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Oceanographic conditions in the Estuary and the Gulf of St. Lawrence during 2001 : zooplankton

Conditions océanographiques dans l'estuaire et le golfe du St-Laurent en 2001 : zooplancton

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Abstract

This report: 1) describes the results on the temporal variability of the zooplankton biomass, abundance, and species composition at two fixed stations and six transects of the Atlantic Zonal Monitoring Program (AZMP; Anticosti Gyre and Gaspé Current) in 2001 and 2) gives an overview of the interannual variability of the macrozooplankton species composition, abundance, and biomass in the Lower St. Lawrence Estuary and the northwest Gulf of St. Lawrence (GSL) as measured in September in each year between 1994 and 2001. We focus on the conditions during 2001 but compare those observations with previous information from 1999 and 2000 for the AZMP results and from 1994 to 2001 for the macrozooplankton results.

AZMP fixed stations and transects

- The annual minimum and maximum zooplankton biomasses occur in April in the Anticosti Gyre and the Gaspé Current respectively. This difference in the timing of the maximum and the minimum observed biomasses at the two stations seems to be “typical” since the same situation was observed in 1999 and 2000.

- Both the mean integrated zooplankton biomass and abundance observed in 2001 in the Anticosti Gyre and the Gaspé Current were on par with what we observed in 1999 and 2000.

- The total abundance of zooplankton in 2001 varied between 22,000 and 317,000 individuals · m^{-2} in the Gaspé Current and between 28,500 and 213,000 individuals · m^{-2} in the Anticosti Gyre. At both stations, the total abundance of zooplankton observed in 2001 was on par with observations made in 2000.

- Copepod eggs, juveniles, and adults were clearly dominant, accounting for more than 80% of the zooplankton community for all sampling dates in the Anticosti Gyre and the Gaspé Current except in May and July in the Gaspé Current.

- In the Anticosti Gyre, the minimum and the maximum copepod abundances occurred in May and November respectively and were synchronized with the minimum and the maximum values observed in 2000; the minimum and the maximum copepod abundances were observed in June and September in the Gaspé Current, ca. 1.5 months earlier than in 2000.

- The total zooplankton biomass varied between 3 and 208 g ww · m^{-2} along the six transects sampled in June and December 2001 in the Lower Estuary and the Gulf of St. Lawrence. The highest biomasses were found along the transects located over the Laurentian Channel (St. Lawrence Estuary, Sept-Îles, Anticosti, and Cabot Strait) and the lowest were in the northern (Bonne Bay) and the southern (Magdalen Island) regions.

- The zooplankton biomass observed in 2001 along all transects for both seasons (spring and fall) was on par with observations made in 2000 except along the

Magdalen Island transect, where the zooplankton biomass was three and two times higher in spring and fall 2001 than in spring and fall 2000, and along the Cabot Strait transect, where the biomass was two times lower in fall 2001 than in fall 2000.

- The overall abundance of zooplankton was generally lower in 2001 than in 2000 for all regions and for both seasons except for fall in the southern Gulf (Magdalen Island transect), where the inverse was true.

- Globally, in both the Lower Estuary and the Gulf of St. Lawrence, the overall abundance of zooplankton was 64% and 41% lower in spring and fall 2001 than in 2000. This difference in abundance between the two years was due to the lower abundance of both copepod and invertebrate eggs in 2001.

Macrozooplankton species composition, abundance, and biomass for 1994-2001

- There were no significant changes in the macrozooplankton and the mesozooplankton biomasses in 2001 compared to 2000.

- There were significant changes in the mean abundance in some macrozooplankton species: 1) decreases in the euphausiid *Thysanoessa raschii*, 2) increases in the euphausiid *Meganyctiphanes norvegica*, the chaetognath Sagitta elegans, the gelatinous zooplankton *Aglantha digitale*, *Obelia* sp., and *Boreo* sp., and the pelagic amphipod *Themisto libellula*.

- The mean abundance of the latter species (*T. libellula*) increased from 0.17 ind · m^{-2} in 2000 to 9.2 ind · m^{-2} in 2001.

- There was a significant negative correlation between the annual CIL core temperature index (Gilbert, 2002) and the abundance of *T. libellula* in the Lower St. Lawrence Estuary and the northwest Gulf from 1994 to 2001.

- Based on this relationship, this species could be considered as an index of the intrusion of cold Labrador Current water into the Gulf of St. Lawrence. If this hypothesis is true, 2001, 1998, and 1995 would be years when there where important intrusions into the Gulf of St. Lawrence.

Résumé

L'information présentée dans ce rapport décrit l'état du zooplancton dans le Saint-Laurent en 2001. Ces résultats provient de l'analyse des données de deux stations fixes situées dans la Gyre d'Anticosti et le courant de Gaspé et de six transects répartis dans l'ensemble de l'estuaire maritime et du golfe du Saint-Laurent. Des informations additionnelles provenant d'une grille de 48 stations échantillonnées depuis 1994 dans l'estuaire maritime et le golfe du Saint-Laurent sont aussi présentées. Nous mettons l'accent sur les conditions en 2001, que nous comparons ensuite aux observations recueillies en 1999 et 2000 dans le cadre du programme de la zone Atlantique (PMZA) et aux observations sur le macrozooplancton recueillies de 1994 à 2001.

Stations fixes et transects du PMZA

- En 2001, le minimum et le maximum de biomasse de zooplancton ont été observés en avril dans la Gyre d'Anticosti et le courant de Gaspé, respectivement. Ce résultat montrant que la biomasse de zooplancton est minimum dans la Gyre en avril alors qu'au même moment elle est maximum dans le courant de Gaspé semble « typique » étant donné que la même situation a été observée en 1999 et 2000.

- La biomasse et l'abondance moyennes de zooplancton observées en 2001 dans la Gyre d'Anticosti et le courant de Gaspé correspondaient à ce que nous avons observé en 1999 et 2000 aux mêmes stations.

- L'abondance totale du zooplancton en 2001 oscillait entre 22 000 et 317 000 individus m^{-2} dans le courant de Gaspé et entre 28 500 et 213 000 individus m^{-2} dans la **G**yre d'Anticosti. À ces deux stations, l'abondance totale du zooplancton observée en 2001 correspondait aux observations pour 2000.

- Les copépodes (œufs, juvéniles et adultes) étaient clairement les organismes dominants, constituant plus de 80 % de la communauté zooplanctonique à toutes les dates d'échantillonnage dans la Gyre d'Anticosti et le courant de Gaspé, sauf en mai et juillet dans le courant de Gaspé.

- Dans la Gyre d'Anticosti, l'abondance minimum et maximum des copépodes se sont manifestées en mai et novembre, respectivement, et se sont produite en même temps que les valeurs minimum et maximum observées en 2000. Dans le cas du courant de Gaspé, l'abondance minimum et maximum de ces organismes ont été observées en juin et septembre, respectivement, soit environ 1,5 mois plus tôt qu'en 2000.

- La biomasse totale du zooplancton a oscillé entre 3 et 208 g m-2 (poids humide) le long des six transects échantillonnés en juin et décembre 2001 dans l'estuaire maritime et le golfe du Saint-Laurent. Les plus fortes biomasses ont été observées le long des transects situés au dessus du chenal Laurentien (Estuaire du Saint-Laurent, Sept-Îles, Anticosti et détroit de Cabot) et les plus faibles, dans le nord (Bonne Bay) et le sud (Îles-de-la-Madeleine) du golfe du Saint-Laurent.

- La biomasse du zooplancton observée au printemps et à l'automne 2001 le long des six transects correspondaient aux observations faites en 2000 dans l'ensemble des régions, sauf le long du transect des Îles-de-la-Madeleine, où la biomasse du zooplancton était trois et deux fois plus élevée au printemps et à l'automne 2001 qu'au printemps et à l'automne 2000, et le long du transect du détroit de Cabot, où la biomasse était deux fois moins élevée à l'automne 2001 qu'à l'automne 2000.

- L'abondance globale du zooplancton était généralement plus faible en 2001 qu'en 2000 dans toutes les régions, au printemps et à l'automne, sauf à de l'automne dans le sud du golfe (transect des Îles-de-la-Madeleine), où la situation inverse a été observée.

- Globalement, dans le l'estuaire maritime et le golfe du Saint-Laurent, l'abondance totale du zooplancton était de 64 % et 41 % plus faible au printemps et à l'automne 2001 qu'au printemps et à l'automne 2000. Cette différence dans l'abondance entre ces deux années était imputable à la plus faible abondance d'œufs de copépodes et d'invertébrés en 2001.

Abondance, biomasse et composition spécifique du macrozooplancton de 1994 à 2001

- Les biomasses de méso- et de macrozooplancton n'ont pas augmenter de façon significative en 2001 par comparaison avec 2000.

- Des changements importants dans l'abondance moyenne de certaines espèces de macrozooplancton ont cependant été observées: 1) une baisse chez l'euphausiacé *Thysanoessa raschii*, 2) une augmentation chez l'euphausiacé *Meganyctiphanes norvegica*, le chétognathe *Sagitta elegans*, les espèces zooplanctoniques gélatineuses *Aglantha digitale*, *Obelia* sp. et *Boreo* sp., et l'amphipode pélagique *Themisto libellula.*

- L'abondance moyenne de cette dernière espèce (*T. libellula*) a augmenté, pour passer de 0,17 individu m^{-2} en 2000 à 9,2 individus m^{-2} en 2001.

- Il existait une corrélation négative significative entre l'indice annuel de la température au cœur de la CIF (Gilbert, 2002) et l'abondance de *T. libellula* dans l'estuaire maritime et le nord-ouest du golfe du Saint-Laurent de 1994 à 2001.

Selon cette relation, cette espèce pourrait être considérée comme une espèce indicatrice de l'intrusion massive dans le golfe du Saint-Laurent d'eaux froides provenant du courant du Labrador via le détroit de Belle Isle. Si cette hypothèse se révèle vraie, d'importantes intrusions d'eau froide ont eu lieu dans le golfe en 1995, 1998 et 2001.

Introduction

The Atlantic Zonal Monitoring Program (AZMP) has recently been established for the Canadian east coast (Therriault et al. 1998). One of the underlying goals of the AZMP is to collect biological, chemical, and physical data to characterize and understand the causes of oceanographic variability at seasonal, interannual, and decadal time scales in the Gulf of St. Lawrence. The purpose of this document is to provide an overview of the temporal variability in 2001 of the zooplankton biomass, abundance, and species composition at two fixed stations (Anticosti Gyre and Gaspé Current) and six transects (St. Lawrence Estuary, Sept-Îles, Bonne Bay, Anticosti, Cabot Strait, Magdalen Island) of the AZMP.

In 1994, a zooplankton survey was initiated to estimate the species composition, the abundance, and the biomass of the macrozooplankton in the Lower St. Lawrence Estuary. The purpose here is to provide an overview of the interannual variability of the macrozooplankton species composition, abundance, and biomass in the Lower St. Lawrence Estuary and the northwest Gulf of St. Lawrence from 1994 to 2001.

