Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences
Quebec Region
Canadian Science Advisory Secretariat
Science Advisory Report 2012/054

# ASSESSMENT OF THE IMPACT OF NORTHERN SHRIMP TRAWLING ON BENTHIC HABITATS COMMUNITIES IN THE ESTUARY AND NORTHERN GULF OF ST. LAWRENCE

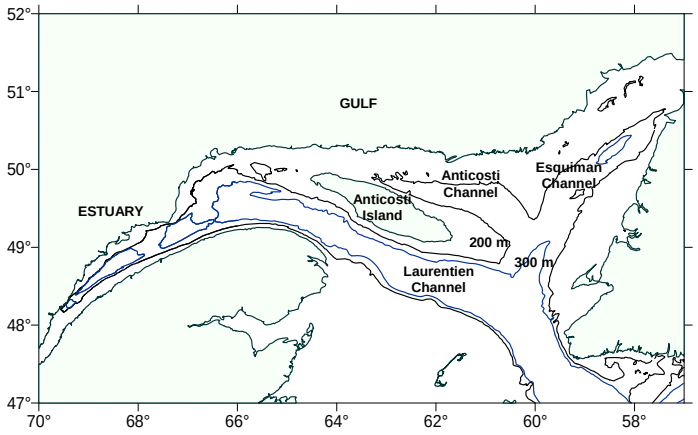


*Figure 1. Estuary and Gulf of St. Laurence and geographic sites mentioned in the text.*

## Background

*The northern shrimp fishery is carried out using mobile gear (otter trawls) with certain components (doors, foot gear) in contact with the seafloor during the tow. The fishery may therefore have an impact on the seafloor and the associated benthic communities. In compliance with the United Nations Food and Agriculture Organization's (FAO) Code of Conduct for Responsible Fisheries, the Department of Fisheries and Oceans (DFO) promotes responsible fishing aimed at reducing by-catches and mitigating impacts on habitat wherever biologically justifiable and cost effective. Canada is also committed, under UN Resolution 61/105, to providing enhanced protection to marine habitats that are particularly vulnerable.*

*In compliance with DFO's Policy for Managing the Impact of Fishing on Sensitive Benthic Areas, the likelihood of serious or irreversible damage to benthic areas of biological or ecological importance in the Estuary and Gulf of St. Lawrence caused by northern shrimp fishing activities must be assessed based on the information available. The northern shrimp fishery in the Estuary and northern Gulf of St. Lawrence has been certified sustainable and well managed according to the Marine Stewardship Council (MSC) criteria for wild fisheries. However, the current certification is subject to certain conditions focusing on determining the impact of trawls used.*

*This document summarizes the information available on fishing activities and on sensitive or fragile benthic species as well as on habitats suitable for the establishment of highly diverse benthic communities. This information is used to produce an assessment of the impact of trawling on benthic communities.*

## SUMMARY


- The shrimp trawl used until now in the Estuary and Gulf of St. Lawrence is designed to maintain contact with the seafloor throughout a tow. Dragging the foot gear and doors along the seafloor disrupts the substrate, affecting benthic communities and habitats.

- The footprint of shrimp trawling was analyzed by reviewing the distribution of the cumulative fishing effort since 1982. Shrimp fishing generally takes place at water depths of 200 to 300 m in the Esquiman and Anticosti channels as well as along the two slopes of the Laurentian Channel as far as in the Estuary. The traditional fishing grounds are located in areas where surface sediments are fine and consolidated and where natural disturbances have minimal impact.

- Coral and sponge fields constitute vulnerable marine ecosystems that are sensitive to bottom trawling due to the sessile nature and low growth rate of these organisms. In the Gulf of St. Lawrence, significant concentrations of sea pens (soft corals) are observed in deep water in the Laurentian Channel, while sponges are distributed in aggregations throughout the area. Benthic communities may also constitute fragile ecosystems in that bottom trawling can reduce their diversity and modify their structure. The great majority of habitats suitable for the establishment of highly diverse benthic communities are found in coastal areas.

