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**Contribution to the identification of
ecologically and biologically
significant areas (EBSA) for the
Estuary and the Gulf of St. Lawrence:
The fish eggs and larvae and
crustacean decapods larvae layer**

**Contribution à l'identification de
zones d'importance écologique et
biologique (EBSA) pour l'estuaire et
le golfe du Saint-Laurent :
La couche des œufs et des larves de
poissons et de crustacés décapods**

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ABSTRACT

An analysis of more than 20 years of data on the abundance of fish eggs and larvae and for a few crustacean decapod species is presented to draw a map of ecologically and biologically significant areas for the Gulf of St. Lawrence and Estuary. The analysis of the spatial distribution of eggs and larvae of fish species and of crustacean decapods species leads to the suggestion of eight areas for the entire Gulf and Estuary system. The principal areas are located around Anticosti Island, the west coast of Newfoundland and in the southern Gulf. However, an absence of data available for mapping in the Estuary limits the value of the analysis for that region of the St. Lawrence system.

RÉSUMÉ

L'analyse sur plus de 20 ans de données sur l'abondance des œufs et des larves de poissons et de quelques espèces de crustacés décapodes est présentée afin de dresser une carte des zones d'importance écologique et biologique pour l'estuaire et le golfe du Saint-Laurent. L'analyse de la distribution spatiale des espèces d'œufs et de larves de poissons et de crustacés décapodes a permis de proposer huit zones dans l'ensemble golfe et estuaire. Les zones principales se trouvent dans les régions de l'île Anticosti, la côte ouest de Terre-Neuve et le sud du Golfe. Par contre, l'absence de données disponibles pour la cartographie pour l'estuaire du Saint-Laurent limite la valeur de l'analyse pour cette région du système.

INTRODUCTION

Spawning and reproduction are among the specific properties and ecological functions to be considered based on the reference manual for identifying ecologically and biologically significant areas (DFO, 2004).

The vast majority of fish species gather at one or more specific locations and at a specific time of year to reproduce and lay eggs. Commercially harvested large crustacean decapods (e.g. snow crab, northern shrimp) do not form shoals and do not migrate as do fish but also have a specific period when larvae are released in the water column. These species therefore reproduce by releasing large quantities of eggs or larvae into the water, which mix and live on zooplankton, often for several months. For each species, the number of larvae that survive determines the annual number of juveniles and the ultimate success of populations. Thus, the location of spawning areas and areas of egg and larval stage concentrations should be important information for defining critical habitats for sustaining the species (or population) in an ecosystem.

In this work, an analysis based on more than 20 years of data on distribution of eggs and larvae of fish and a few crustacean decapod species (meroplankton) is presented to develop a map of potentially sensitive areas for sustaining several of these species in the Gulf of St. Lawrence and Estuary system.

METHODS

Data sources

To ensure that the definition of potentially sensitive areas reflects the current or recent status of the Gulf of St. Lawrence and Estuary system, the exercise is based on data analysis from 1980 to the present. Table 1 presents an overview of the data groups available for the exercise. For the southern Gulf, the data come from the analysis of zooplankton samples harvested annually since 1982, in June, over a grid of 65 stations covering the entire area (see Figure 1). For the northeastern and central Gulf, systematic samples covering all or a significant portion of the area were conducted sporadically, in 1992 and then from 1998 to 2000 (Table 1, Figure 1). In the northern and northeastern Gulf, the systematic sample of the area dates back to the mid-1980s (1985 to 1987). However, a new sampling program for fish eggs and larvae began in 2005 and has provided recent information for this area.

Table 1. Identification of the data sources available for the exercise of delineation of the ecologically and biologically significant areas.

Sector	Period	Data type
Southern Gulf	1982- 2003 (June)	Crabs spp, larvae
	1982 - 2004 (June)	Mackerel and cod eggs and larvae
	1986-89; 1996-99; 2001-04 (June)	Larval fish species community
Centre – Northeastern Gulf	1992 (June)	Larval fish species community
	1998-2000 (June)	Larval fish species community
	1993 – 1994 (May and June)	Cod eggs and larvae
Northern Gulf	1985-1987; 2005 (May and June)	Larval fish species community and decapods crustacean larvae
	2003 (June)	Northern Shrimp (larval stages III and IV)

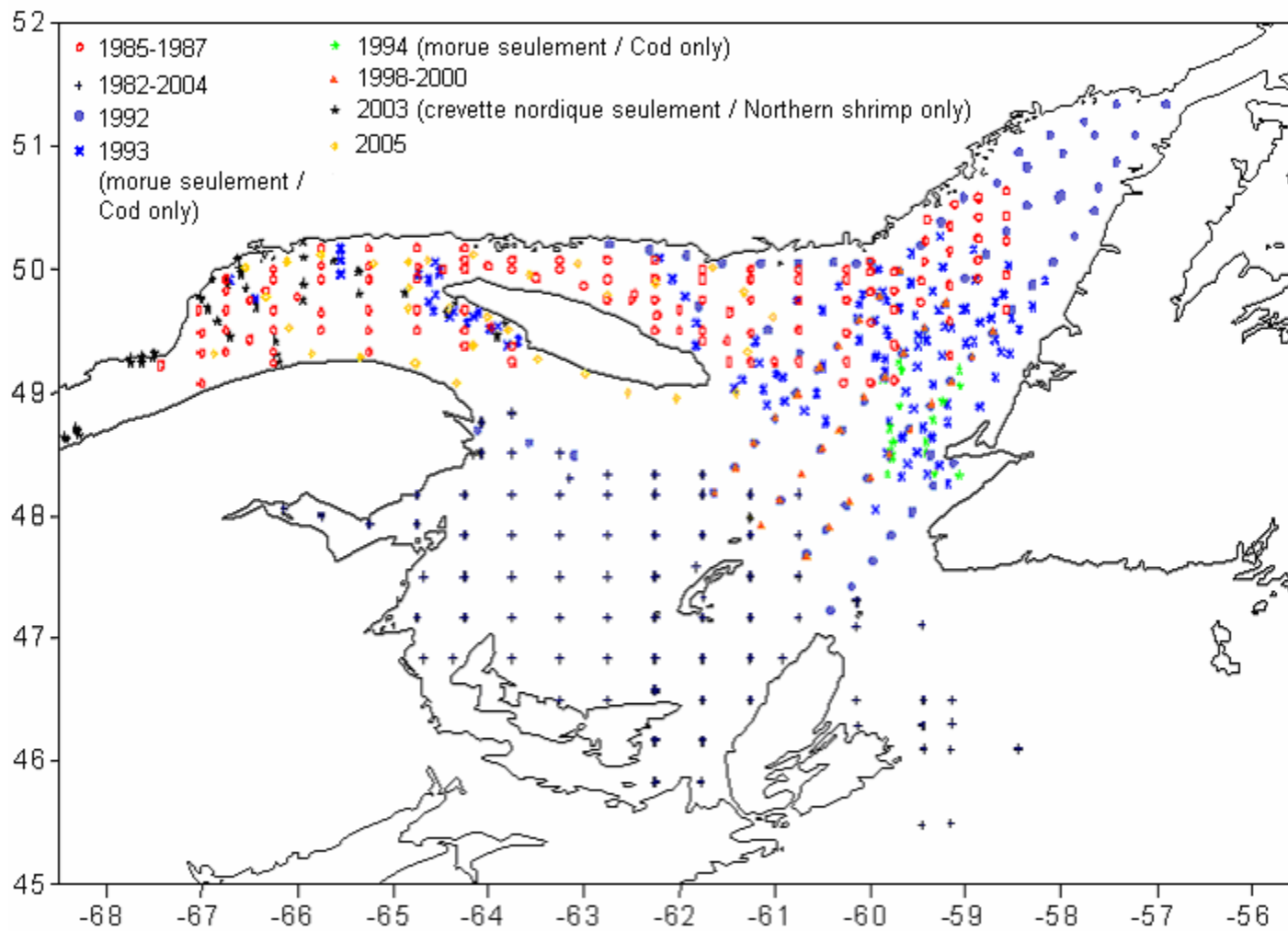


Figure 1. Stations distribution for each sampling used for the exercise. All samplings were carried out in May or June.

Data could not be obtained for the St. Lawrence Estuary and thus distributions could not be analysed as for the Gulf areas. A review of the literature is presented to attempt an approximate definition of important areas in this part of the system.

Data representation

All data used in the analysis were gathered with standard sampling devices for meso- and macro-zooplankton (Bongo, Tucker, BIONESS) equipped with nets of at least 0.3 mm mesh spacing. In most cases, the methodology consisted of oblique tows between the surface (0 m) and a predetermined depth (50 m, 150 m, etc.). When more than one stratum in the water column was sampled (e.g. BIONESS), an abundance value for eggs and larvae at the station was estimated by adding the values for each individual net. All abundance data are presented in concentration by sea surface unit (m^{-2}).

The maximum sample depth varies between data sources but since, for all practical purposes, fish eggs and larvae as well as young crustacean decapod larvae are concentrated in the upper layer of the water column, we can conclude that the distribution maps present the information for the 0 - ~50 m layer of the water column.

For each species or taxon used, the information is presented for each year individually for the northern, northeastern and central Gulf areas. For the southern Gulf, the continuous data between 1982 and 2004 for mackerel, cod and larvae for crab species are presented by average values for five-year periods (1982-1985, 1986-1990, 1991-1995, 1996-2000, 2001-2003). Also for the southern Gulf, the complete information on the community of fish larvae species is available for a few years (1986, 1989, 1996, 1999, 2001 – 2004) only.

Fish eggs and larvae therefore are planktonic and primarily concentrated in the surface layer. During the development period, surface circulation therefore plays an important role in rapidly moving and dispersing concentrations over large areas, thereby making it difficult to specifically define particularly important areas. On the other hand, areas of high concentrations, especially for fish eggs, should clearly define sites with heavy spawning activity. To accurately represent the sites of maximum and minimum abundance for a species or group, a representation in quartiles, 0-25%, 25-50%, 50-75% and 75-100% on the abundance scale was chosen for building the maps.

RESULTS

A total of 50 different taxonomic categories, including 33 fish larvae species, were found in the databases reviewed for the exercise (Table 2). However, many had very low abundance or too low a frequency for a distribution map. This relative taxonomic scarcity is explained by the fact that all the available data come from missions conducted early in the spring (May and early June).

Following review of all the available information, eight large ecologically and biologically significant areas (EBSA) are proposed for the Gulf of St. Lawrence and Estuary system. The various areas are presented moving clockwise around the Gulf, starting with area 1. A summary of the characteristics of the various areas is also presented in Appendix 1.

1- Anticosti Island area

The area boundaries are defined approximately as a line from Quebec's North Shore near Rivière-au-Tonnerre running due south, turning southeast and running along the south shore of Anticosti Island (following the 200 m isobath) to the eastern point, then turning northeast to rejoin Quebec's North Shore at the Natashquan River (Figure 2).

Description: The possibility of upwelling at the head of the Anticosti Channel and the presence of tidewater fronts and mixing in Jacques Cartier Passage create a potentially significant primary production area while contributing to meroplankton retention. The circulation pattern for the surface layer could extend the production area's influence along the island's north shore all the way to the eastern point. On the southwest shore, the hydrodynamics specific to Honguedo Strait (e.g. interactions between the Gaspé Current and the northwestern gyre) might favour egg and larvae retention.

Unicity: The area is notable for its wealth of fish larvae and crustacean decapod species, as well as the abundance of fish and crustacean decapod eggs and larvae (especially in the Jacques Cartier Passage sector) (see Maps C1 to C7 in Appendix 2). Greenland halibut larvae have been harvested at the area's eastern boundary (Map C12). Historically (1985-1987), the abundance of cod eggs (CHW) and winter flounder eggs has been noted in the Jacques Cartier Passage sector, on the island's northeast and southwestern shores, an observation that appears to be confirmed by recent data gathered in 2005 (Maps C8 to C10). The Jacques Cartier Passage sector is also where high concentrations are found of larvae of middle trophic level fish species such as sand lance, capelin and Arctic shanny (Maps C13 and C14). The abundance of crab larvae (including snow crab) is noted in Jacques Cartier Passage and along the island's north shore (Maps C15 and C16). Advanced larval stages of northern shrimp have also been noted in the southwestern area of Anticosti Island (Map C17).

Table 2. List of species or taxonomic groups present in the databases consulted for the exercise. A check mark in the column “Maps” indicates that the information was used for the definition of the ecologically and biologically significant areas.

Group	Name	French Name	English Name	Maps
Fish eggs	CHW	morue franche / aiglefin / plie grise	Atlantic Cod / Haddock / Witch	✓
	CYT	tanche-tautogue / limande à queue jaune	Cunner / Yellowtail flounder	✓
	H4B	gadidés autres que la morue / motelle à quatre barbillons / stromatée à fossettes	Gadidae other than cod / Fourbeard rockling / Butterfish	
	<i>Gadus morhua</i>	morue franche	Atlantic Cod	✓
	<i>Scomber scombrus</i>	maquereau bleu	Atlantic Mackerel	✓
	<i>Pseudopleuronectes americanus</i>	plie rouge	Winter flounder	✓
	<i>Hippoglossoides platessoides</i>	plie canadienne	American plaice	✓
	Autres œufs (non-identifiés)		Other (unidentified)	
	Oeufs de poissons - total		Fish eggs total	✓
Fish larvae	Number of taxa (species)			✓
	Fish larvae total			✓
	<i>Agonus decagonus</i>	agone atlantique	Atlantic poacher	
	<i>Ammodytes spp.</i>	lancons spp.	American sand lance	✓
	<i>Anarhichas lupus</i>	loup atlantique	Atlantic wolffish	
	<i>Aspidophoroides monopterygius</i>	poisson-alligator atlantique	Alligatorfish	
	<i>Clupea harengus</i>	hareng atlantique	Herring	
	<i>Cottidae spp</i>	Cottidée spp.	Cottidae spp.	✓
	<i>Enchelyopus cimbrius</i>	motelle à quatre barbillons	Fourbeard rockling	
	<i>Gadus morhua</i>	morue franche	Atlantic Cod	✓
	<i>Glyptocephalus cynoglossus</i>	plie grise	Witch	✓
	<i>Gymnocanthus tricuspis</i>	tricorne atlantique	Arctic staghorn sculpin	
	<i>Hemitripterus americanus</i>	hémitriptère atlantique	Sea raven	
	<i>Hippoglossoides platessoides</i>	plie canadienne	American plaice	✓
	<i>Hippoglossus hippoglossus</i>	flétan atlantique	Atlantic halibut	
	<i>Liparidae spp</i>	Liparidée spp.	Liparidae spp.	
	<i>Limanda furruginea</i>	limande à queue jaune	Yellowtail flounder	✓
	<i>Lumpenus lumpretaeformis</i>	lompénie serpent	Snakeblenny	
<i>Lumpenus maculatus</i>	lompénie tachetée	Daubed shanny		
<i>Mallotus villosus</i>	capelan	Capelin	✓	
<i>Myoxocephallus</i>	crapaud de mer nain	Grubby		

<i>Group</i>	<i>Name</i>	<i>French Name</i>	<i>English Name</i>	<i>Maps</i>
	<i>aeneus</i>			
	<i>Myoxocephalus octodecemspinosus</i>	chaboisseau à dix-huit épines	Longhorn sculpin	
	<i>Myoxocephalus scorpius</i>	chaboisseau à épines courtes	Shorthorn sculpin	
	<i>Pholis gunnellus</i>	sigouine de roche	Rock gunnel	
	<i>Pollachius virens</i>	goberge	Pollock	
	<i>Pleuronectidae spp</i>	Pleuronectidée spp.	Pleuronectidae spp.	
	<i>Pseudopleuronectes americanus</i>	plie rouge	Winter flounder	✓
	<i>Reinhardtius hippoglossoides</i>	flétan du Groenland	Greenland halibut	✓
	<i>Sebastes spp.</i>	sébastes spp.	Redfishes	✓
	<i>Scomber scombrus</i>	maquereau bleu	Atlantic Mackerel	✓
	<i>Scophthalmus aquosus</i>	turbot de sable	Windowpane	
	<i>Stichaeus punctatus</i>	stichée arctique	Arctic shanny	✓
	<i>Tautoglabrus</i>			
	<i>adpersus</i>	tanche-tautogue	Cunner	✓
	<i>Triglops spp. (Cottidae)</i>	faux-trigle spp.	Sculpin spp.	
	<i>Ulvaria sibbifurcata</i>	ulvaire deux-lignes	Radiated shanny	✓
Decapods larvae	<i>Chionocetes opilio</i>	crabe des neiges	Snow crab	✓
	<i>Hyas spp.</i>	crabe lyre spp.	Toad or Arctic lyre crab	✓
	<i>Pandalus borealis</i>	crevette nordique	Northern shrimp	✓
	<i>Pandalus montagui</i>	crevette ésope	Striped pink shrimp	
	Décapodes total		Decapods total	✓

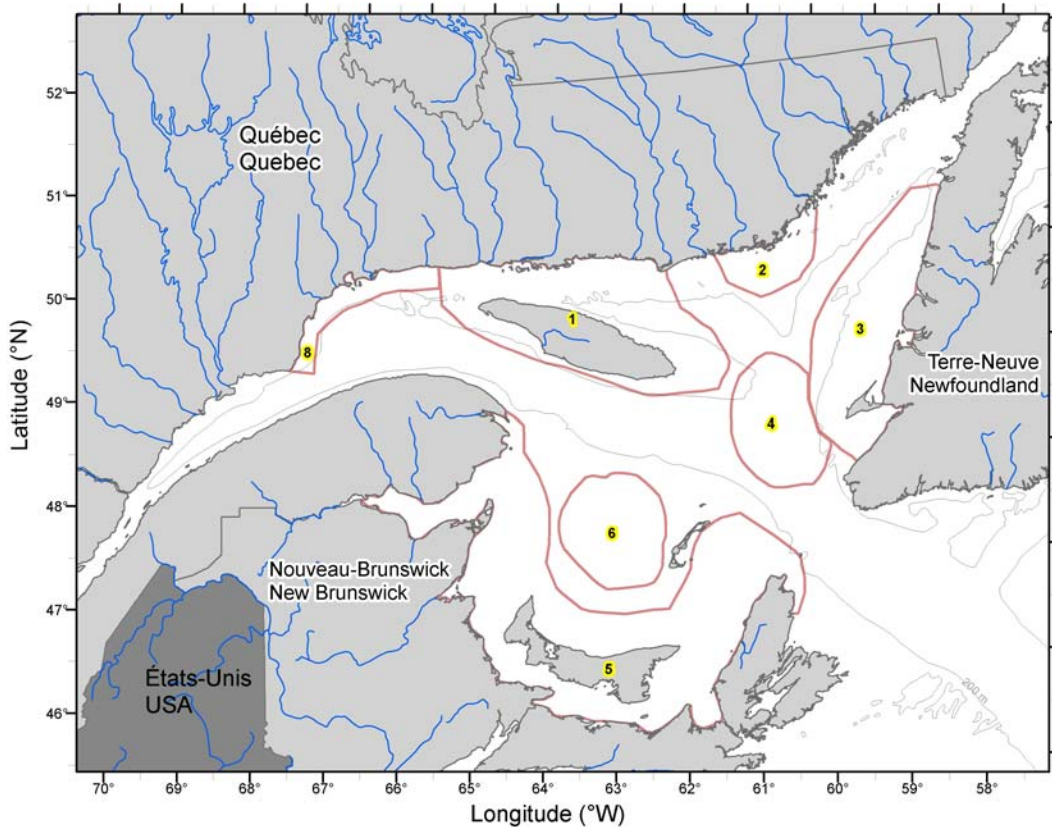


Figure 2. Illustration of seven of the eight (excluding the Estuary) ecologically and biologically significant areas revealed by the analyses in the meroplankton.

Concentration: The area is notable for the number of species of eggs and larvae (fish and crustacean decapods) present and thus for the number of species using the area for spawning and reproduction.

Adaptive value: The observation of abundant concentrations of fish eggs, specifically cod and winter flounder eggs, and the high concentrations of sand lance and Arctic shanny larvae emphasize the area's importance for several components of the ecosystem. The presence of Greenland halibut larvae at the eastern boundary of the area is of particular interest because we still know very little about this species' spawning grounds in the Gulf ecosystem.

Resiliency: The area's definition is based on analysis of data from 1985 to 1987. However, sampling in 2005 appears to confirm that the area is still important for many fish and crustacean species.

Natural characteristics: To date, this area of the Gulf does not appear to have been affected by human activity other than commercial fishing operations.

For all these characteristics, the area receives a rating of 13 points.¹

¹ See Appendix 1 for an explanation of the assignment of ratings.

2- Beaugé Bank area

The area's boundaries delineate a bathymetric structure (Beaugé Bank) between the Anticosti Channel and the Esquiman Channel (Figure 2).

Description: Beaugé Bank lies offshore from a shallow point (~80 m) extending out from Quebec's North Shore (~60° N), marking the separation into the Anticosti and Esquiman Channels. The influence of incoming currents from Belle Isle is probably significant, at least near the shore, in defining the area's physical characteristics.

Unicity: Few samples have been taken from the area but a large number of species and high egg and larvae concentrations for some fish and crustacean decapod species were observed from 1985 to 1987. The presence of redfish larvae was noted in the spring of 1987 (Maps C1, C5, C8, C11).

Concentration: The presence of several species of eggs and larvae was noted, especially an abundance of cod (CHW) and winter flounder eggs. Concentrations of crustacean decapod larvae (unidentified) were observed in June 1986.

Adaptive value: The eggs and larvae of several species have been observed in the area, indicating that the sector may be important for these stocks/populations.

Resiliency: Sampling of the area was only conducted in June 1986 and May 1987 so there are no more recent data to justify the area's boundaries.

Natural characteristics: To date, this area of the Gulf does not appear to have been affected by human activity other than commercial fishing operations.

For all these characteristics, the area receives a rating of 11 points.

3- Newfoundland West Coast area

The area includes Bay St. George and most of Newfoundland's west coast, extending from the shore out to the deep water of the Esquiman Channel (Figure 2).

Description: The entire continental shelf on the west coast of Newfoundland and the eastern slope of the Esquiman Channel. The area therefore includes a shallow inshore sector, a steep continental slope and the deep waters of the Esquiman Channel. The area is influenced by (surface) currents entering through the Cabot Strait.

Unicity: The area is important for spawning of the current northern Gulf cod stock (Map C9). In the inshore sector north of the Port au Port Peninsula, a recent study showed the presence in summer (July) of high concentrations of capelin and herring larvae as well as a diversified community of fish eggs and larvae comparable to that observed for other areas of the Gulf (Grégoire *et al.*, 2006).

Concentration: The area's highlight is the high concentration of cod eggs observed early in the spring in the Esquiman Channel (Maps C2, C7). The wealth of fish larvae species observed in the inshore area is also noted.

Adaptive value: Since 1993, this area has been recognized as the main site for the start of spawning by northern Gulf cod, returning to the Gulf from wintering grounds.

Resiliency: The persistence of cod eggs since the work of the mid-1990s is noted.

Natural characteristics: To date, this area of the Gulf does not appear to have been affected by human activity other than commercial fishing operations.

For all these characteristics, the area receives a rating of 12 points.

4- Central Gulf area (Figure 2)

Description: This is a deep area in the Laurentian Channel at the junction of the Anticosti and Esquiman Channels, perhaps influenced by semi-permanent giratory circulation.

Unicity: Appears to be the main area for emergence of redfish larvae in the northern Gulf (Map C11).

Concentration: The abundance of redfish and Greenland halibut larvae has been observed in the area in June (Map C12).

Adaptive value: Appears to be the main area for the emergence of redfish larvae in the northern Gulf.

Resiliency: The abundance of redfish larvae in the area has been observed on several occasions but no new sampling has been conducted since 2000.

Natural characteristics: To date, this area of the Gulf does not appear to have been affected by human activity other than commercial fishing operations.

For all these characteristics, the area receives a rating of 12 points.

5- Southern Gulf area

The area is defined approximately by a line extending from the Gaspé Peninsula (Cape Gaspé), running south, passing to the west of the Orphan Bank (including Chaleur Bay), to the south of the Bradelle Bank offshore from Prince Edward Island, and returning northeast to the Magdalen Islands Plateau before turning southeast to include the northeastern tip of Cape Breton Island (Figure 2).

Description: This is primarily a shallow inshore area (~< 60 m). The area is influenced by the "inshore" branch of the St. Lawrence Estuary flow as well as local hydrology (e.g. Miramichi River).

Unicity: The area has a great wealth of fish larvae (Maps C18 and C19) and crustacean decapod species and a great abundance of fish eggs and larvae (Maps C20 to C23), including cod, winter flounder, American plaice, yellowtail flounder, etc. The western sector appears to be the main spawning ground for mackerel and, historically, for southern Gulf cod (Maps C28 to C31). The area's southwestern sector is notable for the total abundance of fish eggs, the presence of mackerel and yellowtail flounder larvae (Maps C33 and C34), as well as middle trophic species such as radiated shanny and cunner (Maps C35 to C37). Witch eggs have been harvested in the eastern area offshore from Cape Breton Island (Map C38).

Concentration: The area has the greatest wealth of egg and larvae species as well as the greatest abundance of eggs and larvae of various species, compared with all areas identified in the Gulf. The southern sector (offshore from Prince Edward Island) appears to be the yellowtail flounder spawning ground for the southern Gulf. Recently, cod and sand lance larvae have been present in the eastern area off Cape Breton Island's northern shore.

Adaptive value: The area includes the main spawning ground of the Canadian mackerel population. The abundance of various fish egg and larvae species demonstrates the area's importance for the persistence of many components of the Gulf ecosystem. The southern sector (offshore from Prince Edward Island) appears to be the spawning ground for yellowtail flounder in the southern Gulf. Witch larvae appear to be present only off northern Cape Breton Island.

Resiliency: Despite changes between years in the pattern of distribution within the area and in the abundance of some taxonomic groups, the general pattern has been stable since 1982.

Natural characteristics: To date, this area of the Gulf does not appear to have been affected by human activity other than commercial fishing operations.

For all these characteristics, the area receives a rating of 13 points.

6- Central area (Southern Gulf) (Figure 2)

Description: The southern Gulf area northwest of the Magdalen Islands, including structures such as the Bradelle Bank.

Unicity: The only sector where high concentrations of snow crab larvae are regularly observed (Maps C39 and C40). The abundance of American plaice eggs is also noted (Map C32).

Concentration: There is an abundance of snow crab larvae, as well as winter flounder, American plaice and mackerel eggs. The presence of American plaice and mackerel larvae is also noted.

Adaptive value: Data analysis reveals that this location has the highest concentration of snow crab larvae in the southern Gulf. It also has winter flounder eggs, mackerel larvae and, historically, has had cod larvae.

Resiliency: Snow crab larvae concentrations are recurring.

Natural characteristics: To date, this area of the Gulf does not appear to have been affected by human activity other than commercial fishing operations.

For all these characteristics, the area receives a rating of 11 points.

7- Estuary and Gaspé Current area (Figure 3)

Description: West of Pointe des Monts to the maximum turbidity zone in the Upper Estuary, including the Gaspé Current on the north shore of the Gaspé Peninsula.

The current practice is to recognize two main areas in the St. Lawrence Estuary: (1) the Upper Estuary, from Île d'Orléans to the mouth of the Saguenay River, and (2) the Lower Estuary, from the Saguenay to Pointe des Monts. The Upper Estuary contains a maximum turbidity zone (MTZ) located approximately between Cap Tourmente and Île aux Coudres.

The greatest abundance of fish larvae has been reported in the Upper Estuary (Able, 1978). Concentrations of American smelt (*Osmerus mordax*), Atlantic tomcod (*Microgadus tomcod*) and white perch (*Morone americana*) are present in the MTZ (Dodson *et al.* 1989). Powles *et al.* (1984) studied the abundance of fish larvae in the depth gradient between the shore and the deep water offshore at nine stations in the Upper Estuary between Islet-sur-Mer and Pointe-au-Père. They observed the greatest abundance of fish larvae at the shallow stations near the shore. Herring larvae were abundant in the area of Notre-Dame-du-Portage, American smelt larvae dominated in the area of Islet-sur-Mer while capelin larvae became more abundant toward the Lower Estuary. The stations located near the south shore were also notable for the presence of brackish or fresh water species (*Catostomus* spp., white perch, *Cottus* spp., yellow perch *Perca falvenscens*, *Gasterosteus* spp.). Offshore, smooth flounder (*Liopsetta putnami*) and winter flounder larvae were found (Powles *et al.* 1984).

