

Marine Boundary Delimitation for Ocean Governance

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Key words: boundary delimitation; marine cadastre; governance.

ABSTRACT

There is a Canadian project entitled "Good governance of Canada's Oceans: the Use and Value of Marine Boundary Information" which involves research investigating three case studies to represent typical coastal and offshore boundary issues: the delimitation of the extended continental shelf; the creation of boundaries for a Marine Protected Area (MPA); and a provincial marine administrative boundary. In each case study the research objectives include understanding information requirements for governance, modeling boundary uncertainty, and using ocean mapping technologies to illustrate the delimitation issues.

This paper outlines the progress of the research to date and highlights the significance of taking a multi-disciplinary approach in boundary delimitation. Surveyors generally assume that good boundaries make good neighbours yet a case can be made that sometimes more precise boundaries may not be the best solution. For example, social scientists have expanded the original concept of "clarifying" ocean boundaries to include the possibility of leaving boundaries undefined in order to promote co-management arrangements. The legal interpretations of jurisdiction, administration, and title have also broadened the concept of a 3-D marine parcel to a complex series of overlapping interests offshore. Ocean mapping technology is being used to create and communicate alternative boundary solutions, including ecological boundaries defined by bottom type. The challenges in creating a marine cadastre for Canada is also discussed.

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1. INTRODUCTION

Governance has been defined as the process whereby a society, polity, economy, or organization (private, public or civic) steers itself as it pursues its objectives [Centre on Governance, 2000; Paquet, 1994; Paquet, 1997; Rosell, 1999]. Governance has also been defined as the process of decision-making with a view to managing change in order to promote people's wellbeing [Kyriakou and Di Pietro, 2000]. Manning et al [1998] states that "good governance is essential for all societies to ensure the provision of public services and the control of behaviours [sic] which affect the common good." Good governance of coastal and marine spaces, which are common goods, is therefore of vital importance since these spaces are of tremendous importance to life on Earth, and are at the same time extremely sensitive to human activities [Payoyo, 1994; Lutz and Munasinghe, 1994; BoFEP, 1996; Gomes, 1998; Crowe, 2000; CNPA, 2000]. In order to attain informed decision-making in pursuit of the objective of the good governance of coastal and marine resources, there is the requirement to obtain and manage a range of information. There is need to manage information on (but not limited to) living and non-living resources, bathymetry, spatial extents (boundaries), shoreline changes, marine contaminants, seabed characteristics, water quality, and property rights that all contribute to the sustainable development and good governance of coastal and marine resources [Nichols, Monahan and Sutherland, 2000; Nichols and Monahan, 1999]. This paper is concerned with marine boundary information in support of good marine governance.

There is a Canadian project entitled "Good governance of Canada's Oceans: the Use and Value of Marine Boundary Information" which involves research investigating three case studies to represent typical coastal and offshore boundary issues: the delimitation of the extended continental shelf; the creation of boundaries for a Marine Protected Area (MPA); and a provincial marine administrative boundary. In each case study the research objectives include understanding information requirements for governance, modeling boundary uncertainty, and using ocean mapping technologies to illustrate the delimitation issues. This paper outlines the progress of the research to date and highlights the significance of taking a multi-disciplinary approach in boundary delimitation. The challenges in creating a marine cadastre for Canada is also discussed.

2. THE GOVERNANCE OF MARINE SPACES AND THE NEED FOR INFORMATION

Coastal and marine areas are ever increasing in value to the welfare of countries, communities and regions. These areas provide natural, social and economic functions that contribute to increased quality of life. The oceans are instrumental in determining climate that beneficially affect all life on Earth [Payoyo, 1994]. Other natural functions include habitat for endangered species, species breeding and resting areas, water treatment, groundwater recharge, and flood attenuation. Some social and economic functions include tourism,

commercial and recreational fishing, oil and gas development, and construction [Eckert, 1979; Prescott, 1985; Gomes, 1998]. Additionally these spaces are sources of wealth for humankind by providing [Eckert, 1979; Payoyo, 1994]:

- a. Sources of food from animals, plants and fish;
- b. Means of transportation;
- c. Means of communication (e.g. cables);
- d. Areas for implanting fixed navigational installations (e.g. lighthouses and piers);
- e. Areas for the dumping of waste materials;
- f. Areas for scientific research on Earth's basic physical and biological processes.

