IDENTIFICATION OF ATLANTIC SURFCLAM FISHING AREAS OFF GROSSE-ÎLE (MAGDALEN ISLANDS, QUEBEC) TO AVOID IMPACTING LOBSTER HABITAT

Context

The economy in the Magdalen Islands is based on commercial fishing, but particularly on coastal species. With the decreased access to many offshore stocks (pelagic fish, groundfish, snow crab), the coastal area surrounding the archipelago is increasingly sought, increasing the likelihood of conflicts between different users. In fact, exceptionally serious conflicts took place in 2009 in the Grosse-Île area between Atlantic surfclam and lobster fishermen. In 2009, Atlantic surfclam fishermen, which for several years had focused their activities on the south side of the Islands, began to explore new areas between Pointe-de-l'Est and Grosse-Île. The arrival of these new fishermen using mobile gear in the vicinity of traditional lobster fishing grounds angered lobster fishermen who called for an end to this activity. Their concern was that the recurring passage of dredges could damage lobster habitat and potentially reduce lobster productivity. Fisheries Management is sensitive to this concern and they would like to introduce measures for managing the Atlantic surfclam fishery, and more typically the mobile gear fishery. Fisheries Management from the district office of Department of Fisheries and Oceans Canada in Îles-de-la-Madeleine (Québec) requested that DFO Science identifies and accurately locates the bottoms that represent lobster habitats on the one hand and Atlantic surfclam habitats on the other, and based on this information, delineates areas where Atlantic surfclam fishing with a hydraulic dredge would be acceptable.

To answer this question, the results from a multibeam survey conducted in the summer of 2010 by the Canadian Hydrographic Service (CHS) in the Grosse-Île area, where the conflict appeared between the two groups of fishermen were used. An SSRP was used because Fisheries Management was seeking an advice before the beginning of the Atlantic surfclam fishing season in 2011.

The main conclusions are as follows:

- The two fisheries that are the subject of the dispute, lobster and Atlantic surfclam, are not carried out in the same areas. The lobster fishery is conducted on rocky bottoms, while the surfclam fishery is done primarily on soft substrates.
- Although the bathymetric distribution of both species overlaps, the surfclam fishery is done at depths generally shallower than lobster.
- The conflict between the two groups of fishermen is largely due to the close juxtaposition of habitats for both species. The exploitation of a surfclam bed located very near a rocky reef is a problem because during fishing operations, certain dredge tows could encroach on the rocky substrate. This encroachment can cause habitat damage, especially in the case of sandstone, a weak rock which is frequently found in these areas. This type of rock can easily fracture when it comes in contact with a massive gear such as a dredge.
- The surfclam fishery restriction in defined areas will clearly confine the activity and avoid overlapping or encroachment on hard bottoms. The passage of dredgers would be

strictly limited to primarily soft substrates and would be carried out away from rocky habitats. In such a context, the Atlantic surfclam fishery is not likely to cause any conflict.

Background

The Grosse-Île area has supported a lobster fishery for over a hundred years. Fishermen exploit the rocky substrates, usually between 5 and 35 meters deep, which are the preferred habitat of adult lobsters. Juvenile lobsters prefer rocks and pebbles that have many interstices for shelter. They are generally more abundant in shallow waters (2-5 meters). The Atlantic surfclam is a buried species. They are mainly found on soft bottoms composed of sand mixed with clay and gravel. They are found from the infralittoral zone to a depth of about 20 meters. Lobsters frequent soft bottoms transiently and occasionally in their passage between the reefs, during their seasonal movements between the coast and offshore and after moulting in the fall when they are actively looking for food. However, a small fraction of the lobster population, in particular larger individuals, might occur permanently in soft-bottom areas where they dig trough-shaped depressions.

Since the preferred habitats of lobster and Atlantic surfclam are different, it is believed that if the Atlantic surfclam fishing activities were restricted and took place only within their preferred habitat or on soft substrates, the risk of impacts on lobster habitat would be minor. This would prevent mobile gear from coming into contact with rock outcrops, often made of soft friable sandstone. The fact that lobsters do not use soft substrates on a permanent basis, impacts on lobster would be minimized, except perhaps for the few larger individuals who occur in trough-shaped depressions. These lobsters are likely able to flee at the approach of a dredge, but this behaviour has not been verified. It is believed that dredge fishing activities do not disturb lobster nurseries because the latter are mainly located on rock and pebble bottoms, at shallower depths (< 5 meters) than where Atlantic surfclams are harvested.

In order to obtain information on where lobster and Atlantic surfclams occur, a multibeam survey was conducted in the summer of 2010 by the Canadian Hydrographic Service (CHS) in the Grosse-Île area, where the conflict appeared between the two groups of fishermen. The objective of this survey was 1) to produce bathymetric and backscatter maps, 2) to identify and accurately locate the bottoms that represent lobster habitats on the one hand and Atlantic surfclam habitats on the other, and 3), based on this information, delineate areas where Atlantic surfclam fishing with a hydraulic dredge would be acceptable.

Multibeam Data Collection

Multibeam bathymetric surveys were conducted in the Grosse-Île area by the CHS between July 10 and August 13, 2010. The Guillemot, equipped with a Kongsberg EM-3002 multibeam sounder, was used to cover areas between 2 and 10 meters deep and the Creed, equipped with a Kongsberg EM-1002 sounder, was used to cover areas deeper than 10 meters. The surveys covered an area of 90 km^2 between 2 and 29 m deep.

Image Production by the CHS

Four categories of images were produced by the CHS: 1) a colour bathymetry image, 2) a grayscale image of the raw backscatter data, 3) a colour image representing three substrate

classes and 4), a colour image representing the three substrate classes superimposed on a relief image of the sea-floor.

The classification of substrate types was conducted by the CHS from raw backscatter data. A semi-supervised type classification was done with the HIPS software, version 6.1, by the Caris company (module Image Classification). A first substrate class, associated with hard substrates, was determined based on high backscatter values associated with a bathymetry showing a sea-floor with relief (rough as opposed to smooth). For this “hard” substrate class, the backscatter values were between 78 and 110. All backscatter values below 78 were associated with soft substrates. Two soft substrates classes were defined. A class of soft sediments which backscatter values ranged between 66 and 78 and a class of softer sediments, with lower backscatter values (48 to 66). The splitting of the two latter classes was done arbitrarily and only serves to distinguish a bottom relatively softer than the other. Images showing the three types of substrate were created using a median filter to eliminate noise and better define the contours of the classes. Three colours were associated with the different classes. For the map including sediment classification and relief, the intensity of the colours assigned to each classification diminishes as the depth decreases.

Classification results should not be interpreted as absolute values of the nature of the sea-floor. Field observations (photographs, bottom samples, images, etc.) will be needed to confirm the exact nature and composition of the sea-floor. For example, it is possible that a bottom with a high backscatter value is composed of packed sand rather than bare rock.

Fishery Data

To see how the fishing activities were distributed according to the bathymetry and the different types of bottoms, the lobster (2010) and surfclam (2008-2010) fishing positions were superimposed with the four CHS images. All maps were produced using ESRI ArcGIS Version 9.2 products (2006-2009). The geodetic datum system is the North American Datum 1983 (Nad1983) and the baseline projection used was the Transverse Mercator (NAD 1983 MTM4)

Lobster

During the 2010 fishing season, fishery officers in the Magdalen Islands area identified the location of all lobster traps buoy lines in the conflict area. Every week, the position of each buoy was recorded using a GPS. From the second week of fishing, the buoy position survey was concentrated in the area east of longitude 61^{o}29’ west, and west of longitude 61^{o}25’ west. Additional data on the location of lobster traps were also obtained for 2010 from the DFO at-sea sampling program of commercial catches. This sampling represents 6 fishing trips carried out on two different vessels at three periods (beginning, middle and end) of the fishing season. The sampling covers a wider area than that covered by fishery officers.

During the 1980s, The Ministère de l’agriculture, des pêcheries et de l’alimentation du Québec (MAPAQ) had produced lobster fishing distribution maps from the location of buoys obtained by aerial surveys. Information from the MAPAQ served as basis for image production by the Fish Habitat Management Information System (FHAMIS) of lobster distribution in the Islands (http://sighap-fhamis.qc.dfo-mpo.gc.ca). FHAMIS images were superimposed on the CHS images.

Atlantic Surfclam

The information on the positioning of surfclam fishing operations were obtained from the logbooks of commercial fishermen (one point per day) and at-sea observers (start and end positions of dredge tows, for 5% of days at sea) for 2008-2010.

Other Species (Yellowtail Flounder)

In addition, Magdalen Islands Fisheries Management asked that the location of yellowtail flounder commercial fishing locations be superimposed on the CHS maps. These fish are caught using a small door-trawl. The data on flounder trawl positions were obtained from logbooks (one point per day) and observers (start and end position of tows) for 2009 and 2010.

Analysis and Responses

Bottom Maps and Fishing Positions

A total of 42 maps were produced.

The first 8 maps show the images generated by the CHS. Fishing data were not included in these 8 maps to clearly identify the different environmental characteristics. Bathymetry maps (Figures 1A-B), backscatter maps (Figures 2A-B), substrate classification maps with relief (Figures 3A-B) and substrate classification maps without relief (Figures 4A-B) are presented based on two scales, first for the entire area covered by the survey (series A) and then with a magnification on the Grosse-Île area where the lobster-surfclam conflict is concentrated (series B).

The next 5 maps show the FHAMIS images on the distribution of lobster, which were superimposed on the bathymetry and backscatter images (Figures 5A-B) and the two substrate classification images (Figures 5C-D). The lobster fishing positions were added to the map showing the FHAMIS image superimposed on the bathymetry image, for the entire area covered by the survey (Figure 5E).

The following 12 maps show the lobster and Atlantic surfclam fishing positions which have been superimposed on bathymetry images (Figure 6A-C), backscatter images (Figures 7A-C), substrate classification images with relief (Figures 8A-C) and substrate classification maps without relief (Figures 9A-C). For each image category, maps are presented according to three different scales corresponding to the entire area covered by the survey (series A), and the Grosse-Île area where the lobster-surfclam conflict is concentrated (series B) and the Pointe-de-l'Est area (series C).

Information on the yellowtail flounder fishery is presented on three maps. The fishing positions were superimposed on the backscatter image for the entire area (Figure 10A), for the Grosse-Île area (Figure 10B) and the Pointe-de-l'Est area (Figure 10C), on which the lobster and surfclam fishing positions were kept.

Six maps were added showing the fishing positions for the 3 species (lobster, surfclam and flounder) separately. These maps were produced by placing bathymetry (Figures 11A-C) and backscatter (Figures 12A-C) images in the background.

Finally, 8 maps were produced showing areas where surfclam fishing could be permitted and the lobster habitat protection areas. The first four show the superimposed areas on the image of the three substrate classes (Figure 13A) and the backscatter image (Figure 13B) for the entire area and with a magnification of the areas where the conflict between the two fishing groups was more important (Figures 13C-D). In the last 4 figures (Figures 14A-D), the delineated areas were superimposed with the fishing data, and in the background, the four CHS images.

Lobster

The positions of the lobster trap buoys identified by fisheries officers in 2010 showed that the lobster fishery takes place mainly between 12 and 25 meters deep, in large part on rock outcrops revealed by rough bathymetry (Figure 11A) and by a strong backscatter signal (Figure 12A). Some fishing also occurs on hard smooth substrates, i.e. with high backscatter values, but where no rugosity appears on the bathymetry images. Data from at-sea sampling conducted in 2010 showed that lobster fishing also occurs west of the area surveyed by fisheries officers. This sector consists of a hard and rough substrate (Figures 11A and 12A).

It is interesting to compare data from the lobster fishery in 2010 with the lobster distribution ranges from the FHAMIS (Figure 5E). The FHAMIS images represent lobster buoy concentration areas obtained from a census conducted by the MAPAQ during the 1980s. It provides a general idea of lobster distribution in this area at that time. The FHAMIS distribution areas do not perfectly match the lobster harvesting areas identified in 2010. The differences could be explained by the fact that during the aerial buoy survey by the MAPAQ, a number of them could have been for other fixed gear fisheries. Otherwise, this could mean that the lobster harvesting effort would have shifted over the past 30 years, suggesting that there may have been some silting in this area which would favour the Atlantic surfclam. It should be noted that there is very little data on lobster distribution and FHAMIS images are often used as a reference. The FHAMIS images are presented superimposed on the four image categories from the CHS (Figures 5A-D).

Atlantic Surfclam

The distribution of Atlantic surfclam harvesting positions indicate that this fishery is carried out closer to shore than the lobster fishery and at depths ranging between about 7 meters to a maximum of 20-22 meters (Figures 11B). The surfclam fishery is practiced largely on smooth (Figure 11B) and soft bottoms, as revealed by a weak backscatter signal (Figure 12B). In the Pointe-de-l'Est area, dredge tows overlap a bottom where backscatter signals are relatively strong. However, the bottom is smooth and could be made of highly compacted sand rather than rock. The fact that repeated tows were made suggests that there were surfclams in this area, confirming that it is a soft substrate. The same can be seen in the Grosse-Île area. There seems to have been a few dredge tows (sometimes short) over an area where backscatter values were high. In this case, the proximity of lobster harvesting beds and the fact that dredge tows do not appear to have been repeated, suggests that the bottom is likely rocky in this area.

Yellowtail Flounder

Yellowtail flounder fishing positions are concentrated in shallow water between 7 and 13 meters deep (Figure 11C). Fishing is generally carried out on bottoms where backscatter signals are weak, corresponding to a soft substrate (Figure 12A), with the exception of two sectors in the Grosse-Île area, where the backscatter signal is strong (see Figure 2B). The bathymetry image

indicates that this bottom is rather smooth, which could correspond to a rocky bottom covered with a layer of sand thick enough to form a habitat for flounder (Figure 12C).

Lobster-Atlantic Surfclam Conflict

Figures 6-9 illustrate the harvesting positions of lobster and Atlantic surfclam and in the background, the four CHS image categories. The maps of the entire area covered by the multibeam survey, such as the bathymetric map (Figure 6A) and the backscatter map (Figure 7A), clearly reveal a spatial separation of the two harvesting activities. Although there is no overlapping per say, there is nevertheless a strong proximity between the two harvesting activities in the Grosse-Île area, in an area shallower than 20 meters (Figure 6B), and where an area of soft substrate is neighbour to a rocky reef (Figure 7B). In this particular place, it seems that the preferred habitats of both species are very close. It is observed that a few dredge tows have straddled the rocky substrate (Figure 7B).

There is no noted lobster harvesting activity in the Pointe-de-l'Est area, despite the presence of a rocky reef (high rough bathymetry and backscatter signal) (Figures 6C and 7C). Spatial segregation between the two types of fishing activities is well illustrated on the images where the type of substrate was categorized with relief (Figures 8A-C) or without relief (Figures 9A-C), highlighting the fact that these two fisheries occur on substrates of different nature. Using Grosse-Île area maps, shows the situation in more detail (Figure 8B) and with considerable contrast (Figure 9B).

The addition of yellowtail flounder fishery data on these images shows that this activity takes place at lesser depths than lobster and surfclams. The three fishing activities are segregated in space (Figures 10A). Yellowtail flounder fishing activities are separated by years (2009 and 2010). An agreement was made with flounder fishermen to move their efforts towards the east in 2010 in order to move away from lobster beds located to the west. The effort appears to have declined in the west in 2010 (Figure 10B). However, a tow encroachment over a hard surface, likely rock, was noted (Figure 10B). There seems to be little flounder fishing activity in the Pointe-de-l'Est area (Figure 10C).

Creation of Atlantic Surfclam Harvesting Areas

The information that was gained helped to delineate Atlantic surfclam fishing areas in the related sector (Figures 13A-B). Designated areas protect lobster habitat (protection zones). They were limited to soft substrates at a distance of about 30 meters from the rocky reefs. These areas include suitable habitat for surfclams, as confirmed by the results from the fisheries of the past two years. These habitats are not the primary habitats for lobster, although they are used occasionally and transiently. These areas do not constitute fishing grounds for lobster. Within the delineated fishing area, there are some areas which, in the classification process, were classified as hard substrate (Figures 13C-D). However, a study of the backscatter and bathymetry images seems to reveal that the substrate is soft and smooth. They were thus not excluded from the surfclam fishing area.

Conclusions

The two fisheries that are the subject of the dispute, lobster and Atlantic surfclam, are not carried out in the same areas. The lobster fishery is conducted on rocky bottoms, while the surfclam fishery is done primarily on soft substrates. Although the bathymetric distribution of both species overlaps, the surfclam fishery is done at depths generally shallower than lobster. The conflict between the two groups of fishermen is largely due to the close juxtaposition of habitats for both species. The exploitation of a surfclam bed located very near a rocky reef is a problem because during fishing operations, certain dredge tows could encroach on the rocky substrate. This encroachment can cause habitat damage, especially in the case of sandstone, a weak rock which is frequently found in these areas. This type of rock can easily fracture when it comes in contact with a massive gear such as a dredge.

The surfclam fishery restriction in defined areas will clearly confine the activity and avoid overlapping or encroachment on hard bottoms. The passage of dredgers would be strictly limited to primarily soft substrates and would be carried out away from rocky habitats. In such a context, the Atlantic surfclam fishery is not likely to cause any conflict.

The yellowtail flounder fishery should also be confined to the same areas, but could probably be extended to the hatched area (Figures 13A-B), after validation of the sea-floor classification. To eliminate uncertainties and improve the sea-floor classification, it would be appropriate to conduct substrate sampling in some areas to validate its composition.

This work is based on a visual analysis of bottom images and fishing positions and on existing information and knowledge on the environment and the species in question. The passage of dredges on soft bottoms may have indirect impacts on lobster and buried species (e.g. rock crab) and these aspects have not been covered here. Disruption of the sea-floor by dredges could make some prey more accessible and attract lobster, especially during its postmoult period in the fall, making it perhaps more vulnerable to the gear. These elements should be verified and if necessary, to better protect lobster during its postmoult period, a fishing season could be specified. The location of fishing grounds as defined here will have to be validated over the years due to sediment dynamics that could bring changes in the location of soft substrates.

Contributors

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Appendices

List of Figures

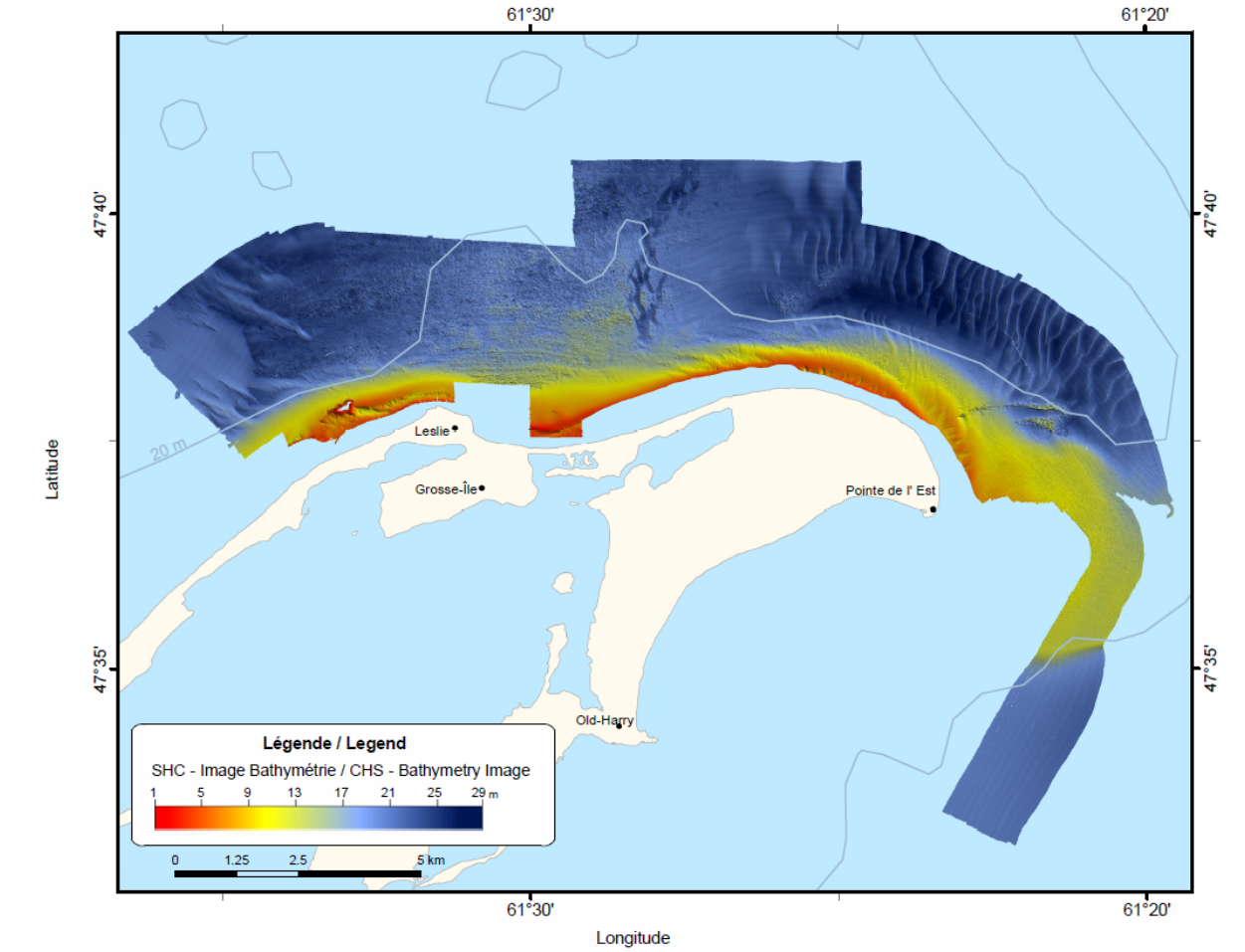

Figure 1A. Bathymetry Image (CHS).

