# Assessment of

# Needs and Opportunities for

# Research Vessel Use in

# Atlantic Canada


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# 1 CONTENTS

# 2 DEFINITIONS

| | |
|---|---|
| AOPS | Arctic and Offshore Patrol Ship |
| AUV | Autonomous Underwater Vehicle |
| BIO | Bedford Institute of Oceanography |
| CCG | Canadian Coast Guard |
| COVE | Centre for Ocean Ventures & Entrepreneurship |
| DFO | Department of Fisheries and Oceans |
| DND | Department of National Defense |
| DP | Dynamic positioning |
| Hugin | Kongsberg™ proprietary AUV |
| IACS | International Association of Classification Societies |
| LARS | Launch and recovery system |
| MEOPAR | Marine Environmental Observation Prediction and Response Network |
| MUN | Memorial University of Newfoundland |
| NRCan | Natural Resources Canada |
| NSDoE | Nova Scotia Department of Energy |
| OFI | Ocean Frontier Institute |
| OFSV | Offshore fisheries science vessel |
| OOSV | Offshore oceanographic science vessel |
| ORCA | Oceans Research in Canada Alliance |
| ROV | Remotely Operated Vehicle |
| RV | Research vessel |
| TC | Transport Canada |

# 3 BACKGROUND

There is widespread concern amongst Canadian ocean researchers that the ability to conduct key research tasks is being impeded by a lack of available research vessel capacity. Historically, research vessel time in Canada (vessel days) has been provided through a variety of federally government funded departments or institutions. Over the last several decades the available fleet of research vessels has seen a re-organization of the departments responsible for their management and retiring of some of the much older vessels. No new tonnage has come into service to replace or supplement the existing fleet.

Growing problems with Canada's ageing research fleet were noted in a Council of Canadian Academies Expert Panel assessment of the state of ocean science in Canada published in 2013. The planning and provision of research vessel capacity was identified as a "key challenge for ocean science infrastructure in Canada" (Expert Panel on Canadian Ocean Science 2013). At a conference of the Oceans Research in Canada Alliance (ORCA) held in April 2018, a group of researchers from multiple sectors agreed that the status quo is not sustainable and that there is an urgent need to increase research vessel capacity.

In the Spring of 2018, the Marine Environmental Observation, Prediction and Response Network (MEOPAR) convened a task team to:

- better quantify the current availability of ocean research vessels impacted by federal government vessel and fleet management decisions;
- assess short term strategies to meet the immediate needs of the research community, and;
- understand the longer-term plans for the provision of research vessel capacity in Canada.

In order to make the task team's composition and product manageable, its focus was on offshore Atlantic Canada. However, it was understood that issues faced in Atlantic Canada are not unique, so that the Task Team's analysis would have relevance for other parts of the country.

This report is an assessment of needs and opportunities written by a vessel management and operations consultant that MEOPAR commissioned to collect and collate the perspectives of diverse research vessel users (the task team). The task team contact list was provided by MEOPAR to the author. All participants were emailed and contacted by telephone to respond to a prepared questionnaire.

This report was produced independently by Hughes Offshore and Shipping Inc. and the views expressed reflect the opinion of the author. The information, statements, statistics and commentary contained in this report have been prepared by the author based on publicly available material and constitute the author's interpretation of the feedback and discussions held with the task team.

# 4 EXECUTIVE SUMMARY

Task team members for the study were selected by MEOPAR on the basis of their familiarity with using research vessels for ocean science research in the Atlantic Canada offshore, and on their desire to participate in defining the performance requirements for ocean research vessels. The task team was comprised of representatives from academic institutions, research organizations, not-for-profits and relevant federal and provincial agencies. The expectation was to develop a set of technical requirements and a performance specification that could be used for proposing and then vetting marine solutions to fill any identified need in the short term. What emerged during the assessment was not entirely as anticipated.

The needs assessment found a significant gap between the desired quantity of time at sea available to conduct ocean research and the provision of marine assets to meet that need. Despite indications of this developing gap almost a decade and a half ago, it is surprising that no plan is currently in place to increase this capacity. What does exist is a program to replace the extremely aged research vessel fleet over the next seven years or so. The advanced age of the existing fleet has contributed to a reduction in the possible days available for research through an increase in maintenance requirements and unplanned service interruptions. Although newer vessels should result in more efficient operations with perhaps some marginal improvements in "time at sea" through more reliable assets, it is important to emphasize that this will not result in an increase in capacity. The management of these new vessels will also be with the Canadian Coast Guard (CCG), a federal transportation agency whose published service mandate does <u>not</u> include scientific research. This agency is tasked with the safety of life at sea and the maintenance of the navigational services on Canada's extensive coastline and waterways. As the Director General, Fleet, of the Coast Guard stated in their fifty-year review, they are facing "challenges associated with more urgent security needs along this immense frontier and the challenges associated with providing services such as search and rescue, icebreaking and environmental response" (Canadian Coast Guard 2011). They clearly state that "CCG has six core services: Search and Rescue, Marine Communications and Traffic Services, Marine Navigation, Icebreaking, Maritime Security, Environmental Response" (Canadian Coast Guard 2018). Scientific research is not included this list.

*The need for increased capacity in the research vessel fleet operating in Atlantic Canada was seen to be both significant and of a longer-term nature.*

In the second part, the determining of the technical requirements necessary to develop a vessel performance specification was not as complicated as anticipated. The participants were forthcoming with the necessary requirements, and a performance specification was developed. The historical shortage of vessel days had, the facilitator believes, led to a reduction in the call for sophistication in vessel requirements in favour simply of a marine platform that was available, reliable, dedicated to the scientific mission, and able to be adapted to meet the mission requirements as developed.

*The performance specification for a compliant vessel, or vessels, to carry out ocean research in Atlantic Canada is not technically demanding.*

It became evident that of perhaps greatest concern to the ocean science research community was both the level of, and the management of, the funding process for ocean research projects/missions in Atlantic Canada (although this concern was expressed more broadly to include other parts of Canada's ocean).

Although not specifically part of the study, comments such as "beyond absurd", "extremely frustrating", "dysfunctional and inefficient" are worthy of note. Significant funds are being spent annually on ocean research. The federal government is chartering in vessels to meet their basic commitments. This is an annual occurrence, and RFP's are already out for 2019. While scientific research on available government vessels does receive funding, what is clearly lacking is a coordinated, collaborative, and cooperative process to maximize the economic benefits of chartering a vessel or otherwise providing vessel capacity through a "pooled" funding mechanism by efficiently scheduling research activities from multiple stakeholders.

*A coordinated and collaborative use of current funding programs would provide a much-improved solution to meeting research vessel needs in the scientific community by leveraging pooled funding to obtain the most suitable commercial marine asset for multiple stakeholders.*

# 5 RESEARCH VESSELS IN ATLANTIC CANADA

## 5.1 CURRENT SITUATION – VESSEL AVAILABILITY

Ocean research in eastern Canada has been the subject of much discussion within the federal government in recent years. In order to conduct ocean research, it is necessary to be able to gain access to both coastal and ocean areas of interest. To gain an understanding of the scope of the issue facing researchers desiring access to the waters off eastern Canada, it is useful to have a review of vessel time made available for scientific projects through current federal government vessels and their funding.

Prior to 1995, scientific survey vessels in the Atlantic and eastern arctic were managed as a fleet operating under the direction of the Bedford Institute of Oceanography (BIO). This institute opened its doors in October of 1962, a key role being the management and operation of federal government research vessels conducting scientific research in Atlantic Canada, the Arctic, and in international waters. The BIO fleet, crewed by civilian crews, operated exclusively for the benefit of the scientists and their research projects. During this period, “ship time was made available to universities without charge, but this policy had to be terminated in the 1980’s due to funding pressures” (Gordon 2018). All the vessels operated by BIO were exclusively for research activities.