- The cumulative impact of shrimp trawling has likely been low on sea pen fields and highly diverse benthic communities since the depths targeted for fishing (200 – 300 m) are not optimal depths for the establishment of sea pen fields (>300 m) or highly diverse benthic communities (<200 m).

- Because sponge aggregations are found in a large range of depths, regular fishing activity may have affected their distribution. Moreover, important concentrations of sponges are observed in areas that were intensively fished in the 1980s but where little fishing activity has since been documented. Therefore, some recovery potential seems to be possible after a period of intensive trawling.

- The likelihood that shrimp fishing activities cause harm to vulnerable or fragile marine ecosystems is low to moderate. High concentrations of sea pens and sponges and habitats suitable for the establishment of highly diverse benthic communities are found on the periphery of traditional fishing grounds. The overlap between trawling activities and these vulnerable or fragile habitats could occur occasionally, as has been the case in the past.


## INTRODUCTION

In the Gulf of St. Lawrence, the only type of authorized northern shrimp *Pandalus borealis* fishing is commercial fishing with a trawl. Experiments in the use of traps for shrimp fishing have been conducted in the past, but the results have been disappointing and the yields poor. The shrimp trawl used so far is designed to maintain contact with the seafloor throughout a tow. Wing spread of the trawl is maintained using two doors. A footrope equipped with rollers and bobbins (foot gear) is used to protect the net from damage caused by the substrate while also keeping it on the seafloor. The foot gear comes into contact with the substrate only at the bobbins and at either end.

The gear (doors, footrope) length in contact with the seafloor on trawls typically used in the gulf was estimated at about 12 m. Taking into consideration mean towing speed (4.2 km/h) and average tow duration (4.6 h), the seafloor area affected by the shrimp fishery in the Estuary and the Gulf could reach 4,000 to 8,000 km² per year depending on the total fishing effort, which corresponds to slightly more than 5% of the total fishing areas. Dragging the foot gear and doors along the seafloor disrupts the substrate, inevitably affecting benthic populations, communities and habitats. However, the impact of trawling is inconsistent and depends on fishing intensity and the characteristics of the benthic habitats.

# ANALYSIS

## Northern shrimp distribution and habitat

According to data from the survey conducted in the estuary and northern gulf by DFO starting in 1990, more than 80% of the cumulative northern shrimp biomass is found between 200 and 300 m in areas with a bottom temperature of 4 to 6 °C (Savard and Nozères 2012). The median depth of the northern shrimp distribution is 259 m and the median temperature 5.2 °C. The survey is deemed to effectively cover the entire distribution range of the northern shrimp in the Estuary and Gulf of St. Lawrence. The distribution of the northern shrimp is generally associated with the deep channels in the gulf (Figure 2). The species occurs only rarely in the southern gulf.

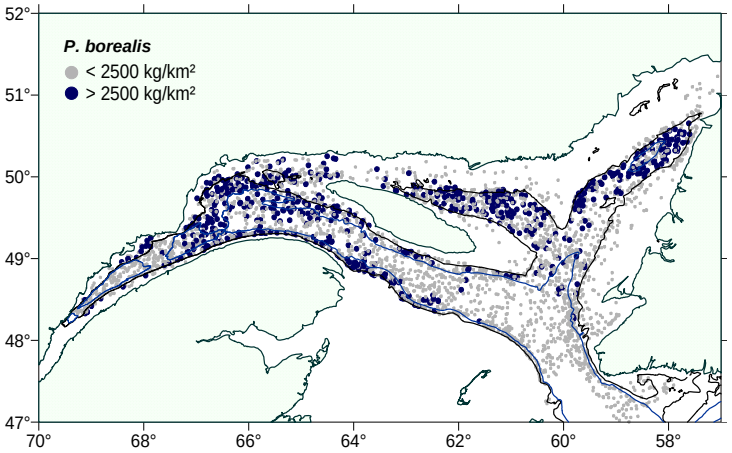


*Figure 2. Distribution of catch rates (kg/km²) for northern shrimp based on research surveys conducted between 1990 and 2011.*

Through classification of habitats based on a series of variables used to characterize the seafloor (salinity, temperature, dissolved oxygen, depth, slope and relief, sediment type), a number of mega-habitats have been identified in the estuary and northern gulf (Dutil et al. 2011). Deep-water habitats are found in channels associated with high concentrations of northern shrimp. The channel bottoms feature fine sediment (pelite, sandy pelite), while the sides with their varying slopes are characterized by coarser sediment (gravelly-sandy pelite). Habitats in coastal areas do not generally support high northern shrimp concentrations. These habitats consist of sediment of various types and sizes (pelite, sand, gravel, rock).

