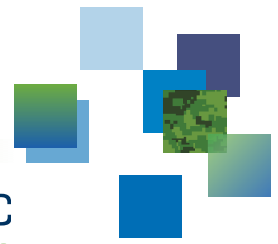




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A strategic review of the CJOC OR&A work program

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Abstract

Since 2014, the Canadian Joint Operations Command Operations Research & Analysis team's work program has been determined via an annual call letter process. While the studies conducted by team have been aimed at increasing the efficiency and effectiveness of joint force employment within the Canadian Armed Forces, the question remains: *Are the team's resources and skills being utilized to their maximum potential?* To help answer this question, the author conducted an assessment of the team's ongoing studies in terms of their status, near-term expected output, and relationship to Defence core missions, initiatives, and tasks. Based on this assessment, a series of recommendations are put forth that collectively aim to increase the team's impact with regards to joint force employment.

Résumé

Depuis 2014, le programme de travail de l'équipe de recherche et d'analyse des opérations du Commandement des opérations interarmées du Canada a été déterminé au moyen d'un processus de lettre d'appel annuel. Alors que les études menées par l'équipe visaient à accroître l'efficacité et l'efficacite de l'emploi de forces interarmées au sein des Forces armées canadiennes, la question demeure : les ressources et les compétences de l'équipe sont-elles utilisées au maximum de leurs possibilités ? Pour répondre à cette question, l'auteur a évalué les études en cours de l'équipe, en termes de statut, de résultats attendus à court terme et de relations avec les missions, initiatives et tâches essentielles de la Défense. Sur la base de cette évaluation, une série de recommandations sont formulées qui visent collectivement à accroître l'impact de l'équipe en ce qui concerne l'emploi de forces interarmées.

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1 Introduction

Since the fall of 2014, Deputy Commander Canadian Joint Operations Command (CJOC), on behalf of CJOC Operational Research and Analysis (OR&A) has issued a call letter in the November–December time frame of each Fiscal Year (FY) to CJOC Headquarters and its Level 2 organizations to solicit requirements for analytic support. In general, these requirements are aimed at increasing the efficiency and effectiveness of joint force employment. Recent requests for analytic support include (the organization or individual requesting support is shown in bold):

- **Canadian Materiel Support Group (CMSG)**: improve the Canadian Armed Forces (CAF)’s readiness through optimizing its inventory of supplies, spares, and clothing as well as its domestic distribution network that delivers these items (Rempel, 2018);
- **Joint Task Force North (JTFN)**: improve the CAF’s medical supply planning for domestic operations in the north through statistical analysis of historical medical incidents to determine the type and quantity of medical kit required (Nixon, 2017); and
- **Deputy Commander CJOC**: increase Commander CJOC’s understanding of issues affecting operations through developing an approach to integrate information about current operations with intelligence and planning (Rempel, 2018).

The resources required—in terms of both personnel and L105 funds—to address the complete set of requests in any given fiscal year tends to exceed CJOC OR&A’s available resources. Given this situation, a Senior Review Board (SRB), co-chaired by Deputy Commander CJOC and Defence Research and Development Canada (DRDC) management, selects a subset of requests to be addressed. This process is depicted in Figure 1.

While the subsequent studies addressing the selected requests often have a significant impact,¹ the question remains as to whether CJOC OR&A resources and skills are being utilized to their maximum potential. With this in mind, based on consultation with Deputy Commander CJOC, in August 2018 CJOC Chief of Staff (COS) Readiness posed the following question to the author—*What would an ideal year for CJOC OR&A look like?* (Anderson, 2018).

If one assumes CJOC OR&A’s purpose, as stated in its charter (Defence Research and Development Canada, 2017), is to conduct operations research and strategic analysis studies aimed at increasing the efficiency and effectiveness of joint force employment, then the immediate answer to this question is relatively straightforward. An ideal year would be

¹ For example, models and methods developed by MacLeod et al. (2018) are now a core component of the Joint Training Authority (JTA)’s business planning process, and were endorsed by Commander CJOC in the 2018 Joint Managed Readiness Plan. This work has significantly transformed how joint exercises are evaluated and selected for inclusion in the CAF’s joint exercise training plan.