Through the decades from the 1970’s to the turn of the century, the research vessel fleet numbered from seven to ten vessels covering both near shore and offshore activities. Annual reports by BIO detailed the number of days spent at sea (conducting scientific work) and the number of miles travelled covering the relevant ocean areas. During those decades, the number of cumulative vessel days available for research in Atlantic Canada averaged some 1300 days per year, and the research fleet steamed some 140,000 nautical miles annually (the equivalent of about 5 voyages around the world) (Alan R. Longhurst 1981) (Scotia-Fundy Region of the Department of Fisheries and Oceans 1987) (Fig. 1).

| Research Vessel Activity | No of Cruises | | Days away from Home Port | | Nautical Miles Steamed | |
|---|---|---|---|---|---|---|
| | 1971 | 1972 | 1971 | 1972 | 1971 | 1972 |
| CSS Baffin | 1 | 2 | 236 | 199 | 31,961 | 13,261 |
| CSS Dawson | 9 | 13 | 139 | 181 | 21,953 | 29,692 |
| CSS Hudson | 4 | 4 | 224 | 130 | 29,996 | 24,249 |
| CSS Kapuskasing | 1 | 2 | 160 | 126 | 10,136 | 10,164 |
| CSS Maxwell | 1 | 2 | 166 | 172 | 5,981 | 5,493 |
| CFAV Sackville | 11 | 11 | 125 | 130 | 17,386 | 16,721 |
| CFAV Bluethroat | 2 | 4 | 9 | 54 | 278 | 2,555 |
| **TOTALS** | **29** | **38** | **1,059** | **992** | **117,691** | **102,135** |

| Research Vessel Activity | No of Cruises | | Days away from Home Port | | Nautical Miles Steamed | |
|---|---|---|---|---|---|---|
| | 1986 | 1987 | 1986 | 1987 | 1986 | 1987 |
| CSS Baffin | 3 | 7 | 214 | 187 | 16,498 | 20,730 |
| CSS Dawson | 18 | 20 | 203 | 202 | 25,985 | 28,481 |
| CSS Hudson | 11 | 10 | 190 | 196 | 27,489 | 30,613 |
| MV Lady Hammond | 22 | 10 | 221 | 173 | 30,718 | 24,580 |
| CSS Maxwell | 3 | NA | 180 | NA | 2,020 | NA |
| MV Alfred Needler | 16 | 21 | 203 | 214 | 29,671 | 28,827 |
| MV E. E. Prince | 15 | 17 | 208 | 180 | 22,290 | 20,749 |
| F.C.G. Smith | 2 | 2 | 97 | 102 | 4,387 | 4,869 |
| Navicula | 3 | 6 | 101 | 116 | 5,259 | 5,715 |
| Hart * | 20 | 26 | 152 | 125 | 9,368 | 7,793 |
| **TOTALS** | **113** | **119** | **1,769** | **1,495** | **173,685** | **172,357** |

* transferred to DFO’s Newfoundland Region in 1987 (no records)

*Figure 1: Historical research Vessel availability*

Further review of the research vessel activity under the management of BIO shows that the dedicated scientific fleet spent, on average, 44.4% of their time away from their home port carrying out scientific expeditions (Fig. 2). The remaining time would have been taken up on mobilizing/de-mobilizing and maintenance/dry-dockings.

| | Days Away as % of Year | | | | AVG Days Away |
|---|---|---|---|---|---|
| **Research VesselActivity** | **1971** | **1972** | **1986** | **1987** | |
| CSS Baffin | 64.7% | 54.5% | | | 59.6% |
| CSS Dawson | 38.1% | 49.6% | | | 43.8% |
| CSS Hudson | 61.4% | 35.6% | | | 48.5% |
| CSS Kapuskasing | 43.8% | 34.5% | | | 39.2% |
| CSS Maxwell | 45.5% | 47.1% | | | 46.3% |
| CFAV Sackville | 34.2% | 35.6% | | | 34.9% |
| CFAV Bluethroat | 2.5% | 14.8% | | | 8.6% |
| CSS Baffin | | | 58.6% | 51.2% | 54.9% |
| CSS Dawson | | | 55.6% | 55.3% | 55.5% |
| CSS Hudson | | | 52.1% | 53.7% | 52.9% |
| MV Lady Hammond | | | 60.5% | 47.4% | 54.0% |
| MV Alfred Needler | | | 55.6% | 58.6% | 57.1% |
| MV E. E. Prince | | | 57.0% | 49.3% | 53.2% |
| F.C.G. Smith | | | 26.6% | 27.9% | 27.3% |
| Navicula | | | 27.7% | 31.8% | 29.7% |
| **TOTAL AVG RV Days at sea** | | | | | **44.4%** |

*Figure 2: Historical RV mission times*

The current situation is quite different. In 1995 the Canadian Coast Guard, previously with Transport Canada, was transferred to the Department of Fisheries and Oceans (DFO) and took over operation of the BIO fleet. The vessels available for scientific activities, now managed by CCG, are comprised primarily of multi-tasked vessels which serve a variety of marine roles. As an example, the CCGS Edward Cornwallis, a High Endurance Multi-Tasked Vessel, has additional berths (above the crew complement) for nine (9), the focsle deck can accommodate two containers and the vessel specification under Scientific Equipment states: "This vessel is not equipped with dedicated Scientific Equipment". As a result, the design of the vessel does not make it an ideal vessel for significant ocean research. In addition, the Coast Guards' service mandate states the responsibility for providing:

- aids to navigation;
- marine communications and traffic management services;
- icebreaking and ice-management services;
- channel maintenance;
- marine search and rescue;
- marine pollution response;
- aids to navigation;
- search and rescue;
- pollution response;
- vessel traffic services;
- support of other government departments, boards and agencies by providing ships, aircraft and other services.

Scientific research is not highlighted and falls within the support offered to other government agencies. Not having scientific research as part of the Coast Guards' stated mandate is perhaps problematic when tasking decisions are being made.

Currently, requests for vessel days (ship time) to conduct scientific research must be applied for through a number of separate funding programs, and the schedules are managed by the Coast Guard on a prioritized basis. The fleet has only three non-multi task vessels, two of which remain in service from the original BIO fleet, the third being a stern trawler conversion (1988 build) added to the fisheries research role (Fig. 3).

| Vessels | Type | Built | Age |
|---|---|---|---|
| | | | |
| CCGS Edward Cornwallis | High Endurance Multi-Tasked Vessel | 1986 | 32 |
| CCGS Sir William Alexander | High Endurance Multi-Tasked Vessel | 1987 | 31 |
| CCGS Earl Grey | Medium Endurance Multi-Tasked Vessel | 1985 | 33 |
| CCGS Hudson | Offshore Oceanographic Science Vessel | 1963 | 55 |
| CCGS Alfred Needler | Offshore Fishery Science Vessel | 1982 | 36 |
| CCGS Ann Harvey | High Endurance Multi-Tasked Vessel | 1987 | 31 |
| CCGS George R. Pearkes | High Endurance Multi-Tasked Vessel | 1986 | 32 |
| CCGS Teleost | Offshore Fishery Science Vessel | 1988 | 30 |

*Figure 3: Current CCG vessels available for research*

If one was to apply the same rate of availability to the dedicated scientific fleet currently available for research on the Atlantic coast, the total number of days at sea would be estimated as 324 (Fig. 4).

| Vessel | Designation | Days Available |
|---|---|---|
| CCGS Hudson | Offshore Oceanographic Science Vessel | 162 |
| CCGS Alfred Needler | Offshore Fishery Science Vessel | 81 |
| CCGS Teleost | Offshore Fishery Science Vessel | 81 |
| **Total Estimated RV Days Available** | | **324** |

*Figure 4:Estimate of current RV Days at sea*

If one adds in the multi-tasked CCG vessels, then the number of available days increases to 567 (Fig. 5). This estimate represents a service level that is between 32% and 38% of what was available in 1986/87, and coincides with the findings of the United Nations Conference on Trade and Development, which postulates that, globally, vessel days available for research are currently running at about 20-30% of levels from the latter part of the twentieth century (UNCTAD 2018).

| Vessel | Designation | Days Available |
|---|---|---|
| CCGS Hudson | Offshore Oceanographic Science Vessel | 162 |
| CCGS Alfred Needler | Offshore Fishery Science Vessel | 81 |
| CCGS Teleost | Offshore Fishery Science Vessel | 81 |
| CCGS Edward Cornwallis | High Endurance Multi-Tasked Vessel | 49 |
| CCGS William Alexander | High Endurance Multi-Tasked Vessel | 49 |
| CCGS Earl Grey | High Endurance Multi-Tasked Vessel | 49 |
| CCGS Ann Harvey | High Endurance Multi-Tasked Vessel | 49 |
| CCGS George R. Pearkes | High Endurance Multi-Tasked Vessel | 49 |
| **Total Estimated RV Days Available** | | **567** |

*Figure 5: Estimate of current vessel that might be available for research*

Although an available and useful metric, which has been tracked for decades allowing comparisons with past practice, the number of available vessel days does not present the complete picture. Improvements in technology available onboard research vessels, particularly in the area of connectivity/communications, have in all likelihood improved the efficiency of research teams onboard. Vessel design has also improved, permitting broader weather windows for operations, improved living conditions and resulting improved operator performance. Combined, the more complex dedicated research vessels being launched by many countries in recent years provide some offset against this reduction in available vessels days. Canada has not yet realized any such potential benefit, though this may be a factor when the replacement for the Hudson is delivered into service in perhaps (optimistically) 2025 or thereabouts.

According to the document prepared to provide guidelines for scientists operating aboard Canadian Coast Guard vessels, “typically for vessels, the requested number of days is about 20-50% more than what is available” (Steve Romaine 2018). Researchers are thus encouraged to apply early.

Research activities aboard government supported vessels is funded through the Natural Sciences and Engineering Research Council of Canada (NSERC). In order to apply for a “Ship Time grant”, the applicant must first be the holder of a Discovery Grant, available to members of academic institutions within Canada that meet the eligibility criteria defined by NSERC.

