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Habitat mapping at three potential Marine Protected Areas in the Newfoundland and Labrador Region

Cartographie de l'habitat de trois zones de protection marines potentielles dans la région de Terre-Neuve et du Labrador.

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Abstract

Three potential Marine Protected Areas (MPA) located at Leading Tickles, Gilbert Bay, and Eastport have been identified in the Newfoundland Region, under the *Oceans Act*. Describing and quantifying habitat has been a part of the ecological assessment conducted at each site, during the site evaluation phase. Among the three Areas of Interest (AOIs) two general methods were used to assess habitat: 1) multibeam bathymetry mapping and substrate classification, and 2) underwater video. Reasons for protecting habitat as part of the MPA program may differ from Species At Risk legislation regarding critical habitat, but the methods used to describe and quantify habitat may be useful. The Leading Tickles AOI is developing a multispecies approach and detailed habitat mapping was conducted to identify the requirements for several species such as lobster, crab, and several groundfish species including Atlantic cod. Habitat mapping methods at Gilbert Bay provides the necessary information to protect the unique local Atlantic cod population and its required habitat. At Eastport, area's having high lobster productivity, as identified by local lobster fishers, was mapped to verify habitat quality and quantity. The identification of habitat within each AOI has been based on substrate characteristics, water column characteristics, and geography, in connection with life history characteristics of particular species, and is site specific.

Résumé

Aux termes de la *Loi sur les océans,* on a cerné trois zones de protection marines (ZPM) possibles dans la Région de Terre-Neuve, situées respectivement à Leading Tickes, dans la baie Gilbert et à Eastport. Dans le cadre de l'évaluation écologique réalisée dans chaque zone lors de la phase d'évaluation des lieux, on a décrit et quantifié l'habitat. Deux méthodes générales ont été utilisées pour évaluer l'habitat dans ces zones d'intérêt (ZI) : 1) la classification des substrats et la cartographie par bathymétrie multifaisceaux et 2) la prise de vues sous-marines. Quoique les raisons motivant la protection de l'habitat dans le cadre du programme de ZPM peuvent différer des exigences de la *Loi sur les espèces en péril* concernant l'habitat essentiel, les méthodes utilisées pour décrire et quantifier cet habitat peuvent s'avérer utiles. Dans la ZI de Leading Tickles, où on met en place une approche plurispécifique, on a cartographié en détail l'habitat, afin de cerner les besoins propres à plusieurs espèces comme le homard, le crabe et divers poissons de fond, dont la morue. Dans la baie Gilbert, les méthodes de cartographie de l'habitat permettent d'obtenir l'information nécessaire pour protéger la population locale unique de morue et l'habitat dont elle a besoin. Enfin, à Eastport, les secteurs de très haute productivité du homard, indiqués par les pêcheurs de homard locaux, ont été cartographiés pour qu'on vérifie la qualité et la quantité de leur habitat. L'identification de l'habitat au sein de chaque ZI a été fondée sur les caractéristiques du substrat, sur celles de la colonne d'eau et sur la géographie, ainsi que sur les caractéristiques biologiques des espèces considérées, et elle est propre à chaque zone.

Introduction

Canada's *Oceans Act* was passed in 1997, obliging the Minister of Fisheries and Oceans to develop an Oceans Management Strategy. The mandate of this legislation is to develop integrated management plans for all ocean and coastal areas. To develop integrated management plans the Minister is provided with a number of tools, including the ability to establish Marine Protected Areas (MPAs). MPAs under the *Oceans Act* will be established for the purposes of conservation and protection of: 1) commercial and non-commercial fishery resources and their habitats, 2) endangered or threatened marine species and their habitats, 3) unique habitats, 4) marine areas of high biodiversity or biological productivity, and 5) other marine resources or habitats within the mandate of the Minister of Fisheries and Oceans

The *Oceans Act* and proposed Species at Risk (SAR; Bill C -5) legislation, each have the ability to conserve and protect endangered or threatened species and their habitats. Furthermore, Bill C-5, section 58 (2), titled 'protected areas', indicates that if critical habitat is in a MPA under the *Oceans Act*, the competent Minister must within 90 days after the recovery strategy or action plan is accepted, publish in the Canada Gazette a description of the critical habitat or portion that is in the MPA. Habitat descriptions within potential MPAs in the Newfoundland Region have been conducted as part of each site's ecological assessment. The necessity of an ecological assessment is outlined in the operational framework (*National Framework for Establishing and Managing Marine Protected Areas*) to establish MPAs.

Development of MPAs under the *Oceans Act* is a relatively new initiative for Canada, and DFO. There are no *Oceans Act* MPAs officially designated in the Newfoundland and Labrador (NL) Region to date, although three Areas of Interest (AOI's) are being developed. Until designation, potential MPAs in the NL region are considered AOIs. AOIs in the Newfoundland region are located at Leading Tickles, Gilbert Bay and Eastport (Fig.1).