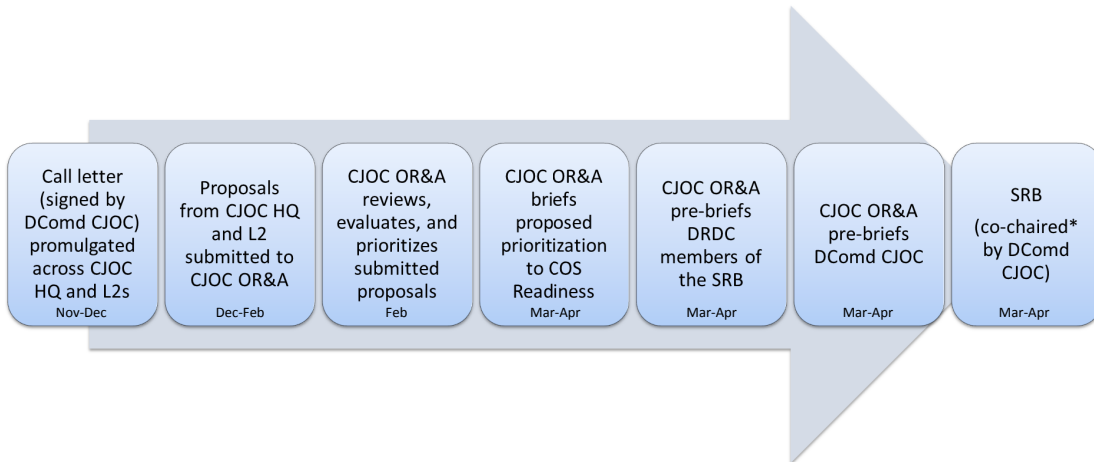


Figure 1: CJOC OR&A call letter process. Each step is represented by a rounded rectangle. The time frame when a step typically occurs is identified.

one in which each member of the CJOC OR&A team can clearly identify how their efforts directly contribute to increasing the efficiency and effectiveness of joint force employment, either through (a) supporting one or more specific significant decisions or (b) improving one or more repetitive processes by reducing the resources or time required. With this in mind, the author initiated and led two activities.

1. An assessment of the CJOC OR&A team’s ongoing studies (section 2).
2. Development of recommendations, to be considered by CJOC leadership and DRDC program formulation staff, that collectively aim to increase the team’s impact with regards to joint force employment (section 3).

These activities were conducted through a combination of (a) working meetings including the author, CJOC OR&A staff, and DRDC program formulation staff (CJOC OR&A, 2018), and (b) discussions between the author and former CJOC OR&A team leads (Kaluzny, 2018; Vincent, 2018).

The remainder of this document presents the output of these activities: section 2 describes the assessment process and results and section 3 lays out the recommendations.

2 Review of existing work program

CJOC OR&A's charter states the team's primary focus to provide analytic support aimed at increasing the efficiency and effectiveness of joint force employment (Defence Research and Development Canada, 2017). Furthermore, it states this analytic support should focus on Horizon 1 (0–5 years) issues, with a minor focus on Horizon 2 (5–15 years) and Horizon 3 (15–30 years). With this in mind, this section presents an assessment of the team's ongoing studies through three lenses:

1. current status and expected near-term output;
2. relationship to the core missions identified in Strong, Secure, Engaged (SSE) (Government of Canada, 2017, p. 17); and
3. relationship to SSE initiatives (Government of Canada, 2017) and tasks identified in Defence Plan 2018–2023 (National Defence, 2018) of primary or collateral interest to CJOC.

While the studies may be assessed through many other attributes, e.g., classification, scientific merit, etc., the aforementioned three place a clear focus on value to CJOC and joint force employment rather than other topics.

2.1 Current status and expected output

The current CJOC OR&A work program consists of eight studies initiated between fiscal year 2013/14 and 2018/19. Each ongoing study was assessed in terms of its *current status* and near-term *expected output*, where near-term was selected to be defined as before the end of fiscal year 2019/2020, i.e., for studies initiated in fiscal year 2018/19, two year's of output are considered.

First, each study's current status was assessed to be in one of three categories which are defined as follows.

- **On track:** The study is on track and progressing well.
- **Delayed:** The study is progressing, but is behind schedule due to various issues, e.g., availability of data, contracting delays, etc., which may be overcome given time and resources.
- **Not progressing:** The study is not progressing due to ongoing significant issues, e.g., lack of client support, availability of data, etc., which are not expected to be overcome in the near future.

Next, each study's near-term expected output was assessed to be in one of four categories which are defined as follows (Dykes, 2016).

- **Data:** Data is unprocessed facts, either quantitative or qualitative, e.g., SQL database of joint exercise data, Microsoft Excel spreadsheet of search and rescue data, etc.
- **Information:** Information is analyzed data that is organized into a format that provides more context, e.g., clustering of search and rescue events, difference in evacuation time in an Arctic maritime scenario as a function of forward operating base, etc. Information is often delivered in the form of data tables, visualizations, reports, and dashboards.
- **Actionable insights:** Actionable insights are generated by analyzing information and drawing conclusions to provide scientific advice, e.g., to fulfill the Joint Training Authority’s desire to develop a five-year joint exercise plan, a significant effort towards joint exercise data capture and management must be undertaken. Such advice may be used to support decision making, to enable a decision maker to rethink a subject, or to influence a decision maker to move in a new direction.