Further pressure on such a limited resource is compounded by the average age of the fleet. The increasing age means more maintenance requirements and thus more “downtime” for refits, dry-dockings, and vessel life extensions. It also increases the risk of unplanned operational interruptions due to mechanical failure. Upcoming maintenance requirements from CCG fleet are shown in figures 6 & 7.

| Vessels | Atlantic Region - 2018-19 | | | | | | | | | | | | Atlantic Region - 2019-20 | | | | | | | | | | | | Atlantic Region - 2021-22 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar |
| CCGS Edward Cornwallis | | | | | | DD | | | | Refit | | | | | | | Refit | | | | | | | | | | | | DD | | | | | VLE | | |
| CCGS Sir William Alexander | | | | Refit | | | | | | VLE | | | | | Refit | | | | | | | | | | | | | VLE | | | | | | | | |
| CCGS Earl Grey | | | | | | Refit | | | | | | | | | | | | | DD | | | | | | | | | | | Refit | | | | | | |
| CCGS Hudson | | | | Refit | | | | | Refit | | | | | | | | | | | | | DD | | | | | | | | | | | | Refit | | |
| CCGS Alfred Needler | | | | | Refit | | | | Refit | | | | | | | | | | | | Refit | | | | | | | | | | | | | | | |
| CCGS Ann Harvey | | | VLE | | | | | | | | | | | | | Refit | | | | | | | | | | | | Refit | | | | | | | | |
| CCGS George R. Pearkes | | | | Refit | | Refit | | | | | | | | | | | | | | | | VLE | | | | | | | | Refit | | | | | | |
| CCGS Teleost | | | Refit | | | | | | | | DD | | | | | | | | | | | Refit | | | | | | | | | | | | Refit | | |

*Figure 6: CCG Fleet maintenance schedule (Government of Canada 2018)*

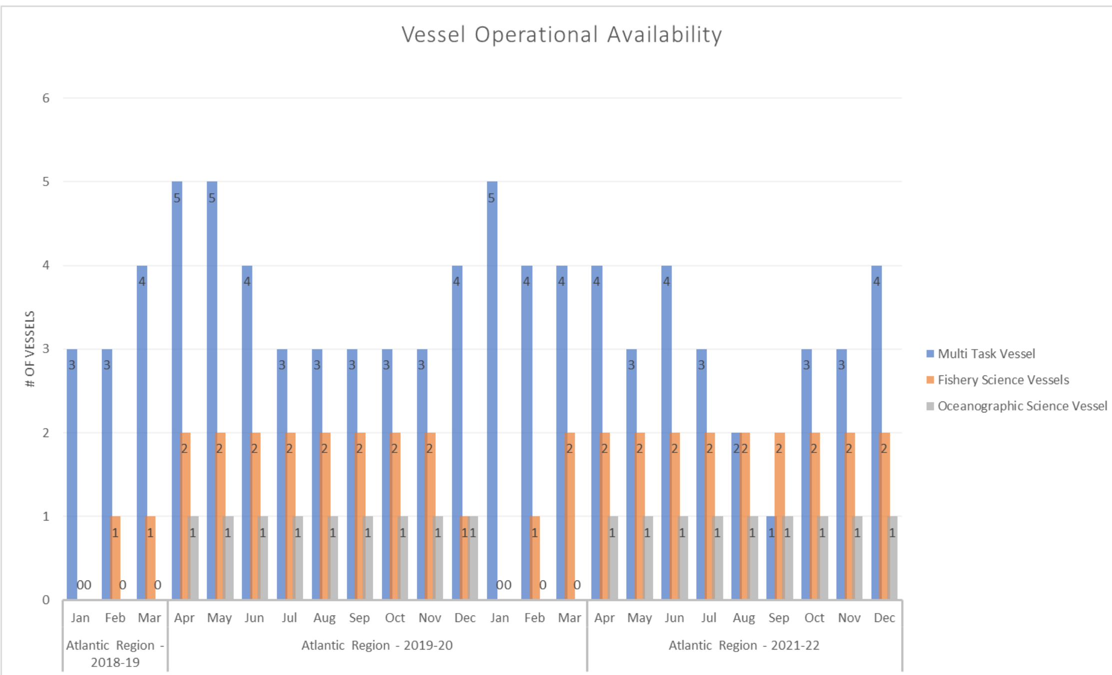


*Figure 7: Forecast science vessel availability*

Interestingly, the average age of ships (by unit) in the world merchant fleet as of 2018 is 20.57 years old, with the average age of the tonnage being 9.9 years old (UNCTAD 2018) (Fig. 8); compare this to an average age of 35 years for the Canadian research vessel fleet and just over 40 years for the science vessel fleet (Fig. 9). The average age of merchant ships sent for scrap in 2018 was 31.72 years old (Allied Shipping Research 2018).

**Table 2.2. Age distribution of world merchant fleet, by vessel type, 2017**

| Economic grouping and vessel type | | Years 0–4 | 5–9 | 10–14 | 15–19 | 20+ | Average age 2017 | 2016 | Percentage change 2016–2017 |
|---|---|---|---|---|---|---|---|---|---|
| **World** | | | | | | | | | |
| Bulk carriers | Percentage of total ships | 35.77 | 33.80 | 12.05 | 9.33 | 9.05 | 8.80 | 8.80 | 0.00 |
| | Percentage of dead weight tonnage | 38.66 | 34.88 | 11.91 | 7.55 | 7.01 | 7.95 | 7.94 | 0.01 |
| | Average vessel size (dwt) | 79 099 | 75 525 | 72 283 | 59 244 | 56 673 | | | |
| Container ships | Percentage of total ships | 18.63 | 30.50 | 22.72 | 15.66 | 12.50 | 11.55 | 11.10 | 0.45 |
| | Percentage of dead weight tonnage | 31.51 | 32.57 | 20.82 | 10.17 | 4.92 | 8.72 | 8.39 | 0.33 |
| | Average vessel size (dwt) | 80 624 | 50 891 | 43 679 | 30 961 | 18 751 | | | |
| General cargo | Percentage of total ships | 7.68 | 16.50 | 10.20 | 7.54 | 58.08 | 25.21 | 24.44 | 0.76 |
| | Percentage of dead weight tonnage | 14.98 | 24.70 | 12.23 | 10.24 | 37.85 | 18.29 | 17.83 | 0.46 |
| | Average vessel size (dwt) | 8 118 | 6 081 | 5 086 | 5 630 | 2 561 | | | |
| Oil tankers | Percentage of total ships | 16.03 | 22.51 | 15.46 | 7.74 | 38.26 | 18.76 | 18.36 | 0.40 |
| | Percentage of dead weight tonnage | 22.07 | 34.74 | 24.44 | 12.67 | 6.09 | 9.90 | 9.54 | 0.36 |
| | Average vessel size (dwt) | 73 274 | 82 242 | 84 610 | 89 498 | 8 777 | | | |
| Other | Percentage of total ships | 14.37 | 18.65 | 10.60 | 8.43 | 47.96 | 22.73 | 22.25 | 0.48 |
| | Percentage of dead weight tonnage | 19.40 | 26.43 | 14.21 | 10.29 | 29.67 | 15.58 | 15.65 | -0.07 |
| | Average vessel size (dwt) | 7 777 | 7 907 | 8 004 | 7 144 | 3 954 | | | |
| All ships | Percentage of total ships | 11.75 | 17.97 | 10.13 | 7.00 | 53.15 | 20.57 | 19.92 | 0.65 |
| | Percentage of dead weight tonnage | 29.80 | 33.16 | 16.95 | 9.78 | 10.31 | 9.90 | 9.55 | 0.34 |
| | Average vessel size (dwt) | 42 207 | 34 948 | 32 847 | 25 991 | 5 917 | | | |

*Figure 8: Age distribution - world fleet (Source: UNCTAD secretariat calculations, based on data from Clarksons Research.)*

