Atlantic Canadian Protocol on Mapping Fishing Activity

Tanya Koropatnick and Scott Coffen-Smout

Aquatic Ecosystems Branch
Fisheries and Oceans Canada
Maritimes Region
Bedford Institute of Oceanography
PO Box 1006
Dartmouth, Nova Scotia, Canada
B2Y 4A2

2020

**Canadian Technical Report of
Fisheries and Aquatic Sciences 3348**

Fisheries and Oceans Canada   Pêches et Océans Canada

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

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Cat. No. Fs97-6/3348E-PDF ISBN 978-0-660-33370-0 ISSN 1488-5379

Correct citation for this publication:

T. Koropatnick and S. Coffen-Smout, 2020. Atlantic Canadian Protocol on Mapping Fishing Activity. Can. Tech. Rep. Fish. Aquat. Sci. 3348: iv + 35 p.

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ABSTRACT

T. Koropatnick and S. Coffen-Smout, 2020. Atlantic Canadian Protocol on Mapping Fishing Activity. Can. Tech. Rep. Fish. Aquat. Sci. 3348: iv + 35 p.

This Atlantic Canadian Protocol on Mapping Fishing Activity was developed in response to a requirement identified by DFO's National Oceans Managers' Committee to provide common and consistent methods and guidance for mapping fishing activity across DFO's regions. The intended audience includes DFO staff involved in geospatial mapping and analysis and Oceans Program practitioners working on marine protected areas and integrated oceans management / marine spatial planning. Operational requirements for developing an Atlantic Canadian Protocol relate to the facilitation of interregional comparisons of spatial data products (e.g., maps, data layers) used internally, inter-departmentally, inter-governmentally, or shared publicly with client stakeholders by request or served via online mapping applications and bioregional atlases. This guidance relates to technical considerations in fisheries data mapping and is intended to ensure the standardization of derived mapping products produced across DFO's regions in Atlantic Canada. These considerations include guidance on data sources, data quality, data privacy and confidentiality, data aggregation, data classification and symbolization, and common map elements. Inter-regional adoption of this Atlantic Canadian Protocol should ensure regional consistency in fisheries mapping products produced at bioregional scales in Atlantic Canada.

RÉSUMÉ

T. Koropatnick and S. Coffen-Smout, 2020. Atlantic Canadian Protocol on Mapping Fishing Activity. Can. Tech. Rep. Fish. Aquat. Sci. 3348: iv + 35 p.

Le présent Protocole pour la cartographie des activités de pêche du Canada atlantique a été élaboré en réponse à une exigence du Comité national des gestionnaires des océans (CNGO) de Pêches et Océans Canada, qui était de fournir des méthodes et de l'orientation uniformes et communes pour la cartographie de l'intensité de la pêche dans l'ensemble des régions du Ministère. Le public cible comprend les employés du Ministère qui mènent des activités de cartographie et d'analyse géospatiales, ainsi que les spécialistes des programmes sur les océans qui travaillent sur les zones de protection marine, la gestion intégrée des océans et la planification spatiale marine. Les exigences opérationnelles pour l'élaboration d'un protocole du Canada atlantique se rapportent à la facilitation des comparaisons interrégionales de produits de données spatiales (p. ex. cartes, couches de données) d'usage interne, interministériel et intergouvernemental ou communiqués de façon publique aux intervenants après une demande, ou offerts par l'intermédiaire des applications de cartographie en ligne et des atlas biorégionaux. La présente ligne directrice porte sur les considérations techniques de la cartographie des données sur les pêches et vise à assurer la normalisation des produits cartographiques dérivés générés dans l'ensemble des régions de Pêches et Océans Canada. Ces considérations comprennent des directives sur les sources, la qualité, la protection et la confidentialité, l'agrégation, la classification et la symbolisation des données ainsi que les éléments cartographiques communs. L'adoption interrégionale de ce protocole du Canada atlantique devrait assurer l'uniformité régionale des produits cartographiques des pêches générés à l'échelle biorégionale.

1. INTRODUCTION

This Atlantic Canadian Protocol on Mapping Fishing Activity was developed in response to a requirement identified by DFO's National Oceans Managers' Committee (NOMC) to provide common and consistent methods and guidance for mapping fishing activity across DFO's regions. The intended audience includes DFO staff involved in geospatial mapping and analysis and Oceans Program practitioners working on marine protected areas and integrated oceans management / marine spatial planning. Operational requirements for developing an Atlantic Canadian Protocol relate to the facilitation of interregional comparisons of spatial data products (e.g., maps, data layers) used internally, inter-departmentally, inter-governmentally, or shared publicly with client stakeholders by request or served via online mapping applications and bioregional atlases.

Various management applications of geospatial data exist in DFO that further highlight the need for a common and consistent inter-regional approach to fisheries data mapping and interpretation. Geospatial data have multiple marine planning and decision support applications, including the following:

- Assessing Ecosystem Approach to Management (EAM) habitat objectives in Integrated Fishery Management Plans e.g., monitoring annual percent area disturbed by fishing gear (Vessel Monitoring System (VMS) fishing footprint, no. of gear sets/grid cell);
- Assessing accident risks and coastal pollution preparedness;
- Coastal and marine spatial planning and cumulative impacts assessment (e.g., aquaculture, shipping terminals);
- Ecological and Biological Significant Area (EBSA) assessment and monitoring;
- Environmental emergency response processes;
- Informing fisheries eco-certification processes e.g., Marine Stewardship Council (MSC);
- Informing Transport Canada's "Places of Refuge" decision making for ships in distress;
- Conservation area site planning and monitoring (e.g., Marine Protected Areas (MPAs), Critical Habitat under the Species at Risk Act (SARA)) and MPA network planning;
- Monitoring compliance in Vessel Traffic Separation (VTS) zones;
- Planning ocean renewable energy development;
- Risk assessment for environmentally sensitive areas;
- Submarine cable and pipeline route planning;
- Cost/benefit analysis of ocean uses; and
- State of the ocean reporting.

Fishing activity can be analysed and mapped in a variety of ways to serve a multitude of purposes. Common portrayals include maps showing catch weights, landings, number of sets or logbook entries, hours fished (e.g., trap soak time, trawl hours), amount of gear (number of traps, number of hooks), catch per unit effort (e.g., weight/hours fished), or remotely sensed fishery footprint data (e.g., from the Vessel Monitoring System (VMS) and Automatic Identification System (AIS)). Regardless of the approach, certain technical and procedural considerations must be addressed as part of any DFO-led fisheries mapping initiative. Important considerations, including technical issues (data sources, quality, and techniques for analysis and mapping), map validation, confidentiality concerns, external data requests, and data management approaches, are explored in detail in the sections that follow.

2. FISHERIES MAPPING 101: TECHNICAL CONSIDERATIONS

In preparation for any spatial data analysis approach, certain methodological considerations are required, such as access to various data sources, data aggregation, classification, symbology, issues related to data quality, and common map elements. Each of these is discussed in detail below.

2.1 Project Scoping

The scoping process for any project to analyse and map spatial fisheries data should include a clear statement of the objective of the project to clarify scale requirements, the required data fields and the data extent. Project scoping should also involve discussions with fisheries subject matter experts to ensure appropriate use of data and analytical techniques.

2.2 Data Sources

2.2.1 Fisheries Logbook Data

DFO currently maintains regional catch and effort data repositories for licencing, vessel, participant (fisher), quota, and catch and effort (logbook) information. Regional databases may also serve as the transactional system used by licencing officers, quota management personnel, dockside monitoring companies and fishers for activities such as logbook data entry, hail out/in record keeping, renewing and paying for licences, registering vessels, setting and monitoring quota for various species, and fisheries valuations. Because reporting and data tracking requirements vary considerably by fishery and by region, these regional catch and effort databases are the best source of data on local fisheries within each region. However, it is important to note that regional databases vary in terms of structure and often do not include catches from fishers who fish in one region and land their catches in another region. Examples of useful information that may be available through regional databases include:

Catch information

- Latitude and longitude
- Species caught
- Value[1]
- Live weight equivalent[2]
- Date caught / date landed
- DFO statistical area, DFO region, fisheries management units (e.g., NAFO division/subdivision or unit area, Pacific management area)

Effort information

- Trip number / set identification number
- Number of days / hours fished
- Gear type
- Gear amount (number of traps, hooks, etc.)
- Gear description (e.g., mesh size)

[1] Values may be based on price slips submitted by fishers, but due to reporting compliance issues the values may also be derived from average prices provided by buyers. Data collection and entry delays are not uncommon for the value field.

[2] Includes a calculation applied to the landed weight of the catch (which may only include processed products minus shell, heads, entrails, etc.) to provide an estimated live weight prior to processing. This is the appropriate weight to use for estimates of biomass removed from the ocean.

- Identifier that marks the species caught as targeted or by-catch[3]

Vessel-related information

- Vessel Registration Number (VRN)
- Vessel description (gross tonnage, overall length, brake horsepower, etc.)

Participant (fisher) information

- Community name / vessel homeport
- Port landed
- Licence information

Dataset Coding

- Code tables to identify variable codes

DFO Headquarters also maintains the Zonal Interchange Formatted File (ZIFF) system as a national data archive for a subset of variables commonly collected nation-wide. Currently, the ZIFF system only contains data from the Atlantic regions and will incorporate data from Central and Arctic region and Pacific region as they develop more capacity to produce and share catch and effort information. Data from each regional fisheries database is uploaded quarterly to the ZIFF archive. These annual datasets are generally quality controlled and finalized within 16 months after each year-end. While not as dynamic, comprehensive, or current as the regional databases, the ZIFF database is useful for assessments of fisheries that span regional boundaries (e.g., for tracking commercial fisheries activities when catches from one region are landed in another region), and contains adequate information for mapping catch-related data (e.g., landings maps). However, the ZIFF does not contain many effort-related variables, and very few of those that are available are reported consistently amongst the regions.

At present, Fisheries Management (NHQ) is leading an initiative to develop a national interactive licencing, quota, and catch/effort system that will replace the regional databases. This nation-wide CANFIS system is currently in the early stages of development [the national online licencing system (NOLS) component became operational in 2013]. These current efforts to centralize and standardize fisheries and licencing data collection, storage and management may create efficiencies and encourage improvements in fisheries reporting standards nation-wide. However, upon implementation of the new system, it is also possible that certain data that is currently gathered by regional systems may no longer be collected.

Until CANFIS development is complete, internal regional data requests for commercial fisheries data should be directed to the Statistical Services staff in the Policy and Economics Branch of each Region. Multi-regional ZIFF data requests should be directed to the Statistical Services Group at DFO National Headquarters (see Appendix C for contact information).

2.2.2 Vessel Monitoring System (VMS)

DFO's national satellite-based Vessel Monitoring System (VMS) is an important surveillance and compliance monitoring tool for certain Canadian fisheries. In Atlantic Canada, many fleets are required to carry VMS transmitters, which report vessel position, date and time at regular (e.g., hourly) intervals. Individual report locations can be connected to create a proxy for vessel-specific tracks via mapping software. While VMS data does not include information about what gear type is used or whether a vessel

[3] Directed species is reported in Gulf Region and Newfoundland and Labrador Region, but this variable is not available for Maritimes Region.

is fishing or steaming, track patterns and vessel speeds can be used to infer vessel behaviour, and methods that link VMS data to catch and effort information (VRN, catch date, location, gear type and species landed) for the same trip have been developed to help further characterize VMS tracks in terms of fishing behaviour. Although hourly VMS reporting rates may not be frequent enough to accurately depict fishing intensity, mapping VMS tracklines for mobile bottom-contact gear on appropriately sized grids (i.e., 200 m to 1 km) can be used to estimate fishery footprints for assessments under, for example, DFO's Sensitive Benthic Areas Policy or in MSC fisheries eco-certification processes (see Appendix A for example).

Internal VMS data requests should be sent to DFO's VMS Centre of Expertise in St. John's, Newfoundland (see Appendix C for contact information).

2.2.3 At-Sea Observer Program

This is a nation-wide program that places certified private-sector observers on fishing vessels to monitor fishing activities and collect detailed data associated with fishing catch and effort. Available data from this program may include discarded and retained bycatch species/quantities, and detailed fishing effort information such as start and stop positions for gear deployments and retrievals.

Internal requests for observer data should be directed to the Observer database manager in each DFO Region (See Appendix C for regional contacts).