Understanding life history characteristics, abundance, and habitat requirements of specific species has been a focus of scientific research at Eastport and Gilbert Bay, while species specific information is not the focus of the Leading Tickles AOI. We present case study examples of each AOI in Newfoundland and Labrador, describing the methods of habitat mapping and rationale for habitat protection. In some instances results are preliminary, in which case methods are described and intentions outlined.

Methods and Results

Leading Tickles

MPAs are often established without detailed scientific baseline data prior to establishment, which makes it next to impossible to interpret the effectiveness of MPA objectives scientifically. The Leading Tickles AOI (Fig 2) presents a good experimental design situation to test the application of MPAs. Collection of fisheries and scientific information before MPA regulations are implemented will provide an experimental situation to test the application of this MPA in eastern Canada. Habitat data as it applies to specific species has not bee prioritized, however the detailed habitat mapping work at the Leading Tickles site is applicable to several species.

At Leading Tickles a bathymetry and habitat map is being developed in addition to the collection of fisheries data. A digital bathymetric 3D geo-referenced base map will provide the basis on which other ecological data can be added as digital layers, to eventually create an ecosystem model. Extraction of the information from the model and database is intended to be user queried. The bathymetry and habitat mapping data collected at Leading Tickles are presented here to illustrate the methods used to develop the baseline bathymetry and habitat map.

During the summer of 2001, the Canadian Hydrographic Service (CHS) collected multibeam acoustic data at the Leading Tickles AOI. The vessel, CGS *Fredrick Creed*, using a Simrad EM 1000 multibeam acoustic system sampled deeper water, and the *Plover*, a 10.5 meter survey launch, using a Simrad EM 3000 sampled the near shore. An inertial measurement unit was used to correct for heave, roll and pitch. A Differential Global Positioning System (DGPS) system provided horizontal location accuracy within less than 3 m and vertical location accuracy within 0.3 m. To correct for variable water column characteristics at different locations, the speed of sound in water was measured using an Applied Microsystems Limited Smart Probe. Bathymetry data were collected with 200% overlap, and the acoustic swath width was about twice water depth, therefore additional tracts were necessary in shallow areas. Tidal gauges recorded tide level every 15 minutes, to correct for tidal fluctuations. A geo-referenced radar satellite image, taken at low tide was used to identify the shoreline. Limits of the acoustic mapping extended from the shoreline 5 m contour seaward to the proposed MPA boundary (Fig. 2). The information collected included geo-referenced bathymetry and backscatter. Data were analysed by the CHS and both digital and hard copy 3D images of the seafloor produced. The CHS conducted a similar survey at Gilbert Bay.

At the Leading Tickles site, a 50 KHz transducer and Quester Tangent View 4 system was used to gather and interpret backscatter data. The Quester Tangent system classifies acoustic backscatter signals that represent substrate types. Since the Quester Tangent classification at Leading Tickles was unsupervised, a catalogue of substrate types must be developed through groundtruthing and comparisons of acoustic data. Groundtruthing must be conducted to verify the acoustic classes before substrate type can be applied to acoustic classes. This information may then be used to produce a substrate map.

To groundtruth each acoustic class identified by the Quester Tangent view 4 system, several geo-referenced sites having the same acoustic signal were investigated. Methods for substrate identification included the use of an aqua-scope, underwater video camera, and benthic grab sampler. Comparison of the groundtruthing data with Quester Tangent View 4 information will be completed in the near future. Preliminary results indicate that in shallow water there are large differences in substrate type over small spatial scales.

Gilbert Bay

Gilbert Bay AOI (Fig. 3) research is focused on a local population of Atlantic cod (*Gadus morhua*) (Green and Wroblewski 2000; Morris and Green 2002) genetically distinguishable from other cod populations (Ruzzante et al 2000; Beacham et al. 2002). Therefore, the initial application of multibeam data is interpreted with emphasis on Gilbert Bay cod life history characteristics. Identifying important habitat elements help to explain particular aspects of cod behaviour, such as spawning behaviour and movement patterns. Reproductive behaviour along with bathymetry mapping and water column characteristics suggests a physical mechanism for egg and larval retention. Given the observed spawning locations, this mechanism may influence spawning behaviour and result in maintaining the unique characteristics of this population.

During fall, 2002, the CHS conducted a multibeam survey of Gilbert Bay in a similar manner as that described for Leading Tickles. The *Plover* was launched from the *Mathew* and used to collect the multibeam data. An area of approximately 60 km^2 was mapped over an 8 day period. Data were collected at speeds of 13-17 km/hr, and at depths between 4 m and 150 m, the maximum depth in Gilbert Bay. This survey information clearly identified sill structures (Fig. 4) thought to influence hydrographic conditions in the area. The backscatter information is useful in identifying areas of hard and soft substrate (Fig. 4).