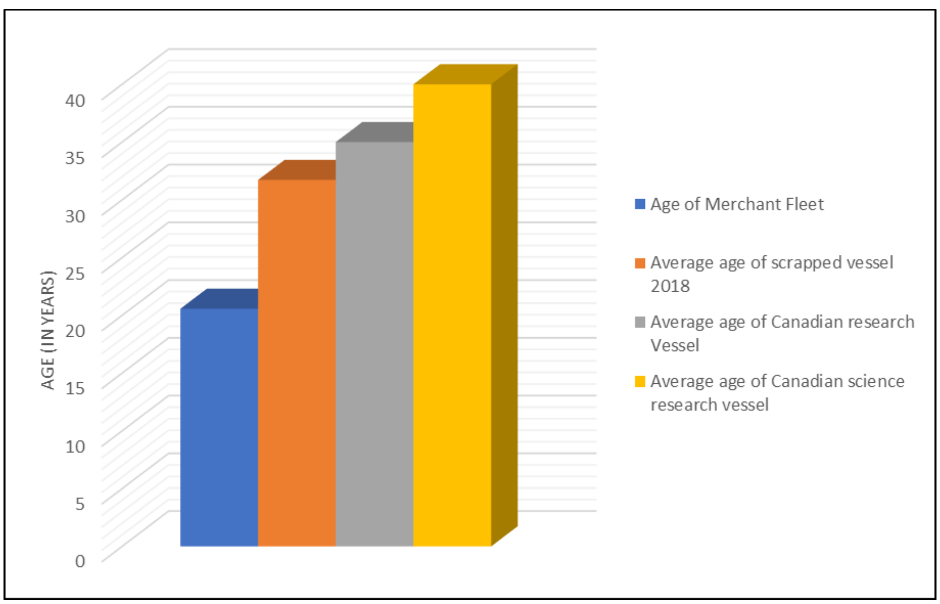


*Figure 9: Aging CCG RV fleet*

The scarcity of available marine resources for critical research results in real costs to government. An analysis of government spending on vessel charters to meet committed ocean research requirements shows that contracts were let for vessel charters/work in the amount of CAD$4.6M (four million six hundred thousand Canadian dollars) (Fig. 10) during 2017/2018 (Public Works and Government Services Canada 2018). To provide perspective, a European scientific research vessel, equipped, crewed, and supplied with fuel and consumables could have provided 170 days of sea time for a scientific crew of over 20 for a comparable cost.

| Charter Description | Date | User | Value |
|---|---|---|---|
| COD Sentinel Survey 2J3KLPs& 4R3Pn (F60 | 10/05/2018 | Fisheries and Oceans Canada | 1,269,749 |
| Cod Sentinel Survey - 2J, 3KL and 3Ps (F60 | 29/06/2017 | Fisheries and Oceans Canada | 757,999 |
| Cod Sentinel Survey - 4R and 3Pn (F6074-1 | 29/06/2017 | Fisheries and Oceans Canada | 511,750 |
| Vessel and Crew to Support the Fisheries | 13/03/2017 | Fisheries and Oceans Canada | 466,792 |
| Department of Fisheries and Oceans (DFC | 24/05/2018 | Fisheries and Oceans Canada | 414,688 |
| Commercial Fishing Vessel Charter (F6081 | 02/08/2017 | Fisheries and Oceans Canada | 303,025 |
| Commercial Fishing Vessel Charter (F6081 | 02/08/2017 | Fisheries and Oceans Canada | 186,300 |
| Department of Fisheries and Oceans (DFC | 10/07/2018 | Fisheries and Oceans Canada | 172,500 |
| Vessel Charter - 4Vn Stratified Random Fi | 08/08/2018 | Fisheries and Oceans Canada | 113,900 |
| Scientific Data Collection - Field (R&D) (F6 | 06/07/2018 | Fisheries and Oceans Canada | 85,664 |
| Vessel Charter (W3999-171347/001/WPG) | 01/02/2018 | Department of National Defence | 63,700 |
| Sentinel Survey - Fogo Island, NL (F6074-1 | 21/06/2017 | Fisheries and Oceans Canada | 51,750 |
| COD Sentinel Survey--Fogo Island (F6074- | 11/05/2018 | Fisheries and Oceans Canada | 51,750 |
| Dive Charter & Support (W3999-165003/0C | 10/01/2017 | Department of National Defence | 45,500 |
| Bare Boat Charter (W010X-17N010/002/HA | 24/06/2017 | Department of National Defence | 28,750 |
| Bare Boat Charter (W010X-17N010/001/HA | 24/06/2017 | Department of National Defence | 28,750 |
| | | **TOTAL VALUE** | **4,552,566** |

*Figure 10: Government contracts for vessel charters (Source: GSINS tpsgc-pwgsc_aa-a)*

The conclusion from this review of external expenditures is that the federal government evidently lacks vessel capacity to undertake its' current slate of research needs and commitments. For academic institutions in Canada looking for opportunities to conduct ocean research, this inevitably means that competition for ship time will be intense. Members of the task team have accessed foreign research vessel ship time programs in order to meet their research needs.

Although most of the vessels were contracted by the Department of Fisheries and Oceans, the Department of National Defense (DND) also chartered some vessels. From the research vessel perspective, DND for many years operated a research vessel specifically engaged on scientific work for the military through the Defense Research Establishment (Atlantic). This vessel, the CFAV *Quest*, was crewed by civilian marine crews. The 1968 built ship was decommissioned in 2016 and scrapped the following year. It is worth noting that the Royal Canadian Navy utilized civilian crew to operate this vessel on research missions throughout her career, understanding perhaps that her operational profile was not compatible with the primary mission training provided to naval personnel. The takeaway – supporting marine research is more suited to a civilian marine crew.

## 5.2 Future Research Vessels in Atlantic Canada

The need for increased research vessel capacity within Atlantic Canada is not a new issue. In its annual review, the Bedford Institute of Oceanography noted fourteen years ago that "2004 was a difficult year for the research fleet. The vessels are old and there was considerable loss of programs due to breakdowns. Modern, well-equipped and -maintained research ships are a crucial requirement for a robust ocean-science program, and the issue of a modern research fleet is the most important challenge facing BIO in the coming years. The Canadian Coast Guard has prepared a long-term plan for fleet renewal, including the scientific research and monitoring component. Implementation of this plan is essential for the future of the Bedford Institute of Oceanography." (Bedford Institute of Oceanography 2005).

Progress, albeit slow, has been made in the nearly decade and a half since 2004. There are currently two programs underway within the National Shipbuilding program in Canada that offer some optimism: the Offshore Oceanographic Science Vessel Project (OOSV) and the Offshore Fisheries Science Vessel(s) Project (OFSV) for three ships. The OOSV and two of the OFSVs are planned to be deployed on the east coast when commissioned. This would effectively replace the vessels *Hudson*, *Needler*, and *Teleost*, modernizing the fleet. This investment does NOT provide for an increase in the number of vessels available to researchers but does modernize the existing fleet.

The funding for this portion of the shipbuilding program was committed in 2007, with an expected delivery of the two OFSVs in 2017. The construction commenced on the first OFSV in 2015. Recent planning now has delivery of the first of the three OFSV's vessels tentatively scheduled for 2019.

The OOSV was also planned to have a construction start in 2016, with a delivery to the east coast of 2018. This program has been significantly delayed, and the expectation now is for a shipbuilding contract to be signed in 2018, with construction to commence after delivery of the OFSVs in perhaps 2020 (Fig. 11). It is thus likely that delivery would be some few years after construction commences.

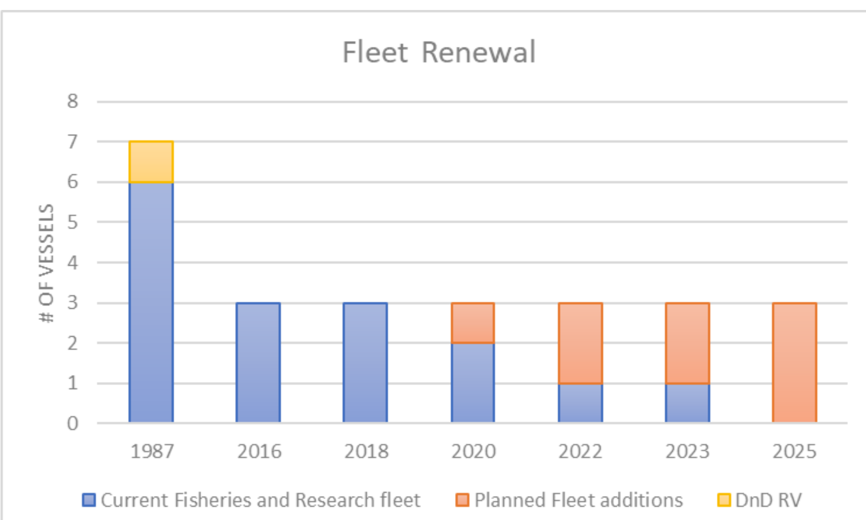


*Figure 11: Estimated schedule for RV fleet renewal*

There is, therefore, a plan to have a more modern Coast Guard research vessel fleet within the next 5-10 years, and it can be expected that this will serve current users well. However, it does not address the gap identified in the private or academic sectors for increased research time at sea. Non-governmental research, based on survey information from the task team members, is seeing an increased divergence between desired research activity offshore, and the committed and funded projects (see Figure 12). Data on the number of missions conducted offshore led by non-governmental institutions is not readily available, but feedback during the survey indicated it has been, and remains, a significant challenge to obtain ship time. There is evidence of a growing need for research in the private and academic sectors. The establishment of the Ocean Frontier Institute (OFI) and the launch of the Centre for Ocean Ventures & Entrepreneurship (COVE) is demonstrative of this increasing demand. Research vessels are the tool needed to access the subject. There is no plan from Government to increase capacity in this area.