The Gaspé Current is included in the St. Lawrence Lower Estuary area (Figure 3). Able (1978) and De Lafontaine *et al.* (1981, 1991) describe a community of fish larvae similar to that in the northern and southern Gulf. However, snailfish larvae (*Liparis* spp.) are present primarily in the Lower Estuary (De Lafontaine *et al.* 1981). In spring, sand lance larvae dominate with sculpin (*Myoxocephalus* spp.), prickleback, and Arctic shanny larvae. Capelin larvae are abundant in inshore areas with depths of less than 200 m and, with fourbeard rockling larvae, are abundant in the Gaspé Current (De Lafontaine *et al.* 1981, 1984, 1991).

For all these characteristics, the area receives a rating of 9 points.

8- Quebec North Shore area (Figure 2)

Description: Area next to the northwestern Gulf gyre along Quebec's North Shore. An important physical characteristic is the upwelling phenomenon on the northwestern shore of the Gulf and the influence of fresh water flows is also noted (e.g. Sainte-Marguerite River).

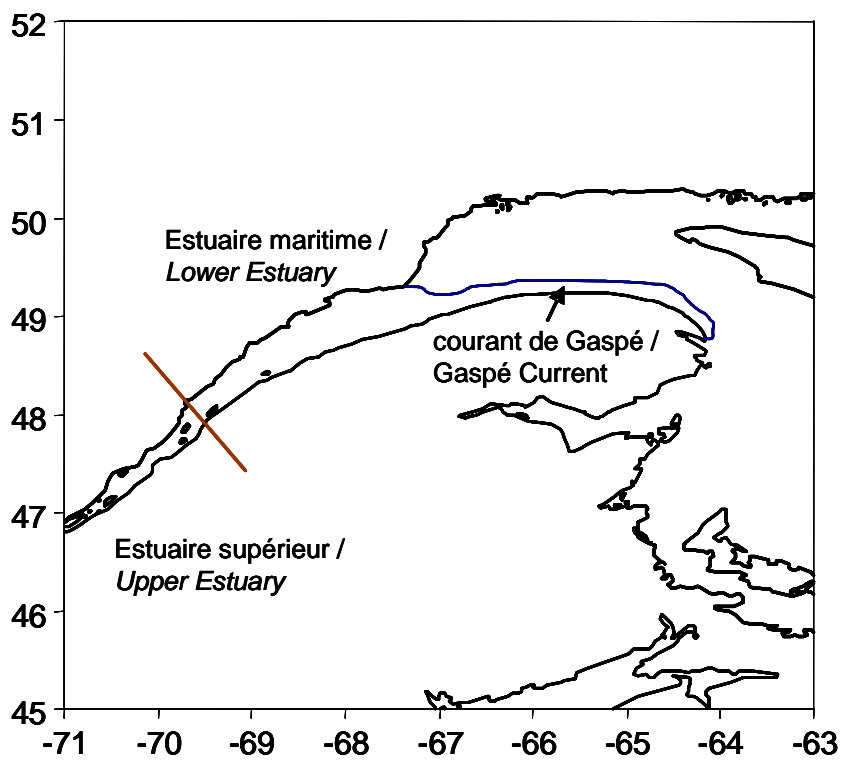


Figure 3. Map of the St. Lawrence Estuary showing the two distinct regions as indicated by the presence of different fish larvae community.

Unicity: This is an important area of northern shrimp larvae concentration in the spring (Map C16).

Concentration: The abundance of crustacean decapod larvae (including snow crab) and sand lance larvae is noted. There is also a fairly high number of fish larvae species.

Adaptive value: This is an important area for the emergence and development of northern shrimp larvae in the northwestern Gulf.

Resiliency: The northern shrimp larvae distribution pattern is recurring.

Natural characteristics: To date, this area of the Gulf does not appear to have been affected by human activity other than commercial fishing operations.

For all these characteristics, the area receives a rating of 10 points.

CONCLUSION

Objective analysis of historical data on the distribution of fish and crustacean decapod eggs and larvae completes a prior description of potentially significant areas obtained through consultation with experts (DFO, 2006). As in the first exercise, the sectors around Anticosti Island, on the west coast of Newfoundland, in the southern Gulf, etc. have been identified as potential EBSA but objective analysis of the data provided greater accuracy in the delimitation and especially the nature of these areas. However, there are also many shortcomings in the objective analysis that require careful consideration of the conclusions presented in this report.

- To correctly assess the proposed ecologically and biologically significant areas, we must realize that the poor spatial resolution of the sampling (necessary to cover large areas of the Gulf) can only provide a fairly rough image of species egg and larvae distribution. The proposed boundaries therefore are only approximate.
- We must also realize that the data used are limited to a single period of the year and, with the exception of the southern Gulf, there has been no recent systematic sampling of ichthyoplankton in most sectors of the Gulf of St. Lawrence and Estuary. The pattern described therefore essentially represents the past status of the system, and the current situation may differ in some areas.
- Finally, the data used (and available) do not support the identification of zones for shallow inshore areas. In the southern Gulf, for example, there are large concentrations of lobster larvae near the Magdalen Islands, along the shores of Prince Edward Island, Chaleur Bay, etc. Special habitats such as major estuaries (e.g. the Miramichi estuary, Locke and Courtenay, 1995) at various locations in the Gulf system also have not been considered.

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I wish to acknowledge the contributions of F. Grégoire (fish larvae community on the west coast of Newfoundland), M. Harvey (crustacean decapod larvae in the southern Gulf) and Jacques Plourde (redfish larvae and fish larvae community in the central Gulf) to the work of identifying ecologically and biologically significant areas in the Gulf of St. Lawrence.

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APPENDIX 1

Summary table: Ecologically and biologically significant areas based on fish and crustacean decapod egg and larvae abundance and on “spawning/reproduction” function as well as the “presence of highly diversified or productive communities” biodiversity characteristic.

The importance of each area is assessed against three main dimensions—unicity, concentration, and the consequences on adaptive value—and two secondary dimensions—resiliency and natural characteristics (see DFO, 2004). For each area, a rating of 1 (minimum) to 3 (maximum) was assigned for each dimension based on an assessment of the relative importance of the observations available.

Zone	Description / characteristics	Unicity		Concentration		Consequence on adaptive value (fish and crustacean decapod species)		Resiliency		Natural characteristics (sensitive to disruption)		
		Description	Wt	Description	Wt	Description	Wt	Description	Wt	Description	Wt	Total
1- Anticosti Island area	The possibility of upwelling at the head of the Anticosti Channel, the presence of fronts and of tidal mixing in the Jacques Cartier Passage create a potentially important area of primary production while contributing to meroplankton retention. The surface layer circulation pattern could extend the production area's influence over the island's north shore all the way to the eastern point. On the southwest coast, the specific hydrodynamics in Honguedo Strait (Gaspé Current, northwestern gyre, etc.) could favour egg and larvae retention.	Remarkable for the wealth of fish and crustacean decapod species larvae and the abundance of fish and crustacean decapod eggs and larvae (especially in the Jacques Cartier Passage sector). Greenland halibut larvae have been harvested at the area's eastern boundary in 2005, a first for the northern Gulf.	3	Area notable for the number of egg and larvae species (fish and crustacean decapods) and thus for the number of species using the area for spawning or reproduction	3	The observation of abundant concentrations of fish eggs, specifically cod and winter flounder eggs, and high concentrations of sand lance and Arctic shanny larvae highlight the area's importance for several components of the ecosystem. The presence of Greenland halibut larvae at the eastern boundary is of particular interest because we still know very little about spawning grounds for this species in the Gulf ecosystem.	3	The area's definition is based on analysis of data from 1985 to 1987. However, sampling in 2005 appears to confirm that the area is still important for many fish and crustacean species.	1	To date, this area of the Gulf does not appear to have been affected by human activity other than commercial fishing operations.	3	13

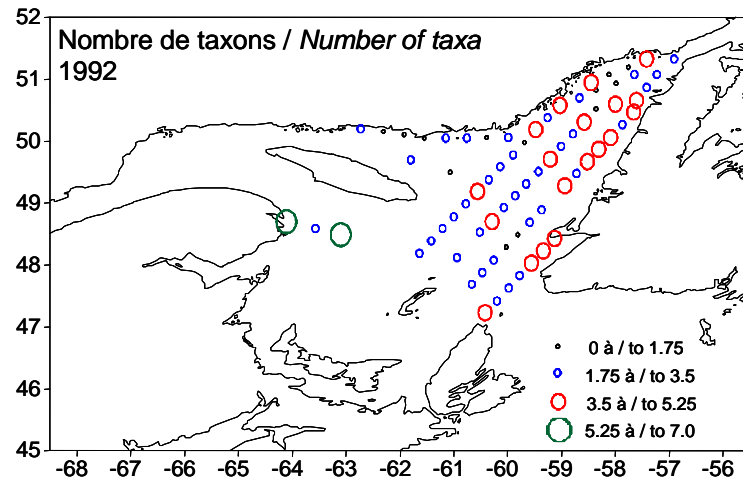
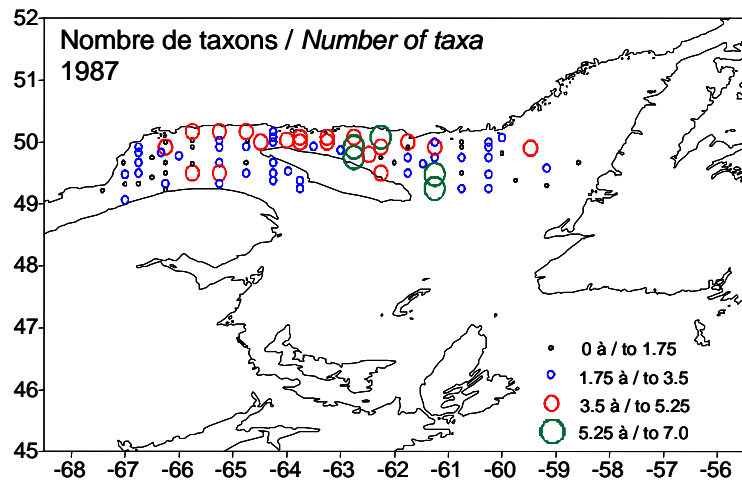
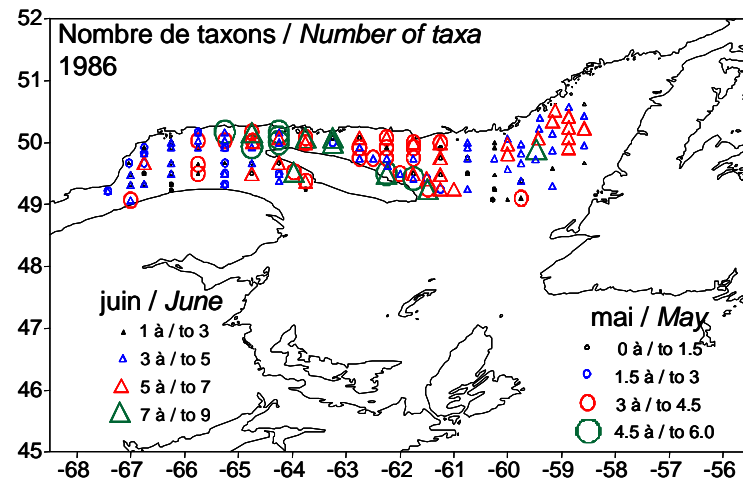
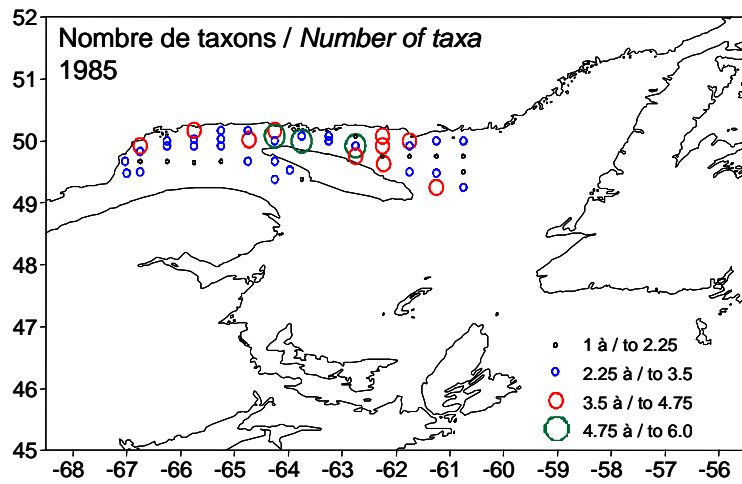
Zone	Description / characteristics	Unicity		Concentration		Consequence on adaptive value (fish and crustacean decapod species)		Resiliency		Natural characteristics (sensitive to disruption)		Total
		Description	Wt	Description	Wt	Description	Wt	Description	Wt	Description	Wt	
2- Beaugé Bank area	Shallow point (~80 m) extending out from Quebec's North Shore (~60° N) and marking the dividing point between the Anticosti and Esquiman Channels. The influence of incoming currents from Belle Isle is probably significant in defining the area's physical characteristics.	A large number of species and high concentrations of fish and crustacean decapod eggs and larvae were observed between 1985 and 1987. The presence of redfish larvae was noted in the spring of 1987.	2	Presence of eggs and larvae of several species, especially an abundance of cod (CHW) and winter flounder eggs. Concentrations of crustacean decapod larvae (unidentified) have been observed (June 1986).	2	Eggs and larvae of several species have been observed in the area.	2	The area was only sampled in June 1986 and May 1987.	2	To date, this area of the Gulf does not appear to have been affected by human activity other than commercial fishing operations.	3	11
3- Newfoundland West Coast area	The entire continental shelf on Newfoundland's west coast and the eastern slope of the Esquiman Channel. The area is influenced by incoming currents from the Cabot Strait.	Important area for spawning of the current cod stock in the northern Gulf. Abundance of capelin and herring larvae in the inshore area north of the Port au Port Peninsula.	3	High concentrations of cod eggs in the spring. Wealth of fish larvae species on Newfoundland's west coast.	3	Since 1993, this area has been recognized as the main site for the start of spawning by cod returning to the Gulf from wintering grounds.	2	Persistence of spawning by cod from the northern Gulf observed since the work in the mid-1990s.	1	To date, this area of the Gulf does not appear to have been affected by human activity other than commercial fishing operations.	3	12
4- Central Gulf area	Deep area of the Laurentian Channel at the junction of the Anticosti and Esquiman Channels, perhaps influenced by semi-permanent giratory circulation.	Main area for the emergence of redfish larvae in the northern Gulf	3	The abundance of redfish larvae has been observed in the area in June.	2	Appears to be the main area for the emergence of redfish larvae in the northern Gulf.	2	The abundance of redfish larvae in the area has been observed on several occasions but there has been no new sampling since 2000.	2	To date, this area of the Gulf does not appear to have been affected by human activity other than commercial fishing operations.	3	12

Zone	Description / characteristics	Unicity		Concentration		Consequence on adaptive value (fish and crustacean decapod species)		Resiliency		Natural characteristics (sensitive to disruption)		
		Description	Wt	Description	Wt	Description	Wt	Description	Wt	Description	Wt	Total
5-Southern Gulf area	Primarily a shallow, inshore area (~< 60 m). The area is influenced by the inshore branch of the St. Lawrence Estuary flow and by the local hydrology (e.g. Miramichi River).	Great wealth of fish and crustacean decapod larvae species and great abundance of fish eggs and larvae, including cod, winter flounder, American plaice, yellowtail flounder, etc. The western sector appears to be the main spawning ground for Atlantic mackerel and, historically, for cod from the southern Gulf. The southern sector (offshore from Prince Edward Island) appears to be the spawning ground for yellowtail flounder in the southern Gulf.	3	Has the greatest wealth of egg and larvae species, as well as the greatest abundance of eggs and larvae of various species of all the areas identified for the Gulf.	3	Includes the main spawning ground of the Canadian population of Atlantic mackerel. The abundance of various fish egg and larvae species shows the area's importance for the persistence of many components of the Gulf ecosystem. The southern sector (offshore from Prince Edward Island) appears to be the spawning ground for yellowtail flounder in the southern Gulf. Witch larvae appear to be present only off northern Cape Breton Island.	3	Despite changes between years in the distribution pattern within the area and the abundance of some taxonomic groups, the general pattern has been stable since 1982.	1	To date, this area of the Gulf does not appear to have been affected by human activity other than commercial fishing operations.	3	13
6-Central area (southern Gulf)	The southern Gulf area northwest of the Magdalen Islands, including structures such as the Bradelle Bank	High concentrations of snow crab larvae are regularly observed. The abundance of American plaice eggs is also noted.	2	Abundance of snow crab larvae. Abundance of winter flounder, American plaice and mackerel eggs. Presence of American plaice and mackerel larvae.	2	The location of concentrations of snow crab larvae in the southern Gulf. The area also has winter flounder eggs, mackerel larvae and, historically, cod larvae	2	Concentrations of snow crab larvae are recurring.	1	To date, this area of the Gulf does not appear to have been affected by human activity other than commercial fishing operations.	3	11

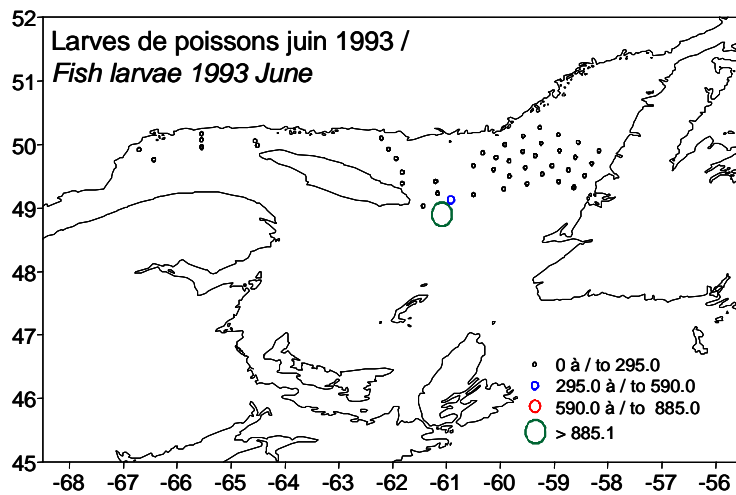
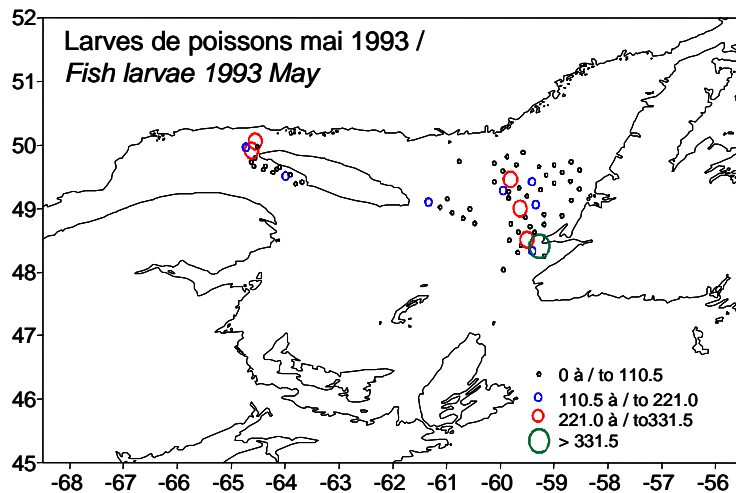
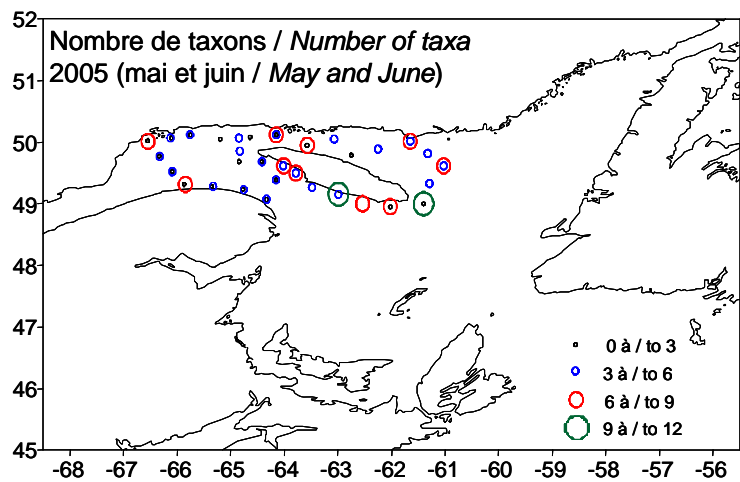
Zone	Description / characteristics	Unicity		Concentration		Consequence on adaptive value (fish and crustacean decapod species)		Resiliency		Natural characteristics (sensitive to disruption)		Total
		Description	Wt	Description	Wt	Description	Wt	Description	Wt	Description	Wt	
7-Estuary and Gaspé Current area	West of Pointe des Monts to the maximum turbidity zone in the Upper Estuary, including the Gaspé Current on the north shore of the Gaspé Peninsula	Concentrations of American smelt, Atlantic tomcod and white perch larvae are present in the maximum turbidity zone (MTZ).	2	The greatest abundance of fish larvae has been reported in the Upper Estuary. Greater abundance of fish larvae at shallow inshore stations (south shore)	2	Concentrations of American smelt larvae, Atlantic tomcod and white perch larvae present in the MTZ	2	There has been no recent systematic sampling of fish eggs and larvae in the St. Lawrence Estuary.	2	Influenced by fresh water fluctuations / flow controls. Farm land drainage. Industrial areas in some sectors of the North and South Shores	1	9
8-Quebec North Shore area	Area adjacent to the northwestern Gulf gyre along Quebec's North Shore. One characteristic is the upwelling phenomenon on the Gulf's northwestern shore and the influence of fresh water flows.	Important area of concentration of northern shrimp larvae in spring	2	Abundance of crustacean decapod larvae (including snow crab) and sand lance larvae. There are also a fairly large number of fish species larvae.	2	Important area for the emergence and development of northern shrimp larvae in the northwestern Gulf.	2	Recurring pattern	1	To date, this area of the Gulf does not appear to have been affected by human activity other than commercial fishing operations. Industrial area in the Sept-Îles area.	3	10

APPENDIX 2

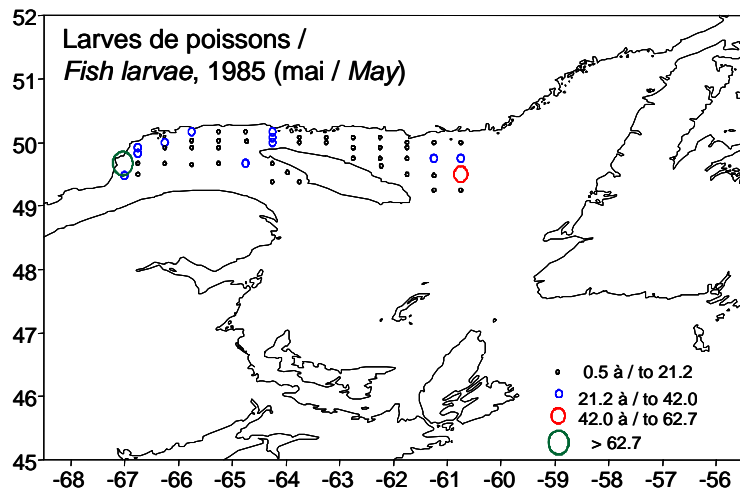
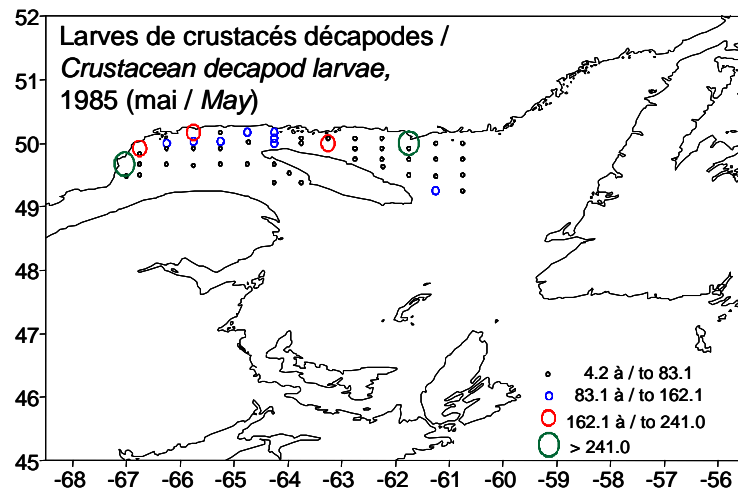
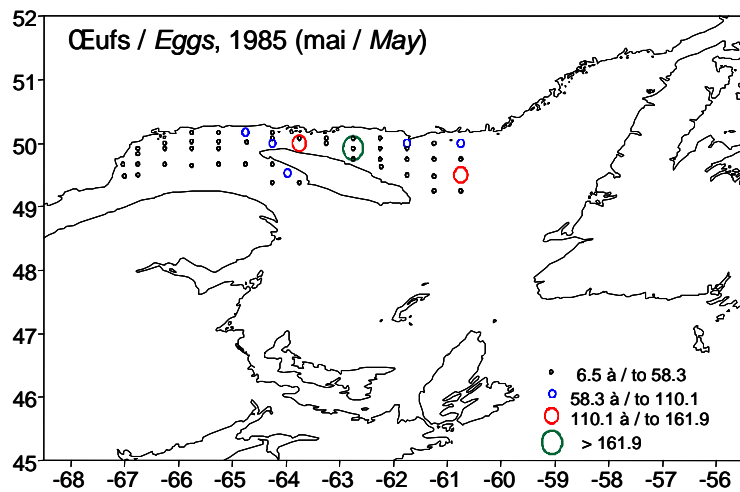
C1- C42: Maps of fish and crustacean decapod egg and larvae distribution in the Gulf of St. Lawrence