In Gilbert Bay, hydrographic conditions during the annual spawning period and shortly afterwards is thought to ensure the retention of eggs and larvae, at particular locations identified as important spawning habitats. The sill depth in the River Out area is clearly identified by bathymetric mapping (Fig. 4) and reaches a depth of approximately 5 m, which is similar to that of the low salinity surface layer. The silled embayment in which Gilbert Bay cod spawn, coupled with increased fresh water input during the spawning season, is thought to prevent the exchange of dense higher salinity water, in which cod eggs are located.

The spatial range of Gilbert Bay cod is primarily within the proposed MPA boundaries (Green and Wroblewski 2000). Few Atlantic cod tagged with external Floy tags, and no Atlantic cod having sonic transmitters (n=18), have been recaptured or tracked outside the AOI boundary (Green and Wroblewski 2000; Morris and Green 2002). Bathymetry mapping has indicated that the deepest location in Gilbert Bay is near the mouth where other forage fishes may be more abundant. After spawning, a large portion of adult cod move from The Shinneys (Fig. 5) to the outer part of Gilbert Bay (Morris and Green, unpublished data), presumably to find better foraging areas. During late fall these fish return to The Shinneys, to over-winter and spawn the following spring.

Habitat mapping data provide information to quantify different habitat types, relate life history data to habitat, and define boundaries and zones. Based on studies of cod behaviour and the bathymetry of Gilbert Bay, several interim measures have been implemented or are being developed to protect the stock. Zone 1 (Fig. 5) is an important spawning area and thus an important part of Gilbert Bays ecosystem. Zone 1 is designated as inland waters under Newfoundland fishery regulations and is closed to all commercial fishing. Zone 2 (Fig 5) represents the main arm of Gilbert Bay, and is closed to all cod fishing, by the *Fisheries Act*. The outer limit of this Zone was chosen arbitrarily in order to reduce commercial fishing from the majority of Gilbert Bay. Spawning also occurs within portions of Zone 2, but apparently to a lesser degree. The outer portion of the proposed MPA (Zone 3) (Fig.5), defines the MPA boundary. The boundary is defined by shallow sills and narrow entrances (< 500 m). These boundaries extend to the primary range of Gilbert Bay cod, a very limited amount of straying has been observed outside these boundaries.

Eastport

At Eastport, research has focused on the American lobster (*Homarus americanus*). Here, both habitat quantity and quality are important considerations to create an effective no-take zone that is large enough to increase productivity with minimal commercial fishing displacement. Commercial fishers near Eastport identified lobster habitat based on substrate and water depth. Lobsters prefer habitat consisting of gravel/cobble with kelp cover. Larger lobsters require coarser particle size in combination with finer substrate which permits burrowing. Around Eastport, lobsters are seldom fished beyond a depth of 40 m. Scientific research conducted at Eastport suggests that protecting two areas, around Round Island and Duck Islands (Fig 6), has helped to sustain and perhaps enhance the local lobster fishery (Rowe 2001).

During the early 1990s, lobster harvesters in the Eastport area observed a serious decline in lobster stocks. The accelerated decline was attributed to increased exploitation of lobsters following groundfish closures. The Fisheries Resource Conservation Council advised harvesters in the area to take measures that would increase egg production and reduce exploitation rates, in a manner best suited to their particular region. Local harvesters formed the Eastport Peninsula Lobster Protection Committee (EPLPC) in 1995. In 1997, the EPLPC and DFO established a boundary around the peninsula, indicating the Eastport Peninsula Lobster Management Area (EPLMA), within which two small areas around Round Island and Duck Islands (approx. 2 sq. km) were closed to lobster fishing. The Round Island boundary was identified as 6550 ft from shore closing an area of 0.33 km^2, and the Duck Islands closed area is 10.76 km^2. Local knowledge indicated that the study areas contained about 40.4 ha of suitable lobster habitat (Rowe 2001). V-notching of lobster by fishers and release of recaptured v-notched lobster within the EPLMA has helped to sustain the lobster fishery in this area.

To understand habitat characteristics within the two closed areas at the Eastport AOI, a habitat mapping exercise was undertaken by DFO. This project is not yet complete, however the methods used are described. In the spring of 2002, a seabed mapping survey was conducted within the closed areas at Round Island and Duck

Islands. Geo-referenced video images were systematically collected within the study area. The primary survey tool consisted of a boat-deployed, towed, underwater video system (Seabed Imaging and Mapping System, or SIMS) which obtained geo-positioned imagery of the seabed. Towing speed was approximately 3.5 km/hr and sampling transect lines were established at approximately 25 m intervals. The images were classified and a geo-referenced description of the seabed within the study area is being produced. Each image (defined as one second of video imagery) is geo-referenced to differential global positioning system (DGPS) standard time (GMT) and depth of the video camera (corrected to chart datum). Following preliminary classification of this video imagery, SCUBA observations were used to groundtruth the SIMS imagery and obtain more detailed information on the biotic community associated with specific seabed features. The video imagery is being reviewed by a geologist and by a biologist using a substrate and biotic classification system initially developed for the British Columbia Land Use Co-ordination Office (LUCO).