2.2.4 Local / Traditional Knowledge

For the purpose of fishing activity mapping, local or traditional fisheries knowledge is knowledge acquired by Aboriginal and non-Aboriginal individuals or communities from extensive first-hand experience with fishing activities (past or present) in a given area. This information source is especially useful for areas where fisheries reporting requirements are not adequate to characterize fishing activities at a scale that is appropriate for the mapping project. Local/traditional knowledge is generally gathered through interviews with knowledge holders. As part of the interview process, paper or electronic charts can be used to collect spatial information on areas of importance for various fishing activities. For more information on the application of local and traditional knowledge for oceans management, please refer to the DFO Traditional Ecological Knowledge Guide for Oceans Management.[4]

2.2.5 Automatic Identification System (AIS)

The Automatic Identification System (AIS) was developed to prevent collisions among large vessels and is mandatory for vessels > 300 tonnes and passenger vessels > 150 tonnes. Although AIS data is not mandatory on Canadian fishing vessels as per federal Navigation Safety Regulations,[5] AIS data feeds from coastal land stations and satellites can be used to characterize fishing activity as more vessels voluntarily adopt AIS transponders for increased vessel safety and collision avoidance. Raw AIS data decoding scripts and quality control techniques for errors have been developed to create reliable fishing vessel density maps.[6] Further voluntary or mandatory adoption of AIS by Canadian fishing fleets offers the potential for improved spatial and temporal planning in coastal and offshore areas.

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[4] DFO 2012. Traditional Ecological Knowledge Guide for Oceans Management: With Best Practices for Aboriginal Engagement in Integrated Ocean Management. Internal draft document.

[5] Canada Shipping Act, 2001, Navigation Safety Regulations (SOR/2005-134) <https://laws-lois.justice.gc.ca/eng/regulations/SOR-2005-134/page-5.html#h-41>.

[6] C.M. Konrad, 2019. Analysis of Automatic Identification System (AIS) Data for the Eastern Shore Islands, Nova Scotia, 2017–2018. Can. Man. Rep. Fish. Aquat. Sci. 3172: vi + 27 p. + Appendices.

Access to coastal and satellite sources of AIS data is possible through the National Strategies Office of the Canadian Coast Guard, and the Space Exploitation Missions Office of the Canadian Space Agency, respectively (see Appendix C for contact information).

2.3 Data Quality

2.3.1 Errors

Caution should always be used when working with fisheries data; most sources (e.g., commercial logbooks, observer records) are susceptible to human-induced errors, including reporting errors (e.g., incorrect catch location reported in a fisheries logbook) and transcription errors (i.e., mistakes made during database entry). While data quality control is part of database management, with such large datasets, review and correction of data is triaged based on departmental priorities and not all errors are corrected by statistical staff. Many datasets are meant to serve a specific purpose and incorrect values, such as missing data when it is know that activity occurred, are not possible to populate with appropriate verification. In fisheries logbook data only one latitude and longitude position is entered per reported landing. A logbook entry may represent one day of activity and fishing gear may cover a large area that goes well beyond the reported position. Using a single position to represent fishing activity is not problematic, nonetheless patterns shown in maps should be considered general patterns of activity and not an absolute determination of where fishing does or does not occur.

Dollar values should not be used to map fishing activity as it is dependent on market value and given the errors in reporting, dollar values are not reliable; it should only be represented as the percentage of the total value or as dollar ranges. Dollar value averages are a more appropriate mechanism to report on the value of fishing activity.

Prior to map/data layer production, fisheries data can be 'cleaned' to remove obvious errors, such as catch coordinates on land or demersal trawl activities reported in water depths >1,500 m. All excluded data should be quantified as a percentage of the total data.

Data records without georeferences should be quantified as a percentage of all data records and the values reported in the metadata. Scaling adjustments should not be performed to accommodate for missing georeferences because scaling assumes that non-georeferenced data are evenly distributed across the fishery. The higher the percentage of non-georeferenced data that is scaled, the more biased the fisheries mapping product.

Alternatively, all data may be displayed as part of the map, including obvious errors. This approach is favoured by some because it makes no assumptions as to data accuracy. Even with the inclusion of erroneous data, patterns and trends should still be discernible, and the audience is permitted to judge the quality of the available data for themselves.

While either approach is valid, it is important to provide an explanation of any steps taken to clean or otherwise manipulate the data, and to outline known deficiencies in the data or map products as part of the companion information and metadata that accompanies the maps (see below).

2.3.2 Inconsistencies in Reporting

Reporting requirements may vary by region, fishery, fleet, directed *vs*. bycatch species, or even by vessel size. For example, some regions require fishers to identify the target species of their fishing efforts while other regions may not have this requirement. Weights may be provided for target species while discarded bycatch may simply be listed by species without weight estimates, or not listed at all. Coordinates may be rounded off to the nearest minute by some fishers while others may document their location to the nearest second. Certain fisheries may report catches by management area or fishing zone rather than by specific coordinate locations. Some fleets may be required to report their catches after every tow, while others may only have to report on their activities once per day. Reporting compliance may be an issue for certain fisheries, with some fishers providing incomplete or inaccurate log records or failing to submit their reports. Report requirements and/or compliance rates may also change from year-to-year.

Given the variability in fisheries reporting even within a given region, it is beyond the scope of the current work to document the requirements and limitations associated with each fishery occurring in Canadian waters. As such, prior to any mapping exercise, practitioners are advised to work with the fisheries subject matter experts, including fisheries managers, scientists, database managers, and industry representatives, to become familiar with the fishery and the caveats of the data to be mapped. This will help ensure appropriate uses of the data and resolve questions of analytical techniques and problems. Furthermore, it would be prudent to exercise caution when combining regional datasets, combining certain effort measures (e.g., number of records, days fished, etc.) from different fisheries in a single analysis (for example, to identify fishing effort by bottom-contacting mobile gear fisheries), or when comparing patterns and trends in fishing effort across fisheries. For example, caution should be used when combining mobile bottom gears such as groundfish otter trawls, shrimp trawls, drags and dredges given varying gear sizes, impacts, scale of operations, and reporting requirements. As a necessary precaution, caveats and assumptions should be clearly stated if such an assessment is attempted.

2.4 Screening for Confidentiality Issues

Fisheries catch and effort and VMS data are considered personal information for self-enterprise fishers and are considered sensitive, proprietary information for commercial fishers (i.e., Protected B third party information). DFO is not permitted to disclose information or data products that might reveal personal or third party information without the consent of the individual or enterprise to whom it relates, except in limited and specific circumstances. To protect against this, practitioners must ensure that fisheries activity maps and other spatial data products intended for public distribution follow the “Rule of Five.” That is, spatial data products made available to external interests cannot reveal any information where there are less than five different licence holders, licences, or vessels in any one geographic area during any of the timeframes displayed (see Section 5 below for further discussion on the Rule of Five).

To screen for cases where the Rule of Five may not be met, some basic analyses should be performed on the raw fisheries datasets prior to the production of final map products. First, statistics should be compiled to determine the number of unique licence numbers, vessels, and Fisher Identification Numbers (FINs) per management unit area (e.g., NAFO statistical areas on the Atlantic coast and Pacific fishery management areas on the West Coast) to flag instances where Rule of Five considerations need to be more closely examined. Catch data might then be plotted on a map to examine the spatial distribution of vessels/licences for areas where a small number of fishers are active.

For many cases where there is a risk of not meeting the Rule of Five, data aggregation and quantitative data classification approaches used in mapping (discussed below) may be sufficient to address the problem. Otherwise, maps and other spatial data products must not be disclosed without written permission from the relevant company(ies) or licence holder(s).

2.5 Data Aggregation

Data aggregation is generally required for spatial data products depicting fishing activity intended for an external audience. Aggregation methods can be used to group data to ensure confidentiality, and also to help reveal spatial patterns and trends.

Across the country, a number of methods have been used to aggregate commercial fishing data. The simplest and most common method to aggregate fisheries data involves binning spatial data into grid cells (see hypothetical example, Figure 1). Grids are an array of cells of equal size, with each cell containing a single attribute value. Grid cell size should be determined based on considerations for the map scale (e.g., region-wide maps may bin the data into larger grid cells than maps focused on a smaller geographic area), and data resolution (e.g., if catch coordinates are rounded to the nearest minute, grid cells should not be smaller than 1 min x 1 min). Certain near-shore fisheries have limited spatial reporting requirements (e.g., inshore lobster in Gulf, Maritimes, NL, and Quebec Regions report catches per management unit and no geographic coordinates are required), so data binning options would be limited to the fisheries management areas, districts, or statistical grids reported in commercial logbooks.[7] Grid cell size may also need to be increased to address confidentiality concerns. When designing a grid, consideration should be given to off-setting grid cell boundaries so that data are captured within the cells rather than on the boundary lines. For example, for fisheries where coordinates are rounded to the nearest minute, grid cells could be offset by half-minute intervals so that coordinates are completely contained within grid cells rather than aligning with the grid lines (see Figure 1). All the catches within each cell can then be summed or averaged to produce a single value per cell.

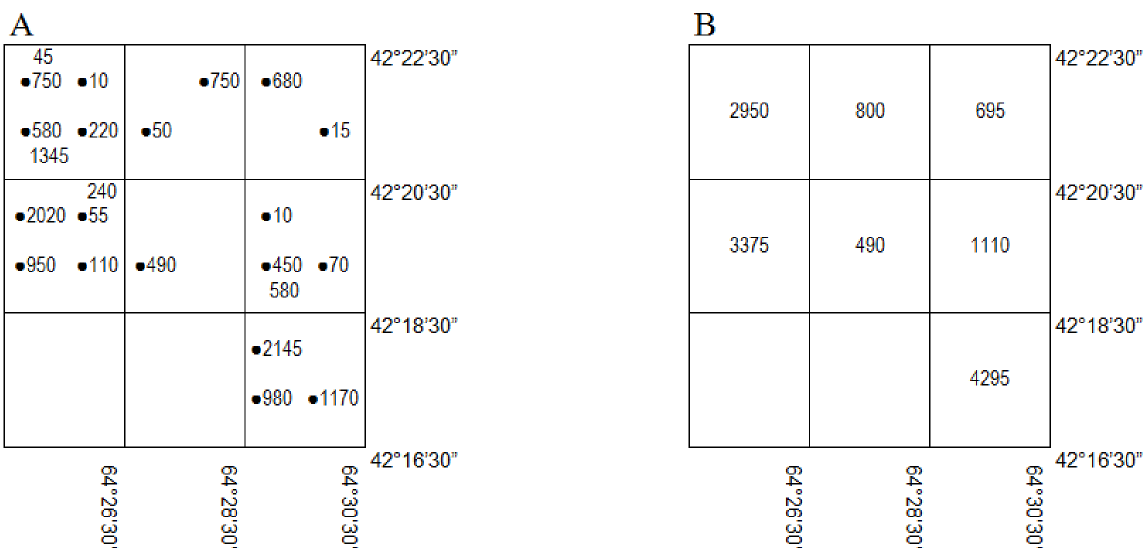

Figure 1. Aggregating fisheries catch weight/landings within 2 min x 2 min grid cells. A) Catch weights (kg) reported at specific geographic coordinates, rounded to the nearest minute. Given this level of reporting resolution, grid cells were offset by half-minute intervals so that each catch location was completely contained within a single cell. In this example, catches may be recorded at four possible locations within each grid cell. B) Catch weights (kg) are then summed to provide a single value for each grid cell. (Source: Breeze and Horsman, 2005, p. 11).

[7] See, for example, A. Serdynska and S. Coffen-Smout. 2017. Mapping Inshore Lobster Landings and Fishing Effort on a Maritimes Region Statistical Grid (2012–2014). Can. Tech. Rep. Fish. Aquat. Sci. 3177: 28 pp. <http://publications.gc.ca/collections/collection_2017/mpo-dfo/Fs97-6-3177-eng.pdf>

Of particular relevance for the Canadian East Coast, which includes five DFO administrative regions, a standardized approach may be required for cases where inter-regional fisheries map comparisons are of interest. To facilitate inter-regional comparisons, grids should be created from common points of origin with consistent cell size and offset distances.

The recommended future standard for aggregation of fisheries data uses a 10-km^2 hexagonal grid system (see Figure 2), projected with a Canada Albers Equal Area Conic Projection to minimize hexagon grid distortion. Square grid systems are prone to edge effects requiring an offset grid and they create perceived linear patterns leading to orientation bias. Hexagon grids are becoming more common for several reasons: (1) they reduce edge effects and sampling bias as a hexagonal grid has the lowest perimeter to area ratio of any regular tessellation of the plane; (2) all neighbours are identical and the distance between centroids is the same for all neighbours; (3) they are a better fit to curved surfaces and along coastlines; and (4) they are better for connectivity and movement paths.[8] Even ArcGIS Pro is facilitating the use of hexagon grids and provides convincing justifications for the adoption of hexagon grid systems.[9] Use of a 10-km^2 hexagon grid would not preclude any region from using smaller grids as required for finer scale spatial analysis to address specific intra-regional questions.