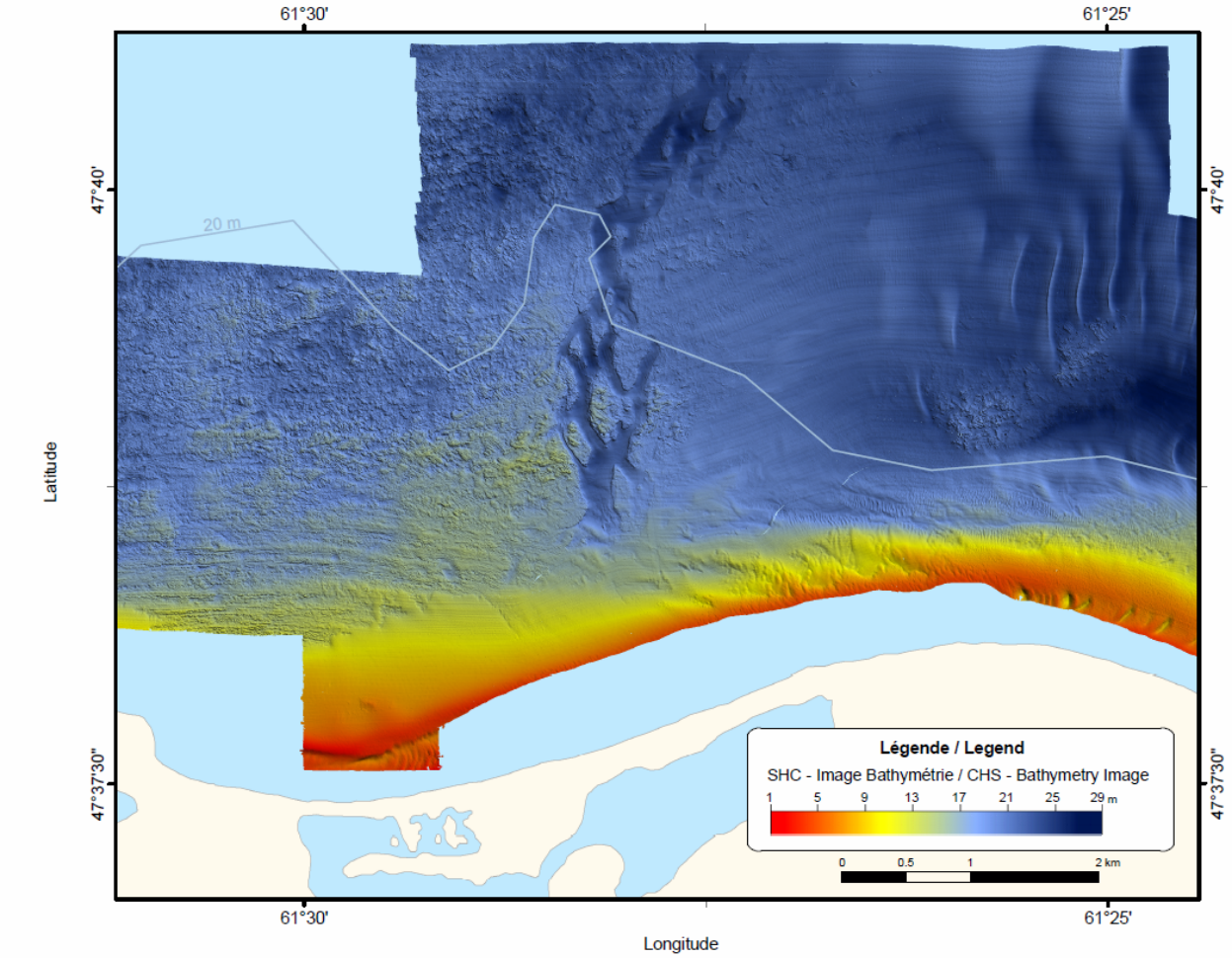

Figure 1B. Image Bathymetry (CHS) (Grosse-Île Area)

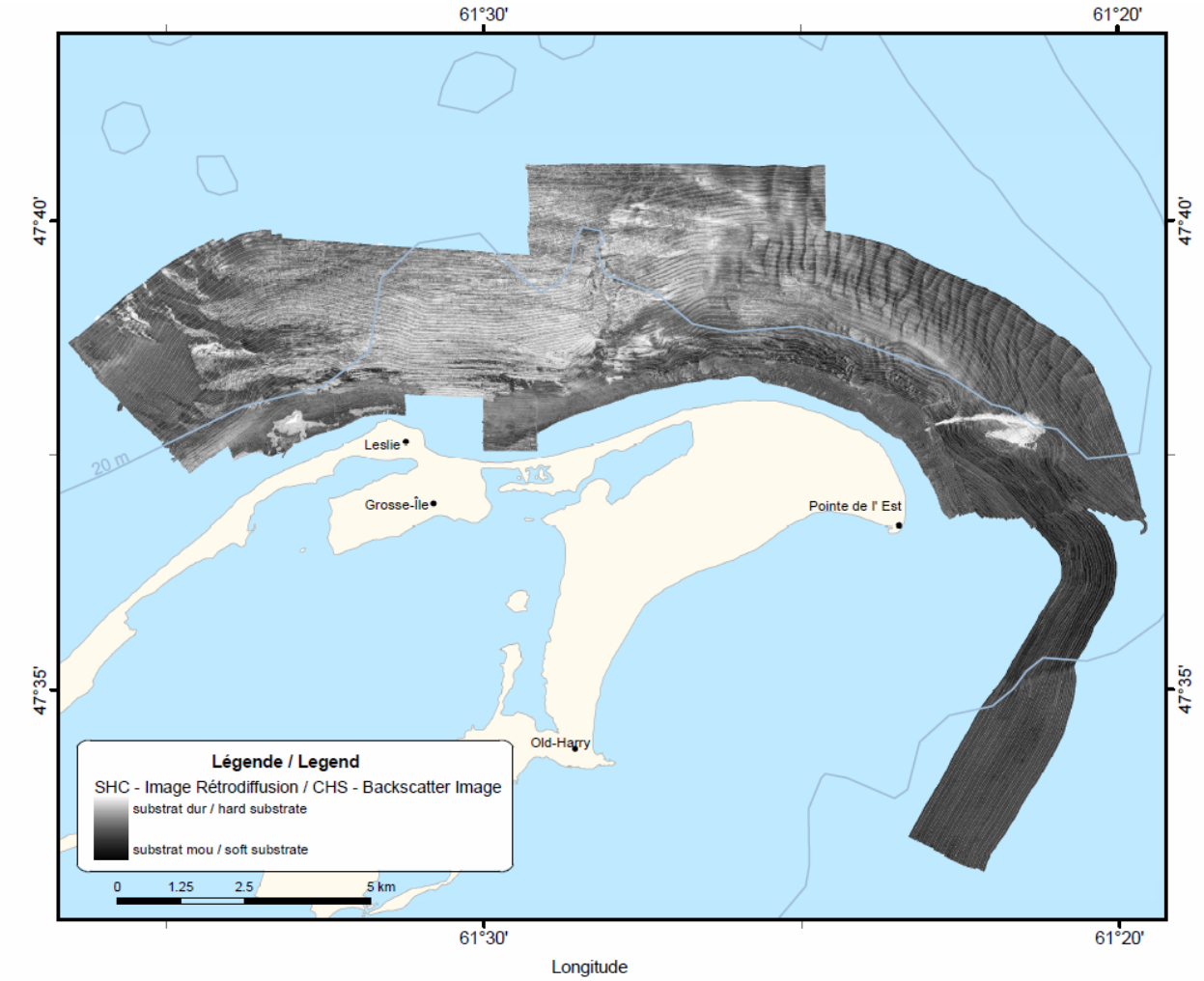

Figure 2A. Backscatter Image (CHS).

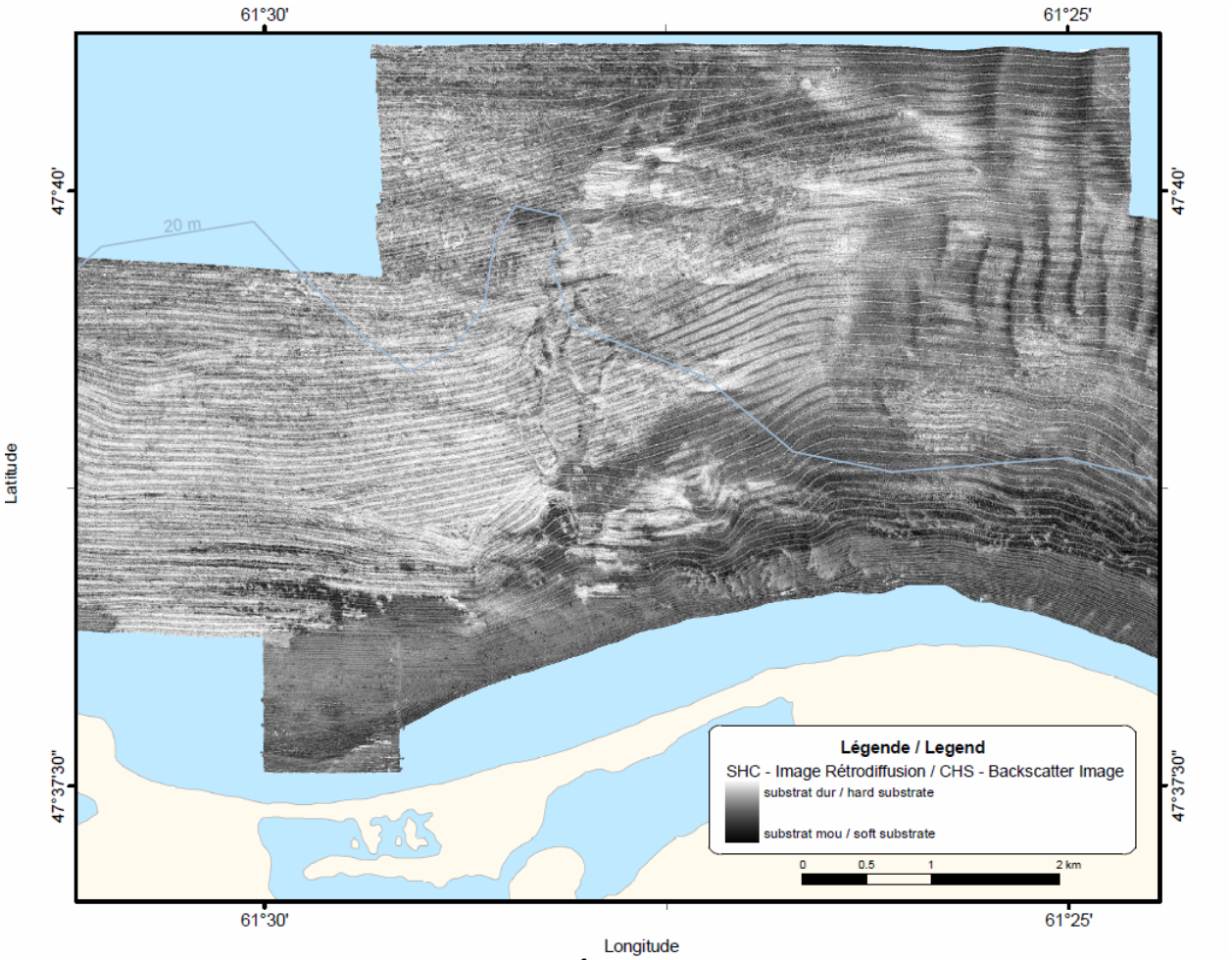

Figure 2B. Backscatter Image (CHS) (Grosse-Île Area).

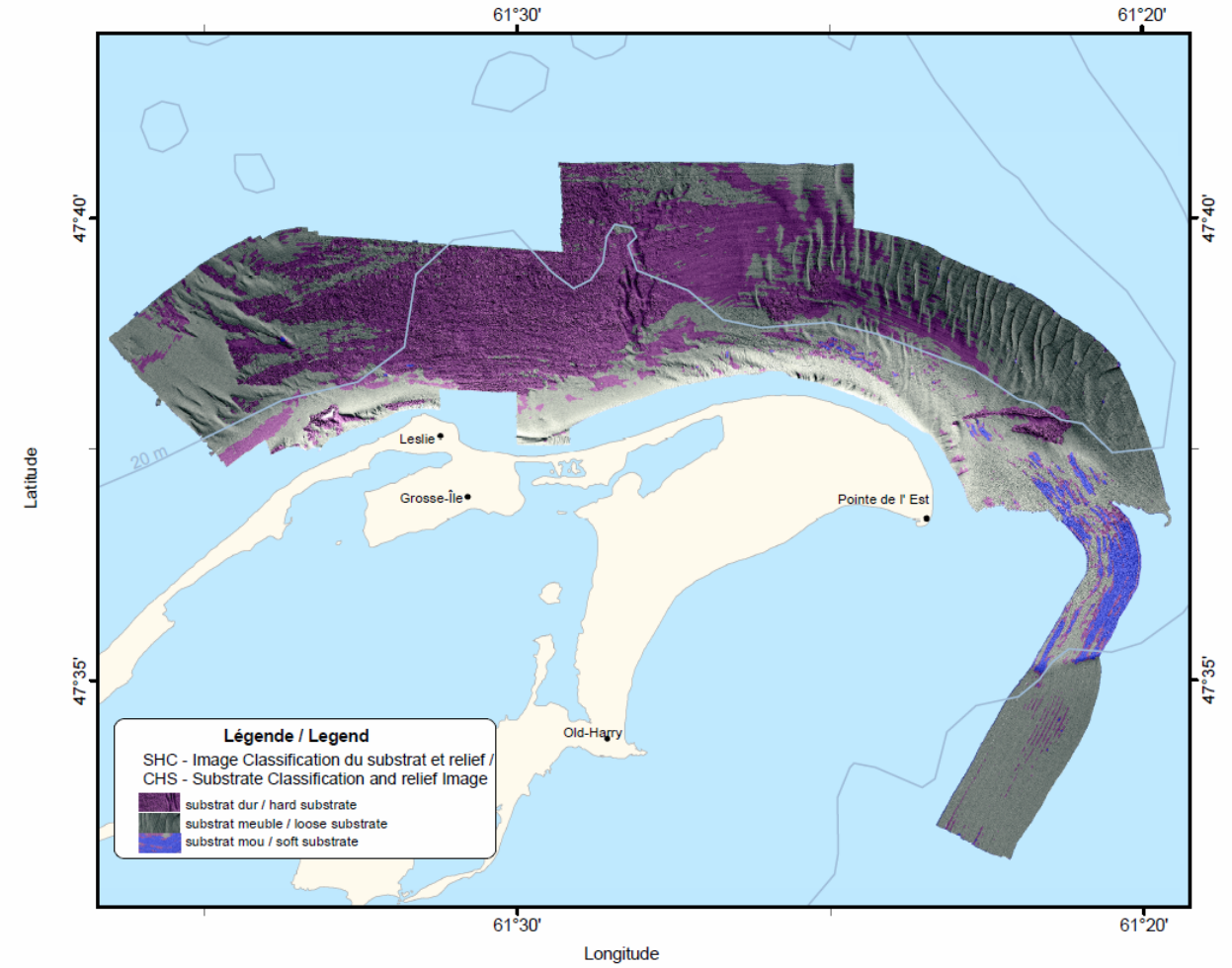

Figure 3A. Substrate Classification and relief Image (CHS).

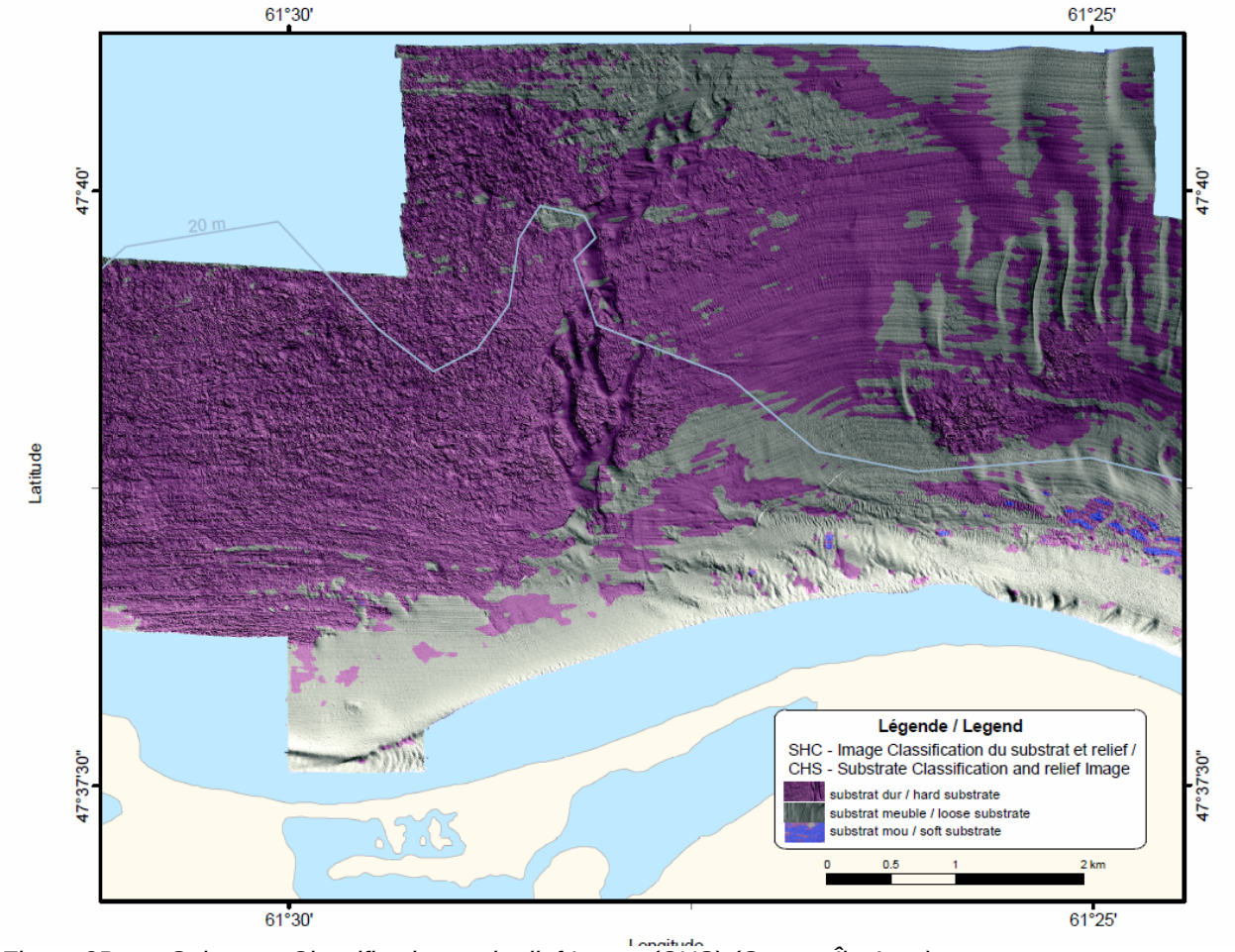

Figure 3B. Substrate Classification and relief Image (CHS) (Grosse-Île Area).

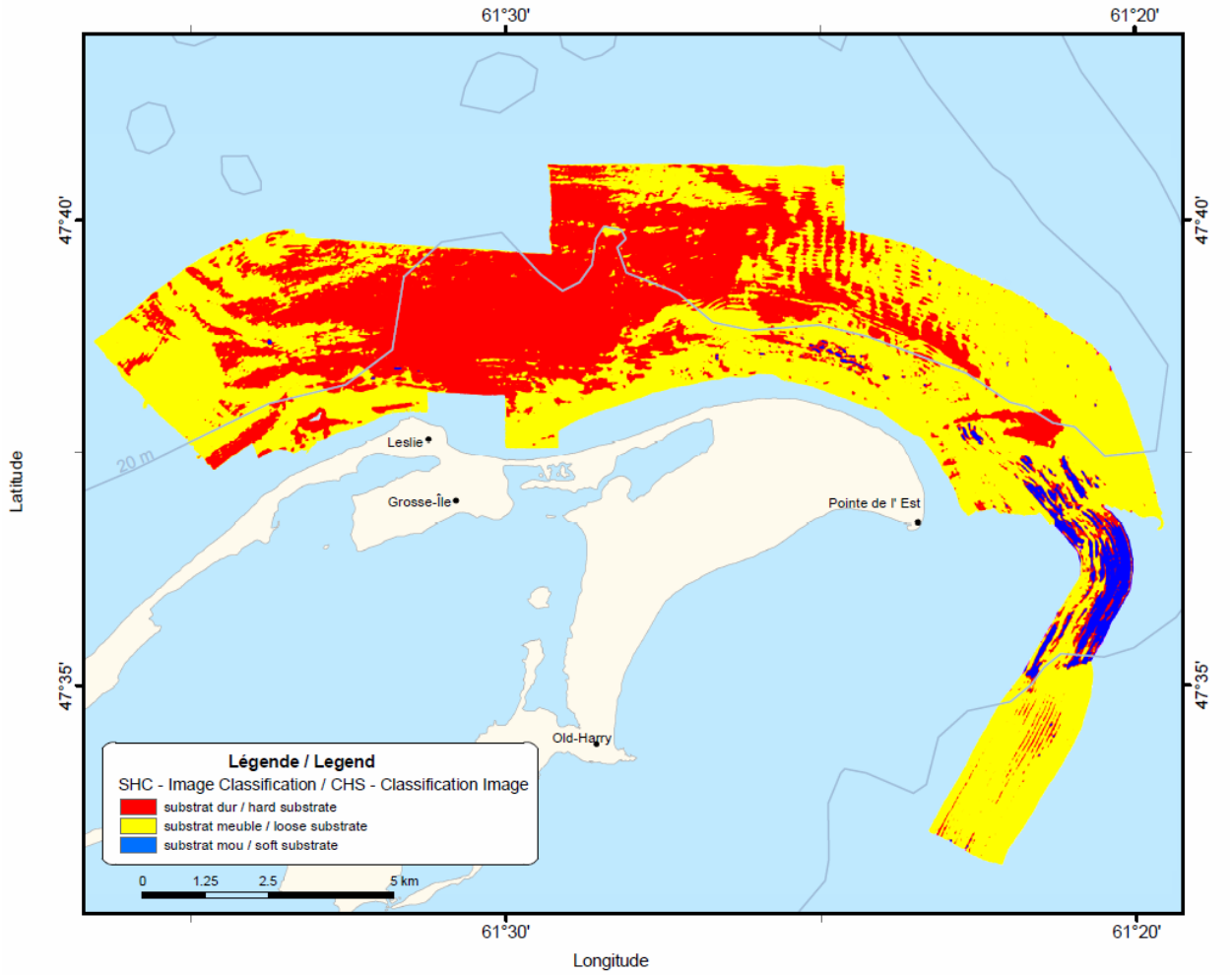

Figure 4A. Substrate Classification Image (CHS).