Using this system, substrate and biota classes are provided for each image, resulting in a data record for each second of video imagery. The geology database contains nine seabed substrate data fields including substrate type, sediment class and gravel content. The biological database captures detail on seabed biota within two general categories, vegetation and fauna, and contains a total of 13 data fields. Primary, secondary and tertiary vegetation types are classified for each image and are evaluated for percent cover. A distribution code is assigned to each classified faunal type. A data dictionary is provided for the geology and biology classification system. The classification system can be modified to incorporate additional features.

Since the position of each image is known, plots of the various substrate and biota classes can be generated, providing the basis for characterising the imaged habitat. Biophysical features will be mapped as polygons by manually contouring the point data. Certain features (e.g. crab distribution) are represented as point features on the track-line plots. Representative image files of seabed type and biota will be geo-referenced and linked to biophysical maps, and placed on interactive CD-ROM. Alternatively, maps may be produced as a separate HTML data product.

Conclusion

Habitat mapping has played an important role in the development of MPAs in Newfoundland and Labrador. Quantitative habitat mapping methods used at potential MPA sites in the Newfoundland and Labrador region have included the use of underwater video and acoustics. The multibeam acoustic method used to map bathymetry is rapid compared to single beam acoustics, scuba surveys, or video transects. The data collected also allows for the discrimination of different habitat types. The multibeam method used however is not suitable for very shallow depths (<5m). To describe depths less than 5 m, we used underwater video.

Using multibeam backscatter data to classify bottom substrates is potentially a very useful tool for the classification of habitat. In our opinion, the CHS has the potential

(i.e. access to large multibeam backscatter data sets) to begin large scale substrate mapping of Canada's marine environment. The CHS has equipment designed for bathymetry mapping, and the expertise to collect new information and post process existing data. Calibration of multibeam transducers and installation of bottom classification software capable of analysing multibeam data, would produce information valuable to the Species At Risk initiative. The end product in addition to bathymetric maps would be substrate classifications, from which habitat maps can be produced, to identify critical habitats.

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References

Beacham , T. P., Brattey, J., Miller, K. M., Le, K. D., and R.E. Wither. 2002. Multiple stock structure of Atlantic cod (*Gadus morhua*) off Newfoundland and Labrador determined from genetic variation. – ICES J. Mar. Sci., 59: 650-665.

Green, J. M. and J. S. Wroblewski. 2000. Movement patterns of Atlantic cod in Gilbert Bay, Labrador: evidence for bay residency and spawning site fidelity. J. Mar. Biol. Assoc. 80: 1077-1085.

Morris, C. J. and J. M. Green. 2002. Biological characteristics of a resident population of Atlantic cod *Gadus morhua*) in southern Labrador. ICES J.Mar. Sci., 59: 666-678.

Rowe, S. 2001. Movement and harvesting mortality of American lobsters (*Homarus americanus*) tagged inside and outside no-take reserves in Bonavista Bay, Newfoundland. Can. J. Fish. Aquat. Sci. 58: 1336-1346.

Ruzzante, D., J. Wroblewski, C. Taggart, R. Smedbol, D. Cook, and S. Goddard. 2000. Bay-scale population structure in coastal Atlantic cod in Labrador and Newfoundland, Canada. *Journal of Fish Biology*, 56p. The Fisheries Society of the British Isles.

Figure 1. Areas of Interest in the Newfoundland and Labrador Region.

