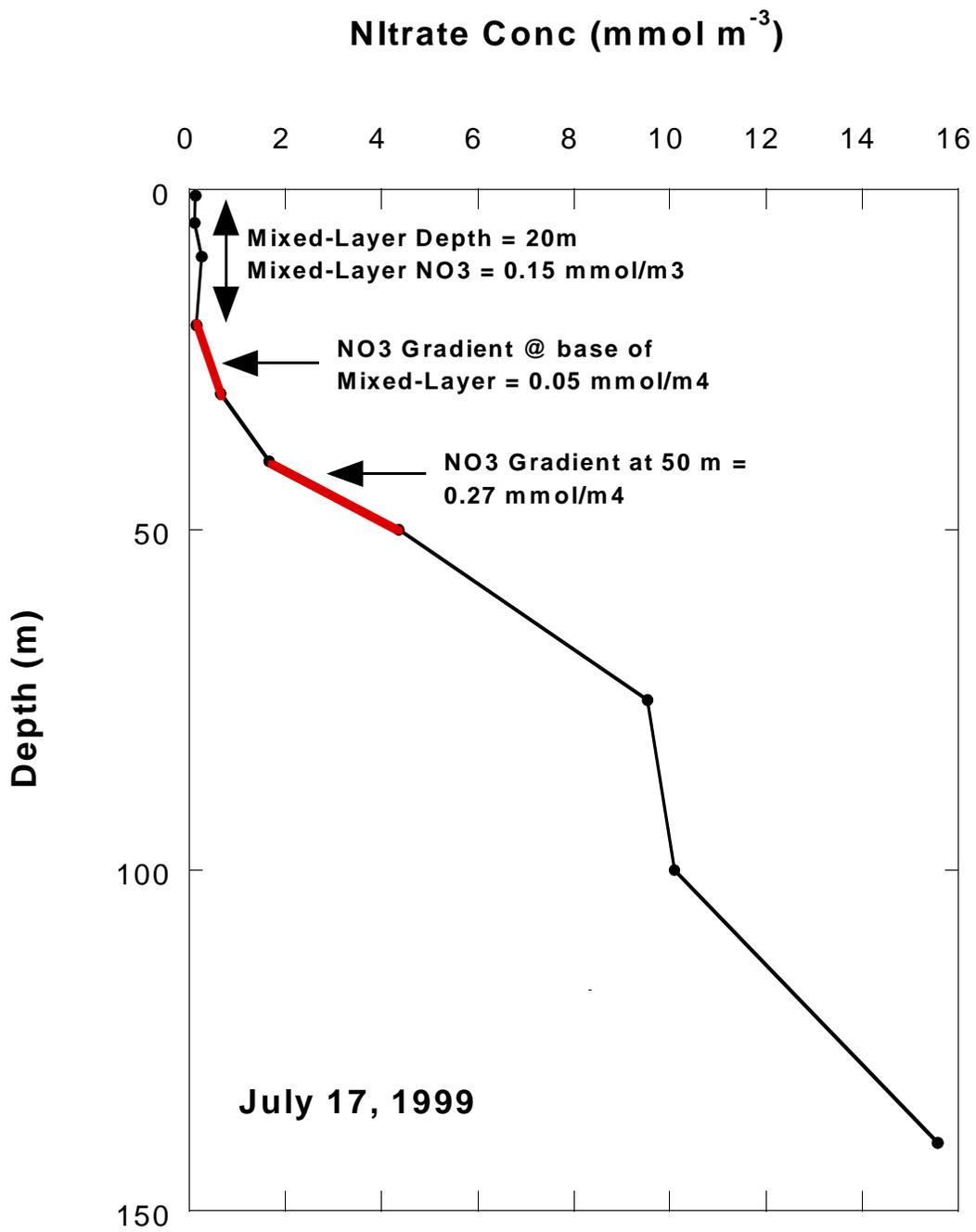


Fig. C1. NO₃ profile from fixed station Halifax Line (Stn 2) showing proposed profile parameters.