Finally, in examining research vessel capacity, one must consider the requirements of the defense research facilities within Canada. The current Arctic and Offshore Patrol Ship (AOPS) program, originally committed to building five vessels, recently announced the construction of a sixth AOPS. Each vessel will have a length of 97m, beam of 19m, draught of 5.7m and will accommodate a crew of 45 members and will carry up to 40 people additionally (Naval Technology 2018). The first vessel in the series is expected to have an initial operational capability in 2020, with the fifth in the series entering initial service in 2023 and the sixth expected in the winter of 2024. There is no scientific capability written into the vessels' role.

There is some potential that the sixth vessel could be designated as a replacement for the *Quest*, which might offer some benefits to the RV fleet. However, the first of the AOPS will not be operationally active until at least 2020, which would put any such RV opportunity several years beyond this. Again, such a vessel allocation would NOT be an increase of research capacity in Canada but would restore capacity lost in 2016. The situation then, is that there will exist a continued shortage of research vessel "sea days" available for dedicated scientific ocean research in the foreseeable future, though the modernized fleet should improve reliability and efficiency.

# 6 Task Team Survey

## 6.1 Purpose

The task team is composed of members who have a vested interest in research vessel availability on the Atlantic coast. The intent of the survey was to (specifically);

1. determine potential utilization (the number of sea days anticipated would be required by each member) for a research vessel over the next five years;
2. ascertain the technical requirements of such research activity in order to develop a performance specification for an interim RV solution.

In addition, the intent was to (generally) collect feedback from team members on financial support available for ocean research, discuss what is needed to address research goals and requirements and to ensure that Canadian research is competitive on the international level.

Although the sample size was comparatively small, the members have a collective experience of the challenges being discussed that surpasses simple written survey responses. To this end, the calls and interviews were invaluable.

Task team members were also cognizant of the idea that the technical requirements were not for a new design of future research vessel, but were intended to provide a solution to the more immediate need for vessel days outside of what is currently provided by the Department of Fisheries and Oceans/Canadian Coast Guard operated vessels.

## 6.2 Utilization

In assessing the potential vessel utilization (sea days), team members were asked to provide an as accurate as possible summary of vessel days they were planning for their institution's combined research requirements. They were asked to indicate days that were committed and funded, days that were planned (funding to be determined), and days that were desired (for which they would expect to have identified research) (Fig. 12).

The results were not entirely accurate, and potentially would err on the cautious side for two reason;

1. one respondent was unable to specifically identify days rather than general periods
2. one respondent preferred not to identify funded and planned days due to internal activities underway

Further clarification would, potentially, increase the total utilization in each category.

The responses on the question of vessel utilization indicate;

- Planned ocean research activities seriously outstrip confirmed sources of funding

- The combined utilization demands would, if funding were available, fully occupy two dedicated RV's

It should be noted that the Department of Fisheries and Oceans research requirements are not included in the above utilization demands.

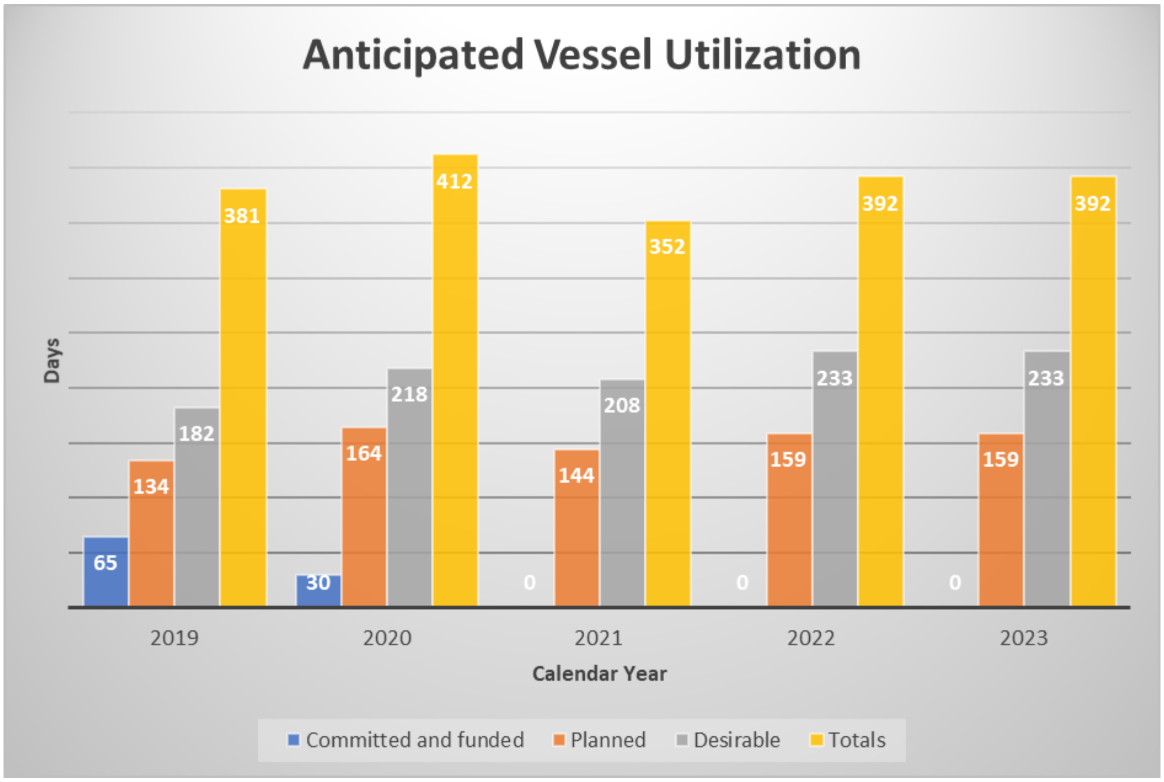


*Figure 12: Anticipated Vessel Utilization*

## 6.3 Performance Specification Survey

The survey posed questions as to the research needs of task team members for any potential interim vessel solution. The intent was to have members describe only their particular needs for their particular research projects, rather than describe vessel features and attributes. Consideration was not asked of other aspects of the mission, such as collaboration with other research teams, economies of scale, solutions to known issues, or preferred ships. A set of diverse requirements was expected, from which it was hoped a common vessel specification could be developed.

Responses received to the questions posed are summarized in the following tables as received:

| **Positioning Accuracy requirement** | |
|---|---|
| **stationary** | • High - as precise as possible - deployments of equipment to precise seabed locations is critical<br>• GPS satisfactory for deploying and recovery of autonomous vehicles<br>• +/- 25 metres<br>• using USBL beacons to precisely know coordinates at bottom of box coring or Rosette sampling<br>• not a high priority<br>• Dynamic Positioning, though not directly correlated to the survey results, is felt to be highly desirable, and is becoming a more common attribute of modern vessels in the offshore oil and gas as well as other sectors |
| **on track** | • Moderate<br>• DP not required specifically<br>• +/- 25 metres<br>• not a high priority |

| **Capability to deploy instrument packages overboard** | |
|---|---|
| **Depth (m)** | • 50-75<br>• 3000<br>• 4000<br>• 600 |
| **Weight in air (kg)** | • 8,000-10,000<br>• 300<br>• 1,800<br>• 1,000 |
| **Weight in water** | • 5,000<br>• 50<br>• 1,800<br>• 800 |
| **Dimensions (m)** | • 4x4<br>• 2x1x1<br>• 2x2x2<br>• 3x2x1 |

| **Requirement for supplied power to package** | |
|---|---|
| **i) electric** | • No<br>• provide 12 & 24 VDC; 12/220 VAC<br>• 380-480 V ac 3 phase 200 Amp (min); and 380-480 V ac 3 phase 125 Amp 50 or 60 Hz |
| **ii) hydraulic** | • No<br>• Hydraulics –20 GPM @ 2000 psi |
| **iii) other** | • Compressed air - 120 CFM @ 120 psi |

| **Speed requirement (for research purposes)** | |
|---|---|
| **minimum sustainable steady speed through water and tolerances** | • not less than 12knts<br>• (2 knots) need slow speed capability for deployment and recovery<br>• up to 1 knot |
| **other (i.e. point to point requirements)** | • 3-15 knots |

| **Atmospheric Sensors/sampling** | |
|---|---|
| **describe requirement** | • Gas sensors on bow (atmospheric and near surface gas sensors) need flexible sensor package capability, hard wired to central unit, stern bow, monkey island.<br>• useful in our work in aiming to location pockmarks and seabed hydrocarbon seeps |

| **Bathymetry** | |
|---|---|
| **describe requirement** | • ability to conduct multibeam surveys would be very useful<br>• Typical sounder - include ADCP<br>• Multi beam is useful; sea chest is desirable.<br>• useful in our work in aiming to location pockmarks and seabed hydrocarbon seeps<br>• will provide own as required |

| **Acoustic recording** | |
|---|---|
| **describe requirement** | • passive acoustic |

| **Species sampling** | |
|---|---|
| **describe requirement** | • underwater positional accuracy ~1m<br>• acoustic modem link for SSBL navigation (talk to ARV)<br>• will provide own as required<br>• All microbial work; DNA sequencing is used for this |