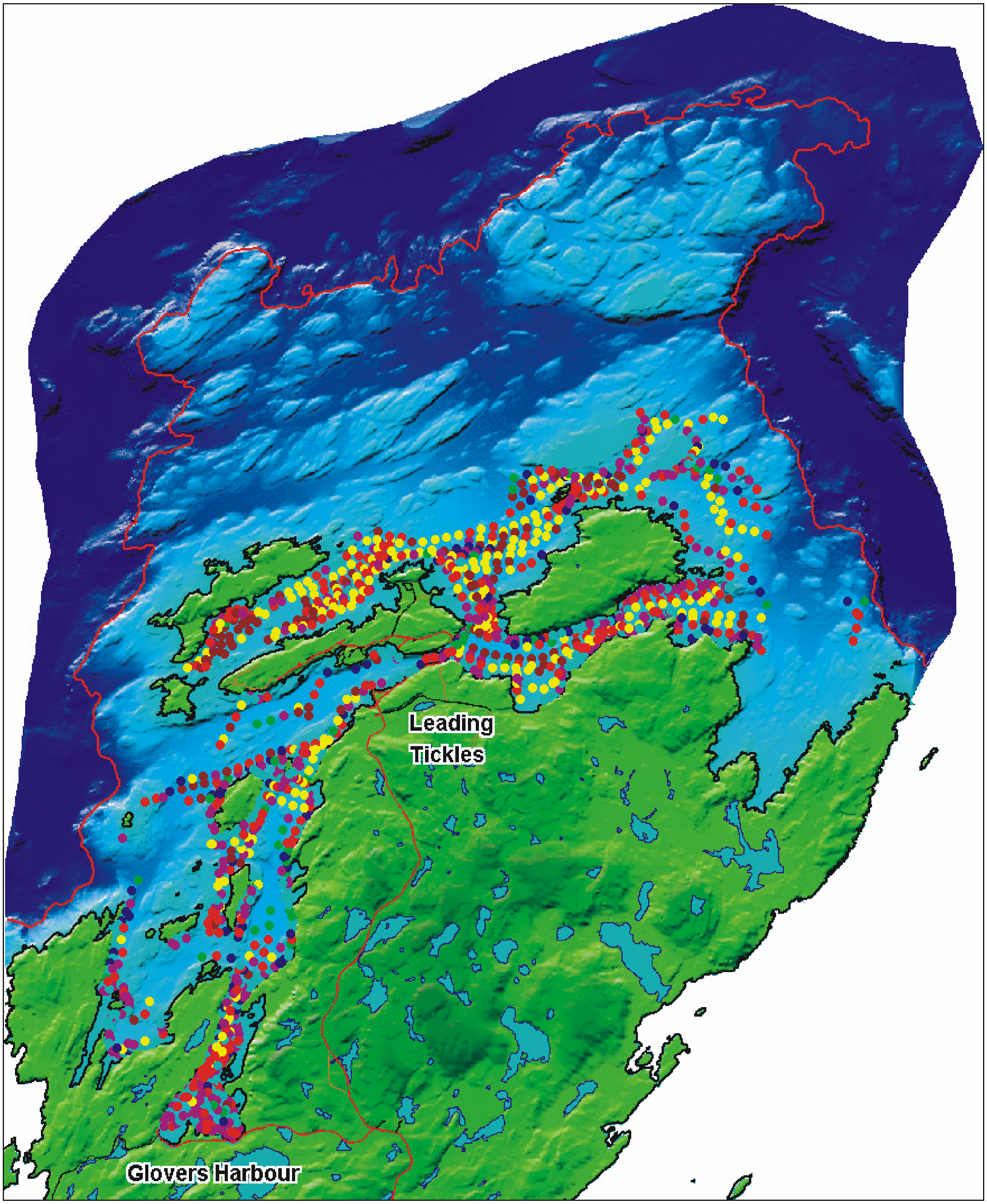

Figure 2. Leading Tickles AOI, indicating bathymetry and colour coded substrate classes. The different colour circles indicate differing substrate classes that have not been identified.