Spatial and Temporal Variability of Zooplankton Species Composition, Abundance, and Biomass at Two Fixed Stations and Six Transects of the Azmp in 2001

Material and Methods

The sampling dates at the fixed stations (Anticosti Gyre and Gaspé Current) and along the transects (St. Lawrence Estuary, Sept-Îles, Bonne Bay, Anticosti, Cabot Strait, Magdalen Island) are given in Figure 1. In 2001, zooplankton samples were collected during 19 visits to the fixed stations and two visits to the transects. Collections and standard measurements of zooplankton biomass and abundance are based on protocols outlined by the Steering Committee of the Atlantic Zonal Monitoring Program (AZMP[1]).

We analyzed the monthly variations of a series of indices describing the state of the zooplankton community at each station in 2001. The indices are: 1) the depth-integrated biomass of both the macrozooplankton and the mesozooplankton, 2) the depth-integrated zooplankton abundance and community structure, 3) the depth-integrated copepod abundance and community structure, 4) the depth-integrated abundance of the stage composition of *Calanus finmarchicus*, *C. hyperboreus*, *Metridia longa,* and *Eucheata norvegica* copepodites.

Results and discussion

Fixed stations. In 2001, the mesozooplankton biomass varied between 80 and 181 g ww · m^{-2} at the Anticosti Gyre station and between 8 and 96 g ww · m^{-2} at the Gaspé Current station (Figure 2). The minimum and the maximum biomasses occurred in April and September respectively at the Anticosti Gyre (AG) station while the minimum and the

[1] http://www.meds-sdmm.dfo-mpo.gc.ca/zmp/main_zmp_e.html

maximum biomasses were observed in February and April respectively in the Gaspé Current (CG). The annual minimum (AG) and maximum (CG) zooplankton biomasses occurring in April seem to be typical since the same situation was observed in 1999 and 2000 (Figure 2). The mean biomass for 2001 was 4.7 times higher in the Anticosti Gyre (151.6 g ww · m^{-2}) than in the Gaspé Current (32.6 g ww · m^{-2}). The higher biomass at the Anticosti Gyre station was largely due to the higher abundance of *Calanus hyperboreus*. The macrozooplankton biomass varied little with time and represented less than 5% of the total zooplankton biomass at both stations. The mean integrated zooplankton biomass in the Anticosti Gyre and the Gaspé Current were on par with what we observed in 1999 and 2000 (Figure 3).

The total abundance of zooplankton in 2001 varied between 22,000 and 317,000 individuals · m^{-2} in the Gaspé Current and between 28,500 and 213,000 individuals · m^{-2} in the Anticosti Gyre. At both stations, the total abundance of zooplankton observed in 2001 was on par with observations made in 2000 (Figure 4). Copepod eggs, juveniles, and adults were clearly dominant, accounting for more than 80% of the zooplankton community for all sampling dates in the Anticosti Gyre and the Gaspé Current except in May and July in the Gaspé Current, where the invertebrate larvae (mostly echinoderm larvae) accounted for 30% (May) and 80% (July) of the zooplankton assemblage (Figure 4). In the Anticosti Gyre, the ostracoda were present at all sampling dates and accounted for ca. 20% of the zooplankton assemblage in April. In September, the larvacea accounted for 5% and 15% of the zooplankton assemblage in the Anticosti Gyre and the Gaspé Current respectively. All others zooplankters (mollusk larvae, euphausiids, jellies, chaetognaths, polycheates) represented less than 5% of the zooplankton community for all sampling dates at both stations. They mostly occurred during the summer season at both stations.

In 2001, the total abundance of copepods integrated over the water column varied between 19,300 and 203,700 individuals · m^{-2} in the Gaspé Current and between 19,745 and 208,200 individuals · m^{-2} in the Anticosti Gyre (Figure 5). These values are on par with those observed in 2000 at both stations. In the Anticosti Gyre, the minimum and the maximum copepod abundances occurred in May and November respectively and were synchronized with the minimum and the maximum values observed in 2000; the minimum and the maximum copepod abundances were observed in June and September in the Gaspé Current, ca. 1.5 months earlier than in 2000 (Figure 5). Close examination of the monthly variations of the copepod community structure reveals that large copepod species (*Calanus finmarchicus* and *C. hyperboreus*) were dominant for all sampling dates in the Anticosti Gyre except in May, when the predator species *Eucheata norvegica* was the dominant species (25% of the assemblage), and in November, when smaller species (*Metridia longa*, *Oithona similis*, *Microcalanus pusillis*) were more abundant (Figure 5). On the other hand, the small copepod *Oithona similis* was dominant for all sampling dates in the Gaspé Current except in July, when larger species such as *Calanus finmarchicus* and *C. hyperboreus* were more abundant (Figure 5). The same situation was observed in 2000 at both stations. There were 2 peaks of abundance of calanoid nauplii caught by the 202 μm mesh net at the Anticosti Gyre station (Figure 5). They occurred in April and September and coincide with the reproductive period of *Calanus hyperboreus* and *Metridia longa* respectively. Likewise, the abundance of calanoid nauplii caught by the 202 μm mesh net at the Gaspé Current station showed a first peak of abundance in early April coinciding with the reproductive period of *Calanus hyperboreus*. Contrary to the situation at the Anticosti Gyre station, the abundance of calanoid nauplii remained relatively high during the summer and the fall periods in the Gaspé Current (between 20 and 58% of the copepod assemblage). This probably coincides with the reproductive period of *Calanus finmarchicus* in summer and *Acartia* sp. at the end of August.

Finally, the depth-integrated abundance of the stage composition for the four most important copepods species (in terms of biomass) found in the Anticosti Gyre and the Gaspé Current showed that: 1) there was no apparent reproductive period for *Calanus hyperboreus* at either stations; 2) *Calanus finmarchicus* reproduced in summer and fall in the Gaspé Current and only in fall in the Anticosti Gyre; 3) *Metridia longa* reproduced in September and October at both stations; and 4) *Eucheata norvegica* reproduced in April and May in the Anticosti Gyre (Figure 6).

Transects. The total zooplankton biomass varied between 3 and 208 g ww · m-2 along the six transects sampled in June and December 2001 in the lower Estuary and the Gulf of St. Lawrence (Figure 7). The biomass increased with the depth along all transects during the two sampling periods. The highest biomasses were found along the transect located over the Laurentian Channel (St. Lawrence Estuary, Sept-Îles, Anticosti, and Cabot Strait) and the lowest were in the northern (Bonne Bay) and the southern (Magdalen Island) regions. The zooplankton biomass was higher in December than in June along all transects except at the shallow stations on both ends of each transect, where the inverse was true (Figure 7). The zooplankton biomasses observed in 2001 along all transects at both seasons was on par with observations made in 2000 except along the Magdalen Island transect, where the zooplankton biomass was three and two times higher in spring and fall 2001 than in spring and fall 2000, and along the Cabot Strait transect where, the biomass was two times lower in fall 2001 than in fall 2000 (Figure 8).

The overall abundance of zooplankton varied between 6,891 and 253,000 ind. m^{-2} for all transects in June and between 10,697 and 296,034 ind. m^{-2} in December. The highest abundances of zooplankton were observed along the Magdalen Island, Sept-Îles and Cabot Strait transects in fall (Figure 9). Juvenile and adult copepods were clearly dominant along all transects, accounting for more than 65% and 85% of the assemblage in June and December respectively (Figure 9). All other zooplankters (copepods eggs, invertebrate larvae, larvacea, mollusk larvae, ostracods, euphausiids, gelatinous zooplankton, and cheatognaths) represented less than 35% of the zooplankton community in all regions in June and December (figure 9). The overall abundance of copepods integrated over the water column varied between 4,505 and 220,054 ind. m^{-2} along all transects in June and between 10,425 and 295,669 ind. m^{-2} in December (Figure 10). A closer examination of the abundance and the spatial distribution of the most important copepod species showed different patterns of distribution in the lower Estuary and the Gulf of St. Lawrence (Figure 10). In June, a group composed of large copepod species (*Calanus finmarchicus*, *C. hyperboreus*, *Metridia longa*) dominated in abundance in all regions except in the northern part of the Cabot Strait transect, where the small species

Oithona spp. was more abundant. In December, *Oithona* spp. dominated in abundance in all regions (Figure 10).

The overall abundance of zooplankton was generally lower in 2001 than in 2000 in all regions for both seasons except in fall in the southern Gulf (Magdalen Island transect), where the inverse was true (Figure 11). Globally, in the lower Estuary and the Gulf of St. Lawrence, the overall abundance of zooplankton was 64% and 41% lower in spring and fall 2001 than in 2000. This difference in abundance between the two years was due to the lower abundance of both copepod and invertebrate eggs in 2001.

Interannual Variations of the Macrozooplankton Species Composition, Abundance, and Biomass in the Lower St. Lawrence Estuary and the Northwest Gulf of St. Lawrence From 1994 to 2001

Material and Methods

The survey involves sampling with a 1 m^2 BIONESS plankton net equipped with 333-µm mesh nets at each of up to 44 stations along eight transects covering the lower Estuary and the northwest Gulf of St. Lawrence from Les Escoumins to Sept-Îles (Figure 12). In 1994, only transects K through T were surveyed. Transects G and I, at the head of the Laurentian Channel, have been sampled in since 1995 whereas transect U in the Anticosti Gyre has only been sampled since 1997. The survey has taken place in September of each year, usually during a period of 10 days in the middle of the month. At each station, the water column was sampled twice, each time with two nets (bottom-150m and 150-0m or bottom-0 for stations < 150 m depth). Approximately half the stations were sampled in day and half at night. The total zooplankton wet weight and the wet weights of fish (the Atlantic soft pout, *Melanostigma atlanticum*), pandalid shrimp, and gelatinous zooplankton, were measured on board immediately after the tow. Since 1998, larger samples have been split on board with a Folsom plankton splitter to obtain a maximum volume of 125 ml. The catch was then preserved and the following categories (sorted manually) were analyzed for wet weight upon return to the laboratory:

- **Macrozooplankton**: adult and juvenile euphausids (*Meganyctiphanes norvegica, Thysanoessa inermis* and *T. raschii*). This category also includes mysids which were commonly found in deep samples, and hyperiid amphipods.

- **Mesozooplankton**: predominantly copepods, but also other mesozooplankton, including chaetognaths and benthic invertebrate larvae. Excludes gelatinous zooplankton, decapods, and macrozooplankton (as defined above).

One replicate per station per year was thereafter analyzed to determine the species composition and the abundance of the macrozooplankton (adult size > 1 cm). Wet weights and species abundance for each tow were divided by volume filtered (m^3) as measured by a General Oceanic flow meter installed in the mouth of the BIONESS. Wet weight for each tow were divided by volume filtered (m^3) as measured by a General Oceanic flow meter installed in the mouth of the BIONESS. Integrated biomass and abundance for the water column (t ww · km^{-2}) was calculated by multiplying the standardized wet weight and abundance by the depth interval sampled by the net.

Results and discussion

The total mesozooplankton biomass observed in September 2001 in the Lower St. Lawrence Estuary and in the northwest GSL is comparable to the September 1996 measurements, slightly lower than the September 1995, 1997, 1998, 1999, and 2000 observations, and two times lower than in September 1994 (Figure 13). Likewise, the total macrozooplankton biomass observed in September 2001 is comparable to the 1997 measurements, slightly higher than the September 1996, 1997, 1998, 1999, and 2000 observations, and 1.5 and 2 times lower than in September 1995 and 1994 respectively.