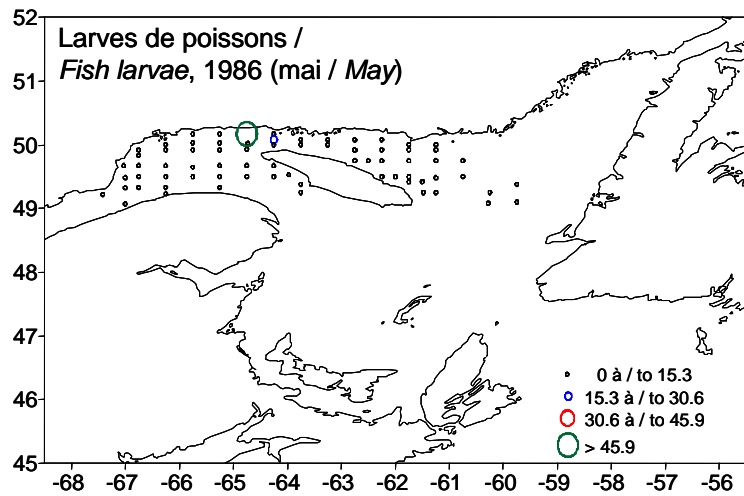
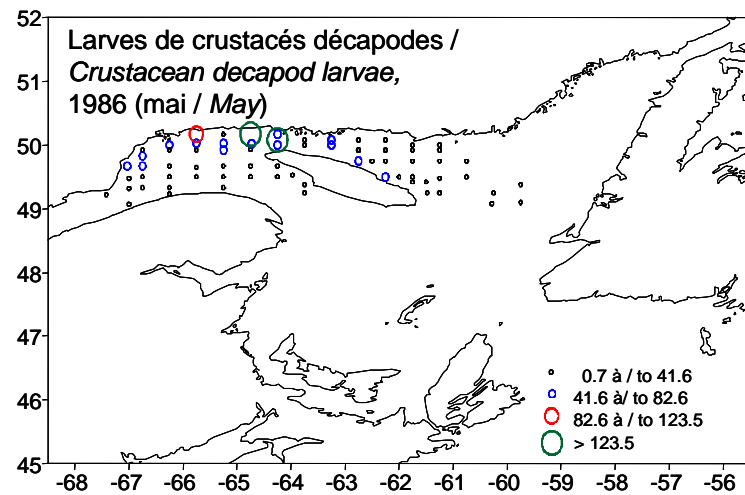
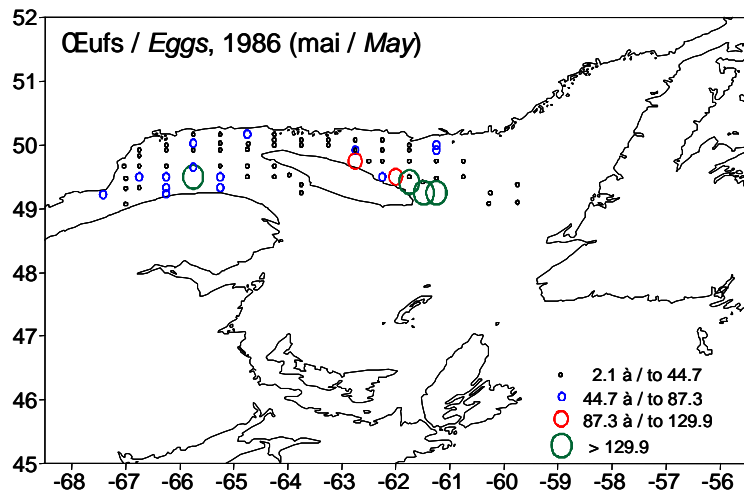
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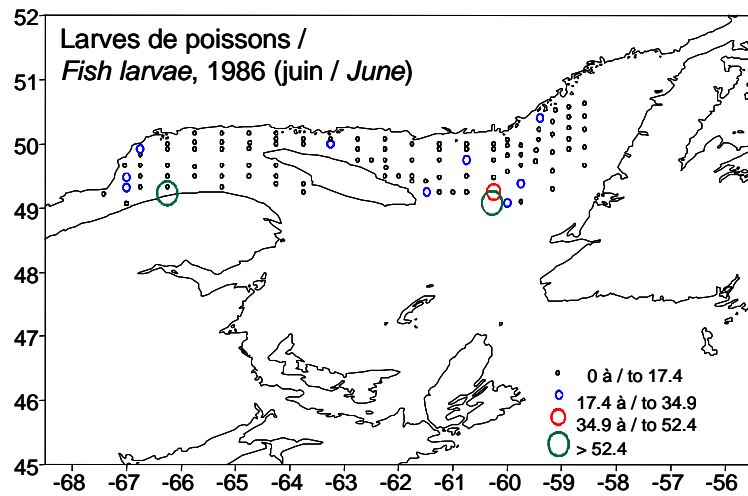
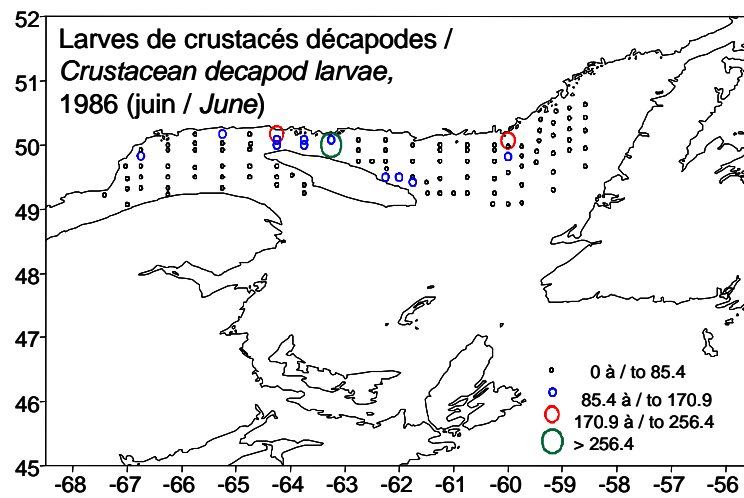
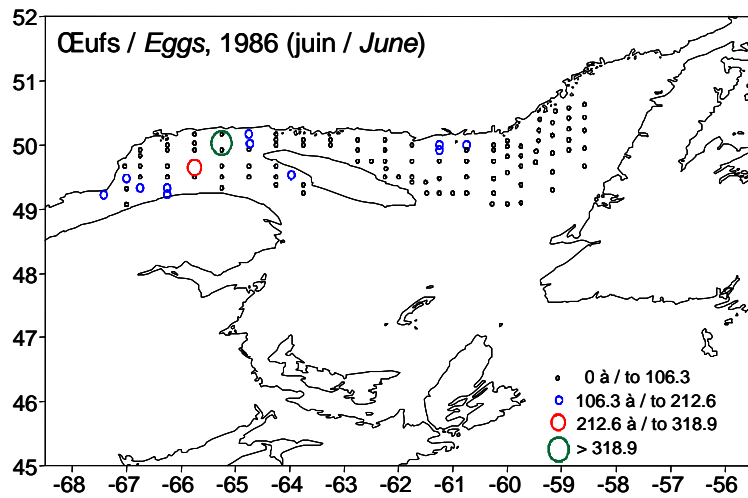
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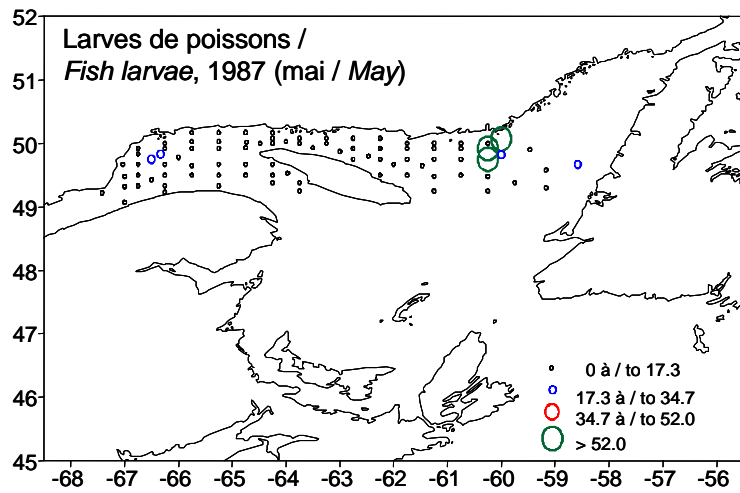
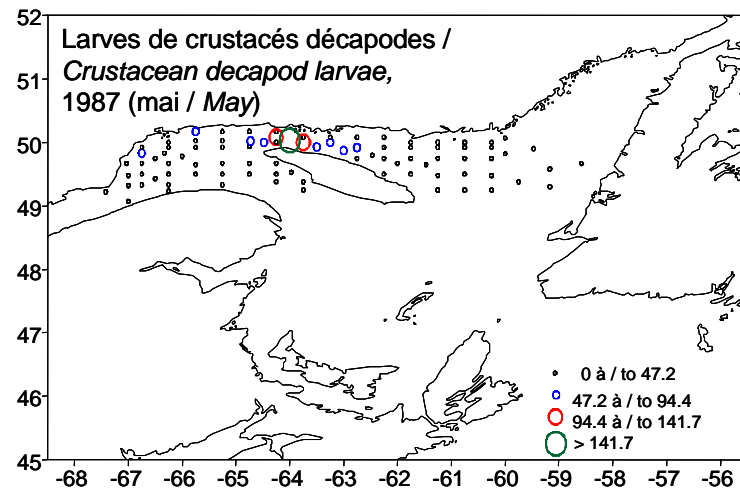
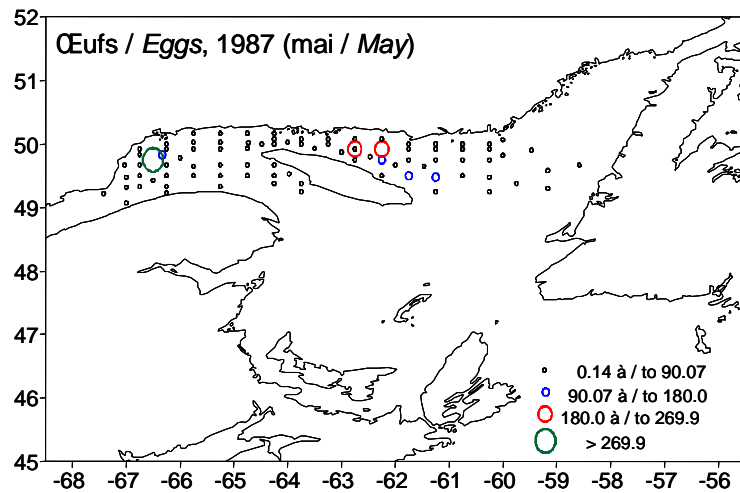
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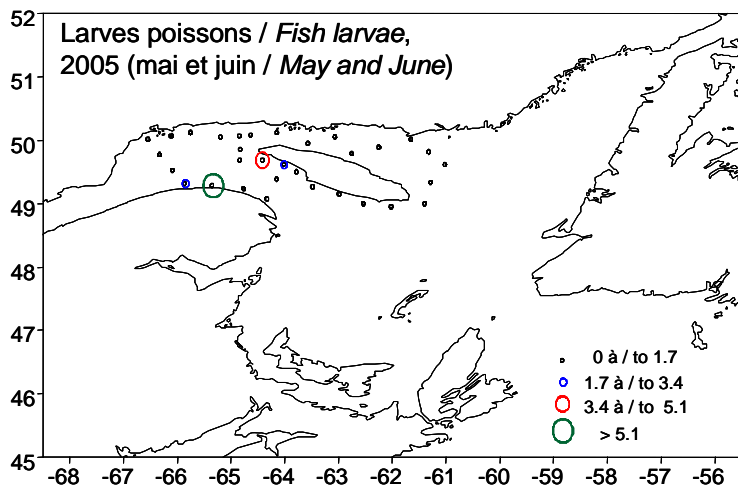
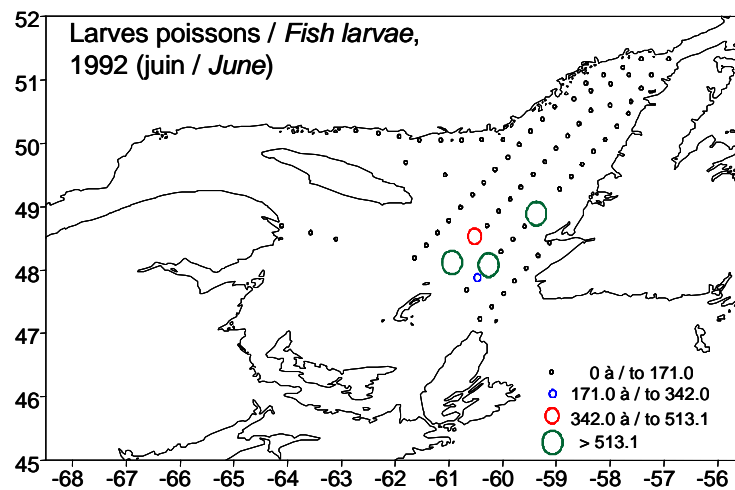
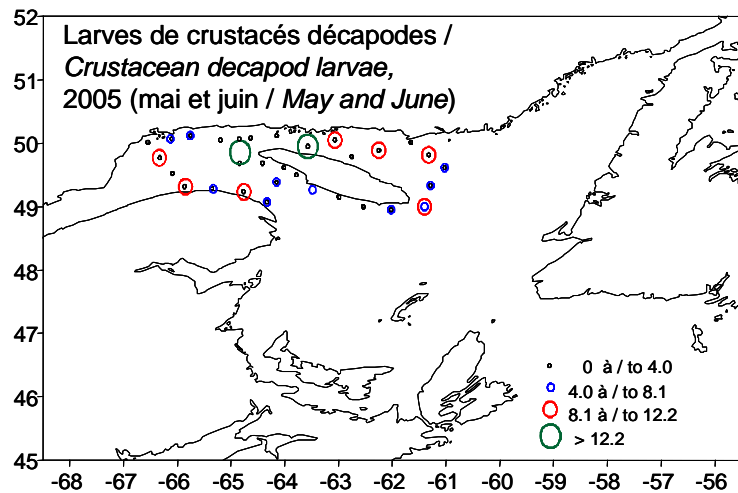
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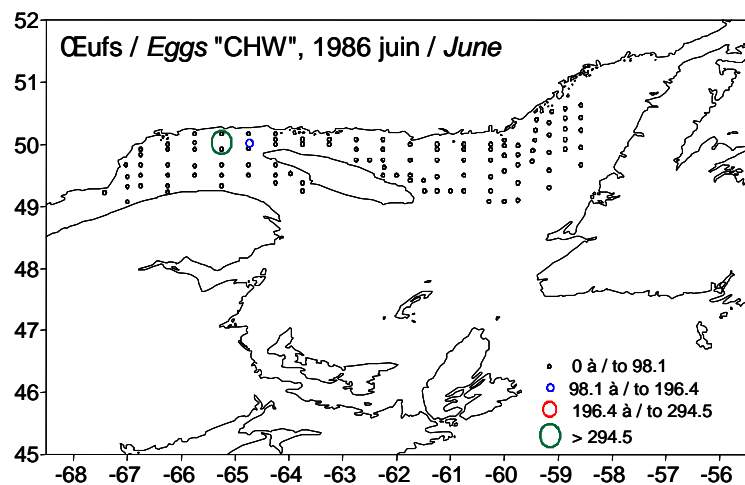
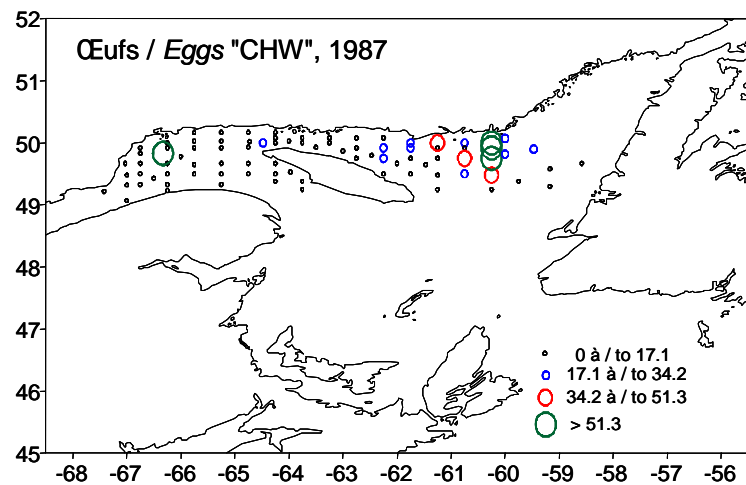
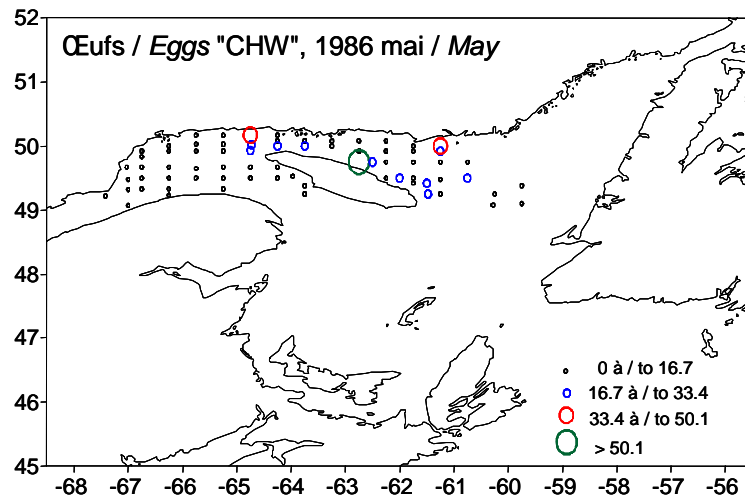
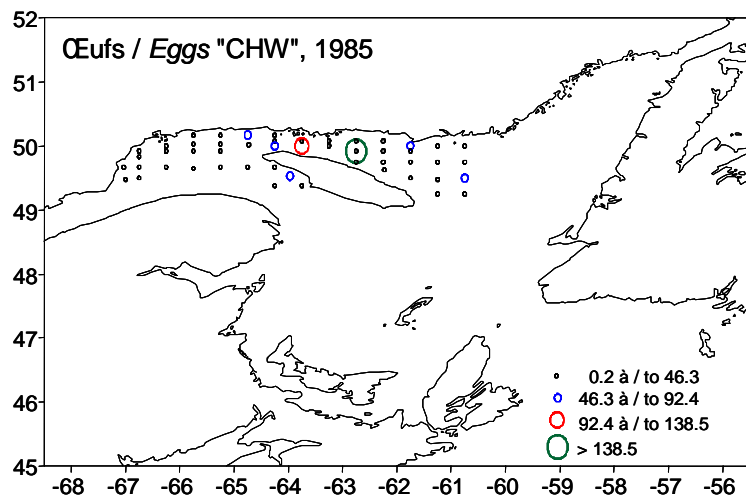
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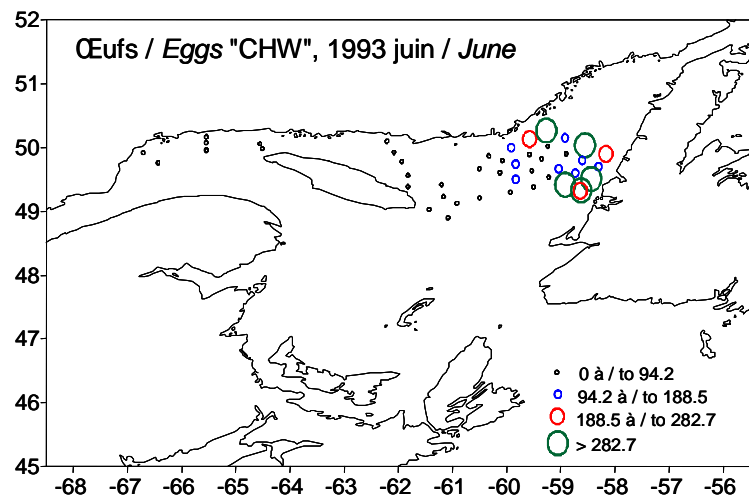
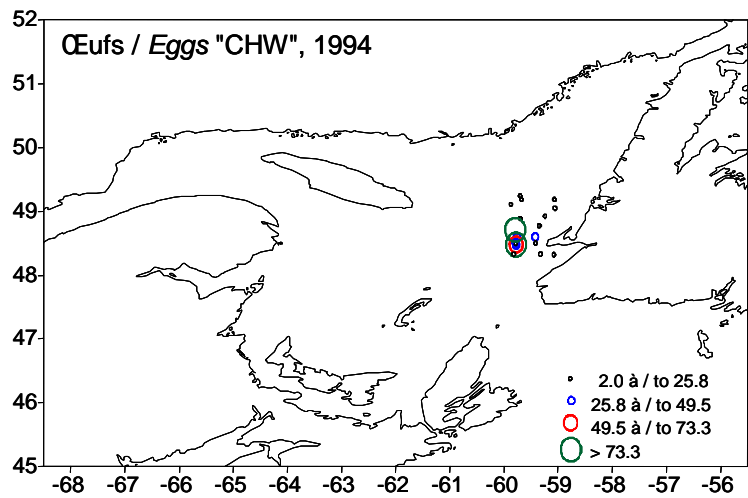
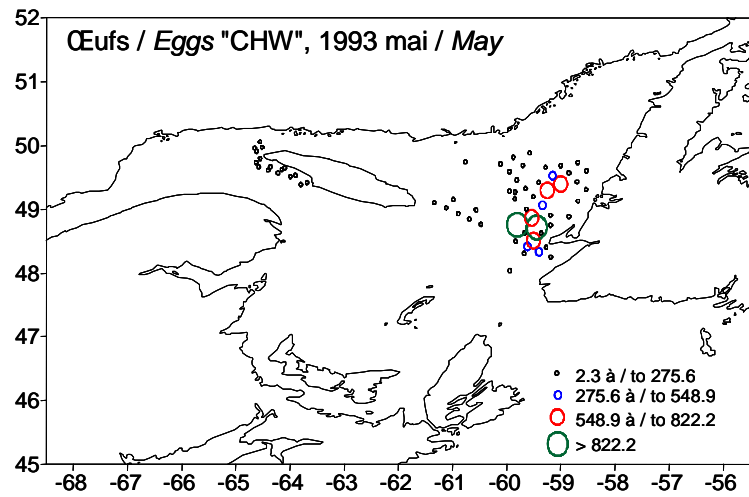
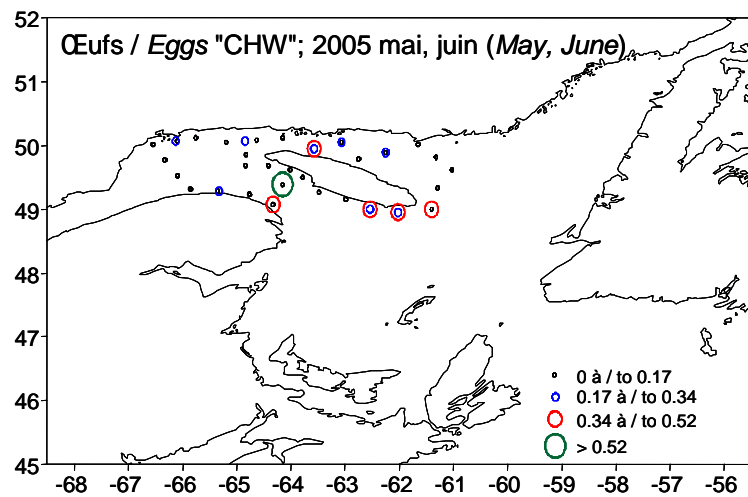
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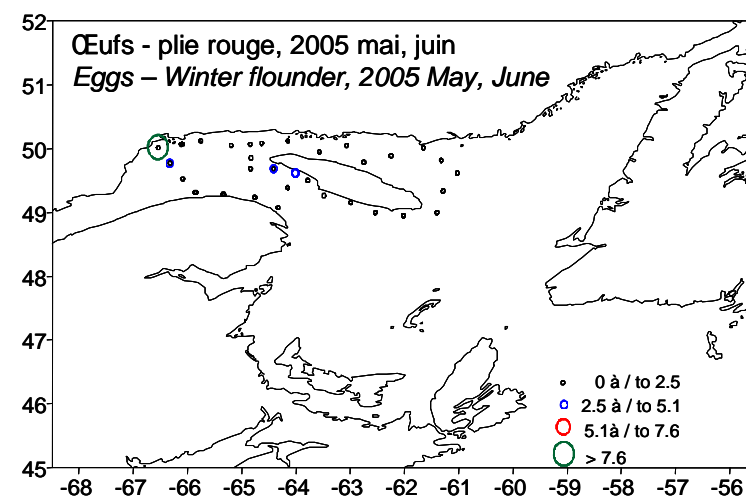
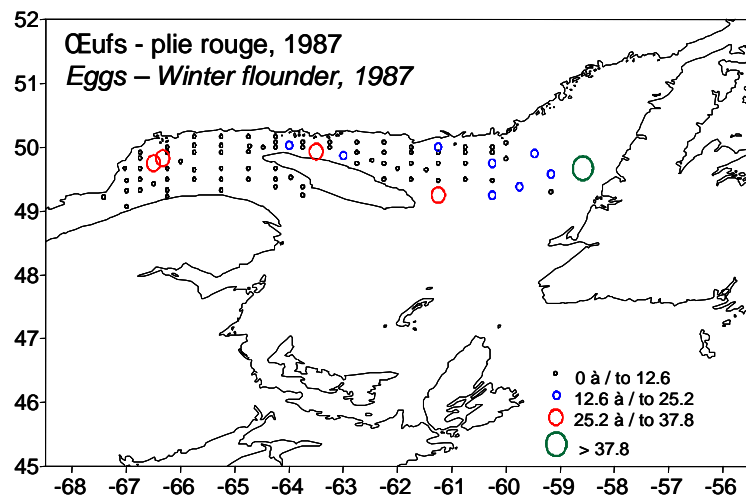
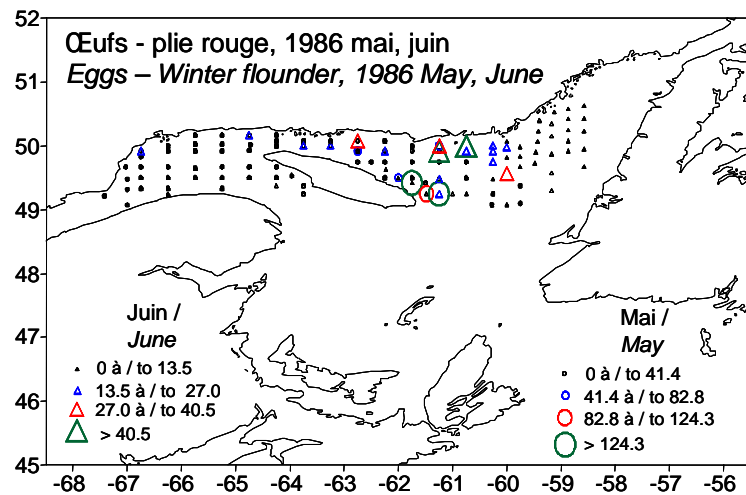
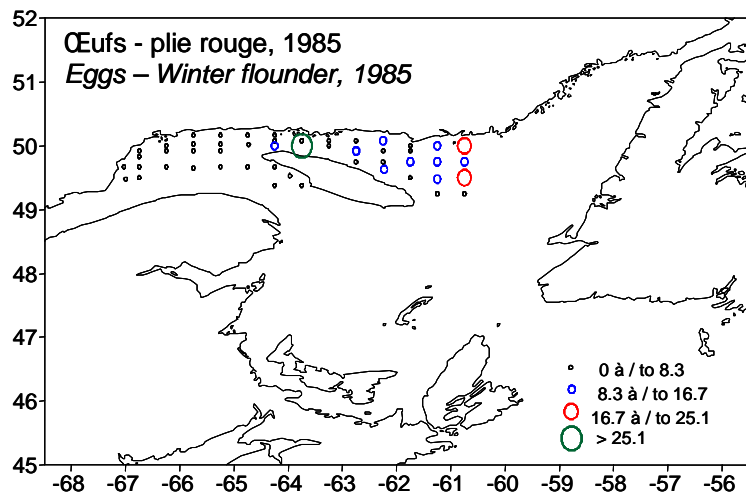
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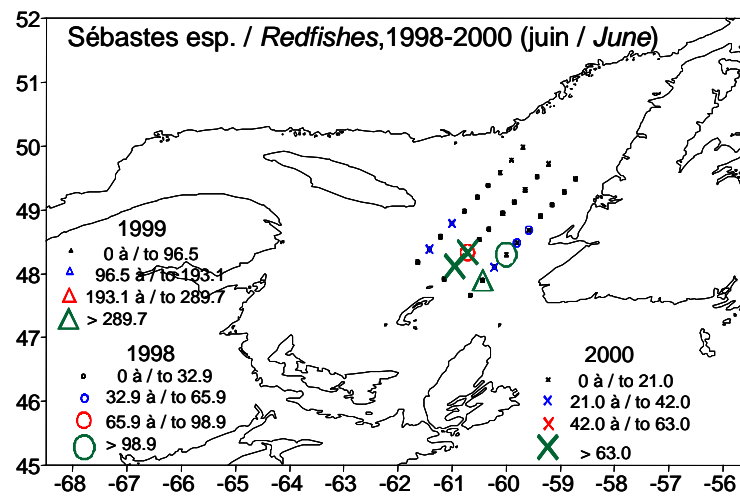
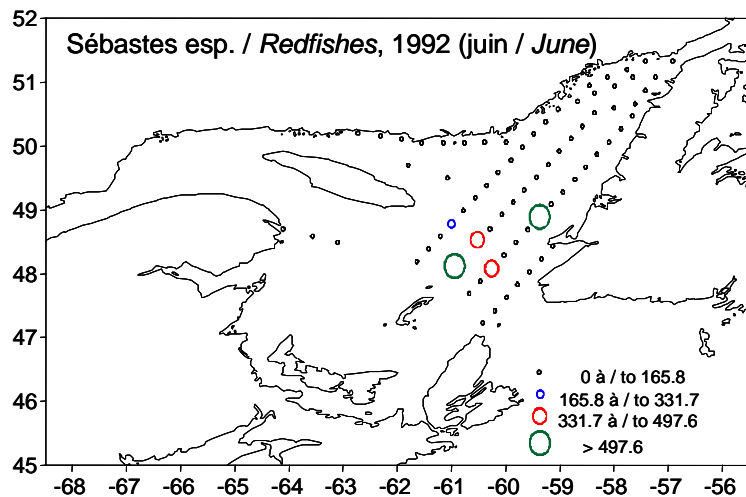
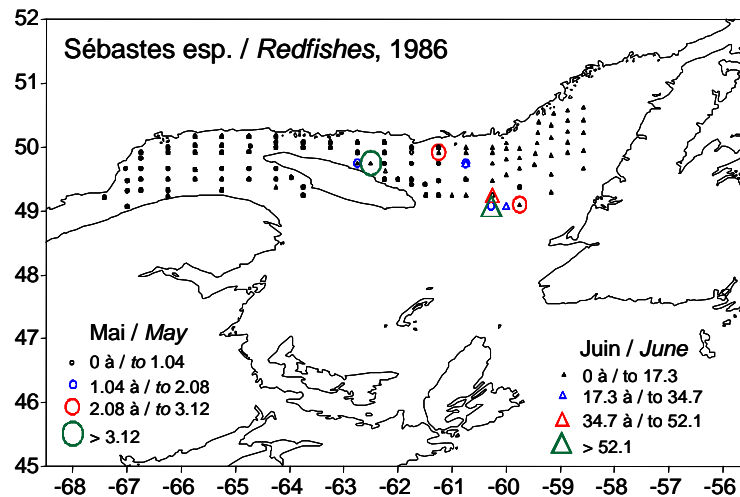
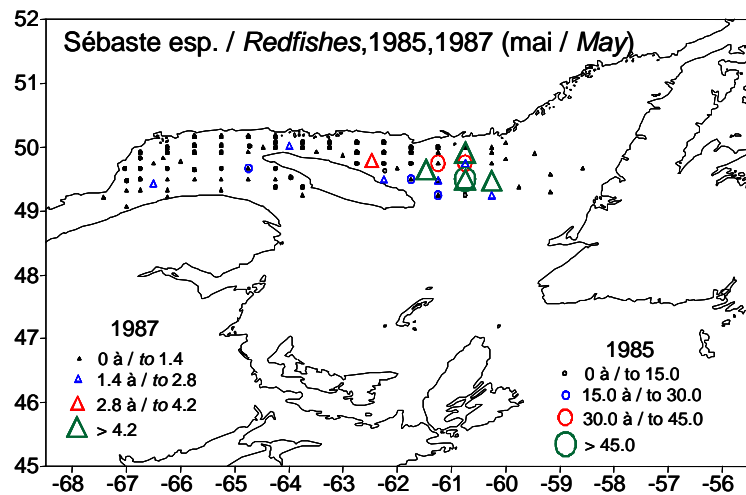
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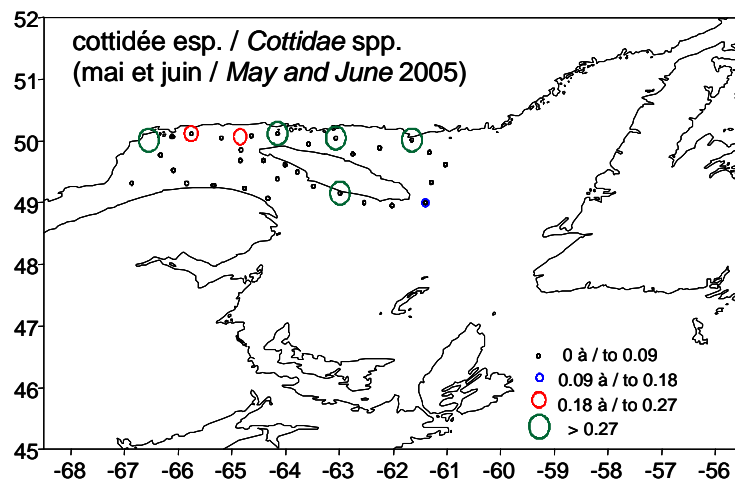
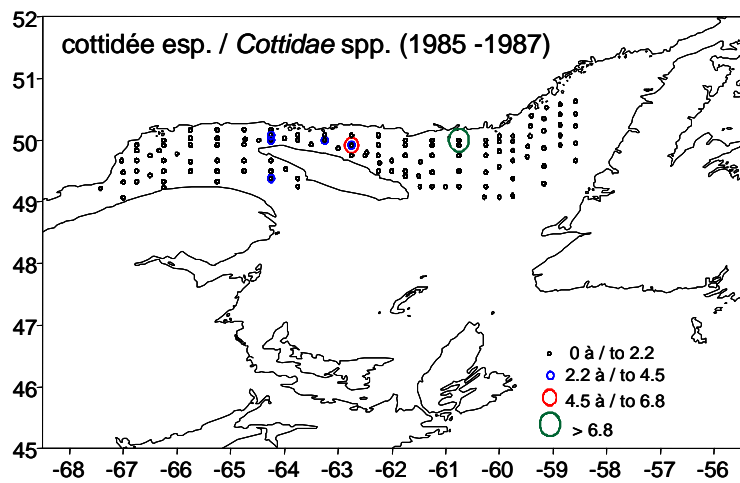
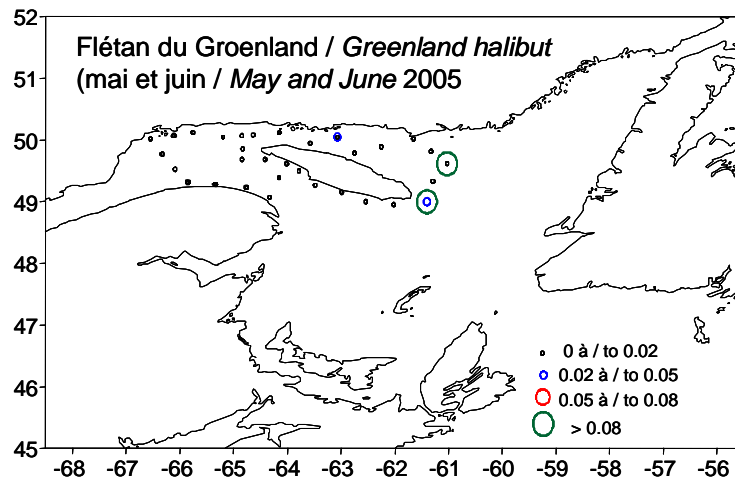
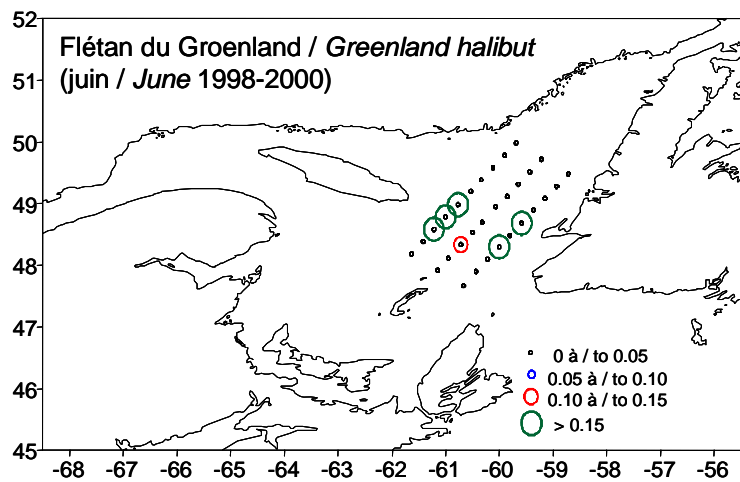
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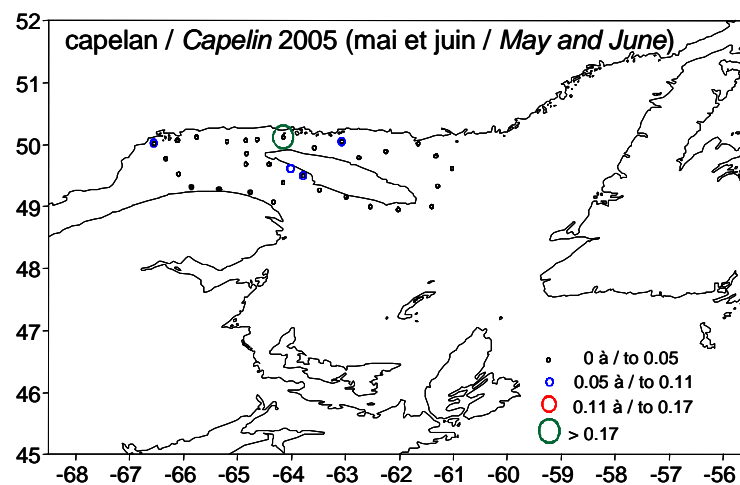
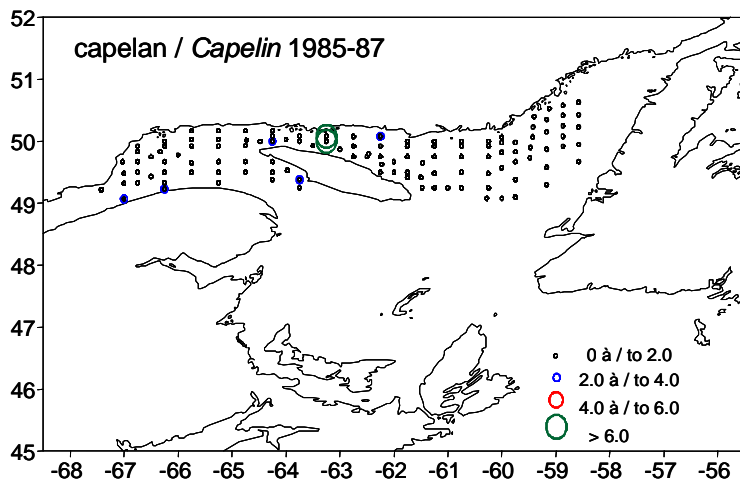
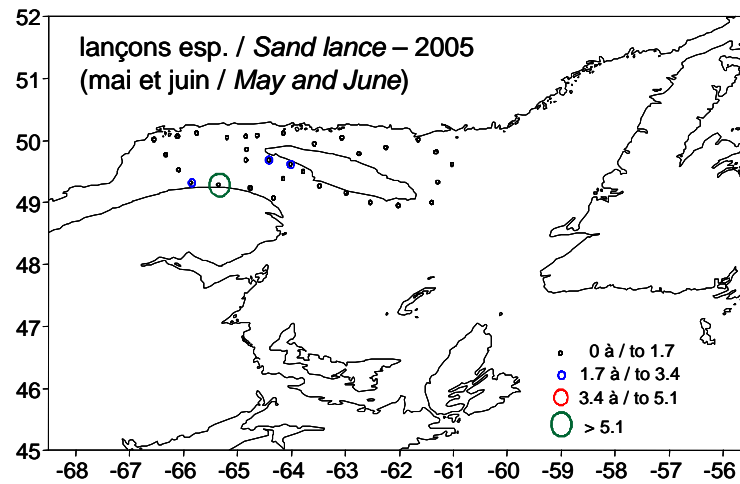
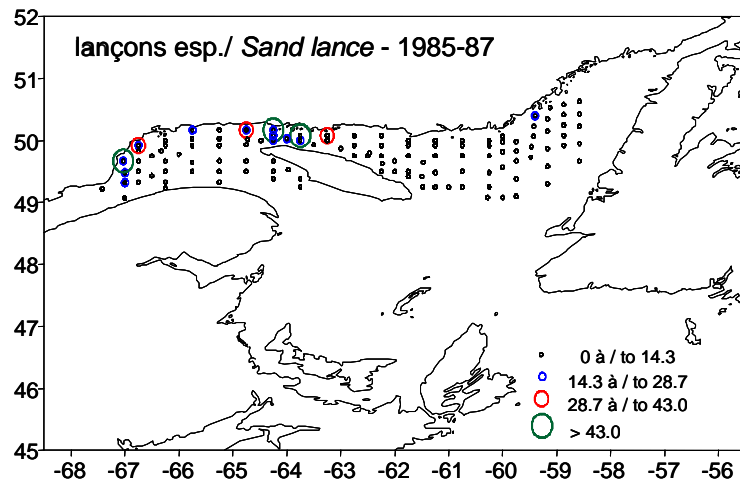
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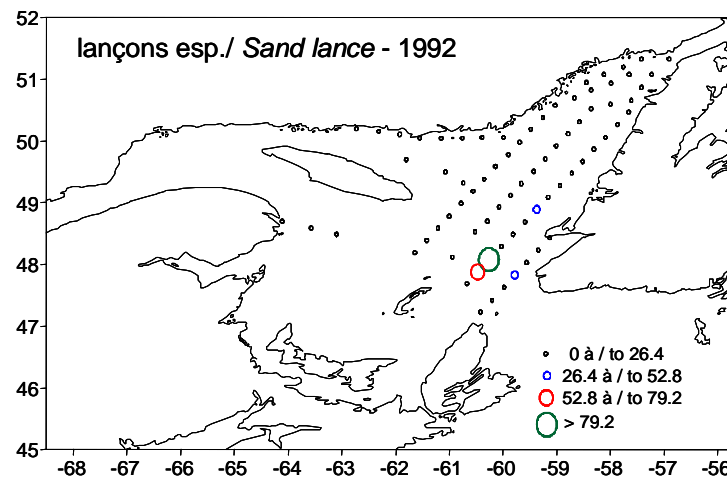
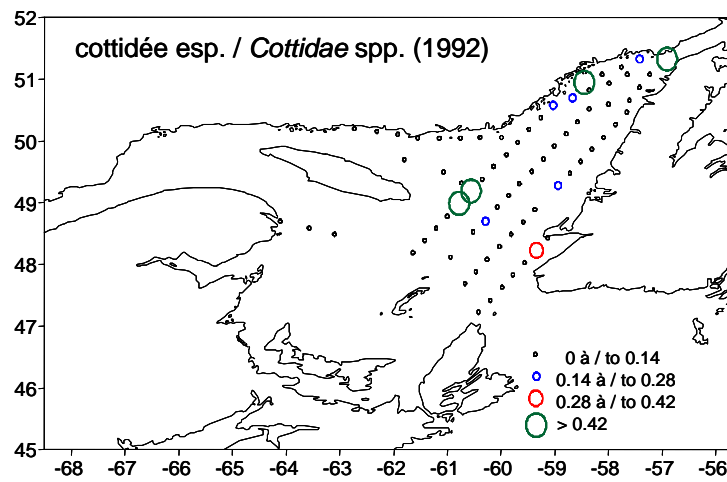
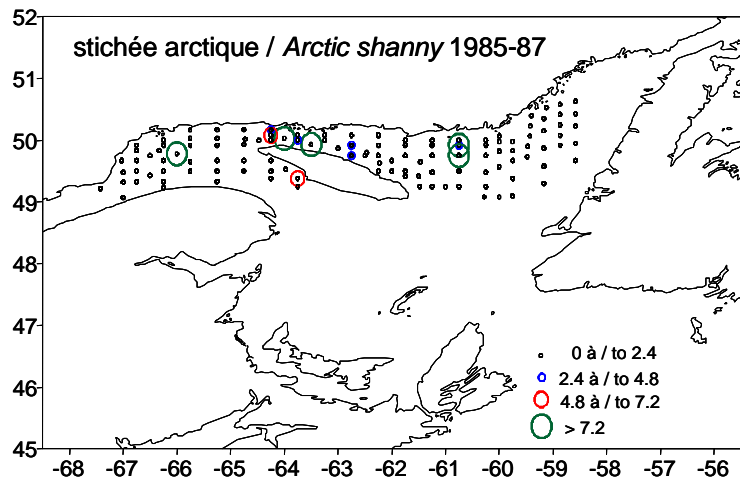
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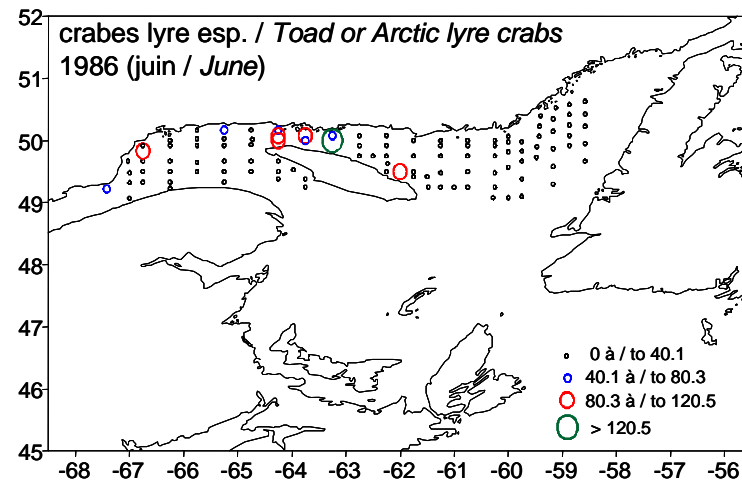
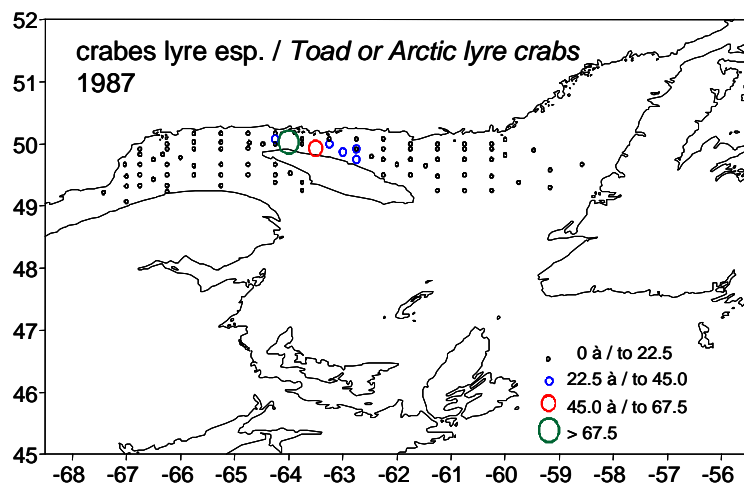
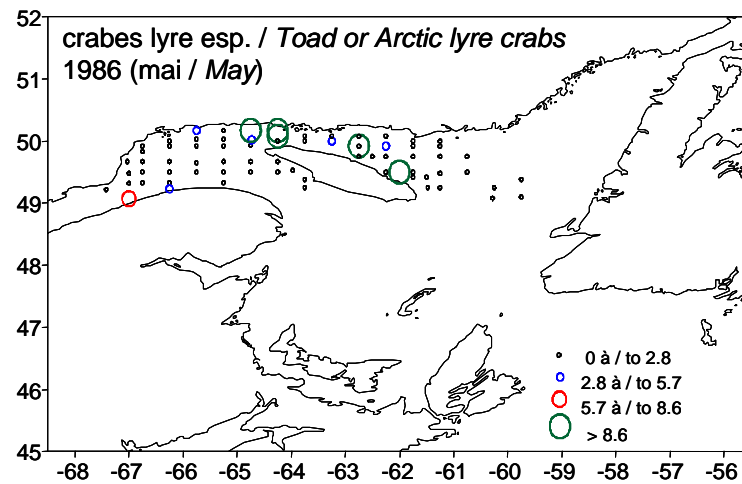
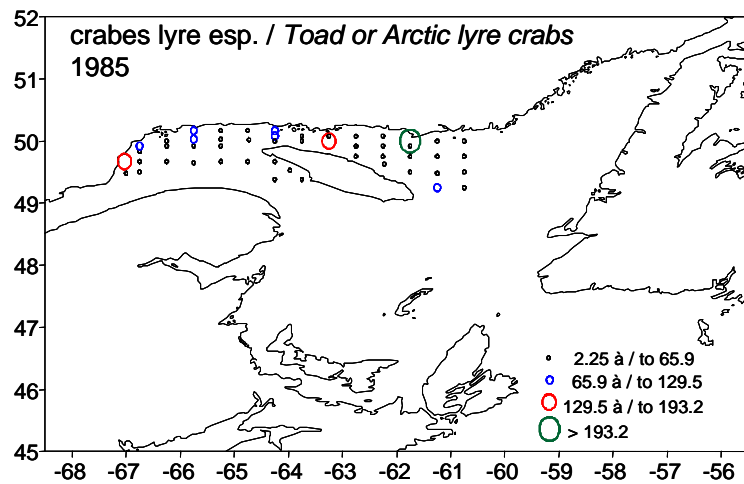
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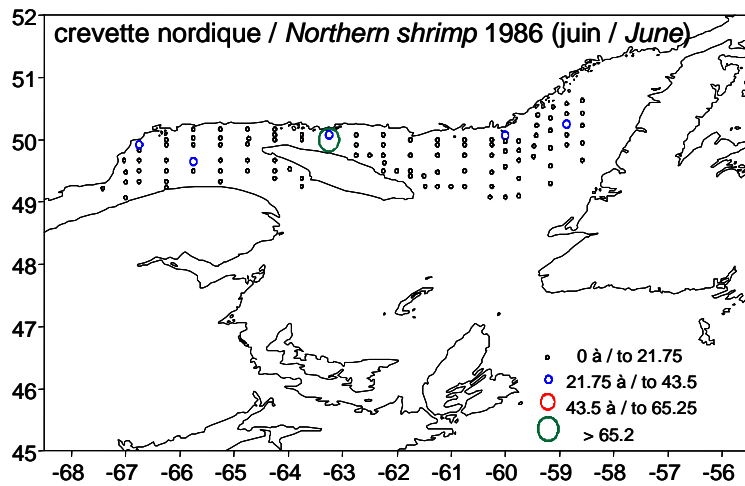
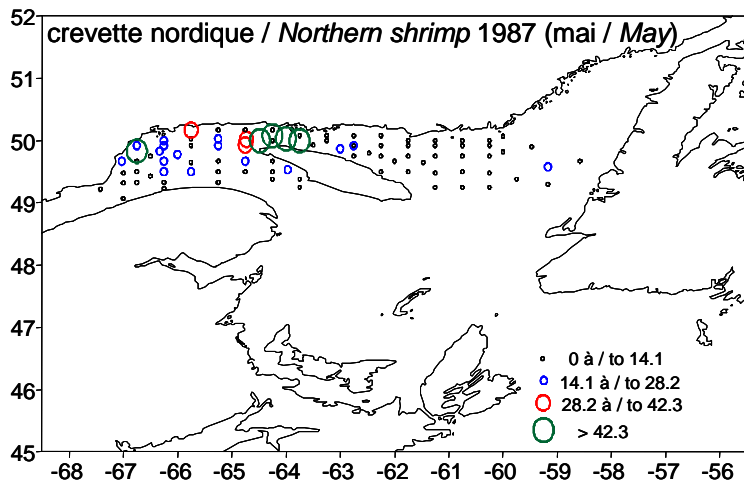
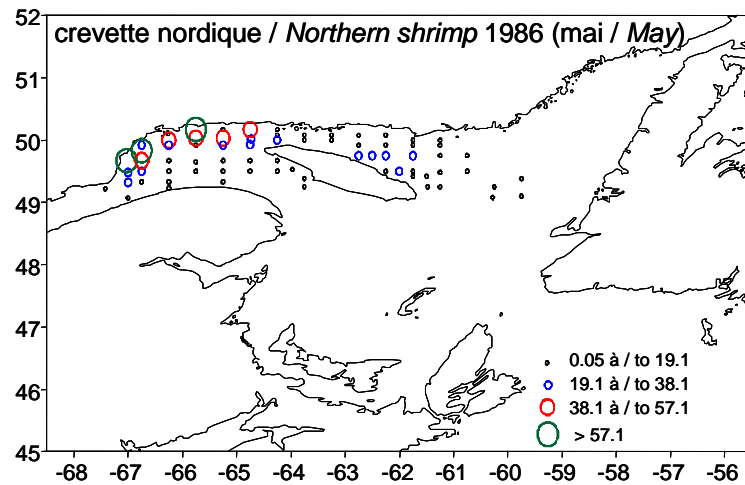
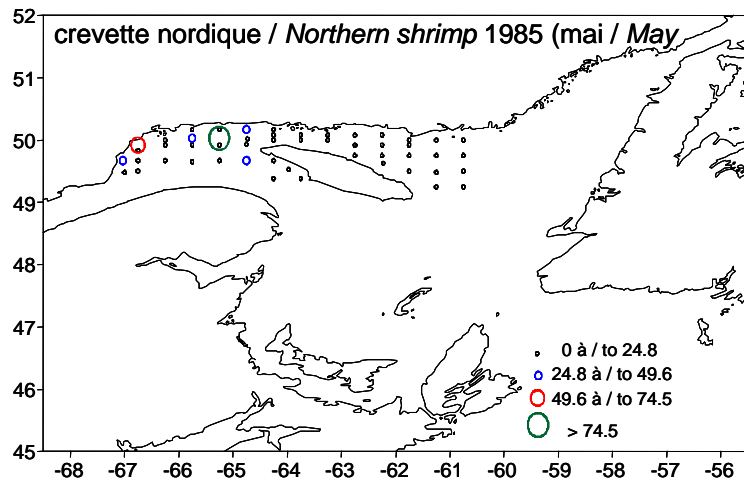
C13 – Abundance values as number / m²