## Distribution of fishing effort

Licence holders for shrimp fishing are required to document their operations in a logbook. This has enabled data compilation on the fishing effort in grid format (statistical squares of 10 minutes of latitude by 10 minutes of longitude) from 1982 to 2011 (Savard 2012). The distribution of cumulative effort by decade is illustrated in Figure 3. The resolution of information in the grid does not support fine analysis of individual tows. It is possible for a single grid square to cover a significant range of depths. A surveillance program of at-sea operations with 5% coverage of fishing activities is ensured by observers who record detailed information concerning individual tows (Savard 2012). According to data from at-sea observers from 1999 to 2011, the majority of tows took place at depths of between 200 and 300 m (Figure 3). The mean tow depth for tows done with observers was 251 ± 47 m (n = 15 291).

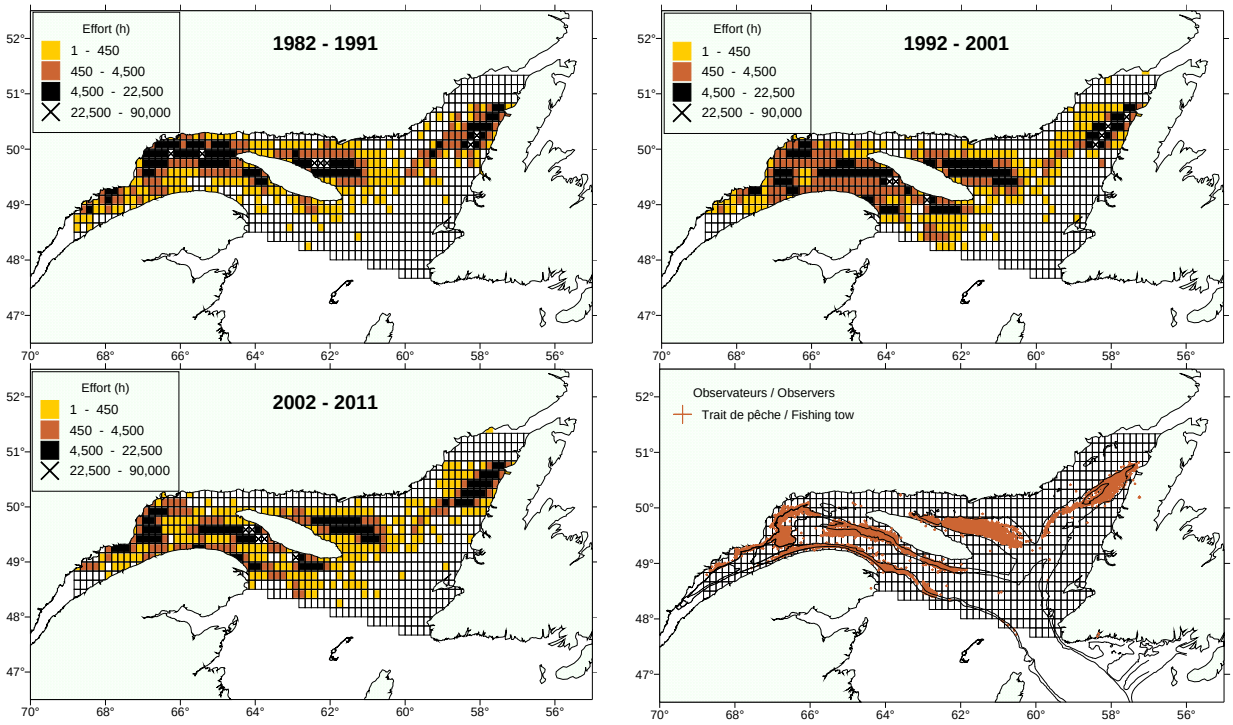


*Figure 3. Distribution of fishing effort by decade from 1982 to 2011 and distribution of tows conducted with at-sea observers on board between 1999 and 2011.*

The same areas are fished by shrimp harvesters from one decade to the next and constitute the traditional fishing grounds. Shrimp fishing generally takes place at water depths of 200 to 300 m in the Esquiman and Anticosti channels as well as along the two slopes of the Laurentian Channel as far as the estuary.