If a study’s near-term expected output was assessed to likely generate information, then it is assumed it will also generate data, and likewise for actionable insights. In addition, each study’s near-term expected output was assessed as to whether methods/models are expected to be deployed or not. Both status and output assessments were performed in consultation with CJOC OR&A staff.

The results are listed in Table 1. Four of the existing eight studies are classified as *on track* (shown in green), three are *delayed* (shown in yellow), and one is *not progressing* (shown in red). Furthermore,

- those considered *on track* are studies either initiated in 2018/19, i.e., CAF distribution network, positive ship identification, have been ongoing for several years, i.e., search and rescue, or have produced their primary output and are awaiting further discussions with the study sponsor, i.e., joint exercise portfolio optimization;
- studies considered *delayed* were initiated in fiscal year 2017/18 or 2018/19, and have experienced delays due data acquisition, data validation, or client engagement; and
- the study considered *not progressing* is due to a lack of sponsor interest and/or response to CJOC OR&A requests for access to data, scheduling engagement meetings, etc.

With respect to near-term *expected output*, the majority of studies (6 of 8) are expected to produce *actionable insights*, with the remainder (2 of 8) generating information. In addition, half are expected to result in either methods or models being deployed to the study’s sponsor.

Table 1: Ongoing CJOC OR&A studies in fiscal year 2018/19. The current status of each study is assigned one of three categories as depicted by its row colour: green indicates a study in on track; yellow indicates a study is delayed; and red indicates a study is not progressing. Near-term expected outputs are categorized by type: *Data*, *Information*, or *Actionable insights*; and whether methods/models will be deployed.

Title	FY	Sponsor	Description of current status	Expected output	
				Type	Deployed?
Support to Search and Rescue	2013/14	CJOC SAR	Annual summer search and rescue squadron response posture conducted (Vincent and Chan, 2015; Chan, 2015, 2017, 2018). Search and rescue mission reporting template has been designed and distributed to squadrons. Ad hoc requests to perform data mining are supported as required.	Actionable insights	Yes
Joint exercise portfolio optimization	2016/17	Joint Training Authority	Value model and optimization model designed, implemented, and demonstrated in fall 2017 (MacLeod and Rempel, 2017b). Results briefed to the Joint Training Advisory Group Conference (MacLeod and Rempel, 2017a). Models/methods incorporated into the 2018 Joint Managed Readiness Program. Scientific report detailing methods, example application, and recommendation submitted to DRDC Editorial Office (MacLeod et al., 2018), final publication expected in October 2018. Future work dependent upon pending discussions with Joint Training Authority staff.	Information	Yes
CAF distribution network: distribution and inventory optimization	2018/19	Comd CMSG	Distribution optimization component of the study initiated in June 2018. Supply depots visited in Aug/Sept 2018. Definition of problem statement and way forward expected to be published as scientific letter and briefed to Comd CMSG in mid-October 2018.	Actionable insights	No
An algorithm to support positive ship identification	2018/19	DCOS Contl Ops	Study kick-off meeting held in early June 2018. Study commencing in Sept 2018 upon the posting of Mr. Rick McCourt to the CJOC OR&A team. Initial work includes visits to various groups relevant to this study, i.e., DRDC Atlantic, MARLANT N6, etc.	Actionable insights	Yes

Continued on next page

Title	FY	Sponsor	Description of current status	Expected output	
				Type	Deployed?
Northern infrastructure study	2017/18	DCOS Contl Ops	Database of enterprise northern infrastructure compiled in summer 2017 (Chan and Rempel, 2017). Major maritime scenario developed and initial modelling results briefed to the study's sponsor in spring 2018 (Chan et al., 2018). Based on feedback, data validation occurred in summer 2018 and updated modelling results expected in late 2018.	Information	No
Northern health support services	2017/18	JTFN and CAF Health Services	Study initiated in fall 2017. Significantly delayed due to data sharing issues. Data has become accessible as of summer 2018, however modelling has not progressed due to a lack of resources.	Actionable insights	No
Strategic analytic support to Commander's operational estimate and theatre campaign plan development	2018/19	DCOS Plans	Options presented to Commander CJOC in January 2018. Estimates produced for Europe/Russia in spring 2018 (results are classified). Awaiting further direction from CJOC leadership in fall 2018.	Actionable insights	Yes
A feasibility study of Canadian Forces Integrated Command Centre backup locations	2018/19	CFICC Director	Study kick-off meeting held in early May 2018. Sponsor has failed to respond to inquiries since mid-June 2018. Limited progress has been made due to a lack of client input.	Actionable insights	No

2.2 Relationship to operations

The second lens through which to view the ongoing CJOC OR&A studies is their relationship to the CAF's core missions (Government of Canada, 2017, p. 17). Table 2 lists the mapping between studies and core missions in terms of whether a study *directly* supports the CAF either planning for or conducting a core mission, or if a study *indirectly* supports these activities. In the context of this assessment, these are defined as follows.