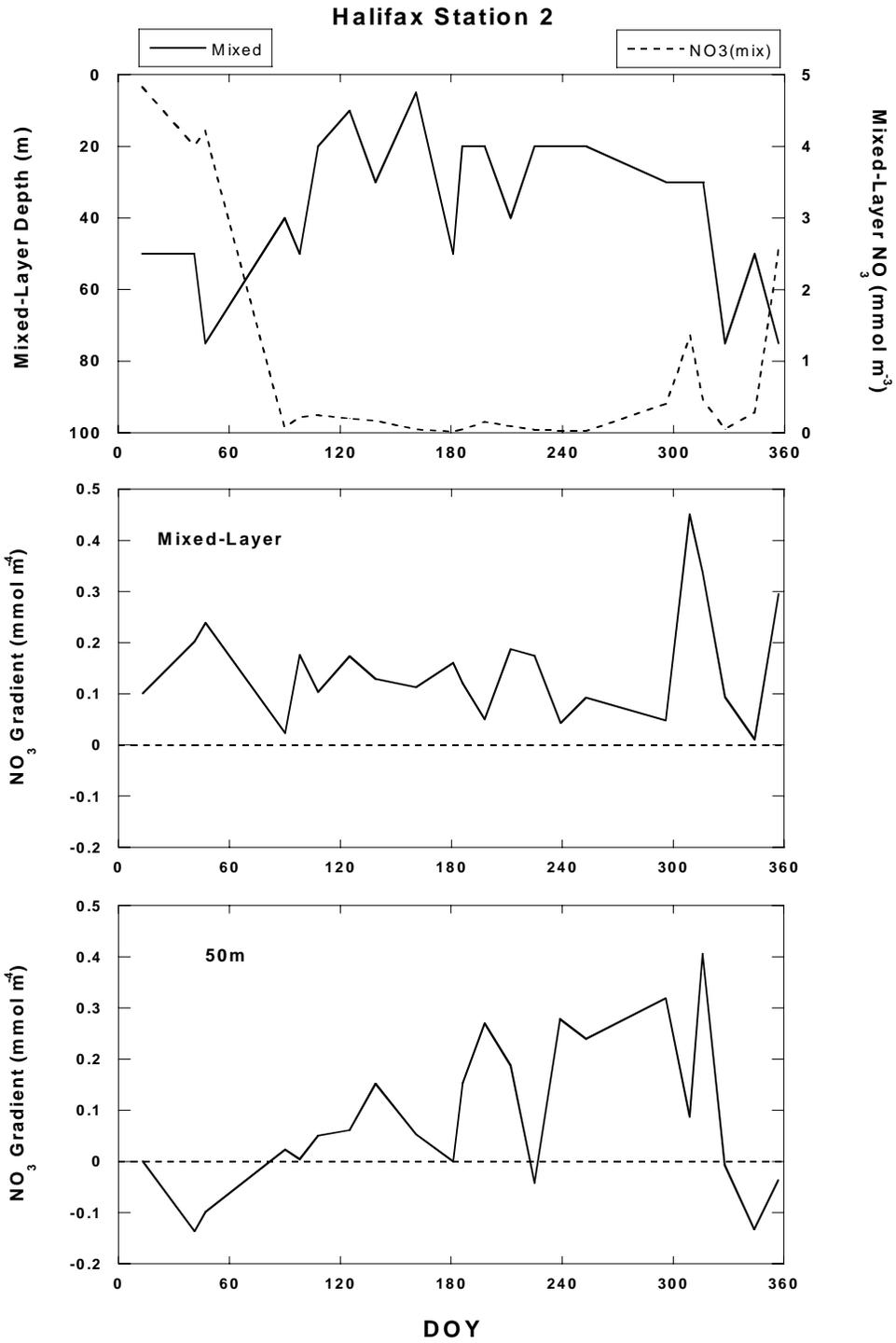


Fig. C2. Seasonal variation in NO_3 profile parameters (see Fig. 1) for fixed station Halifax Line (Stn 2). Note that gradients from the bottom of the mixed-layer and from a constant depth (50 m) show different seasonal patterns.