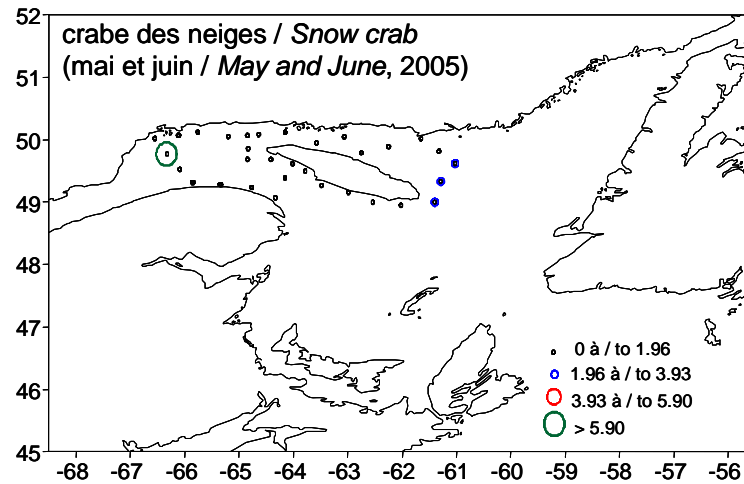
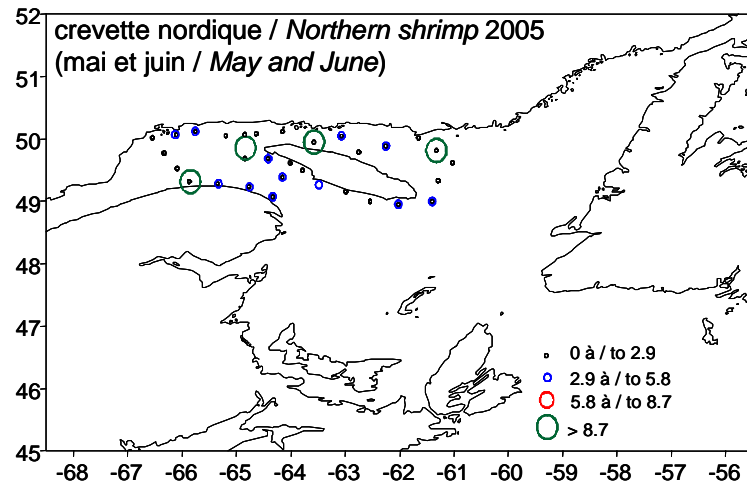
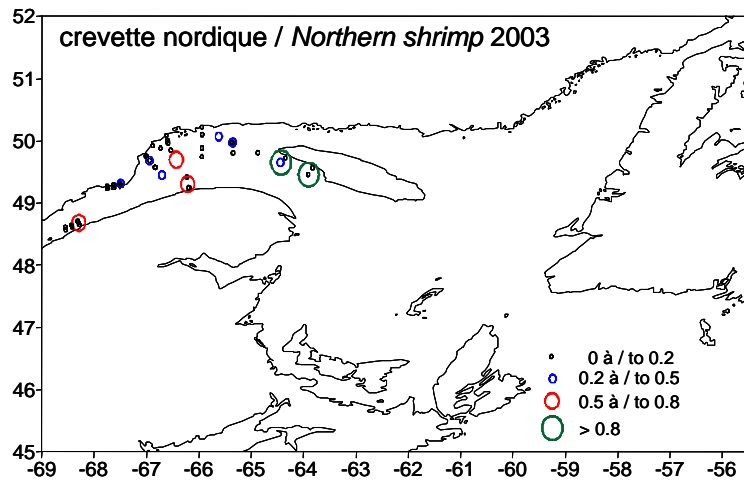
C14 – Abundance values as number / m²