[8] See the pros and cons of square vs. hexagon grids in "Fishnets and Honeycomb: Square vs. Hexagonal Spatial Grids" <http://strimas.com/spatial/hexagonal-grids/>.
[9] See "Why hexagons?" <https://pro.arcgis.com/en/pro-app/tool-reference/spatial-statistics/h-whyhexagons.htm>.

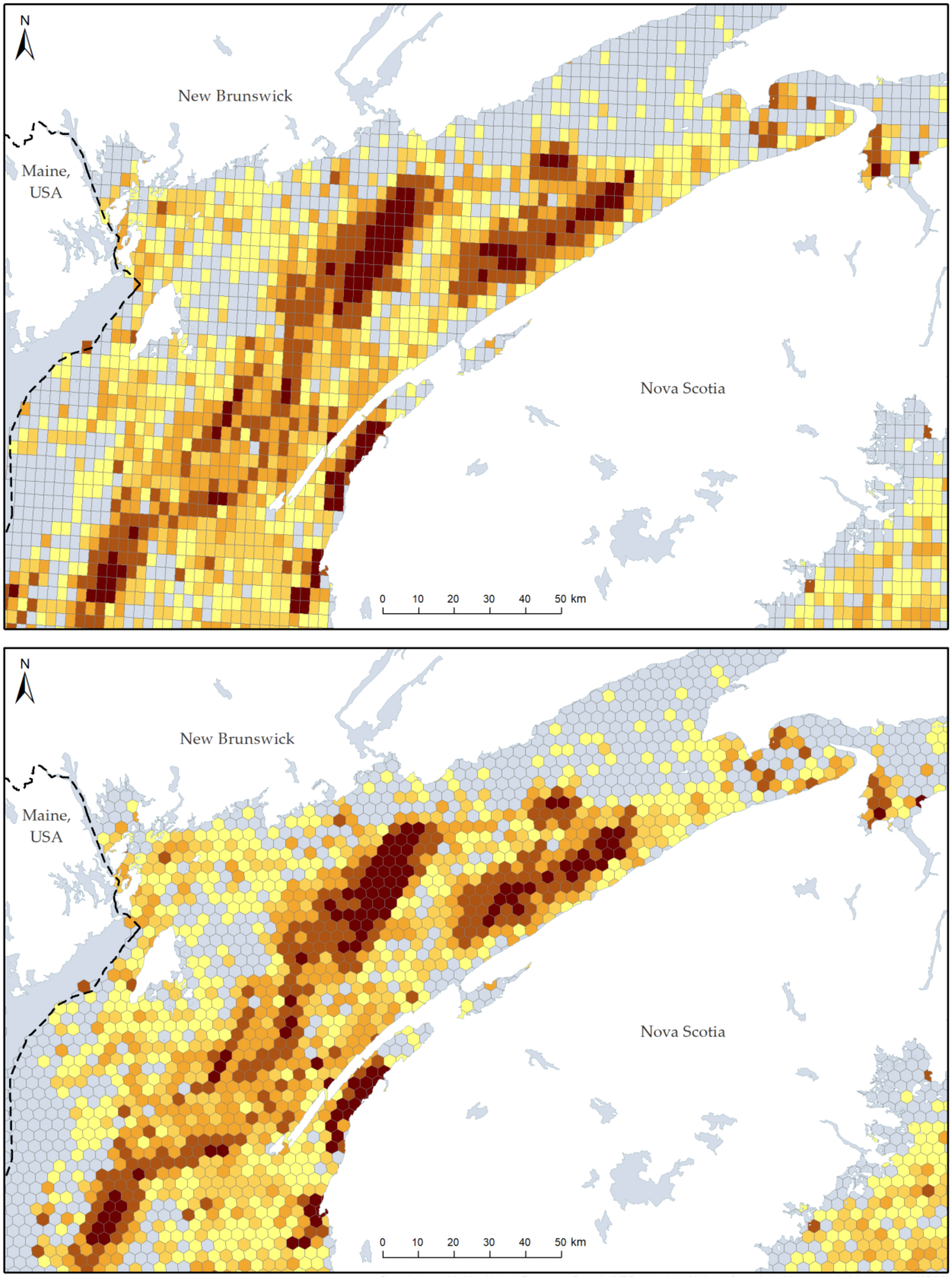

Figure 2. Maps of the Bay of Fundy illustrate comparisons of the same data displayed on a 2-minute fishnet grid vs. a 10-km^2 hexagon grid.

Data interpolation is a technique used to find intermediate values in datasets to create smooth, continuous map surfaces. Data interpolation approaches are based on the assumption that there are distance-dependant spatial relationships between known measurements. As such, data interpolation is generally applied to phenomena that generally occur as gradients (e.g., bathymetry, salinity, temperature, contaminant concentrations). Interpolation approaches, such as kernel density mapping, have been applied to fisheries catch (e.g., weight) and effort (e.g., number of sets) data in several regions (see kernel density example in Appendix A). This method can be a visually appealing approach to depicting hotspots of fishing activity, particularly for areas where fishing is known to occur but empirical data are sparse. However, caution should be used when applying this method for fisheries activity mapping, as fisheries data do not necessarily have strong spatial relationships (i.e., fishing may be intensely focused on one location while adjacent areas are not fished at all). Application of this method for fisheries activity mapping requires very careful consideration of the radius and search distance, which must be appropriate to the fishery in question.

For cases where the data are considered relatively comprehensive, grid maps are generally a more appropriate choice for mapping fishing activity. Grid mapping methods are simpler to comprehend and reproduce, and provide spatial consistency for comparisons across years or between data sets (e.g., observer data *vs*. commercial data).

In addition to the spatial aggregation techniques described above, practitioners may also wish to consider different temporal groupings of data to help distill patterns and trends in fishing activity. Common temporal aggregations include seasonal or yearly maps, and cumulative maps that include 5 or 10 years of data.

2.6 Classification / Symbolization

Quantitative data classification is the meaningful grouping of attributes together into classes of like symbology to help visualize patterns and trends, and to further aggregate data to address confidentiality concerns. Fisheries data can be classified using a variety of standard approaches.[10] These include:

- Natural breaks (Jenks) – breaks up data based on grouping patterns inherent to the dataset
- Equal intervals – data is subdivided into classes of equal value (e.g., 1–10, 11–20, 21–30)
- Quantile breaks – each class contains an equal number of records[11]
- Manual – classes are divided manually based on what needs to be communicated

Considerations for data distribution, purpose of the map, and aesthetic appeal may all influence the selection of a classification method. Note that to compare fisheries maps across seasons or over multiple years, the same class breaks should be applied for each map in the series. Regardless of the approach, care should be taken to explain the classification scheme as part of the text accompanying any map product.

Quantitative data can be symbolized by graduated colours or graduated symbols. A common choice for fisheries intensity mapping is the ‘heat map’ approach, where warmer colours (yellow, orange, red) indicate areas of higher intensity fishing than cooler colours (blue, green, purple). However, another recommended approach is a monochromatic palette that shows higher intensity in darker tones. This makes it easy to detect patterns and trends in the data for even colour-blind members of the intended

[10] For more information on quantitative data classification, see ESRI online: <http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=Ways_to_map_quantitative_data>.
[11] Note that there is an issue with classifying data into quantiles in ArcGIS. See Newfoundland and Labrador Region’s workaround in Appendix B.

audience. Symbology considerations for the colour-blind should also be considered in the context of map product compliance with the Treasury Board's Standard and Guidance on Web Accessibility.[12]

2.7 Common Map Elements

To date, fisheries activity maps that have been produced by the various regions have shared very few common display elements. In many cases, without accompanying text, individual maps would not be identifiable as products of DFO. Going forward, we propose that validated maps produced for general public distribution (e.g., pdfs available on the website or published in atlases) use a common map display template that includes certain required elements (see example templates, Appendix D), and standardized map fonts. Specifically, Arial font should be used for land features, with capital cities in **bold** and *italicised Times Roman* should be used for water labels. All other map information (title, legend, etc.) should be in Arial.

Common map elements should include:

- Title
- Legend
- Geodetic parameters (coordinate reference system)
- Data source(s)
- Data aggregation specifications (grid cell size, interpolation technique)
- Data disclaimers (caveats, sources of error, missing data)
- Distribution restrictions
- Copyright
- Scale bar
- Compass rose/north arrow or graticule
- Fisheries and Oceans Canada Logo
- Branch/Division/Region name
- Date produced

3. VALIDATION AND TRANSPARENCY

Prior to sharing fisheries spatial data products publicly it is recommended as a best practice that validation processes are conducted with DFO Science, DFO Resource Management, DFO Statistics and fishing industry representatives to receive constructive feedback and seek endorsement of mapping products before official and authoritative use in marine planning and decision support. Validation processes are encouraged for region-wide digital atlases or similar products that are shared publicly and used by industry or for regulatory-based decision support. Public validation processes are not required for one-off spatial analyses used in targeted consultations where geographic scale limits the scope of stakeholder involvement (e.g., marine protected area site planning), or which are vetted in peer-reviewed advisory processes. Validation should include the provision of backgrounders on methodologies, a presentation of the mapping products with time allotted for discussion, and careful documentation of concerns raised, questions posed, and any follow-up work that may be required. Where possible, validation efforts should take advantage of existing engagement opportunities, including Resource Management's fishery advisory committee processes, Canadian Science Advisory Secretariat (CSAS) framework and assessment review meetings, and fishing industry conferences and workshops.

[12] See Standard on Web Accessibility: <http://www.tbs-sct.gc.ca/ws-nw/wa-aw/index-eng.asp>.

To ensure transparency, all spatial data products that are publicly distributed should be accompanied by text and/or metadata that briefly explains the mapping method, identifies the data source(s), describes the data, and explains any data and/or map caveats and deficiencies. Examples of information to be communicated include: percentage of missing spatial reference (coordinates or management unit), or georeferences on land; missing data in internationally shared fishing zones (e.g., US/Canada) with different reporting requirements; and expected underestimates due to differences in reporting requirements or known reporting non-compliance rates.

4. ACCEPTABLE USE AND CONFIDENTIALITY

The purpose for analysing and mapping fishing activity is to inform integrated oceans management decision-making processes, including fisheries management decisions. The purpose for and intended uses of all fisheries mapping products must be consistent with DFO's mandate and be appropriate for implementation of departmental program objectives. Fisheries maps and other spatial data products can be used for: mitigating conflicts, emergency response, monitoring compliance, risk assessment for species at risk, eco-certification processes, supporting industry planning, environmental impact assessment, marine conservation planning, policy implementation, and decision support for economic development.

Fisheries catch and effort information for an individual licence holder is considered personal information and is protected under Section 8(1) of the *Privacy Act* and section 19 of the *Access to Information Act*.[13] Fisheries catch and effort information for a corporate licence holder is considered to be sensitive, proprietary, third party information and generally protected under Section 20 of the *Access to Information Act*. Without written consent, DFO is not permitted to release information or data products (e.g., maps and data layers) that might reveal personal or third party information such as catch, landed values, and vessel-specific fishing locations.[14]

To address this issue of confidentiality, the DFO Directive on Privacy Practices and DFO Guidelines for the Informal Release of Information provide direction for DFO's guidance procedures on data sharing stipulating that the public disclosure of data should follow the "Rule of Five."[15] That is, fisheries data and data products (e.g., maps) are not to be shared without consent for fisheries where there are less than five different licence holders, licence numbers, or vessels in any one geographic area during any of the timeframes displayed in map products (i.e., the Rule of Five is not met).

As discussed above, statistical tests can be performed to help identify areas where Rule of Five considerations need to be more closely examined. Spatial and temporal data aggregation methods may be applied to ensure that data shared publicly are combined from 5 or more licence holders. The classification of fisheries data into a multi-class range (e.g., quantiles, equal interval breaks) will also help group the data in such a way as to hide precise information from individual fishers. The Rule of Five is scale dependent, that is, the finer the map scale the more the rule will impact the mapping product. For example, in Atlantic Canada, NAFO unit areas are recommended for Rule of Five screening on a bioregional scale.

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[13] In some instances the protection does not apply. If the information is already publicly available, it is not protected under Section 8(1). There are also provisions under Section 8(2) of the *Privacy Act* that allow the department to disclose information without the consent of the individual in certain circumstances.

[14] For more details on what information can and cannot be released, see the DFO Guidelines for the Informal Release of Information <https://intra.ent.dfo-mpo.ca/policies/GuidelinesforInformalRelease>, especially Appendix B.

[15] DFO Directive on Privacy Practices <https://intra.ent.dfo-mpo.ca/policies/DFODPP> and the DFO Guidelines for the Informal Release of Information <https://intra.ent.dfo-mpo.ca/policies/GuidelinesforInformalRelease>.