On the other hand, the relative abundance of the three most important macrozooplankton groups in terms of biomass (euphausiids, mysids, hyperiid amphipods) varied significantly as a function of the year (Figure 13). The relative abundance of the euphausiids decreased steadily from 87% to 55% between 1994 and 1998 and then increased slightly every year since 1998 to reach 73% of the macrozooplankton assemblage in 2001. The relative abundance of the mysid *Boreomysis artica* increased from 3% in 1994 to 29% in 2000 and decreased again to 16% in 2001 (Figure 13). Finally, the relative abundance of the hyperiid amphipods increased from 8% in 1994 to 18% in 1995, stayed around 20% from 1995 to 1998, significantly decreased from 23% to 1% between 1998 and 2000, and significantly increased again from 1% to 16% in 2001 (Figure 13).

Figure 14 shows the interannual variation in the total abundance of the various macrozooplankton species belonging to each of the groups previously discussed. From 1994 to 1996, the mean abundance of *Thysanoessa raschii* and *Meganyctiphanes norvegica* decreased from 250 to 40 ind. m^{-2} and from 35 to 5 ind. m^{-2} respectively. The mean abundance of *T. raschii* was stable at ca. 40 ind. m^{-2} from 1996 to 1999 and increased to 50 ind. m^{-2} in 2000. From 2000 to 2001, the mean abundance of *T. raschii* decreased from 46 to 25 ind. m^{-2}. On the other hand, the mean abundance of *M. norvegica* increased from 5 to 22 ind. m^{-2} from 1996 to 1997 and decreased again to 5 m^{-2} in 2000. From 2000 to 2001, the mean abundance of *M. norvegica* increased from 5 to 15 ind. m^{-2}. The mean abundance of the chaetognath *Sagitta elegans* decreased from 35 to 8 ind. m^{-2} between 1994 and 1997, increased to 25 ind. m^{-2} in 1998, and decreased again to ca. 10 ind. m^{-2} in 1999 and 2000. From 2000 to 2001, the mean abundance of *S. elegans* increased slightly from 3 to 6 ind. m^{-2}. The mean abundance of the gelatinous zooplankton (mostly cniderians) varied between 15 and 4 ind. m^{-2}, with the minimums observed at the beginning (1994 and 1995) and the end (2000, 2001) of the time series and the maximum between 1996 and 1999 (Figure 14). In contrast with all other macrozooplankton species, the mean abundance of the mysid *Boreomysis arctica* was lowest in 1994, 1995, and 1996 (ca. 18 ind. m^{-2}) and increased significantly in 1997, 1998, and 1999 to reach a value that was three times higher in 1999 than in 1996. Since 1999, the mean abundance of *B. artica* has been stable at ca. 60 ind. m^{-2} (Figure 14). Finally, the mean abundance of the hyperiid amphipod, *Themisto abysorum* decreased from 40 ind. m^{-2} in 1994 to 3 ind. m^{-2} in 1995, slightly increased in 1997 and 1998, and decreased again in 2000 and 2001 to reach 1 ind. m^{-2} in 2001. Likewise, the mean abundance of *Themisto libellula* decreased from 15 to 5 ind. m^{-2} between 1995 and 1996, increased to 10 ind. m^{-2} in 1998, and decreased to 0.17 ind. m^{-2} in 2000. From 2000 to 2001, the mean abundance of *T. libellula* largely increased from 0.17 to 10 ind. m^{-2} (Figure 14). We hypothized that this significant increase in the mean abundance of *T. libellula* observed in 2001 in the lower Estuary and the Gulf of St. Lawrence would be associated with the intrusion of the cold Labrador Current water into the Gulf of St. Lawrence via the Strait of Belle-Isle. This hypothesis is supported by different results:

1. Based on daytime and nighttime depth of the centers of mass of the distribution of *T. libellula* in the Anticosti gyre in September 1999 (Figure 15), the presence of this species in the EGSL is closely associated with the CIL. As seen in Figure 15, the depth of the center of mass varied between 40 and 130 m over a 24-h period, indicating that *T. libellula* is only present within the CIL and lives in water with temperatures lower than 4 ºC.

2. The low value of the CIL core temperature index (Gilbert, 2002) observed in 2001 suggests that there was an important intrusion of the cold Labrador Current water into the Gulf of St. Lawrence via the Strait of Belle-Isle during the winter of 2001.

3. There was a highly significant negative relationship (R^2 = 0.72) between the annual CIL core temperature index (Gilbert, 2002) and the mean annual abundance of *T. libellula* sampled since 1994 in the Lower St. Lawrence Estuary and the NW Gulf (Figure 16).

4. *T. libellula* sampled in September 2001 were distributed over the whole sampled area and were all adult (mean size 27 mm). These individuals were not hatched in the Estuary and the Gulf of St. Lawrence during the previous summer since they were all more than one year old (Percy 1993), and they were not present in September 2000 (mean abundance 0.17 ind. m^{-2}) (Figure 17).

Conclusion

In summary, there were no significant changes in the macrozooplankton and the mesozooplankton biomasses in 2001 compare to 2000. On the other hand, the year 2001 was characterized by a decrease of the mean abundance of the euphausiid *Thysanoessa raschii* and by an increase of the mean abundance of the euphausiid *Meganyctiphanes norvegica*, the chaetognath *Sagitta elegans*, the gelatinous zooplankton *Aglantha digitale*, *Obelia* sp., and *Boreo* sp., and the pelagic amphipod *Themisto libellula*. The mean abundance of *T. libellula* increased from 1.7 ind. ·10 m^{-2} in 2000 to 92.3 ind. ·10 m^{-2} in 2001. Based on the significant correlation between the annual CIL core temperature index (Gilbert, 2002) and the mean abundance of *T. libellula* in the lower St. Lawrence Estuary and the NW Gulf, this species could be considered as an index of the intrusion of cold Labrador Current into the Gulf of St. Lawrence. If this hypothesis is true, 2001, 1998, and 1995 would be years where important intrusions of Labrador Current waters occurred. Bousfield (1951), who studied the pelagic amphipods of the Belle Isle Strait region suggested that the presence and the mean abundance of *T. libellual* there could be considered as an index species of the cold Labrador Current in that area.

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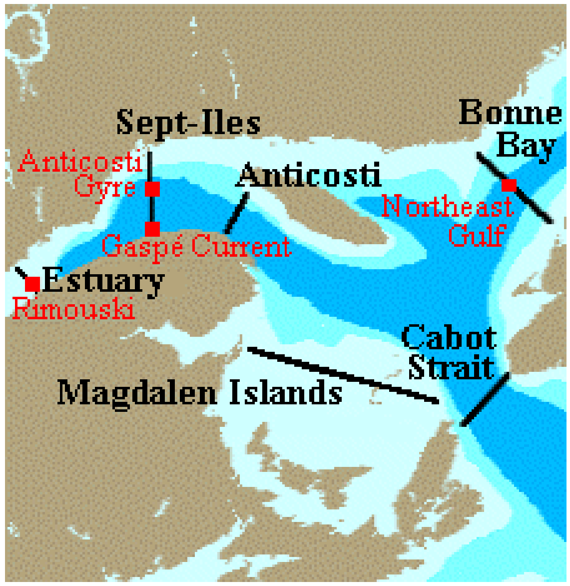


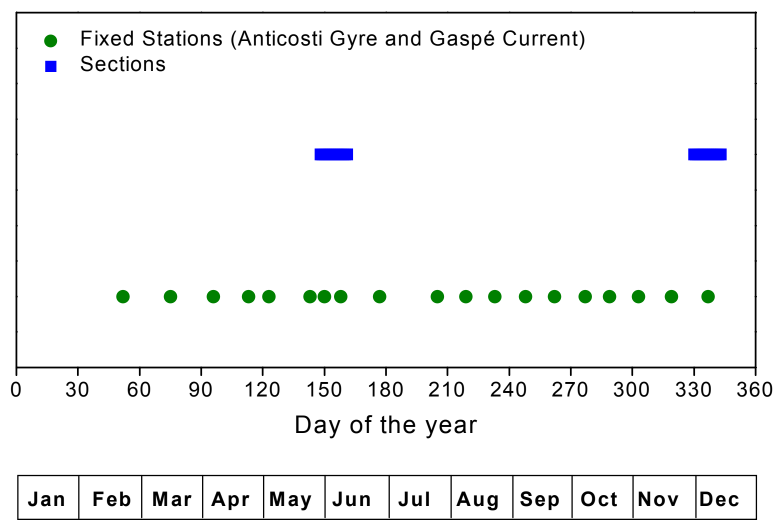


Figure 1.Dates of 2001 sampling at the Atlantic Zonal Monitoring Program (AZMP) sections (lines) and fixed stations (dots).