- **Direct:** Direct support is defined as methods, models, advice, etc. that are used by operators or planners to either conduct or plan a core mission, e.g., the *Positive ship identification study* aims to develop an algorithm to be used by operators to help assess whether a potential contact is a legitimate contact and assign a confidence level to each assessment (Rempel, 2018, p. 3).
- **Indirect:** Indirect support is defined as methods, models, advice, etc. that influence how operators or planners either conduct or plan for a core mission, however the operators or planners are not expected to use the methods, models, advice, etc. themselves. For example, the *CAF distribution network study* indirectly supports defending threats against Canada and North America, providing assistance to civil authorities, etc. through optimizing the domestic distribution network and inventory to ensure that supplies and spares are delivered to units at domestic bases such that they can effectively conduct core missions.

The main takeaway from Table 2 is that the majority of linkages (28 of 31) provide indirect, rather than direct, support to core missions. In addition, the *Canadian Forces Integrated Command Centre (CFICC) backup location study* is neither directly nor indirectly linked to any core mission, primarily due to that the study is not relevant to the operation of the CFICC itself but rather its business continuity plan.

Beyond direct/indirect support, Table 2 also indicates the majority of analytic support (19 of 31 linkages) is provided to those core missions related to being strong at home, with less support (12 of 31 linkages) being provided to missions related to being secure in North America or engaged in the world—although it should be noted that many studies are related to more than one core mission.

Table 2: Mapping CJOC OR&A studies to core missions. A filled circle indicates a study either directly supports the CAF planning for or conducting a core mission, whereas a half-filled circle indicates an indirect relationship. Study titles have been shortened for readability.

Core mission	Search and Rescue	Joint exercise	Distribution network	Ship identification	North infrastructure	North health services	Commander's estimate	CFICC backup
Detect, deter and defend against threats to or attacks on Canada	●	◐	●	◐	◐	◐		
Detect, deter and defend against threats to or attacks on North America in partnership with the United States, including through NORAD	◐	◐	●	◐	◐	◐		
Lead and/or contribute forces to NATO and coalition efforts to deter and defeat adversaries, including terrorists, to support global stability	◐							◐
Lead and/or contribute to international peace operations and stabilization missions with the United Nations, NATO and other multilateral partners	◐							◐
Engage in capacity building to support the security of other nations and their ability to contribute to security abroad	◐							◐
Provide assistance to civil authorities and law enforcement, including counter-terrorism, in support of national security and the security of Canadians abroad	◐	◐	◐					◐
Provide assistance to civil authorities and non-governmental partners in responding to international and domestic disasters or major emergencies	◐	◐	◐	◐				◐
Conduct search and rescue operations	●	◐	◐	◐				

2.3 Relationship to policy

The third lens through which to view the ongoing CJOC OR&A studies is their relationship to the SSE initiatives and Defence Plan tasks for which CJOC is either an Office of Primary Interest (OPI) or Office of Collateral Interest (OCI) (National Defence, 2018). The mapping between the SSE initiatives for which CJOC is either an OPI or OCI and the existing CJOC OR&A studies is listed in Table 3. Each mapping is classified as either *direct* or *indirect*. In the context of this assessment, these are defined as follows.

- **Direct:** Direct support is defined as methods, models, advice, etc. that are used by either the OPI or OCI to complete the task.
- **Indirect:** Indirect support is defined as methods, models, advice, etc. that influence how either the OPI or OCI complete the task, however the OPI or OCI are not expected to use the methods, models, advice, etc. themselves.

The main takeaway from Table 3 is that currently 10 of the 37 initiatives are supported, in particular both in which CJOC is the OPI. However, all linkages are deemed to be indirect rather than direct support.

Table 3: Summary of Strong, Secure, Engaged initiatives in which CJOC is either the OPI or OCI. Check marks indicate the assigned status as listed in the Defence Plan (National Defence, 2018). A filled circle indicates an initiative is directly supported by an ongoing CJOC OR&A study and a half-filled circle indicates an initiative is indirectly supported.

Initiative	OPI	OCI	Task	Direct / Indirect	Study
9		✓	Provide tax-free salary for all Canadian Armed Forces members deployed on all named international operations, up to the maximum rate of pay applied to a Lieutenant-Colonel. This would not impact hardship and risk pay or operational allowances regulated by the Military Foreign Service Instructions (MFSI), which will continue. This Initiative is retroactive to January 2017.		
31		✓	Operate and modernize the four Victoria-class submarines.		
34		✓	Acquire ground-based air defence systems and associated munitions capable of protecting all land-based force elements from enemy airborne weapons.		
40		✓	Modernize logistics vehicles, heavy engineer equipment and light utility vehicles.		