It is clear that coastal and marine areas are of vital importance to human life. Yet human terrestrial and marine activities have proven to have deleterious effects on these areas. According to CNPA [2000] the major threats to the health, productivity and bio-diversity of the marine environment result from human activity in the coastal areas and further inland. Approximately 80 percent of marine area contamination results from land-based activities such as municipal, industrial and agricultural waste and run-off, in addition to the deposition of atmospheric contaminants resulting from human industrial activities [CNPA, 2000; Sanger, 1987].

The previously held belief that marine spaces are infinite in its resources has in recent times proven to be a myth, because while living marine resources are renewable their production is finite. For example, the negative effects of over-fishing on the social and economic welfare of communities dependent on fishery in the Canadian Maritimes are well documented. This is just one example of a failure to manage commonly held resources [anon., n.d.; Miles, 1998].

Coastal and marine environments are also always subject to change. This change is affected by factors ranging from geology and climate, to human terrestrial, coastal and marine activities. It is almost impossible to control geology and climate, and very difficult to avoid human impact on coastal and marine environments as these environments play such an integral role in the quality of human life. The current pattern of the use of coastal and marine spaces is not sustainable and there is an urgent need to make sustainability a fundamental norm in the use of these areas [Miles, 1998].

The dilemma facing humankind with regard to marine and coastal spaces may be a tragedy of the coastal commons [anon., n.d.], but not all areas of the commons are subject to abuse (only those not owned and unmanaged) [Friedheim, 1999]. There is a need for a wider dissemination of knowledge relevant to the importance of coastal and marine areas to the world's wellbeing, and a re-evaluation of societies' attitudes towards these spaces. Good coastal and marine governance (e.g. information dissemination, management, monitoring etc.) is therefore a key factor in the sustainable use of these environments and will require an integrated, coordinated and equitable approach [Crowe, 2000].

Accurate, complete, up-to-date and useful information (on many levels) regarding the resources that currently exist, the nature of the environment within which those resources exist, as well as on the users of those resources is always a requirement for effective monitoring of coastal and marine areas. Information on (but not limited to) living and non-

living resources, bathymetry, spatial extents (boundaries), shoreline changes, marine contaminants, seabed characteristics, water quality, and property rights all contribute to the sustainable development and good governance of coastal and marine resources [Nichols, Monahan and Sutherland, 2000; Nichols and Monahan, 1999].

With regard to spatial extents, surveyors generally assume that precise boundaries make good neighbours yet a case can be made that sometimes more precise boundaries may not be the best solution. For example, social scientists have expanded the original concept of "clarifying" ocean boundaries to include the possibility of leaving boundaries undefined in order to promote co-management arrangements.

3. BOUNDARY COMPLEXITIES WITHIN A MARINE PARCEL

The governance of coastal and marine spaces has at least four functions as described below [Nichols, Monahan and Sutherland, 2000]:

- Allocation within society and among government organizations of rights of use, ownership, and stewardship to marine resources;
- Regulation of these rights of use, ownership, and stewardship;
- Monitoring and enforcement of these regulations by the appropriate authorities;
- Provision of effective means to prevent and adjudicate disputes.

The authors assume that the successful performance of these functions depend in part on how well the information about marine resources is managed. Of concern is the management of spatial information, and more specifically marine boundary information. A small selection of some of these boundaries might include [Nichols, Monahan and Sutherland, 2000; Monahan and Nichols, 2000]:

- Limits of private and public ownership (e.g., ordinary high water mark);
- Limits of private rights below high water (e.g., water lots, aquaculture sites, oil and gas);
- Municipal, county, provincial, and territorial limits of jurisdiction and administration;
- National and international boundaries, including national coastal baselines;
- Government departmental limits;
- Environmental protection areas (e.g., wetlands, marine protected areas, coastal zone management)
- Military limits (e.g., disposal and weapons firing ranges);
- Pipeline and cable rights-of-way.