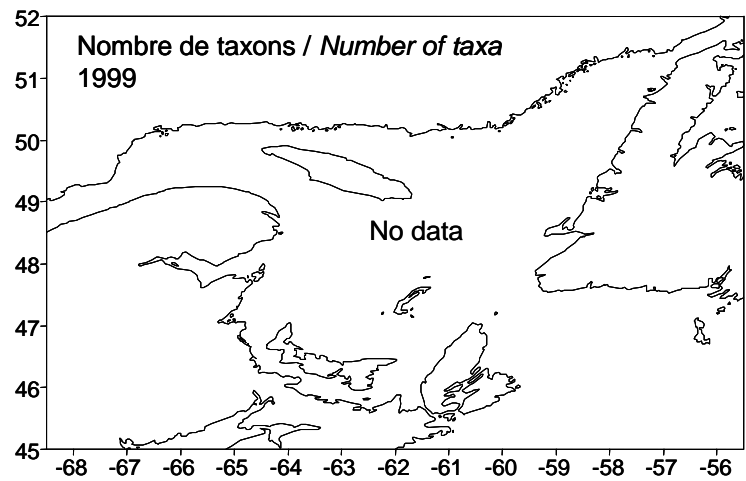
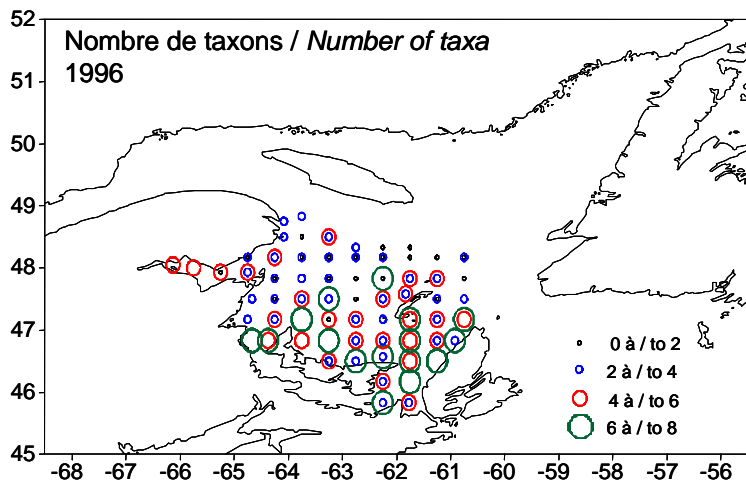
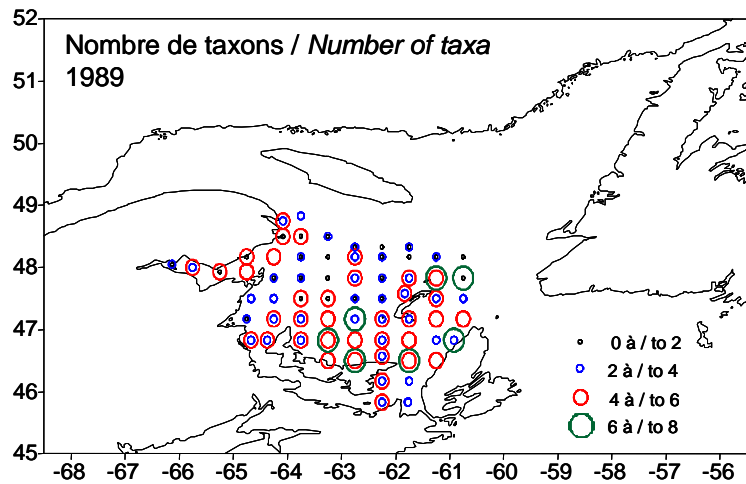
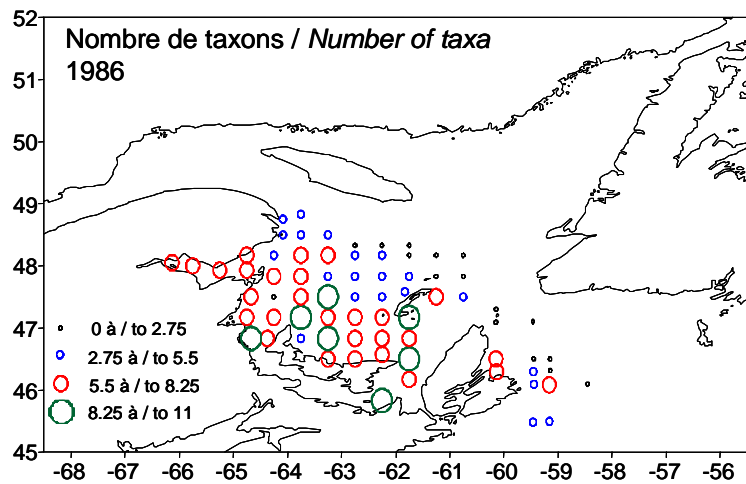
C15 – Abundance values as number / m²



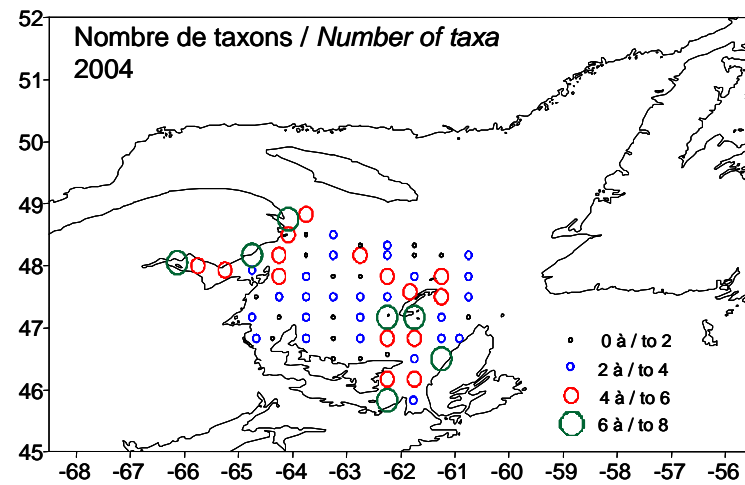
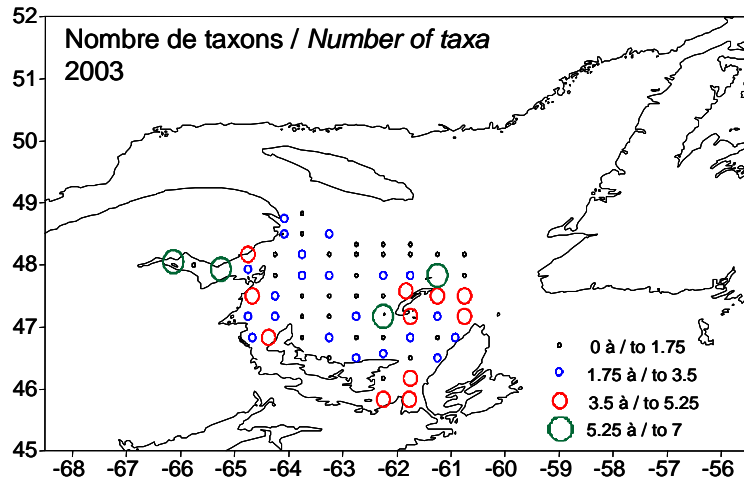
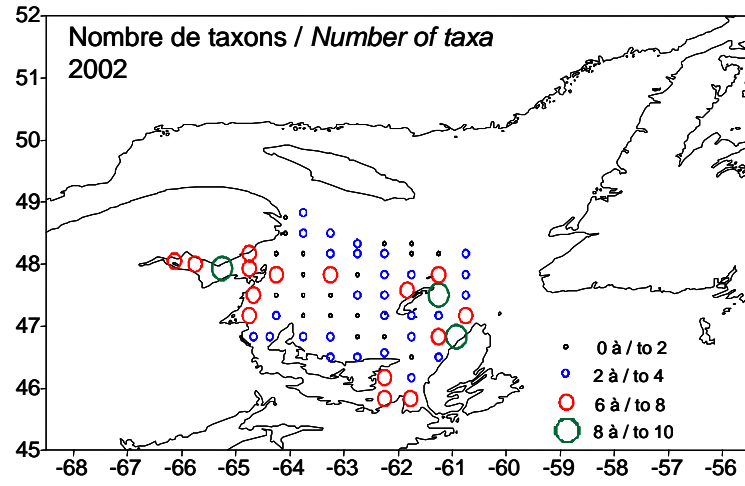
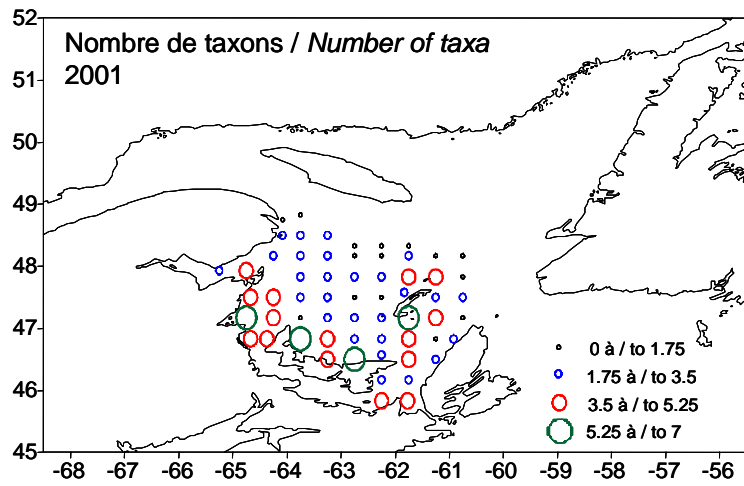
C16 – Abundance values as number / m²



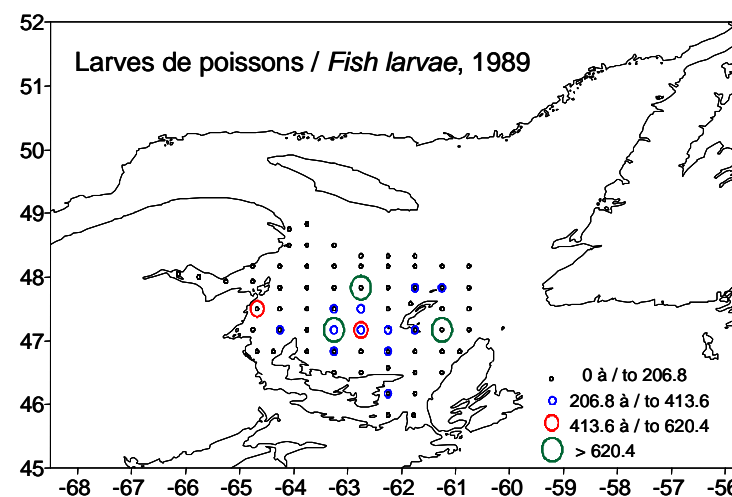
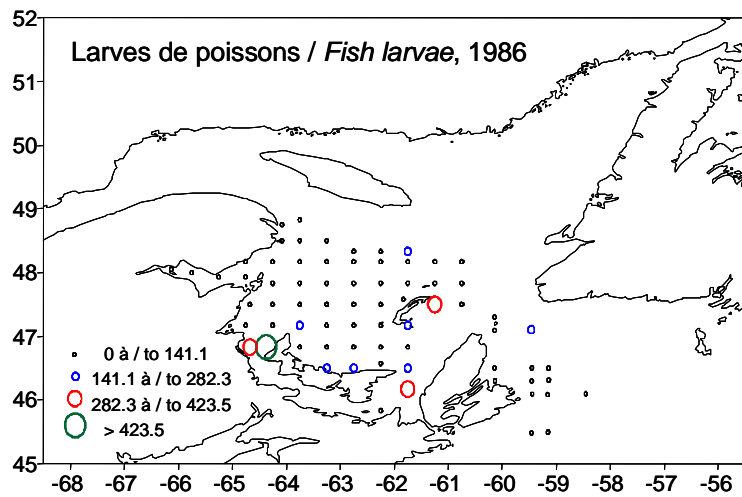
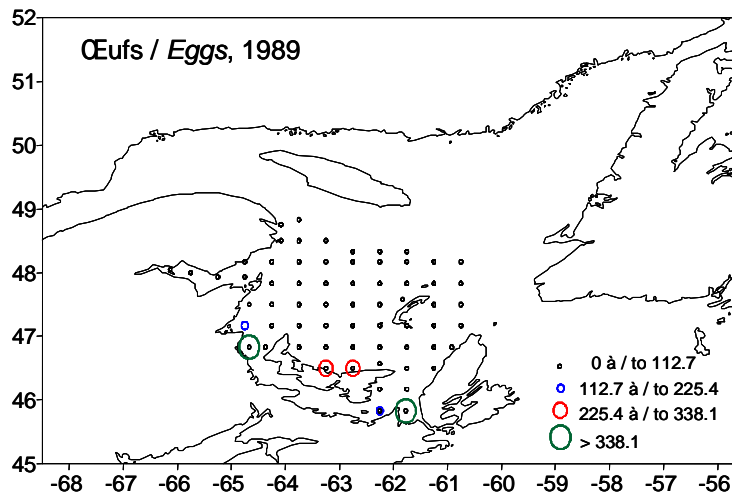
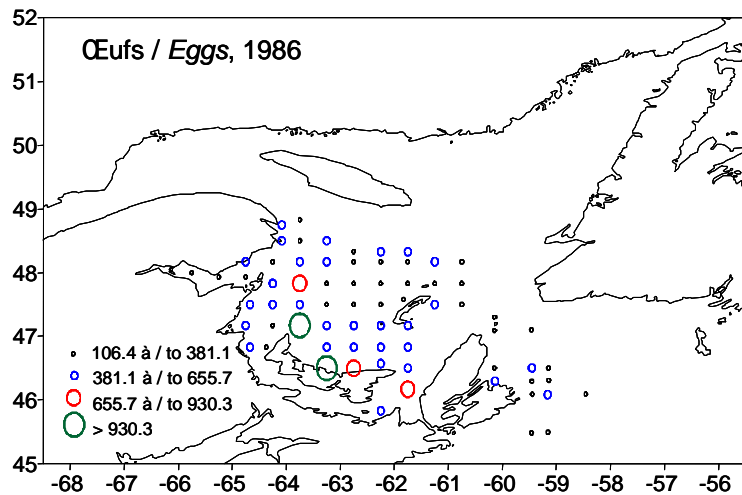
C17 – Abundance values as number / m²



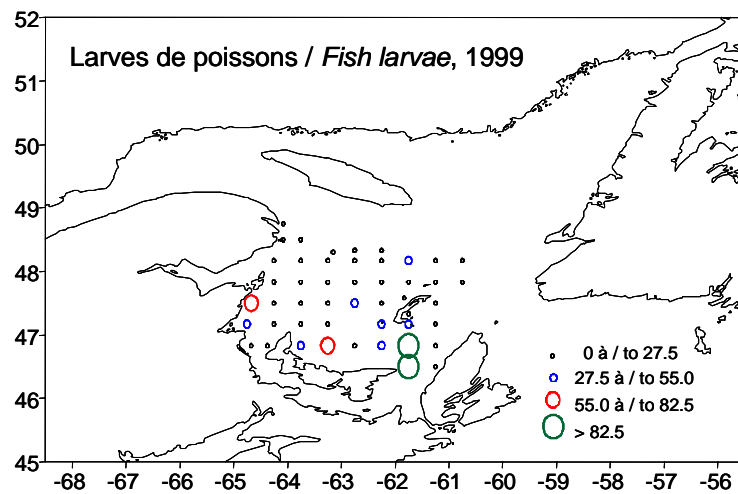
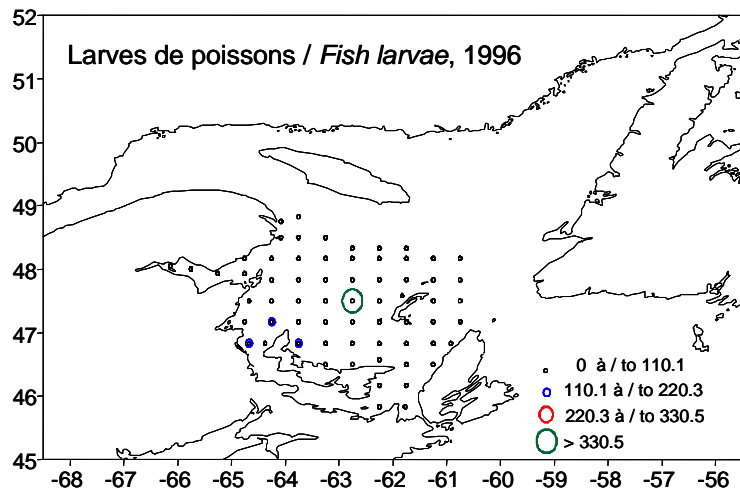
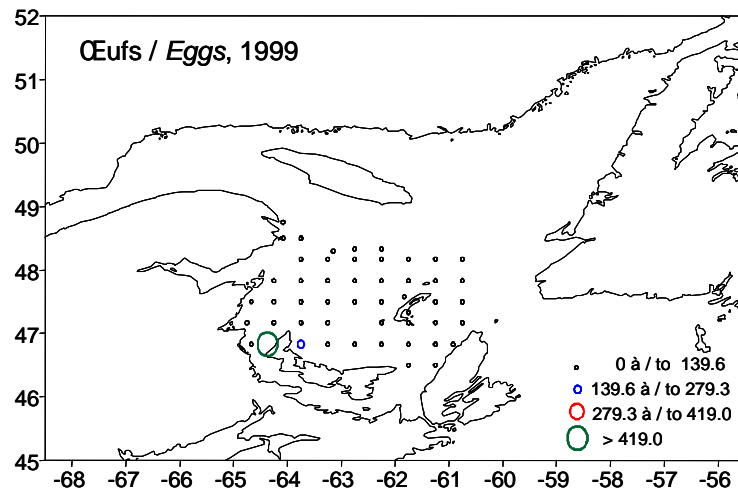
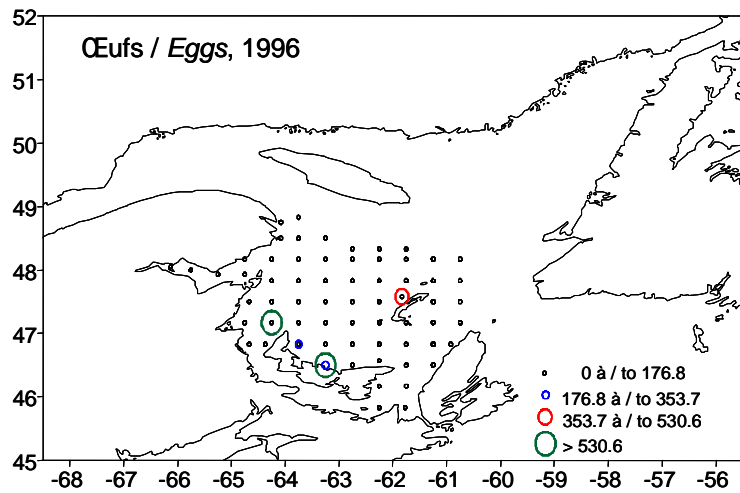
C18



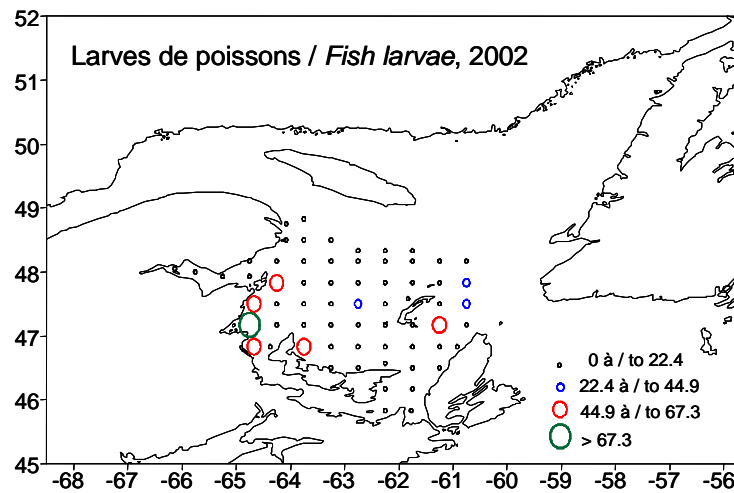
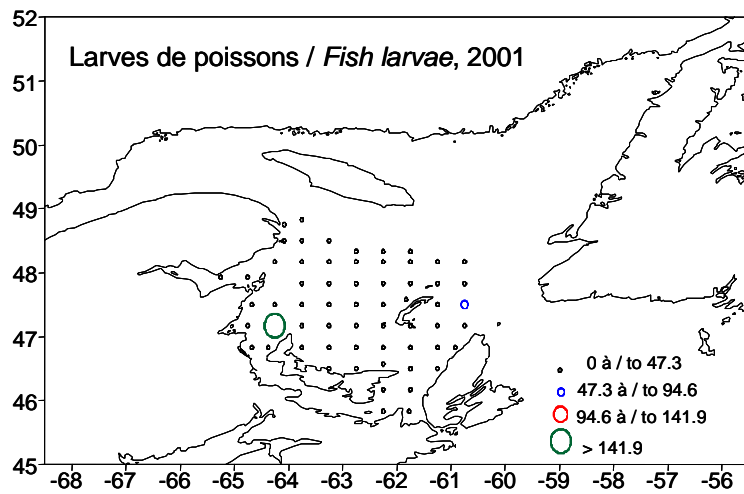
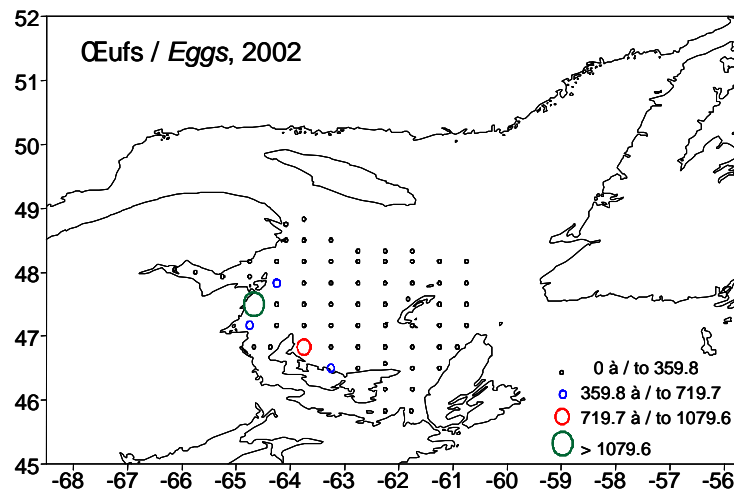
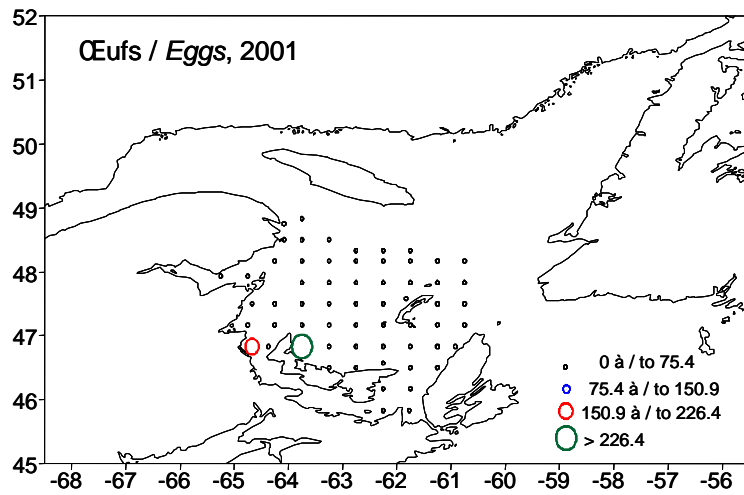
C19



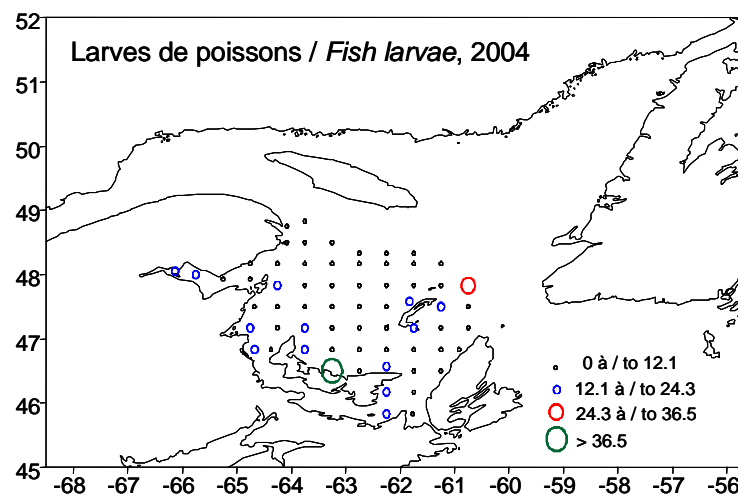
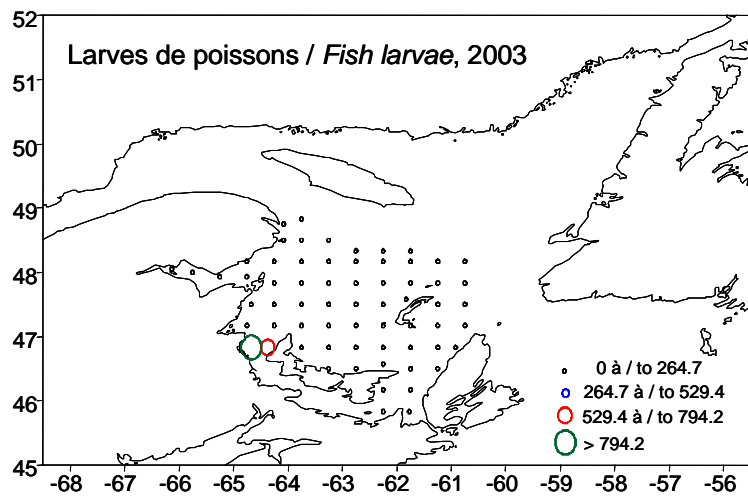
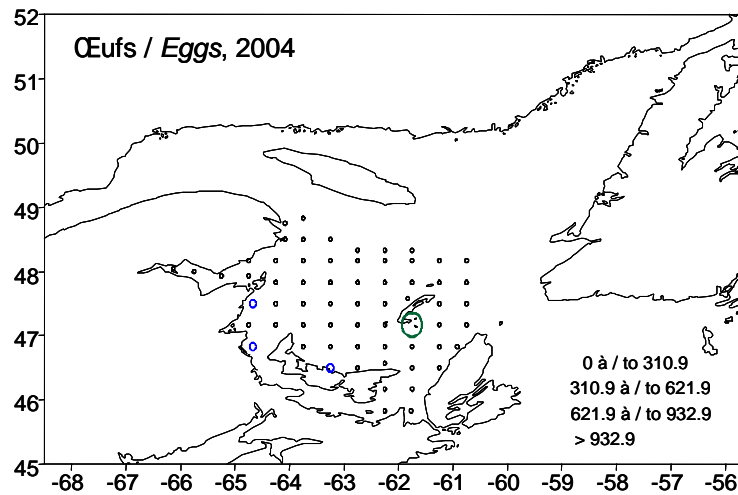
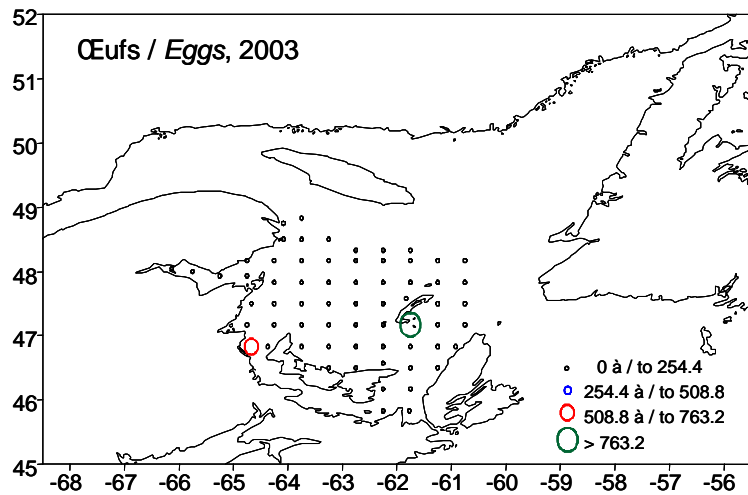
C20 – Abundance values as number / m²