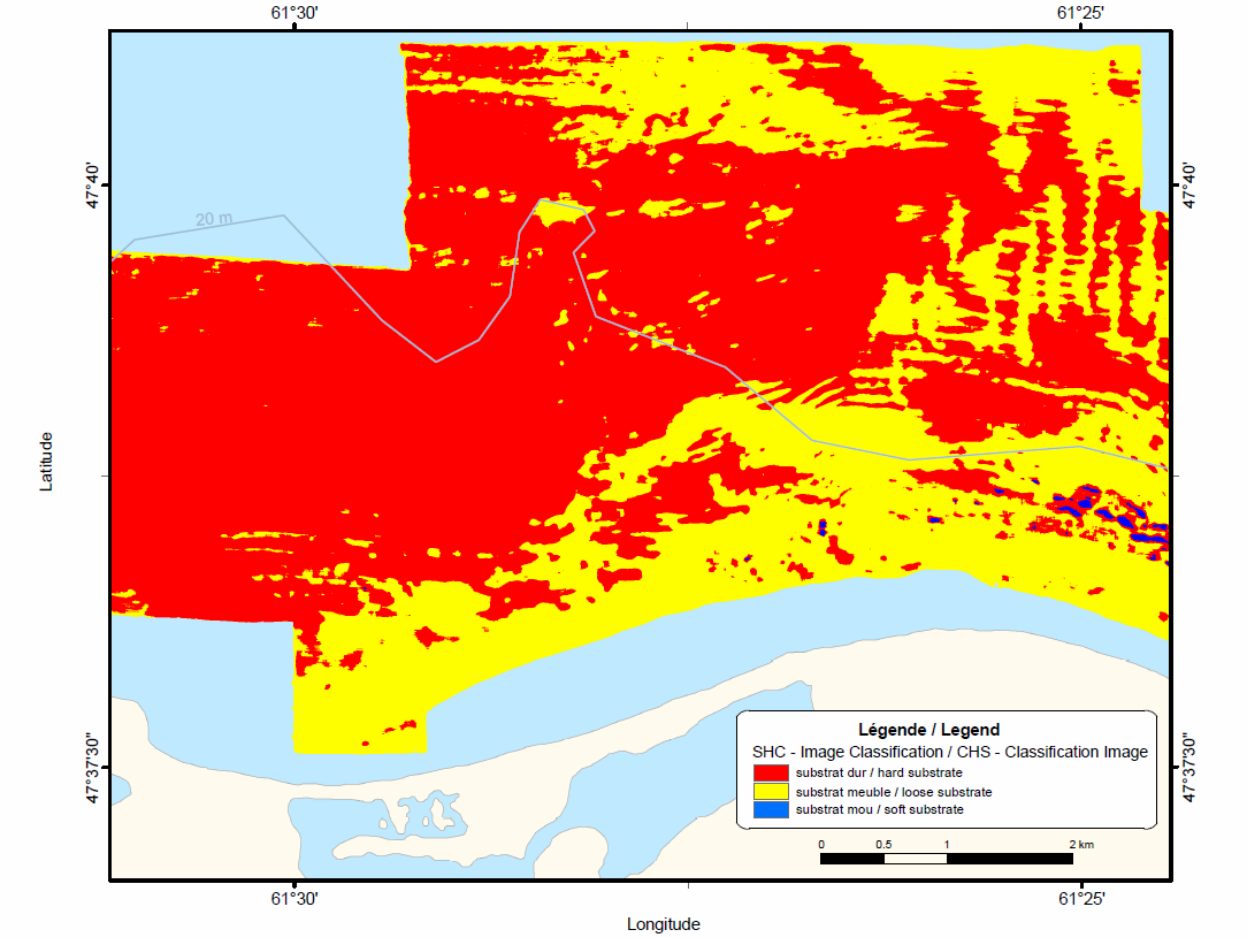

Figure 4B. Substrate Classification Image (CHS) (Grosse-Île Area).

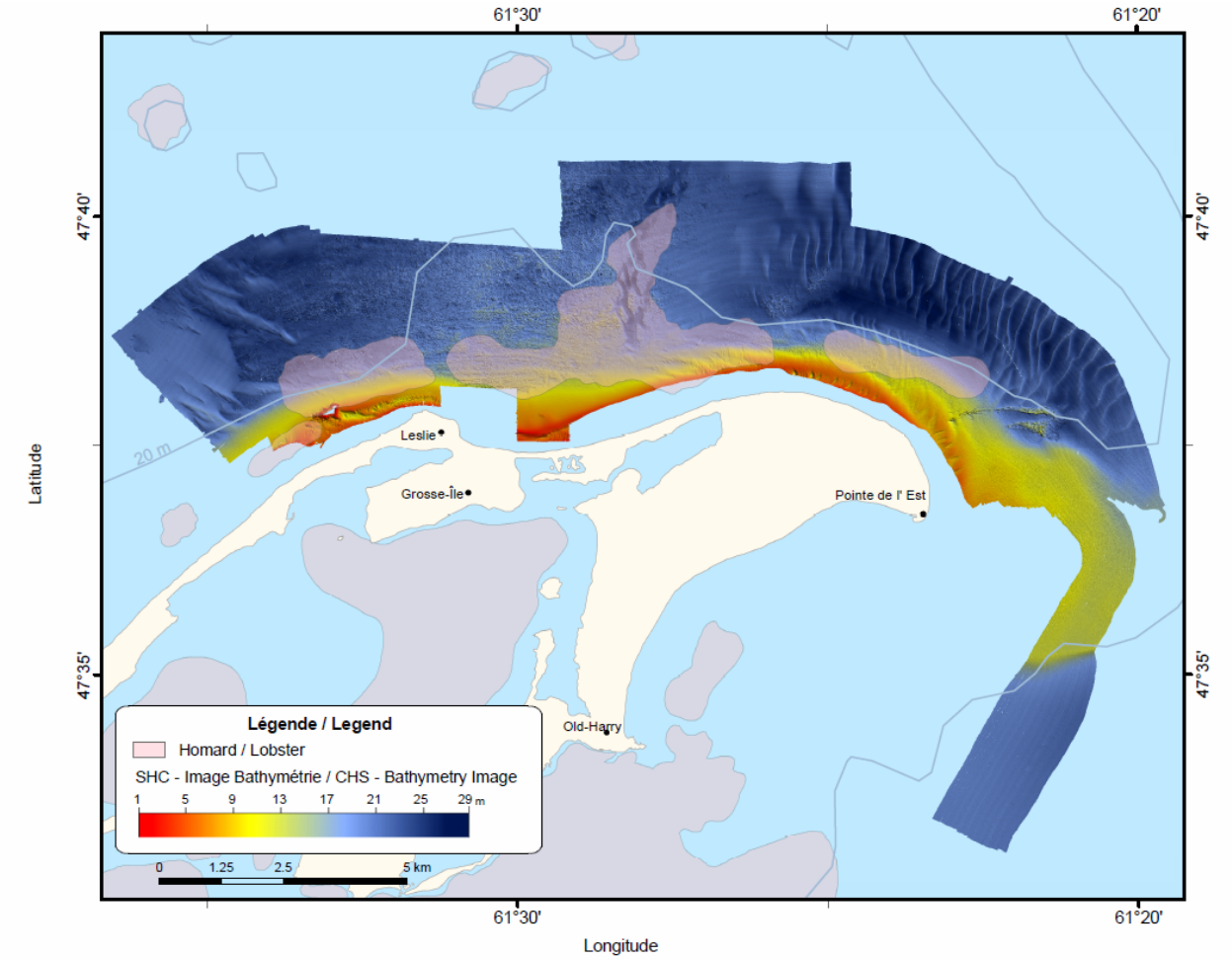

Figure 5A. Bathymetry Image (CHS) and Lobster presence (FHAMIS)

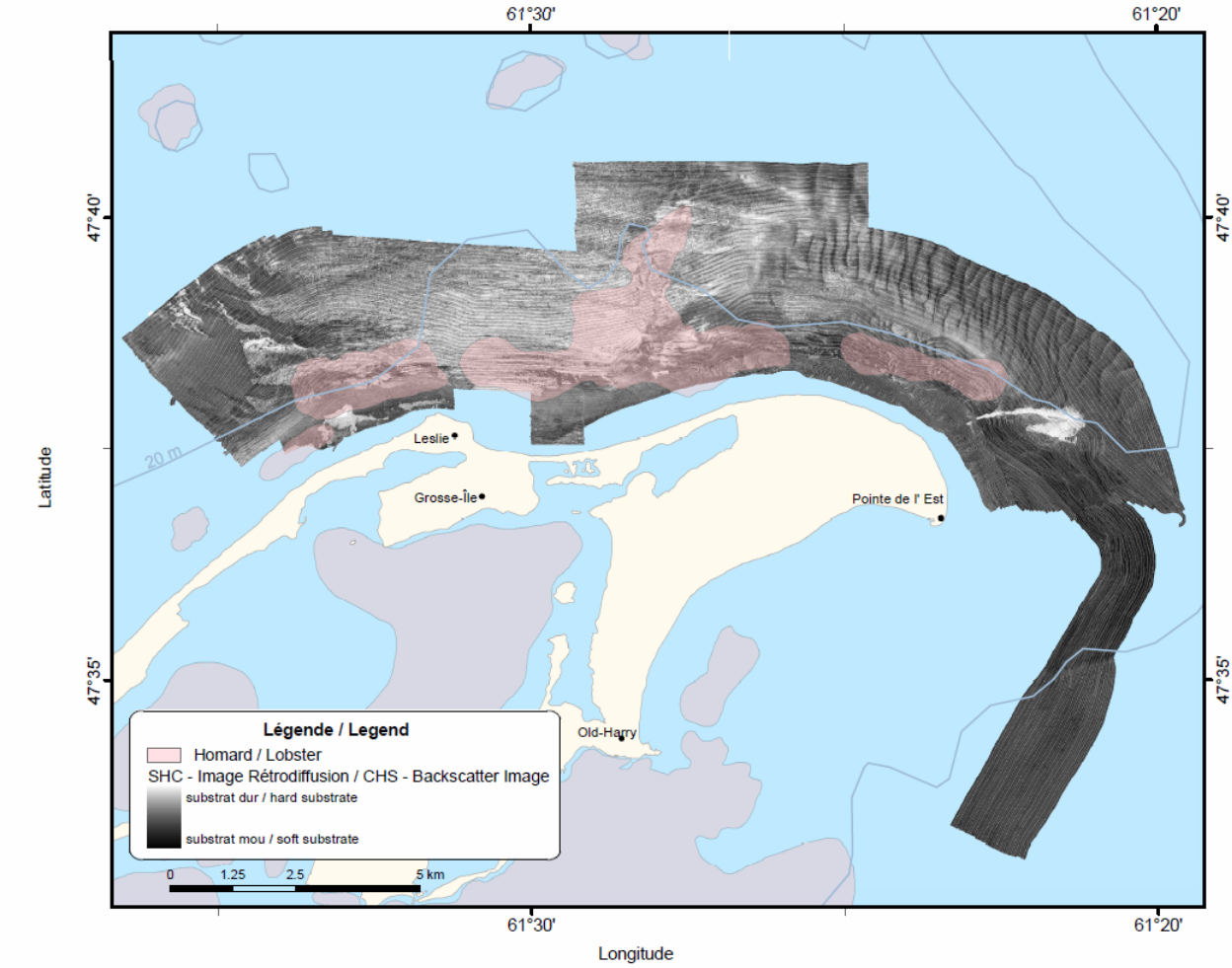

Figure 5B. Backscatter Image (CHS) and Lobster presence (FHAMIS).

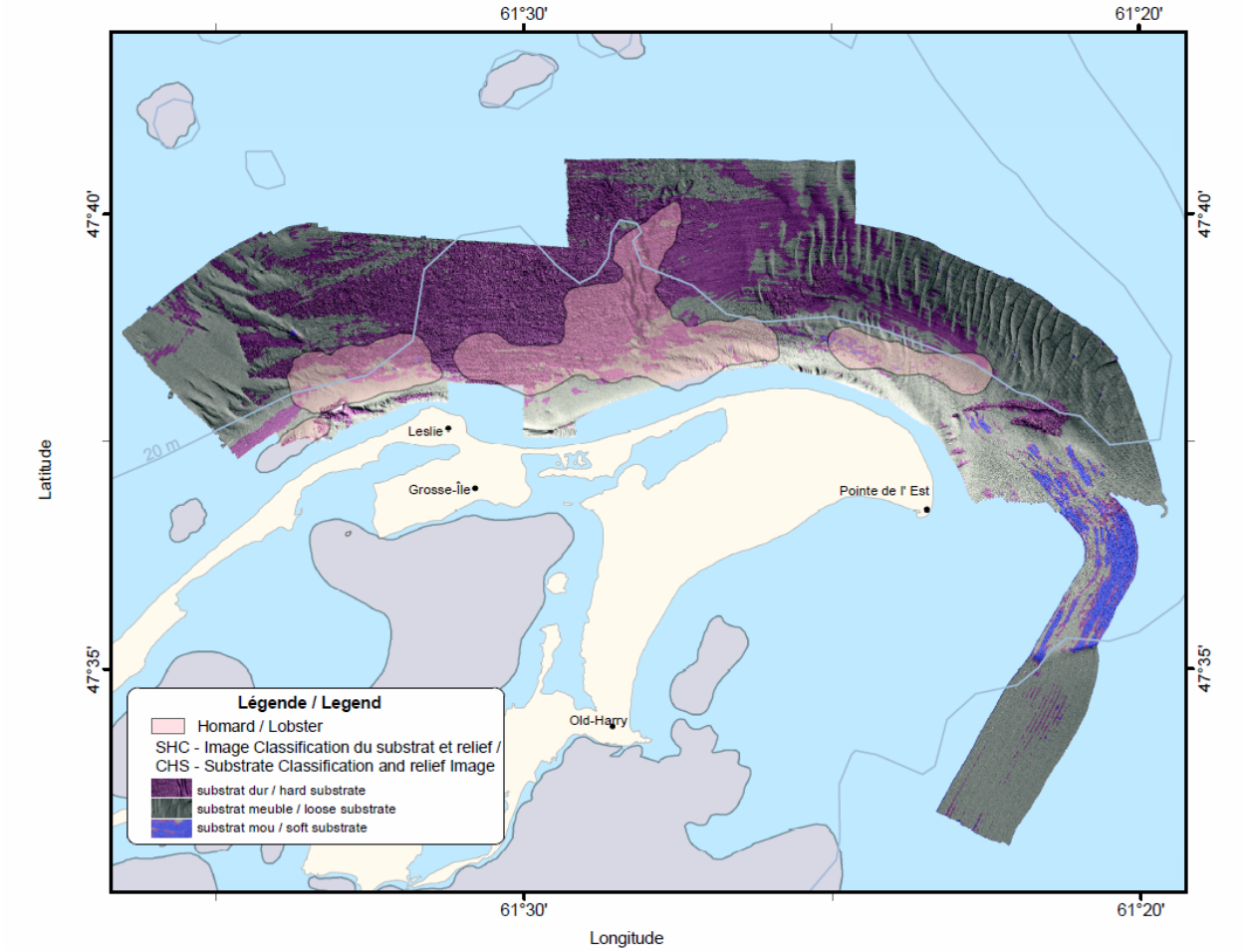

Figure 5C. Substrate Classification and relief Image (CHS) and Lobster presence (FHAMIS).

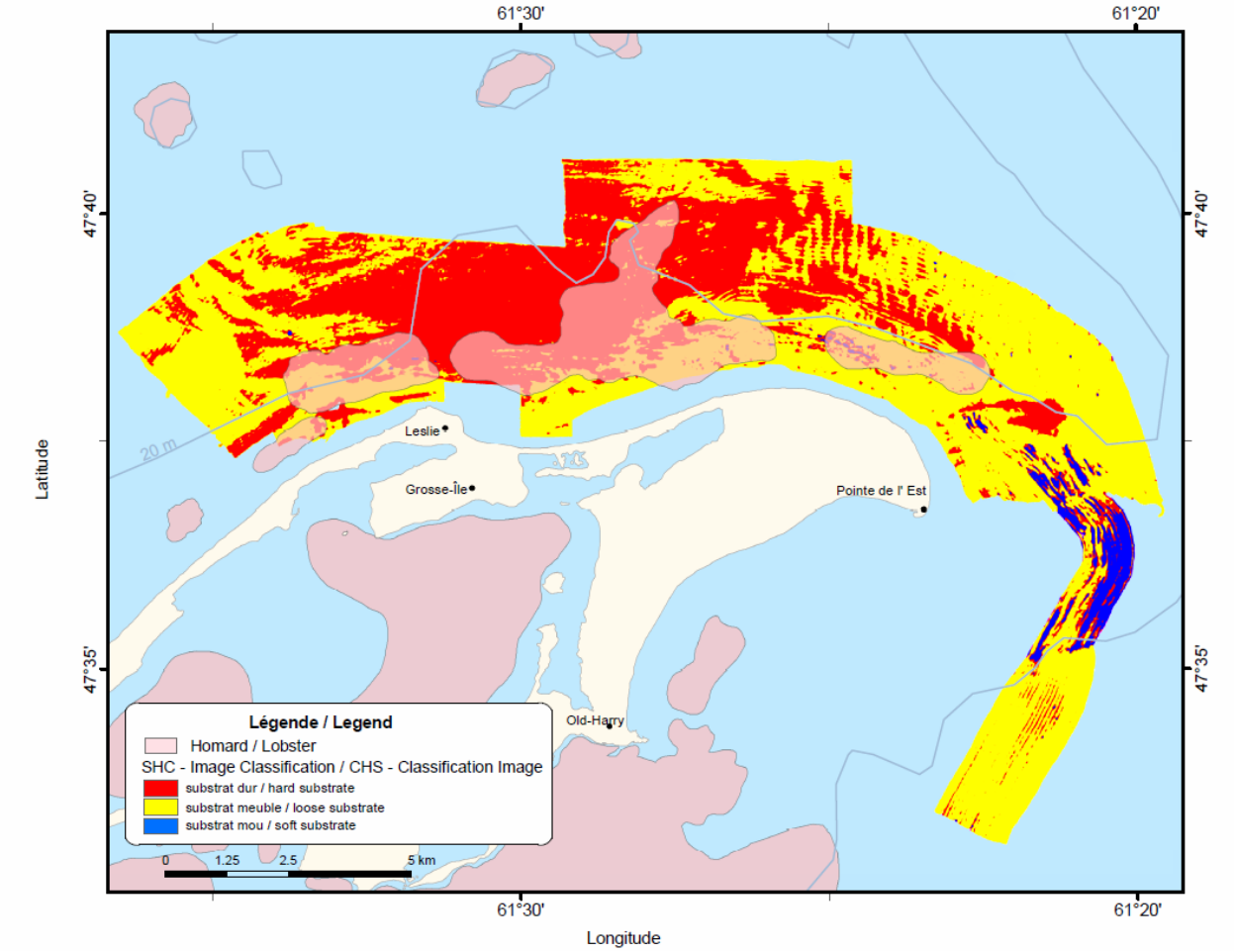

Figure 5D. Substrate Classification Image (CHS) and Lobster presence (FHAMIS).

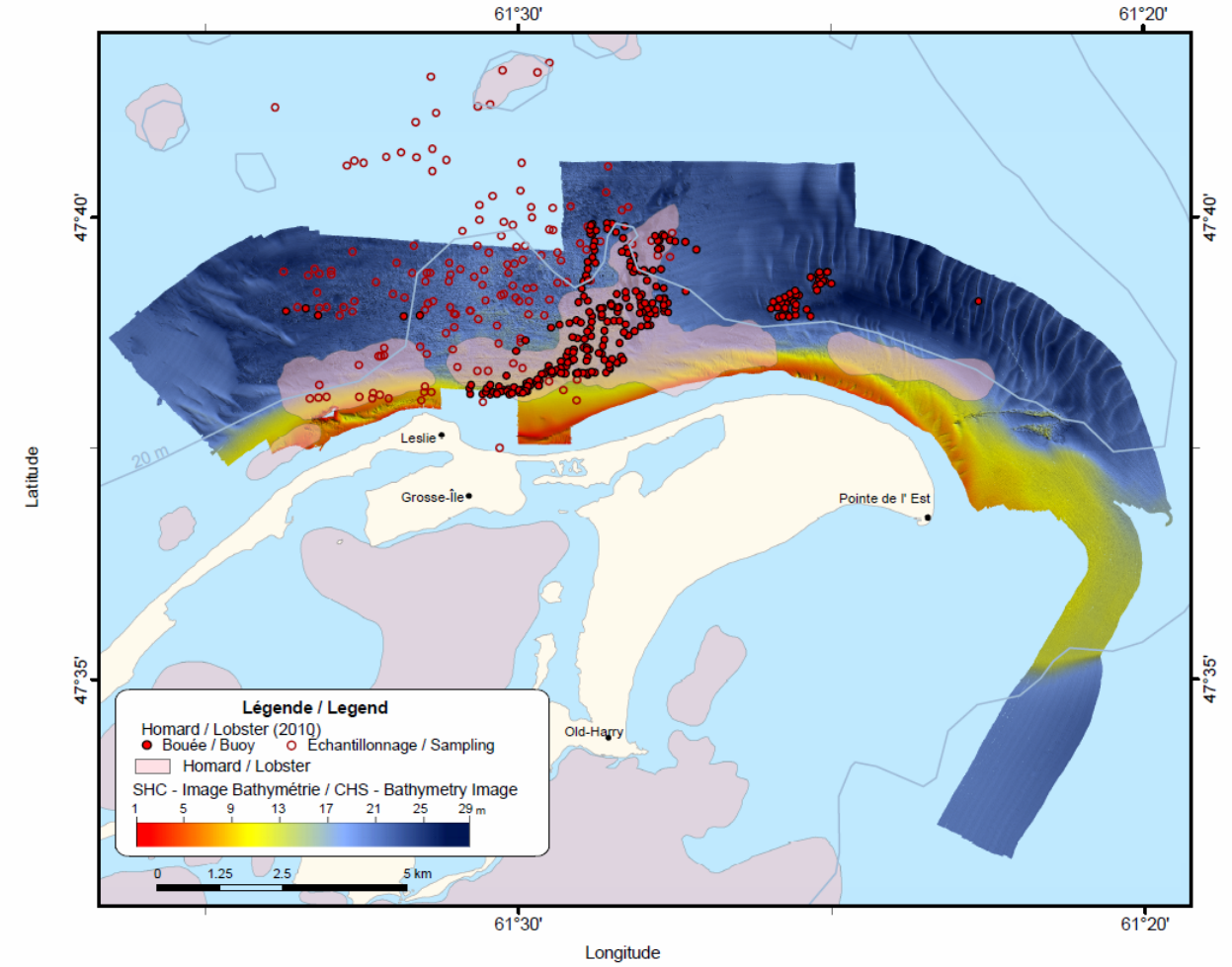

Figure 5E. Bathymetry Image and Lobster presence (FHAMIS) and fishing.

