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CHARTING THE FUTURE: THE NEED FOR NAVAL HYDROGRAPHY

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CHARTING THE FUTURE: THE NEED FOR NAVAL HYDROGRAPHY

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Par le capitaine de corvette M.W. Eelhart

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ABSTRACT

Hydrography is the foundation of safely navigating on waterways. The Royal Canadian Navy has relied on its domestic partners, its allies and commercial means to supply the products that enables its missions. The navy's lack of a hydrographic capability resulted from history and fundamental lack of requirement. Other similar navies have retained their capability or control of the domestic agencies. Nonetheless, the Royal Canadian Navy requires a hydrographic capability to support its current and future operations. Historical requirements for hydrography entail a need for non-locals to safely navigate coastal areas and often the requirement was filled by navies. There are other government departments that would gain while the navy developed and practiced this new capability. In addition, naval hydrography would enable disaster relief and military specific requirements for hydrography.

Naval hydrography will enable the Royal Canadian Navy in expeditionary operations. These operations include hyper accurate charts to improve navigational safety of both submarine and surface operations. With the capability the Royal Canadian Navy will be able to exploit the water space, and without the capability the Navy will have to necessarily rely on allies. Naval hydrography is needed both to enable current operations and as a necessity for future operations.

INTRODUCTION

The Canadian Navy has relied on its domestic partners, allies and commercial means to supply the hydrographic products that enables naval missions. The navy's lack of a hydrographic capability is a product of past decisions and a fundamental lack of requirement. Other similar navies have retained their capability or retained control of the domestic agencies. The Royal Canadian Navy requires a hydrographic capability to support its current and future operations. Historical requirements for hydrography entail a need for non-locals to safely navigate coastal areas and often the requirement was filled by navies. There are other government departments that would gain while the navy developed and practiced this new capability. In addition, naval hydrography would enable disaster relief and military specific requirements for hydrography.

LITERARY REVIEW

Little academic work exists on the need for naval hydrographic capability. The available literature falls into three broad categories. First there is the history of various governmental agencies and how and why they conducted hydrographic surveys. The second major category is the economic benefit of conducting surveys and improving the maritime infrastructure. The final major category is the scientific research into the methods of obtaining hydrographic data and processing that data. There may be no academic work on this topic because the nations who have this capability have no need to generate arguments for the capability or the need for the capability might be self-evident. It could also mean that this is a small and very specialized field of operations. Included in

this category are modern accounts of activities such as reports on action during the response to Hurricane Katrina[1]

The historical literature is often cited as either a narrative of why nations or organization came to being and the demands for their services. This work includes histories of both the Royal Navy and their demand to protect their sailors. There are numerous individual ship officer accounts of their voyages. Some of these include both chart artifacts and descriptions of the landscape. From these accounts, it can be inferred what the survey ships were interested in. The reason for the surveys and the continued need for future operations are safe coastal navigation areas, locations of potential landings sites and strategic harbours and anchorages. The main Canadian work published through the auspices of the Canadian nautical Research Society, is a collection of essays entitled *Charting Northern Waters*.[2] The book describes the origins of the Canadian Hydrographic Service and demand in Canada for commercial navigational safety from the establishment of New France until modern times. The book focus is on the technical challenges of charting in Canadian waters including in ice-bound areas.

The second set of writing concerning the economic benefits of charting is mostly written, sponsored or endorsed by the International Hydrographic Organization. The organization's mandate is to improve safety at sea by charting the world's oceans. The organization aids coastal nation states to develop their own hydrographic capability in order to improve the overall state of navigation. It provides a compelling case for the economic benefits of charting so that economically challenged hydrographic offices can

[1] United States Navy. "Fleet Survey Team Response" accessed March 8, 2013. http://www.public.navy.mil/fltfor/cnmoc/Documents/NAVO/FST.pdf.

[2] William Glover, *Charting Northern Waters: Essays for the Centenary of the Canadian Hydrographic Service* (Montreal: McGill-Queen's University Press, 2004).

more effectively lobby their own governments for funds. The overriding publication supporting the case is IHO publication M-2.[3] It also creates supporting regional hydrographic conferences in an effort to improve the skills of hydrographers. IHO also sets out the standards for data collection, hydrographic competence and chart depiction criteria. National hydrographic offices are not bound by the regulations but often adhere to them.

The final class of writing encompasses the technical advancements in hydrographic surveying. The work is academic in nature for the most part but this technical academic work is often not germane to developing a capacity for a navy. Included in this class are works that describe new methods of signal processing to determine more information about the water column and the geological classification of the sea floor. It also describes new methods of processing the data for purposes outside of commercial navigation including mineral extraction and biomass data. Processing does include new methods to automate the data flow to generate new products which can include military application.

As a result of no academic work on the subject either for or against the need for a hydrographic capability many arguments must be inferred. The requirement for a naval hydrographic capability is a logical extension of the demand using historical requirements, current demand and envisioned future naval requirements.

[3] International Hydrographic Organization, *The Need for Hydrographic Services* (Monaco: IHO, 2011).

INTRODUCTION

Historically, hydrography was used to prevent horrible losses and allow non-local experts to safely proceed from port to port. The historical requirements of naval hydrography and the development of the Hydrographic service in Canada show that in he past there was a need to prevent loss to ships and sailors in the navigational rivers and commercial shipping routes. The leading cause of death for sailors was shipwrecking caused by inaccurate positioning and poor charts. As a result, both commercial companies such as the East India Trading Company and government departments commissioned charts to be created as they traveled. Good quality charts became valuable commodities and assets. Although commercial demands predominated governments and naval forces used the charts for other purposes. Governments employed charts to assert sovereignty by showing that they controlled certain sea areas. Often the survey ships were the only contact that the locals would have with the controlling government for years. Naval forces used the charts to not only improve their positional information but also as an intelligence aid. They used charts to support operations including landings, but also for more mundane reason such as knowing where fresh water sources might be exploited in less friendly areas of the world. As a result, most hydrography organizations were developed by, and remain, part of the Navy.

Why does the Royal Canadian Navy not have a hydrographic capability? Three main historical reasons account for why the RCN does not currently have a hydrographic capability. The minister responsible for transportation in the St. Lawrence Seaway created a civilian hydrographic service in order to better chart the changing, erratic conditions of the river. He felt that he could use this new service to create a Canadian

naval militia. His ambitious plan was overtaken by events but the result was that a civilian agency was created from the outset to chart waters in Canada. The second major reason was that the Royal Canadian Navy was heavily integrated into the Royal Navy and received support for some activities through them. This activity includes hydrography during both world wars. This support carried on after the war and was expanded to include support for operations with other allies. As a result the Royal Navy never felt that it was deficient in hydrography because it always relied on allies or commercial means to support operations. In other words there never was a capability deficiency that the Navy needed to rectify.

Since the Royal Canadian Navy did not develop its own capability it has relied on civilian partners to fill the requirements of the service. The Navy requires the capability to support the implied tasks of other departments such as the Environment Canada, the Canadian Coast Guard and the Canadian Hydrographic Service. The implied tasks come from the Canada Defence First Strategy which has the defense of Canada and Canadian sovereignty as two of the pillars that the Canadian Forces must support. Defence of Canada means that the Canadian Forces must to go anywhere in Canada. The Royal Canadian Navy assumes unacceptable levels of risk when patrolling and navigating in poor and unsurveyed waters and this risk can only be mitigated by hydrographic surveys. Although the RCN does not have the mandate to survey in Canada, it can support the Canadian Hydrographic Service (CHS) in assigned tasks. Also, although CHS is responsive to user's needs, often civilian priority areas and the Royal Canadian Navy's priorities are not the same. If the RCN had their own capability, it could survey their own priority areas to naval standards, compliant but exceeding civilian standards, and supply

the data to CHS so as to not take or subsume their mandate. To improve charting for naval purposes and to improve sovereignty as required by its foundation strategy document, the Navy should logically have a hydrographic capability.

The argument may be made that the RCN already has a hydrographic capability resident in each coast's hydrographic offices and the Route Survey section. The route survey section uses side scan sonar systems to depict the bottom floor. From that picture, objects may be investigated or a change detection algorithm may be used to discover new objects. Could not this section take the skills and equipment and put them to use for hydrographic means? The simple answer is that few of the skills and equipment and none of data collected can be utilized in a hydrographic manner as it is collected for another purpose with different standards and equipment. The data collected often has very gross horizontal precision and is not at the standard required for hydrography. Second, there is often non-existent or very poor vertical data. Essentially, hydrography resolves the depth of water is in a given location. Route survey equipment uses sides scan data that cannot achieve the precision required of the current hydrographic standards. Side scan equipment is optimized for providing the most accurate and detailed picture for change detection for the specific task of searching for mines and ground objects. Although there is hybrid side scan hydrographic equipment that can achieve the functionality for both data sets, the RCN does not have that type of equipment. In the critical task of object detection few compromises should be risked so a hybrid system would not be ideal. However, some skills required for route survey can be used for hydrography. The data evaluation and the exacting lines of ship driving are skills that do translate into hydrography.

The Coastal Hydrographic Service Offices (HSOs) primary task is to provide government ships with legal navigation products. Most of these products are commercially obtained and the hydrographic offices act as an informed distribution center. There is a small capability to create specialized products but the data used is superficial or an overlay. The offices are not qualified or capable of collecting hydrographic data and producing products. Recently some capability of reprocessing existing CHS data into specialized military products for both submarines and surface ships has improved the operational and navigational safety, but they have neither the authority nor the capability of producing legal navigational products. As a result the HSOs do not have the requisite skill to produce navigational products.