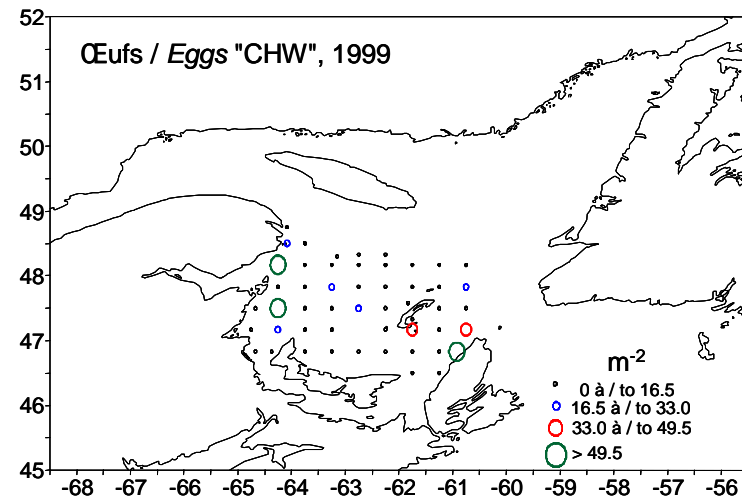
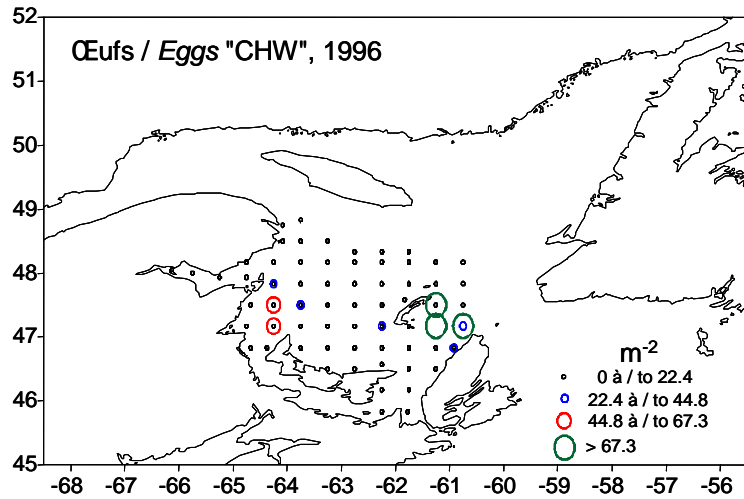
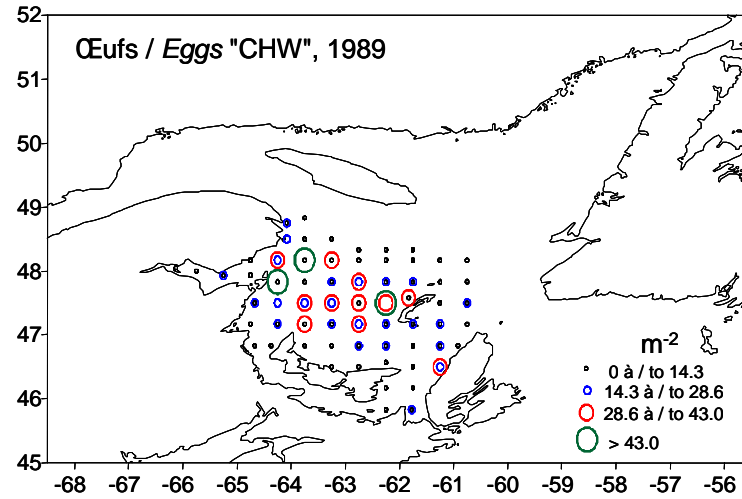
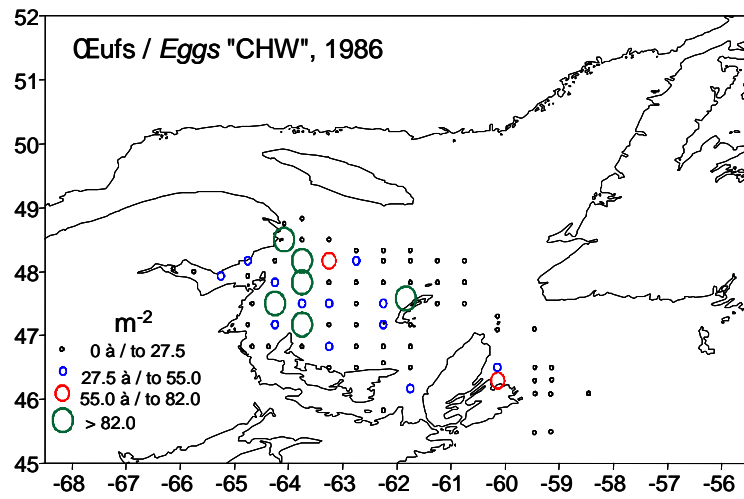
C21 – Abundance values as number / m²



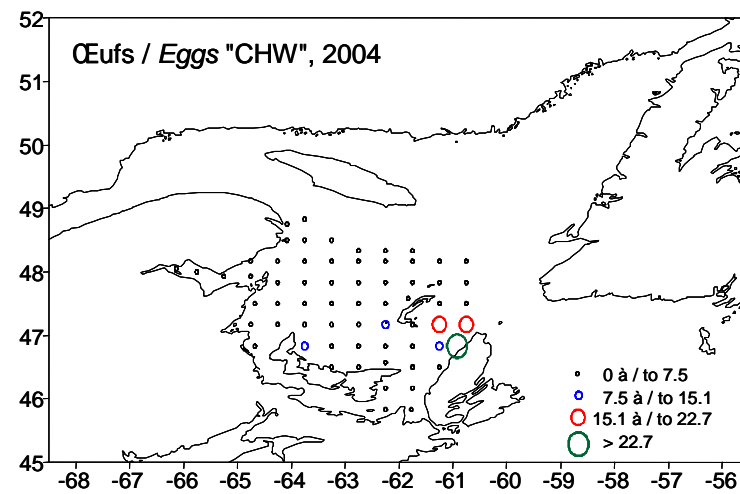
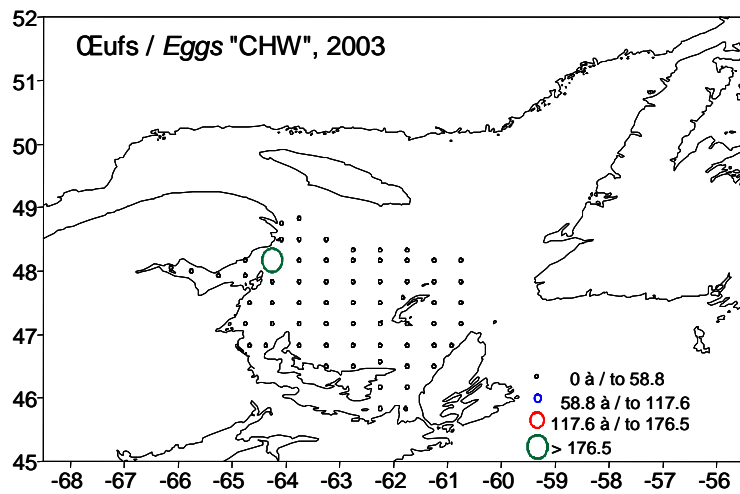
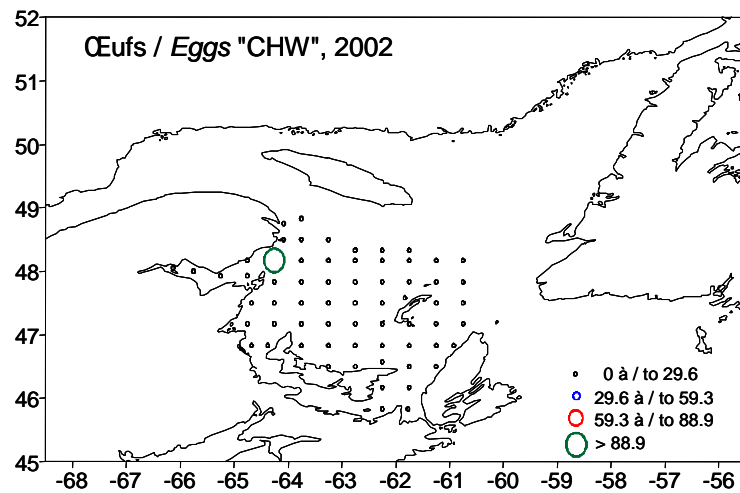
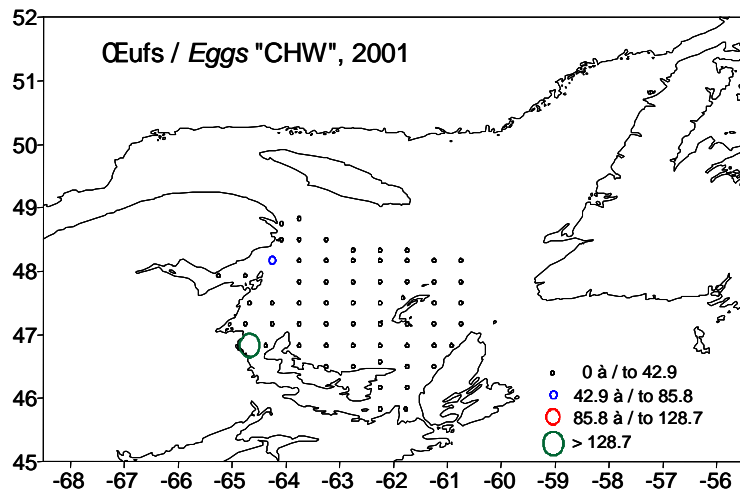
C22 – Abundance values as number / m²



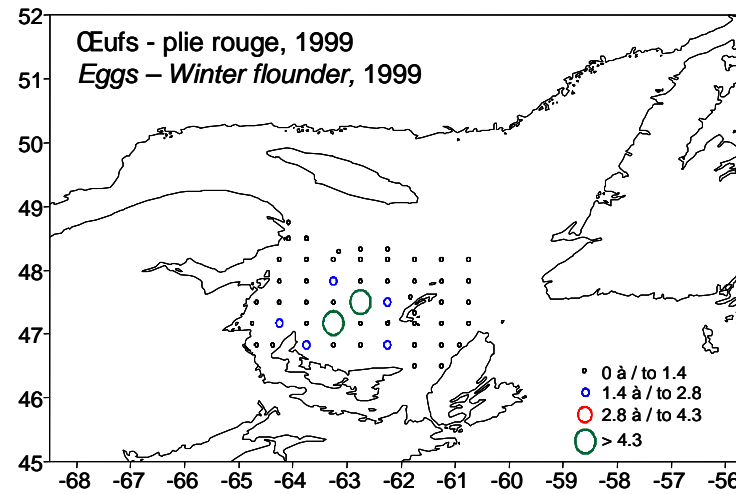
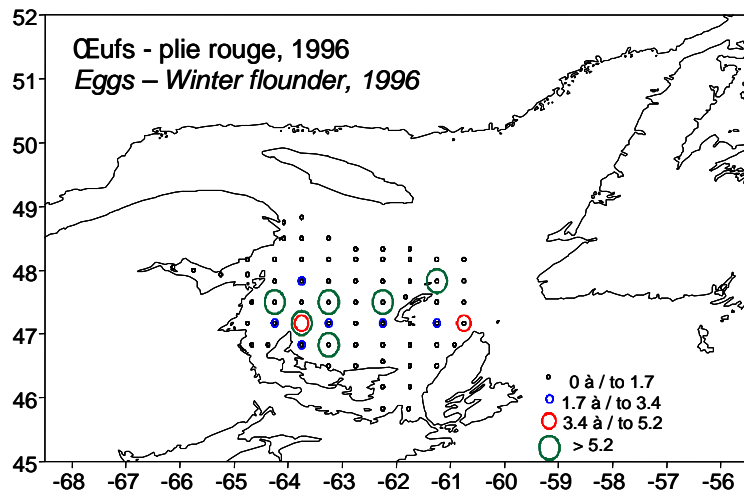
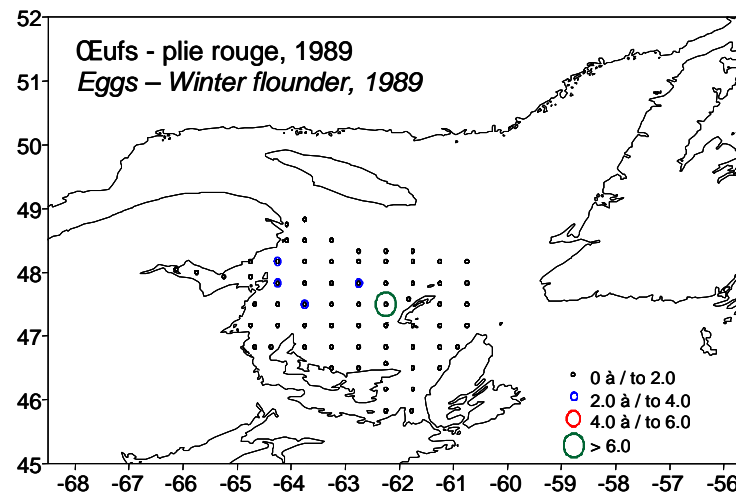
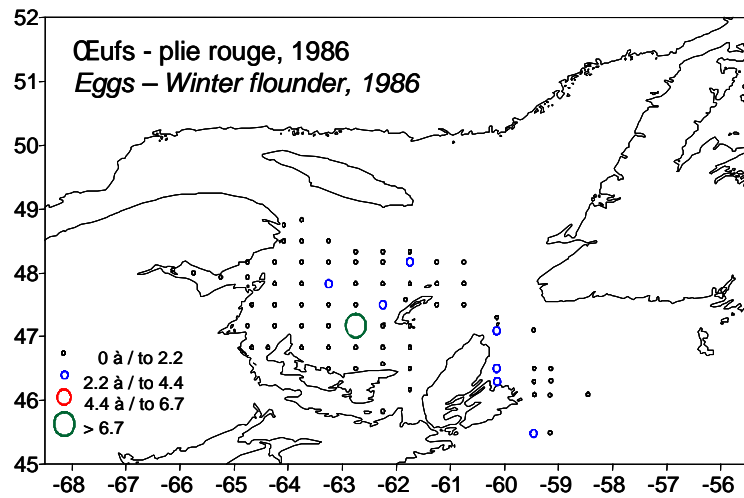
C23 – Abundance values as number / m²



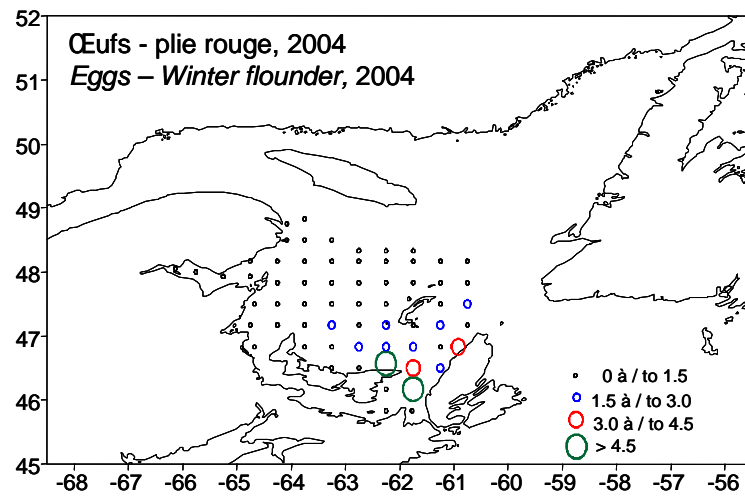
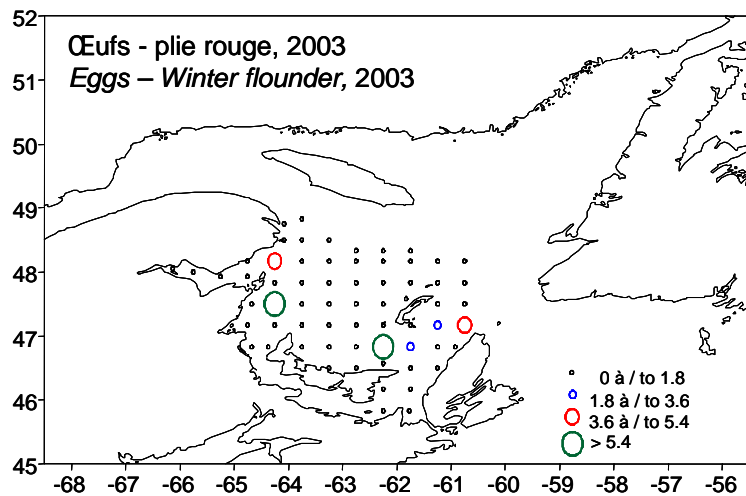
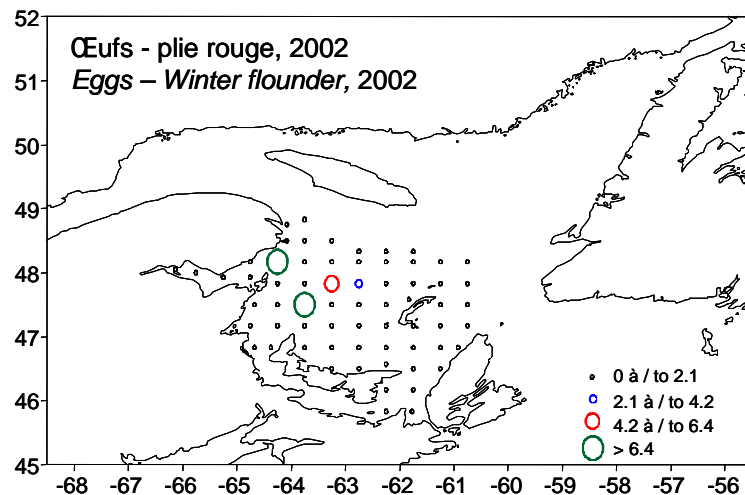
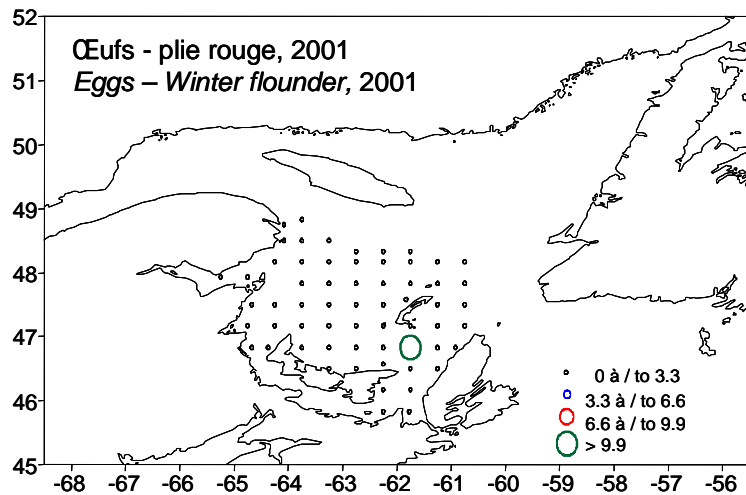
C24 – Abundance values as number / m^2



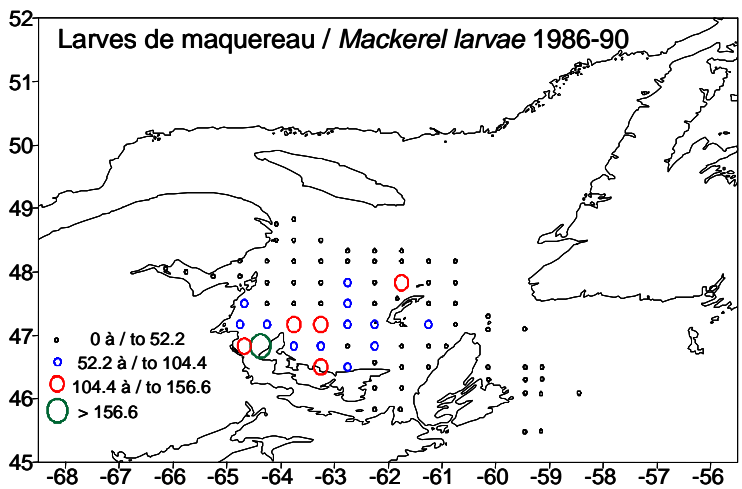
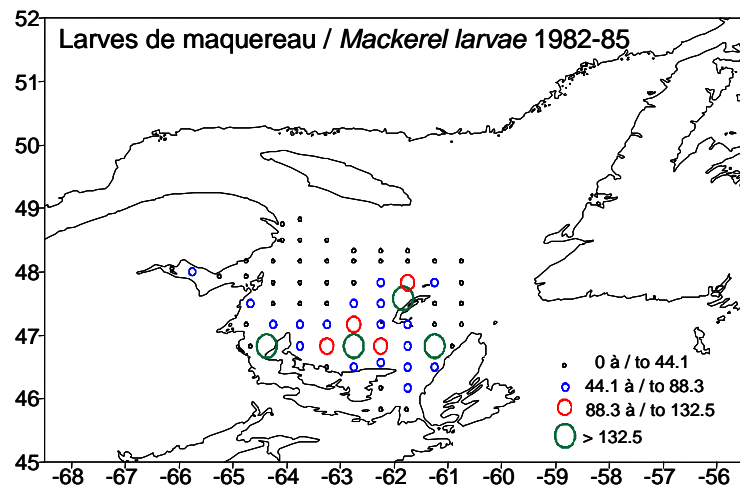
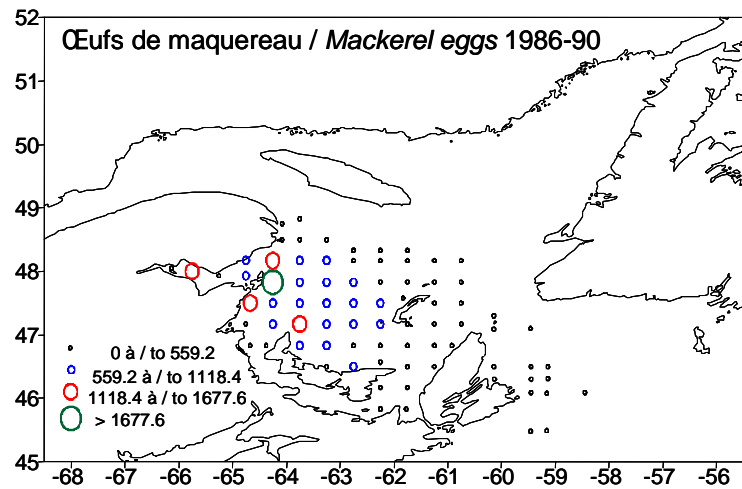
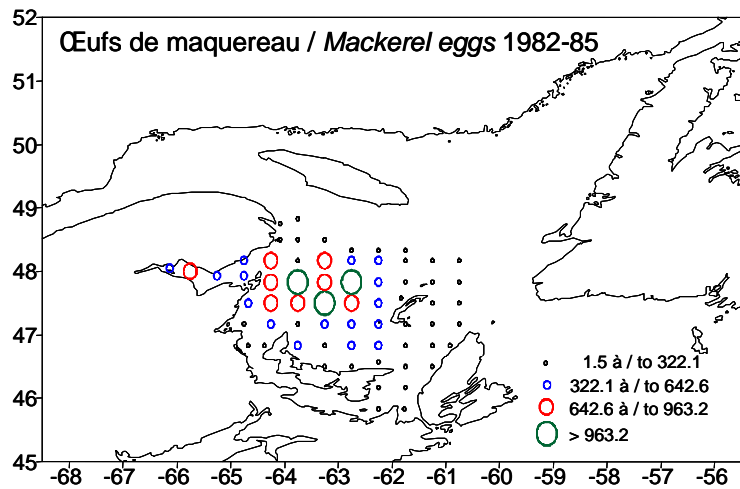
C25 – Abundance values as number / m²



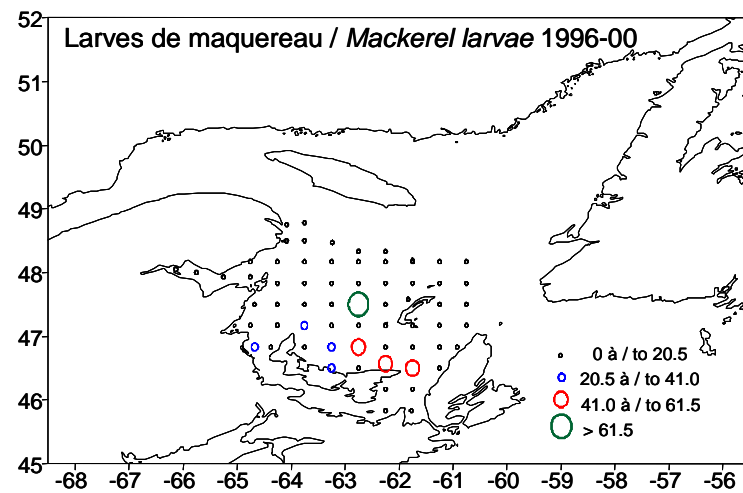
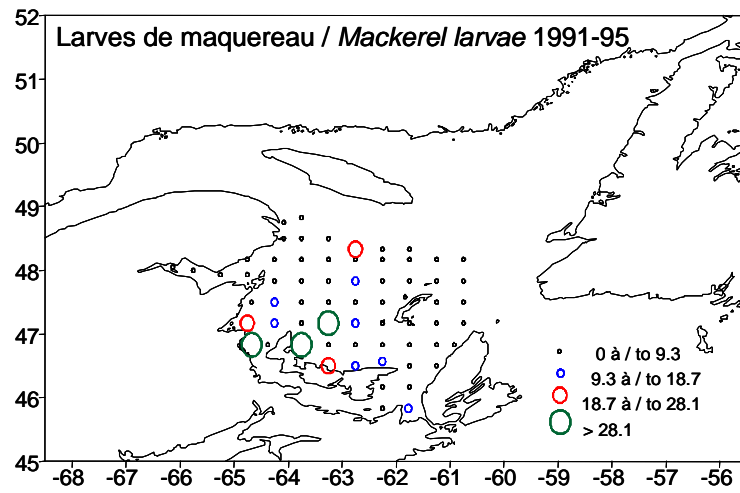
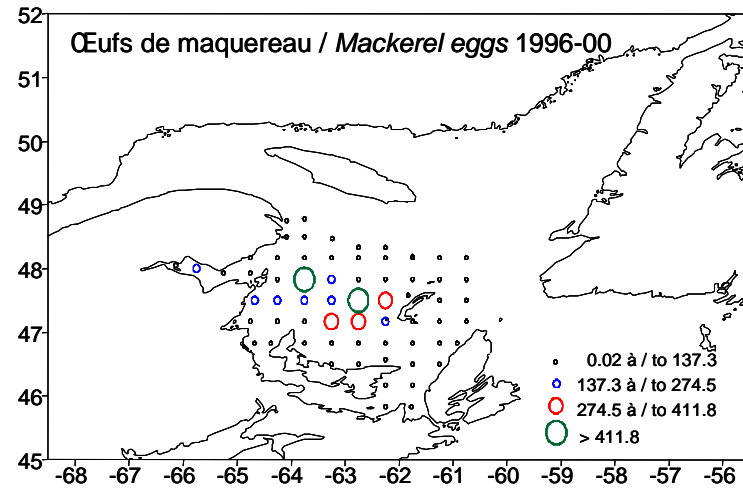
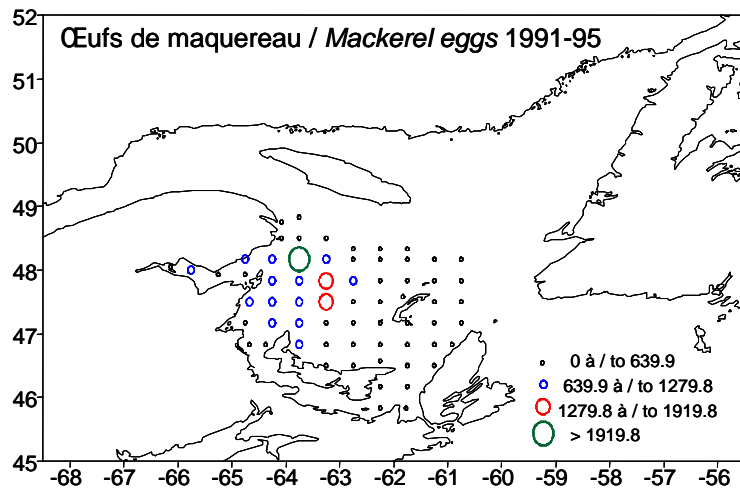
C26 – Abundance values as number / m²