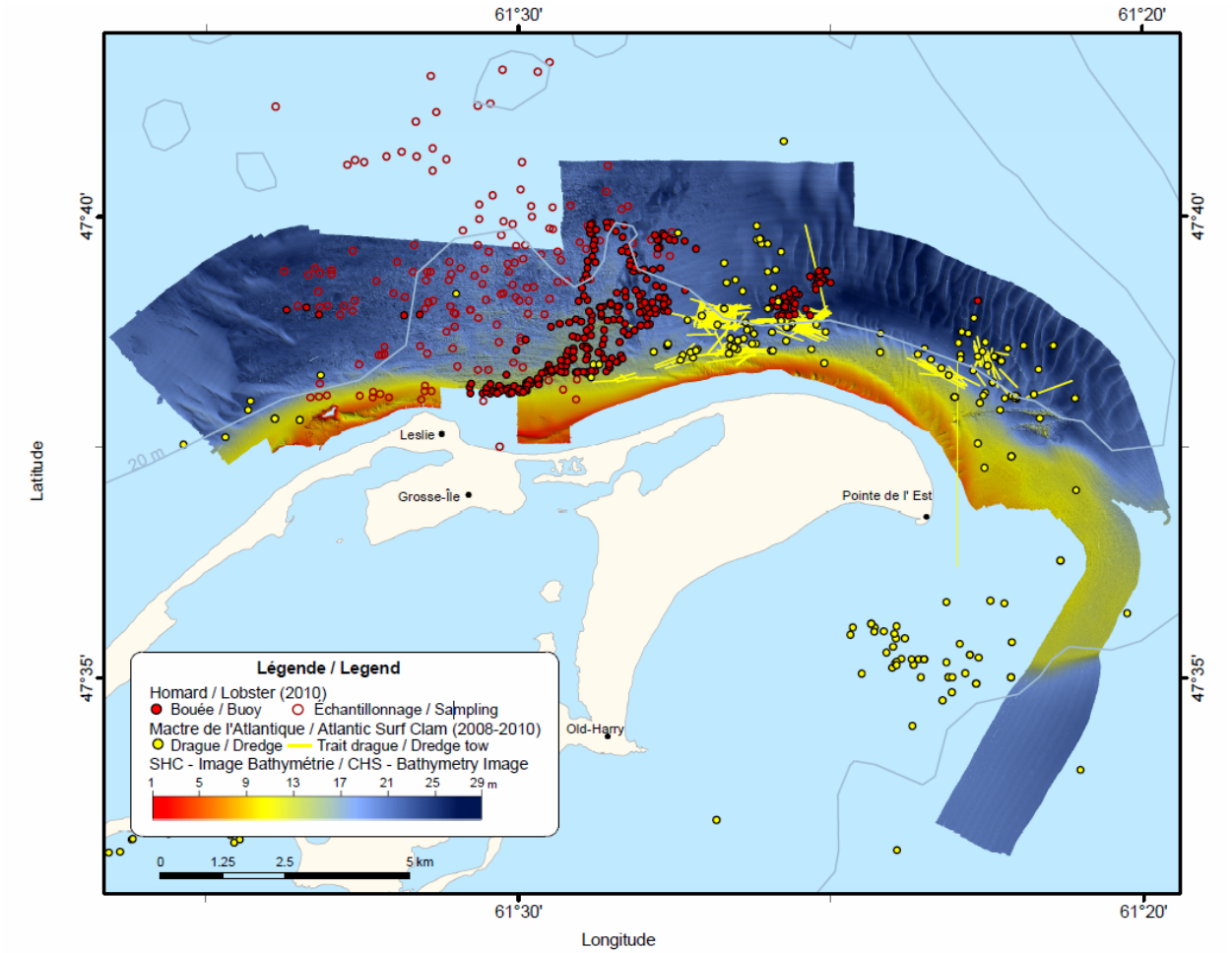

Figure 6A. Bathymetry Image (CHS) and Atlantic Surf Clam Fishing.

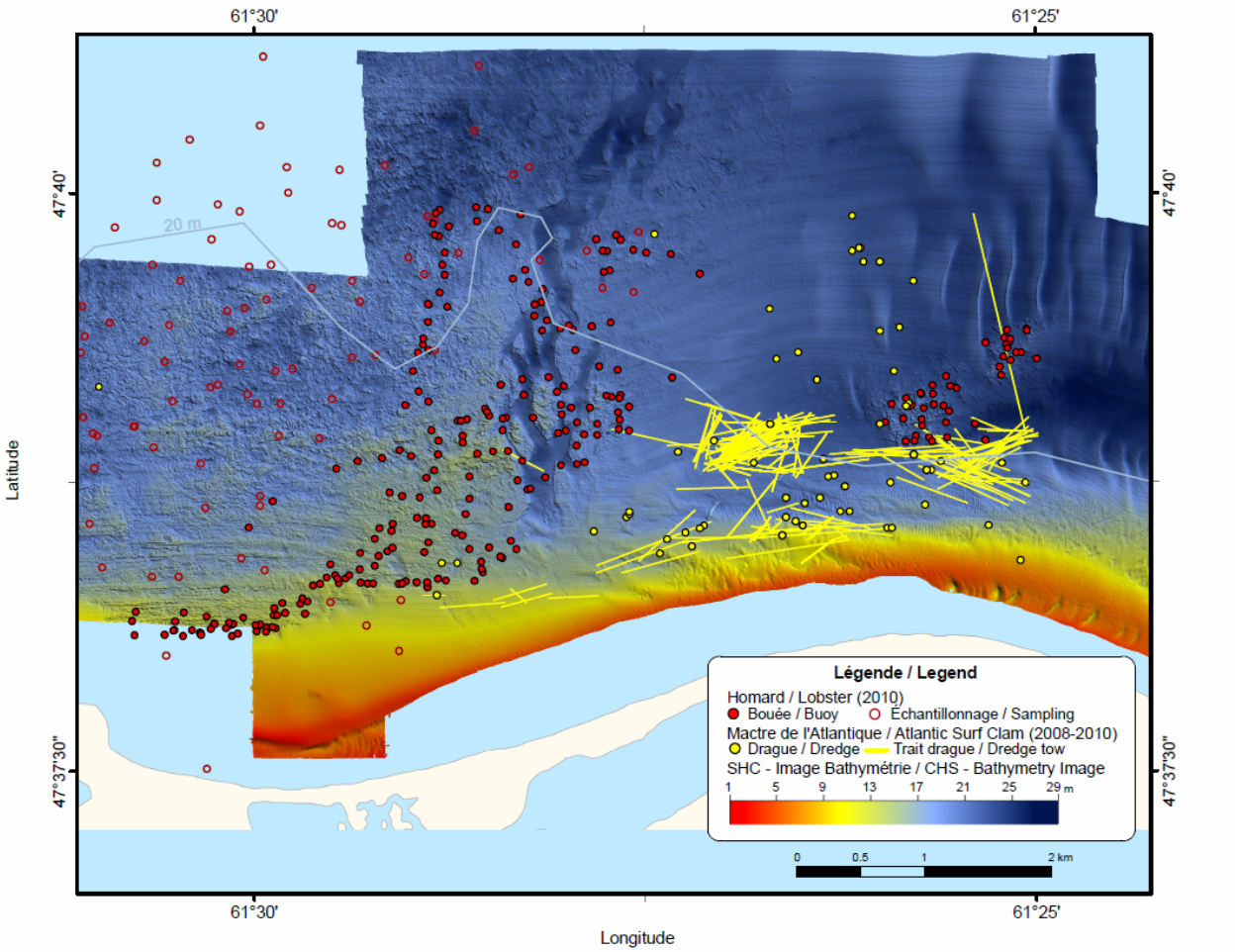

Figure 6B. Bathymetry Image (CHS) and Lobster and Atlantic Surf Clam Fishing (Grosse-Île Area).

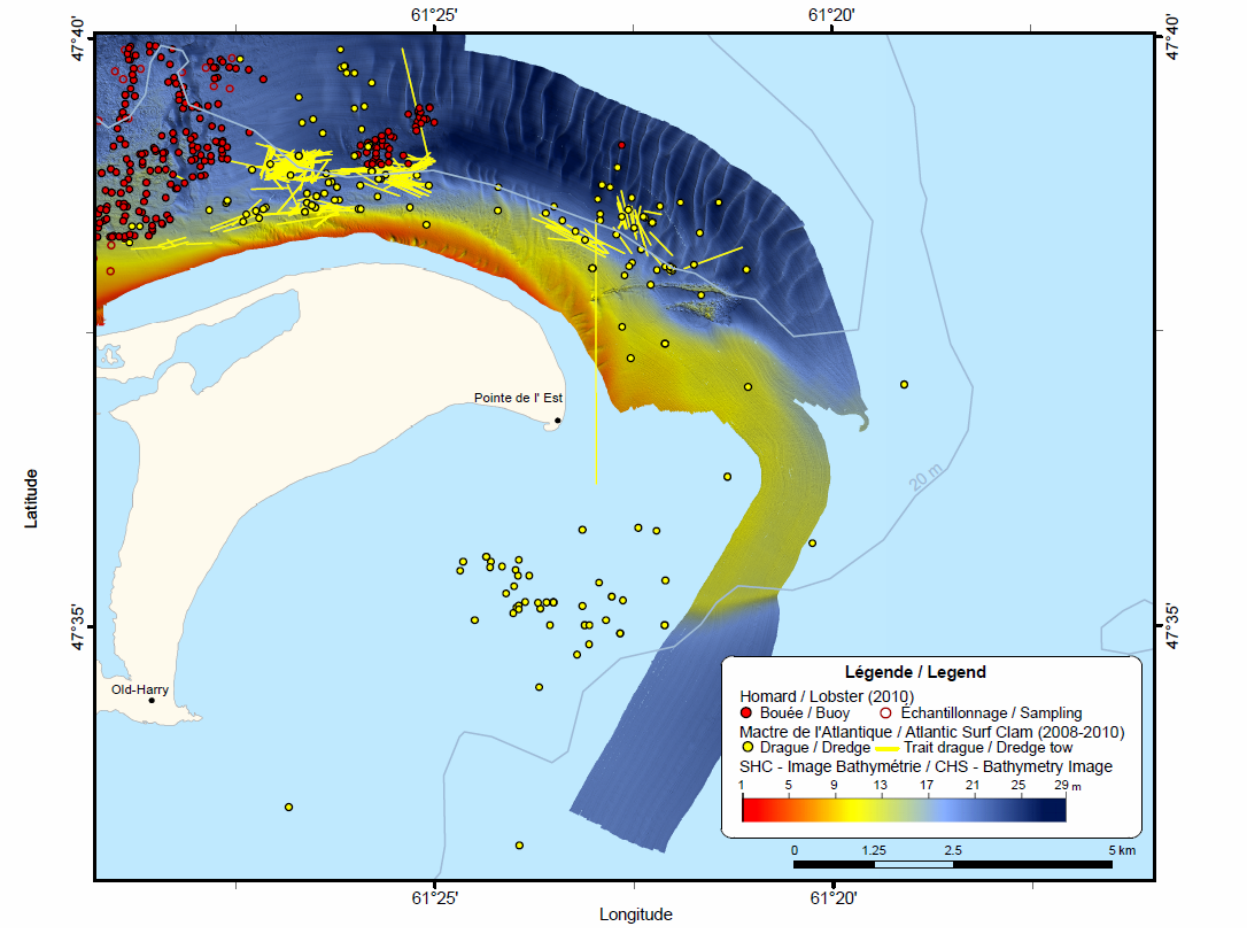

Figure 6C. Bathymetry Image (CHS) and Lobster and Atlantic Surf Clam Fishing (Pointe de l'Est Area).

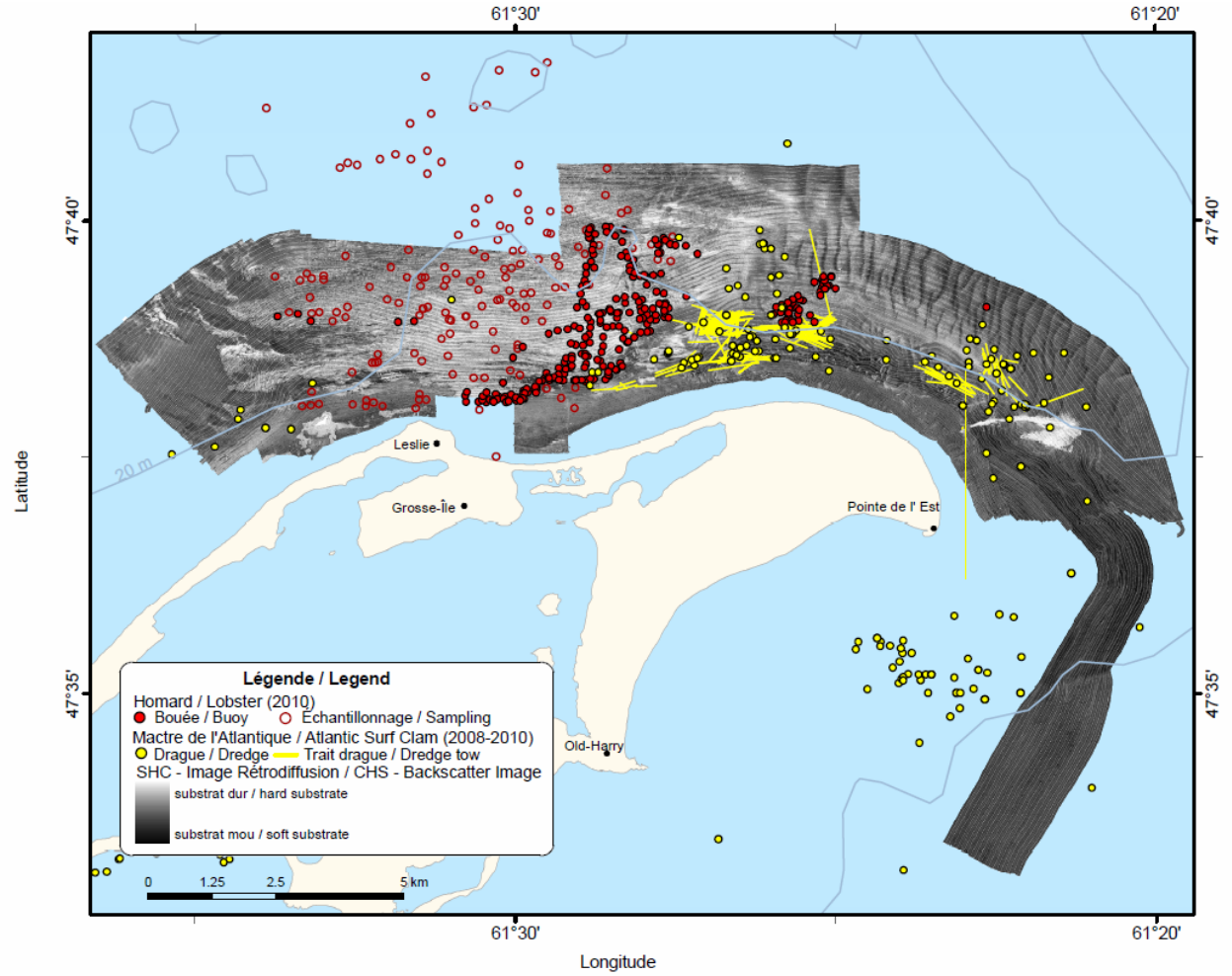

Figure 7A. Backscatter Image (CHS) and Lobster and Atlantic Surf clam Fishing.

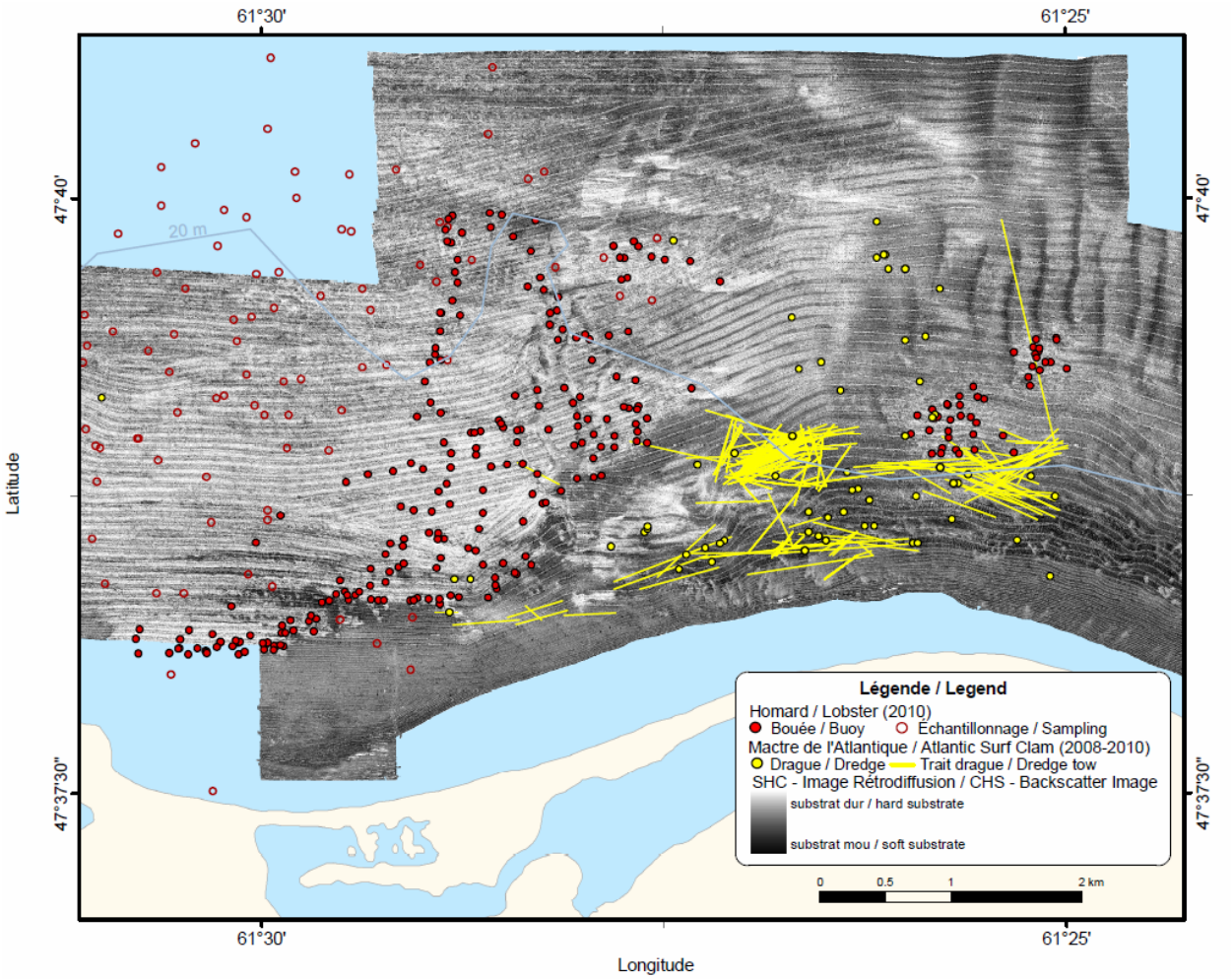

Figure 7B. Backscatter Image (CHS) and Lobster and Atlantic Surf Clam Fishing (Grosse-Île Area).

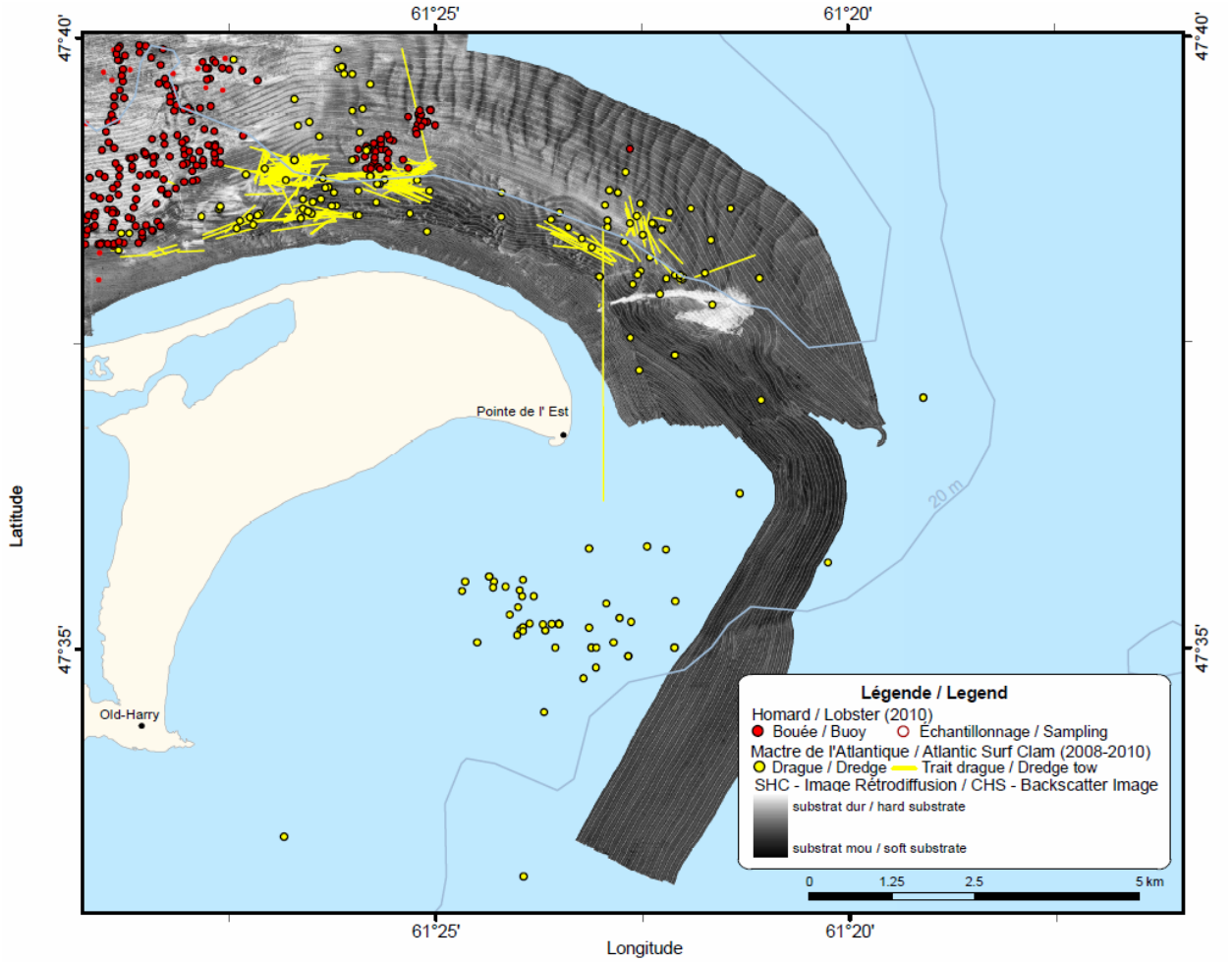

Figure 7C. Backscatter Image (CHS) and Lobster and Atlantic Surf Clam Fishing (Pointe de l'Est Area).