## Distribution of benthic communities

An analysis of data relating to benthic epifauna from the DFO survey conducted between 2006 and 2009 indicates that benthic communities are structured by environmental variables, the most important of these being depth and temperature (Lévesque et al. 2012). The analysis has also confirmed that bottom structure affects the distribution of benthic epifauna. Habitats suitable for the establishment of highly diverse benthic communities have been modelled for the full study area based on physiographic and oceanographic variables recorded for the entire estuary and gulf (Figure 4). The sectors marked in yellow represent sites where potential for the establishment of diverse benthic communities is highest.

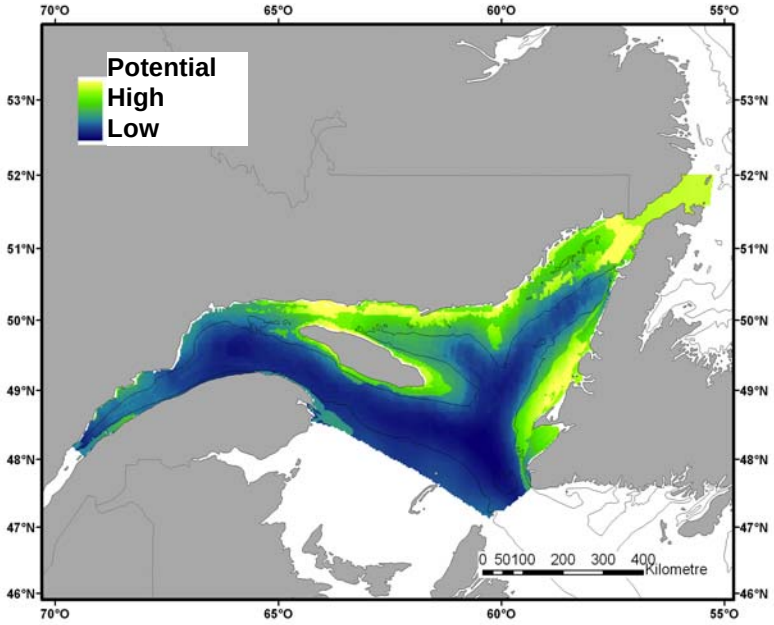


*Figure 4. Predicted potential for establishment of highly diverse benthic communities based on results of survey between 2006 and 2009.*

Overall, the shoreline and the 200 m depth contour appear to clearly delineate the areas with high potential for benthic diversity. These areas are located in the Strait of Belle Isle and along the north shore in the eastern gulf as well as along the western coast of Newfoundland and around Anticosti Island. The deep channels, the estuary and the Gaspé Peninsula coast do not appear a priori to be optimal habitats in terms of observing high benthic diversity.

## Distribution of sensitive species

Habitat complexity may also increase due to the presence of structures such as soft corals and sponges which could giver shelter to various small size organisms (particularly invertebrates) and attract fish, increasing the diversity of an ecosystem. Moreover, the presence of these

species, which are sessile or not much mobile and have a low growth rate, makes a community even more fragile. The vulnerability of these organisms was determined in accordance with FAO guidelines in response to UN resolution 61/105 and taking into account lifecycle characteristics, their role in the ecosystem and their recovery capacity after a disturbance.