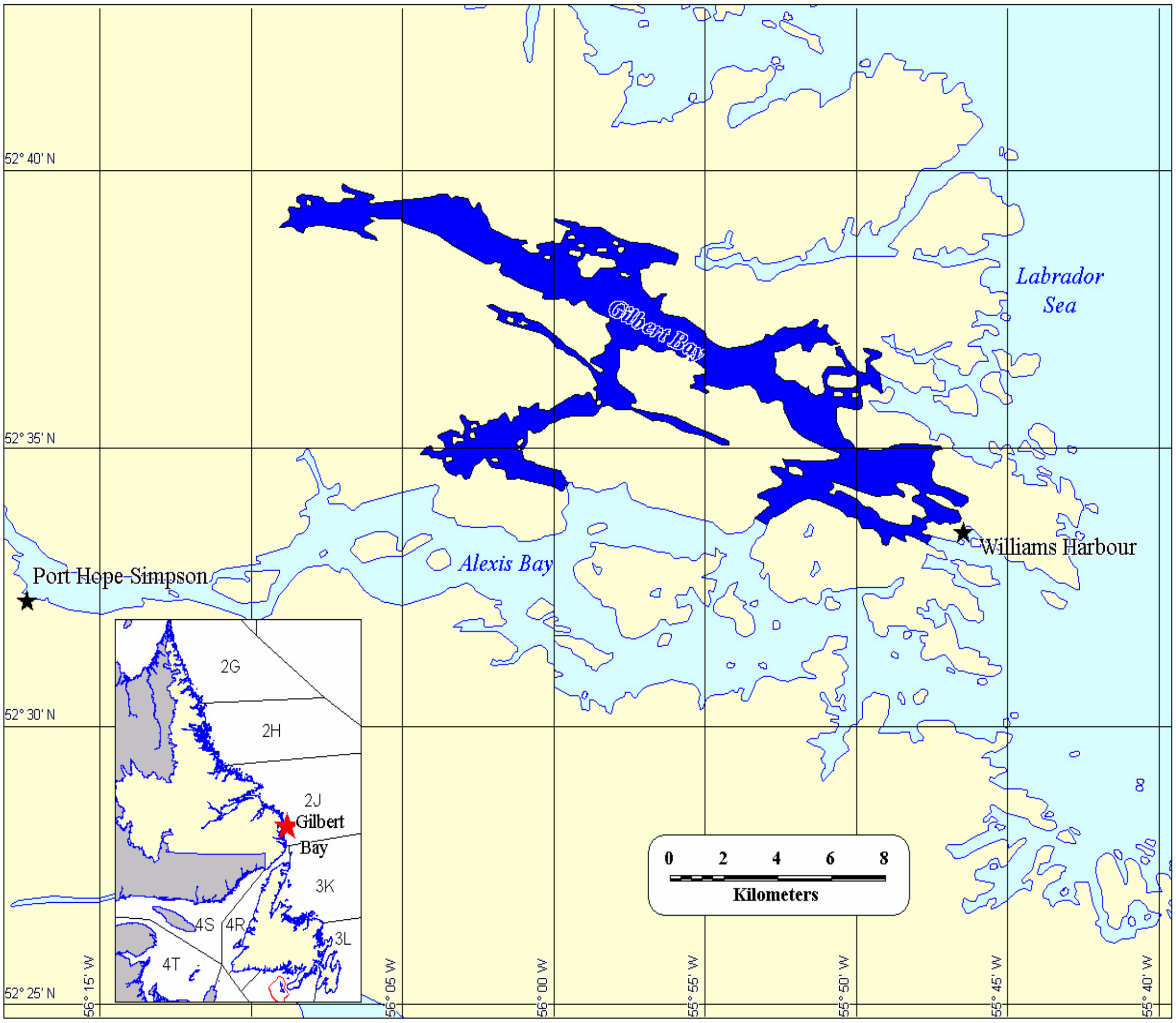

Figure 3. Proposed boundaries for the Gilbert Bay MPA.