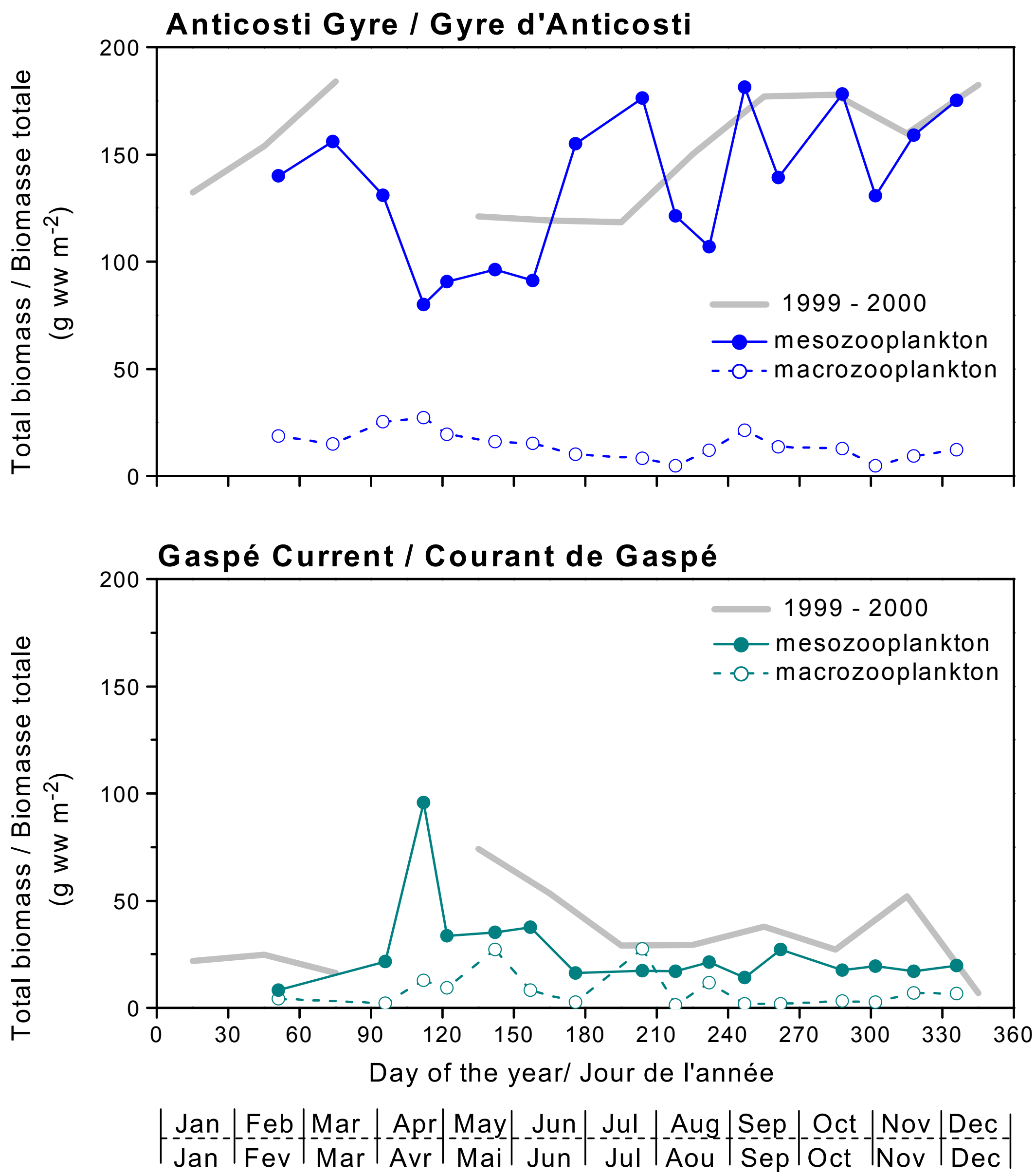


Figure 2.Monthly variations of the total zooplankton biomass in the Anticosti Gyre and the Gaspé Current in 2001. 1999-2000: average value between years for mesozooplankton.

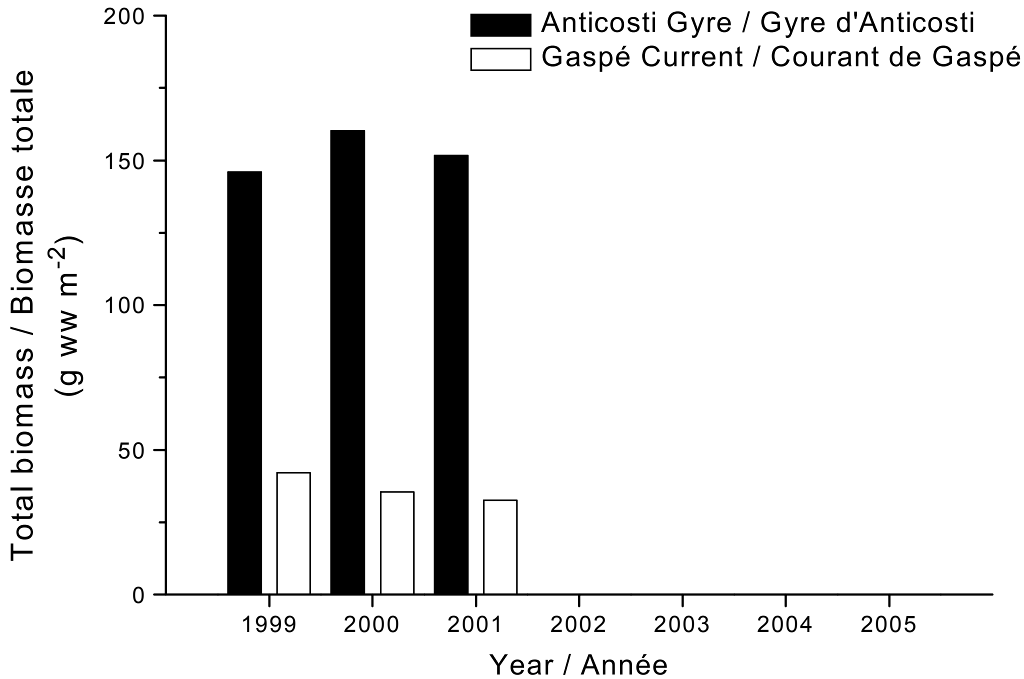


Figure 3.Mean integrated zooplankton biomass in the Anticosti Gyre and the Gaspé Current in 2001.

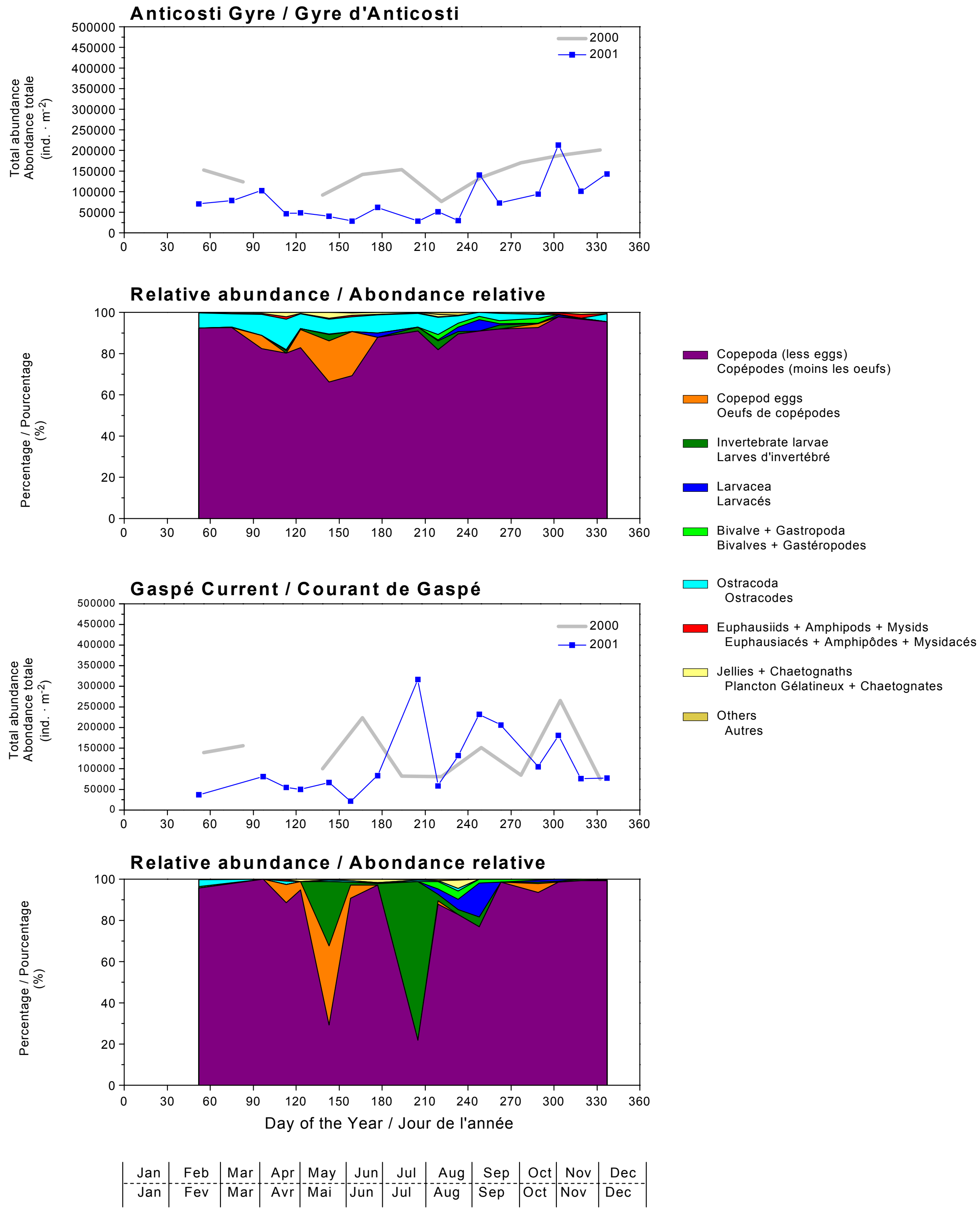


Figure 4.Monthly variations in integrated zooplankton abundance and community structure for the Anticosti Gyre and the Gaspé Current fixed stations in 2001.

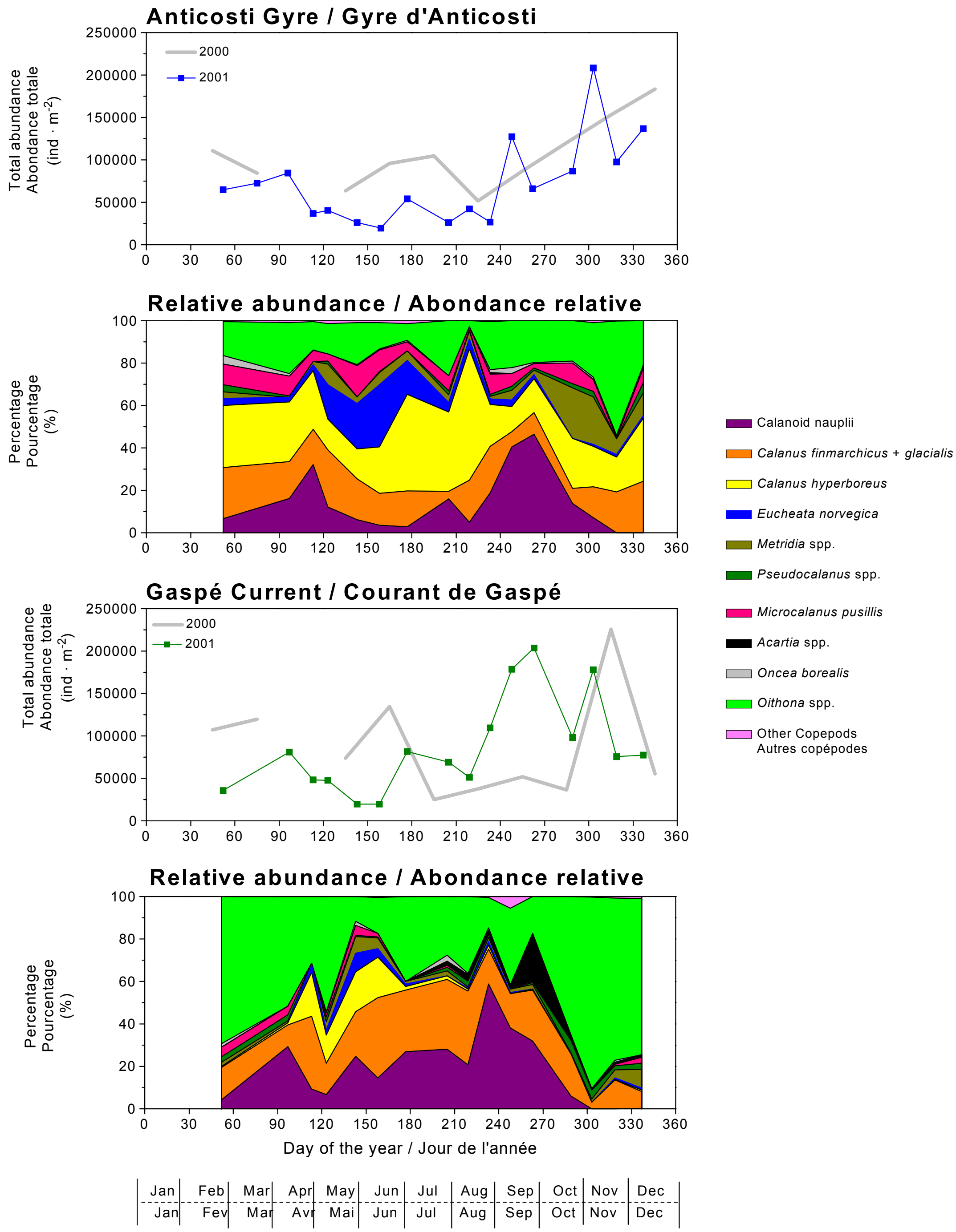


Figure 5.Monthly variations in the integrated copepod abundance and community structure for the Anticosti Gyre and the Gaspé Current fixed stations in 2001.