Continued on next page

Initiative	OPI	OCI	Task	Direct / Indirect	Study
41		✓	Improve the Army's ability to operate in remote regions by investing in modernized communications, shelters, power generation, advanced water purification systems, and equipment for austere environments.	●	North infrastructure
42		✓	Modernize land-based command and control, intelligence, surveillance and reconnaissance systems.		
56		✓	Operationalize the newly acquired Fixed-Wing Search and Rescue aircraft fleet.		
62		✓	Acquire joint command and control systems and equipment, specifically for integrated information technology and communications.		
64		✓	Improve the capabilities of the Joint Deployable Headquarters and Signals Regiment, including the portable structures that house the headquarters when deployed and the equipment employed by that headquarters for command, control and communications.		
65		✓	Improve cryptographic capabilities, information operations capabilities, and cyber capabilities to include: cyber security and situational awareness projects, cyber threat identification and response, and the development of military-specific information operations and offensive cyber operations capabilities able to target, exploit, influence and attack in support of military operations.		
70		✓	Establish up to 120 new military intelligence positions, some of which will be filled by Reservists, and add up to 180 new civilian intelligence personnel.		
71		✓	Build CFINTCOM's capacity to provide more advanced intelligence support to operations, including through an enhanced ability to forecast flashpoints and emerging threats, and better support next generation platforms, and understand rapid developments in space, cyber and other emerging domains.		
72		✓	Establish a Canadian Armed Forces targeting capability to better leverage intelligence capabilities to support military operations.		

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Initiative	OPI	OCI	Task	Direct / Indirect	Study
75		✓	Assign Reserve Force units and formations new roles that provide full-time capability to the Canadian Armed Forces through part-time service.		
76		✓	Enhance existing roles assigned to Reserve Force units and formations.		
77		✓	Employ the Reserve Force to deliver select expeditionary missions in a primary role such as Canadian Armed Forces capacity building.		
81		✓	Offer full-time summer employment to Reservists in their first four years with the Reserves commencing in 2018.		
83		✓	Defend and protect military space capabilities, including by working closely with allies and partners to ensure a coordinated approach to assuring continuous access to the space domain and space assets.		
84		✓	Work with partners to promote Canada's national interests on space issues, promote the peaceful use of space and provide leadership in shaping international norms for responsible behavior in space.	●	Commander's estimate
85		✓	Invest in and employ a range of space capabilities, including space situational awareness, space-based earth observation and maritime domain awareness, and satellite communications that achieve global coverage, including in the Arctic.		
88		✓	Develop active cyber capabilities and employ them against potential adversaries in support of government-authorized military missions. This capability will be developed in close cooperation with the Communications Security Establishment.	●	Commander's estimate
91		✓	Invest in a range of remotely piloted systems, including an armed aerial system capable of conducting surveillance and precision strikes.		
102		✓	Examine alternative energy options and their potential use for operations.		
106		✓	Enhance the mobility, reach and footprint of the Canadian Armed Forces in Canada's North to support operations, exercises, and the Canadian Armed Forces' ability to project force into the region.	●	North infrastructure, North health services

Continued on next page

Initiative	OPI	OCI	Task	Direct / Indirect	Study
109		✓	Collaborate with the United States on the development of new technologies to improve Arctic surveillance and control, including the renewal of the North Warning System.		
110	✓		Conduct joint exercises with Arctic allies and partners and support the strengthening of situational awareness and information sharing in the Arctic, including with NATO.	●	Joint exercise
111		✓	Modernize NORAD to meet existing challenges and evolving threats to North America, taking into account the full range of threats.	●	Commander's estimate
D		✓	Bolster its ability to respond to increasingly severe natural disasters at home and abroad.		
E	✓		Increase presence in the Arctic over the long-term and work cooperatively with Arctic partners.	●	North infrastructure, North health services
K		✓	Canada will pursue a leadership role and will prioritize interoperability in its planning and capability development to ensure seamless cooperation with allies and partners, particularly NATO.		
L		✓	DND will be able to support conflict prevention, mediation, and post-conflict reconstruction, with an emphasis on human rights and, in particular, gender equality.	●	Commander's estimate
M		✓	DND will maintain the capacity to provide protection and relief to the world's most vulnerable populations, creating the stability necessary for development and sustainable peace to take root.		
N		✓	DND will foster world-class expertise for building the capacity and resiliency of others, and delivering tangible results in those areas.		
O		✓	CAF will further integrate the Reservists into the total force.		
Q		✓	Defence Global Engagement Strategy - DND will continue to support Canada's engagement and leadership in international policy discussions.	●	Commander's estimate
S		✓	CAF will develop and maintain a robust capacity to respond concurrently to multiple domestic emergencies.		

Continued on next page

Initiative	OPI	OCI	Task	Direct / Indirect	Study
Z2		✓	Address the threat stemming from terrorism and the actions of violent extremist organizations, including in the ungoverned spaces.	●	Commander's estimate

The Defence Plan tasks for which CJOC is either an OPI or OCI and their relationship to existing CJOC OR&A studies are listed in Table 4. Each mapping is classified as either *direct* or *indirect*, where the definitions are those used in the previous table.