Studies on the distribution of corals and sponges have been undertaken in the gulf based on DFO research surveys (Kenchington *et al.* 2010). Corals were represented by multiple taxa, half of which corresponded to soft corals from the subclass Alcyonaria and are not considered to be sensitive species due to their capacity to retract when disturbed. Sea pens (soft corals from the order Pennatulacea) and gorgonians (order Gorgonacea) are considered to be sensitive, but only the sea pens were sufficiently abundant to allow for classification. No species of black coral, which occur occasionally in deep water elsewhere in Canada, were collected in relation to the surveys subject to analysis. All of the sponge species collected were classified as falling into a single taxon.

Using the survey data, biomass thresholds were defined above which sea pen and sponge concentrations are considered high (Figure 5). The high concentrations of sea pens are found exclusively in deep areas in the Laurentian Channel, while the high concentrations of sponges are distributed in aggregations throughout the study range. It is to be noted that sea pen concentrations in the Laurentian Channel are considered unique in that their density is more than 10 times that observed in the Canadian Atlantic.

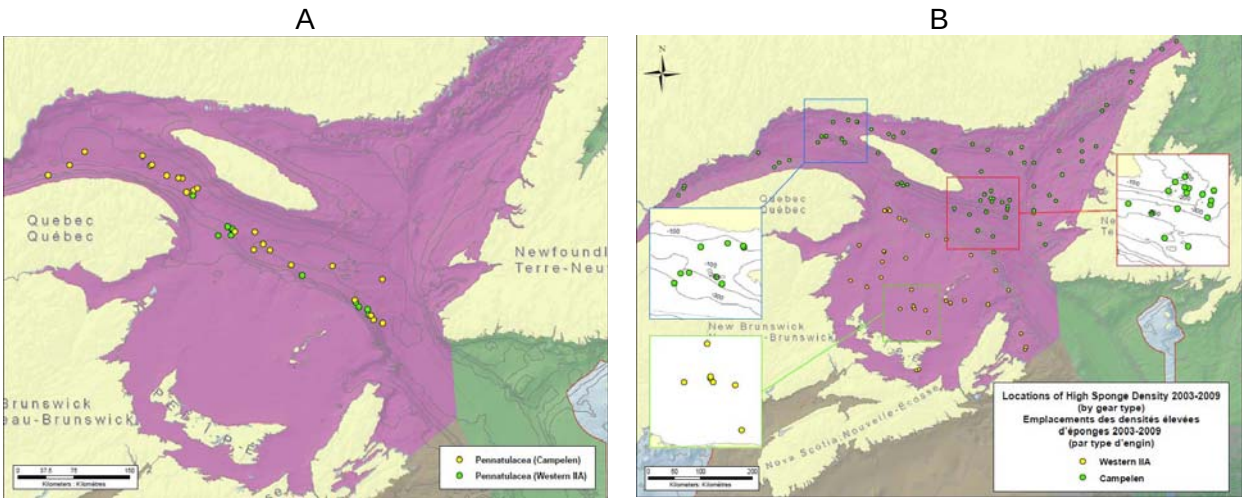


*Figure 5. Distribution of significant catches of A) sea pens and B) sponges in the Gulf of St. Lawrence (source: DFO 2010).*

## Assessment of the impact of trawling

A science advisory report on the potential effects of mobile gear (including trawls) on benthic habitats and communities was published by DFO's Canadian Science Advisory Secretariat in 2006 (DFO 2006). According to this report, dredges and bottom trawls were considered to be the most damaging to benthic populations, communities and habitats per unit of effort. It also found that consideration of gear impacts needed to take into account both the expected impact per unit of effort and the amount of effort required to harvest a given amount of the target species.

### Effect of trawling

More than a dozen effects of the use of mobile gear on the seafloor and on benthic populations and communities are listed in the science advisory report on the impacts of mobile gear (DFO 2006). It is noted in general that bottom mobile gears can damage or reduce habitat structure and complexity. These gears can also change the relative abundance of species and hence can alter the composition of benthic communities. They can decrease the abundance of long-lived species with low turnover rates and affect populations of structurally fragile species more often and to greater extents than populations of robust species. Bottom mobile gears may have sub-lethal effects (i.e., injury, exposure) on individuals of benthic populations. These effects may increase the vulnerability of these individuals to other sources of mortality.