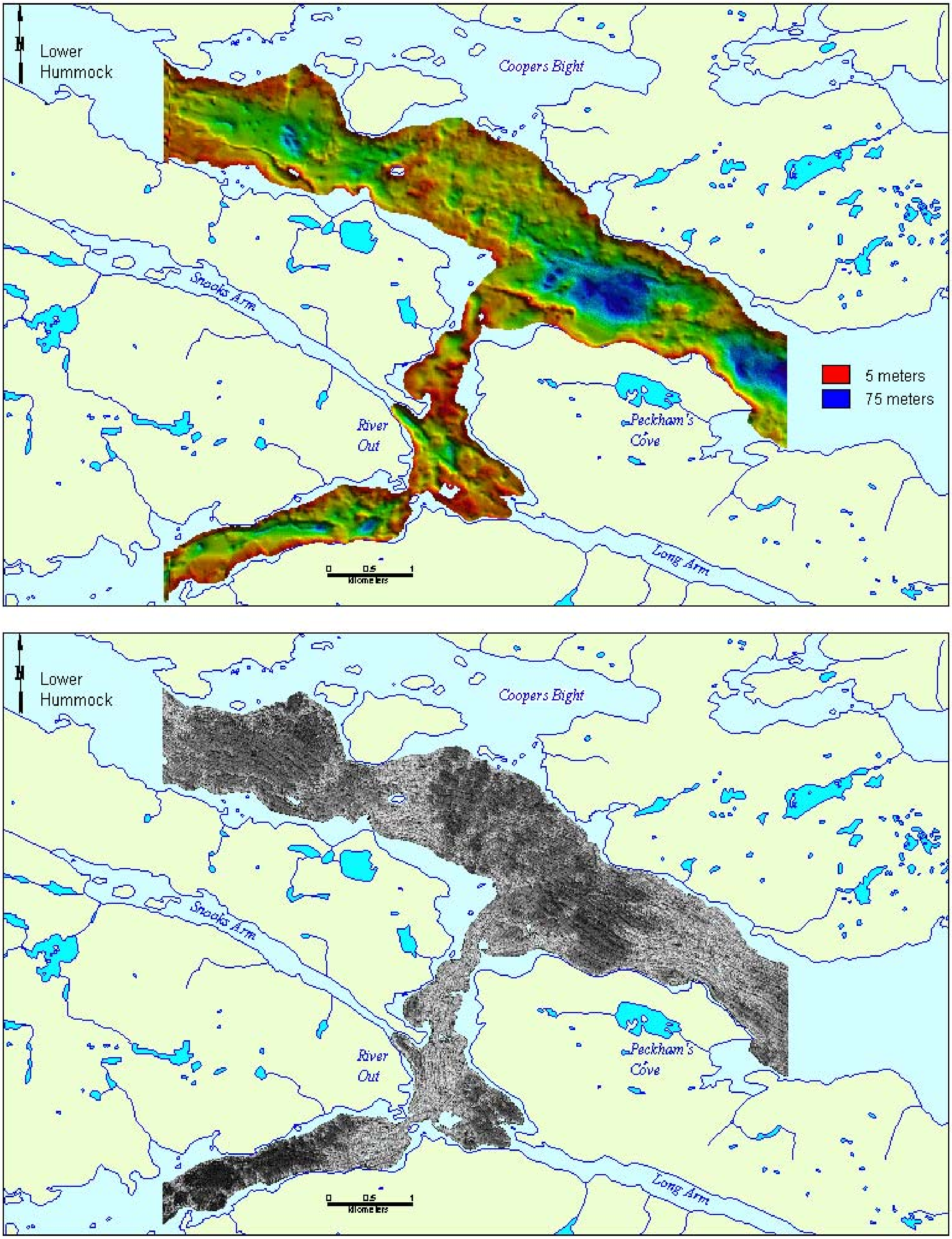

Figure 4. Multibeam and backscatter images of a portion of Gilbert Bay. Upper panel indicates bathymetry. Lower panel indicates backscatter information, dark shaded areas indicate a soft bottom type and light shaded areas indicate a hard bottom type.