For cases where the Rule of Five is not met, a full disclosure is required and informed consent must be sought prior to sharing the confidential data or data products. This may be done by submitting consent requests for information sharing to the relevant company(ies) or licence holder(s).[16] The level of formality and frequency required for such requests should be determined in consultation with the confidential industry data source. Permission requests may require senior management (i.e., RDG-level) or NHQ Access to Information/Privacy (ATIP) Office staff involvement with an exchange of formal letters and/or the development of an information sharing agreement.[17] Alternatively, depending on regional departmental and industry needs, consent may be arranged informally via e-mail between DFO working level staff and the company/licence holder.

In cases where Geographic Information System (GIS) consultants are contracted by DFO to process and analyse fishing industry data to produce map products, Non-disclosure Agreements must be established with the GIS consultant engaged in map production. The Non-disclosure Agreement should comprise a clause of the DFO contractual services agreement signed off by the consultant. DFO ATIP has developed an Information Sharing Agreement (ISA) template to ensure that all routine disclosures of personal/third party information are protected appropriately. Sample Non-disclosure Agreement texts are as follows:

> *All copies of fisheries log data and other tangible products produced containing or representing the data and all copies thereof in the possession of the Project Consultant shall be and remain the property of Fisheries and Oceans Canada. The Project Consultant agrees not to disseminate or share the original fisheries logbook data for any purpose except to evaluate and engage in discussions with Fisheries and Oceans Canada staff.*
>
> *The Consultant agrees not to use, disseminate or publish VMS data or related products for any purpose except to evaluate and engage in discussions with Fisheries and Oceans Canada staff. All copies of VMS data, At-sea Observer data, Logbook data, and other tangible products produced containing or representing the data and all copies thereof in the possession of the Consultant shall be and remain the property of Fisheries and Oceans Canada and shall be promptly returned to Fisheries and Oceans Canada upon termination of the contract period.*

To assuage data confidentiality concerns from data providers, requests for fisheries data for mapping purposes should clearly state the purpose of the proposed project and clarifications should be provided regarding how confidentiality will be protected. For example:

- compiling statistics on the number of unique licence numbers/vessels/Fisher Identification Numbers per unit area by species to meet the Rule of Five;
- aggregating catch weight/landings and effort values (e.g., binning data into grid cells) rather than mapping vessel-specific latitude/longitude coordinates;

[16] Getting consent from the licence holder satisfies the requirement for permissible disclosure under 8(1) of the *Privacy Act* (in the case of personal information) and the spirit of subsection 27(2) of the *Access to Information Act*. Consent should be explicit, in writing, voluntary, describe who the information will be disclosed to and for what purpose, it should be renewed periodically, and have a process for withdrawing consent. DFO ATIP (Policy and Privacy Division) is available for further guidance. A written consent to release private information should include the licence holder's signature, specifics of the information to be shared, to whom the disclosure is to be made and for what purposes, the time limits to the information access, and a process to withdraw consent.

[17] When informed consent is not sought from a fisher and DFO knowingly discloses information to a third party through an information sharing agreement, a privacy impact assessment may be required. See Treasury Board Directive on Privacy Impact Assessment: <http://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=18308&section=text>. Privacy Impact Assessment: Needs Analysis <https://intra.ent.dfo-mpo.ca/folios/00951/docs/PIA_Needs_Analysis-eng.docx> and
Information Sharing Agreement Template <https://intra.ent.dfo-mpo.ca/folios/00951/docs/ISAtemplate-eng.docx>.

- classifying catch weight/landings and effort values in a five-class range (e.g., quantiles, equal interval breaks) rather than as precise values; and
- displaying yearly and cumulative year catch weight/landings and effort values rather than by individual date.

5. EXTERNAL DATA AND MAP REQUESTS

When external clients request maps and/or data from DFO, all standard data sharing policy requirements apply in terms of access to information and privacy legislation and addressing confidentiality concerns. Regional data requests for commercial fisheries data should be directed to Statistical Services staff in the Policy and Economics Branch in each region. Multi-regional data (including spatial data) requests should be directed to the Statistical Services Group at DFO Headquarters.

Validated fisheries map and spatial data products (e.g., fisheries catch weight/landings, effort maps and data layers) that are approved for public distribution by DFO Oceans should be accompanied by a DFO map/data sharing form that tracks the release of the information products and summarizes key metadata for the recipient of the map/data products. A sample DFO map/data sharing form is shown in Appendix E. The form includes details on the project title, project description, a description of the products (e.g., format, spatial extent and date range), as well as conditions for release (e.g., restrictions on the use of maps and data, Rule of Five-related restrictions on shared information, and any clearance requirements established by consent of industry partners).

6. DATA MANAGEMENT

Effective geospatial data management requires that regional guidance be developed on how geospatial data is created, organized and maintained. Guidance should include data dictionaries and metadata standards for all geospatial data in the inventory, and be updated as the data inventory changes. Guidance on geospatial data management is necessary for spatial planning and decision support to ensure that existing and future data and information requirements align with program objectives.

Regional Oceans' data storage should be secure, routinely archived, and managed and maintained by a data manager or IT Services. A centrally managed, organized repository of large quantities of geospatial data will benefit Oceans users more than *ad hoc* management approaches. Shared data storage should be organized and managed in a way that makes geospatial information and the associated metadata as easy to store and access as possible.

A data share is a secure, routinely backed-up server that is managed and maintained. Its purpose is to provide a centrally managed, organized repository of the large amount of geospatial data that each regional Oceans division uses and produces. A data share should thus be organized and managed in a way that makes geospatial information and the associated metadata as easy to store and retrieve as possible.

Data shares can be divided into two fundamental hierarchies: the 'Data' and 'Projects' folders (Figure 3). The 'Data' folder is intended to hold final versions of data, the structure is strictly prescribed (see theme and subtheme example structure in Figure 3), and it is not intended to store working map documents such as ArcMap MXDs. The 'Projects' folder, in contrast, contains data that is being modified or developed for project-specific purposes. This folder and file structure is not as strict as it contains working map documents (e.g., MXDs) and may reference data in both the 01_Data and 02_Projects subfolders.

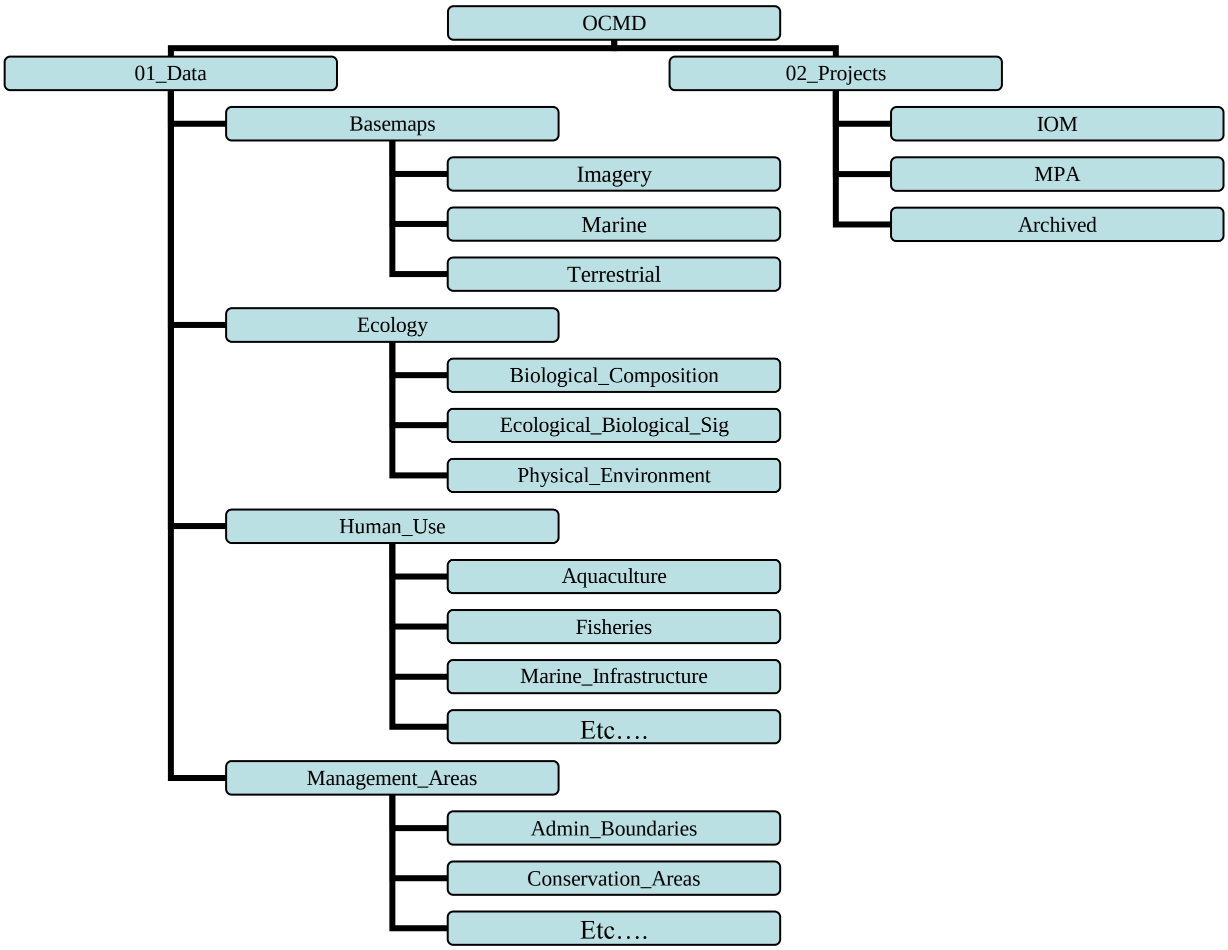


Figure 3. Model structure of GIS layers in a shared data storage.

Within each sub-theme folder, additional levels of file structure may be required to further organize the data. Once those additional levels have been developed, data should be placed in the appropriate location in a standardized folder structure (see example, Figure 4). For each data set, the Raw_Data folder should house original data in the format that it was provided. The Value_Added_Data folder should contain data that has been altered to create a new product (e.g., track lines or density plots from VMS point data). Products available for public distribution should be stored in the For_Public_Distribution folder. Note that for each of the three types of data, the associated documentation folder should be used to provide metadata and any other helpful information, such as emails, code tables, or methodology reports. These data models may serve as a guide to organize and archive Oceans' geospatial data in a shared national data storage.

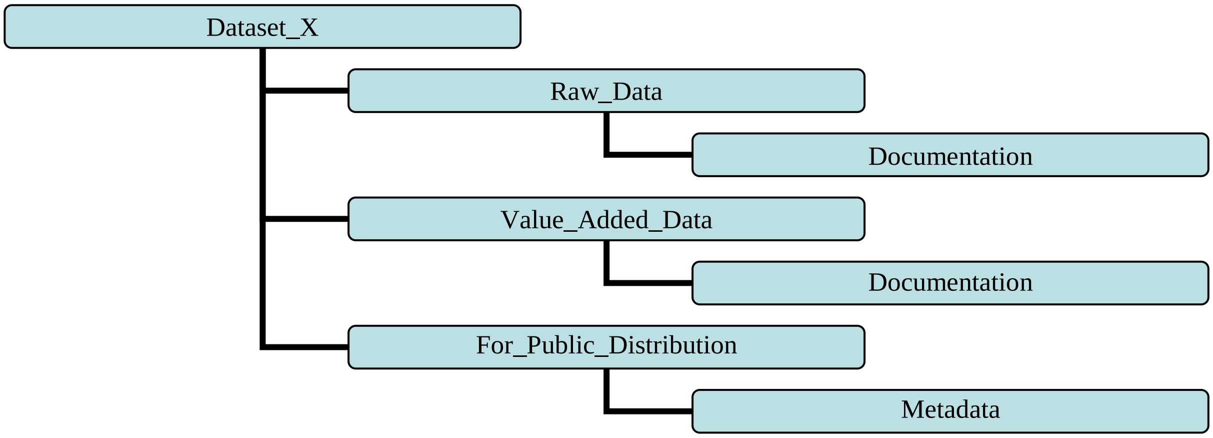


Figure 4. Model structure for a specific dataset in a shared data storage.

7. METADATA DEVELOPMENT

Metadata is a dry subject, but is essential to mapping fishing activity and other forms of ocean use data. It is important that the accuracy and origins of data displayed on maps can be verified. By including tombstone information on who, when, where, and how the data were created, this can be achieved. Metadata files may include actual standardized metadata created specifically for a dataset or data layer, but may also include information related to analysis methodologies, process, or interpretation and results. Examples include static maps, technical reports, contractor reports, step-wise methodology documentation, or data sharing agreements.