In aiding CHS in its domestic mandate, the Navy could similarly aid both the Canadian Coast Guard (CCG) and Environment Canada. CCGs tasks include search and rescue and aids to Navigation. As with the RCN patrolling areas that are outside available charts, search and rescue events sometimes occur where there is no chart. As seen with the Clipper Adventurer grounding in the Arctic, a survey had to be completed prior to the Coast Guard ship being able to provide assistance. Similarly, the RCN could be called on to provide assistance and then have no way of providing that assistance. Another service that could be aided by hydrography is the placement and servicing of navigational aids. It is unlikely that the RCN would be required to help the Coast Guard in this task. The Navy does have its own specialized navigational aids such as buoys and special sound range markers to service. Likewise, Environment Canada requires surveys to ascertain extent in pollution events. These specialized surveys of the littoral areas are critical to their assessing if an event has taken place and to what extent has the pollution spread or

is likely to spread. These types of surveys which investigate the littoral zone and in deeper water the bottom composition have military applications. This area is where the two departments might collaborate and aid each other, if only the Navy had the ability to do so. The Navy would gain in expertise that could then be applied in areas that the other government departments are unwilling or unable to go. As a result, the RCN cannot greatly aid the other government departments, but it could if it had a hydrographic capability.

The RCN requires a naval hydrographic capability in support of both potential and real operational requirements. Hydrography would allow the navy to operate in areas outside of Canada that could be potentially surveyed, thereby increasing operating areas, but also possibly aiding the coastal state in building up its own infrastructure. Oceanographers could benefit from better integration and overlapping efforts for a more accurate depiction of the ocean floor which would then improve efficiency and effectiveness in submarine hunting and tracking. With a hydrographic capability, amphibious operations of all sizes would be enabled into areas where there is poor, inadequate or no data. Without hydrographic capability the areas of assault could be unpredictable or risky. The submarine community requires a naval hydrography capability to both enhance the safety of navigation but also to improve its operational capability. Naval hydrography would be able to support the specialized submarine requirements that commercial means do not meet. In addition, the specialized processing required for the types of products that submarines require including detailed wreck, deep water shoals and dense bathymetry contours. These military specific products would enable the submarine to operate more effectively, but only if the survey and processing

has been completed. As result, naval hydrography supports the potential requirements and current requirements that cannot be met by any other means.

1. HISTORY OF HYDROGRAPGY

For a long period of time, the significant losses at sea resulted from grounding in uncertain conditions. Naval admiralties became more concerned about the type of losses that ship were sustaining and started to develop remedies to address some of these concerns. The evolution of hydrography was as a direct result in trying to accomplish both military and commercial tasks. Charting became increasing important as commercial shipping traffic went trans-oceanic. Modern hydrography in Canada was developed as a result of a need to improve commercial shipping infrastructure and military needs and will be demonstrated by examining the Royal Navy's demand for charting and the resulting development of a Canadian Hydrographic Service (CHS). The commercial demands for hydrography were to decrease the risks associated with the shipping. The military demands were also to improve navigational ability and improve the freedom of movement. The Navy required detailed coastal descriptions to enable landing for invasion, and simple restoring of vital goods such as fresh water. Some of the by-products of producing charts on unclaimed lands were an improvement of the sovereignty claims. All these historic requirements for hydrography ensured Canada developed its own hydrographic capacity but not a naval hydrographic capability.

Hydrography as a science was developed to mitigate some of the risks associated with travel at sea. That unpredictability is exacerbated at sea by terrifyingly unpredictable weather conditions that seemly want to destroy or delay any mariner. The possibility of floundering and drowning after a ship is splintered adds to the risk of seafaring. Any mitigation of any of these risks would be a welcome improvement not only for insures of any maritime venture, but also for the mariners themselves. Hydrography for

improvement of safety of navigation became a viable and lucrative occupation for any competent person early in production of charts. A leading source of commercial improvement came from the East India Trading Company.[4] Their wide ranging ships would return with world-wide observations which would then be incorporated into their charts. These charts became so valuable that the company was able to leverage them to improve its competitive advantage and held them closely as company secrets.[5] Other commercial publishers of charts could become wealthy even with products of dubious accuracy. Improvement to the safety of the ships was felt to be immeasurable and worth the price. What resulted from the commercial ventures was a dramatic improvement both in the number and quality of charts available but also improvement in hydrographic science. Early periods of hydrography were dominated by commercial demands and led to an improved products and processes, but those commercial secrets demanded that navies secure the environment for their governments.

The military uses of hydrography caused the Royal Navy to develop its own hydrographic capability. This hydrographic capability created specialized naval officers and ships tasked with the tedious mission of collecting data. Hydrographic officers had specialist training or learned on mission. They then would be assigned to a ship that would be either exploring or transiting to an area of importance with minimal charts for direct data collection. Eventually, the Admiralty would become more systematic in its acquisition of data for portrayal and dissemination.[6] Based on a priority list, the revisit time for some areas of only minimal interest might never occur. It would be common for

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[4] Jerry Brotton, "Mapping the World: Possession and Plunder" directed by Annabel Hobley, aired 7 February 2011 (London: BBC, 2010), DVD.

[5] *Ibid.*

[6] William Glover. *Charting Northern Waters: Essays for the Centenary of the Canadian Hydrographic Service.* (Montreal: McGill-Queen's University Press, 2004): 53.

charts to have been created and used for many years. There are charts in Canada that have not updated for almost 100 and some data originates from the original surveys.[7] Since oceans and rivers change, the data becomes increasingly suspect but amazingly most of the data is of high quality. So as the Royal Navy deemed they were not able to rely on commercial and existing charts there was a need to acquire the hydrographic data themselves but they surveyed on their own priority basis.

The Royal Navy saw a military and strategic advantage to conduct hydrographic surveys. The surveys enabled operations to occur more safely and to support operations ashore. After crossing the ocean, accurate depictions allowed the ships to more accurately determine their position. This ability helped the ships to better and more quickly arrive at assigned destinations. Charting also improved the sea room that a ship could operate. It enabled ship's captains to exploit areas that other navies might think impassable. In addition, the Royal Navy would also know where ships could not go and would therefore not have to defend against. This advantage would also enable them to exploit shoals and other known dangers to their advantage and potentially run enemy vessels aground. Regardless of the possibilities of tactical advantage, the major positive strategic impact was the lessening of the losses of vessels due to grounding on shoals. The clear safety advantages that were gained also contributed to the other needs that a naval presence would require.

The Royal Navy was able to use hydrography to enable operations supported by the naval forces. There is often a requirement for navies to affect operations ashore. These operations would include landings and shore bombardment. Accurate charts helped

[7] *Ibid*, 63.

landing operations by enabling larger vessels to approach the shoreline before launching their landing craft. The boats themselves are able to more safely proceed ashore. In addition to having to land marines ashore, a more accurate chart allows ships to provide better gun support to a battling force. The support would include bombarding shore facilities where elevation and positioning would be vitally important. Finally, the Royal navy used hydrography to aid the ships in gaining fresh water. An accurate survey plotted all of the position of streams where a ship may potentially gather fresh water. Supplies could often make the difference in how long a ship could maintain station near an enemy coastline. Without the locations of the vitally important fresh water already charted ships assumed higher risk as they sailed near the shoreline. The enemy would be able to locate the ship and potentially cause harm from the sea. These historic reasons for hydrography point to future uses of the capability. Modern naval hydrography may benefit from the historic demands. These requirements forced the Royal Navy to develop their hydrographic capability in order to support their operations.

The primary reason that the Royal Navy embarked on creating better charts led to other effects. The Royal Navy was able to use hydrography to improve the territorial claims and further assertion of sovereignty. Establishment of territorial claims was often enforced but the accurate depiction reinforced those claims. Charting also allowed the nation to exert their claim over an area. This ability was evident in the Northwest area of the inner passage of Vancouver Island where the initial surveys were conducted by the Spanish but the British were able to assert control after their own surveys.[8] The second effect was most surveys enabled the government to show the flag and establish a presence

[8] William Glover. *Charting Northern Waters: Essays for the Centenary of the Canadian Hydrographic Service.* (Montreal: McGill-Queen's University Press, 2004): 54.

in areas that may have not been visited by government agents. The extended presence of a government vessel conducting detailed coastal survey would show the local population that the government was exerting control in the area and improving the maritime infrastructure of the area. Although these events are secondary effects of the hydrographic survey, governments gained tangible long term advantages.

Canada developed its hydrographic capability by creating a civilian agency, The Canadian Hydrographic Service (CHS), to support shipping in the St. Lawrence. The Royal Navy was the natural British government agency to carry out the surveys for Britain; however the Canadian version was not created as a natural extension of naval capabilities. The Department of Marine was created to ensure safe navigation of shipping through rivers and internal water and around complex land forms into the major shipping ports. As a result, a hydrographic service was created from the civilian agency associated with the pilotage authority and not as an extension of the Navy.[9] The service was designed to regularly survey the dynamic river conditions. As the service gained capability and experience the mandate was extended to the rest of the navigable waters of Canada. Their main mission was to improve the safe navigation of Canadian waters for commercial purposes. Neither a reason nor a mandate to produce products for military purposes or to venture into international or foreign waters existed as their focus was on internal waters. The hydrographic service in Canada was also not created as an extension of the Navy because CHS predates the Royal Canadian Navy who was formed in 1910 and CHS was created in 1904.[10] The minister of Marine and Fisheries, Hon. Raymond

[9] *Ibid*, 74.
[10] William Glover. *Charting Northern Waters: Essays for the Centenary of the Canadian Hydrographic Service*. (Montreal: McGill-Queen's University Press, 2004) 74.

Prefontaine, responsible for creation of the hydrographic service was ambitious and was trying to use the service to create a standing Canadian navy, but his ambitions were never realized.[11] Whereas most hydrographic services were created as an extension of the navy, the Canadian service was created out of civilian agency to support the economic development of Canada instead of purely military demands.