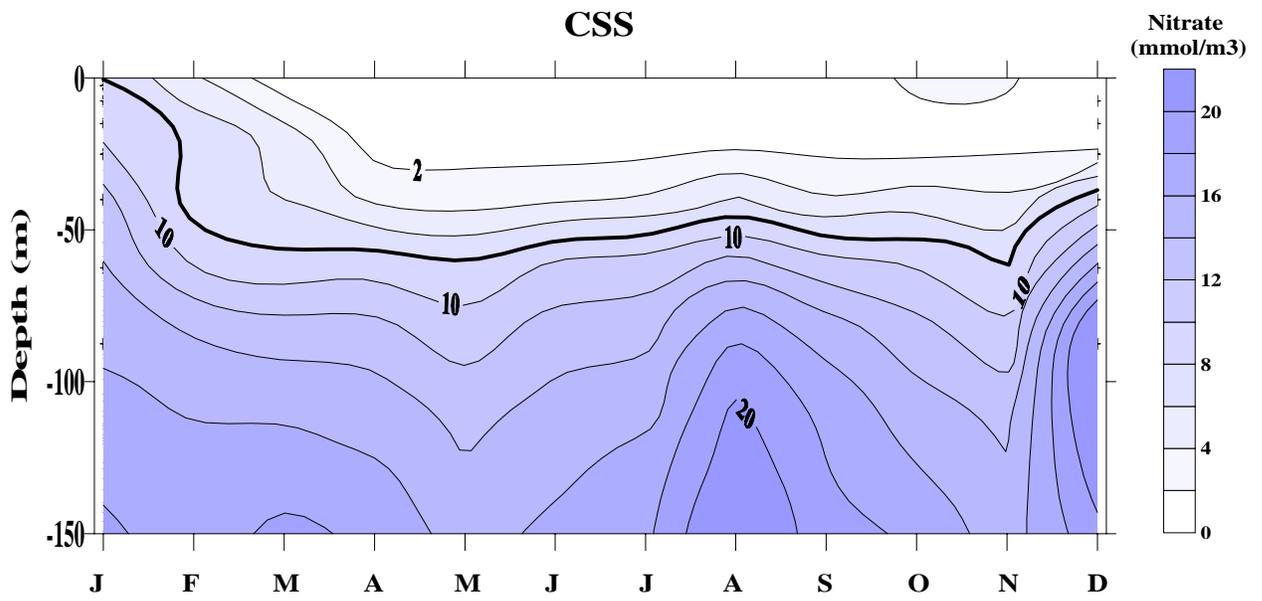


Fig. C3. Contour plot of climatological monthly mean NO_3 concentrations on the Central Scotian Shelf (CSS) showing the time-variation in the depth of the winter-time surface maximum concentration ($8\mu\text{M}$). This property may be useful in selecting nutrient integration depth.

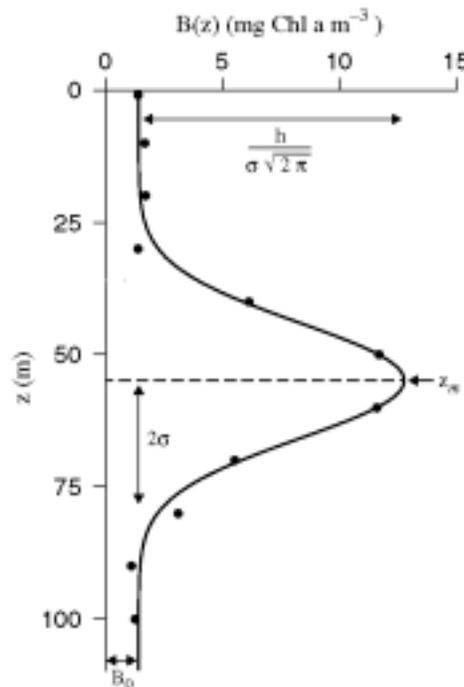


Fig. C4. Shifted gaussian representation of the vertical structure of chlorophyll (Platt et al. 1988).