As a recommended best practice, metadata should be prepared in ArcCatalog using the methodology outlined by DFO's Central and Arctic Region in Appendix F. While metadata in any format (e.g., e-mails, text files, Word documents, PDFs, etc.) is better than none, it should be noted that metadata will be required to meet ISO 19115[18] and 19128[19] Standards (North American Profile) by May 31, 2014, so efforts should be made to address at least the mandatory metadata elements required by these Standards.

Basic metadata elements should be maintained for a dataset to answer the 'what', 'where' and 'who' aspects of specific datasets. In general, practitioners should attempt to provide as much information as possible to increase interoperability and allow users to understand without ambiguity the geographic data and the related metadata provided. For a list of defined ISO data theme categories, see Appendix G.

8. FUTURE MAPPING CONSIDERATIONS

To advance DFO's implementation of national web-based mapping services, additional prescriptive measures other than those outlined in this protocol may be required to ensure inter-regional consistency and a "common look and feel" for regional map products shared with national headquarters staff and publicly. NOMC direction may be required to ensure that national needs are satisfied from regional mapping products. Further discussion is warranted on the merits, structure and content of an Oceans' shared national data storage. With the release of ArcGIS Pro there is also enhanced capacity and greater

[18] ISO 19115 provides metadata terms and definitions that describe the elements of geospatial data. See online: <http://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=16553&section=text#appB>.

[19] ISO 19128 defines protocols for uniform access to maps rendered via web mapping services to the public, e.g., ArcGIS Online or ArcServer. See online: Standard on Geospatial Data, <http://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=16553&section=text#appC>.

potential for sharing workflows as well as data. This could greatly improve consistency regarding analysis and visualization of fishing data and all spatial data.

ACKNOWLEDGEMENTS

The authors would like to thank DFO staff who contributed to the drafting of this Atlantic Canadian Protocol, including Carolyn Bakelaar, Nicholas Benoy, Tony Bowdring, Leah Brown, Brandon Chavarie, Michelle Dunn, René Duplain, David Forsey, Gilles Fortin, Mardi Gullage, Tim Hall, Glen Herbert, Beth Hiltz, Judy Hosein, Laura Hussey-Bondt, Cory Large, Gaëlle Lemay, Pascal Levesque, Mark MacLachlan, Émilie-Pier Maldemay, Colin O'Neil, Kasia Rozalska, Anna Marie Russell, Mike McMahon, Erick Merner, Léa Olsen, Glen Rasmussen, Carol Sampson, Gina Sinclair, Heath Stone, Gilles Tremblay, Tonya Warren, and Darren Williams.

APPENDIX A – EXAMPLE GEOSPATIAL ANALYSIS APPROACHES

Catch Weight by Species (Maritimes Region)

Yearly catch weight maps were created by plotting catches (kg) per 2 x 2-minute grid cell for a select list of species (see example map, Figure 4). Data were classified using quantile breaks, and the same intervals were used for each year to allow for comparisons between years. Maritimes Region-specific maps show all catches that occurred in the Maritimes Region (i.e., for some fisheries, catches may have been landed at ports in neighbouring regions). In addition to yearly maps, composite maps were produced for each map series that aggregate all catch weights for 2010–2014.

Caveats: This map series shows biomass removed by fishing activities (including targeted species and retained bycatch). It does not provide fishing intensity information for directed fisheries.

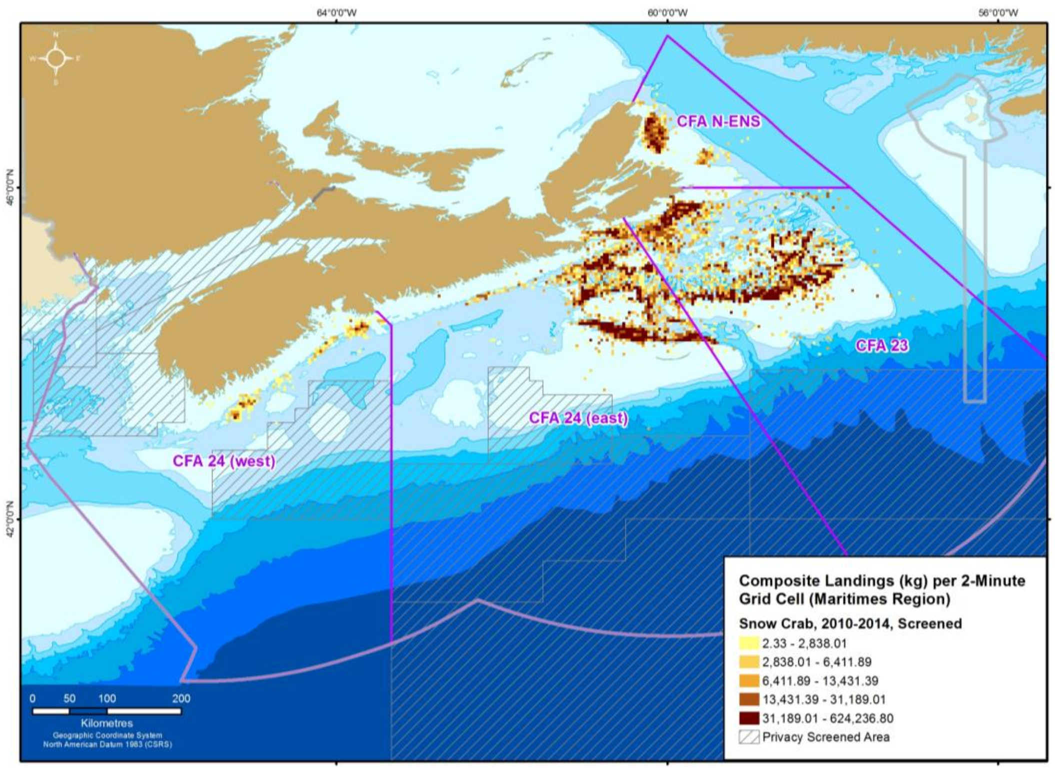


Figure 5. Five-year composite (2010–2014) map of snow crab trap catches (kg) per 2 x 2-minute grid cell on the Scotian Shelf.

Effort Maps by Gear Type (Maritimes Region)

Five-year composite and yearly maps of fishing effort were created by plotting the number of sets per 2 x 2-minute grid cell for a select list of species/gear types (see example, Figure 5), and gear type groupings (i.e., fixed and mobile bottom contact gears). For the purpose of this map series, a 'set' was defined as a logbook entry that includes information for all species caught for each reporting interval assigned a single location. Because reporting requirements vary by directed fishery (i.e., defined here as a species- and gear-specific fishery), a set might be a summary of fishing activity for a full day, for a single gear deployment/retrieval, or for some other reporting interval. Data were classified using quantile breaks, and the same intervals were used for each year to allow for comparisons between years.

Caveats: While reporting requirements are generally consistent within a directed fishery, they can differ significantly across fisheries. As no standardization of reporting intervals was performed on the dataset, the maps may be used to determine areas of relative importance within a directed fishery, but they should not be used to compare effort across fisheries. Another issue raised during the map validation process was that for certain fisheries (i.e., scallop drag), the daily reporting interval was not a meaningful measure of effort, as the number of drag tows can vary dramatically within a day. As such, Maritimes Region is currently exploring alternative effort mapping approaches that better represent effort for specific fisheries (e.g., number of tows/pots/hooks, hours fished, etc.)

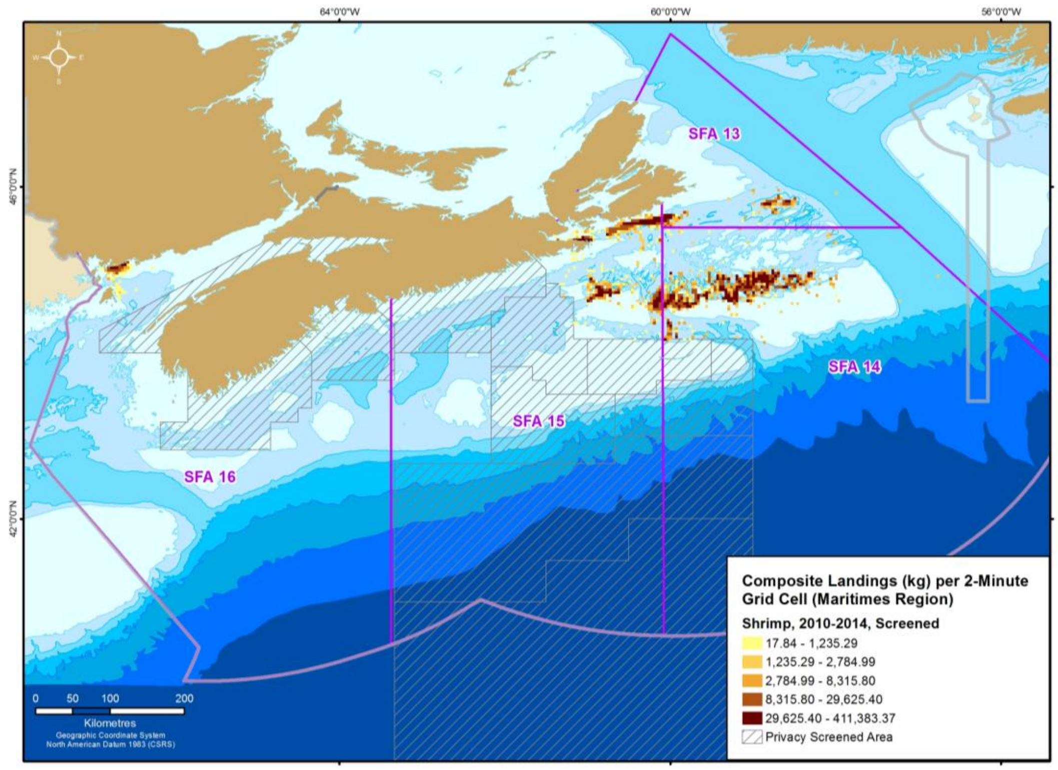


Figure 6. Scotian Shelf shrimp trawl effort (2010–2014), mapped as number of sets per 2 x 2-minute grid cell.

Fisheries Footprint Mapping by VMS (Maritimes Region)

To assess the footprint of bottom-contacting fisheries in and around the St. Anns Bank Area of Interest (AOI), gear-associated VMS trackline maps were developed using VMS and Maritimes Region fisheries logbooks from 2004–2010. Vessel-specific tracks were created for each vessel in the VMS dataset. When > 6 hours elapsed between VMS reports, a new trackline was created in order to break the tracks when the vessel left the study area (e.g., to return to port) or stopped reporting for an extended period. "Apparent speed" (apparent distance[20] / time) was calculated for track segments between each successive positional report. Logbook data were linked to VMS tracks in cases where catches were reported in the vicinity of the corresponding vessel's track within an appropriate time frame. Logbook-associated tracks were then analysed for patterns by apparent speed and gear type. First, a speed filter was applied to separate higher

[20] Both the calculated speed and the distance between two position reports are 'apparent' because for the purpose of the analysis we must assume the vessel travels in a straight line at constant speed between each known position. In reality, the vessel may have traveled any number of curved paths, thus covering a larger distance and traveling at higher average speeds than is evident from the dataset.

(transiting) apparent speeds from fishing/loitering and other non-transiting activities. Speed filters were determined by a visual analysis of speed frequency distribution plots for each gear type. For otter trawlers, the transiting threshold was set at above 4.5 knots. VMS track densities were mapped as the number of track segments with apparent speeds below the transiting threshold (e.g., 4.5 knots for the redfish otter trawl fleet) per 200 x 200-metre grid cell. Data were classified using a manual method to assign approximately the same number of cells to each class. Composite maps of all years combined were produced for each gear type and yearly maps were also created for selected gear types (see example map product, Figure 7).

Caveats: For these maps, it is always important to note that the data that appear on the map include track line counts for vessels engaged in fishing activity as well as other slow-moving activities such as loitering (sheltering during storms, sleeping), gear/vessel repair, catch processing, etc. As well, industry has expressed concerns about the private nature of VMS data. Given the level of resolution (hourly position reports), it is possible that individual vessel patterns/preferred fishing areas may be revealed by these maps. Permission is required before these map products can be shared externally. One possible solution might be to further process the data to remove grid cells containing 1–2 track lines from the final map display. Another possible issue related to this map series is the use of 200 x 200-metre grid cells to bin track segment counts. While VMS data is reported at a resolution that would allow for such a small grid cell size, the uncertainty related to vessel position (i.e., unknown off-track distances) between hourly reports may necessitate the use of a larger grid to avoid misrepresenting the accuracy of the dataset.