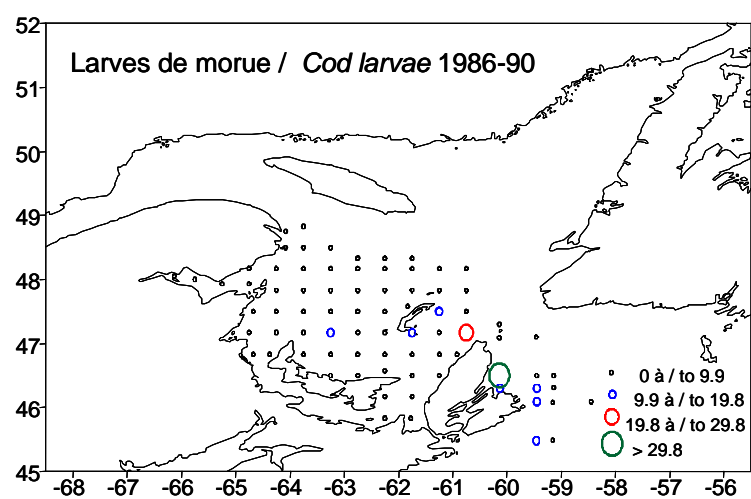
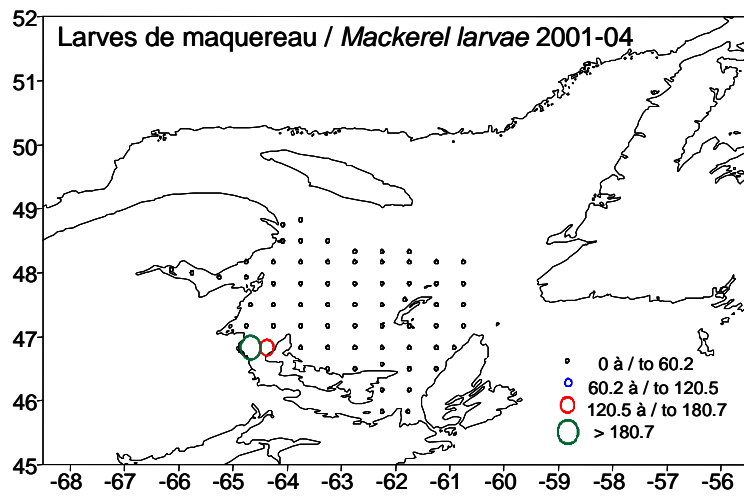
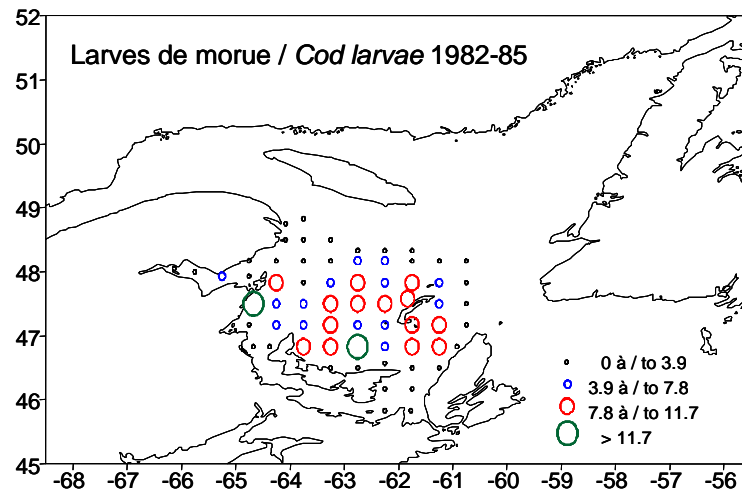
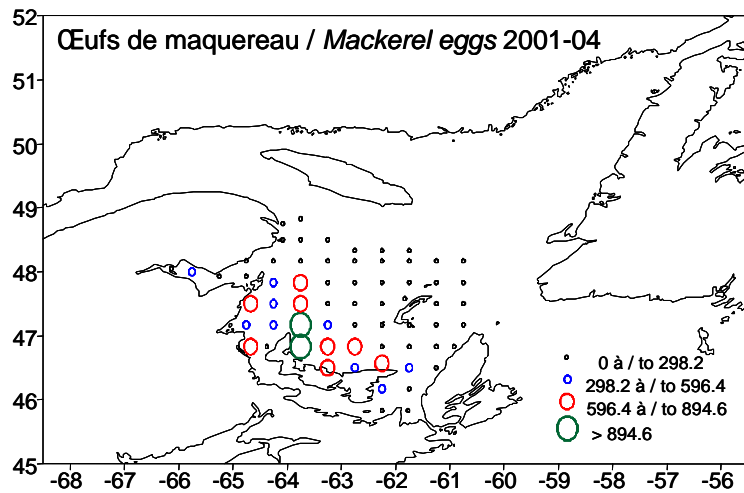
C27 – Abundance values as number / m²



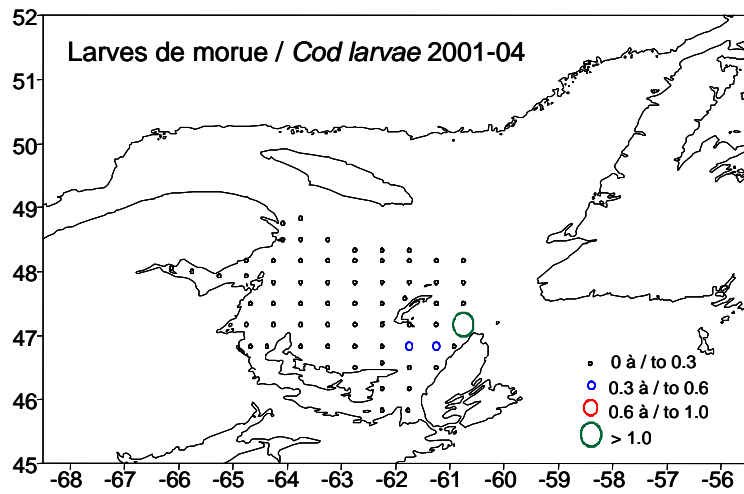
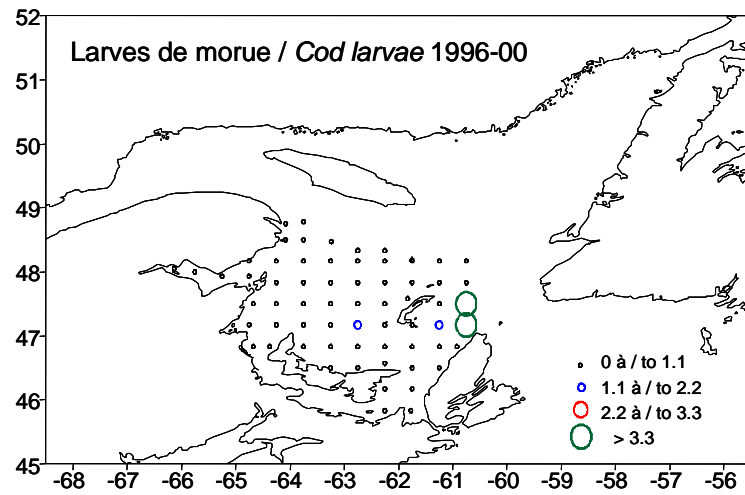
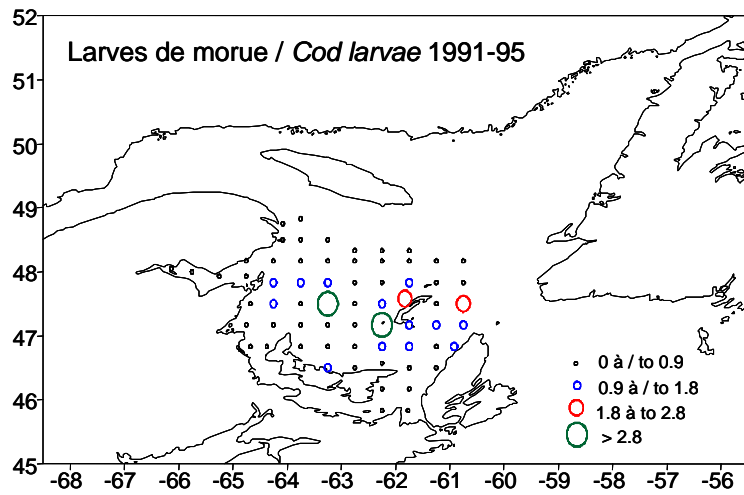
C28 – Abundance values as number / m²



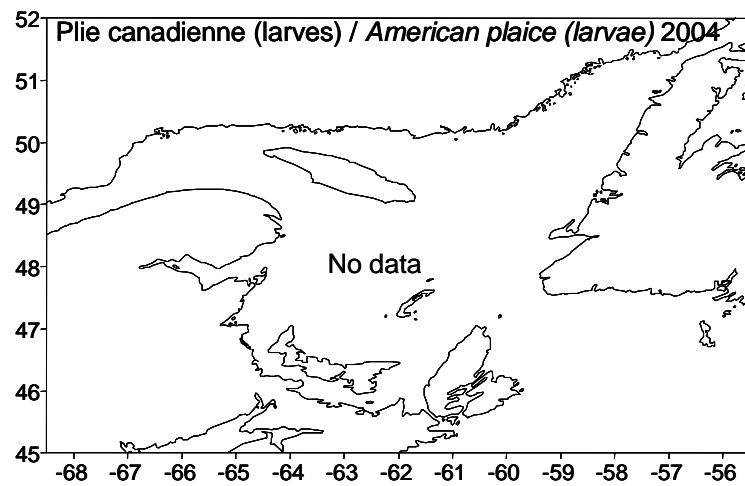
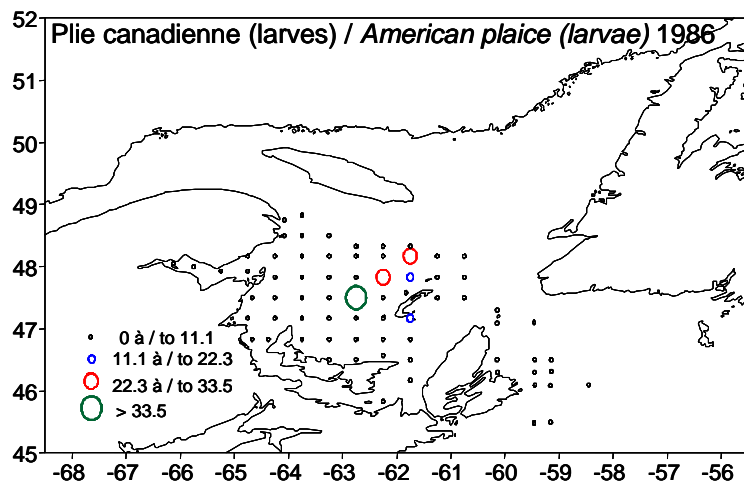
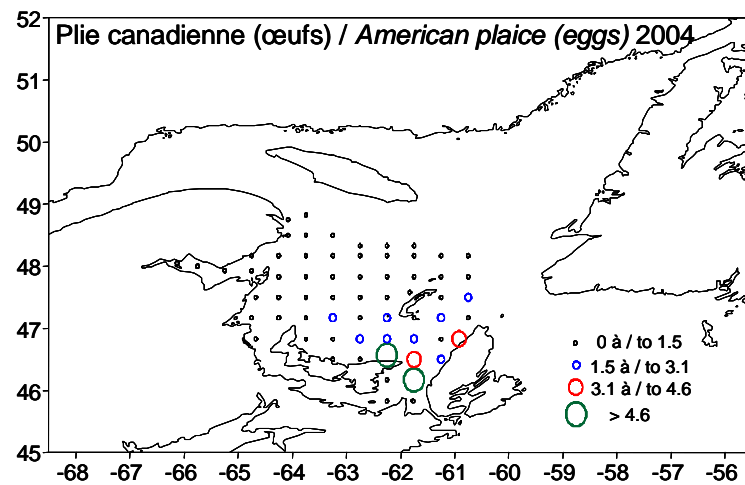
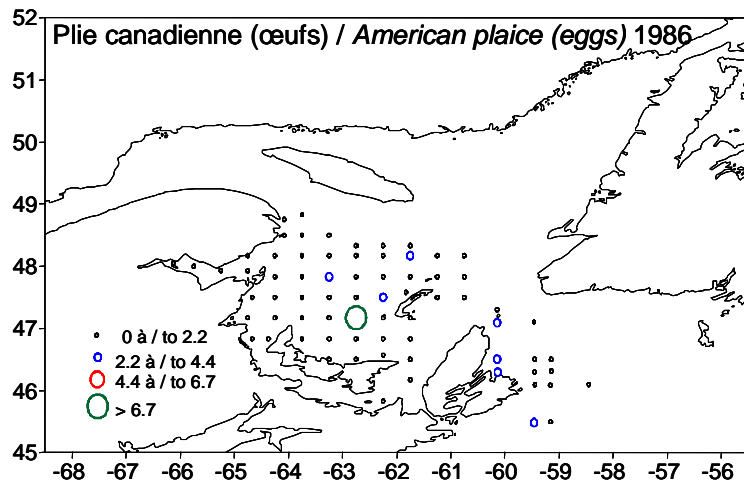
C29 – Abundance values as number / m²



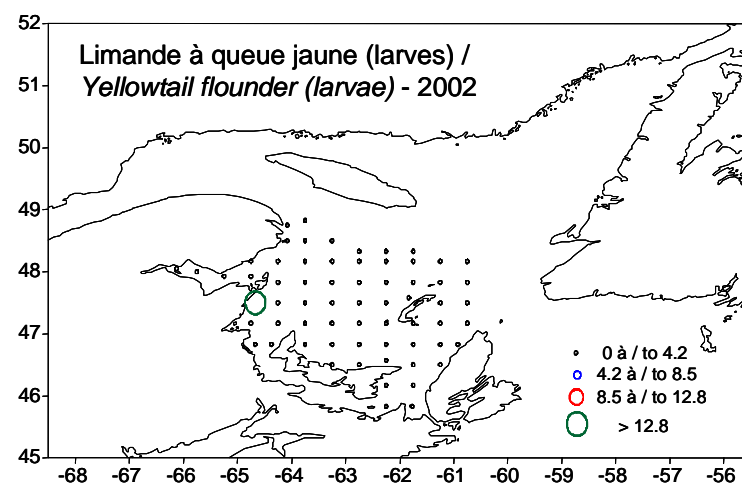
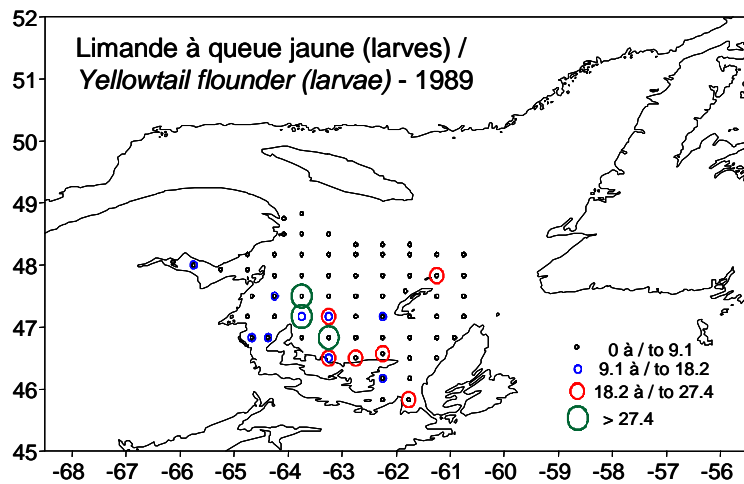
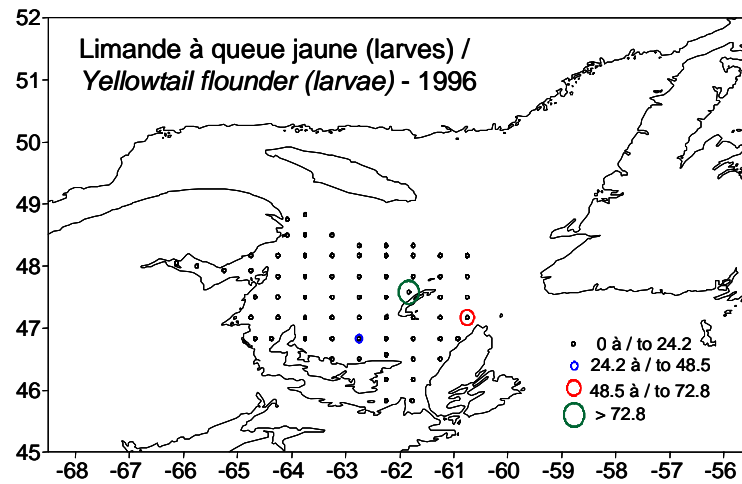
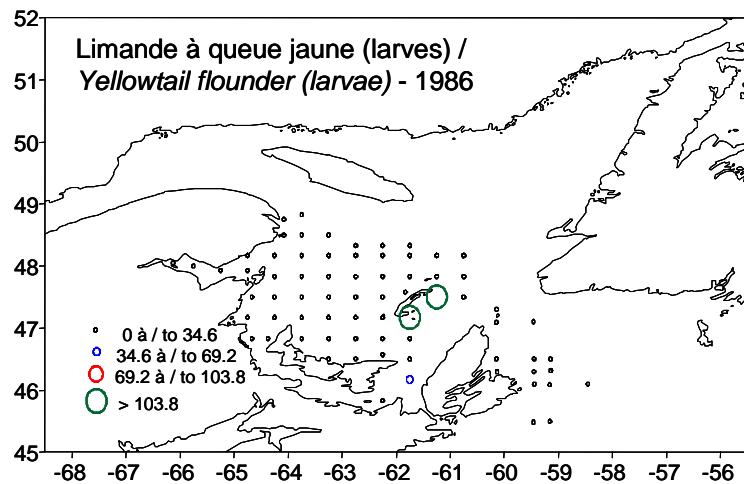
C30 – Abundance values as number / m²



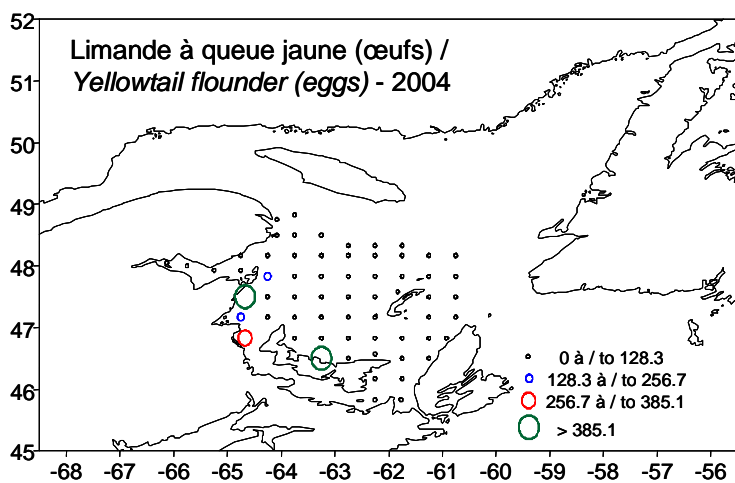
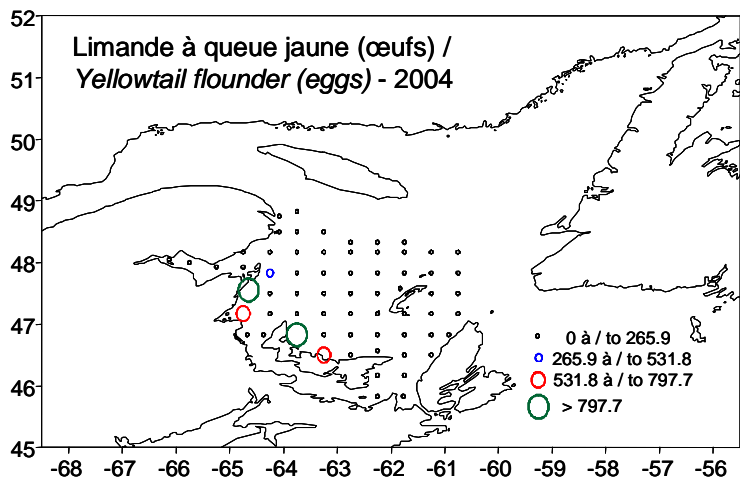
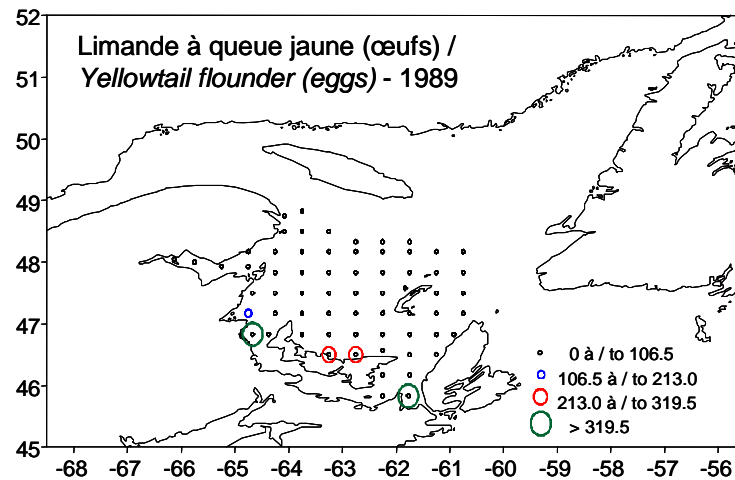
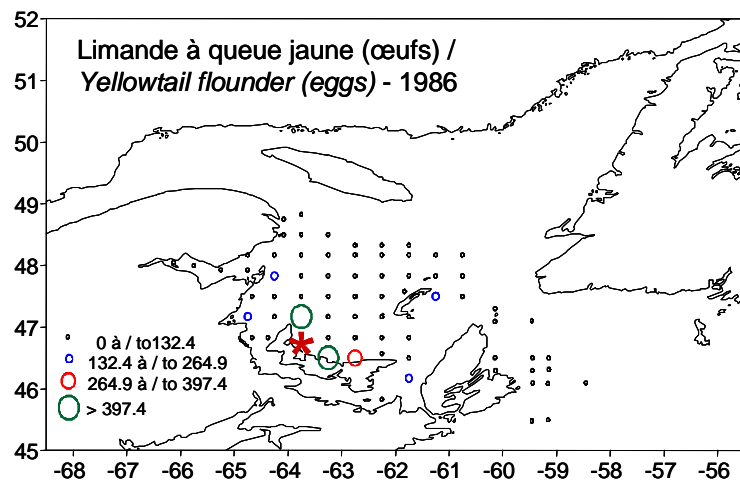
C31 – Abundance values as number / m²



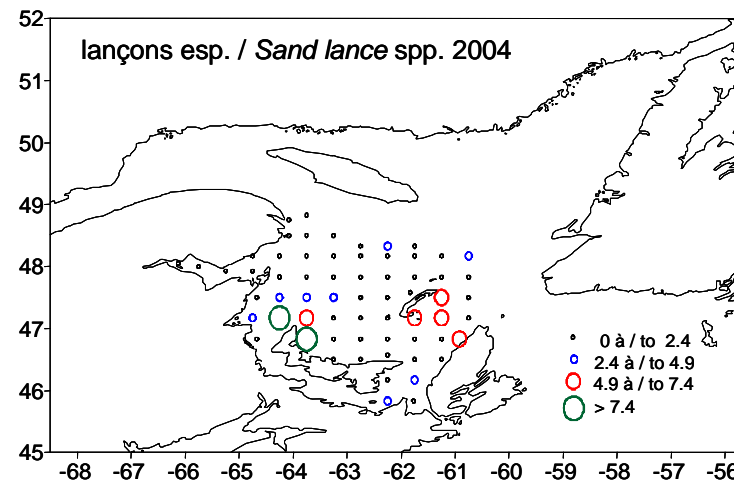
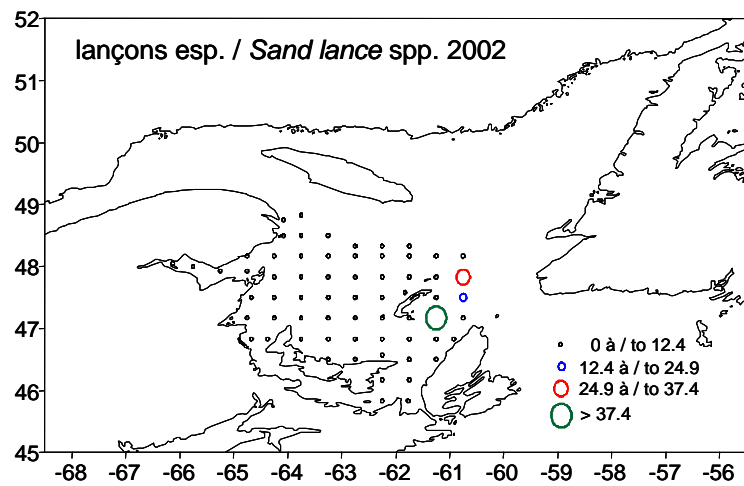
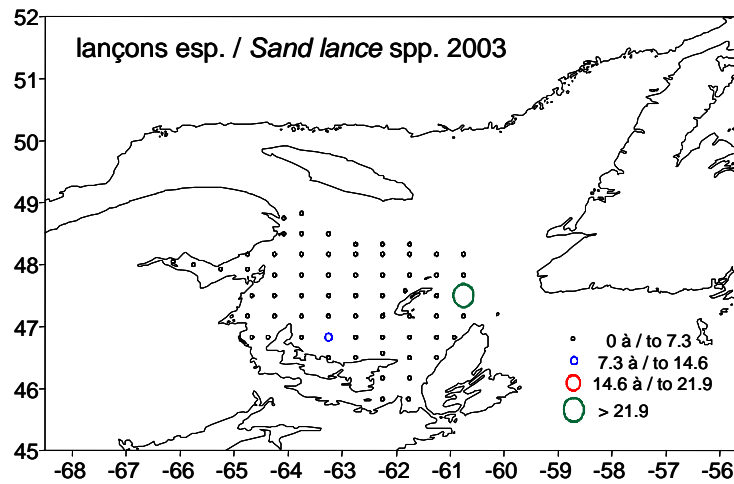
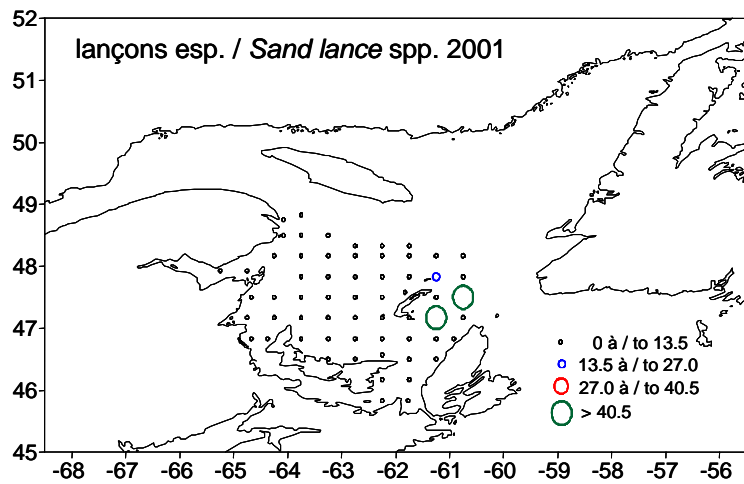
C32 – Abundance values as number / m²



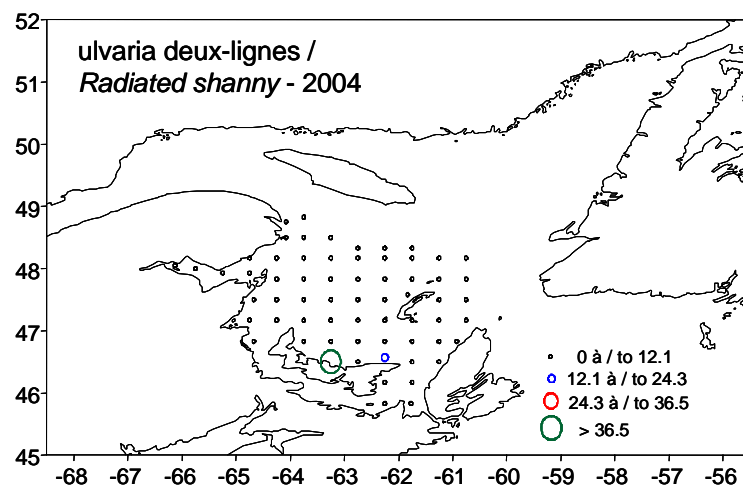
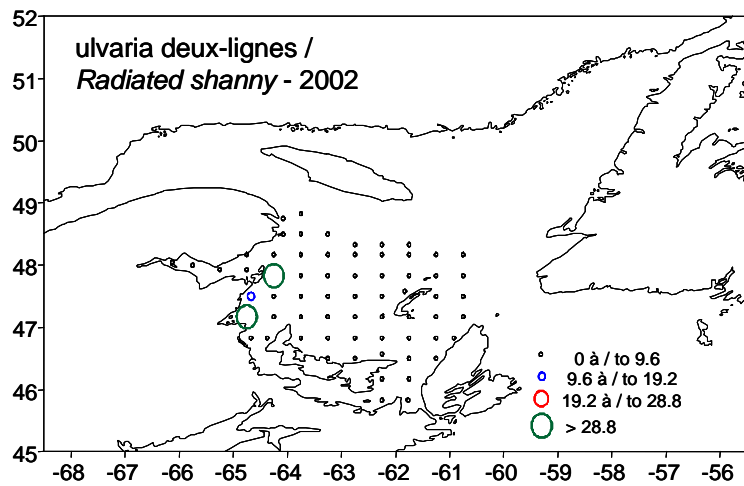
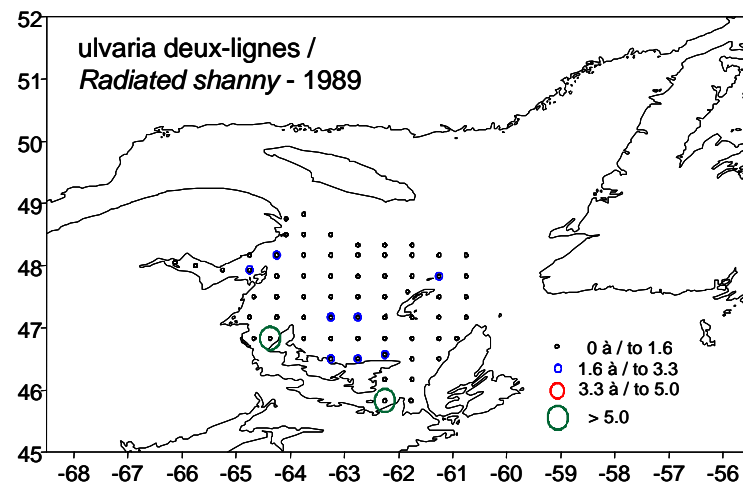
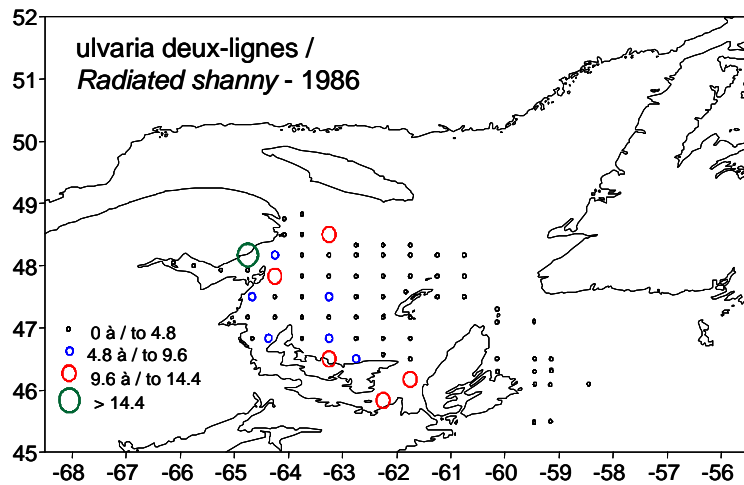
C33 – Abundance values as number / m²