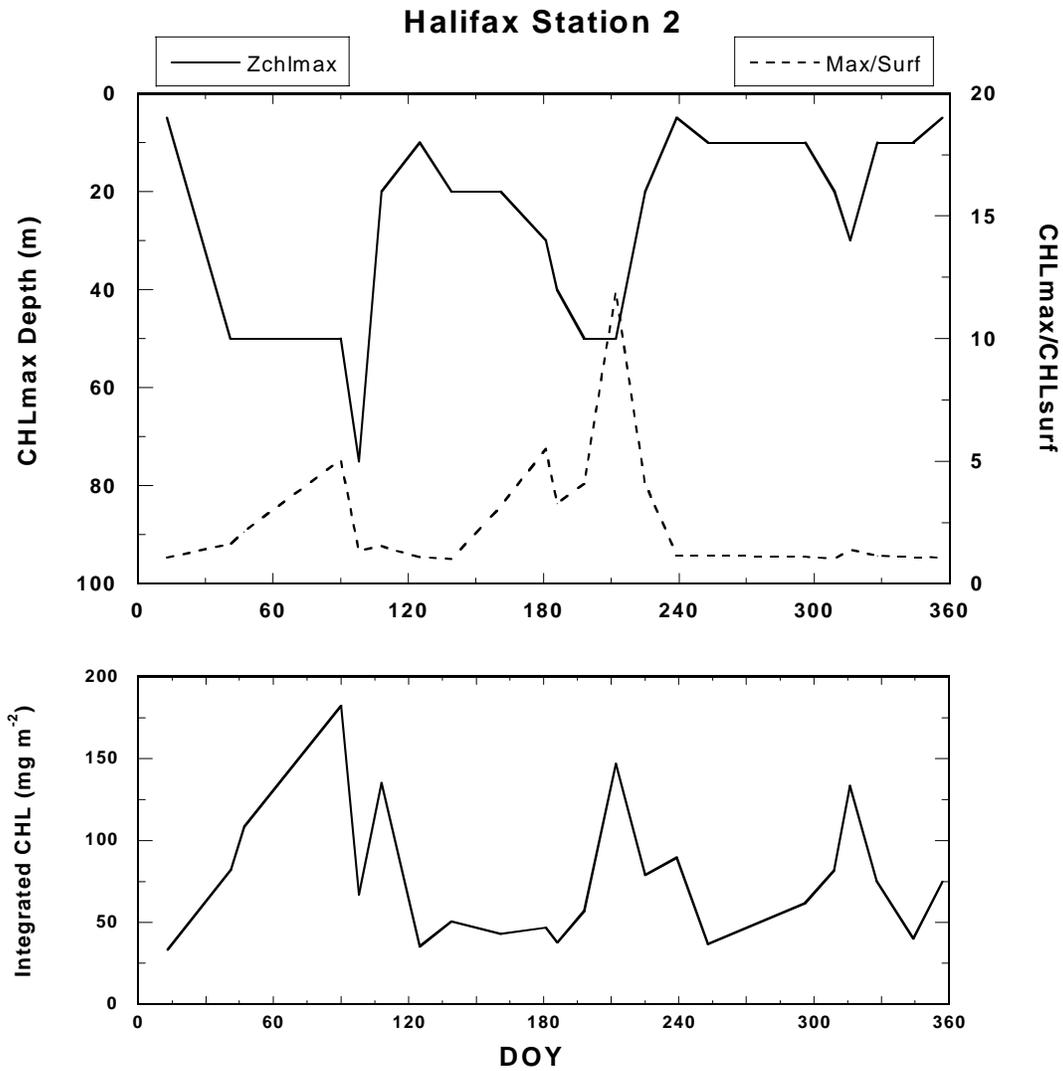


Fig. C5. Seasonal variation in the vertical structure of chlorophyll (top panel) and column-integrated concentrations (bottom panel) at the fixed station Halifax Line (Stn 2) in 1999. Note that the depth of the CHLmax and the relative magnitude of the CHLmax peak during the spring and summer bloom periods.