The foregoing boundaries contribute to a complexity of rights existing in marine spaces. Their inherently multi-dimensional nature makes a two-dimensional definition of these rights legally inadequate [Nichols et al., 2000]. The legal interpretations of "jurisdiction," "administration," and "title" have also broadened the concept of a 3D marine parcel to a complex series of overlapping interests offshore. Many of these boundaries overlap not only at the water surface but also within the water column and even within the seabed. In order to enact good marine governance there is need to understand the multi-dimensional nature of rights existing within a "marine parcel" as well as how these rights may affect the environment and other overlapping property rights [Hoogsteden and Robertson, 1998, 1999; Ng'ang'a et al, 2001].

4. THE PROJECT

In June 2000 a team of researchers from four universities (University of New Brunswick, Memorial University, University of Ottawa, and University of Victoria) successfully secured funding for a project from the Geomatics for Informed Decisions (GEOIDE) Research Network under the National Centres of Excellence. The project is entitled "Good governance of Canada's Oceans: the Use and Value of Marine Boundary Information." The multidisciplinary research team is comprised of graduate students, lawyers, a sociologist, a governance expert, an economist, and specialists in ocean mapping and geomatics. The research aims to address some of the marine boundary issues in Atlantic Canada in three case studies [Ocean Governance, 2000]:

- The outer limits of Canadian jurisdiction (a portion of the extended continental shelf);
- Private, public, municipal, environmental, and coastal zone boundaries associated with Marine Protected Areas (MPA) for the Department of Fisheries and Oceans under the new *Oceans Act* (the proposed Musquash MPA in the Bay of Fundy);
- The administrative marine limits of the Province of New Brunswick (for Service New Brunswick) as part of the framework data for the Canadian Geospatial Data Infrastructure.

The research objectives, to be achieved over 18 months, are the following:

- To evaluate the socio-economic, legal, and sovereignty marine boundary requirements for good governance of Canada's oceans;
- To investigate spatial data uncertainty and its impact on data integration and boundary delimitation, including an assessment of existing information and ways in which data from various sources may be integrated;
- To develop and enhance visualization tools, including the use of CARIS LOTS and SPATIAL FUSION [CARIS, 2000] that may be used to illustrate problem areas and alternative solutions;
- Communicating the results to policy-makers and stakeholders through one or more workshops.

This research is just one step towards understanding Canada's ocean governance requirements. It is already apparent that the multidisciplinary nature of the team will add a new dimension to our understanding of why and when boundaries need to be clarified, as well as our understanding of the roles that both boundary delimitation and geomatics technologies can play in marine management.

4.1 The Use of Appropriate Technology

One step towards resolving the lack of knowledge on marine boundaries is the use of geographic information management tools that can serve to enhance visualization of the marine boundaries that exist, and which may be used to illustrate problem areas and alternative solutions. These tools include CARIS Spatial Fusion™ and CARIS LOTS™. CARIS Spatial Fusion™ is one of the applications that integrate and distribute geographically referenced information across the worldwide web. CARIS Spatial Fusion™ is being used to

visualize the complexities of rights in the proposed Musquash marine protected area. CARIS LOTS™ is a geographic information application, based on CARIS GIS, which is designed to aid in the delineation and delimitation of marine boundaries as required by the United Nations Convention on Law of the Sea (UNCLOS). CARIS LOTS™, along with CARIS GIS, are also being used to aid in the calculation and visualization of New Brunswick's marine administrative polygons.

4.2 Project progress to Date – New Brunswick's Marine Administrative Boundaries

Considering that administrative boundaries have been federally recognized in Canada as an important component of the spatial framework data layer of the Canada Spatial Data Infrastructure, and in consideration of a proposed marine policy for the province of New Brunswick, it has become imperative for Service New Brunswick (SNB) to secure knowledge of the spatial extents of its marine administrative areas. SNB responsible for managing most of the New Brunswick's legal and administrative spatial information is one partner in the project.

From a legal perspective there are many administrative, jurisdictional and title issues that impact upon the delimitation of these marine administrative boundaries. Among them are issues related to the US-Canada international border (seaward), federal-provincial administrative uncertainties in the offshore, and competing public-private interests. Until these issues are adequately addressed, good governance of New Brunswick's coastal and offshore areas will be hindered by uncertain jurisdiction, undefined and ambiguous boundaries, as well as the possibility of increasing conflicts between customary, public and private interests. The clarification of the legal issues will help to determine how the marine boundaries are delimited. Extensive documentary evidence and legal precedence both within and without Canada are being researched and as at the date of the drafting of this paper a preliminary report is near completion.