The hydrographic capability of the RCN was never developed as a result of initial demand and support provided by allies. As a result of the initial development of the CHS, the Canadian capability for hydrographic work was never developed in the RCN. The demand for the service from the government was entirely domestic and the civilian service was capable of meeting that demand. When the navy was created it had other priorities and demands for its small numbers of ships and sailors with a large area to cover and as such could not assume a mandate that was now entrenched in another departmental prerogative and protected by statutes. So at its outset the RCN could not delve into the affairs of the hydrographic survey in Canada.

The RCN throughout its history never generated the capability because the demand was being filled by allies and domestic agencies. In the three major conflicts Navy participated in, World War I, World War II, and the Korean War, the allies were able to take on the expeditionary hydrographic demands to support the missions. As a result, the RCN found neither need nor priority to create its own capability. Furthermore, the British Hydrographic Office was able to provide both commercial and military products during non-conflict periods. The RCN did realize that a central agency was required to distribute and maintain the hydrographic and navigational products for the

[11] *Ibid*, 89.

Navy. As a result, Coastal Hydrographic Service Offices (HSOs) were created to meet that need. The HSO solution of using commercial navigation products produced by the Canadian Hydrographic Service for domestic use and United Kingdom and American hydrographic offices met the RCN needs for world-wide coverage. Since the RCN hydrographic demand was mostly met by commercial means and there is no articulated demand for a hydrographic capability, one has not been created. Due to the creation of the civilian hydrographic capability in Canada, and lack of military specific demand from the RCN, naval hydrography was never properly developed but despite historic causes the RCN requires naval hydrography to enable current and future operations.

Hydrographic capabilities have evolved from being a safety of navigation tool for decreasing the number of groundings experienced by shipping to integrated products for both commercial and military use. The Royal Navy used hydrography to improve naval ability for freedom of action, and to enable some its missions. The UKHO evolved to provide world-wide commercial support and at the same time provide military specific products. The Canadian hydrographic capability has developed from a need to provide support to shipping in the St Lawrence and has since provided hydrographic mandate to chart and maintain the charts for navigation throughout Canada's oceans, lakes and rivers. The Royal Canadian Navy has not developed an expeditionary capability because commercial solutions have been adequate for their needs. Events where commercial requirements have not been sufficient have been covered off by the allied capability. The result has been the RCN has not yet developed its own organic capability to acquire hydrographic data and use it for military means because it has not yet needed it. The historical lack of requirement is no longer valid as current operations both domestically

and outside of Canada require more than civilian departments can deliver. Most nations have not had this issue because historically the capability grew out of or was absorbed by navies in other nations the CHS was created strictly for civilian reasons.

2. AID TO DOMESTIC OPERATIONS

Hydrography has grown from a need to prevent groundings and losses of ships, sailors, and cargo in order to improve the commerce of the nations. A Naval Hydrographic capability could aid Environment Canada (EC) in pollution control, Canadian Coast Guard (CCG) in safety of navigation and Canadian Hydrographic Service (CHS) in data collection. Aiding the other government departments in their tasks would help the Navy in the execution of their tasks. Environment Canada has the task of monitoring and preventing pollution at sea and its effects on land. To enable this task, Environment Canada requires an accurate depiction of the land and the maritime environment, including the sea floor and the water-land interface. An implied task of every agent of government is pollution monitoring, control and reporting, so the Navy would be indirectly required to aid. The Department of Fisheries and Oceans has two directorates that are directly responsible for the safety of navigation and hydrography, the Canadian Coast Guard (CCG) and the Canadian Hydrographic Service (CHS). The CCG has responsibility to maintain the navigational routes and for maritime search and rescue. The CHS has the responsibility of maintaining and improving navigational charts. These tasks overlap with the tasks of the Navy. The RCN is directly tasked with the aid of rescue at sea; they also routinely use the navigational passages and have a vested interest in keeping Canadian ports open and safe. Both these tasks are predicated by the requirement of good navigational charts. All these tasks could be aided by naval hydrography.

The Navy has implied tasks that overlap with Environment Canada's responsibilities and as such is obliged to aid in their task. Although not directly

mentioned in the Canada Defense First Strategy, pollution control is every government department's responsibility to report and prevent.[12] Part of the prevention plan is to have an accurate depiction of the Canadian shoreline and the bottom composition of the sea bed. In addition to having an accurate picture of the shoreline, having an accurate survey of the littoral space would aid the Canadian Forces. They would be able to practice the collection of the data to enable an operation in Canada to be used expeditionally. Some may argue that the RCN already has this ability in the Route Survey section its inadequacy will be dealt with in another section. Naval hydrography could aid in creating an accurate navigational surveys in Canada would aid in Environment Canada in their pollution prevention role while exercising the capability in Canada.

The Canadian Coast Guard requires accurate surveys in their tasks and these tasks are similar to the Royal Canadian Navy. The CCG's main roles are maritime search and rescue and maintenance the navigational routes into Canada.[13] In their search and rescue role, they attempt to have ships positioned to be able to respond throughout the vast Canadian waterways. Occasionally, the CCG have requested the aid of the RCN because of the proximity of the ships involved or need for specialized naval capability. The Navy's response to the Swiss Air disaster augmented naval divers due to their large numbers, specialized ability and proximity to a large naval base.[14] However, search and rescue events occasionally occur in waters that have not been surveyed, or inadequately surveyed for ships to respond. The grounding of the Arctic Explorer grounding in largely

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[12] Department of Defence. *Canada First Defence Strategy. (*Ottawa: Canada Communication Group, 2005): 3.

[13] Department of Fisheries and Oceans. "Canadian Coast Guard: Mission," last access on 27 March 2013, http://www.ccg-gcc.gc.ca/eng/CCG/Who_We_Are.

[14] Transport Safety Board of Canada. *Aviation Investigation Report, In-Flight Fire Leading to Collision with Water, Swissair Transport Limited,* (Ottawa: Transportation Safety Board, 2001): 90.

unsurveyed waters demonstrated that even areas near communities and transited by local contain dangerous shoals.[15] Only small and expendable vessels would be able to get close enough to a stricken vessel. This option might not even be infeasible if weather was the cause of the event and the small vessels are unable to approach the vessel. In such a situation, air rescue would also be risky. The other approach would be to conduct a hydrographic survey while approaching the stricken vessel. This would be time consuming difficult to conduct the survey in poor weather. The first two approaches are not necessarily mutually exclusive as both rescue by small boats and surveying may be conducted concurrently. The preference in these scenarios would be to have adequate coverage before an event occurs. This contemporary scenario highlights the risk that ships engaging in search and rescue in unsurveyed waters of which Canada has large area. The only method of mitigating this risk is to have an organic hydrographic capability. Regardless of the method of arriving at a vessel, having a naval hydrographic capability to respond to stricken vessel in an emergency situation is beneficial to the RCN and Canada.

Naval hydrography would also aid the CCG in the maintenance of navigational aids. The CCG maintains navigational aids such as lighthouses, buoys, ranges and markers which improves the navigational safety of all mariners.[16] Currently the RCN currently only aids the coast guard by occasionally reports of navigational aids that are not functioning or out of position. The Navy has been forced to rely on other agencies, contractors when laying or servicing the markers. There is no guarantee of precision

[15] Dave Shipley, "Arctic Rescue," accessed on 27 March 2013, http://www.unb.ca/difference/arcticrescue.html.

[16] Department of Fisheries and Oceans. "Canadian Coast Guard: Aids to Navigation," last access on 27 March 2013, http://www.ccg-gcc.gc.ca/eng/Ccg/atn_Home.

when the navy conducts these tasks themselves because of lack of equipment and expertise. The RCN would gain from placing hydrographically precise navigation markers as a cost savings and the ability to place markers themselves in very remote areas that they are operating in anyway. In the Arctic, navigation markers are few as the cost of placement is high and the net benefit of placement for the betterment of navigation is small. However, there are locations and areas that the navy is greatly invested and would benefit from some navigation aids both domestically and expeditionally. Also there are occasions and areas where civilian placement is impossible due to the risk involved. Such areas include high threats to navigation, namely mine swept channels where the risks of placing the navigation markers are large but also very beneficial. It would also then be as critical to place them as precisely as possible, requiring hydrographically quantifiable precision. One of the ways to prepare for such placement would be to practice in areas of lower risk with the aid of an expert agency, the CCG. This practice would have the added benefit of aiding the maritime infrastructure of Canada. Thus, naval hydrography enables precise placement of navigation markers in Canada.

CHS would gain the most from the Navy having a hydrographic capability. They would gain from the new hydrographical data, they would gain in any specialized processing that the RCN conducts for military purposes, and they would gain alternate platforms that they could use for data collection. When the Navy creates a hydrographic capability, any data in Canada should belong to CHS. The CHS is responsible for Canadian government-owned hydrographic data.[17] There are already agreements in place

[17] Oceans Acts, R.S.C., c.31, s.43 (1996).

for collaboration and cooperation on mutually beneficial hydrographic data collection.[18] One argument against sharing the specialized data collected for military purposes is potential operational security that may be required for such data but the agreements respect each department's special and sensitive needs for any data collected.[19] Another argument against sharing is the data demanded by the Navy is often of a higher quality than required by the International Hydrographic Organization (IHO) for normal navigation.[20] Regardless of data requirements, CHS would benefit from any type of data collection as long as it is to IHO minimum standards. If a data collection plan proposed by either party it may be in each other's interest to obtain a standard that is beneficial to both parties. It would also be useful to fill in any data gaps that may exist and may require either party to slightly alter their survey plan. Any data collection conducted by a naval hydrographic capability in domestic waters would benefit CHS.