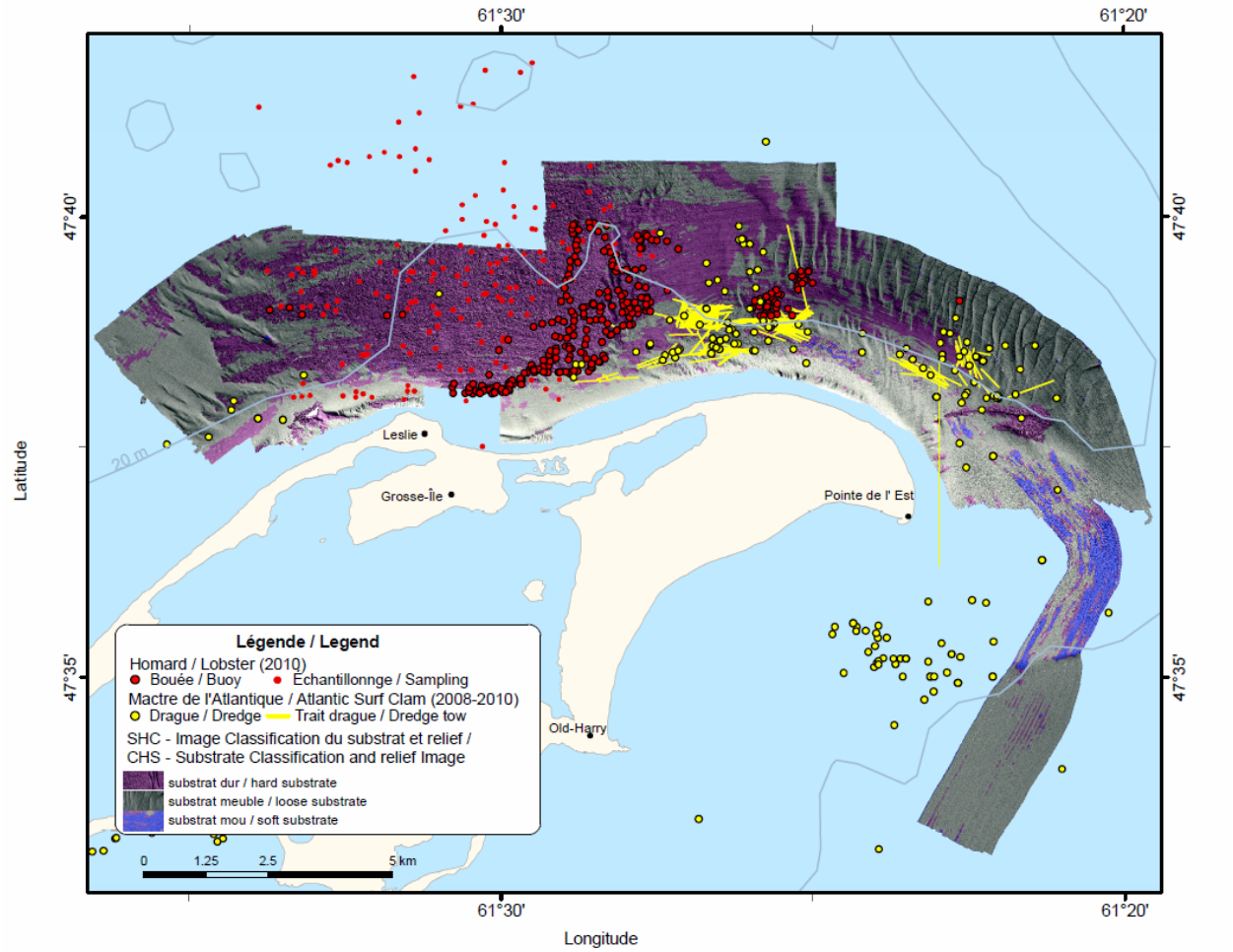

Figure 8A. Substrate Classification and relief Image (CHS) and Lobster and Atlantic Surf Clam Fishing.

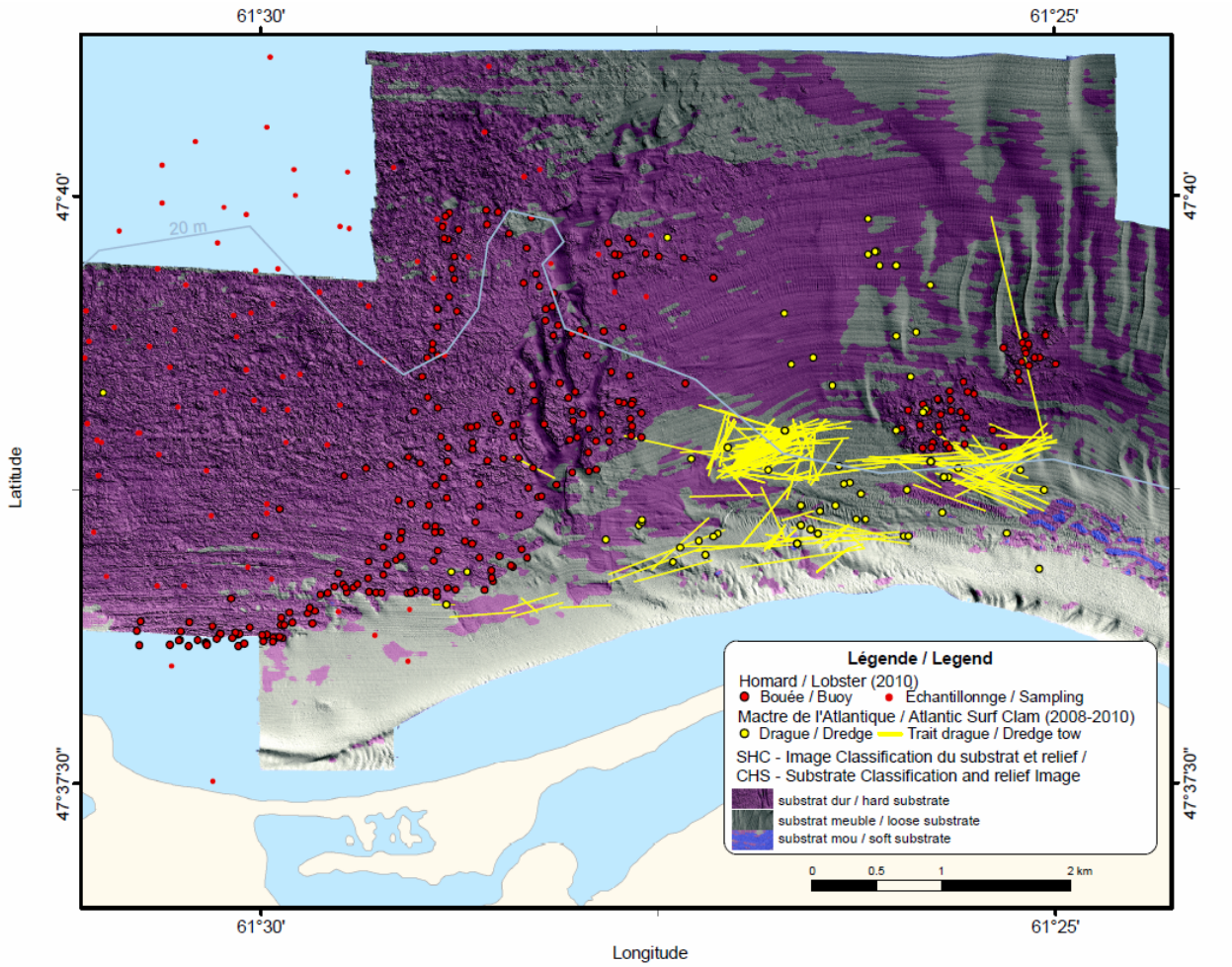

Figure 8B. Substrate Classification and relief Image (CHS) and Lobster and Atlantic Surf Clam Fishing (Grosse-Île Area).

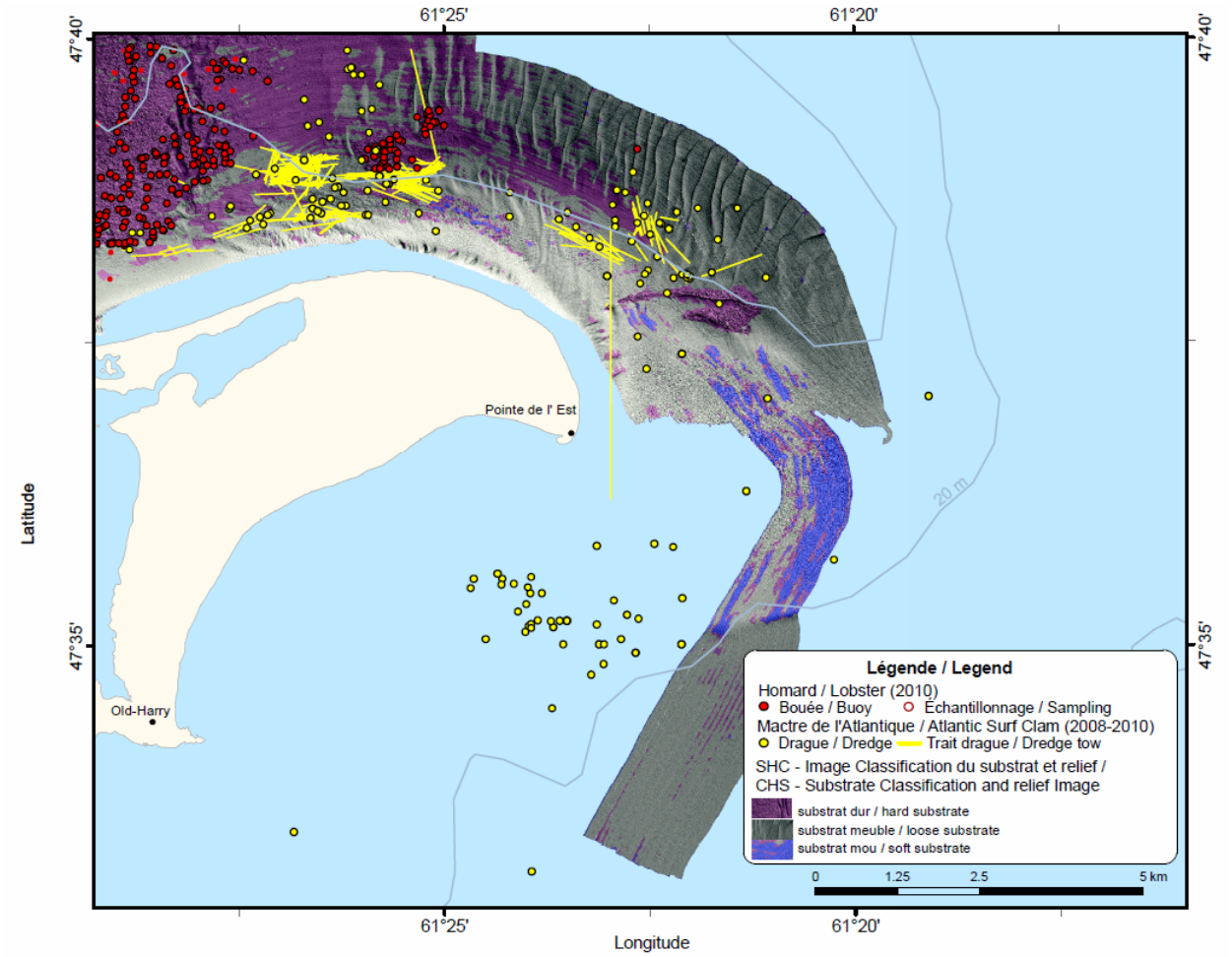

Figure 8C. Substrate Classification and relief Image (CHS) and Lobster and Atlantic Surf Clam Fishing (Pointe de l'Est Area).

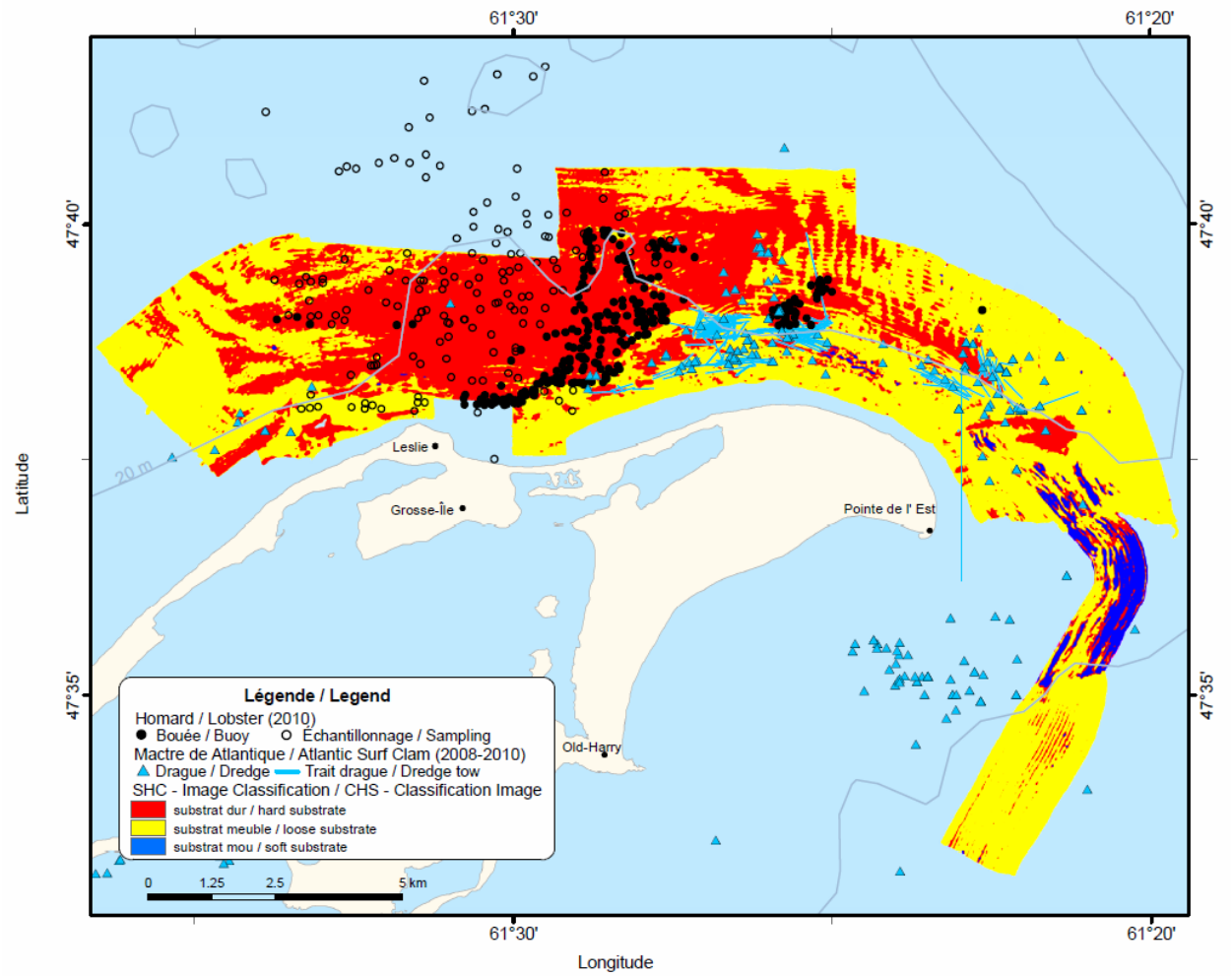

Figure 9A. Substrate Classification Image (CHS) and Lobster and Atlantic Surf Clam Fishing.

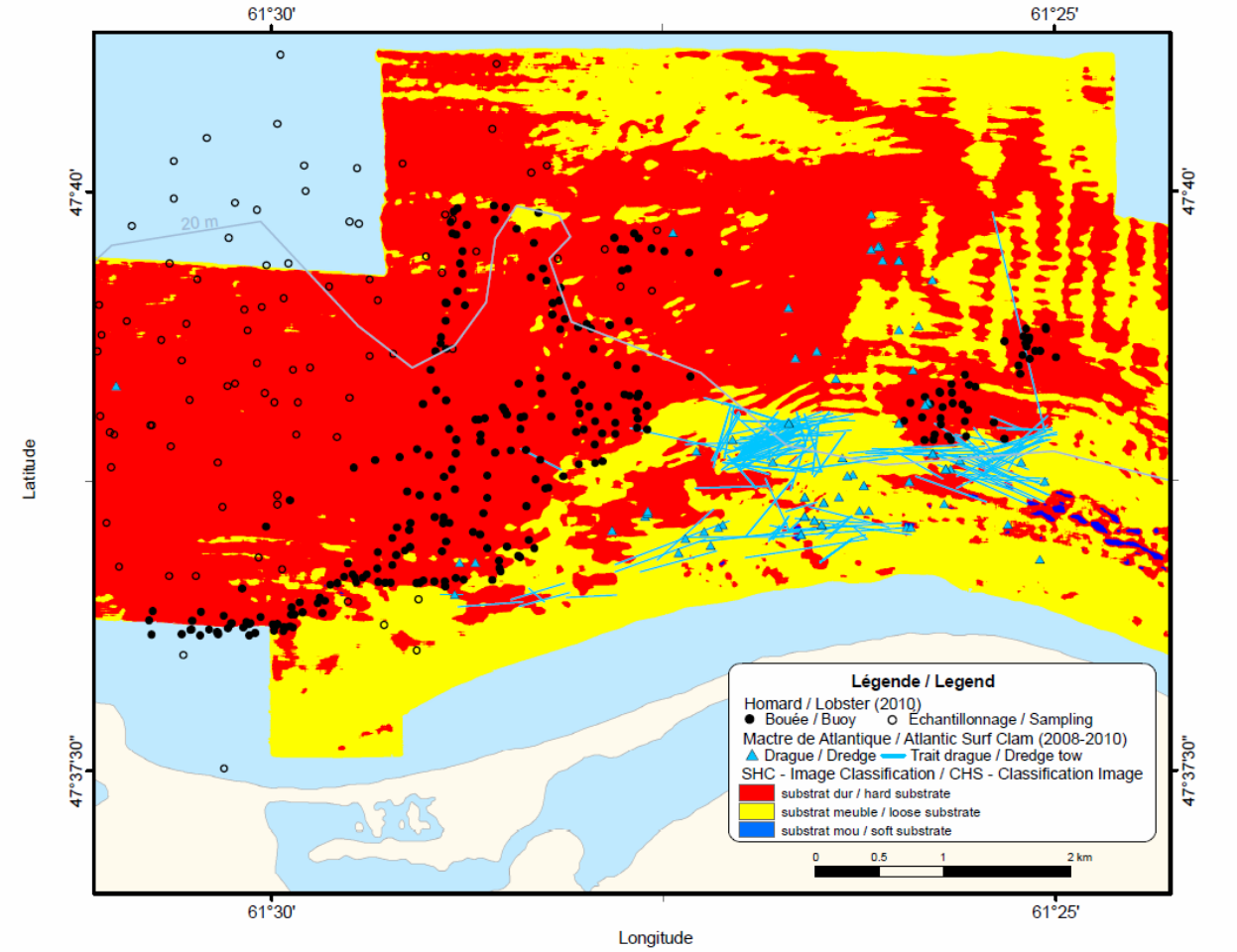

Figure 9B. Substrate Classification Image (CHS) and Lobster and Atlantic Surf Clam Fishing (Grosse-Île Area).

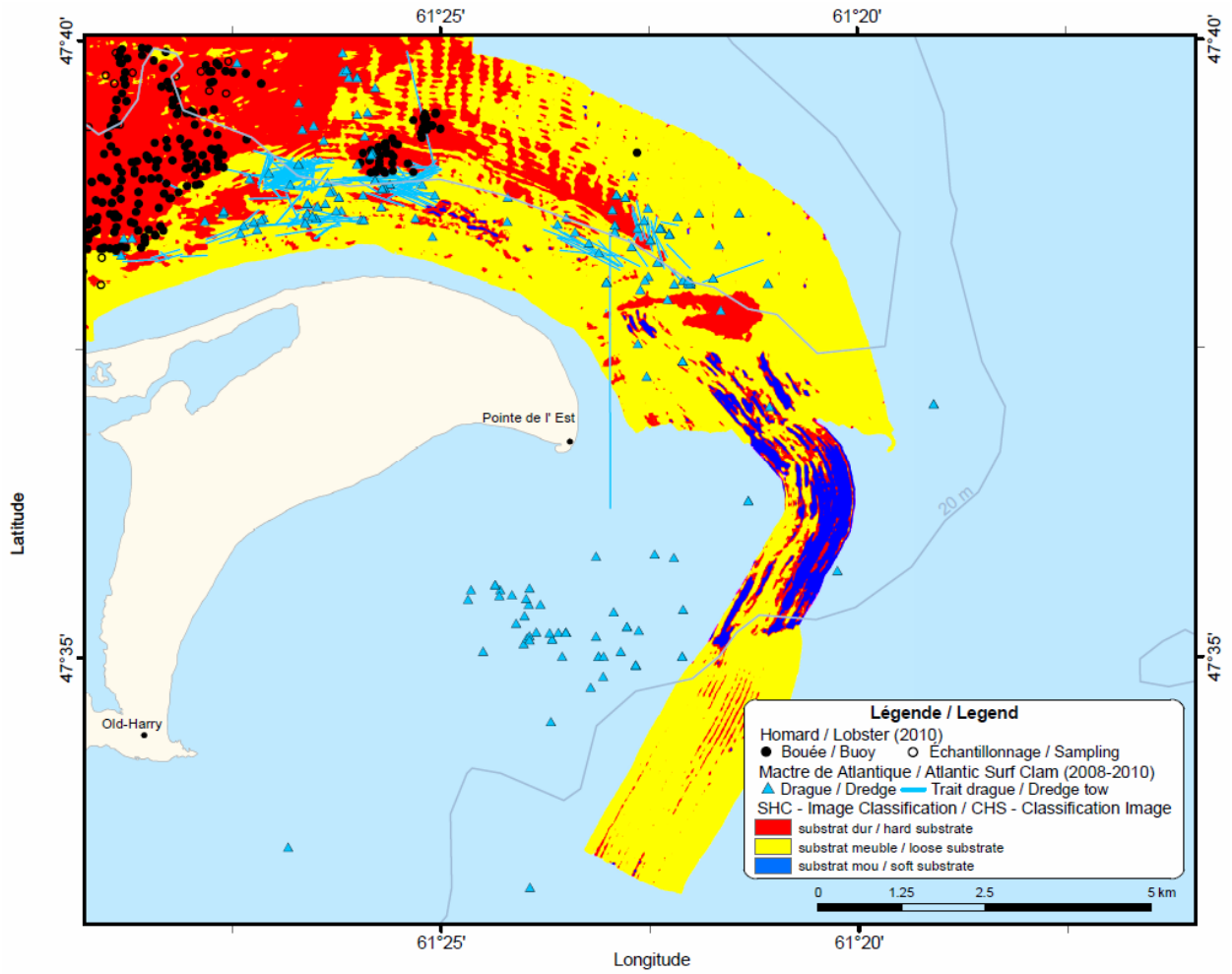

Figure 9C. Substrate Classification Image (CHS) and Lobster and Atlantic Surf Clam Fishing (Pointe de l'Est Area).