In light of the likely effect of use of bottom mobile gears, it may be presumed that shrimp trawling as currently practised in the gulf can cause damage to the habitat and the associated benthic communities.

### Footprint of shrimp fishing

Fishing grounds may be classified by the intensity of the trawling practised on them since 1982. Trawling intensity can be assessed for each fishing squares in terms of cumulative total fishing hours per decade and total number of years during which activities were observed. Trawling was regularly and intensive and the impact is maximum when the effort by fishing square is more than 450 hours per decade for at least two decades. Fishing squares are considered to have been subjected to occasional trawling where they have been trawled for more than 450 hours but for only one decade. Trawling is classified as rare and its impact as insignificant where the cumulative effort per square per decade is less than 450 hours. The threshold of 450 hours per square corresponds to trawling covering approximately one-tenth of the area available for fishing in an average square assuming no overlapping of trawling tows. Figure 6A illustrates the footprint of shrimp trawling.

The majority of fishing sites subjected to regular and intensive trawling are located at depths of 200 to 300 m in the Esquiman and Anticosti channels and along the two slopes of the Laurentian Channel between the eastern end of Anticosti Island and the estuary (Figure 6A). The distribution of regular fishing grounds is confirmed by at-sea observer data collected between 1999 and 2011 (Figure 6B).