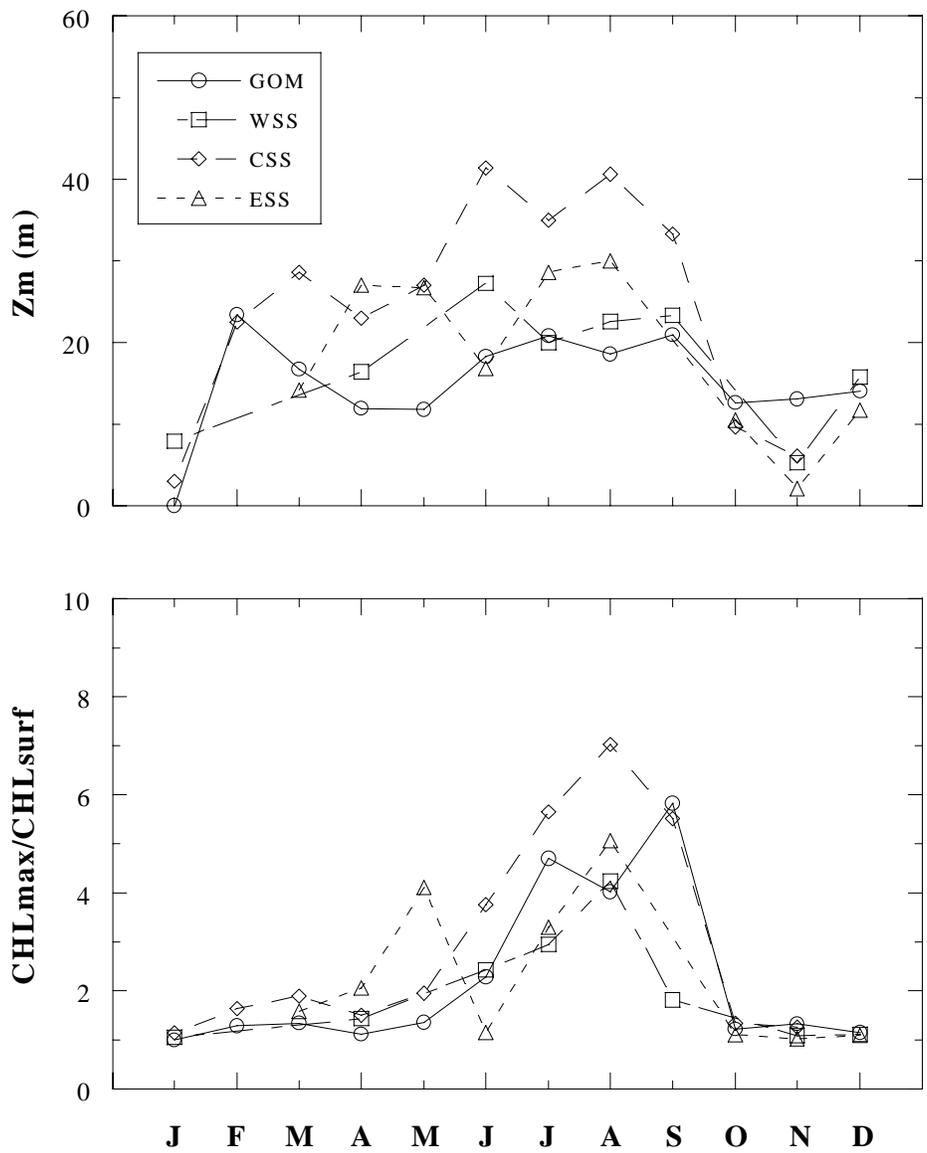


Fig. C6. Climatological monthly means of two parameters of chlorophyll vertical structure, the depth of the subsurface maximum and relative magnitude of the maximum for four sub-regions of the Scotian Shelf: the Gulf of Maine (GOM), the western (WSS), central (CSS) and eastern (ESS) Scotian Shelf.

Appendix D

Outline of the Laymen's report of AZMP activities

Introduction

- Aims and objectives
- Activities
- Responsibility: J.-C. Therriault

Environmental Review

- 1998 and 1999 (and 2000 if significant changes have occurred during the year)
- Only include highlights, details are already in Res Docs and SSRs
- Responsibility: Physical Oceanography (K. Drinkwater, E. Colbourne)
- Responsibility: Biological/Chemical Oceanography (P. Pepin, G. Harrison, M. Harvey)

Contributed Articles

- CPR (D. Sameoto)
- Air Temperature Records Set in 1999 (K. Drinkwater)
- Biological Response to Warming Conditions (E. Colbourne + J. Anderson)
- Recent Biological Changes in Gulf of St. Lawrence (J.-C. Therriault, J. Plourde and others)
- Changes in Slope Water Characteristics 1997-1999 (K. Drinkwater)

Articles should be no longer than two pages using 1.5 spacing and 12 font. Colourful diagrams will be useful but no more than 2 figures per article.

Future Activities (B. Petrie)

A brief paragraph or two on what AZMP is planning in the upcoming year

Cruises and Publications (J. Plourde; E. Colbourne; K. Drinkwater)

- List of cruises and/or activities (fixed stations)
- List publications from AZMP (Res. Docs, Technical Reports, SSRs, primary publications based upon monitoring data)

AZMP Staff (J.-C. Therriault; P. Pepin; G. Harrison; S. Narayanan)

- List of Staff working on AZMP (should contribute significantly)
- For new Employees it was agreed that we should have photo and short (5-7 sentence description stating background and their duties under AZMP)