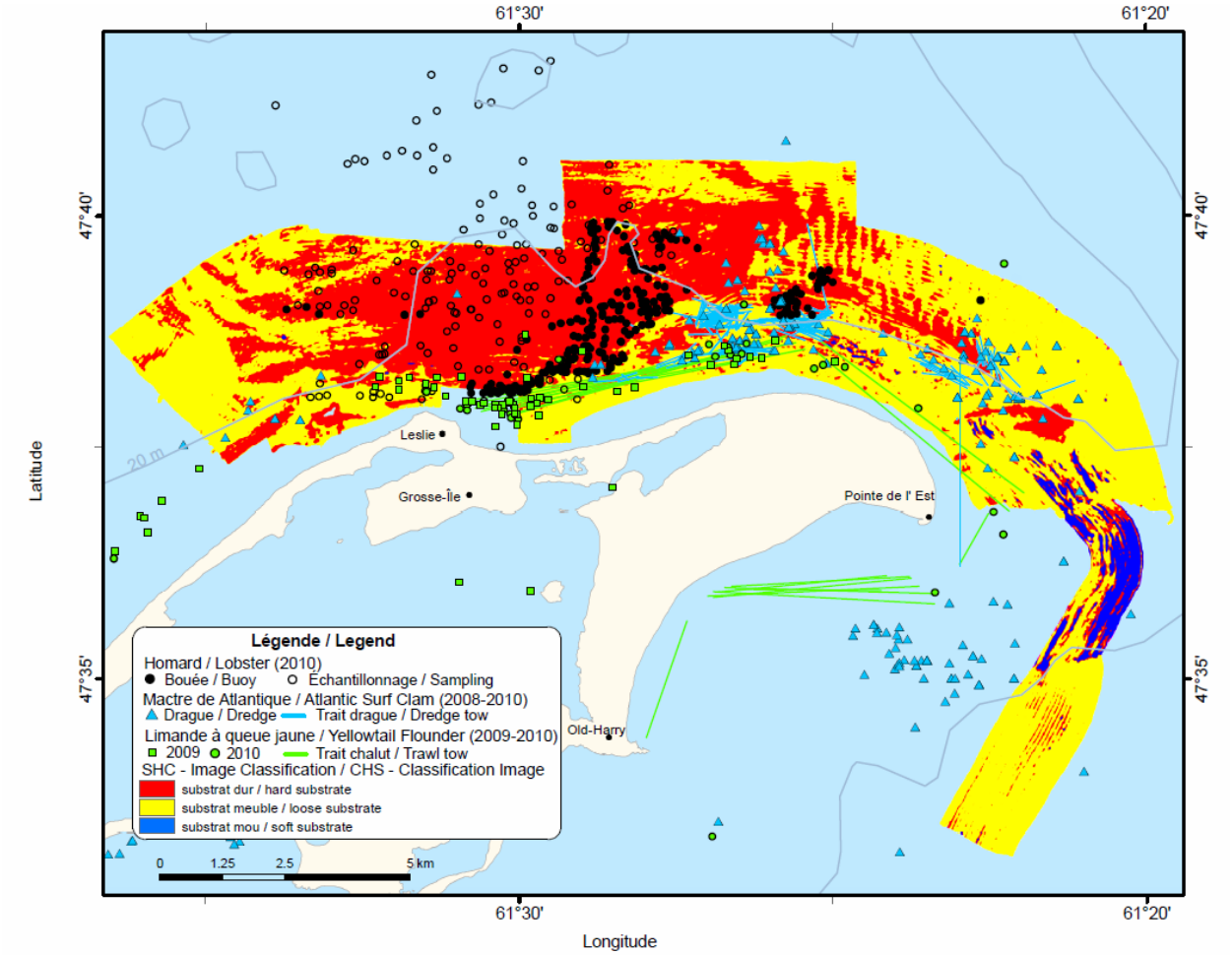

Figure 10A. Substrate Classification Image (CHS) and Lobster, Atlantic Surf Clam and Yellowtail Flounder Fishing.

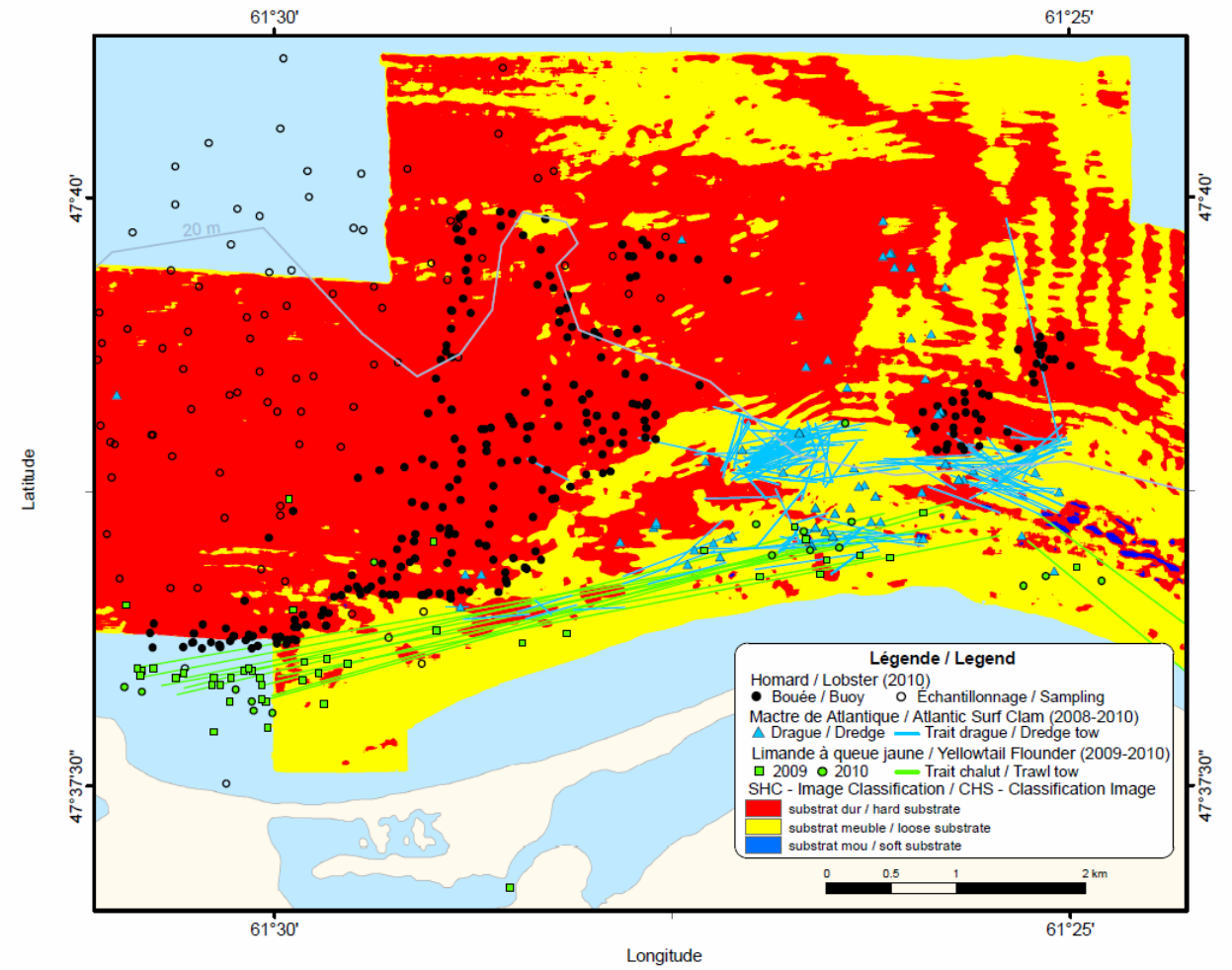

Figure 10B. Substrate Classification Image (CHS) and Lobster, Atlantic Surf Clam and Yellowtail Flounder Fishing (Grosse-Île Area)

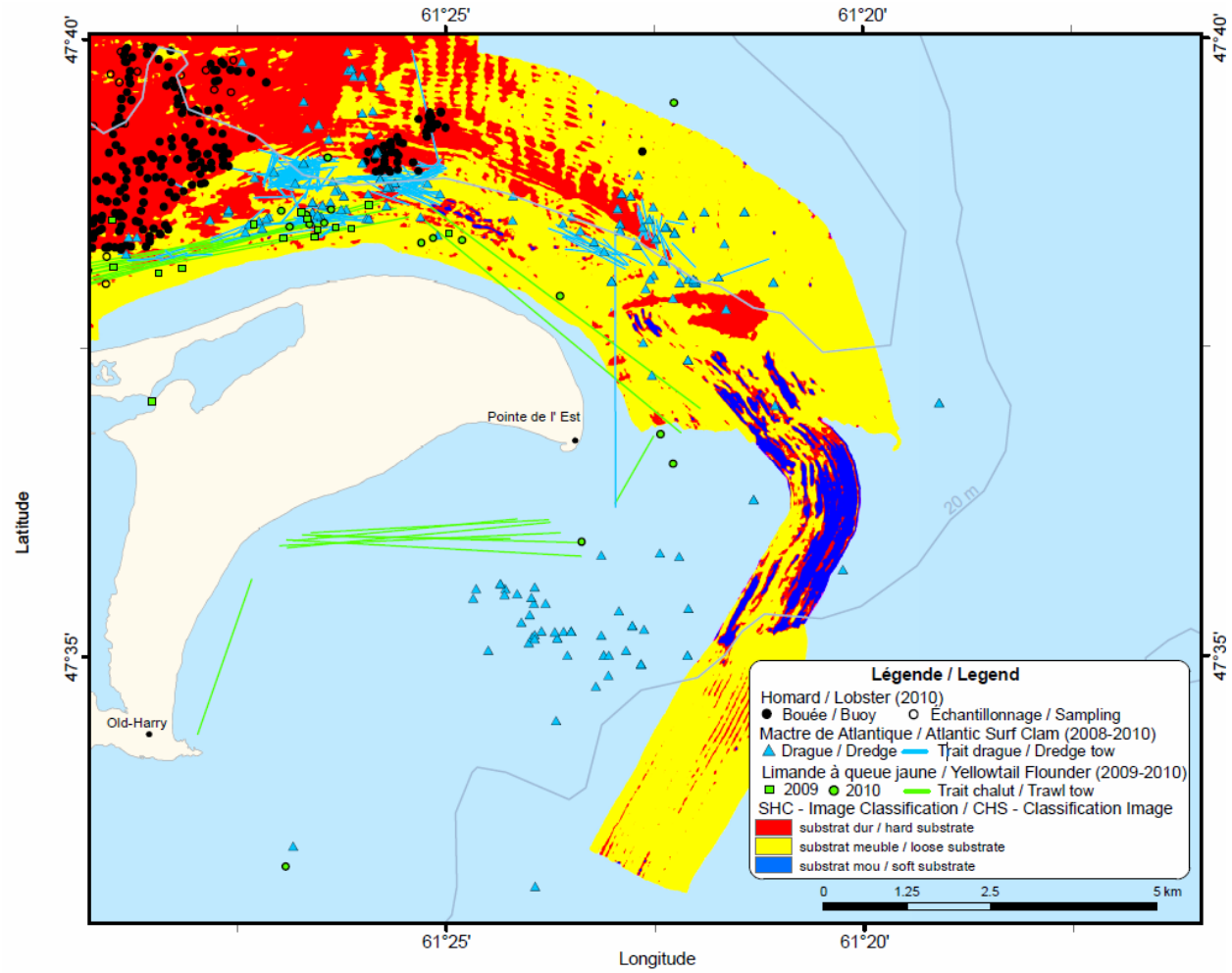

Figure 10C. Substrate Classification Image (CHS) and Lobster, Atlantic Surf Clam and Yellowtail Flounder Fishing (Pointe de l'Est Area).

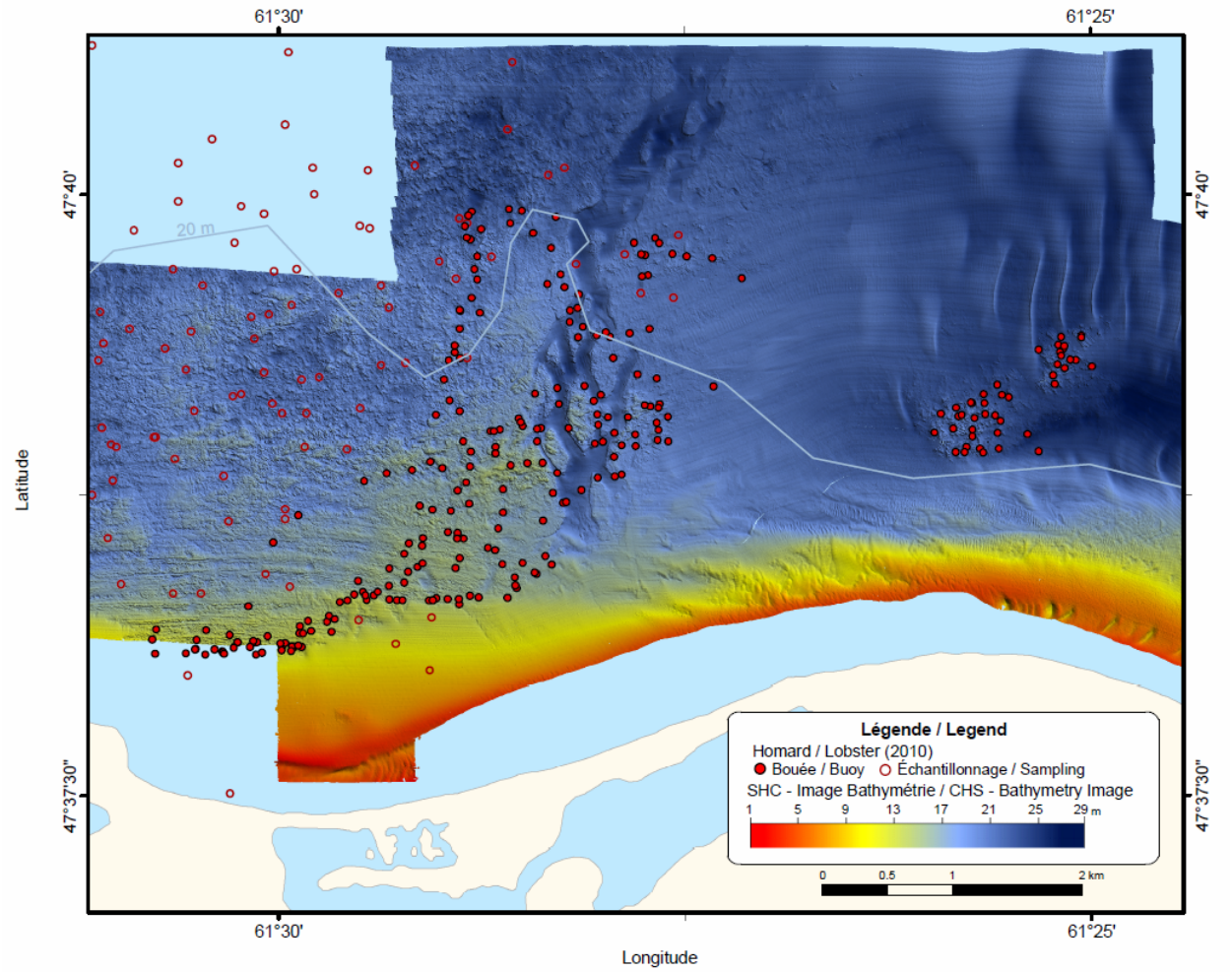

Figure 11A. Bathymetry Image (CHS) and Lobster Fishing (Grosse-Île Area).

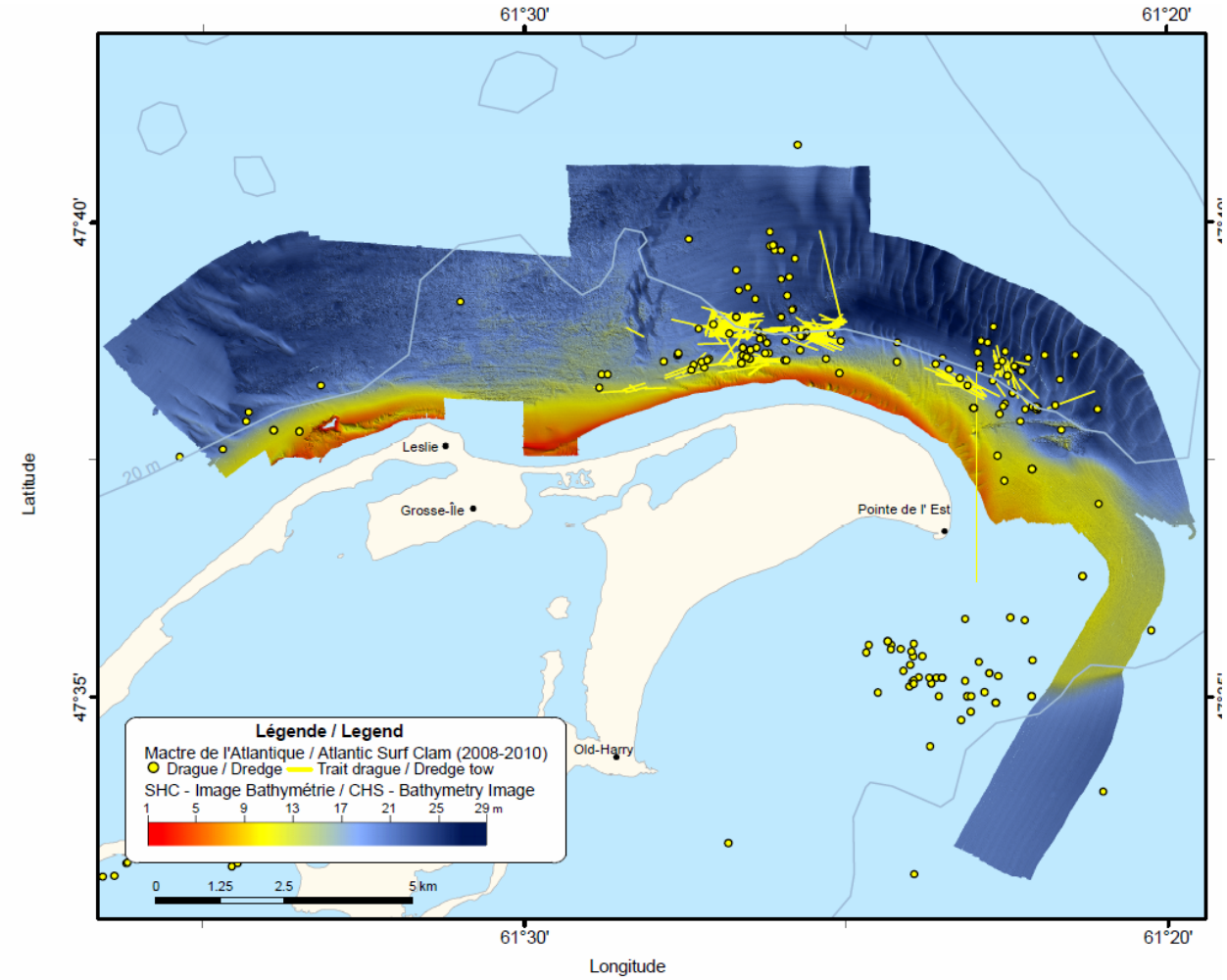

Figure 11B. Bathymetry Image (CHS) and Atlantic Surf Clam Fishing.