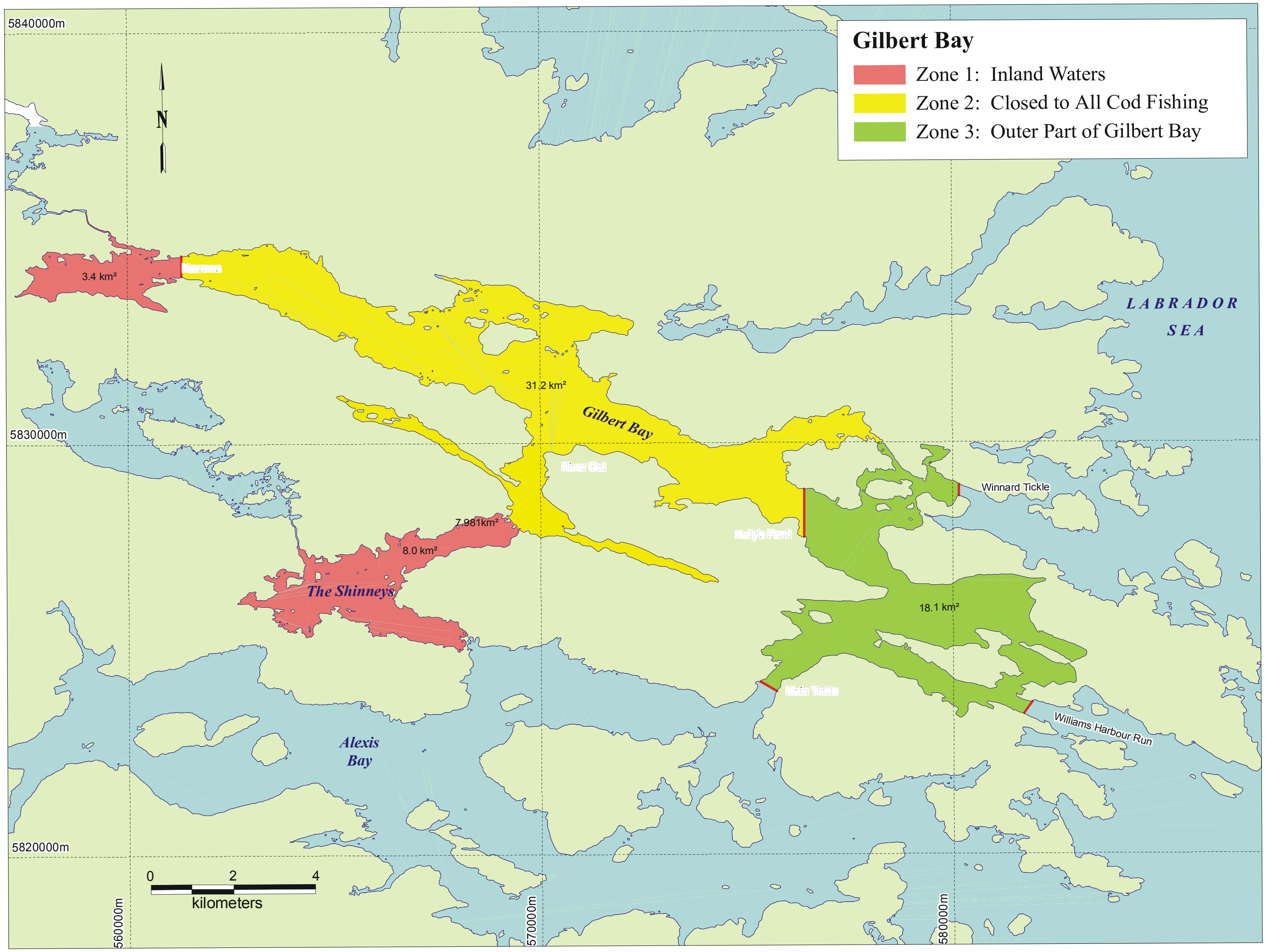

Figure 5. Zones identifying specific management areas within the Gilbert Bay AOI.

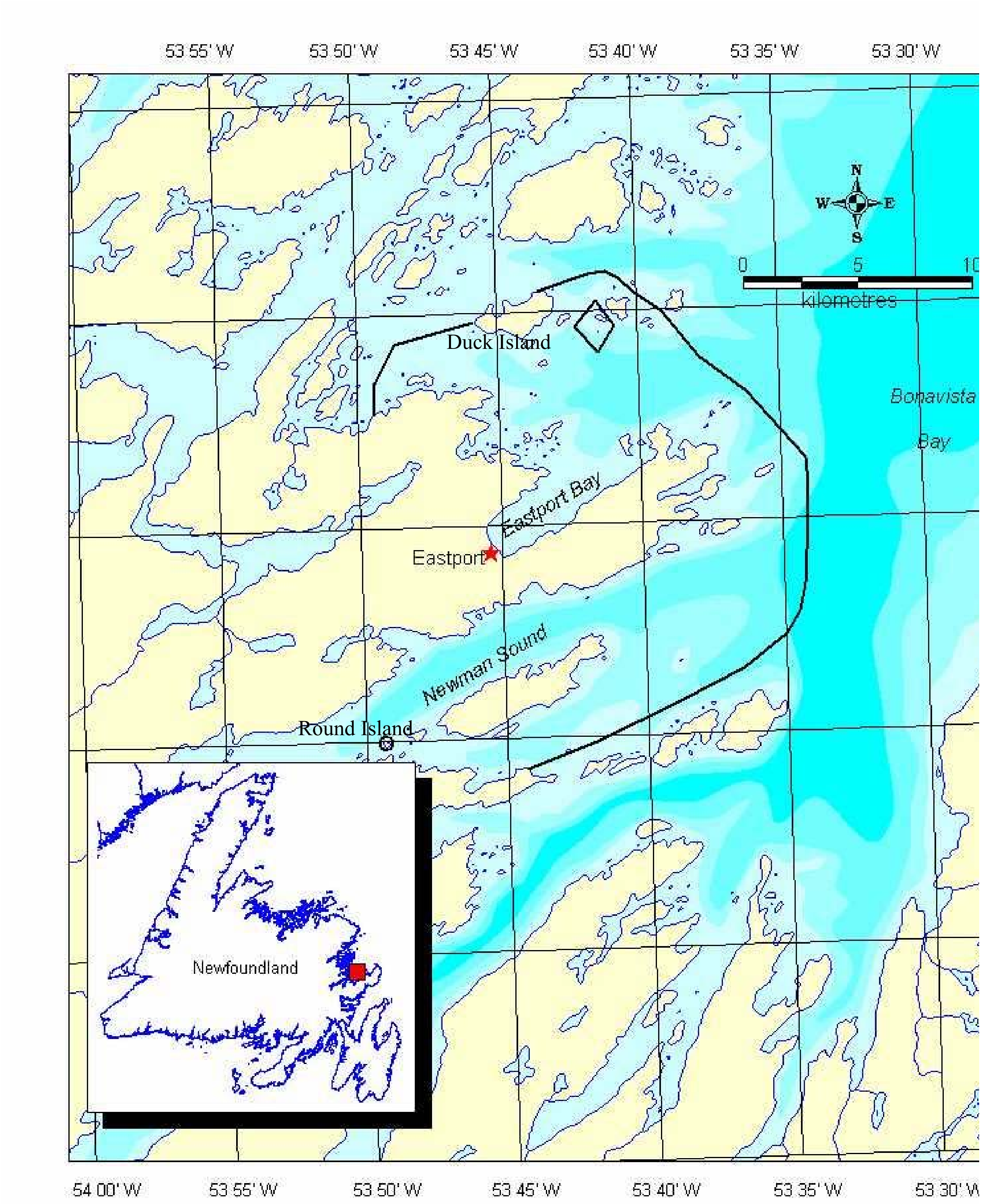

Figure 6. AOI boundaries at Duck Island and Round Island within the Eastport Peninsula Lobster Management Area