CHS would also benefit from any processing the Navy conducted for their own tasks. Although the products may be different and the processing conducted to another standard, the production streams would likely have some overlap and therefore the processed data would mutually benefit.[21] Also hydrographic data storage paradigm has shifted from product specific to generalized data from which multiple products can be created. The multiple products from one source means that CHS, and the military, would greatly benefit from any data processed to the correct format. CARIS systems used by

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[18] Department of Defence. *Memorandum of Understanding between Department of Defence and Department of Fisheries and Oceans regarding the Provision of Service*. (Ottawa: Canada Communication Group, 2011):6.

[19] *Ibid, Annex F Amendment 2, 2.*

[20] Ministry of Defence, *Submarine Dived Navigation: Concept of Operations v 1.0*. (London: Ministry of Defence, 2011): 5.

[21] Department of Defence. *Memorandum of Understanding between Department of Defence and Department of Fisheries and Oceans regarding the Provision of Service*. (Ottawa: Canada Communication Group, 2011):6.

both agencies are optimized for this processing.[22] Unfortunately bringing data into the CHS system does not obligate them to create new products. CHS creates products dependent on a priority scheme that may not benefit the Navy. The data, however, would be verified against existing data sets to ensure that there are not any great safety discrepancies. Also since the data set would be in their data base, other users would be able to use the data for other products not just navigation charts. Finally, CHS will eventually incorporate the data set into the chart when a new edition of a product is warranted. So CHS would be able to benefit from any data set collected to their standards and any collector, including the Navy, would eventually benefit from CHS having the data.

The RCN would benefit from creation of a hydrographic capability and collaboration with CHS domestically by leveraging their expertise in data collection, data storage and data representation or chart creation. This collaboration would enable the Navy to apply skills outside CHS' mandate. CHS would also be able to impart valuable lessons on methods and operating procedures as well as equipment procurement advice for data collection. Hydrographers are very specialized in their skill set. Very few people in Canada outside of CHS have the requisite qualifications because there are few institutions in Canada deliver training to the level required for the IHO. Any individual or organization wanting to train in hydrography would be forced to send candidates to a foreign university or a foreign naval training plan. CHS is capable of providing advice on

[22] CARIS, "Bathy DataBASE," accessed on 27 Mar 2013, http://www.caris.com/downloads/brochures/BathyDataBase-en.pdf.

training and they have an integrated on-the-job training program in their organization.[23] The RCN would be able to leverage both their training plan and the program that CHS employees partake. This type of training would be a significant investment in an individual as it often requires years of practice. One flaw in a standard training course is that hydrographers are trained in data acquisition and cartographers are trained in data portrayal and the Navy would require both to produce their own products. The advantage of the CHS system is that they produce employees that can do both.[24] CHS will be able to provide the RCN valuable advice as what training would best fit.

CHS is the Canadian government's experts on hydrography and as such they would be best placed to advise on equipment procurement. If the Navy is to generate a hydrographic capability, it would need both expertise and equipment. It would be cost prohibitive to experiment and conduct extensive testing for a naval equipment package. What type of an equipment solution that fits the Navy needs is debatable; but, CHS is capable of providing advice. They would be able to provide objective advice on what systems would be able to better integrate with CHS systems. They would also be able to ensure that whatever system the Navy procures would meet IHO standards and therefore would generate navigationally legal data. There are two potential issues on having another government agency procure equipment for the Navy. First, they might not provide the most cost effective systems that meet the requirement, and advise purchasing the best system available since it is not their budget. Second, they may advise the Navy to procure an untried system and use the Navy to test a system that CHS is interested in

[23] Department of Fisheries and Oceans, "Training Multi-Disciplinary Hydrographers at the Canadian Hydrographic Service," accessed on 8 March 2013, http://www.dfo-mpo.gc.ca/science/publications/article/2011/08-23-11-eng.html.

[24] *Ibid.*

procuring. The only way to protect the Navy from potential CHS abuse is to have its own educated oversight and requirements cell to ensure that the Navy gets what it needs and not what CHS wants. Regardless of potential CHS abuse, they still are the Canadian experts and therefore best placed to provide advice on what the Navy should procure.

After data has been collected, CHS could advise the Navy on both data storage and portrayal. Having a collection of data is useless to end users. The data must be discoverable and it must be able to be portrayed or created into products demanded by users. CHS has a robust process to clean, store and portray the data. There are several options that the Navy could pursue and CHS could advise the Navy in how to setup an appropriate system. First, the navy could process the data themselves, second CHS could possibly process the data that the Navy has collected or third, data processing could be conducted by a contractor. If CHS helps the Navy to create a process, then the Navy would need more people. The number of people would depend on how much data was being collected and the desired processing rate. Although CHS has excellent processing capability, if CHS processed the data for the Navy, there are potential issues. First CHS already has difficulty in processing the data that they already have so if more data is being processed then CHS would want more resources. Second, CHS has its own priority system and naval data may be in areas that have a lower priority for them. Third, CHS may not want to store or process the data obtained outside Canadian waters. Fourth, the Navy may collect data that is of a sensitive nature either due to the source or the area in which it was collected meaning CHS would be incapable of processing. So CHS may not be the solution for storage or processing. If the RCN used a contractor to process the data, it would face a couple of issues as well. Contractors would have similar issues about the

sensitivity of data being processed; however, the overall cost may be effective. The solution may be to a mix of the solutions between self-processing, CHS processing or having a contractor process dependent on priority and data type. Regardless on method of processing, CHS would be able to aid the Navy in creating a data flow for processing hydrographic data. They would also advise on what type of work and what contractors could be used. In creation of a naval hydrographic capability in the Navy, CHS would be able to aid the Navy in creation of the processing system.

CHS would benefit from data sharing, but also increase the hydrographic capacity in the Canadian Government as CHS is struggling to meet its stated objectives. There would be a large amount of effort to have CHS experts help the RCN in training, equipment, and experience. The Navy would be very reliant on CHS during the start-up phases of introducing this new capability. The major payoff for CHS would be more platforms collecting data in remote areas. The largest gain would be any data collection that occurs in the Arctic which is an area that is very expensive to get private contractors to provide platforms. This area lacks in modern data and is increasingly important to naval operations.[25] Lack of data in the Arctic severely limits potential patrol areas. So although CHS has the domestic lead in hydrography, it would be mutually beneficial to both departments to work together to improve the capability on Naval ships. Although it would be outside of the mandate of the RCN to directly conduct surveys, collaborative surveys would aid everyone safety.

[25] Department of National Defence, *Leadmark: The Navy's Strategy for 2020* (Ottawa: DND Canada, 2002), 2

Hydrographic capability allows the Navy to meet the requirements of the Canada First Defense Strategy with enabling the defense of Canada and support to operations outside of Canada. [26] Hydrographic surveying is among the historical methods of ensuring sovereignty. If a nation can more accurately describe their own territory they would be able to exert control over it. Surveying is also a method to demonstrate ownership of remote and isolated regions. In addition, creating surveys of an area is the maritime version of improving the infrastructure of an area. Secondly, hydrographic surveying enables operation outside of Canada whether that is in direct support of operations or in strategic capacity building of nation. So while it may be beneficial if the Navy aided the other government department it would also be in direct support of its task in the Canada First Defense Strategy.

As the navy does not have the lead for domestic for hydrographic data collection there are a number of departments that would benefit from a naval capability. Environment Canada would benefit from an improved picture of the water depth in its role for pollution control. The Navy would gain as a responsible department taking reasonable steps to prevent and report pollution violations. The CCG would benefit by having improved navigation charts for Search and Rescue and the ability for the Navy to help with Navigational aids. The Navy would also gain from the improved charts for search and rescue and they would learn how to precisely place their own navigational aids. The greatest interdepartmental aid would be with CHS. They would gain from the increased data that the Navy would obtain. CHS would obtain data in areas that are not necessarily their priority, but would likely be in areas that they would need modern data.

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[26] Department of National Defence, *Canada First Defence Strategy* (Ottawa: DND Canada, 2006): 7.

The Navy would gain from the relationship in the expertise for hydrographic equipment procurement. CHS would be able to provide advice on the data processing work flows and data storage that would best enable sharing. The Navy would be able to gain from the training systems that CHS has in place for both their hydrographers and for their cartographers. This collaboration with other government departments may seem to be duplicating work, but the navy is the only department which can assume risk for domestic operations and is the only department which regularly acts for the government outside of Canada. The navy lacks the skills to conduct hydrographic operations and can most easily achieve them by close cooperation with other governemental experts. Also when the RCN gains this capability it would be prudent to practice and exercise this capability in a manner that is useful to the rest of Canada. Other government departments would gain by the Navy directly aids their tasks. Canada would benefit economically as improved navigational charts are a major part of the infrastructure required for marine shipping and resource extraction.

3. DISASTER SUPPORT

Supporting others in times of great need is among of the characteristics that define a person or a nation. Naval hydrography is critical in aiding coastal nations that have been afflicted by hurricanes, earthquakes and tsunamis. The nature of the support is in the immediate opening of ports and coastal approaches to ships bringing aid with the long term goal being the re-establishment of the maritime infrastructure. Recent events over the last decade have proven the need for a hydrographic capability. Events include Hurricane Katrina which devastated the New Orleans region in 2005, the earthquake in Haiti in 2009, and the Japanese earthquake and the tsunami of 2011 with each causing widespread destruction along the coastlines. All these horrible situations caused widespread human suffering with which the world struggled to help. Immediate response was hampered by the lack of airports facilities or their limited availability. Despite the air response that most nations were able to provide, longer and more substantial aid would come via sea due to the amount of supply that ships can provide. In large affected areas such as Haiti or in Japan, it becomes more difficult to support more remote areas as they tend to be further away from the airports and roadways connecting the towns and villages are often destroyed. For such reasons, world response becomes more efficient and effective if substantial aid arrives by sea. The only way to verify the safety of the seaborne routes is to have a hydrographic survey completed. Without the survey, ships risk grounding causing issues vice solving them.