The main takeaway from Table 4 is that:

- each task is directly supported by at least one CJOC OR&A study, with the exception of the Binational Northern Approaches task which is supported by the North American Aerospace Defence Command (NORAD) Operational Research Team; and
- three of the eight ongoing studies are neither directly nor indirectly supporting a Defence Plan task that is of interest to CJOC.

Table 4: Mapping CJOC OR&A studies to Defence Plan tasks for which CJOC is either the OPI or OCI. A filled circle indicates a study either directly supports the task, whereas a half-filled circle indicates an indirect relationship. Study titles have been shortened for readability.

Defence Plan task	Search and Rescue	Joint exercise	Distribution network	Ship identification	North infrastructure	North health services	Commander's estimate	CFICC backup
CJOC will further develop the Joint Managed Readiness Plan, ensuring that the joint readiness agenda objectives can be fulfilled.	●							
Strategic Joint Staff (SJS), supported by CJOC and ADM(S&T), in collaboration with the United States, will lead and coordinate the Department of National Defence (DND)/CAF contribution to the Binational Northern Approaches Surveillance Analysis of Alternatives.	NORAD Operational Research Team							
CJOC, in collaboration with other L1 organizations and allies, will enhance and expand the Defence northern footprint, while increasing capabilities in surveillance, mobility and training in Canada's north, in order to enhance the CAF's ability to operate in the Arctic and adapt to a changed security environment.				◐	◐	◐		
In support of existing fleets, ADM(Mat), supported by the ADM(Fin) / CFO, DOS SJS and CJOC is to lead the continued departmental effort to enhance materiel accountability by implementing modern, effective inventory controls, supply chain management and inventory valuation.	●							

2.4 Summary

In this section the ongoing CJOC OR&A studies have been reviewed in terms of their current status, expected type of output, whether methods/models developed will be deployed, and their relationship to core missions, SSE initiatives, and Defence Plan tasks. Table 5 presents a summary of this analysis, where check marks indicate a positive response to a yes/no question, half-filled circles indicate an indirect relationship, and filled circles indicate a direct relationship.

Table 5: Summary of ongoing CJOC OR&A studies. Green status indicates a study is on track, yellow indicates a study is delayed, and red indicates not progressing. Check marks indicate a positive response to a yes/no question, half-filled circles indicate an indirect relationship, and filled circles indicate a direct relationship.

Characteristic	Search and Rescue	Joint exercise	Distribution network	Ship identification	North infrastructure	North health services	Commander's estimate	CFICC backup
Status	Green		Yellow		Red			
Data								
Information		✓		✓				
Actionable insights	✓		✓	✓		✓	✓	✓
Deploy methods/models	✓	✓		✓			✓	
Core mission	●	◐	◐	●	◐	◐	◐	
SSE initiative		◐			◐	◐	◐	
Defence Plan task	●	●			◐	◐	◐	

The key points from Table 5 are as follows.

- Both the *Joint exercise portfolio optimization study* and *CAF distribution network study* provide significant value to CJOC as they each have a direct relationship to a Defence Plan task of interest to CJOC and indirectly support one or more core missions. In addition, the *Joint exercise portfolio optimization study* has deployed methods/models to their respective study's sponsor. It should be noted that the *Joint exercise portfolio optimization study* has completed its initial objectives, however it generated several recommendations that if acted upon by the JTA would generate follow on OR&A studies.

- Both the *Northern infrastructure study* and *Northern health support services study* have value to CJOC as they each have an indirect relationship to a Defence Plan task of interest to CJOC and have an indirect relationship to one or more SSE initiatives and core missions. The *Northern health support services study* is expected to generate actionable insights through evaluating the impacts of changes to medical protocol standards and investigating the standardization of medicine/equipment used during Arctic exercises—however, this study has experienced significant delays due to data accessibility issues. The *Northern infrastructure study* is not expected to generate actionable insights as its main contribution is to demonstrate a methodology that may be used to support Arctic infrastructure investment/divestment decisions, and thus a specific decision is not being supported. That said, the study’s results are expected to be of interest to those beyond CJOC, include CAF Health Services, Air Force, etc.
- Neither the ongoing support to Search and Rescue (SAR) nor the *Positive ship identification study* are linked to a Defence Plan task or SSE initiative of interest to CJOC. However, both are directly related to one or more core missions, and either have or are expected to generate actionable insights and deploy methods/models to their respective study’s sponsors. While the support to SAR has been going on for several years and produces output on an annual basis, the *Positive ship identification study* was initiated in September 2018.
- The *Commander’s operational estimate study* is delayed solely due to the change of command within CJOC during summer 2018.
- Lastly, *CFICC backup location feasibility study* has experienced significant issues with respect to sponsor engagement. CJOC OR&A has made numerous attempts to contact the study sponsor and have not received a reply. In addition, when data collection did occur in spring 2018, CFICC staff did not provide adequate information and thus this process was significantly hampered.