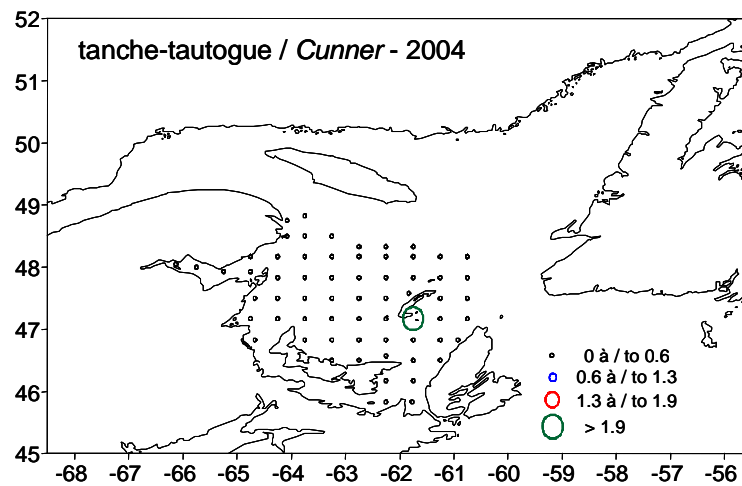
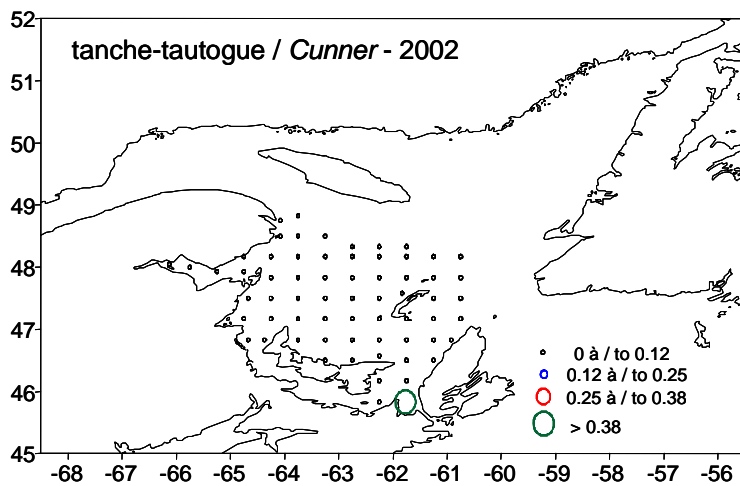
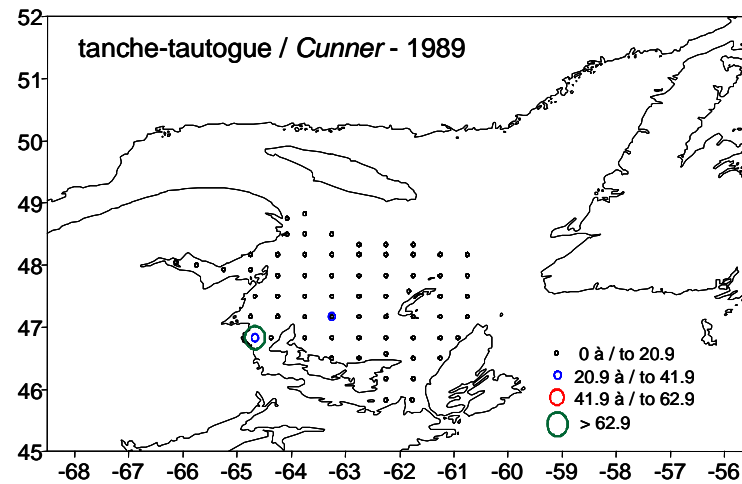
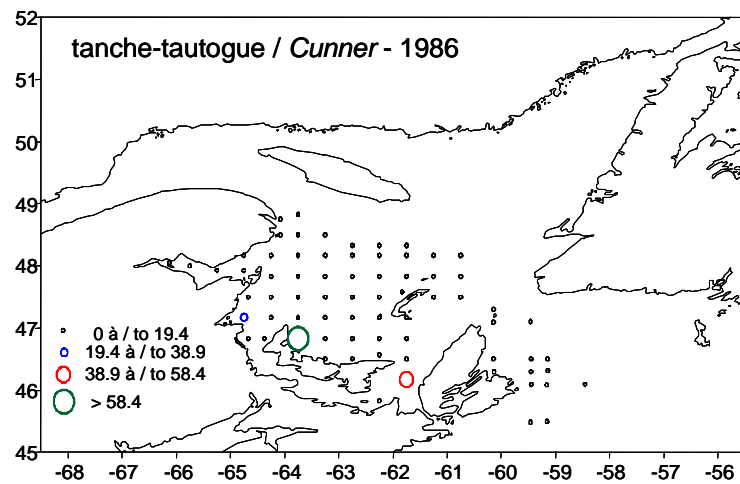
C34 – Abundance values as number / m^2 . For 1986, the star symbol indicates an extreme value ($>10\,000$ eggs m^2) excluded from the quartiles representation.



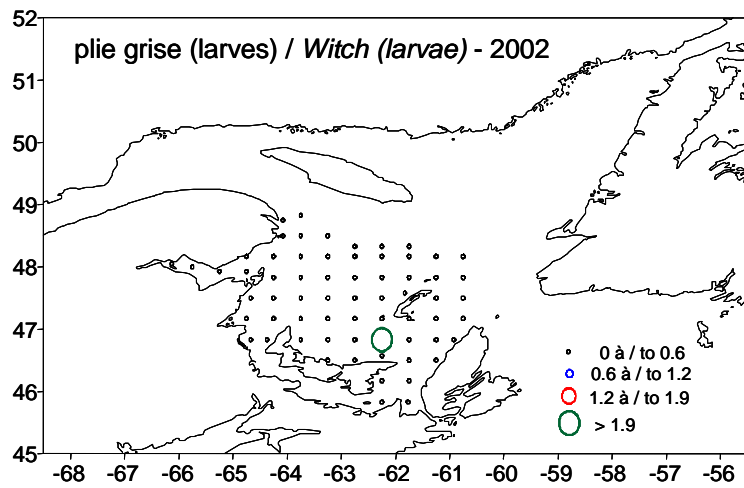
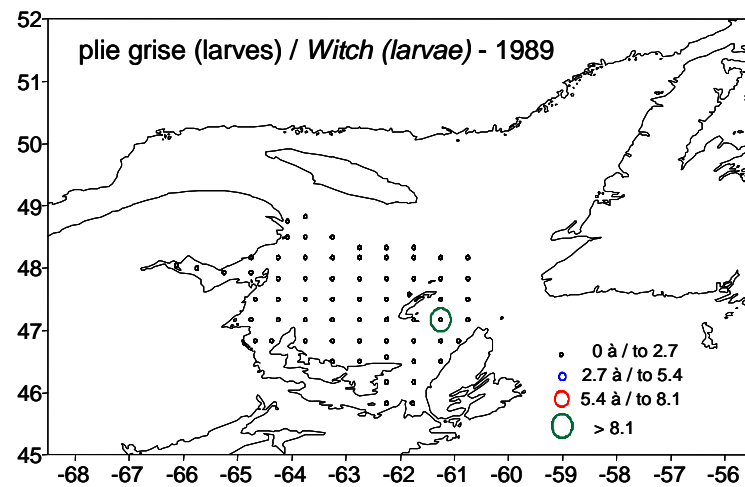
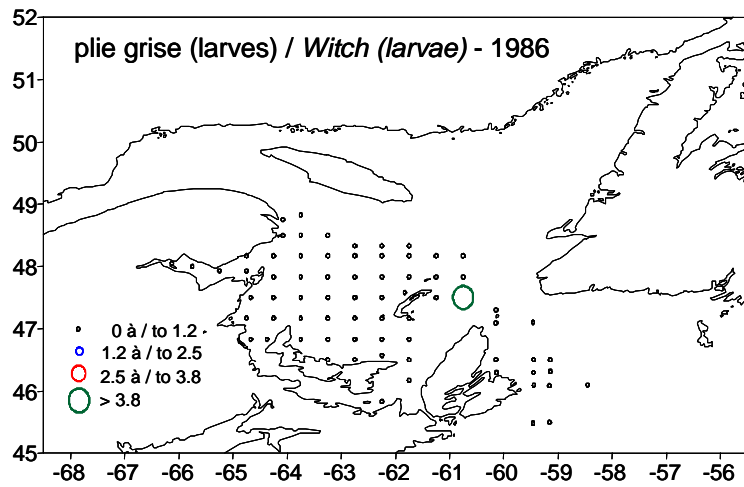
C35 – Abundance values as number / m²



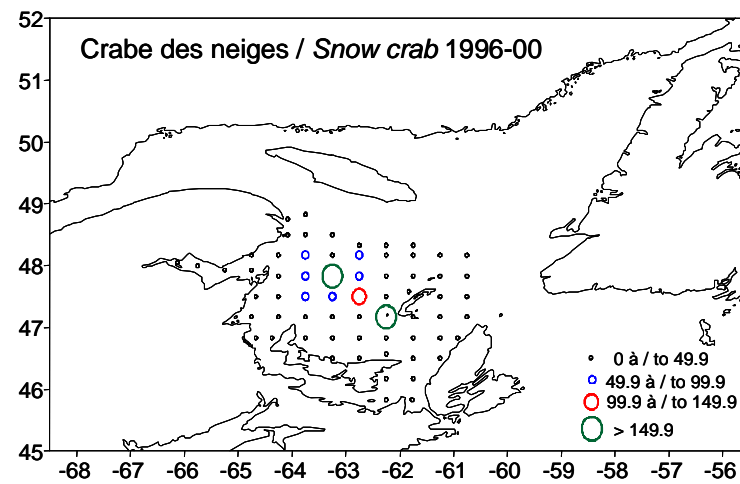
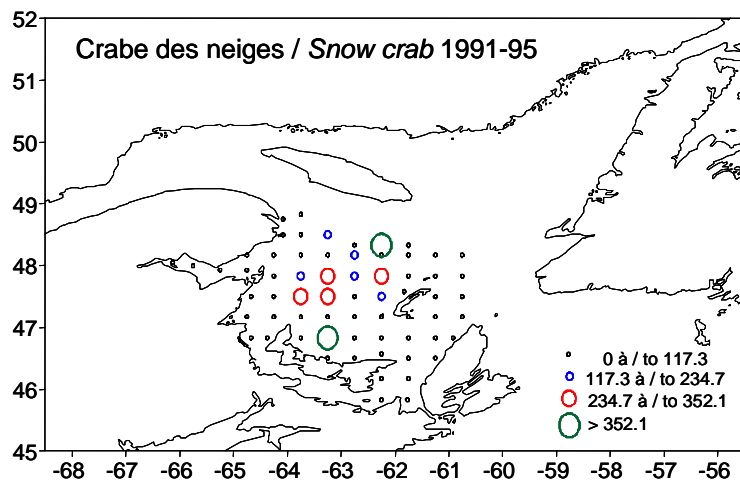
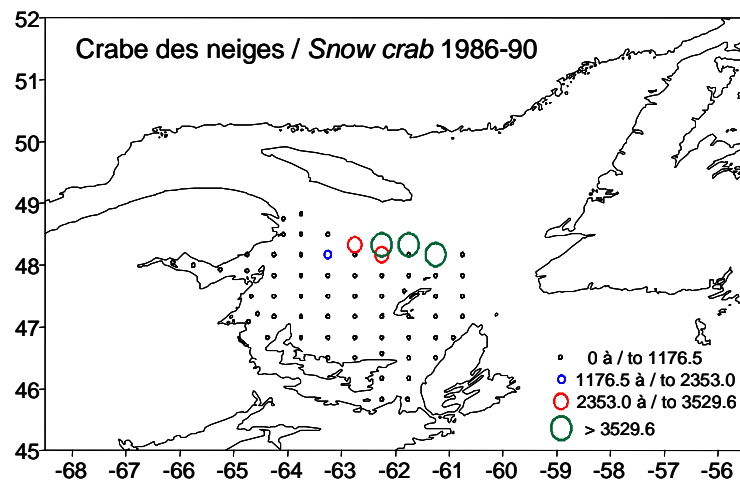
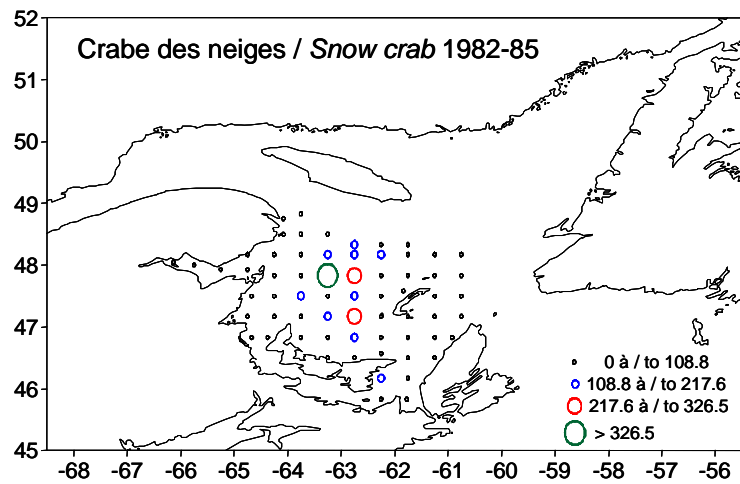
C36 – Abundance values as number / m²



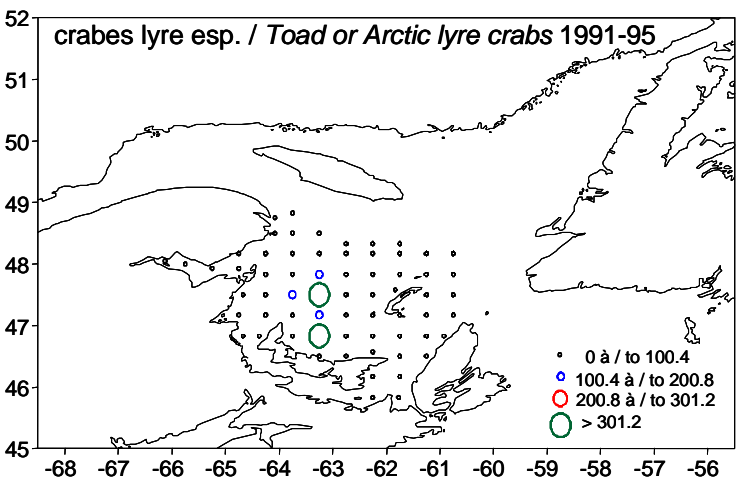
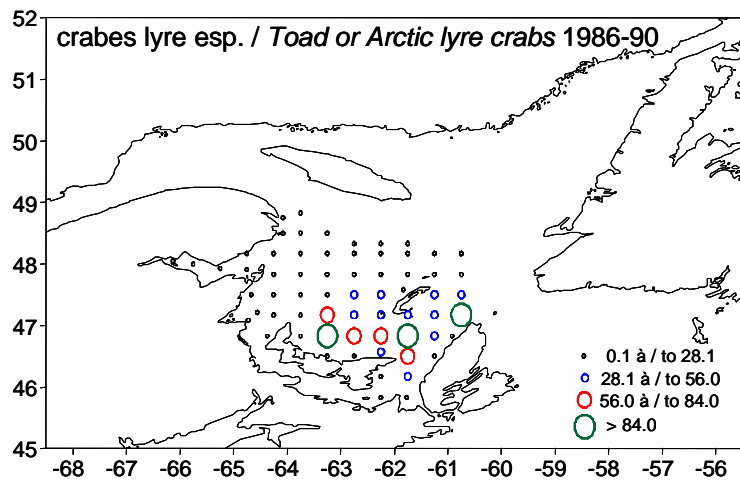
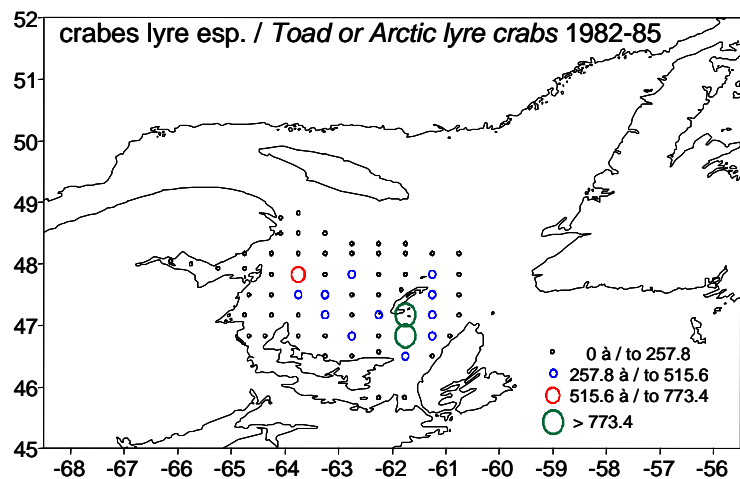
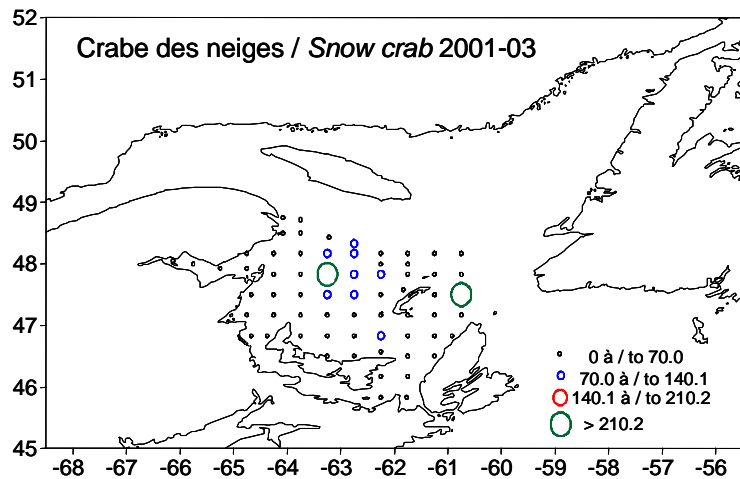
C37 – Abundance values as number / m²



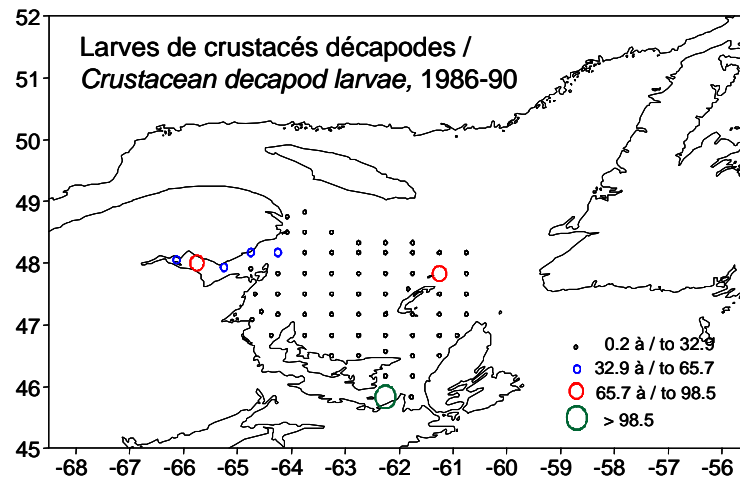
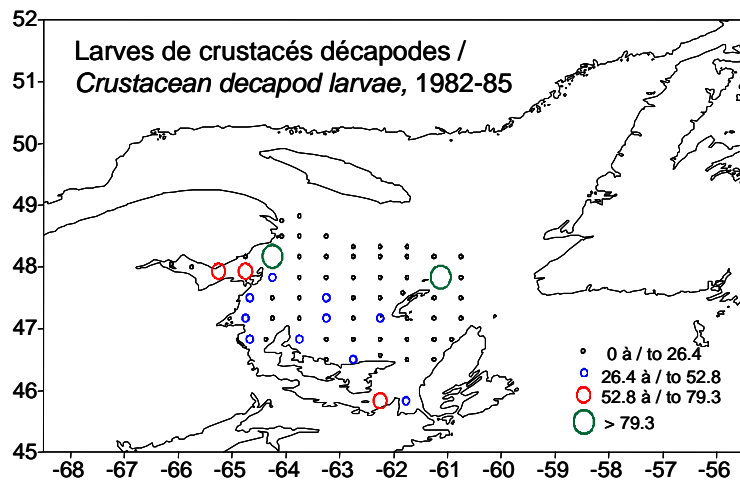
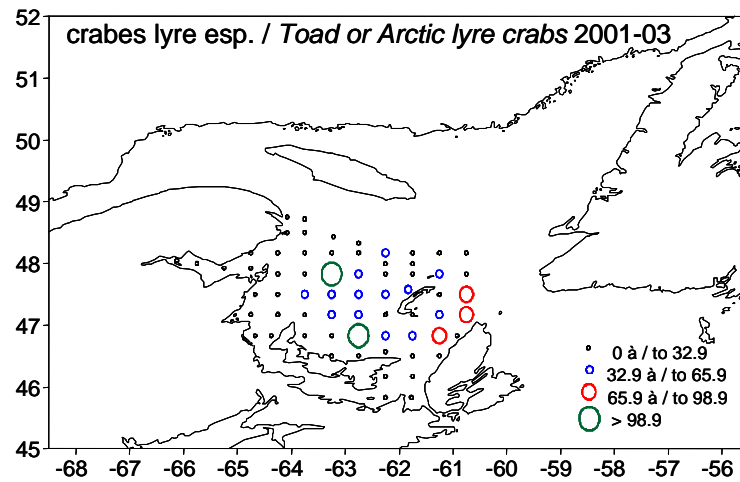
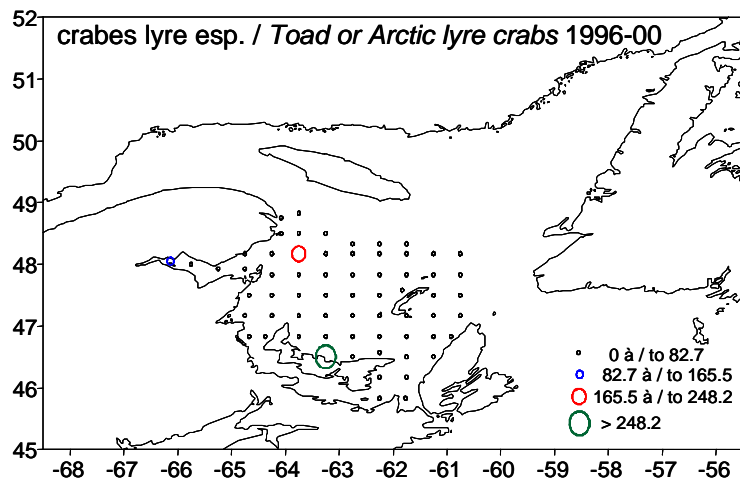
C38 – Abundance values as number / m²



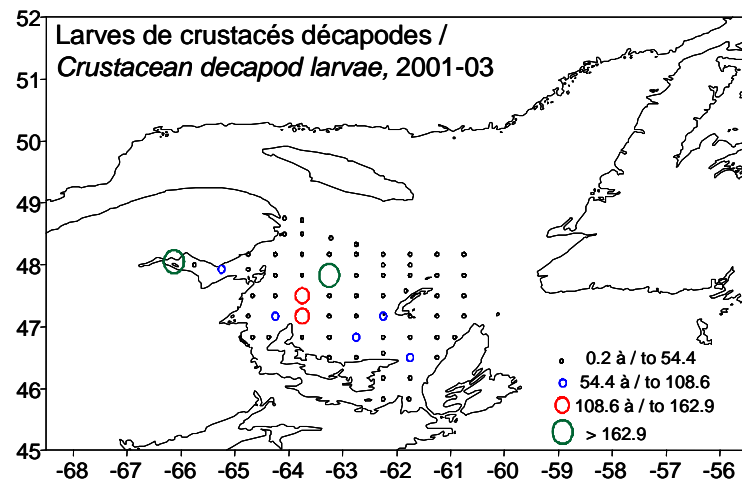
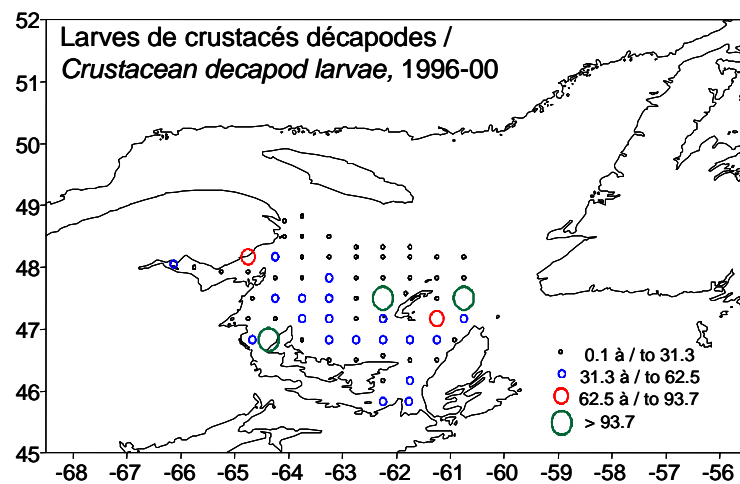
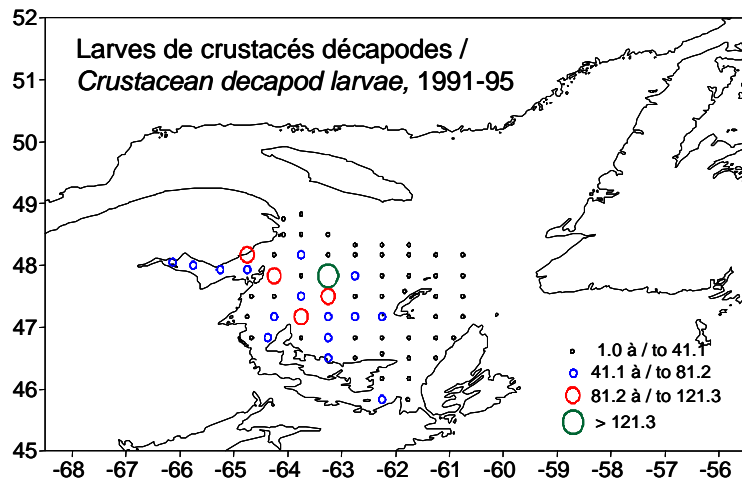
C39 – Abundance values as number / m²



C40 – Abundance values as number / m²



C41 – Abundance values as number / m²



C42 – Abundance values as number / m²