| **Bottom Sampling** | |
|---|---|
| **describe requirement** | • will provide own as required<br>• Box coring, piston coring, gravity coring |

| **Remotely Operated Vehicle Requirements (subsea and aerial drone)** | |
|---|---|
| **Past Use** | • video surveys of cable and equipment<br>• have flown aerial drones repeatedly - need launch and recovery capability (size - low power, endurance of 1 hr; weight of 10 -20 kg). May sacrifice a drone for landing on iceberg for sensors.<br>• CSSF ROPOS, Amundsen SUMO<br>• have our own systems |
| **Forecast Need** | • increasing<br>• Deploy and recover Ocean Gliders<br>• with all proposed missions<br>• there should be a ROV dedicated to east coast operations |
| **Operating depth** | • 50m<br>• up to 5,000 m |
| **Utility (tool packages etc.)** | • camera, sonar, manipulator - ability to work in high current<br>• numerous: benthic sampling, imagery, water column in situ, niskins, and others (EM mapping, multi-beam mapping) |

| **Autonomous Operated Vehicle Requirements** | |
|---|---|
| **Past Use** | • we used an AUV with NSDoE and NRCan in 2018 and the results were excellent<br>• have own systems |
| **Forecast Need** | • MUN Explorer, Hugin<br>• we would like to continue using AUVs |
| **Operating depth** | • up to 5,000 m<br>• we have deep-water targets between 3000-4000 m |
| **Utility (tool packages etc.)** | • multi beam mapping, imagery<br>• space for 20' and/or 40' container laydown |

| **Shallow Water Operations** | |
|---|---|
| **If anticipated, describe** | • landing operations on beach to embark equipment and personnel highly desirable<br>• 0-1000 m |
| **Requirement to land personnel ashore in remote areas** | • highly useful<br>• Requirement to land personnel ashore in remote areas<br>• Yes -a means of landing personnel is essential |

| Small boat operations (from mother-ship) anticipated | |
|---|---|
| **Describe activity** | • Most research related activity involves small (50'-75') vessels<br>• For recovery of ocean gliders<br>• small soft sided zodiac for autonomous systems retrieval and deployment activities and spooling out in water arrays. |

| Other Specialized Equipment or Technical requirements | |
|---|---|
| **Describe** | • pole mount for transducers that extends well below the water line to significant stability<br>• interested in collaborating with Dalhousie on using containerised labs for molecular biology that can be installed on the deck of ships like the Atlantic Condor<br>• acoustic quiet state capable<br>• crane capacity for 7m long, 1.5m wide, 3000kg equipment<br>• ships' cranes with the ability to load/offload equipment during mobilization/de-mobilization provide increased flexibility |

| Personnel Requirements | |
|---|---|
| **Expected maximum size of research team embarked** | • 6 persons<br>• 6 persons<br>• we typically send teams of 2-4 people on larger expeditions<br>• 15 persons |
| **Expected minimum size of research team embarked** | • 2 persons<br>• 3 persons<br>• 3 persons |

**NB:** the survey respondents were asked specifically as to the size of research teams for particular research projects. The consensus of the task team is that economies of scale would favour collaborative scientific cruises "bundling" a number of projects within a cruise. This would favour vessels with significant accommodation for researchers. See section 6.4.2

| Voyage Duration | |
|---|---|
| **Maximum duration of voyage** | • 2 days (48 hrs continuous)<br>• 28 days<br>• the ideal expedition is 2-3 weeks; longer is difficult for colleagues. This should be considered in planning, for morale, motivation, and results<br>• 14 days |
| **Minimum duration of voyage** | • 6 hrs<br>• 6 days<br>• 3 days |

| **24hr research operations anticipated** | |
|---|---|
| **Describe** | • mobile vessel surveys are conducted on a 24hr operational basis<br>• Regular Conductivity Temperature Depth survey operations plus deck deployment and recovery<br>• this can be advantageous, for cost reasons, when doing ROV work it is very frustrating working with DFO coast guard when workers do not do operations 24 h or at least strategically into the evening shift<br>• for Vehicle work may be day ops only |

| **Office Space requirement** | |
|---|---|
| **Number of workstations/docks/PC's** | • space to operate laptop computers<br>• 3-4 PC Sites<br>• will bring own<br>• it is useful for each person to have a workstation<br>• we bring own systems |
| **Connectivity requirements (local server, internet?)** | • internet capability<br>• Internet, connected to ship system<br>• internet bandwidth<br>• this is always a problem and complication; there is often downtime at sea, and if students can do their work with internet access (online analyses that connect to servers on campus; ability for regular contact with home lab) that's ideal<br>• we bring own systems<br>• INMARSAT comms |
| **Meeting rooms** | • n/a<br>• yes - meeting room for 12<br>• nil |

| **Laboratory Requirements** | |
|---|---|
| **describe** | • Electronics dry lab<br>• operational fume hoods; large lab benches for processing sediment; walk-in cold rooms; ample freezer space (-80C and -20C) |
| **portable units?** | • 20-foot sea container - operations centre<br>• yes, for molecular biology work<br>• 20' portable lab |
| **required power supply** | • 110 and 220 AC<br>• 10-foot HPU cube<br>• 440VAC, 480VAC, 600VAC |
| **supplied gases** | • Dry N2 is possible<br>• yes, for setting up experiments (various compressed gas cylinders) |
| **other** | • winch drum and level wind<br>• permission to work with low-level radioactive tracers; totally safe (e.g. 35S)<br>• crane (optional) |

| **Workshop Requirements** | |
|---|---|
| **describe** | • basic machining/repair of equipment<br>• small machine capability, lathe, milling machine |
| **portable units?** | • 20-foot sea container - workshop |
| **required power supply** | • 10-foot power module cube |
| **supplied gases** | • welding/cutting |

## 6.4 Performance Specification Summary

A summary of the responses provided allows a broad vessel performance specification to be developed that meets the requested capabilities. The most demanding requirement is used per response to each question to ensure all team members needs are addressed.

### 6.4.1 Navigation and Positioning; Endurance

Vessel positioning accuracy was deemed critical for operations involving box coring and Rosette sampling. As water depth increases, the relative positions of the surface vessel and bottom package become more flexible (i.e. a 10m movement of the ship will not translate immediately in to a similar movement sub-sea). What is critical is knowing the absolute position of the sub-sea package. In order for this to be possible, it would be typical to specify a high precision hydroacoustic system as part of the ship's equipment. Such a system must have deep water capability (with appropriate transponders) to operating depths of >4000m, and ideally up to 5000m. Vessels equipped with such a hydroacoustic system would typically couple this type of installation with a Dynamic Positioning (DP) system to provide greater commercial opportunities for the ship owner. However, DP was not specifically identified as critical. From an experience perspective, dynamic positioning capability of the vessel provides a useful capability for many purposes. The type of DP system and redundancy, the certification standard, and the capability vary significantly between "DP" systems. A detailed requirement for use would need to entail a review of actual mission requirements, the system, and its operation.

Track keeping (the ability to accurately follow a defined set of waypoints) during operations was not identified as critical, with cross track positioning of +/- 25m being acceptable. This can usually be achieved by manual control of the ship's progress. It was identified that the ship be able to sustain a speed of as low as 1 to 2 knots while maintaining a specified track.

Transit speed was not one of the questions on the survey, as it is not a research critical element. Its only impact is on the time (and therefore cost) required to move between the mobilization port and the research area and return.

The length of research voyages was described as anywhere from 3 to 28 days at sea. This would require sufficient fuel, stores, and supplies to maintain operations 24hrs/day for this period, with a sufficient reserve.

### 6.4.2 Personnel and Accommodation Spaces

The task team members identified typical research team sizes to be embarked at any given time as between 2 and 6 persons. The largest contingent was stated to be 15 persons. Cognizant of the question posed concerning personnel was directed at individual team members, it should be noted that it is standard operating practice to plan vessel missions to accommodate as many similar projects as possible. This not only promotes a collaborative approach to research, but also permits economies in vessel operating costs. Typical modern research vessels are designed to accommodate between 25 and 90 scientists on a mission/cruise.

During the follow up interviews, a dependency on the marine crews' ability and cooperation was identified as being a key factor determining the size of the research team. For launch and recovery operations, maintenance may be required on certain equipment, and general assistance with scientific deck operations, a high level of cooperation allows the embarked team to be minimized. Participants expressed past disappointment with government crews not consistently offering the desired level of cooperation. Additional comments were noted (specific to the use of AOPSs) that using navy crews might prove problematic due to mission incompatibility. In Canada certainly, this would be a new concept to be tested.

For normal (non-laboratory) requirements, the focus was on the capacity to have office type space for working on reports and administration. Each team member having an individual workstation with internet connectivity with good bandwidth and the ability to exchange data with shore facilities was deemed critical. A meeting or conference room for no less than 12 persons was identified as a useful addition.