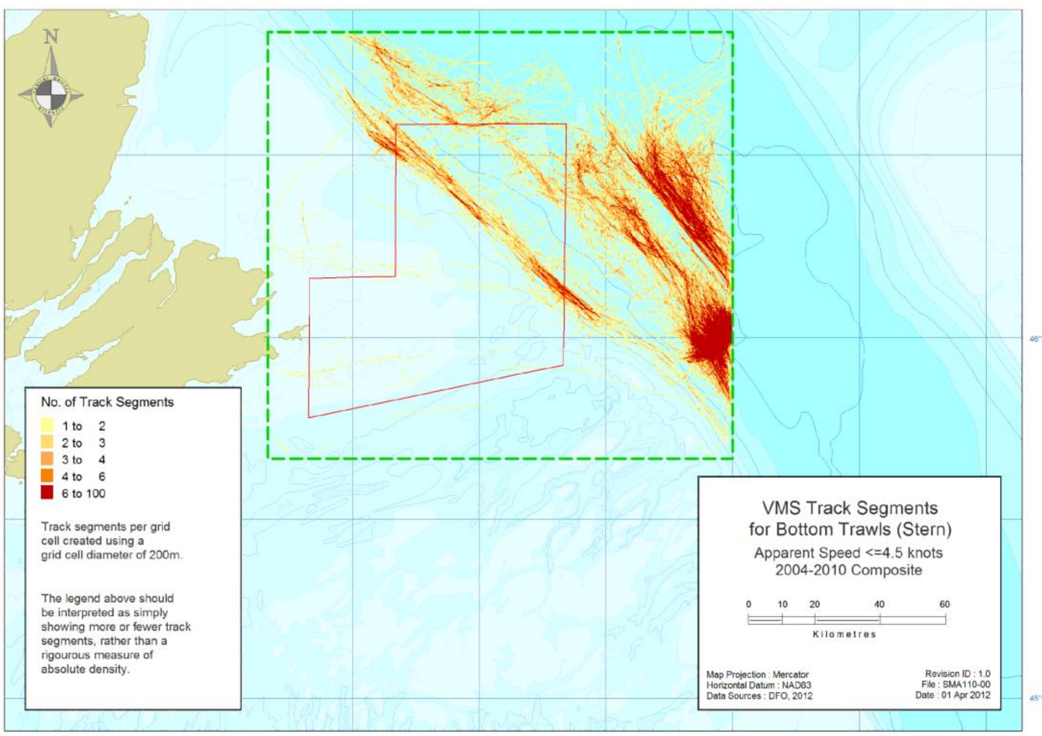


Figure 7. Composite (2004–2010) map of the number of redfish otter trawl-associated VMS tracks with apparent speeds below the transiting threshold (4.5 knots) per 200 m by 200 m grid cell within the St. Anns Bank Study Area (green stippled polygon). Red polygon, St. Anns Bank AOI.

Regional Vulnerability Atlas using Kernel Density Mapping (Gulf Region)

In 2009, DFO Gulf Region created a Regional Vulnerability Atlas with a series of fishing intensity maps using 1991–2007 logbook data. A kernel density method was applied using a search radius of 20 km^2 and output cell size of 100 km^2 to represent relative fishing intensity by species or by gear type.[21] The maps illustrate locations and relative proportions of fishing intensity as reported in logbook data, but do not reflect absolute values (see example map product in Figure 8). The colour ramp of intensities should be interpreted as being "above average" in red to "below average" in dark green. Specific areas fished infrequently may not be represented on the maps and the presence of colour in any specific area does not imply the occurrence of actual impacts or fishing activity.

Caveats: As noted in section 2.5 above, caution should be used when applying data interpolation for fisheries activity mapping, as fisheries data do not necessarily have strong spatial relationships (i.e., fishing may be intensely focused on one location while adjacent areas are not fished at all). Application of this method for fisheries activity mapping requires careful consideration of the radius and search distance, which must be appropriate to the fishery in question.

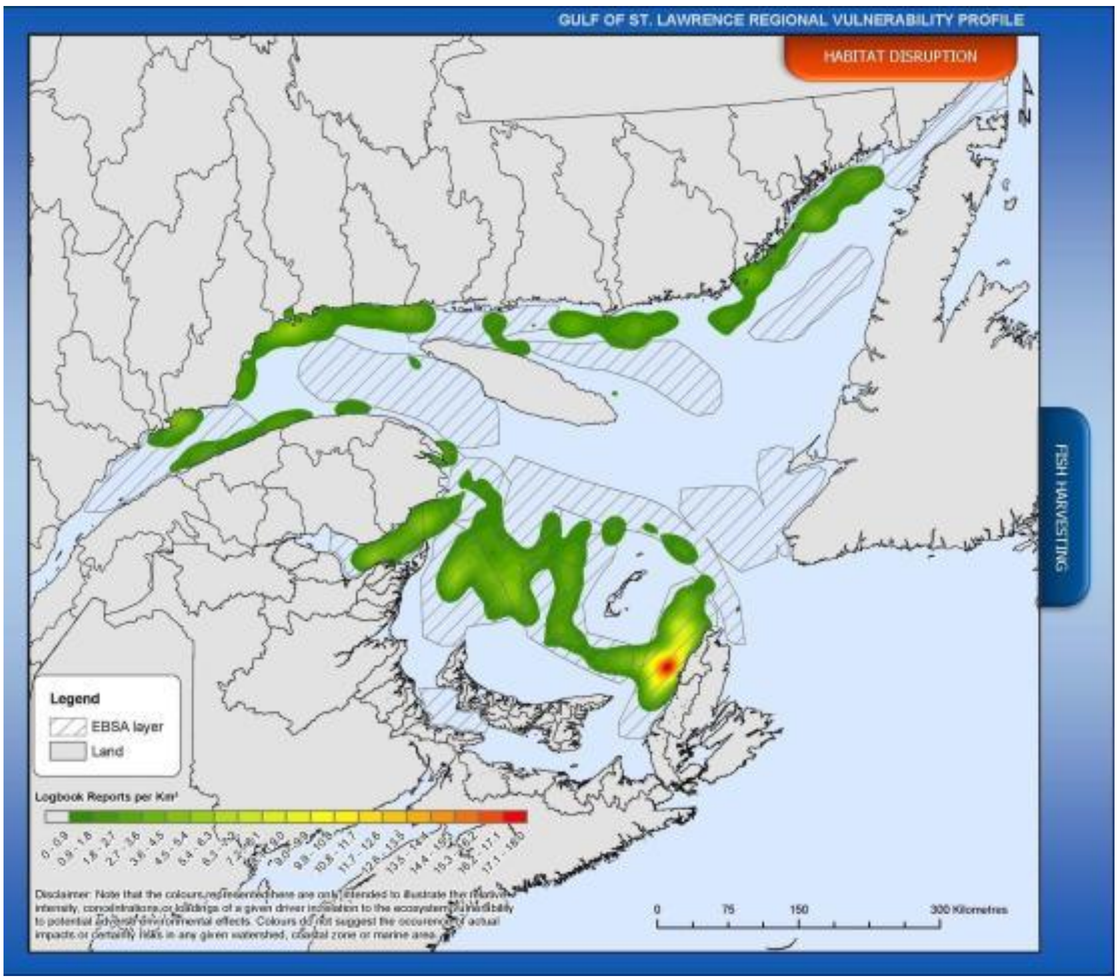


Figure 8. Snow crab fishing intensity using trap gear based on a kernel density calculation applied to 1991–2007 logbook data.

[21] The kernel density tool is available under the Spatial Analyst extension in ArcGIS or with Hawth's analysis tools.

Laurentian Channel Area of Interest Commercial Fishing Activity (NL Region)

Commercial fishing activity was mapped for the Laurentian Channel Area of Interest (AOI) for 2007–2011. The goal was to extract the top 20 percent of catch weight over that period within the AOI boundaries. A separate density surface (using parameters dictated by the individual fishery) was created for each species (Figure 9A). This surface was then classified into quantiles (see Appendix B regarding classification issues with ArcMap) and contours were created to denote breaks in the data. Contours above the 20 percent threshold were selected out (Figure 9B) and dissolved into a single polygon (Figure 9C), which represented the top 20 percent of catch weight for that species within the AOI. The polygons were used to denote both the location of the most intense fishing activity for individual species and the coincidence between species when mapped together. The same method was used to map gear types and catch values. This information can inform zoning regulations, consultations with stakeholders, and boundary decisions during the AOI process.

Caveats: This is only one method of mapping fishing intensity used during the AOI development process. This method demonstrates where the most intense activity is taking place, but does not incorporate the total value of the commercial fishery in this area; separate analyses were undertaken to inform that requirement.

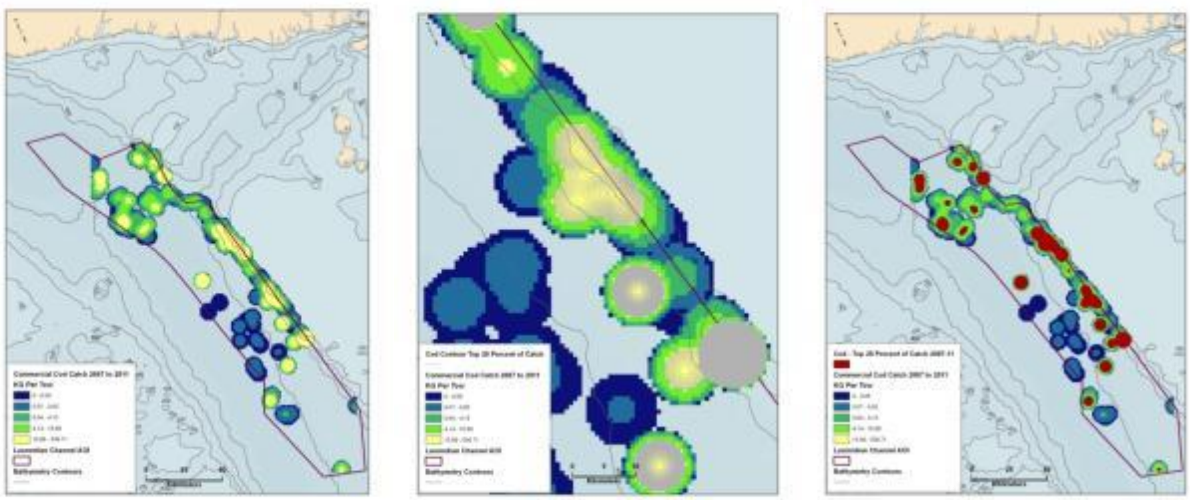


Figure 9A. Density surface for Atlantic Cod 2007–2011. **B.** Contour – top 20 percent. **C.** Top 20 percent polygons for Atlantic Cod.

APPENDIX B – ARCGIS QUANTILE CLASSIFICATION

In 2012, while analysing data for the Labrador Shelf EBSAs, a bug was discovered with ArcGIS when data was classified into quantiles where the data was being incorrectly binned. During this type of classification, an equal number of values should be assigned to each bin. For example, if there are 500 values divided into five classes, there should 100 values in each bin or 20 percent of the total dataset. When this was reported to ESRI, it appeared to be an algorithm issue and they came up with a workaround which is outlined below. To date, although a bug report was issued, it has not been corrected in the software. This is applicable to all versions of ArcGIS up to and including Version 10.1 (at the time of writing this 10.2 has not been tested) and for classification of all raster and vector datasets. The work-around to fix the quantile problem seems to work with variables that are discrete; however, some variables with continuous values may still be in error so it should be checked. The quantiles may have to be adjusted manually.

To correctly classify data into quantiles in ArcMap:

1. ArcMap must be in Data View. Doing this in Layer View causes ArcMap to crash.
2. Open the properties for the layer. On the “Symbology” tab – select “Unique Values” click OK and close the dialog box.
3. After the layer has drawn, open the layer properties again and reclassify the data using quantiles and the appropriate number of classes.
4. To verify that the layer is correct click on each class break in the Classify menu to check the number of items in each bin (The total appears underneath the histogram).
5. If at any point you change classification schemes, you may need to rerun this process.

Example:

In the Atlantic Cod density surface created for the Laurentian Channel analysis (pp. 18–19), the initial quantile classification in ArcMap indicated there were 4,561(which is incorrect) cells with a value greater than zero and they are binned in five classes ranging in size from 697 to 1,215 values (Figure 10A). After using the process outlined above, the Atlantic cod dataset actually showed 11,648 values greater than zero binned into five classes (three classes of 2,294 values each and two with 2,293 values each) (Figure 10B).