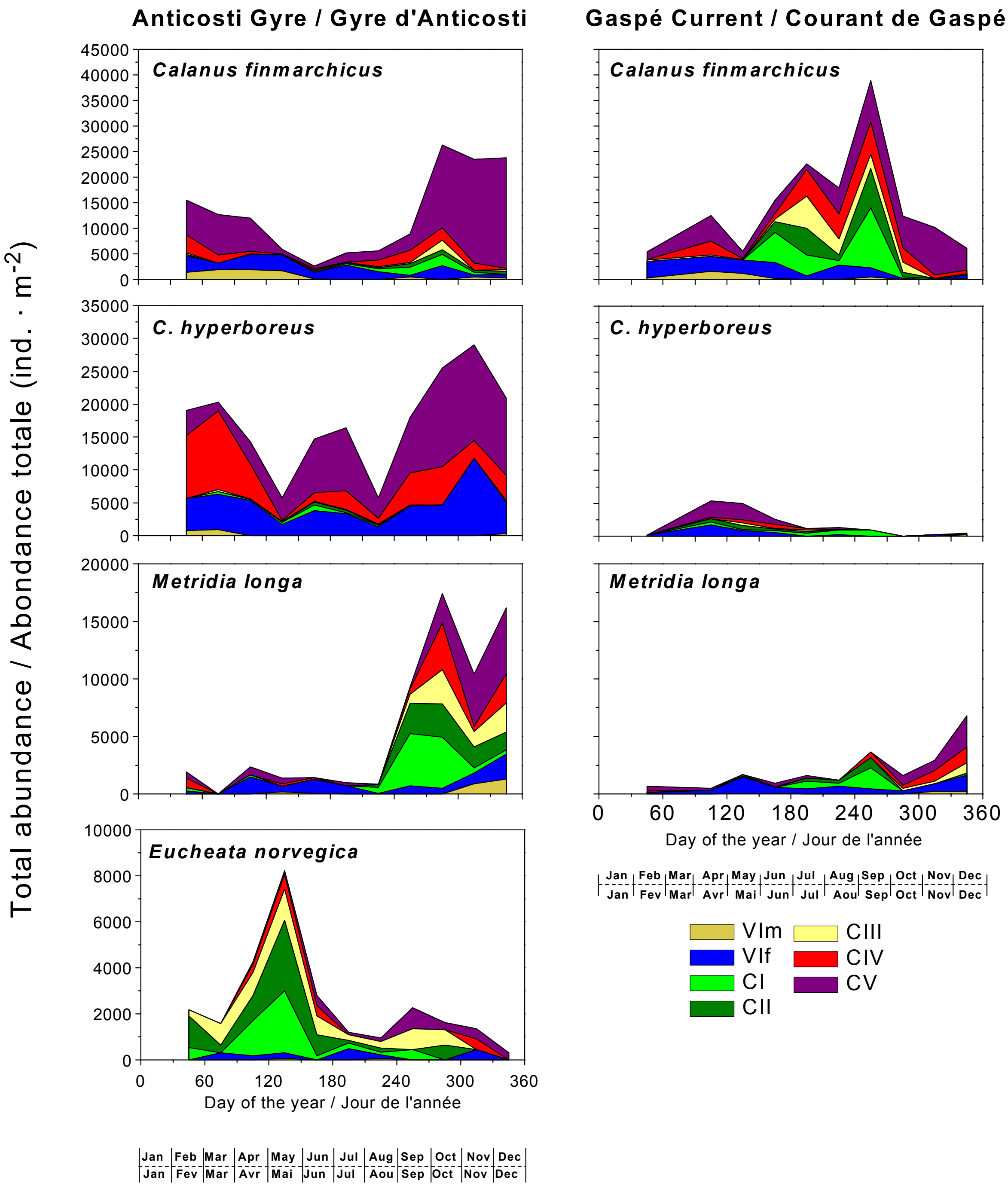


Figure 6.Monthly variations in the depth-integrated abundance of the stage composition the four most important copepods species (in terms of biomass) found in the Anticosti Gyre and the Gaspé Current in 2001.

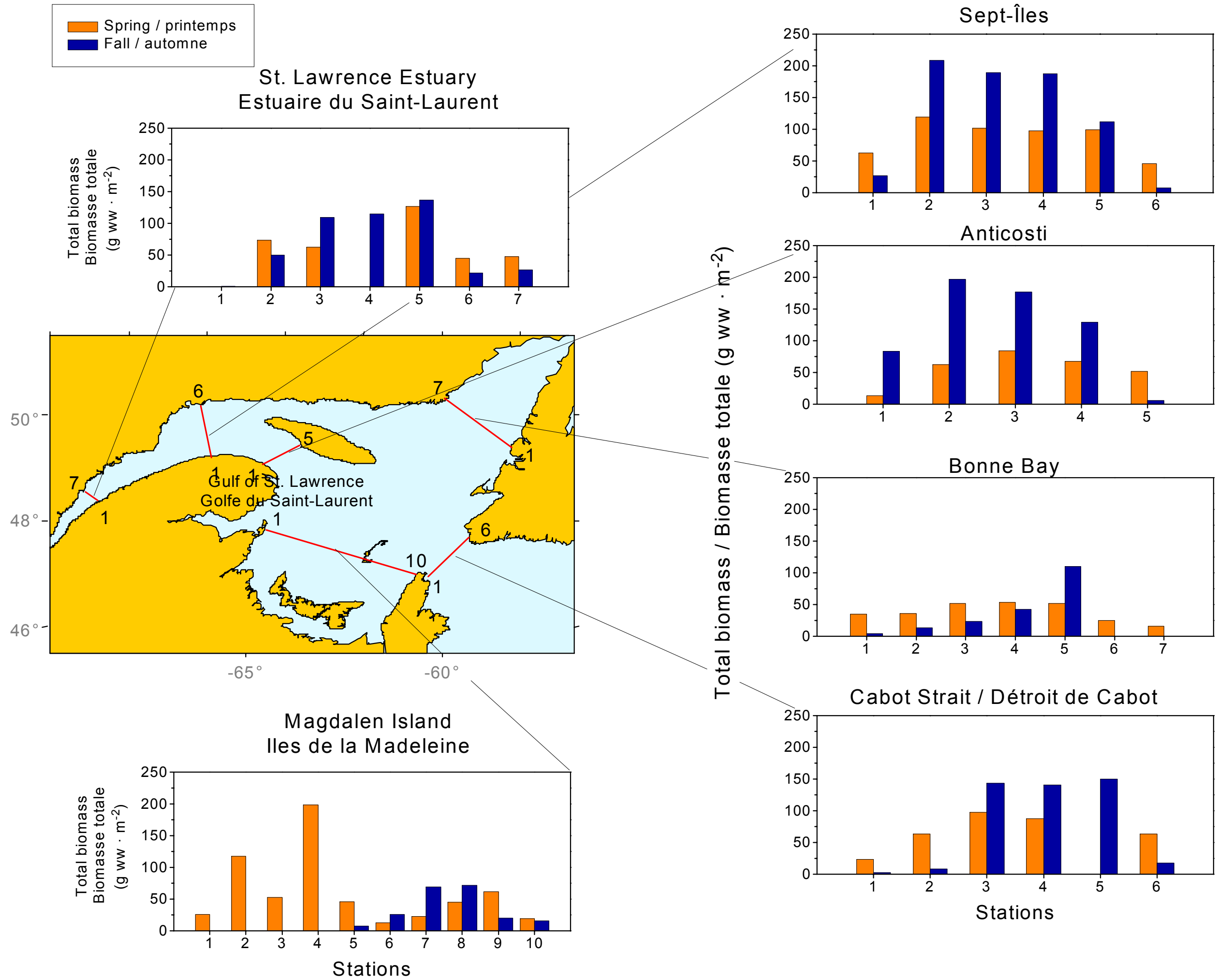


Figure 7.Total zooplankton biomass (wet weight) along the six transects sampled in June and November 2001 in the Lower Estuary and the Gulf of St. Lawrence.