From a technical perspective a lack of consistent spatial coastal data among New Brunswick and its contiguous and neighboring provinces adds another dimension of difficulty towards delimiting New Brunswick's marine administrative areas. Coastal and other relevant boundary data has been collected from SNB's Coastal Topographic Database, Natural Resources Canada (NRCan) National Topographic Database, other relevant provinces' enhanced topographic databases and the International Boundary Commission among other sources.

All the data sets collected from both provincial and federal entities, and representing coastlines and other boundaries relevant to New Brunswick's proposed marine administrative polygons show, when integrated, inconsistencies in data representation of these boundaries. This is apparently so because the data were collected via various methodologies, to serve different mandates, and at various times among other things. This situation underscores the need for standard datasets representing coastlines and administrative boundaries. The integrated datasets are currently being processed with CARIS GIS and CARIS LOTS™. Visual and statistical comparisons of the various digital boundary information collected will be combined with the results of ongoing legal research to eventually produce and visualize

the preliminary marine administrative polygons for New Brunswick.

4.3 Project progress to Date – The Proposed Musquash Marine Protected Area

The Musquash estuary and environs, located in the Canadian province of New Brunswick's portion of the Bay of Fundy, have been designated as a proposed marine protected area (MPA). A number of stakeholders representing various levels of government, the private sector, communities and academia all have interests in this geographic area. The interests cover the economic, the social, the political, the cultural and traditional, and the academic spheres. Spatial data ranging from cartographic to socio-economic and administrative data are maintained by a variety of stakeholders in the Musquash MPA process. The MPA designation process is overseen by Canada's Department of Fisheries and Oceans (DFO).

As part of the project's objective field survey data of the ordinary high water was collected in order to compare with other data on the same spatial extent so that confidence could be put in the final spatial dimensions of the MPA. Also, tools to visualize and integrate the various boundary and other spatial data held by stakeholders were developed using CARIS Spatial Fusion™. This is because of the ability afforded by web-GIS technologies in facilitating stakeholders to share and integrate spatial information with each other in real-time (or near real time) and over the internet without significant investments in changing the way in which they store and maintain their data. Sharing data in this manner economically promotes collaborative, cooperative and integrative governance and may represent significant savings in time and money.

An example of this collaboration and cooperation in the governance of the proposed MPA facilitated in part by web-GIS technologies was recently demonstrated. The spatial extent of the Musquash MPA was originally crudely outlined on a paper map without consideration to datum and projection, and consequently to what the drawn lines meant or enclosed in reality. Multi-beam data of the area was collected by the project team and integrated with data representing the proposed outer boundaries of the protected area as originally drawn. Sand waves outside of the proposed boundaries, as revealed by the multi-beam data, showed that there may be tidal flushing actions in and out of the Musquash area. If this is the case then there is the potential for the movement of contaminants in and out of the Musquash estuary and gave indication that the proposed boundaries may have to be moved in order to give the area the desired protection. Here geographically dispersed parties with varying mandates but collecting data on the same spatial extent, and without changing the structure and format of the data they maintain, were able to use web-GIS technologies to integrate data for more effective decision-making. The web-GIS applet and servlet developed continues to be finetuned for increased functionality.

4.4 Project progress to Date – Delimitation of the Continental Shelf

Nichols, Monahan and Sutherland [2000] states that:

The new millennium will be one in which the *United Nations Convention on Law of the Sea* (UNCLOS) ... will form the basis for dividing two thirds of the earth's surface among nations of the world. Jurisdiction over the seafloor is apportioned between Coastal States and the UN, with the authority of Coastal States diminishing seaward while that of the

UN takes over. All ratifying Coastal States are automatically granted a Territorial Sea, a Contiguous Zone and an Exclusive Economic Zone. In addition, some fifty countries, including Canada if it ratifies the Treaty, will be able to claim an extended juridical Continental Shelf. Since this is an area that is currently sparsely surveyed, submission of a claim may involve extensive collection of new data.