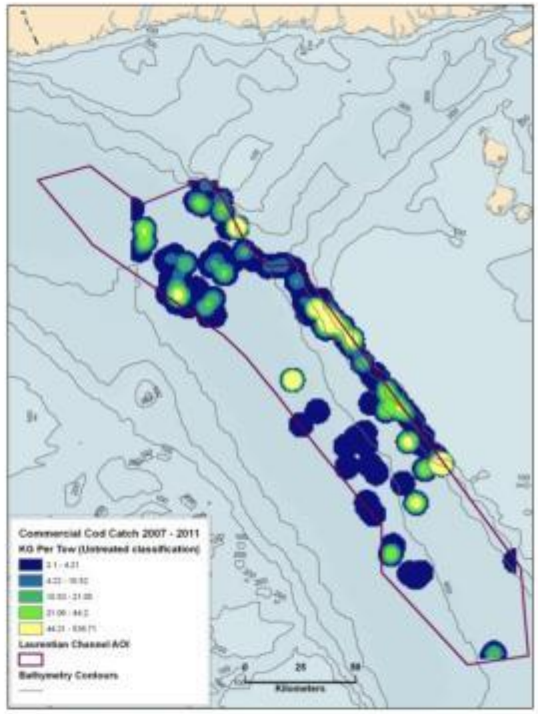


Figure 10A. Incorrect ArcMap quantile classification

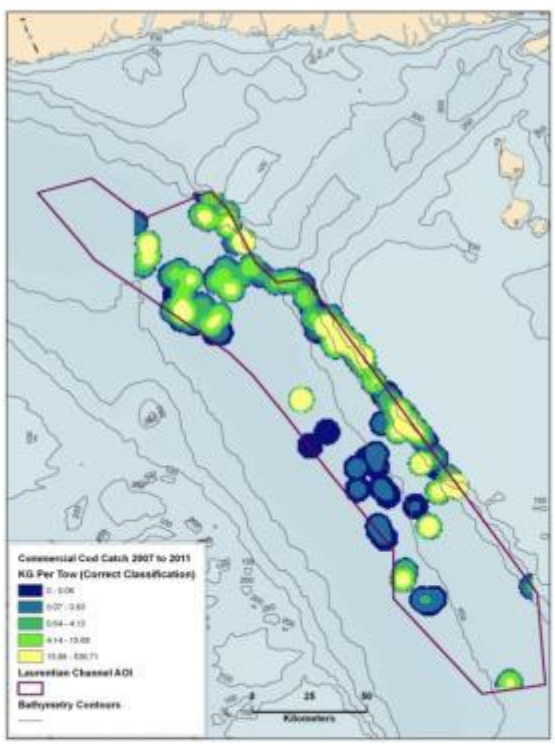


Figure 10B. Correct quantile classification

APPENDIX C – CONTACT INFORMATION

Commercial Fisheries Data Requests

National Headquarters:
Tracey Telik
Phone: (613) 993-8958
Email: Tracey.Telik@dfo-mpo.gc.ca; infostat@dfo-mpo.gc.ca

Maritimes Region:
Colin O'Neil, Commercial Data Division
Phone: (902) 426-6738 / 440-0392
Email: XMARComData@dfo-mpo.gc.ca

Gulf Region:
Gaëlle Lemay
Phone: (506) 851-7822
Email: StatisticsGLF@dfo-mpo.gc.ca

Newfoundland and Labrador Region:
Barry Peters
Phone: (709) 772-6159
Email: Barry.Peters@dfo-mpo.gc.ca

Quebec Region:
Bernard Morin
Phone: (418) 648-5935
Email: Bernard.Morin@dfo-mpo.gc.ca

Central and Arctic Region:
Josh Humphreys
Phone: (204) 983-5953
Email: XCA_HarvestStats@dfo-mpo.gc.ca

Pacific Region:
Justin Mundy
Phone: (250) 756-7237
Email: Justin.Mundy@dfo-mpo.gc.ca; CatchStats@dfo-mpo.gc.ca

Vessel Monitoring System Data Request (VMS Centre of Expertise)

Natasha Barbour
Business and Technology Coordinator
Phone: (709) 772-5788; 1 888 772-8225
Email: Natasha.Barbour@dfo-mpo.gc.ca; xnflvms1@dfo-mpo.gc.ca

At-Sea Observer Data Requests

Maritimes Region:
Heath Stone
Phone: (902) 426-1579
Email: Heath.Stone@dfo-mpo.gc.ca

Gulf Region:
Ron Belliveau
Phone: (506) 851-3790
Email: Ron.Belliveau@dfo-mpo.gc.ca

Newfoundland and Labrador Region:
Todd Inkpen
Phone: (709) 772-6119
Email: Todd.Inkpen@dfo-mpo.gc.ca

Pacific Region:
Justin Mundy
Phone: (250) 756-7237
Email: Justin.Mundy@dfo-mpo.gc.ca; Pacific.CatchStats@dfo-mpo.gc.ca

Quebec Region:
Sarah Larochelle
Phone: (418) 648-5935
Email: infostat.qc.XLAU@dfo-mpo.gc.ca

Central and Arctic Region:
Margaret Treble
Phone: (204) 984-0985
Email: Margaret.Treble@dfo-mpo.gc.ca

AIS Data Contacts

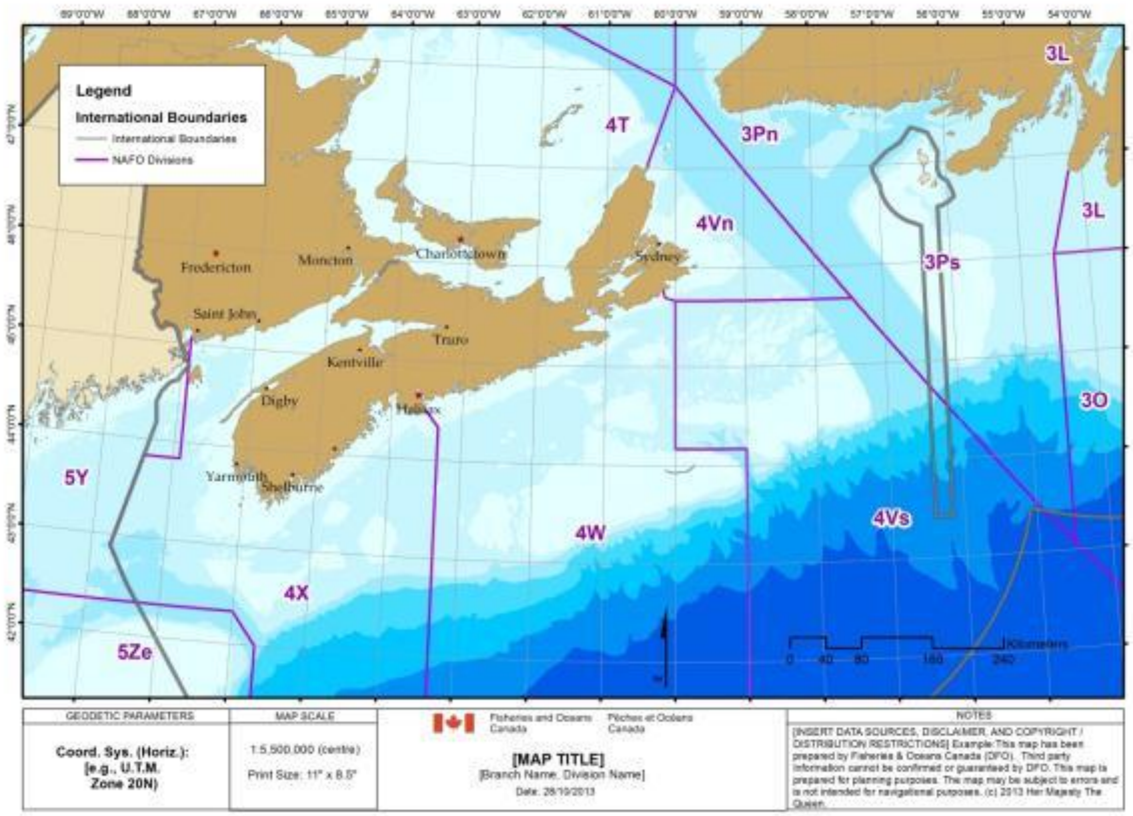
David Toomey
National Strategies, Cost Recovery
Canadian Coast Guard
Tel: (613) 990-3119
Email: David.Toomey@dfo-mpo.gc.ca

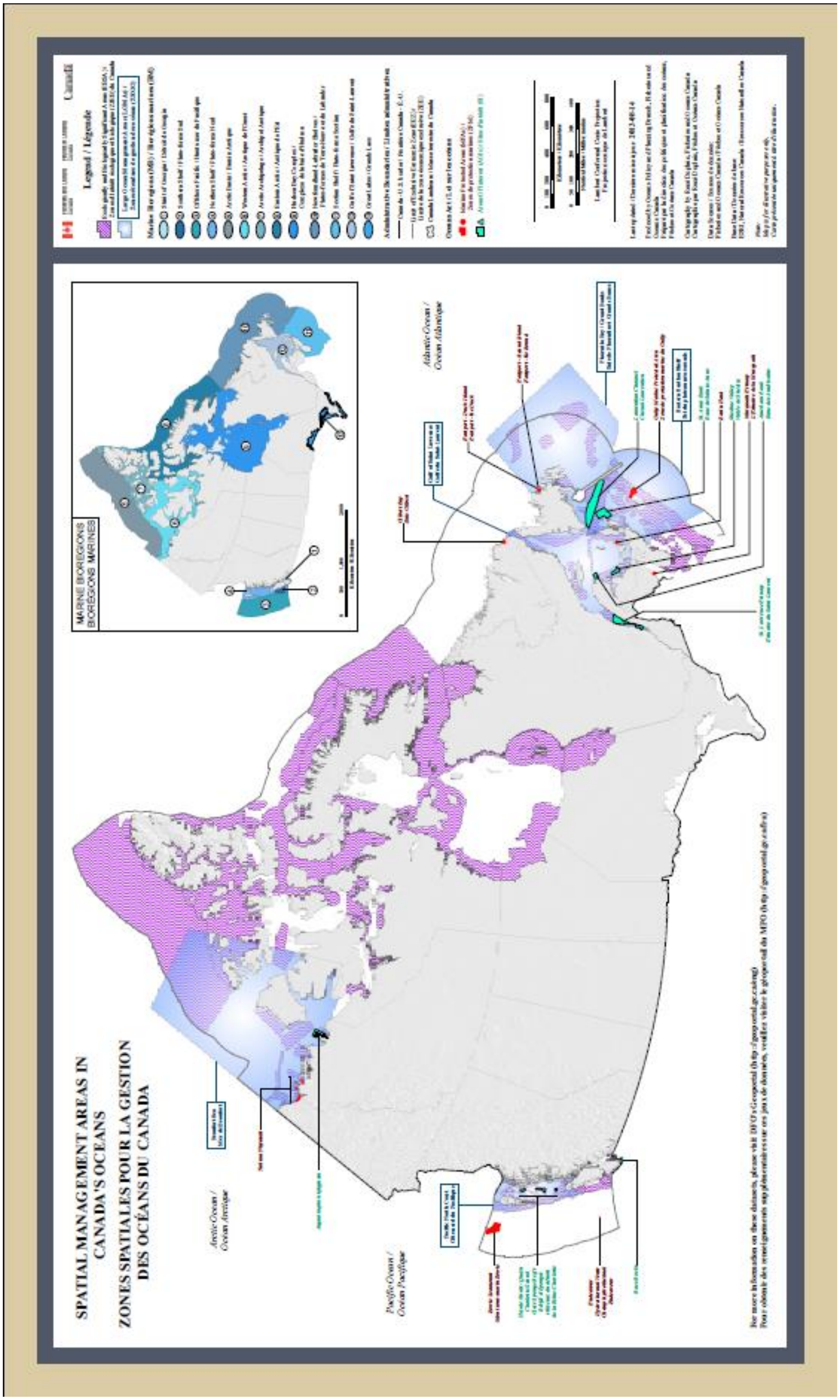
Bob Banik, M. Eng.
Head, Planning System
Space Exploitation Missions
Canadian Space Agency
Tel: (450) 926-5134
Email: Bob.Banik@canada.ca

ATIP Contacts

ATIP Policy and Privacy Division
Phone: (613) 993-3115
Email: DFOprivacy-vieprivee MPO@dfo-mpo.gc.ca

APPENDIX D – GENERIC MAP TEMPLATES




SPATIAL MANAGEMENT AREAS IN CANADA'S OCEANS
ZONES SPATIALES POUR LA GESTION DES OCÉANS DU CANADA
Legend / Légende
MARINE BIOREGIONS
BIORÉGIONS MARINES
Arctic Ocean / Océan Arctique
Pacific Ocean / Océan Pacifique
Atlantic Ocean / Océan Atlantique

APPENDIX E – SPATIAL DATA/DATA PRODUCT DISTRIBUTION/REQUEST FORMS

MAP/DATA DISTRIBUTION - EXTERNAL CLIENT

Client: [*Provide the name of the client requesting the maps/data. If the client is a consulting company acting on behalf of a government department/company, also include the name and contact information of the company/department/agency that hired the consultant for the project work.*]

Project Title: [*Insert short project title – this should match the title in the Map Request Tracker spreadsheet*]

Project Description: [*Provide a brief description of the project (e.g., MSC certification process for X fishery, Environmental Assessment for XX activity in XX area, etc.)*]

Description of map(s)/data: [*Provide a list of maps/data to be distributed to the client, including format (shapefiles, pdfs, etc.), spatial extent, time frame (e.g., date range of data).*]

Conditions for Release: [*Include any restrictions on the use of the maps/data. If any of the materials to be released required explicit consent from a licence holder/data owner, any restrictions related to that consent should be clearly stated here. Examples provided below.*] Information provided as accompanying text for the maps (e.g., text identifying data sources, caveats and limitations of the analysis) must be published along with the maps. If applicable, some information [e.g., catch weight/landings/value/effort etc.] has been withheld to protect confidentiality. The maps/data have been provided for the purpose of the above-stated Project. These maps/data are not to be shared or used by the client or by third parties for other purposes without the express written permission of DFO.