### 6.4.3 Laboratories and Workshops

The ideal scenario is a vessel where a versatile and adaptable laboratory is available to accommodate different missions. Such a facility would have a dry electronics component for working on sensitive equipment isolated from other activities. Other requirements would include fume hoods, large lab benches for processing sediment, walk-in cold storage rooms, and ample freezer space. Power supplied to the lab should be 110/220/440/600VAC. Gases should be available with storage for setting up different experiments including the use of nitrogen. The lab should be provided with the permission to work with low level radioactive tracers. Team members offered that such labs could be supplied as fitted ISO containers (sea cans) with appropriate locations for integrating with ship's power and systems (comms and alarms) and proper sea-fastening.

Workshop requirements varied from member to member. There was an expressed interest in having support from ship's crew around basic machining, milling, lathes for small machine repairs during the voyage on research equipment. Again, portable task specific workshops in ISO standard 20-foot containers are often in use, and a vessel should be capable of accommodating these as well. Welding and cutting/burning gear and operators supplied by the marine crew as required is deemed essential by most.

### 6.4.4 Small Boat Operations

All task team members considered the availability of small work boats and launching system essential. The activities they would be used for included the landing of personnel on remote shores/beaches when required, the recovery of ocean gliders and equipment, and for use during recovery and deployment of in-water arrays. Ideally, such work boat(s) would be larger inflatables or semi-rigid inflatables with dedicated launching systems to enable a reasonable weather operating window so as not to limit research activities.

#### 6.4.5 Cranes and Winches

This is an area where requirements can vary considerably. For ease of operations, a working crane that can safely access the working area of the deck is most useful. One stated requirement was the ability to lift 3 tonnes at 7m outreach where the package was 1.5m length and width. In any event, most team members conduct research that requires deploying various scientific packages to depths up to 4,000m. Weights vary considerable as well depending on the application; under 2 tonnes is typical, with a maximum weight specified of 10 tonnes. Specialized sub-sea winches permanently installed and supported with large capacity small diameter wire and level wind capability (spooling gear) for sampling, box coring, and Rosette sampling etc., are perhaps the ideal solution. Winches for this purpose are easily installed on a semi-permanent basis for specific voyages. In these cases, they may require power supplies from the ship's systems (perhaps up to 200A service), hydraulic power (perhaps 2000psi at 20GPM), and even compressed air at about 120 CFM of 120psi. Each winch (if not a permanent installation) would have unique requirement that would need to be reviewed for compatibility and suitable mounting prior to mobilization.

#### 6.4.6 Sampling and Recording

Much of the research involves bottom and water sampling using devices deployed by down wires (cranes and winches described previously). There is an expressed desire, however, to have the capability to conduct multi-beam surveys for bathymetry and have ADCP capability (Acoustic doppler current profiler). A hydrographic quality recording bottom profiler is also a desired capability. In addition, atmospheric sampling has been identified as desirable, with hard wired sensors able to sample both near surface and highest possible locations on the vessel with inputs routed to a central recording unit.

In addition, the capability of installing an over-the-side pole mounted transducer was identified (though perhaps this would be unnecessary with integration to a suitable ship system); an accessible sea-chest/cofferdam that would enable mission specific equipment to be installed without dry-docking the ship was described.

A requirement for acoustic recording capability coupled with an acoustically quiet state of vessel operations was also identified as desirable.

#### 6.4.7 Remotely Operated Vehicles

Remotely operated vehicles (ROVs) are used for research activities covering a range of applications. Installations are either an integral part of the ship's systems or are mobilized to the ship for specific missions. Unless purpose built in to the ship design, ROVs tend to occupy a significant footprint on the ship's deck and are mostly self-contained with a dedicated launch and recovery system, winches, power packs (often supplied by ship's power), and control vans (operator controls), and dedicated crew for flying, operating, and maintaining the vehicle. ROV operating companies can provide a particular suite of tools (camera, sonar, manipulators, etc.) for the ROV independent of the task and ROV capabilities.

#### 6.4.8 Autonomous Underwater Vehicles

Autonomous vehicles are increasingly versatile tools for a variety of underwater tasks including mapping and research applications. AUVs such as the Kongsberg HUGIN have completed dives to 4500m while being tracked by hydroacoustic transducers for communicating data and commands. Being untethered, they can perform different tasks than ROVs and have different applications for an RV. The ability to accommodate an AUV launch and recovery system (LARS) is likely an essential component of any longer-term ship project. Like ROVs they would be contracted for specific missions and would need footprint on the deck of the vessel for a LARS and control van.

#### 6.4.9 General concerns arising

During the course of the survey, conversations/interviews produced a clear concern around the issue of funding for research projects, both qualitatively and quantitatively. The absolute amounts of funding levels were of some concern, but discussions of the process through which funding for sea time might be obtained invariably was of more importance. There was a definite sense that the performance specification of vessel(s), though of primary interest for the task team facilitator, was overshadowed by the frustration of not being able to access sea time for researchers on any (even marginally) suitable vessel. Although beyond the scope of this study, this was evidenced by the significant spread observed when the team members were asked about “funded” versus “desired” days to conduct research at sea (see Figure 12, pg. 19).

Overall, responses to the survey of the task team demonstrated a sense that Canada is very much lagging the other nations bordering the North Atlantic and Arctic in terms of a proactive approach to providing marine (ship) infrastructure necessary for ocean research. The funding mechanisms have been described as “beyond absurd”; in terms of access to research vessel time, Canada is “better off than nobody”; the required collaboration between government programs to obtain ship time is “dysfunctional and inefficient”; and it was expressed that government vessels exhibit significant organizational challenges compared to industry (private) vessels where research projects “tend to go more smoothly”.

Collaboration between funding agencies, between the institutions requiring access to the ocean laboratory, and between academia, government and industry would appear to be a key factor in solving the immediate need for “at sea” research time. The response to these expressed concerns must be multi-disciplinary and multi-sectoral if indeed more time at sea is to be made available for research on the Atlantic coast (Ocean Research in Canada Alliance 2018).

## 6.5 Summary Table of Performance/Capabilities

| **Summary of Vessel Performance Requirements** |
|---|
| 1. Accurate absolute vessel position system (DGPS quality)<br>2. Ability to maintain track at a minimum speed between 1-2 knots.<br>3. Accommodation for up to 15 persons on each research team. This number would increase by 3 for an ROV and/or AUV crew; additionally, if multiple research projects were run concurrently then the number increases per project.<br>4. Total accommodation for a science crew of no less than 25. Economics would necessitate a collaborative mission/cruise with a number of teams embarked.<br>5. Sufficient crew to assist to research teams for deck operations.<br>6. Sufficient marine crew to enable 24hr/day operations while at sea and support research teams throughout.<br>7. At sea endurance up to 28 days plus reserve.<br>8. Lab space with fume hoods, coolers, freezers, science gases (i.e. nitrogen) and storage, supplied VAC power. Capable of working with radioactive tracers.<br>9. Workshop able to support research equipment repairs and maintenance. Welding and burning/cutting equipment and operators.<br>10. Workboat and launch/recovery system with decent weather capabilities<br>11. Crane(s) to cover the working deck area (up to ~3 tonnes SWL).<br>12. Winches capable of deploying sub-sea sampling equipment up to 5000m depths, typically up to 2 tonne SWL.<br>13. Deck power supply; electrical to 200A; hydraulic to 20GPM@2000psi; pneumatic at 120CFM@120psi<br>14. Deep water hydro-acoustic positioning system<br>15. ADCP<br>16. Multi-beam<br>17. Acoustic recording and quiet state operations<br>18. Atmospheric monitoring system installed and centrally hard wired<br>19. Over-the-side pole mounted transducer capability<br>20. Accessible sea chest/cofferdam<br>21. Ability to accommodate LARS for an ROV.<br>22. Ability to accommodate LARS for an AUV. |

These requirements for research vessel performance are not complex. The vessel should be of a size and design that is capable of working on the open ocean of the North Atlantic as comfortably as practicable, and be fully certified to do so; sufficient deck space for necessary equipment; accommodation and endurance to carry a combined science crew of at least 25 (if research projects were run concurrently); the ability to use either installed or mounted over-the-side high accuracy deep water hydroacoustic referencing/positioning system; ability to remain at sea for a month plus reserve; craneage for deck services; workboat onboard capable of launch and recovery in a reasonably wide set of weather conditions; a crew that are an integral part of the research team and able to work closely with and support marine operations of the research team.

This basic set of requirements opens the field to a large number of vessels that might meet, or be adapted to meet, the need.

# 7 MEETING THE NEED

The results from discussions and responses from task team members clearly demonstrates that there is a defined shortage of vessel time available to conduct ocean research on the east coast of Canada. The current fleet of research vessels is managed and operated by DFO through the Canadian Coast Guard. DFO themselves have insufficient vessel days provided by this fleet to meet their annual research needs. Their solution has been to charter vessels for specific, defined, short term tasks. They have spent CAD$4.6M on charter fees in the last two years to be able to meet their historic ocean monitoring commitments. Using the published all-inclusive rates for a fully equipped European research vessel, this would have enabled a 170-day charter. It is unlikely that DFO will be able to provide sufficient assets for government driven ocean research obligations in the near term and more likely for the next several years. This will put other researchers in an unenviable position. Ocean research requirements from academia, and industry/institutional collaboratives need alternative solutions.