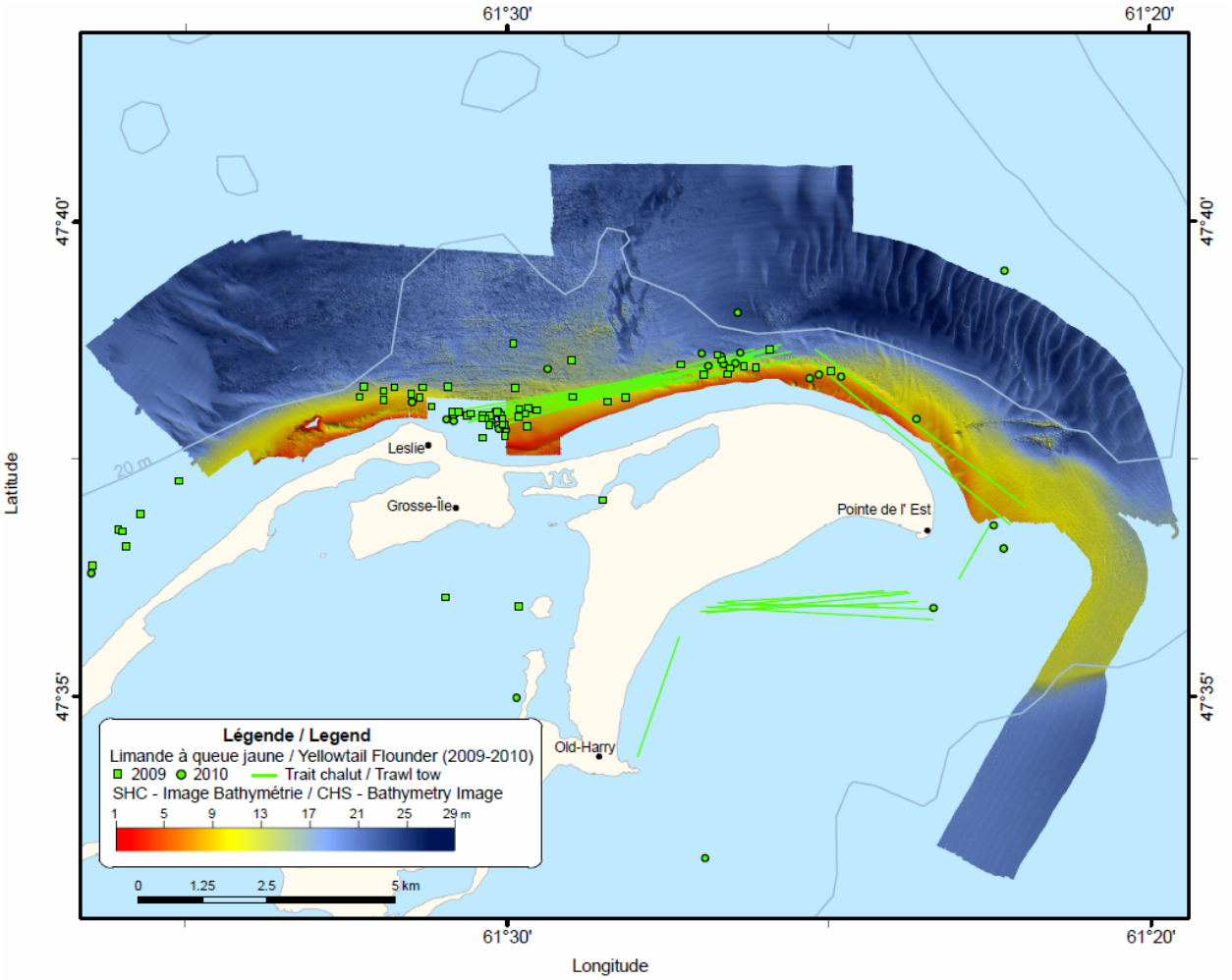

Figure 11C. Bathymetry Image (CHS) and Yellowtail Flounder Fishing.

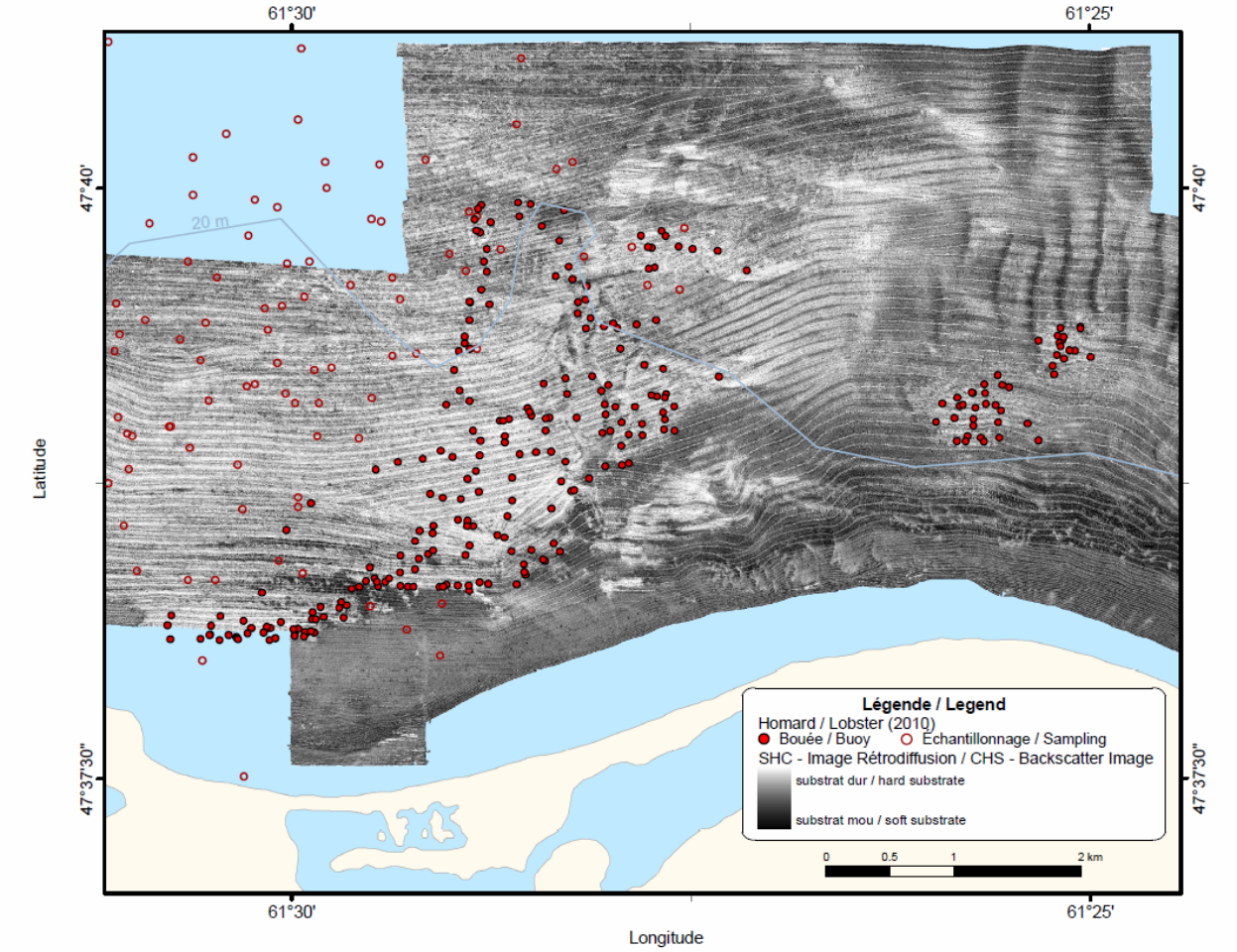

Figure 12A. Backscatter Image (CHS) and Lobster Fishing (Grosse-Île Area).

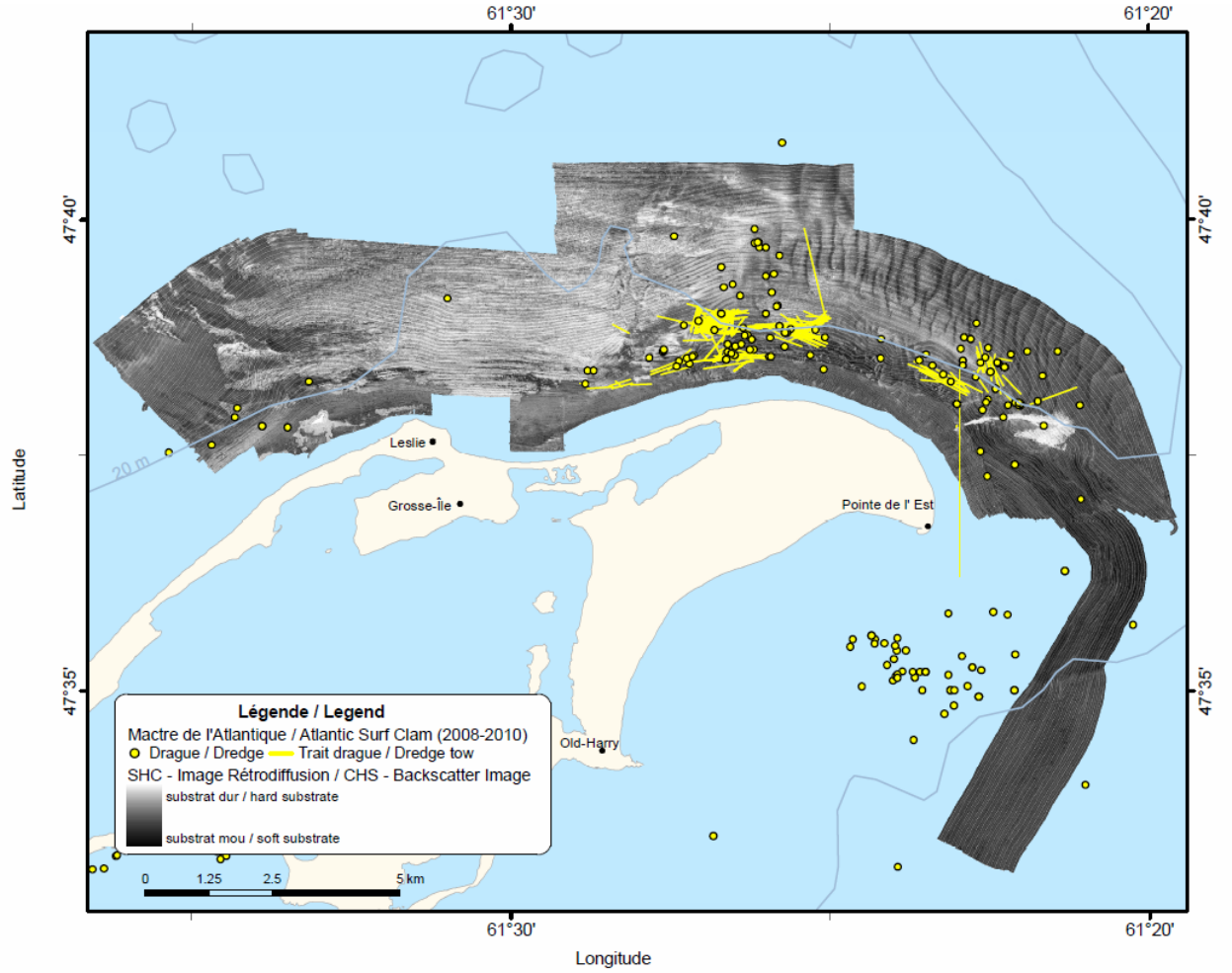

Figure 12B. Backscatter Image (CHS) and Atlantic Surf Clam Fishing.

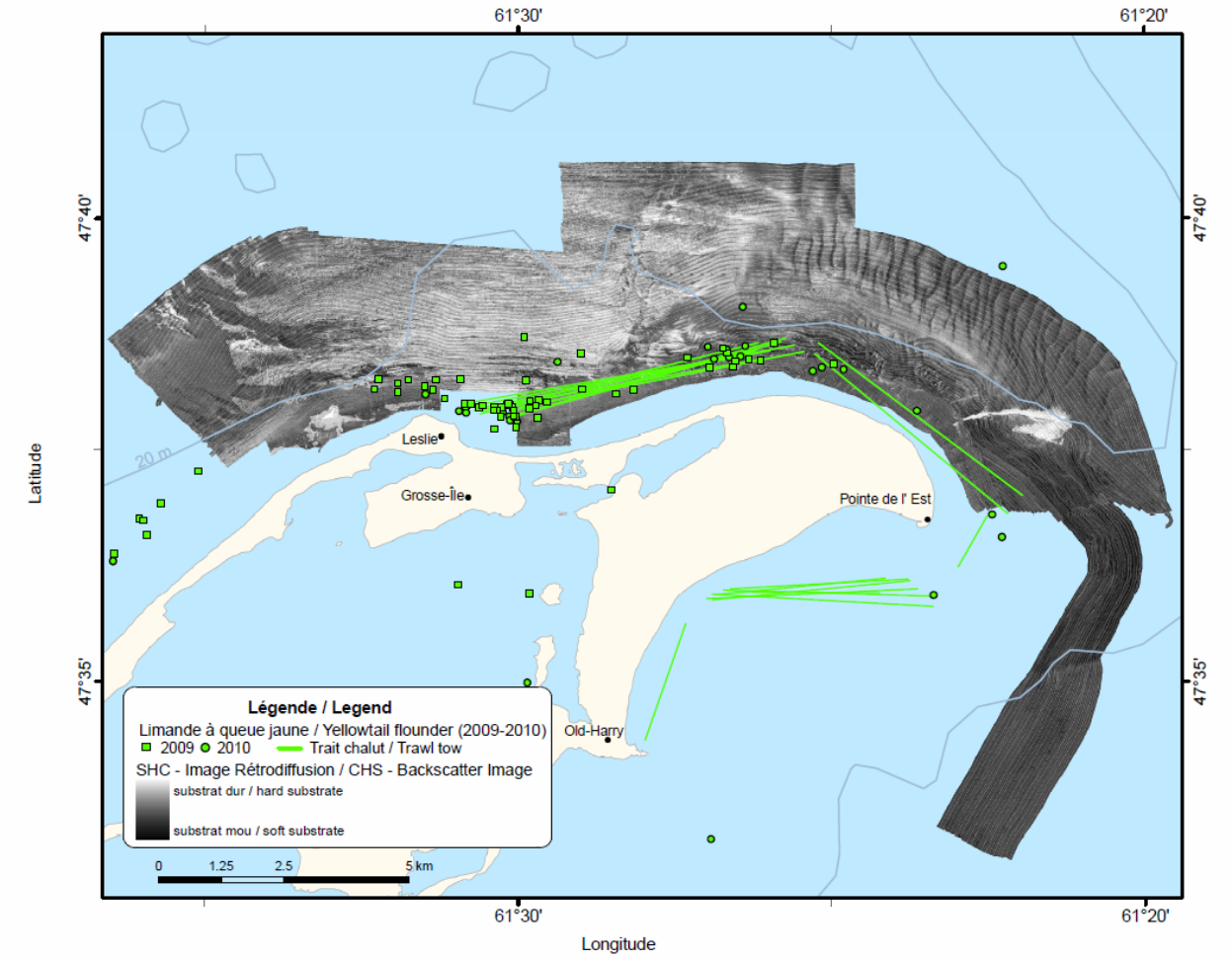

Figure 12C. Backscatter Image (CHS) and Yellowtail Flounder Fishing.

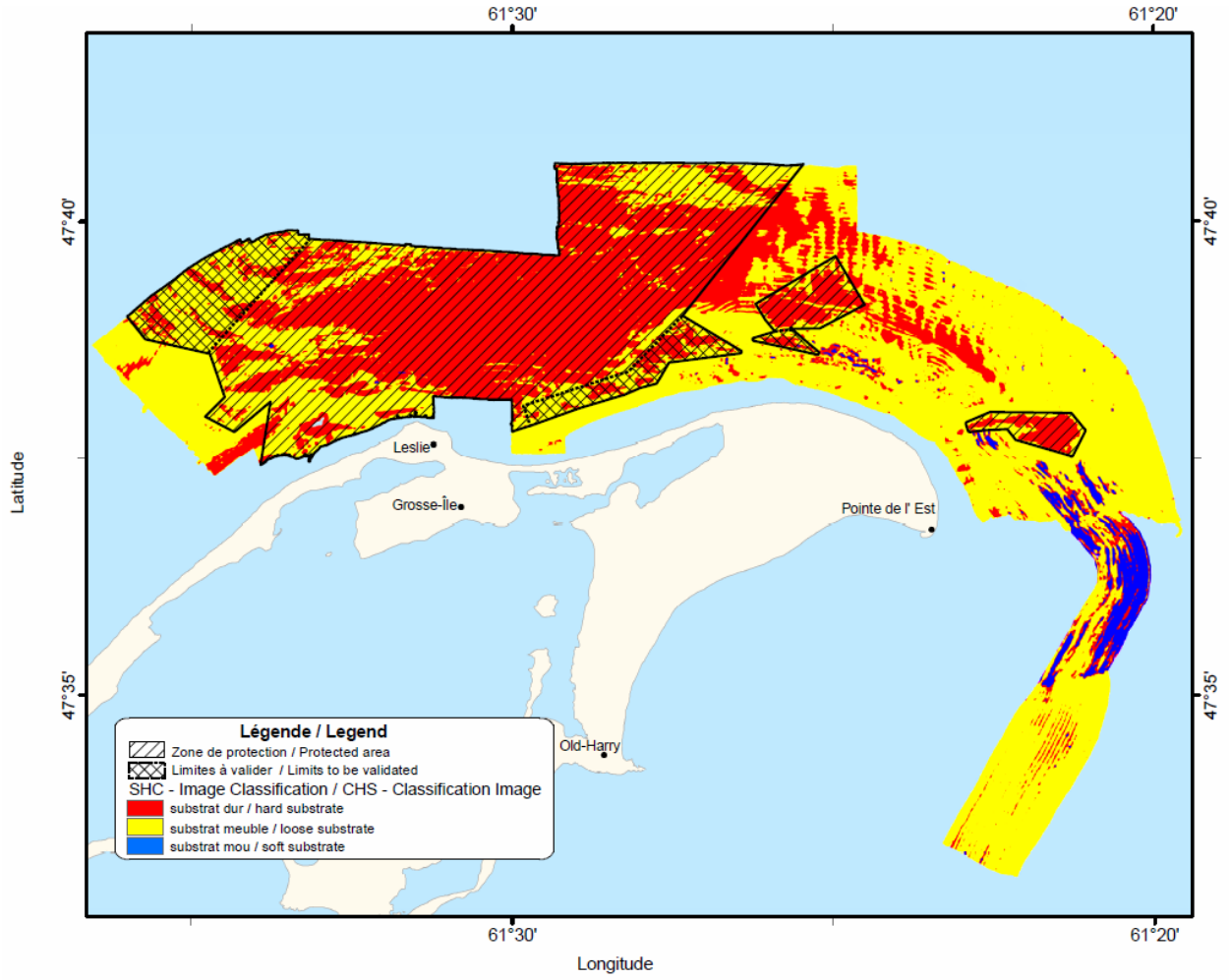

Figure 13A. Substrate Classification Image (CHS) and protected areas.

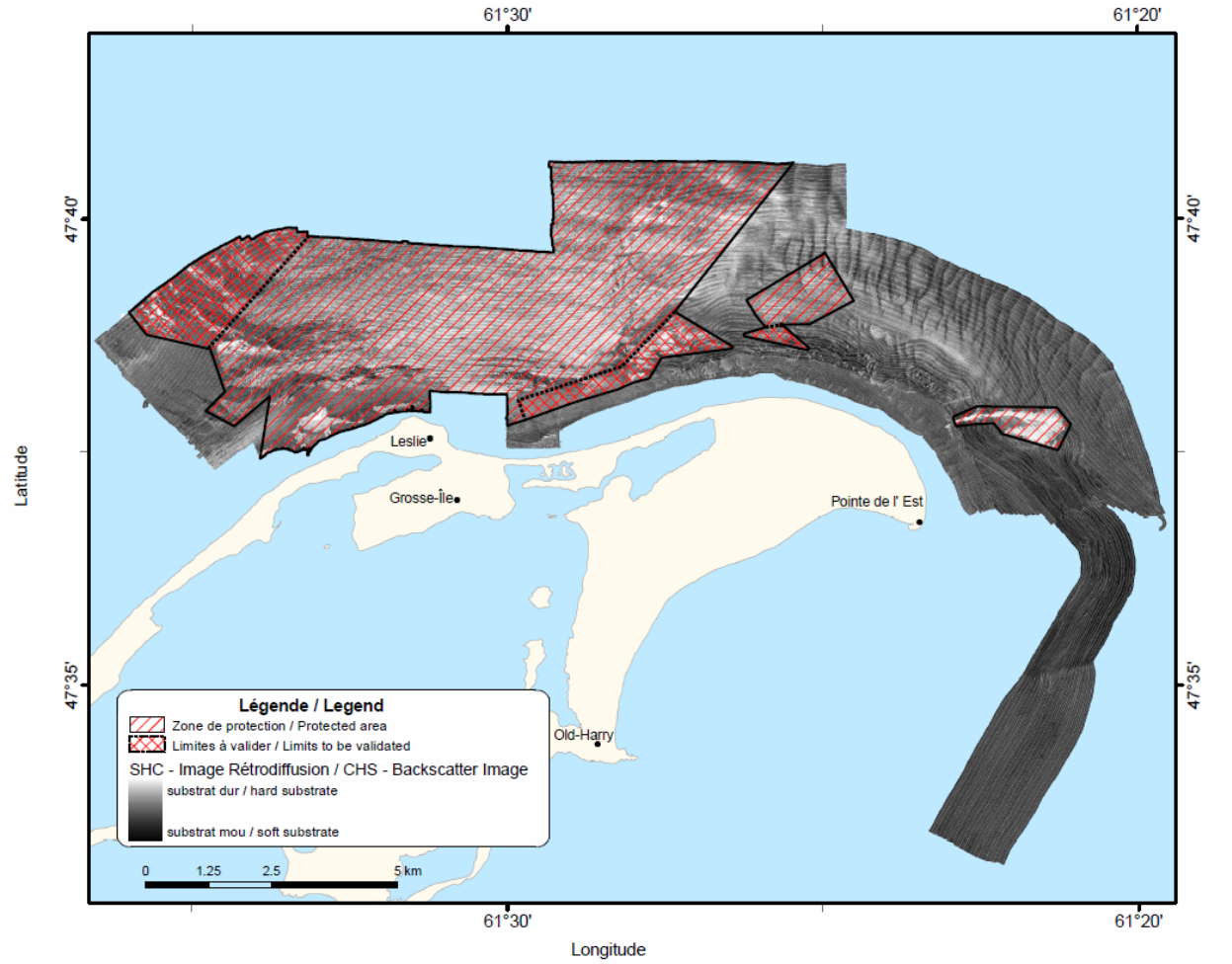

Figure 13B. Backscatter Image (CHS) and protected areas.