Client Contact:
Name, Affiliation:
Address:
Email:
Phone:

DFO Contact:
Name, Affiliation:
Address:
Email:
Phone:

(Optional data/map share sign off):
Client Agreement: ____ Date: ________________

DFO Approval:

Custodian: ____ Date: ________________
Regional Director: ____ Date: ________________

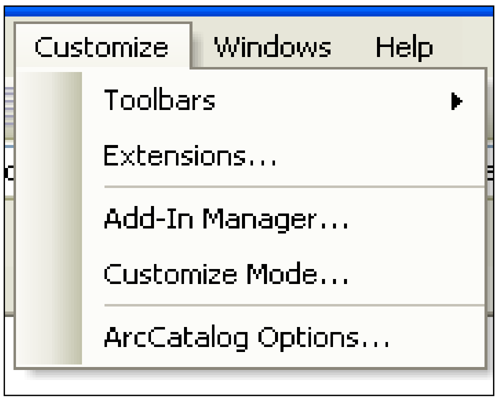
APPENDIX F – HOW TO COMPLETE METADATA IN ARC CATALOG

Fisheries and Oceans Canada follows the ISO 19115 North American Profile standard; however, the default setting in ArcCatalog, where you can get access to the metadata, is not the ISO 19115. You can change the metadata setting by following the instructions:

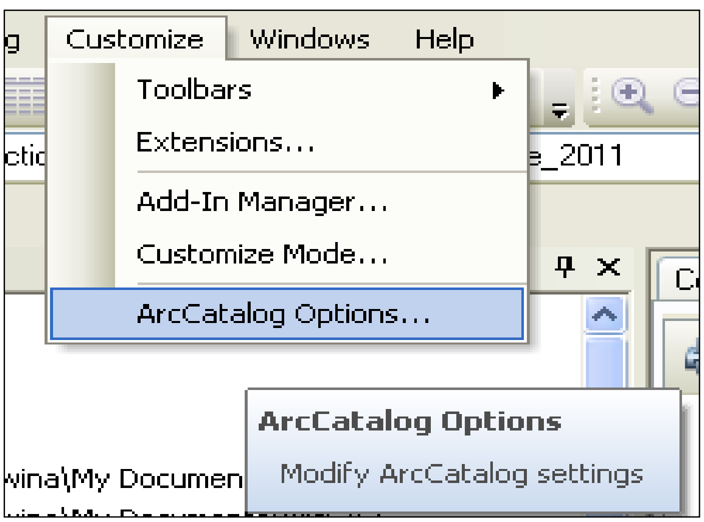
I. Customize the Metadata View

1) Open ArcCatolog

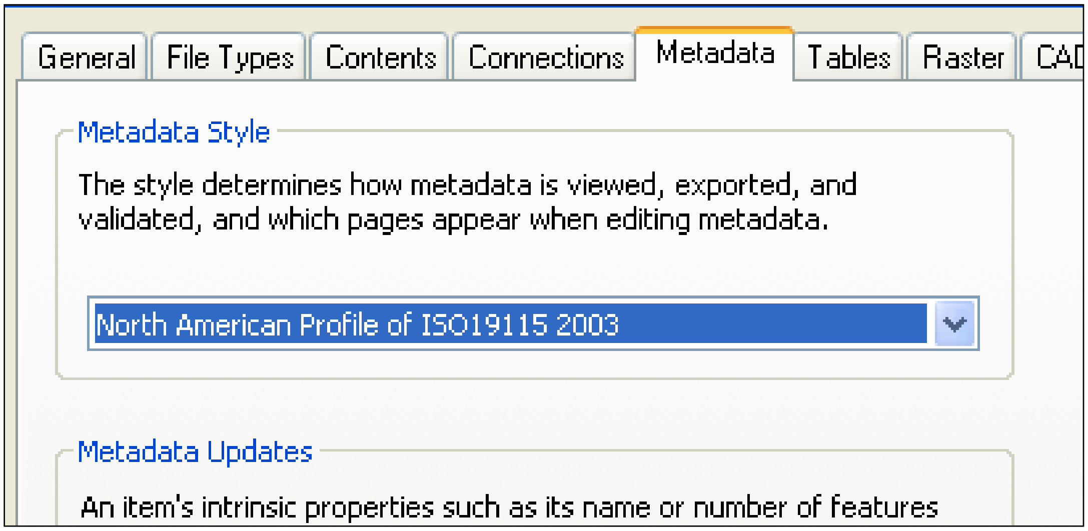
2) Click "Customize" on the top menu



3) Click "ArcCatalog Options" on the dropdown menu

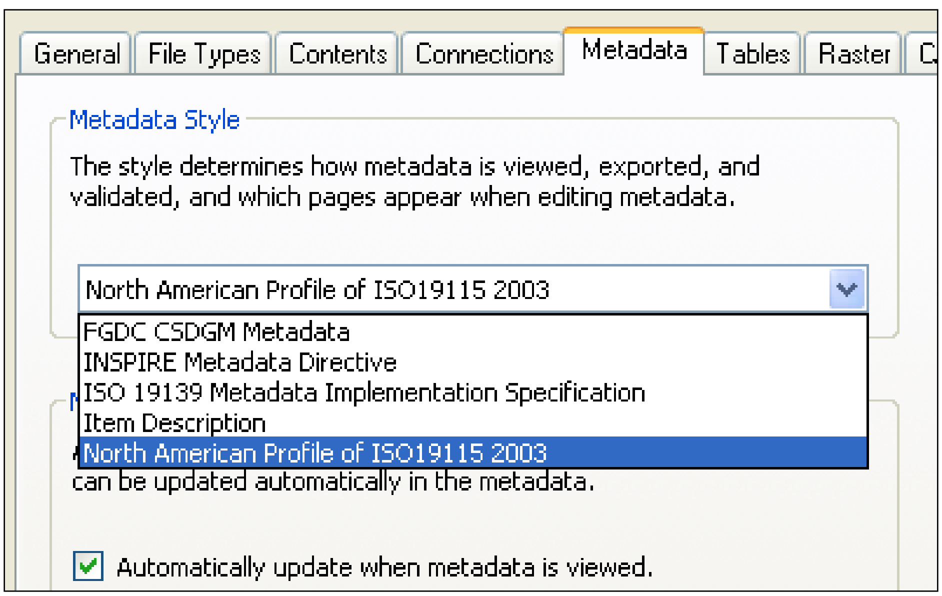


4) Click the "Metadata" tab



5) Click the "Dropdown box" and

- select North American Profile of ISO 19115 2003

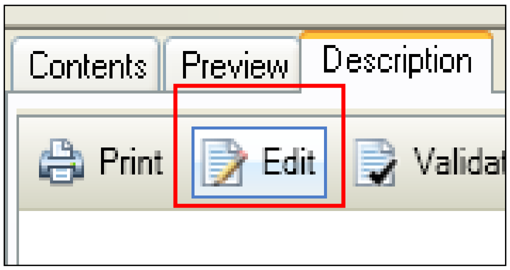


6) Click “OK”

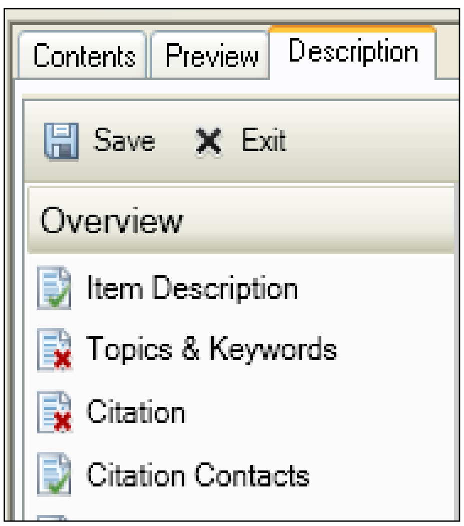
The metadata profile on the “Description” tab will change to the North American ISO 19115 2003 Profile where you will be able to view the metadata.

I. Adding or Editing Metadata

1) Click “Edit” on the top menu of the working panel

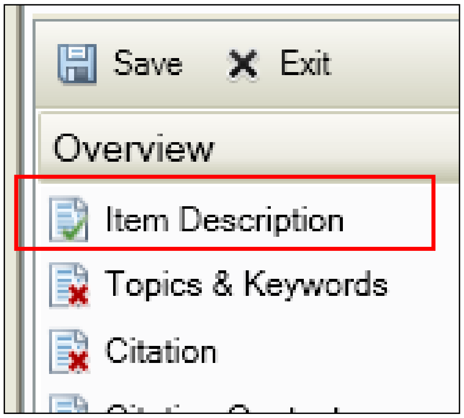


2) On the left of the of the working pane, you will see a table of contents

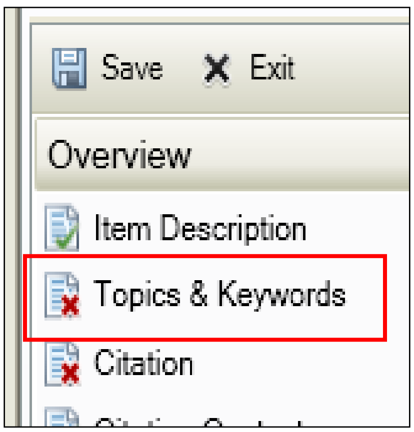


3) Click on each item in the table of contents to view each one

4) If an item has a ☑, then it has been filled out

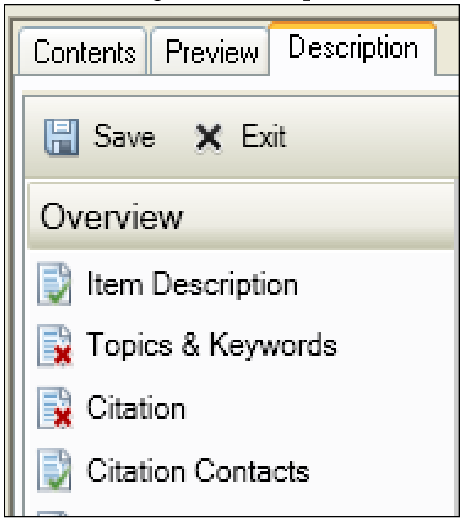


5) If an item has an “**X**”, then the item has not been filled out



The following fields should be completed:

Headings marked with * are Required by **ISO19115 NAP standard**
Headings marked with ** are Required or Recommended by DFO
All remaining fields are optional



Overview (general information about the layer and contacts)

- ***Item Description** - abstract
- ***Topics & Keywords -** topic category
  - ** Content Type
  - ** Place Keyword
  - ** Keyword Thesaurus
- ***Citation -** title, date
- **Citation Contacts**
  - ** name, organization of responsible party
  - ** role
- Contacts Manager
- Locales

Metadata (refers to Metadata record, not data)

- ***Details-** language (option English or French), file identifier (auto create)
- ***Contacts -** can be same contact as in Citation
- Maintenance
- **Constraints**
  - ** Note: Option to restrict publication of metadata, complete if constraints to metadata (not actual data)

Resource (refers to actual data layer)

***Details -** language

- ****** status
- ****** spatial representation type

Service Details

Extents

Points of Contact

- ****** name, organization of responsible party (can be the same as Citation)

Maintenance

- ****** Update Frequency
- ****** Maintenance Contact

Constraints

- ****** complete as required by Owner

***Spatial Reference -** primarily horizontal

Spatial Data Representations

Content - attribute description

Quality

Lineage

- ****** optional. Complete if value-added or source data modified significantly

***Distribution**

***Fields -** attribute definition and the source of the definition (for each attribute)

- ****** complete the fields that define the data or theme
- ****** remove fields that don't require description (this removes fields from metadata but not the attribute table/data)

References - if different from the overview Citation

Geoprocessing History - automatic