3 Way forward

Based on the assessment presented in the previous section, discussions with former CJOC OR&A team leads (Kaluzny, 2018; Vincent, 2018), meetings with current CJOC OR&A staff and DRDC program formulation staff (CJOC OR&A, 2018), as well as the author's own experience, eight recommendations have been developed whose aim is to collectively increase the team's impact with regards to joint force employment. These recommendations put a clear emphasis on increasing support to operations, however it should be noted that other themes, which may have overlapping recommendations, exist, such as: supporting headquarters functions, supporting repetitive processes, etc. While such themes could be explored, it is the author's opinion that support to operations has a stronger direct alignment with joint force employment than other themes. Thus, these themes are not further explored within this document.

The remainder of this section lays out the eight recommendations, which the author hopes will be discussed and considered amongst CJOC leadership and DRDC program formulation staff.

Recommendation #1—Supporting operations: While CJOC OR&A studies do directly support operations, such as Operation LIMPID through the *Positive ship identification study* and Search and Rescue through the ongoing support, Table 5 indicates the majority of support to core missions is indirect. In an effort to increase the team's impact, it is recommended that the team investigate avenues to directly support operations, i.e., Operation PRESENCE-Mali, Operation REASSURANCE, Operation IMPACT, etc. To do so, CJOC OR&A staff must have an understanding of the problem terrain, thus enabling decision-makers and the team to communicate effectively about problems and/or opportunities in the environment. This may include in-depth discussions with those CJOC branches directly supporting operations, technical assistance visits for face-to-face meetings with operations' commanders and staff, etc.

Recommendation #2—Supporting intelligence analysis: Related to directly supporting operations is providing direct support to intelligence analysis. Operations Research (OR) has been applied in this field, although not extensively Kaplan (2011, 2012).^a How CJOC OR&A may best support J2—such as determining *What is the best way to allocate intelligence resources between competing areas of intelligence concern? What is the best allocation of resources between the intelligence production phases? For a given intelligence collection requirement, what is the optimal portfolio given budget, time, and accuracy constraints?*—remains an open question. To answer this question, a deep understanding the intelligence environment, gained through direct observation,

is required. Thus, similar to Recommendation #1, in-depth discussions with J2 staff must occur to gain such knowledge.

^a Examples include: developing mathematical models that describe how different pieces of battlefield intelligence combine to determine the overall value of an intelligence report (Caldwell et al., 1961); constructing networks that describe tasks, their duration, and precedence relations required to enable the completion of an adversarial's project (Harney et al., 2006); and developing methods and processes to determine which policies, research and development, and programs to implement in military intelligence (Cesar et al., 1994).

Recommendation #3—Reporting structure: As of September 2018, CJOC OR&A functionally reports to COS Readiness, and as such attends two meetings on a regular basis: *COS Readiness Weekly Coord* and *Future Ops and Plans*. In general, neither of these meetings keep the team abreast of developments and emerging requirements. Thus, to effectively implement Recommendation #1 and #2, it is recommended that how CJOC OR&A interacts with the Command be reconsidered. For example, attending COS Operations and Support coordination meetings, attending individual branch meetings, working groups, planning sessions, etc. should be considered. While it is recognized that each meeting itself may not generate a study, such attendance will help team members gain a deeper understanding of the operations and the intelligence environments and build strong relationships CJOC staff.

Recommendation #4—Call letter: As of September 2018, the overwhelming majority of studies conducted by CJOC OR&A are initiated through its call letter process. While the team occasionally receives requests to address emerging requirements, these tend to be extensions of existing studies approved through previous call letter processes. In order to effectively implement Recommendation #1 and #2, the CJOC OR&A team must be able to tackle emerging requirements in a timely manner. Thus, it is recommended that the number of studies accepted via the call letter process be limited to ensure resources are available when required.

Recommendation #5—Reviewing support to existing studies: As noted in Table 1 and Table 5, one of CJOC OR&A's current studies is not progressing. Given this situation, it is recommended that support to the *CFICC backup location study* be terminated.

Regarding the *Commander's operational estimate study*, it is recommended that the requirement for analytic support to develop theatre campaign plans be confirmed with CJOC leadership.

In addition, although the *Northern infrastructure study* is indirectly linked to four core missions, three SSE initiatives, and one Defence Plan task, it is neither expected to produce actionable insights nor to deploy methods/models. Thus it is recommended as *Northern infrastructure study* document its current work and subsequently commence discussions with the study's sponsor to determine if this study should continue or be terminated. However, if this study is continued it will impact the resources available to implement Recommendations #1 and #2.