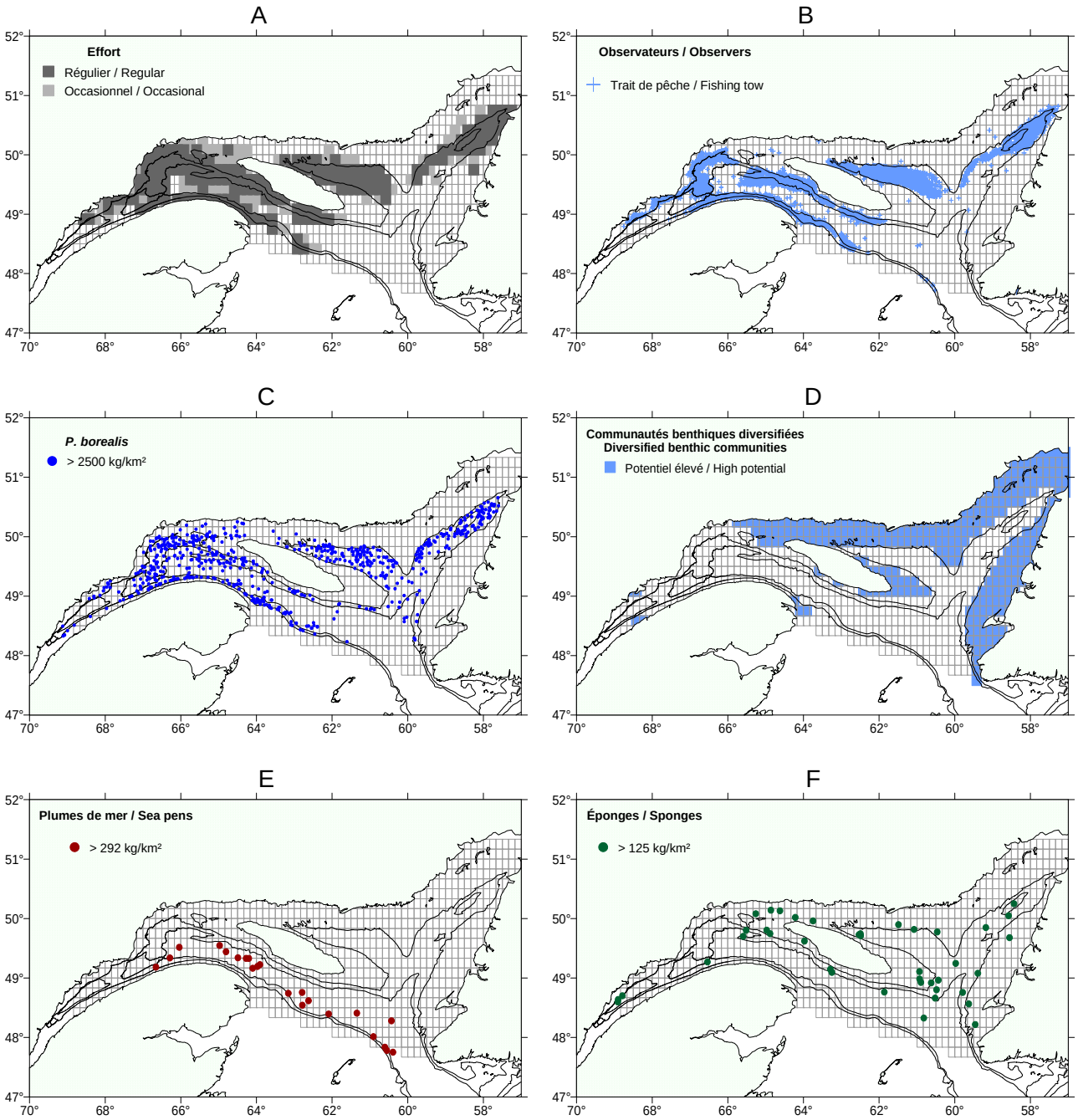


*Figure 6. Spatial distribution of:*
*A) cumulative fishing effort from 1982 to 2011*
*B) tows conducted with an observer on board between 1999 and 2011*
*C) high northern shrimp concentrations from surveys conducted between 1990 and 2011*
*D) habitats suitable for the establishment of diverse benthic communities from surveys conducted between 2006 and 2009*
*E) significant sea pen concentrations from surveys conducted between 2004 and 2009*
*F) significant sponge concentrations from surveys conducted between 2006 and 2009.*

Impact on sensitive or vulnerable benthic communities

Northern shrimp are associated with the deep water mass. The species is found mainly in channels at depths of 200 to 300 m where sediment is fine and consolidated and natural disturbances have minimal impact (Figure 6C). These areas are less suitable for the establishment of highly diverse benthic epifauna (Figure 6D). Sites targeting northern shrimp for fishing are consequently not expected to fall within areas with high potential for benthic diversity. Based on data for the distribution of effort and from observers, fishing activities have for the most part remained clear of inshore areas. As a result, the impact of fishing on the establishment of diverse benthic communities appears to have been low.

Significant concentrations of sea pens have been observed in the Laurentian Channel at depths exceeding 300 m (Figure 6E). However, according to data from at-sea observers, shrimp fishers have avoided most of these sites because they are too deep. The impact of trawling on these sensitive organisms has likely been low.

Significant concentrations of sponges are distributed throughout the area at depths ranging from 100 to 300 m (Figure 6F). Regular fishing activities appear to have affected sponge distributions. However, few sponges are found of in sectors where trawling is regular and intensive while aggregations are observed in sectors where trawling is rare (east of Anticosti Island). We also observe sponge aggregations in sites where intensive fishing activities occurred during the 1980s but where few activities have occurred since (west of Anticosti Island). Trawling consequently appears to have had significant impact on sponges, although these species also appear to exhibit certain recovery potential after intensive fishing.

## Sources of Uncertainty

There are several uncertainties concerning the footprint of the shrimp fishing. The contact length of the trawl with the sea bed can be larger than estimated. The distribution of the fishing effort by statistical square is not precise and the at-sea observer data cover only 5% of the fishing activities. The data on sensitive species and vulnerable communities result from research surveys of which continuation will contribute to precise their distribution. However, the premise that the shrimp trawl causes damage on habitat and benthic communities on the whole surface of a fishing square that is exploited at least occasionally allows to determine the sectors where the impact of trawling was significant in the past and could eventually be important in the future.

# CONCLUSIONS

Neither sensitive marine ecosystems nor habitats suitable for the establishment of highly diverse benthic communities are found in the grounds fished most heavily within the last 20 years.

The cumulative impact of shrimp trawling has likely been minimal on sea pen fields and highly diverse benthic communities since the depths targeted for fishing (200 – 300 m) are not optimal depths for the establishment of sea pen fields (>300 m) or highly diverse benthic communities (<200 m). However, the regular fishing activities have likely had a significant impact on sponges. This impact appears reversible but the sponge field recovery rate is not determined.