Hurricane Katrina caused massive devastation to the New Orleans region overwhelming local emergency response. Aid was slow in arriving and not focused on

the needy.[27] Efforts were ineffective due to a lack of understanding on how much suffering was occurring. Support was complicated due to the levees in the town failing and large swaths of the city being flooded by the ocean and the Mississippi river. Thus the scope of the aid required was underestimated. Due to the widespread destruction leading into the city, the quickest response to the area was by tactical helicopters. The best sustained effort was by ships that were able to approach the coastline, but within limits. Harbour facilities were destroyed and any seaborne support would have to come from ships anchored a significant distance and support would have to be brought by landing craft and smaller boats.[28] The type of support would then be limited to what could be transported. One of the main advantages of ship support is the vast amount of supplies that can be transported, but if the supplies cannot be brought directly to the shore, then that advantage is partially negated. Ships were unable to dock and off load supplies because the facilities were destroyed, and the approaches to the harbour were unnavigable.[29] The devastation was exacerbated by an inability to provide meaningful support.

Immediate hydrographic surveys of the New Orleans area helped mitigate the length of the suffering. Since the hurricane caused the water levels to significantly rise, large amounts of debris and silt deposited throughout the Mississippi delta. In addition to the unknown amount of silt, the waterways were altered. Since the levees had been breached in several areas, the flooded areas would not have been surveyed for water

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[27] Executive Office of the President of the United States Office of Homeland Security. *The Federal Response to Hurricane Katrina Lessons Learned*, (Washington, DC Government Printing Office, 2006) accessed on 13 February 2013 http://library.stmarytx.edu/acadlib/edocs/katrinawh.pdf. :48.
[28] *Ibid,* 34.
[29] *Ibid,* 34.

navigation.[30] It is unlikely that larger vessels with significant drafts would be able to enter flooded areas; even small craft would be susceptible to damage caused by grounding on objects. All these events caused significant risks to navigating ships. A hydrographic survey would allow larger ships to approach the city so that they may be able to dock or at least shorten the distance that the landing craft would have to travel. The disadvantage to rapid surveying of the affected areas is that as the water from the hurricane recedes, the areas would have to be resurveyed to verify the accuracy of the information. In the end, hydrography would enable to disaster relief ships to approach the city to more effectively provide aid and the United States Navy provided support by rescuing victims and supplying communities with necessities.

The American fleet survey teams provided support to the disaster relief effort. The teams were able to provide rapid hydrographic surveys of the area so that ships could safely operate in the areas.[31] They were able to create corridors of safe transit zones and then create a more detailed survey in support of the relief efforts. One of the main reasons for the rapid support for this effort was the non-domestic fleet support teams are based at the Stennis Space Center in Mississippi. As a result, the response to reopen the port and the local anchorages was immediate and effective. Although any domestic survey capability could have responded to the Hurricane, foreign aid into the area proceeding by sea would have been hampered by the inability to proceed close to the affected areas. Even though United States Navy hydrographic response was rapid and effective, their priority may not have been the most effective in enabling non US support.

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[30] *Ibid*, 6

[31] Debbie Ethridge. "NOAA Ship Thomas Jefferson Aids Hurricane Katrina Relief Efforts," *NOAA Magazine*, 15 October 2005. http://www.magazine.noaa.gov/stories/mag181b.htm.

Regardless, the RCN could have enabled its own support of the response if it was able to survey for its own ends. Canadians are infrequently affected by hurricanes and the destruction caused rarely requires hydrographic responses, but Canada can be expected to respond to hurricane events worldwide in the future and a hydrographic capability is critical to that aid. The widespread coastal damage would also have meant that if aid was required away from the major centers then any seaborne support would have to have its own survey. American response to the disaster shows that a hydrographic capability responsive to disaster events enabled the relief effort.

The earthquake in Haiti in 2010 caused widespread devastation to an already struggling country. The country suffered a 7.0 level quake centered near the capitol of Port au Prince.[32] The immediate destruction of most of buildings left many trapped by the rubble. The situation was further exacerbated by the total immolation of most of the basic services including sewage, water and shelter. There was already an international mission on the island run by United Nations who was supporting the local government, but the main headquarters was destroyed killing the head of the mission.[33] Immediate response was centered on the capitol and supported by the airport. Most of the islands road communication network was destroyed by the earthquake which made it difficult or impossible to provide assistance to outlying communities as the support had to arrive by airlift into the capitol and then distributed.[34] The lack of aid delivered to communities

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[32] CNN, "Try to prevent the 'Absolute Catastrophic' Situation in Haiti" *CNN World,* 10 January 2010, accessed on 13 Feb 2013, http://www.cnn.com/2010/WORLD/americas/01/14/haiti.relief.efforts/index.html?hpt=T1

[33] United Nations, "Earthquake in Haiti: Facts and Figures,: accessed on March 8, 2013, http://www.un.org/en/peacekeeping/missions/minustah/memoriam.shtml.

[34] Ned Potter. "Haiti's Earthquake Relief Begins: Thousands Feared Dead," *ABC News* 13 Jan 2010, accessed on 8 March 2013, http://abcnews.go.com/Technology/HaitiEarthquake/haiti-earthquake-relief-efforts-begin-thousands-feared-dead/story?id=9547609.

without airfields demonstrates some concerns about relying on airlift only to provide support. The only methods would be to try to repair some of the road network or find another method of supplying aid. The earthquake was devastating to an already struggling country and aid was centered initially on the capitol.

Aid to the equally devastated country side could only be delivered by methods other than airlift into the capitol city. The methods would include transporting aid from the neighboring country, Dominican Republic who was also dealing with the effects of the earthquake. Helicopters could provide support into the country and support could be provided to the coastal communities by sea. The coastal communities had most of their infrastructure destroyed including maritime infrastructure making receiving large aid ships impossible. In addition, it would be unsafe for vessels of any size to approach a shoreline affected by an earthquake until another survey was completed or the ships would in in risk of grounding. Also major support would have to arrive into the capitol city by sea as the airlift could not support the requirements of the population. An earthquake would not cause debris to litter the navigational passages but shifts in the seafloor could have occurred and could have drastically altered the waterway. Support to disaster relief would require a new survey before meaningful aid could be delivered by sea.

Support to the relief effort included deployment of the American Fleet Survey Teams. Their aim was to open corridors to ports and areas where support would be delivered by sea. Their priority was the capitol region as that was the location of both the widest devastation and largest populations needing aid. Their ships included a mobile

hydrographic capacity and a salvage ship to remove any debris. They then proceeded to other areas to support the efforts of other nations providing aid. Haiti still requires its own hydrographic capability to enable their economy but the emergency work that the United States Navy provided mitigated the disaster. Earthquakes outside of Canada cause damage that may require a hydrographic response. Canada can learn and replicate the US response to this disaster in the methods and capability that they provided. With a hydrographic capability, Canada could contribute in similar ways. Their efforts enabled support groups to provide much needed aid and certainly reduced the suffering of the Haitian people.[35]

The Japanese 9.03 earthquake and the resulting tsunami in 2011 also caused widespread destruction along mostly remote northern towns. The tsunami was at its height 40m and traveled up to 10km inland in some areas.[36] The tsunami resulted in more damage and casualties than the actual earthquake. There were numerous buildings destroyed and damaged, and the road and rail infrastructure linking these communities was severely disabled.[37] The human and economic toll was one of the worst in recorded human history. There were many complicating events including nuclear meltdowns at the local power plant. Numerous commercial and fishing ports were damaged and closed following the tsunami.[38] The domestic and international humanitarian response was rapid but the widespread nature of the event meant that aid was uneven in distribution. Since

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[35] Brian Connan. "Hydrographic Response to Haiti Earthquake" http://www.hydro-international.com/issues/articles/id1192-Hydrographic_Response_to_Haiti_Earthquake.html 13 Feb 2013.
[36] Roland Burke. "Japan earthquake: Tsunami hits North East." *BBC World News* 11March 2011.
[37] *Ibid.*
[38] John Ydstie. "Japan's Fishing Industry Crushed by Tsunami." *NPR* 29 March 2011.

this was a coastal disaster the easiest method of providing massive aid to the affected communities was by sea or air.

The Japanese hydrographic response was required because of large amounts of debris, silting, and the seafloor shifting. Japan has a robust hydrographic capability to service its own coastline to improve navigational routing. Their hydrographic teams worked diligently to open the coastal communities as rapidly and as safely as possible.[39] They focused on creating a route into the port and not on surveying the entire waterfront. They had the ability to open their own ports and did not require foreign assistance was a fortunate circumstance because their own vessels were not destroyed in the tsunami. The Japanese efforts prompted them to propose to the International Hydrographic Organization that in the event of a disaster affecting a coastal community then the International Community would be obliged to aid.[40] Their proposal recognized the need for timely hydrographic surveys to reopen the communities safely to the marine traffic. Again having the ability to provide a hydrographic response to a disaster is a precursor to providing effective long term aid. Earthquakes and tsunamis are a significant threat to the West Coast of British Columbia. Communities in BC would be affected in similar fashion to those in Japan and the Japanese response is a valuable lesson for other coastal nations. The Japanese hydrographic organization was able to reduce suffering by enabling aid to be safely delivered to the affected communities.