Lastly, the *Northern health services study* is indirectly linked to two core missions, two SSE initiatives, and one Defence Plan task, and is expected to generate actionable insights; however, this study is significantly delayed. Thus, it is recommended that in consultation with the study's sponsor the *Northern health services study* be critically reviewed to determine its value and whether it should be continued or terminated. However, if this study is continued it will impact the resources available to implement Recommendations #1 and #2.

Recommendation #6—Reviewing Search and Rescue: Based on a study by Kaluzny (2014), in each fiscal year the team assesses the SAR response posture's alignment with incident occurrence. While this effort is directly linked to a core mission, as the models/methods employed are well developed this work is a strong candidate to be either conducted by contractor or a student. Thus, it is recommended that the team investigate options to conduct this analysis such that team's resources may be utilized within other studies.

Recommendation #7—Building on success: While the previous recommendations put an emphasis on operations, *one-off decisions* and *repetitive processes* within CJOC headquarters and its L2 organizations do significantly benefit from the application of operations research and strategic analysis. In fact, these constitute the overwhelming majority of submissions to the current call letter process. Thus, it is recommended that the team continue to build on its successes over the last few years, such as the *Joint exercise portfolio optimization study*, *Commander's operational estimate*, etc., and provide analytic support to these organizations as required, although with less focus as stated in Recommendation #4.

Recommendation #8—Resources constraints: As mentioned in the Introduction, the CJOC OR&A team's resources are constrained in terms of both personnel and funding.

- **Personnel constraints:** As of September 2018, the CJOC OR&A team consists of six positions—five operations research analysts and one strategic analyst, of which one position is assigned team lead / project manager duties. Depending on expertise, experience, professional development commitments, etc., typically an analyst may contribute to two studies per fiscal year, although this varies depending on the posed research questions and the time frame required for a response. However, in general more than one analyst contributes to each study, thus limiting the number of studies that can be conducted at any given time.
- **Funding constraints:** Each fiscal year DRDC provides the CJOC OR&A team with L105 funding to be used for travel, training, software, and contracting related to its ongoing studies. Historically, this funding has been approximately \$100k, however additional funding, which may take up to several months to be allocated, may be requested to support specific initiatives.

Given these constraints and that the demand for CJOC OR&A resources typically exceeds its supply, it is recommended that multiple avenues to access additional resources be investigated, such as: (a) hire either co-op (four month term) or internship (eight or 16 month term) students; (b) sponsor foreign military officers (with experience in operations research) to work within the team for a period; (c) collaborate with universities to explore if certain proposed studies may in part be tackled as undergraduate or graduate projects; and (d) engage colleagues within the Five-Eyes and NATO communities to collaborate on topics of common interest and gain access to established models/methods.

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List of symbols, abbreviations, and initialisms

CAF Canadian Armed Forces

CFICC Canadian Forces Integrated Command Centre

CJOC Canadian Joint Operations Command

COS Chief of Staff

CMSG Canadian Materiel Support Group

DND Department of National Defence

DRDC Defence Research and Development Canada

FY Fiscal Year

JTA Joint Training Authority

JTFN Joint Task Force North

NORAD North American Aerospace Defence Command

OPI Office of Primary Interest

OCI Office of Collateral Interest

OR Operations Research

OR&A Operational Research and Analysis

SAR Search and Rescue

SJS Strategic Joint Staff

SRB Senior Review Board

SSE Strong, Secure, Engaged

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Since 2014, the Canadian Joint Operations Command Operations Research & Analysis team's work program has been determined via an annual call letter process. While the studies conducted by team have been aimed at increasing the efficiency and effectiveness of joint force employment within the Canadian Armed Forces, the question remains: *Are the team's resources and skills being utilized to their maximum potential?* To help answer this question, the author conducted an assessment of the team's ongoing studies in terms of their status, near-term expected output, and relationship to Defence core missions, initiatives, and tasks. Based on this assessment, a series of recommendations are put forth that collectively aim to increase the team's impact with regards to joint force employment.

Depuis 2014, le programme de travail de l'équipe de recherche et d'analyse des opérations du Commandement des opérations interarmées du Canada a été déterminé au moyen d'un processus de lettre d'appel annuel. Alors que les études menées par l'équipe visaient à accroître l'efficacité et l'efficacité de l'emploi de forces interarmées au sein des Forces armées canadiennes, la question demeure: les ressources et les compétences de l'équipe sont-elles utilisées au maximum de leurs possibilités? Pour répondre à cette question, l'auteur a évalué les études en cours de l'équipe, en termes de statut, de résultats attendus à court terme et de relations avec les missions, initiatives et tâches essentielles de la Défense. Sur la base de cette évaluation, une série de recommandations sont formulées qui visent collectivement à accroître l'impact de l'équipe en ce qui concerne l'emploi de forces interarmées.