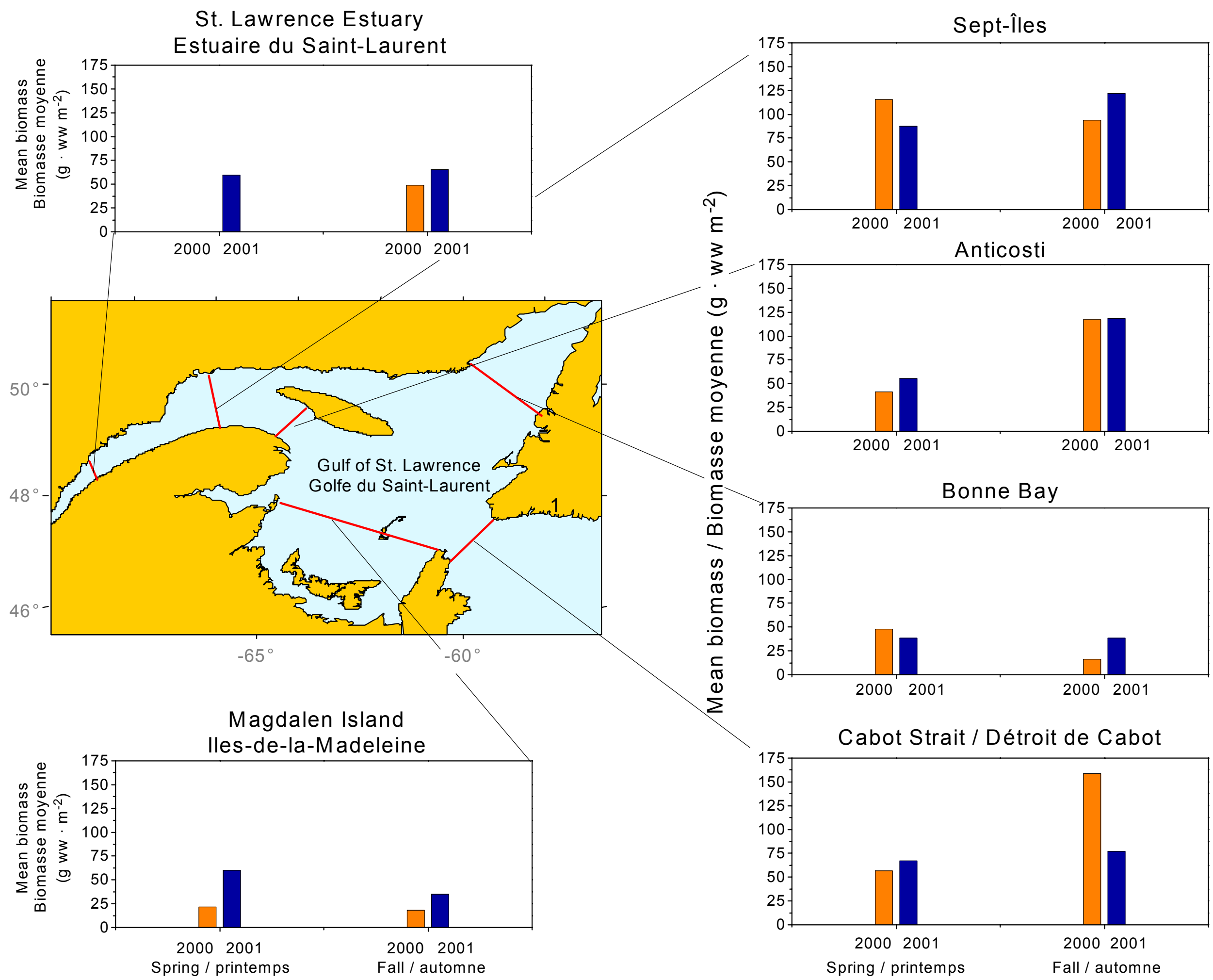


Figure 8.Mean zooplankton biomass (wet weight) along the six transects sampled in June and November 2000 and 2001 in the Lower Estuary and the Gulf of St. Lawrence.

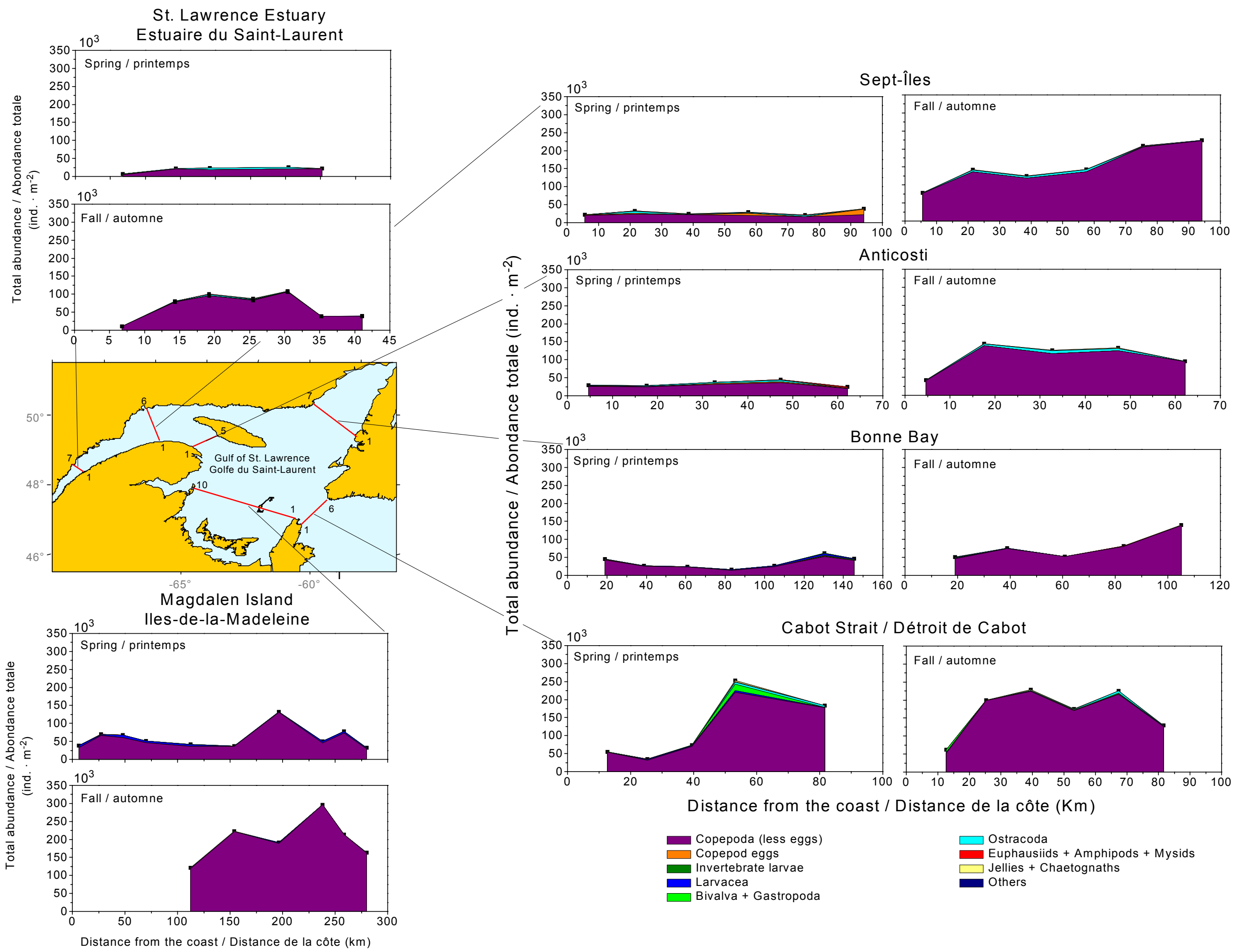


Figure 9. Integrated zooplankton abundance and community structure along the six transects sampled in June and December 2001 in the Lower Estuary and the Gulf of St. Lawrence.

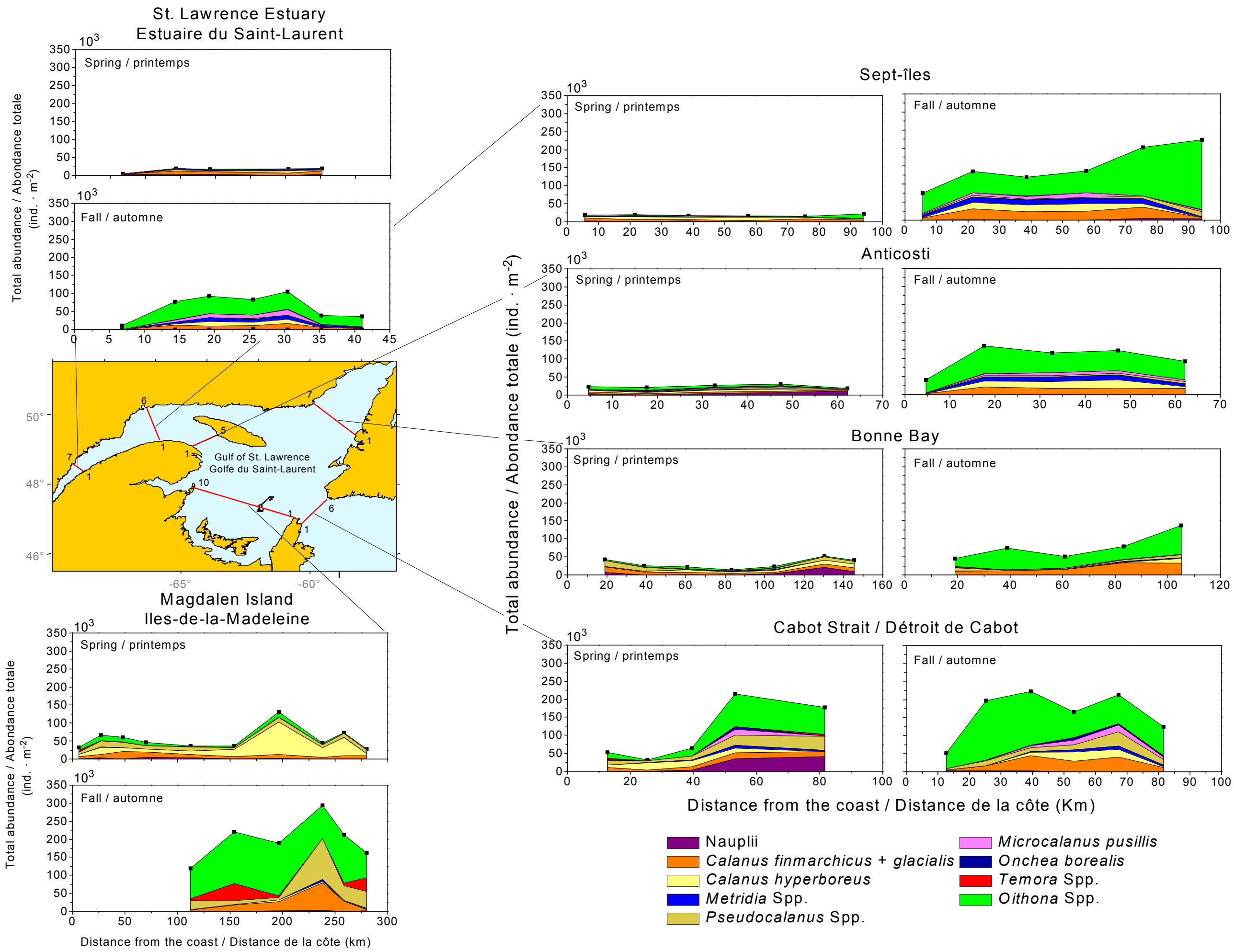


Figure 10. Integrated copepod abundance and community structure along the six transects sampled in June and December 2001 in the Lower Estuary and the Gulf of St. Lawrence.