To support disaster support operations requires the RCN to have a hydrographic capability. The RCN requires the capability to support the foreign and domestic relief

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[39] Arata Sengoku and Jun Saegusa. "Hydrography after Huge Earthquakes."*Hydro-International* 15, no. 5 (September October 2011): http://www.hydro-international.com/issues/articles/id1293-Hydrography_After_Huge_Earthquakes.html.

[40] International Hydrographic Organization. *IHO Response to Disasters*. (Monaco: IHO, 2005).

efforts in coastal communities. Domestically the capability would enable the Navy to support the efforts of the CHS in the event that they would be overwhelmed by the need or they are unable to proceed to the affected areas. Expeditionally, the RCN would be the only government department that would be equipped to support. It is not inconceivable that CHS could support an operation but currently there is no mechanism or facility for them to participate. Part of the mandate defined in the Canada First Defense Act is to support operations in the areas demanded by the Canadian Government.[41] The government has focused on the Americas region and operations in that region would likely require disaster support in the future from either hurricane or earthquakes. It is likely that the government will demand that the Canadian Forces support disaster relief operation. In order to enable that support, the RCN requires a hydrographic capability to safely open the affected areas to marine traffic. The navy requires the capability to support disaster relief.

Natural disasters will continue to affect populations along the coastal regions in devastating ways. As populations get denser along the coastal areas the impact of those disasters will become greater. The USN supported the relief to gulf region affected by Hurricane Katarina and the earthquake in Haiti by having ships and mobile teams deploy to the region and safely to allow access to the ports and the affected regions. The Japanese were able to open their own communities from their own national capabilities after the earthquake and resulting tsunami. All these events affected a large region and adversely affected the land communication systems. Loss of the communication network

[41] Department of Defence. *Canada First Defence Strategy. (*Ottawa: Canada Communication Group, 2005): 3.

meant that immediate relief and support could only arrive via the air or via the sea. Air relief would only be able to support the immediate area surrounding viable airfields and the amount of supplies and equipment that could arrive is limited to the type of aircraft available. Relief from sea would be more substantial but require safely opening the port. As a result, the hydrographic capability is required to support the sustained relief operations. The RCN requires the capability to open marine access to affected areas as an expedient to providing aid. Without hydrography the RCN would be unable to safely bring substantial aid ashore. Without the organic hydrographic support the RCN would have to rely on other agencies. The RCN is the best government department to provide that expeditionary relief and support enabled by hydrography.

4. SUPPORT TO MILITARY OPERATIONS

Hydrographic capabilities over time have evolved for safe surface navigation. Military hydrographic requirements require greater precision than that which is required for surface navigation and particular to specific operations. A naval hydrographic capability critically enables military operations by improving oceanography, rapid assessment of the environment for operations, and to fulfill the unique requirements demand by submarine littoral operations. To meet emerging requirements and obligation to Canadian Allies there is equipment, processing and training deficiency in the RCN. Hydrography enables operations in both scope and freedom of maneouvre for when the RCN goes inshore, it needs some ability to exploit the sea space and interface with the land environment. The more command understands about the water space, the more he is able to exploit the limits without taking excessive risk. Hydrography adds to the information superiority by enabling operations the enemy cannot respond to. Current capabilities in the RCN include a route survey and oceanography section. Hydrography can help enable operations by improving understanding of the ocean. Although oceanography is a separate discipline from hydrography, there are mutual technologies and data that both users can exploit. Route survey is concerned with identifying sea mines and establishing a safe passage though the infected water spaces. Future operations such as amphibious submarine operations require detailed knowledge of the littoral water space.

There is a deficiency between what capability the RCN has and what it needs to complete its tasks requiring the development of a hydrographic capability. The RCN hydrographic capability includes side scan sonars, and echo sounders recording devices.

The side scan sonars are operated by the Route Survey sections. They were developed to provide a method for naval ships, MCDVs, to accurately depict the ocean floor in an attempt to discover sea and ground mines. The systems were designed as a critical angle tow fish which flies within close proximity of the ocean floor.[42] This system is susceptible to seafloor collisions when there is a rapid decrease in the depth of water. The preferred operating area of these devices is in well surveyed waters so that seafloor elevation changes are predictable to the operators. The images captured by these devices are very fine as they were designed to detect mine like objects placed on the seafloor. The operators can then compare the previous images to determine if new objects have been placed.[43] Side scan survey equipment, unless it is a hybrid device, does not give accurate positional or depth data and is therefore of negligible use to hydrography. The tow fish is pulled by a cable at a difficult to ascertain angle and cannot verify its position relative to a survey quality GPS on ship. As a result the horizontal and vertical data is not within tolerances for hydrographic work.[44] Therefore, the side scan sonars operated by the RCN cannot be used for hydrographic purposes in most circumstances.

The other piece of equipment that navies operate with potential use for hydrography is the ship echo sounder. For centuries hydrographic ships used a line weighted by lead to determine the depth and obtained spot soundings with reliability. An echo sounder is used for similar purposes. To be effective, RCN echo sounders would have to be modified to be able to log data. To be accurate enough for survey quality, the

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[42] Department of Defence. "Canada Invests in Sonar Technology for the Royal Canadian Navy." news release, 2 November 2012, http://www.forces.gc.ca/site/news-nouvelles/news-nouvelles-eng.asp?id=4483.
[43] Department of Defence. *CFCD 126: Standard Operating Procedures for Mine Countermeasures and Underwater System Payloads and Equipment. (*Ottawa: Canada Communication Group, 2006): 4-1.
[44] International Hydrographic Organization. *Manual of Hydrography*. (Monaco: IHO, 2005): 10.

data logging device would have to have same time sampling of the pitch and roll of the ship in addition to a GPS stamp for horizontal positioning. So although ships could currently log the positional and depth, it would not achieve the requirements for actual survey work.[45] Also the echo sounders equipped on naval ships are optimized for surface navigation and missing the automatic features essential for accurate depth. One could have an operator constantly adjust the echo sounder in order to obtain good data, that method is inefficient and prone to human error. Finally, use of echo sounders as hydrographic devices would be ad hoc, ineffective and not meet the IHO standards for surface navigation. Also echo sounder use would also not meet the military requirement of an IHO special order survey.[46] Therefore the data would be of limited use and it would also require the ship to survey on strict lines to achieve any area coverage. What is being attempted for naval operations is the use of a data logging device called OLYX which is designed to be used as a crowd sourcing hydrographic device.[47] This device would be useful in areas where there is moderate traffic but poor coverage, such as areas frequented by fishing vessels. Each vessel would contribute to the survey over time. This crowd sourcing method is a cost effective for improving the navigation picture that might prove effective in the Arctic. The issue with it is that the vessels would not be following any survey plan and improvements in the survey could be exasperatingly slow and not methodical. The RCN hull mounted echo sounder is inefficient and ineffective as a hydrographic tool.

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[45] *Ibid:* 10.
[46] *Ibid:* 10.
[47] Department of Defence. *Memorandum of Understanding between Department of Defence and Department of Fisheries and Oceans regarding the Provision of Service*. (Ottawa: Canada Communication Group, 2011): Annex F Amendment 2 page 1.

The Navy has two methods of obtaining hydrographic data, but these methods are insufficient for the requirements of allies. The NATO Rapid Environmental Assessment, REA, asks nations to state what type of data is available in a given operational area in the event that a NATO Naval operation could take place.[48] If there is insufficient data and operation still needs to occur, then the nations are expected to provide methods of obtaining the required data. Canada would be unable to meet either of these requirements. The RCN has no method to obtain data in an expeditionary realm and in addition to this it has no foreign data that it could contribute to the alliance. Although the point of the alliance is to share capability, Canada has nothing to offer. As a result, during any expeditionary operation Canadian naval units are at the mercy of how much data other nations are willing to share. If Canada either joins a non-NATO mission or conducts operations for national reasons then there is a significant gap in products available. The RCN has a capability deficiency between what it can contribute to NATO operations and what would be expected meaning that the RCN may be denied military specific product and forced to rely on suboptimal commercial sources.

There is gap in naval product demands in domestic operating areas. Although, CHS is willing to share most data in Canada, there are often large gaps in the data types that are available. These data gaps affect both training and operations. Since CHS works on a priority system for data acquisition focusing on major shipping areas these are often not the areas that are of interest to the RCN. These areas are typically practice areas and littoral zones that are near the practice zones. The Navy often tries to choose areas that

[48] Brian G Whitehouse, and Paris Vachon, Andrew Thomas, Robert Quinn, Wayne Renaud. "Rapid Environmental Survey of the Maritime Battlespace," *Canadian Military Journal,* (Spring 2006): 66.

are near bases but away from high traffic areas and these areas are rarely CHS priority areas. The Navy could pay for the areas that are of interest to them, but these areas would be excellent hydrographic practice areas to hone skills prior to obtaining data outside the domestic context. The Navy does not have the ability to contribute hydrographic data or products to NATO as required by the REA. The Navy has no direct ability to improve the products in areas where they practice. The result is that the Navy requires a hydrographic capability to support military operations and improve both the ability to produce military catered charts and operate with the enhanced product.

In addition to lacking the ability to aid allies in producing data and products for catered operations, demand for military specific products has different data demands from civilian surface navigation. The prime applications for naval hydrography are for oceanography and littoral and submarine operations. Oceanography is the branch of Earth science that studies the ocean. It covers a wide range of topics, including marine organisms and ecosystem dynamics; ocean currents, waves, and geophysical fluid dynamics; plate tectonics and the geology of the sea floor; and fluxes of various chemical substances and physical properties within the ocean and across its boundaries. The military applications for oceanography extend to understanding the environment in which ships operate. A critical part of effective understanding of how the ocean operates is the physical depiction of the sea floor. Hydrographic processing techniques can also determine the bottom type. As a result, hydrography builds the general oceanographic picture. Oceanographers require more data to complete the picture and aid the military operations. So while hydrography would be able to support oceanography, it can more directly support military operations.