The likelihood of damage to these types of habitats due to fishing is low to moderate insofar as fishing activities and these sensitive or vulnerable habitats may occasionally overlap, as has

been the case in the past. High concentrations of sea pens and sponges and habitats suitable for the establishment of highly diverse benthic communities are found on the periphery of traditional fishing grounds in sites fished occasionally since 1982. Since some of these sites also support concentrations of northern shrimp, they may eventually be subjected to fishing in the future.

## SOURCES OF INFORMATION

This Science Advisory Report is from the May 17, 2012 Assessment of the impact of northern shrimp trawling on habitat and benthic communities in the Estuary and northern Gulf of St. Lawrence. Additional publications from this process will be posted as they become available on the Fisheries and Oceans Canada Science Advisory Schedule at www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

Coulombe, F., Rivière, A. and Plourde, Y. 2011. Étude technologique sur le chalut à crevettes et impact potentiel de la modification de certains éléments du train de pêche sur l'écosystème benthique. Merinov, RP 11-05. 13 p.

DFO. 2006. Impact of Trawl Gears and Scallop Dredges on Benthic Habitats, Populations and Communities. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/025.

DFO. 2010. Occurrence, Susceptibility to Fishing, and Ecological Function of Corals, Sponges, and Hydrothermal Vents in Canadian Waters. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/041.

DFO. 2012. Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas. May 2012 version. http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/benthi-eng.htm

Dutil, J.-D., Proulx, S., Chouinard, P.-M., and Borcard, D. 2011. A hierarchical classification of the seabed based on physiographic and oceanographic features in the St. Lawrence. Can. Tech. Rep. Fish. Aquat. Sci. 2916: vii+ 72 pp.

Kenchington, E., Lirette, C., Cogswell, A., Archambault, D., Archambault, P., Benoit, H., Bernier, D., Brodie, B., Fuller, S., Gilkinson, K., Lévesque, M., Power, D., Siferd, T., Treble, M., and Wareham, V. 2010. Delineating Coral and Sponge Concentrations in the Biogeographic Regions of the East Coast of Canada Using Spatial Analyses. DFO Can.Sci. Advis. Sec. Res. Doc. 2010/041. vi + 202 pp.

Lévesque, M., Savard, L., Moritz, C. and Archambault, P. 2012. Assessment of the potential impacts of northern shrimp (*Pandalus borealis*) trawl fishing on benthic habitats in the Estuary and northern Gulf of St. Lawrence.DFO Can. Sci. Advis. Sec. Res. Doc. 2012/094. ii + 31 p.

Savard L. 2012. Distribution of Northern shrimp fishing effort in the Estuary and Gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/092. ii+ 21 p.

Savard L. and Nozères, C. 2012. Atlas of Shrimps of the Estuary and Northern Gulf of St. Lawrence. Can. Tech. Rep. Fish. Aquat. Sci. 3007: vi + 67 p.

## FOR FURTHER INFORMATION

Contact: Louise Savard
Maurice Lamontagne Institute
850 route de la Mer
P.O. Box 1000
Mont-Joli, Quebec
G5H 3Z4

Tel.: 418-775-0621
Fax: 418-775-0740
E-mail: louise.savard@dfo-mpo.gc.ca

This report is available from the:

Centre for Science Advice (CSA)
Quebec Region
Fisheries and Oceans Canada
Maurice Lamontagne Institute
P.O. Box 1000, Mont-Joli
Quebec, Canada
G5H 3Z4

Telephone: 418-775-0825
Fax: 418-775-0679
E-mail: Bras@dfo-mpo.gc.ca
Website: www.dfo-mpo.gc.ca/csas-sccs

ISSN 1919-5079 (Print)
ISSN 1919-5087 (Online)


*La version française est disponible à l'adresse ci-dessus.*

## CORRECT CITATION FOR THIS PUBLICATION:

DFO. 2012. Assessment of the impact of northern shrimp trawling on benthic habitats communities in the Estuary and northern Gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/054.