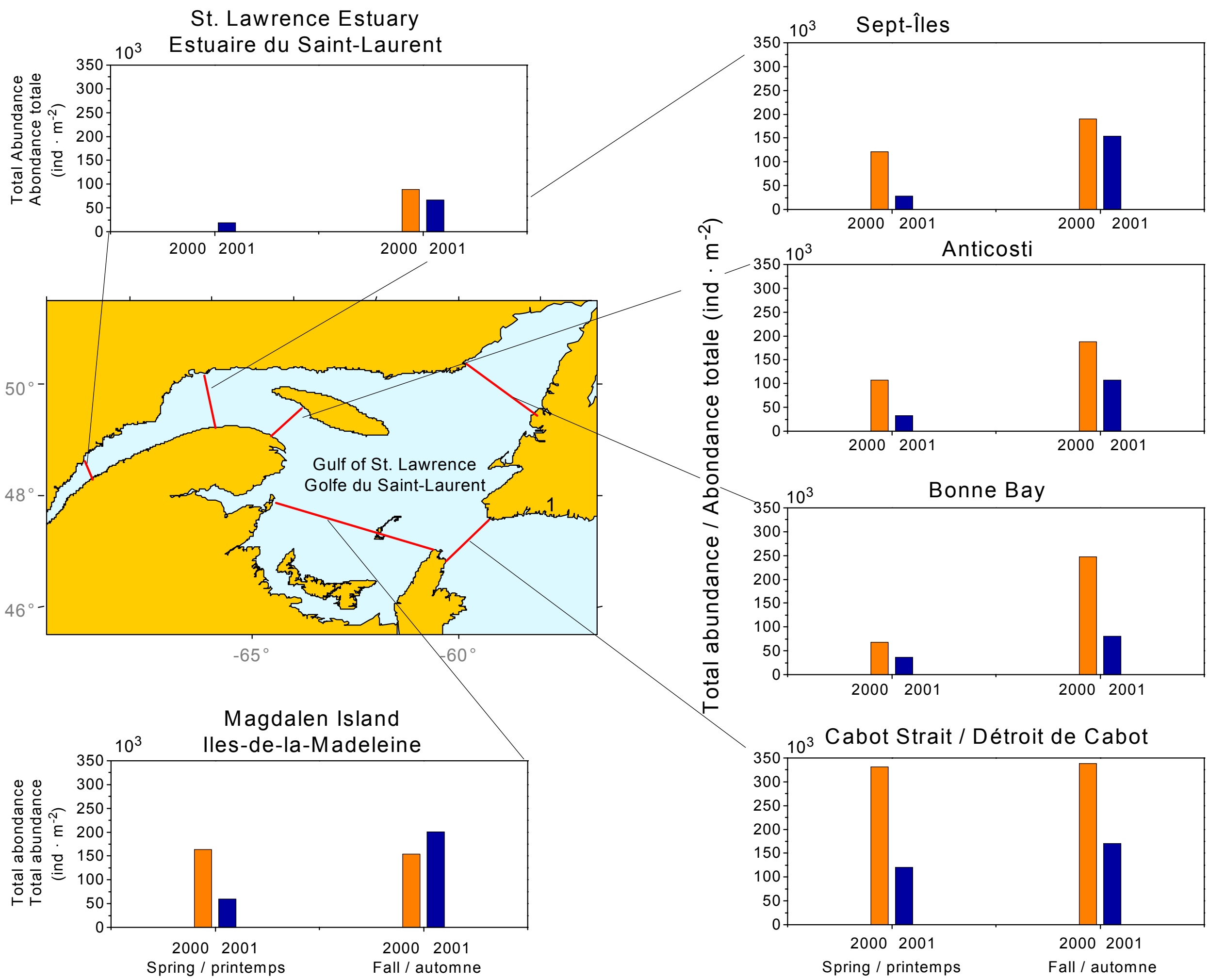


Figure 11. Integrated zooplankton abundance along the six transects sampled in Spring and Fall 2000 and 2001 in the Lower Estuary and the Gulf of St. Lawrence.

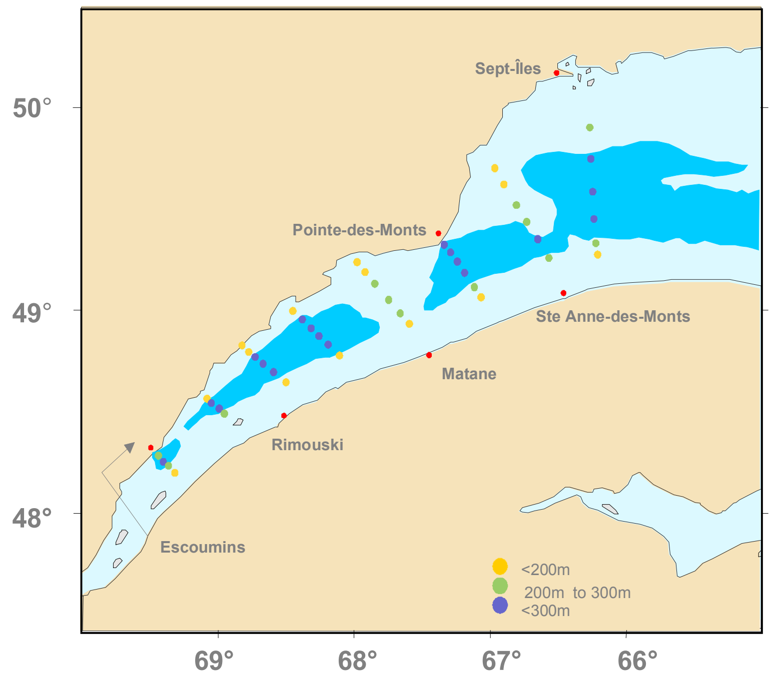
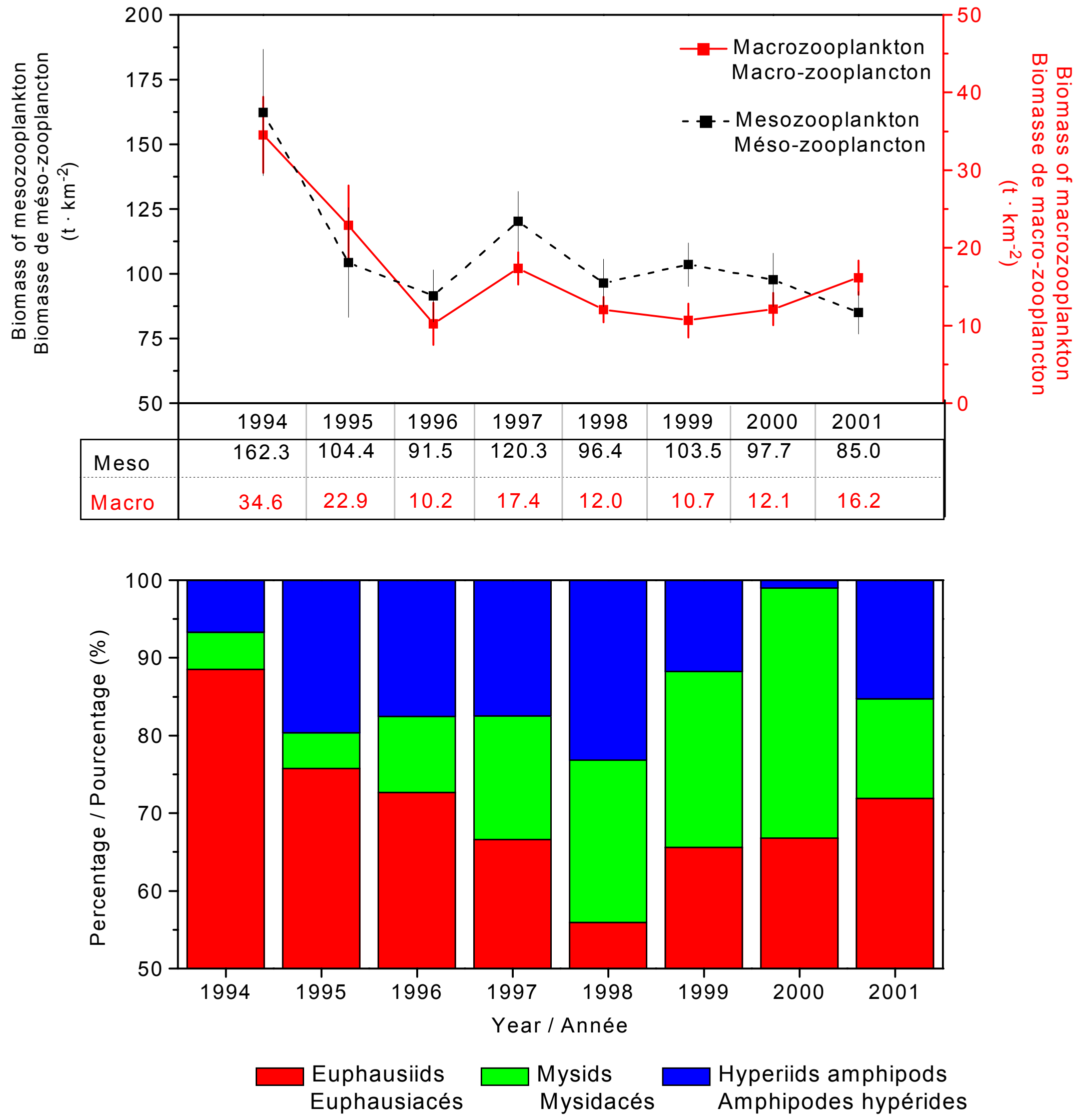


Figure 12. Map showing station locations of annual zooplankton survey in the lower St. Lawrence Estuary and the northwest Gulf of St. Lawrence. Survey takes place in September of each year, since 1994.



	1994	1995	1996	1997	1998	1999	2000	2001
Meso	162.3	104.4	91.5	120.3	96.4	103.5	97.7	85.0
Macro	34.6	22.9	10.2	17.4	12.0	10.7	12.1	16.2

Figure 13. Mean biomass (± SE) of mesozooplankton and macrozooplankton in the Lower St. Lawrence Estuary and the northwest Gulf of St. Lawrence from 1994 to 2001 (upper panel) and relative abundance of the three most important macrozooplankton groups in term of biomass (lower panel).