After the support requirements, naval hydrography would also be able to support surface navigation. In areas of the world where surveys are poor, there will still be a requirement to operate. Currently operations are occurring in the Caribbean where ships are tracking and boarding vessels suspected of running drugs.[49] There are areas where the operational commander would like ships to operate but since surveys in the area are poor would entail unreasonable risk. These areas can include waterways outside of the territorial waters which would make it legal to survey without infringing on the sovereignty of the coastal nation. In addition to the aiding surface navigation operations, hydrographic surveys would be one area where the navy could help a coastal nation with infrastructure. The surveying of navigational approaches to ports is an enabler for that port to open. An open port would be able to aid the harbour city in becoming more economically viable as few commercial ships would approach an unsurveyed port.[50] Without an organic capability of obtaining hydrographic data, the navy would not be able to contribute to opening areas of operation and the navy would not be able to help a coastal nation in improving the potential economic viability. As a result, the navy requires hydrographic capability to accomplish any of these potential tasks. After helping improve the operating area of the naval forces, hydrography would directly aid in military operations such as amphibious landings.

Naval hydrography is used to enable effective amphibious operations. Although Canada does not have the capability to conduct amphibious operations on a large scale, the RCN can conduct small boat operations for basic insertion and extraction. The RCN

[49] Paul Forget. "Law Enforcement Detachments and the Canadian Navy: A New Counter-Drug Capability" *Canadian Naval Review* 7, no. 2 (Summer 2011): 4.
[50] International Hydrographic Organization. *The Need for Hydrographic Services*. (Monaco: IHO, 2011): 10.

could also use this capability to support amphibious operations if the capability was ever acquired. Naval hydrography is critical to support these operations because knowing the depths of water in the littoral space of enemy waters is crucial in both the planning and execution of an assault. The presence of shoals and slope data of the beaches or landing sites would be able to prevent the boats from grounding away from the objective beaches. Having the ability to survey the area prior to an insertion or extraction would aid in minimizing that risk. Often the countries where the amphibious operations occur have poor littoral surface charts and the risk of insertion would be increased and compounded by the presence of sea mines. Also if ship's boats are being used to conduct the operation, only a limited number of boats are available meaning that loss of a single boat could seriously affect the mission and operational capability of the ship. This situation means that the risk due to grounding will be higher than a normal amphibious operation. Naval hydrography would be used to help minimize the risk and support further operations. Although naval hydrography would be used to support a possible capability, the submarine community requires the capability immediately.

The greatest need for naval hydrography comes from the submarine community. Navigation under water is determined by numerous factors. Submarines have a requirement to understand the environment in 3 dimensions. When a submarine transits underwater their positional accuracy degrades overtime because of the lack of precise updated positional information from any source including GPS. As a result a submarine generates an expanding area of probability where it could exist based on their last known position and their movement. In littoral areas this area becomes rapidly dangerous as it begins to include shoaling areas. In June 2011, HMCS CORNERBROOK ran aground in

Nootka Sound while conducting littoral operations. While the Board of Inquiry found the human error to be the cause, it highlights that navigating underwater in confined waters is dangerous.[51] To mitigate and the risk, this area of probability can be reduced by several methods. The most accurate method for a submarine to re-establish its position would be to surface and obtain an exact GPS position. The next couple of methods of reducing the area of probability is either to visually sight a known object and get its true bearing, or determine the distance based on its height.[52] All these methods expose the submarine to detection as they would need to have a mast above the surface in addition to being near the surface and in a water column known to the submarine hunting units. In the open ocean a submarine position is less critical as there are often less navigational dangers which may affect the submarine but there is never any certainty until an accurate survey is completed. In littoral waters near the coast, having a precise position is critical for safe navigation. The most effective method of reducing the expanding positional error without being detected is to have hyper accurate bottom contour charts.

Bottom contour charts allow the submarine to remain underwater and still reduce the expanding positional area and minimize the risk of grounding. By knowing the total depth of water column and comparing that depth against a chart, a submarine will be able to eliminate depth areas where there is no match. This awareness can only be accomplished if there is sufficient hydrographic data and the data has been processed for submarine operations. The difference between surface navigational charts and submarine

[51] Royal Canadian Navy, "HMCS CORNER BROOK Grounding Incident: Board of Inquiry Complete," accessed on 6 April 2013, http://www.navy.forces.gc.ca/marpac/4/4-w_eng.asp?id=1158.

prepared charts is the number and frequency of contours displayed. The IHO has minimum standards for the number and type of contours required to be displayed on charts but they become less frequent after 20m.[53] A surface navigational chart may also have a 50m and a 100m contour. However, the type of data collected becomes less precise after 20m even with the most accurate type of survey methods.[54] This is not an indictment of the hydrographic community; they simply have a focus on surface navigation with ship of draughts less than 20m. An underwater submarine routinely navigates in in water where their draught can be assumed to be more than 50m. This disparity creates specific hydrographic requirements for submarines that exceed that of surface navigation. As a result, the data and the processing focused on surface navigation and therefore is insufficient for submarine navigation.

Naval hydrography would therefore bridge the gap from what is required for surface navigation and what a submariner requires to safely navigate. Naval hydrography would be required to obtain similar data as that which is required for surface ships to a much greater depth. Although the technology exists to obtain this type of data, new standards and procedures would have to be adopted.[55] A submarine chart would be required to be processed to a different standard. The chart would likely have to have a depth contour every 2m. In addition, the existence of these charts in littoral water would be an indicator that submarines operate in the area, so charts would have to be classified especially if the charts are outside of Canadian territorial waters. The main use of specialized charts inside of Canada would be to train the submarine crews both in the use

[53] International Hydrographic Organization. *Regulations of the IHO for International Charts and Chart Specifications of the IHO*. (Monaco: IHO, 2012): Annex B, 3.
[54] International Hydrographic Organization. *Manual of Hydrography*. (Monaco: IHO, 2005): 10.
[55] United Kingdom. Ministry of Defence, *Submarine Dived Navigation: Concept of Operations v 1.0*. (London: Ministry of Defence, 2011): 25.

of the charts and in bottom contour navigation. Hydrographic Service Offices have already created a small set of these charts both to fill a need demanded by the submarine community and as proof that the office could create the product. The main issue on creating more products is lack of adequate data in the areas demanded by the submarine community. As soon as the submarines start to deploy away from Canada, they will start demanding better charts. The only way to acquire the data that they would require would be if the RCN acquired it themselves. The best way to support their needs would be if the RCN had a hydrographic capability. Without the capability submarines would be assuming higher risk navigating especially outside of Canadian waters. As a result the submarine community will require naval hydrography to produce products to enhance their capabilities and reduce the risk of their operations.

Naval hydrography would fill the deficiency between what data and products are available for commercial consumption and specific uses demanded by the military. The gaps in what is available and what is required include data for oceanographers, ability to improve the surface navigational picture, aid to coastal nations, and support to amphibious operations and submarine operations. To fill this deficiency, the RCN has a very limited and deficient ability to collect the data and produce the products that are required for the consumption of the navy. The RCN's ability is limited by lack of equipment and the lack of expertise in acquiring data. The HSOs have some expertise in preparing and processing the data but its capacity is limited. In addition to being unable to acquire data for Canadian use, the RCN will be unable to share in any of the data that our allies acquire as we will have nothing to offer them in support. The allies may be able to aid in providing expertise, but having the data to share is the critical in the exchange.

With a lack of data to share, the RCN may not be able to participate in data sharing during critical operations or operations that may be important to only Canada, but not our allies. Having a naval hydrographic capability would enable support data requirements demanded by oceanographers. A hydrographic capability would be able to support any amphibious operations that may be required even if the operation is small, such as required for a ship's boat, or on a larger scale as demanded from a more robust assault. The main beneficiary of naval hydrography would be the submarine community. They would be able to vastly improve their capability by improving the areas that they could operate and do so more safely. Naval hydrography would be the only method of providing the data and the processing to the submarine force because of the unique data requirements and the specialized processing required. The demands of non-domestic littoral areas that submarines would be operating would only be able to be filled by a naval hydrographic capability. The security required based on of where the submarine could operate could only be assured by having the military control the entire process. The requirement to support the submarine is real and immediate and it would greatly reduce the risk to the boats for navigation and would at the same time improve their operational performance. Thus the requirement for development of a naval hydrography capability is both real and necessary.

5. HYDROGRAPHIC COMPARISIONS

Most coastal nations have naval hydrographic capabilities. The RCN requires its own hydrographic capability in order to conduct current operations and to meet future requirements. By comparing what capabilities that allies have will show a similar capacity and capability that the RCN should acquire to meet this need. The United States navy (USN) and the Royal Navy (RN), have a robust capability to meet their national requirements especially for their nuclear submarine operations. The Royal Australian Navy (RAN) is responsible for the national hydrographic requirements and also fills the military operational requirements. They also have a submarine fleet which requires specialty products. The Royal New Zealand Navy does not have a submarine fleet to support, but their navy has retained a hydrographic capability to support specific naval operations.

The USN is responsible for all hydrographic demands for their deployed forces. They have significant capability to acquire data and provide the charts in a variety of user demanded formats. They have hydrographic ships capable of both deep water and inshore surveys.[56] They hydrographic ships carry launches which allow them to multiply the area that a single ship can cover in a single day. The US Forces also have Light Detection and Ranging (LIDAR) mounted on aircraft to allowing rapid surveying of shallow water. They also have "fly away" kits which allow for a portable multi-beam system to be mounted on virtually any small boat. The kits allow for a very rapid survey to be completed almost anywhere in the world. This system was employed in Haiti after the

[56] Delgado R.R. "Fleet Survey Team: Providing Operational Hydrography to the U.S. Forces" http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA527615 Feb 12

earthquake to attempt to rapidly open the capitol city.[57] They conduct surveys of waters as part of the nation building, to enable future amphibious operations, and to allow their submarine fleet to safely navigate under water. All of this capability does not include any of the federal resources that maintain the domestic navigable waters. The USN has a very robust hydrographic capability to enable and sustain their maritime fleet that would be beyond the resources and demands of the RCN.