For many decades, ships at sea have voluntarily reported weather observations many times daily to allow weather forecasting services to gather data from a multitude of positions around the globe. This voluntary observation program is well developed and has proven a valuable source of data. The data is collected on the ship's normal voyages as a matter of routine. There is no control by researchers over the location from which the data is collected; this is governed by the commercial activity of the ship(s). Similar programs initiated to collect other data for ocean researchers are in place today. As these are more routine data collection activities, they are not considered in the context of research projects for ship time in this study.

## 7.1 CHARTERING

The assumption is made that any vessel brought in to meet the shortfall in RV time is chartered for the purpose.

In considering chartering in a vessel to meet the need, there are some basic considerations;

1. A key driver for determining vessel availability is the length of the requirement. The longer the charter, the greater likelihood of attracting a larger pool of shipowners to bid on the opportunity.
2. Fixed cost reduction – with any vessel activity, there is typically a mobilization and de-mobilization cost attached to the work. This cost is not dependent on the length of charter and may make short research projects costly.
3. The number of available "suitable" vessels in a local pool will control the market cost to charter a vessel.
4. Ocean research commissioned by DFO can utilize a foreign vessel without needing to comply with the Coasting Trade Act.

Ideally then, one would wish to align research activities to identify the longest possible period of activity in order to charter a vessel for a longer duration. This also reduces the amortized cost for mobilization/de-mobilization. It will be beneficial to tender this longer-term charter to the maximum number of possible interested shipowners for both cost and quality focused solutions. Finally, if DFO were to commission the charter, it would ease the process of using non-Canadian ships in a competitive bid process. This, of course, is what DFO themselves have been able to achieve.

There are two potential chartering options;

A. charter a research vessel designed for the specific activity;
B. charter a vessel that meets the performance specification established and install needed equipment for the voyage on a more temporary basis.

In considering the chartering of a purpose-built research vessel, size of the available pool of vessels is very limited. Although these vessels tend to be owned by government agencies and therefore not perhaps influenced by normal economics (point 3 above), they may be fully utilized by their nationals during the normal working season. They may not provide the charterer with full schedule flexibility if their other commitments take priority. (This was one of the greatest difficulties experienced by task team members with the CCG ships used on research activities that were multi-tasked).

Chartering a vessel that meets the basic performance requirements and has the requisite infrastructure in place, then installing the necessary equipment for the research voyage, becomes an attractive solution. One of the key benefits that may accrue from this solution is the ability of the charterers' client representative on the ship to fully control the vessel schedule and activity. The vessel owner would be governed by the terms of the charter alone, with no other conflicting influences.

In both A and B above, it will be necessary to bring additional specialized equipment onboard for the projects. It may be substantially reduced in scenario A and may be crated equipment for use in existing spaces/laboratories onboard. The amount of installation and commissioning work alongside will be a cost factor.

Many of the task team members have had, or have expressed an interest in, working with portable labs fitted in standard sea containers. Shared use of such "pre-fab" labs would reduce costs. The mobilization of such units to the selected vessel will minimize problems with mobilization and allow researchers to set up and commission equipment in advance of the vessels' mobilization period. Compatibility with the vessel supplied power and services connections can be verified in advance to avoid delays during mobilization. This approach to project vessels is fairly typical on the offshore oil and gas exploration/exploitation industry and has been used with good success.

One of the challenges with the modular approach to a (Canadian) solution lies in the dependence on a "pool" of vessel available to charter. Unlike Europe, where activity levels in many marine sectors ensure an abundant supply of vessels of opportunity, Canada has a marine sector that has a weak supply side. By way of example, in the offshore oil and gas marine sector, Aberdeen saw 4,292 vessel arrivals directly related to offshore oil and gas activity in 2017 (Aberdeen Harbour Board 2018). Halifax recorded visits from 210 "other" vessels in the same period only a small portion of which were related to offshore oil and gas (Atlantic Pilotage Authority 2018). The Canadian experience is that vessels are purpose built/purchased against long term contracts, and there is no "spot" market catering to short term requirements. With a restriction on the supply side, both the economics and operability of short-term charterers become difficult, despite the remarkable adaptability of the vessel type. It should be noted that in the European theatre of offshore operations, there are currently an estimated 284 offshore vessel less than 15 years old in lay-up (no work) and a further 601 laid up which are over 15 years old and unlikely to be attractive to the oil industry in todays' market (Foxwell 2017). The effect has been to maintain low day rates in the marketplace for supply vessels, much to the charterers benefit (Fig. 13) (Offshore Shipbrokers 2018).

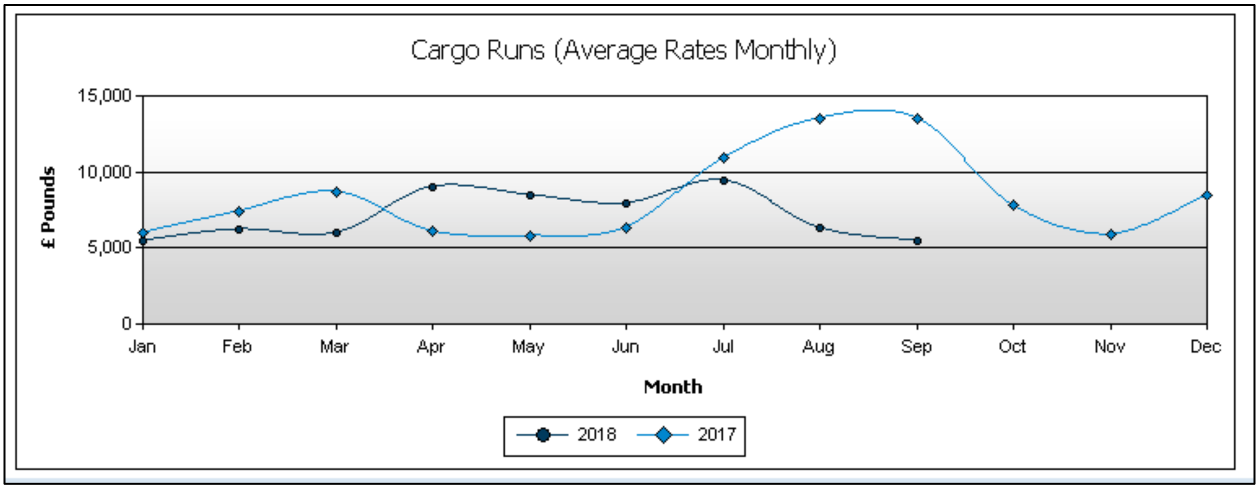


*Figure 13: OSV average charter rates North Sea (Source: Offshore Shipbrokers, 2018)*

Two other factors to be aware of in vessel chartering;

- Fuel is a significant cost for the charterer. To this end, the ideal vessel will maximize fuel economy through efficiency in hull shape and propulsion design for research requirements.
- Crew costs comprise a significant portion of the vessel operating costs. In this respect offshore crew rates (and CCG) in Canada are high, particularly in comparison to other marine sectors.

## 7.2 Asset Mix

Task team members discussed two broad categories of ocean access; coastal research and ocean research. The difference relates most importantly to the designed and certified capability and also endurance (range) of the asset needed. It is fair to say that an ocean-capable RV can well cover the requirements of coastal research, but not the other way around. Operating a coastal RV can be cost effective, but if the division of geographic parameters divides the funding available for a longer-term vessel charter, then it may not be an efficient solution for the team as a whole. The identified deficiency was clearly for ocean research. Additionally, it is worth noting that two known coastal research-capable vessels are available for charter on the east coast that are not fully utilized at present. Their specific capabilities have not been reviewed, but it is the author's considered opinion that this capacity might be more effectively utilized to meet the current need for coastal research through a coordinated approach bringing together multiple users for economies of scale.

# 8 NEXT STEPS

If funding sources were available to support the planned research of the task team members out to at least 2023, and/or until the delivery of the new CCG ocean research vessel, then the cost-effective solution is to:

1. select a lead organization;
2. develop a pooled funding mechanism that can support research from academia, industry, and government;
3. coordinate the research project activities to consolidate the days at sea required by the team as a whole;
4. develop a tender requirement for a vessel based on the performance specification;
5. further develop, test, and investigate the collaborative use of modular labs as a means to provide a flexible and economic solution to varying research requirements on shorter- term basis;
6. enlist the support of DFO for commissioning of the charter and as well for support through the use of the vessel on their mandatory ocean monitoring requirements;
7. tender the opportunity;
8. award a long-term charter for the most effective and economical solution; and
9. invite CCG/DND personnel to participate as observers on the vessel operations in advance of the new CCG/DND vessel deliveries to develop operational experience based on commercial/civilian crew methods and share expertise from the government experience.

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