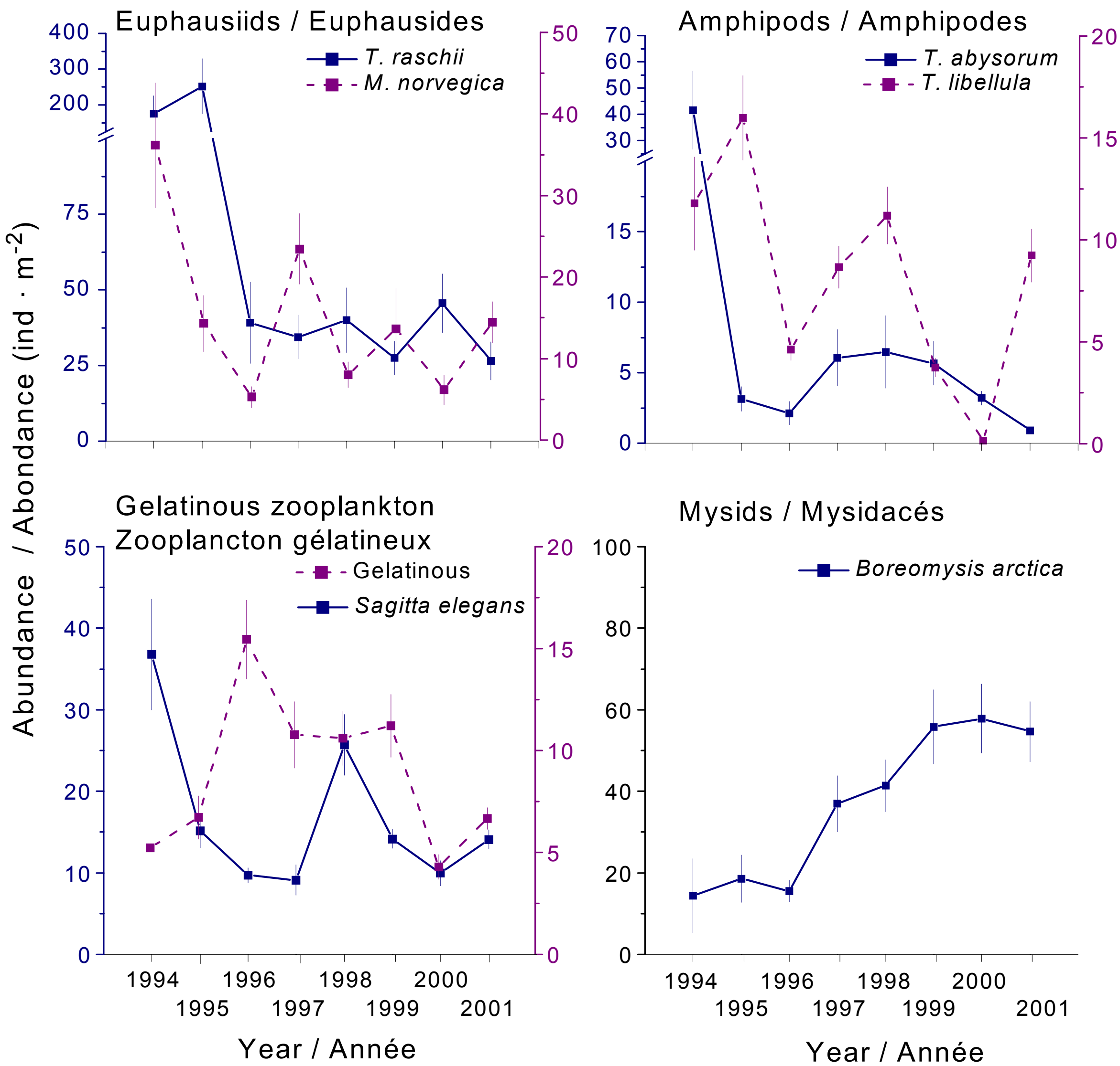


Figure 14. Mean abundance (± SE) of the most important species of macrozooplankton in the Lower St. Lawrence Estuary and the northwest Gulf of St. Lawrence from 1994 to 2001.

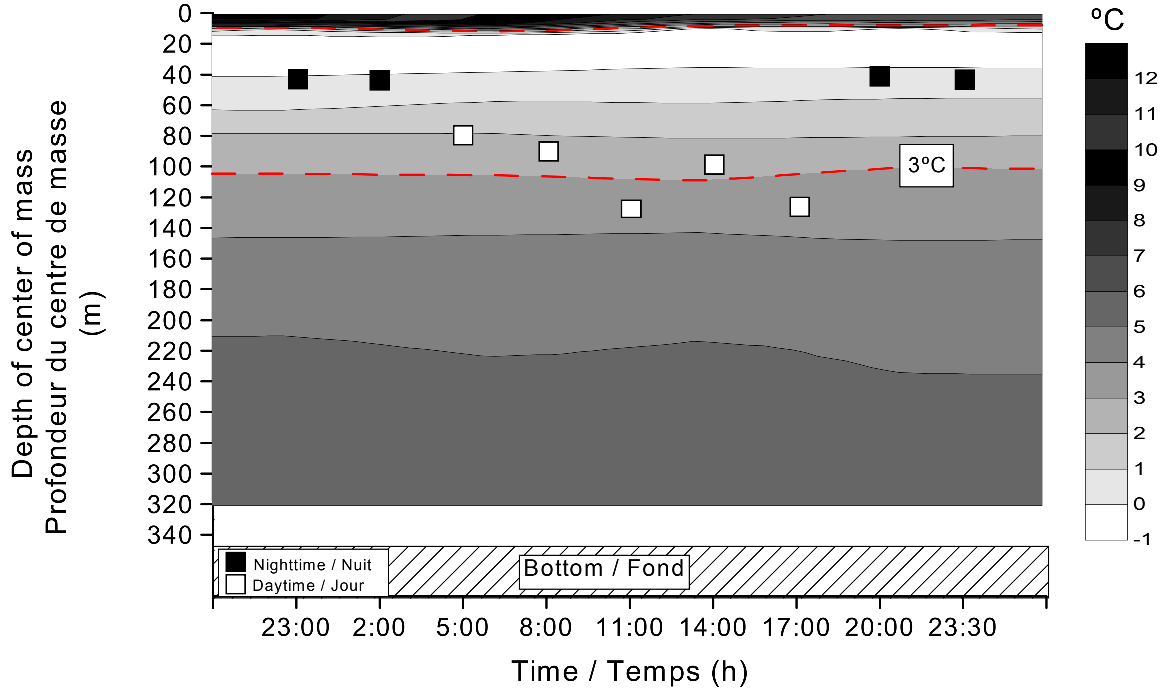


Figure 15. Daytime and nighttime depth of the centers of mass of the distribution of *Themisto libellula* in the Anticosti Gyre in September 1999.

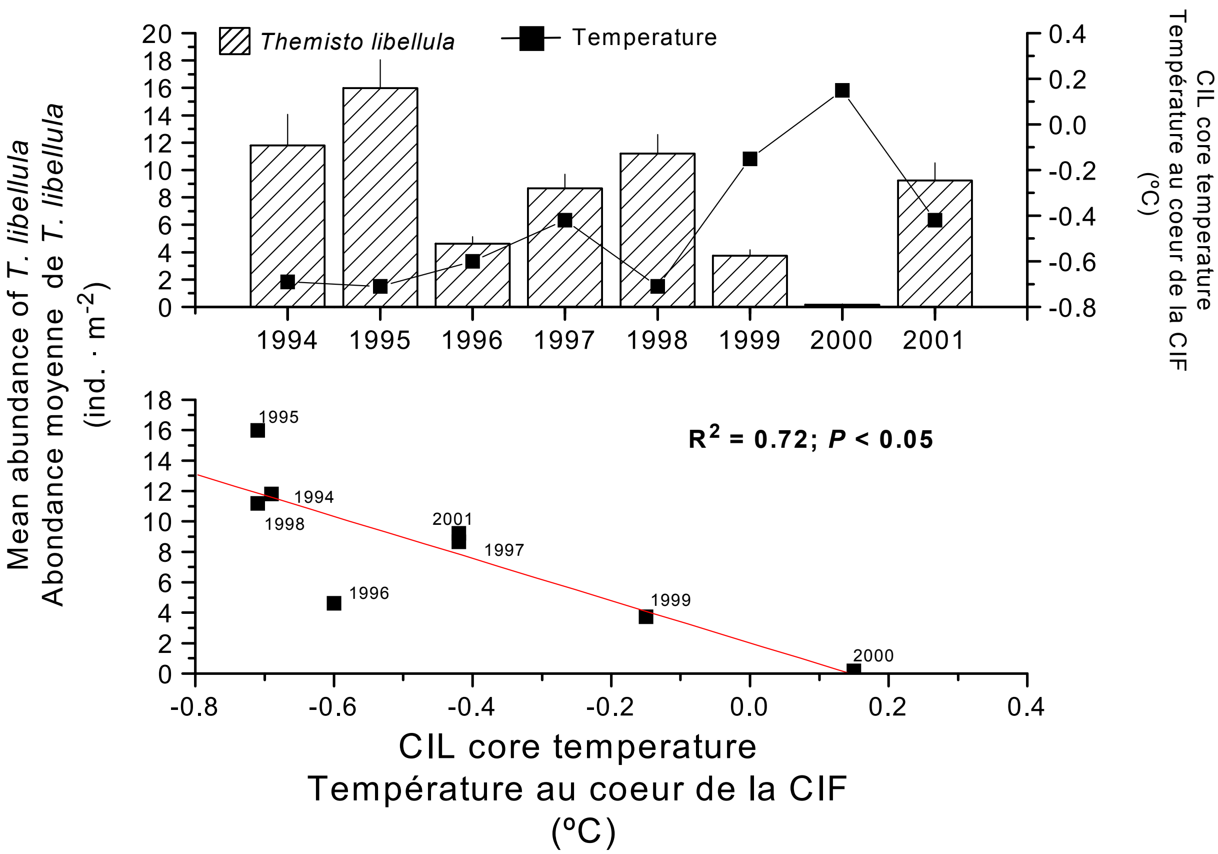


Figure 16. Relationship between the annual CIL core temperarure index (Gilbert 2002) and the annual mean abundance of the hyperiid amphipod *Themisto libellula* in the Lower St. Lawrence Estuary and the northwest Gulf of St. Lawrence from 1994 to 2001.

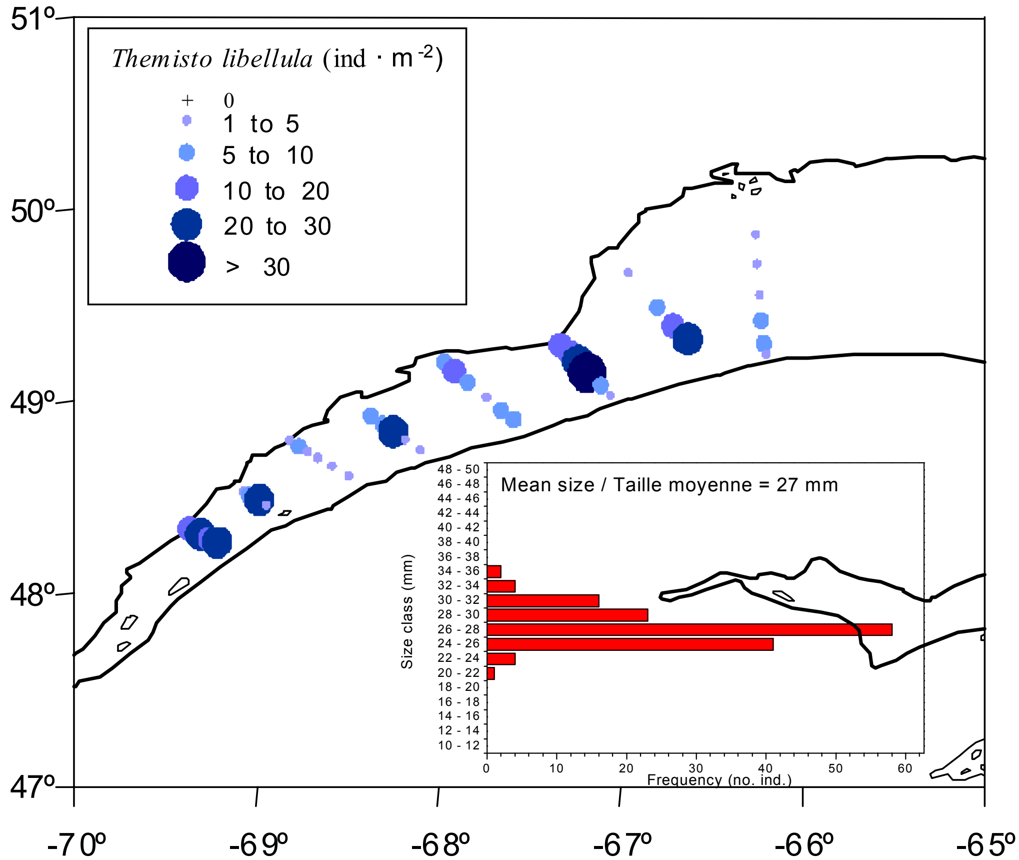


Figure 17. Spatial distribution and abundance of the hyperiid amphipod *Themisto libellula* in the Lower St. Lawrence Estuary and the northwest Gulf of St. Lawrence in 2001. Also on this figure: the size distribution of 100 individuals sampled in 2001.