The Royal Navy has historically conducted the majority of the initial surveys throughout the world and as such continues to maintain a fleet. They have a maritime nation whose wealth depended on the safe movement of trade between nations. The UKHO and the RN, provide data for products that service their operational needs including amphibious landing charts and specialize navigational products. On the civilian side, their current focuses have been to chart waters of coastal nations whom they some governance responsibility. They also survey places that require some capacity building to improve the overall navigational safety. As a result the UKHO services the worldwide maritime needs of commercial shipping.[58] To meet their operational and commercial demands the RN has hydrographic ships including an ice class vessel. The RN and the UKHO demands are greater than the demands of the RCN and therefore the RCN would require a less robust capability.

The Royal Australian Navy is responsible for the both the domestic hydrographic demands and to support the military demands of their navy. The RAN has hydrographic vessels to meet their domestic and expeditionary requirements. The RAN is a regional

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[57] *Ibid.*

[58] United Kingdom Hydrographic Office, "Admiralty Vector Chart Service Overview" accessed on 8 March 2013, http://www.ukho.gov.uk/productsandservices/electroniccharts/pages/avcs.aspx.

power who maintains a balance of both security requirements and improvements in navigational safety.[59] Part of the improvements in navigational safety is the capacity building that the RAN does for hydrographic improvements of nations in the region. The Australians use their hydrographic service in ways similar to the other nations in terms of how the navy is supported. All the previous three nations have submarines which require hydrography different than what is required for surface vessels. Submarine operations are enabled by charting of different level of accuracy. Thus the Australian model is sufficient to meet both their domestic and expeditionary demands but is not appropriate for the RCN to model.

The Royal New Zealand Navy has a more modest hydrographic service that still meets their demands. They have hydrographic ships in their navy which meets the demands of their surface fleet.[60] Their naval hydrographer's expertise is not focused but defused throughout their navy with the most senior officer acting as the national authority. As a result their navy can maintain both the capability and the expertise with having to focus any of their scant human resources on the problem. Their navy also does not have submarines which mean that their demands will be less intensive than the other nations. Regardless, The Royal New Zealand Navy is able to meet the demand of their force and of their nation.

In examining allies' naval hydrographic capability, Canada's lack of capability becomes starker. Although a dedicated hydrographic department complete with ships and

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[59] Australia, Department of Defence. "Australian Hydrographic Office: Roles and Responsibilities." Last accessed on 5 February 2013, http://www.hydro.gov.au/factsheets/WFS_Roles_And_Responsibilities.pdf.

[60] Hannah, John and Peter Knight. "Hydrography in New Zealand: A New Economic Approach," *Hydrographic Society of New* Zealand, accessed on 8 Parch 2013, http://www.hydrographicsociety.org.nz/reports/report_hydro.htm

a robust training program would fill the requirement, it would far exceed the demand from the RCN. A more modest capability, similar to what RNZN has, would likely fill the requirement. With allies to model the level of capability required and used to enable operations, the RCN can better understand the level of service that it might require to support current and future operations. With this capability, the RCN would also be able to better support allies contributing to enabling military operations.

CONCLUSION

Canada is a large coastal state with vast maritime interests and hydrography is a recognized part of sea power. Royal Canadian Navy requires naval hydrography to enable and complete their missions; a modest capability is required to meet these needs. An examination of what other allies have to achieve their missions. Although the Royal Navy and United States Navy have significantly larger forces and a historic precedence demands their hydrographic capability is similarly larger. In a similar sized ally, Australia has a robust capability and even a smaller nation such as New Zealand has a reasonable capability.

The RCN requires a hydrographic capability which can be broken into three parts: an equipment requirement to obtain the data, an expertise requirement to verify the data and a portrayal requirement to utilize the data that is obtained. Although most nations have hydrographic ships that are focused on that mission, the RCN demand does not need dedicated ships. The equipment demands of the RCN merely require that data can obtain to support the other government departments in Canada, to meet the expeditionary requirements of the surface fleet in disaster response and data requirements for submarine navigation. As a result, the minimum demand envisions installing the capability on the ship that was deploying or responding to the crisis. The easiest method to obtain this capability requirement could be met by either having specialty launches, small boats with a multi-beam sonar installed in the hull, or to have a pole mounted sonar system mounted to a ship. The advantages of the small boat would be that it could be flown in to a ship in an emergency or it could sail with the ship from its home port. If it came as a self-contained module then the set-up requirements would be minimal and it could operate on

its own allowing the mother ship to carry on with other missions. The main disadvantages would be that most RCN ships have limited boat carrying capacities and having a dedicated launch would mean that it would not be suited to other tasks like landing operations. Having a pole mounted multi-beam sonar system would be more portable but would require more set-up on a ship including testing. The ship would then also be limited in operations when conducting a survey which may not be the most effective use of that resource. After the equipment is obtained, the RCN still requires trained personnel to operate the systems.

The RCN requires hydrographic expertise when collecting and assessing any data collected. Most navies have dedicated specialists of hydrographic officers who are trained and employed solely in the task of data acquisition. They also form the nucleus of an expertise of officers who can prioritize the hydrographic survey demands to fulfill the requirements of their navies. In addition, these officers can assess equipment and resource demands for navies. The RCN currently has very few officers who have either the training or the expertise to even attempt becoming a hydrographer. There is no career path nor are there many positions that a hydrographer could fill. In order to train hydrographers the training varies between a master's program and technical course. Both are strenuous technical programs which enable candidates to fulfill the requirements of a hydrographer. Most hydrographers will need to consolidate their skill set with either executing a survey or assisting another hydrographer. It would likely be best if the RCN allowed navigators to become hydrographers and post them to roles where they could complete education. Afterward, they would become standby officers, able to fill the role in the event of a crisis or a mission where a survey is required to enable a mission. This is

very similar to how the RNZN, another small navy, operates its hydrographic capability. To enable the critical hydrographic, the RCN requires hydrographic personal.

After the data has been acquired and verified, RCN requires a process to display, portray and access the data. The coastal Hydrographic Service Organizations do an admirable job with limited resources to process what data is available to them. The HSOs have no authority to create a safe navigation product and if new data comes from the RCN they will quickly become swamped. To support the operations, a reach back capability for analysis and processing would be required to send the partially processed data for portrayal and inclusion in military products. The data would be useless unless an operator can make use of it in the future and dependent on the crisis may require a very quick response time. Most of the allies operate with a similar system where agencies have an ability to produce products for the navy on newly procured data. Regardless, the RCN requires hydrographic equipment, hydrographers and cartographers to enable the entire process to happen.

Hydrographic organizations were created to prevent ships from grounding in areas where the sailors were not the local expert. The early casualties for this preventable situation became deplorable and expensive. After the science started producing charts, navies and governments soon realized the use and power of the product. Hydrographic products were then used to enable a variety of operations and at the same time enforce and improve the sovereignty of nations. The Canadian Hydrographic Service has evolved out of a demand for domestic safety of navigation and as a result the RCN has not developed or needed a hydrographic capability.

If the RCN had a hydrographic capability it could aid the other government departments in their mandates. A hydrographic capability would aid Environment Canada in their understanding of the physical world and their demand for pollution protection. The Canadian Coast Guard would be aided in how they maintain the navigational aids in the water. The real advantage would be to the Canadian Hydrographic Service who has the mandate to maintain the navigable waters for shipping and transit. They would benefit from having platforms that are collecting data, and from any processing from the data for military means. The naval hydrographic capability would gain in expertise from conducting the hydrographic surveys. The navy would gain from the long expertise that each department has garnered over the recent past. The economy of Canada would benefit from the improved picture provided by the new capability.

A naval hydrographic capability would enable Canada's missions in aid for disaster support. The support would enable maritime relief in devastated coastal regions. Nations have been affected by hurricanes, earthquakes and tsunamis. The maritime and land infrastructure have been damaged to the extent that the best sustained support arrives from the ocean. To enable that support new surveys must be completed to ensure that the shipping is safe to enter the area. Both American and Japanese surveys were critical in the support to the affected areas. In addition to requiring the surveys for disaster relief the surveys are critical in re-establishing the affect economic infrastructure. Both of these tasks are critical if Canada intends on providing support. An expeditionary capability is best suited as a naval hydrographic capability.

The greatest demand for naval hydrography is to fulfill the operational deficiencies in current and for future operations. Oceanographers would benefit from the

data by improving knowledge of the ocean and thereby improve both their analytic capability and predictive power for military operations. Future amphibious operations require the capability. The greatest current needs are to enable patrols in the Arctic in sovereignty defence and support to the submarine community. The Arctic has poor and incomplete charts which restricts the movement in protection of Canada's waters. Submarine operations would be enhanced by specialized charts enabling them to more safely achieve their missions. The need for naval hydrographic capability to provide the data in military priority areas, the sensitivity of the data obtained and to obtain data expeditionary. Without the capability future naval operations would be risky, impossible or unsustainable.

Although many nations have fulfilled their naval hydrographic needs in different methods, Canada solution may unique. The equipment, training and personal package requirements are an area for further study. The capability is required or the RCN will find itself unnecessarily impotent in the exploitation of the water space. It will not be able to effectively conduct operations and the RCN will be unable to contribute to allies. Without the capability the RCN is standing into danger.

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