This "extensive" collection of new data represents a very expensive endeavor in terms of time and money. Macnab[1994] discusses the pros and cons of various data collection scenarios and concludes that a program that would encompass all of Canada's waters could take as long as 8 to 10 years and cost between \$60 and \$100million. Clearly before launching such an expensive and extensive program, the types of data required and the pattern of their spatial arrangement must be examined and optimized. To render this process manageable, it was decided to select an area of the Canadian margin and prepare a "partial claim" for the area. Work was performed on both public domain and existing Government data sets using CARIS LOTS™ software to prepare an early approximation to the edge of the continental shelf and to determine the accuracy and completeness of existing data sets [van de Poll et al, 2000]. From this, a plan for data acquisition over the entire margin can be developed. Side benefits of the exercise includes allowing a deeper analysis of the Commission on the Limits of the Continental Shelf (CLCS) Guidelines [United Nations, 1999]. The development of the test claim is ongoing and being finetuned.

5. TOWARDS A MARINE CADASTRE FOR CANADA

The premise of this paper is that more accurate, complete, up-to-date and useful information, including information on spatial extents and the rights, responsibilities and restrictions associated with those spatial extents, is needed to support the good governance of coastal and marine spaces. There is definitely the need in Canada to effect the efficient management of rights within federal and provincial offshore jurisdictions and administrative areas within the limits of territorial waters. Additionally the United Nations Convention on the Law of the Sea (UNCLOS) has added another level of rights management out to the limits of (the yet to be defined) continental shelf. Therefore the management of marine boundary information is of great importance, and the development of a marine geospatial data infrastructure (MGDI) and its attendant development of appropriate laws and institutional arrangements are being pursued. The MGDI is a component of the greater Canadian Geospatial Data Infrastructure initiative.

A marine cadastre supporting the management of marine rights, the spatial extents of those rights, and the object of those rights is a necessary component of the MGDI. The inclusion of other relevant thematic and attribute data (e.g. biological, ecological, geophysical, hydrological etc.) would make the marine cadastre multipurpose. However, considering that marine rights are essentially at least 3D, it is imperative that information models used represent the existing subject-object-rights relationships of this reality as closely as possible. Ng'ang'a, Sutherland et al [2001] support this view with the the following statement:

The multipurpose cadastre concept has been traditionally designed on a three dimensional spatial unit representing unique, homogeneous, contiguous interests ... In some senses the cadastre also represented a fourth dimension, time (e.g., time-shared interests). In the oceans where resources and activities, and therefore rights and restrictions, can co-exist in time and space and can move over time and space, the definition of a parcel is even

more complex. Furthermore, it may not be the best unit of representation for all interests (such as the overlapping administrative units described above). Until another framework is proven more useful, the cadastral concept may help the initial exploration of ideas.

The foregoing demonstrates the importance for the development of a Canadian marine cadastre. The project team is aware of this and it is expected that the outcomes from the the project (i.e. improved administrative boundary information, progress in the delimitation of Canadian continental shelf, the development of visualization technologies etc.) will positively contribute to that endeavour.

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BIOGRAPHICAL NOTES

Michael Sutherland obtained a Diploma in Computer Science from the University of Technology (Jamaica), and a Master of Science in Engineering (land information management) from the Department of Geodesy and Geomatics Engineering, University of New Brunswick (Canada). He is currently pursuing a Ph.D. at the University of New Brunswick where he is developing global models regarding the need for marine boundary information in coastal and ocean management. His work experience includes 18 years in land management with the Government of Jamaica, a number of private consulting jobs related to the development of land information management software in both Canada and Jamaica, as well as lecturing in land administration. Michael is a member of the Canadian Institute of Geomatics.

Sue Nichols is a Professor in Land Administration and Property Studies at the University of New Brunswick and has conducted research on tidal and marine boundaries for over 20 years, including a chapter on Coastal Boundaries in Survey Law in Canada[1989]. Sue is a Past-President of the Canadian Institute of Geomatics and has been on the Advisory Committee for the Canadian Minister of Natural Resources. She is currently the Project Leader on a multi-year, interdisciplinary research project on "Good Governance of Canada's Oceans: The Use and Value of Marine Boundary Information" which includes examination of boundary uncertainty.