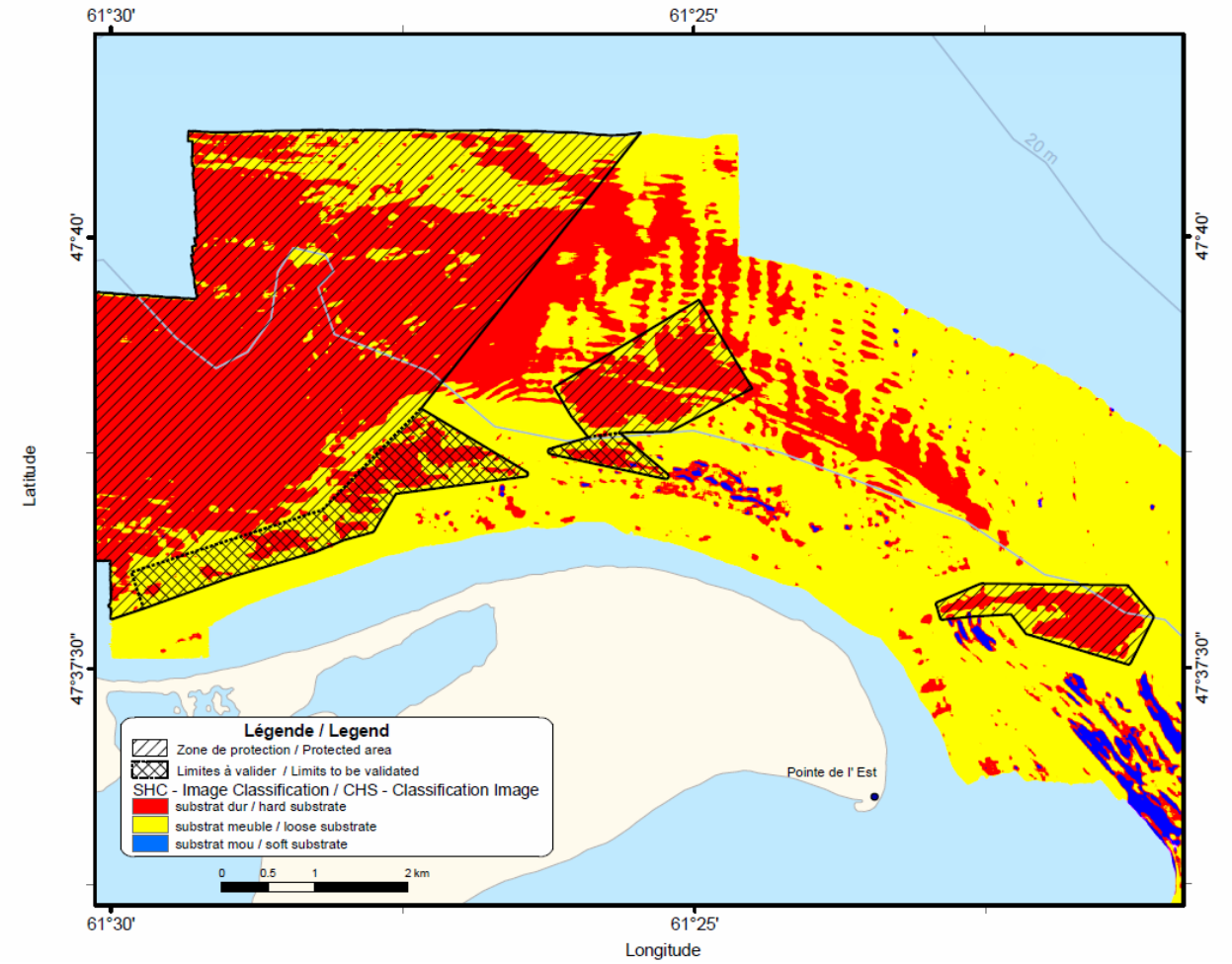

Figure 13C. Substrate Classification Image (CHS) and protected areas (Eastern Area).

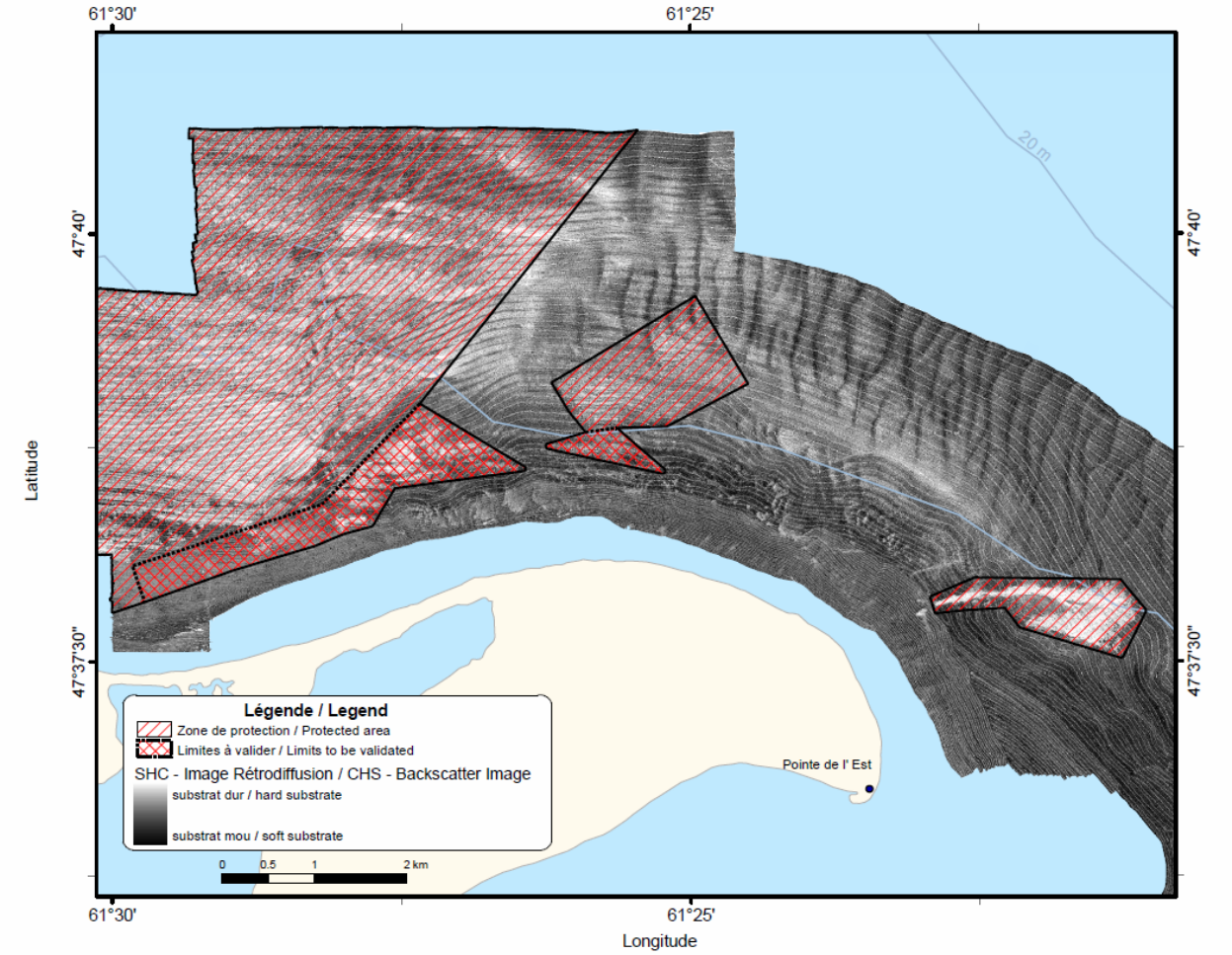

Figure 13D. Backscatter Image (CHS) and protected areas (Eastern Area).

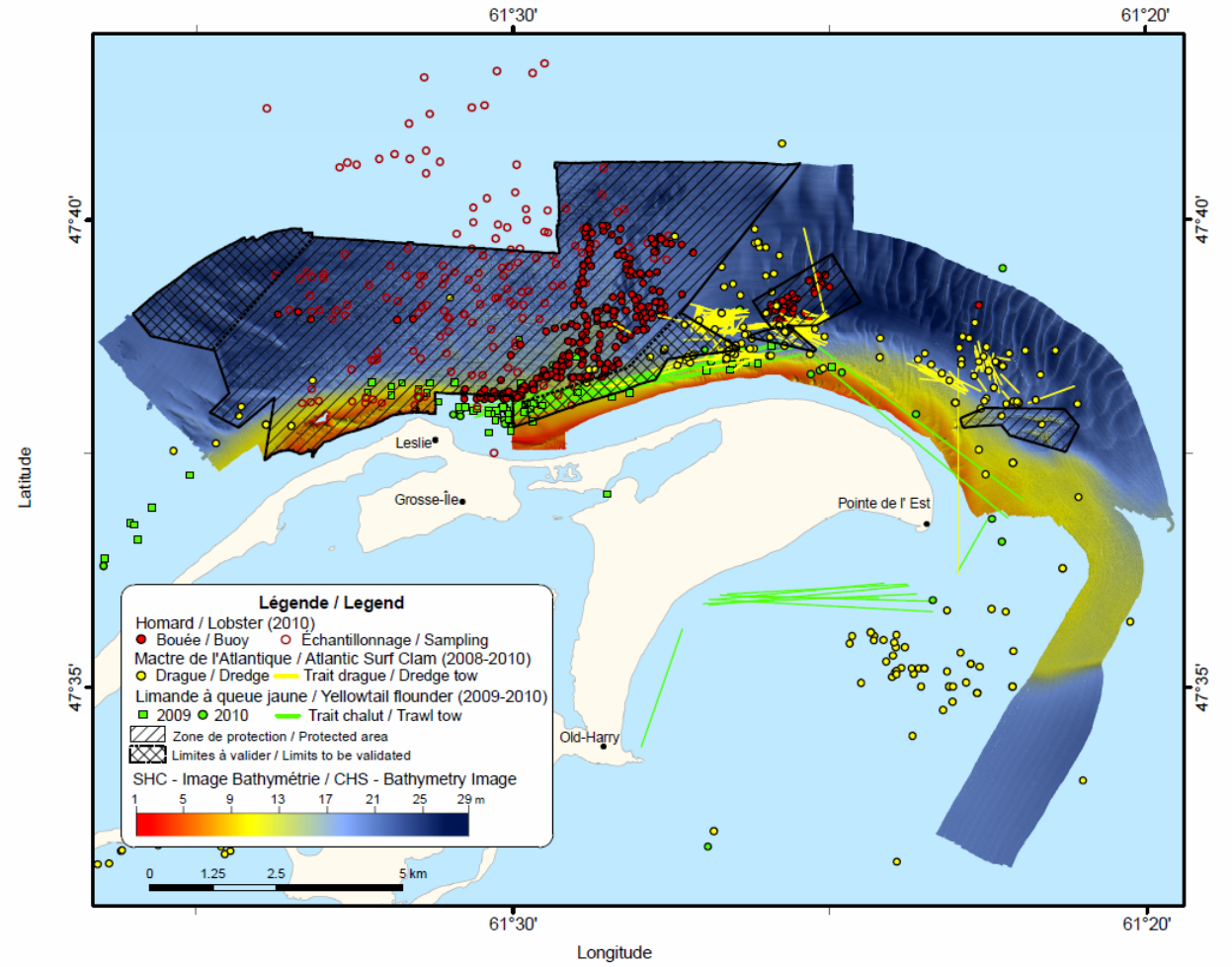

Figure 14A. Bathymetry Image (CHS) and Atlantic Surf Clam Fishing.

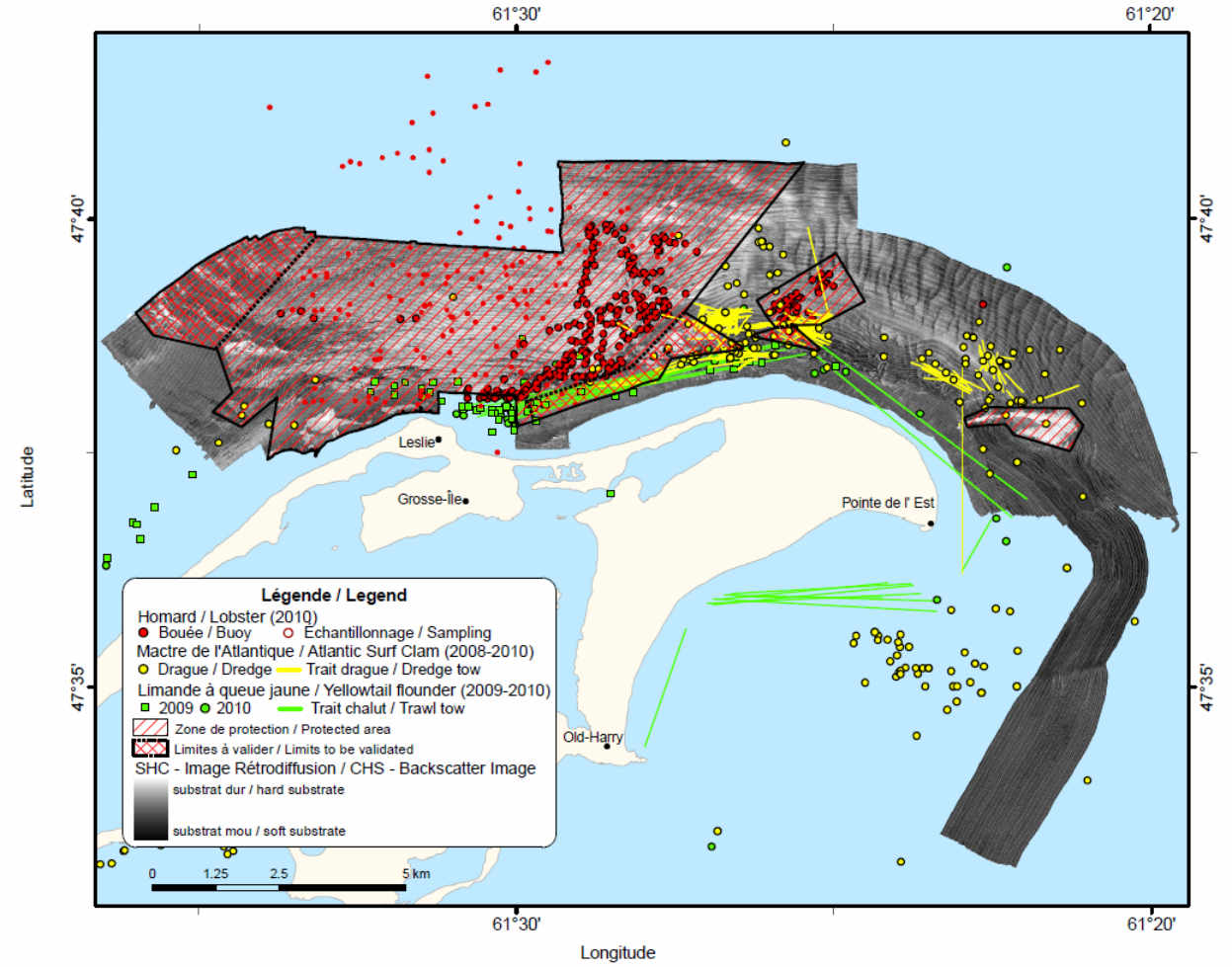

Figure 14B. Backscatter Image (CHS) and Atlantic Surf Clam Fishing.

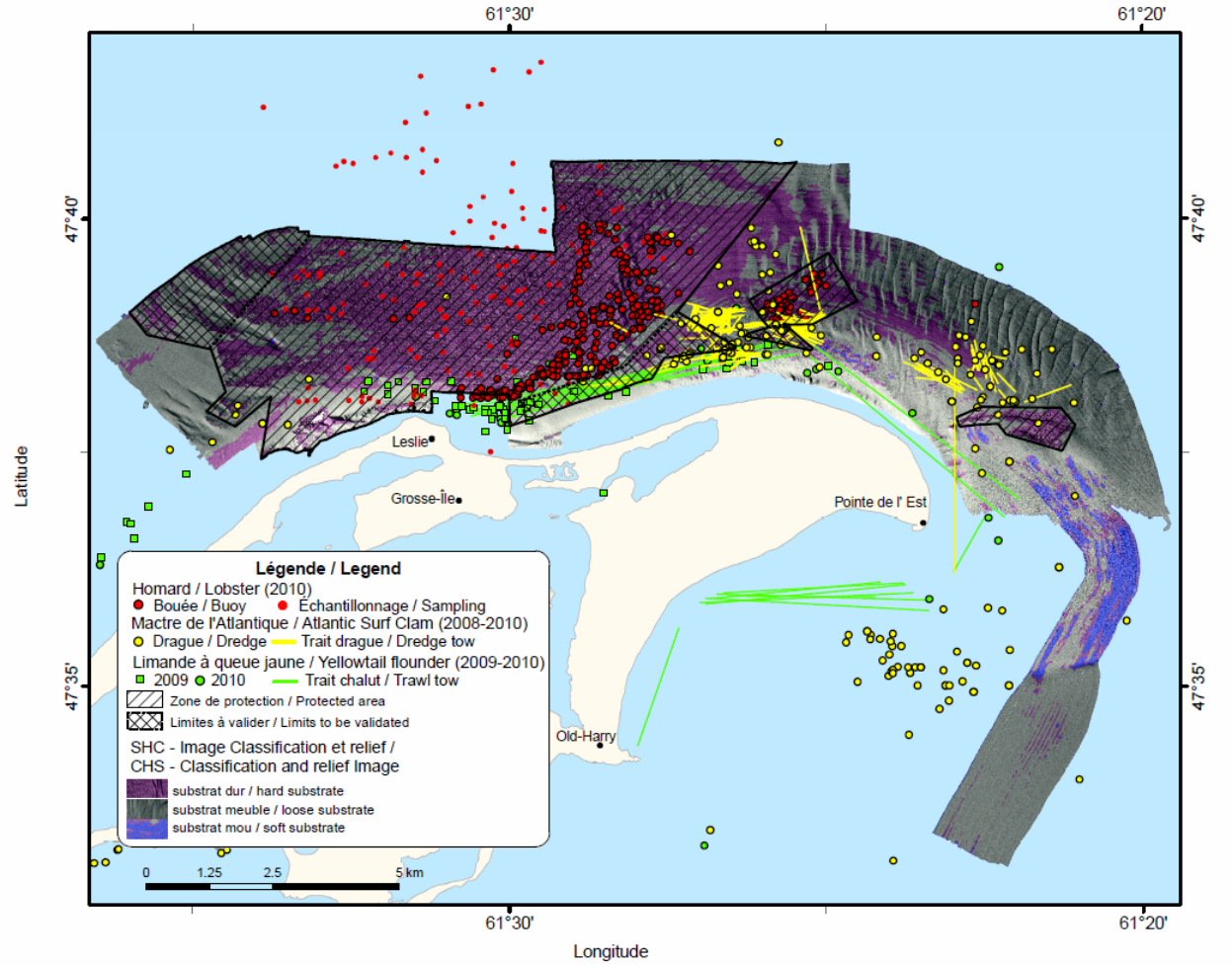

Figure 14C. Backscatter Image (CHS) and protected areas.

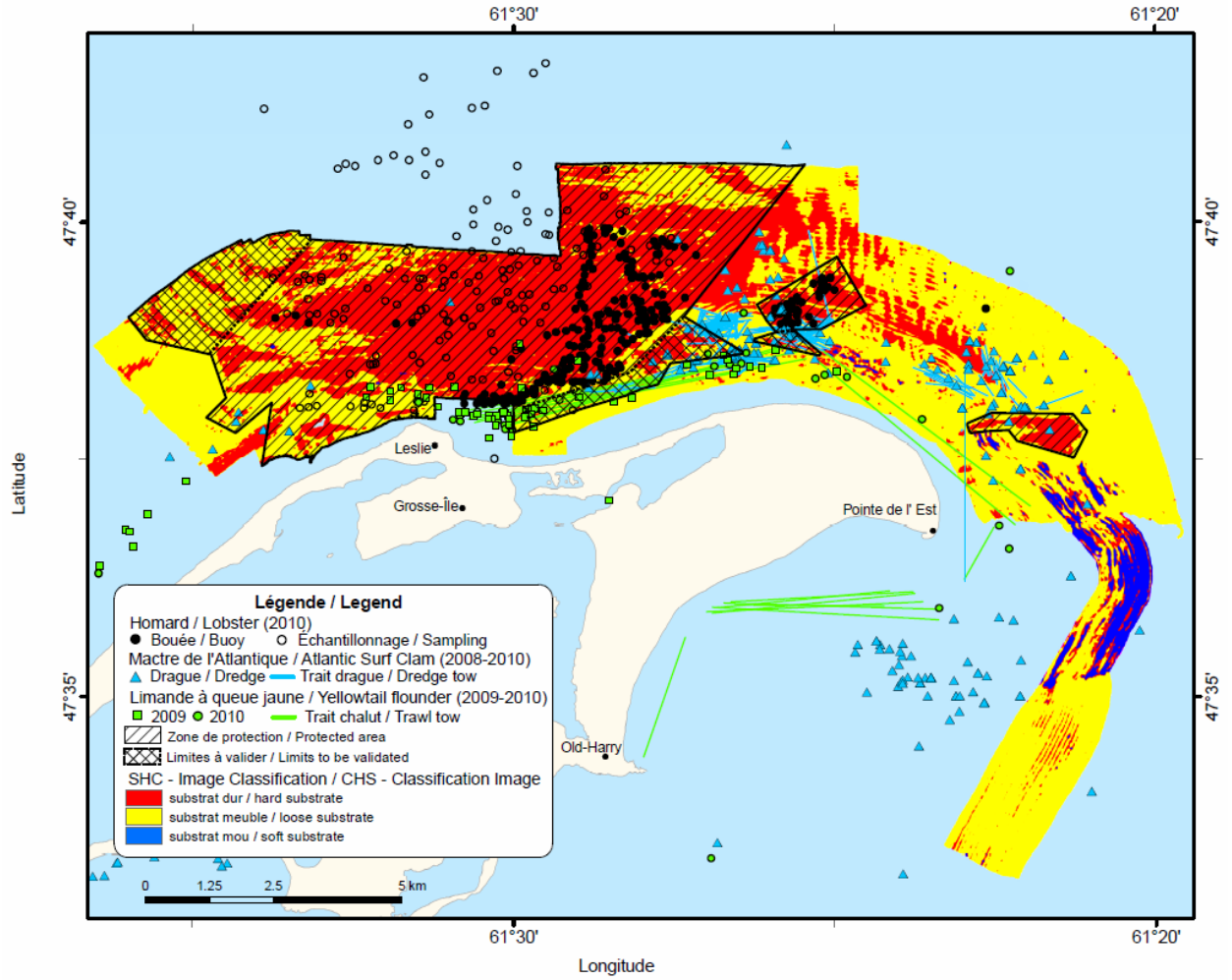

Figure 14D. Substrate Classification Image (CHS) and protected areas (Eastern Area).

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