Operational Analysis at Combined Maritime Forces

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Abstract

Combined Maritime Forces (CMF) is a multi-national naval partnership, which exists to promote security, stability and prosperity across approximately 2.5 million square miles of international waters in the Middle East. This area of operations encompasses some of the world's most used shipping choke points, including the Bab Al Mandeb and Straits of Hormuz. While Operational Analysts (OA) from four (US, AUS, UK and CAN) countries have conducted analysis to support command decision-making at both the headquarters and subordinate task force levels since 2006, there has been relatively little formal scientific publication of the work, even in internal reports. As such this paper will first provide an overview of the operation of CMF and its subordinate task forces, and the role of OA therein. Historical analysis projects have included reporting the relationship between the rate of seizures and other key factors such as deployment of forces, time, environmental factors and narcotic cultivation/production. The challenges of covering such a large area of operations with relatively few units, as well as for OA tracking and reporting realistic effectiveness will be included. Finally, recent attempts to deepen the analysis of the maritime pattern of life in the area will be discussed.

Introduction

This paper provides an overview of the Operational Analysis (OA) work that has been conducted at Combined Maritime Forces (CMF) in Bahrain over the past decade. CMF is a 30 nation "naval partnership, which exists to promote security, stability and prosperity across approximately 2.5 million square miles of international waters," with a United States Navy (USN) Vice Admiral as its Commander, and Royal Navy (RN) Commodore as its Deputy [1]. It comprises three Combined Task Forces (CTFs) focused on: counter terrorism (CTF-150); counter piracy (CTF-151); and Arabian Gulf security and cooperation (CTF-152). CTF-152's Area of Operations (AOO) is the Arabian Gulf, while CTF-150 and CTF-151 both patrol an area which extends from the Suez Canal in the North West to 15 degrees South (see Figure 1). Unlike, for instance, the North Atlantic Treaty Organization (NATO), CMF's members are not bound by a treaty and participation is purely voluntary; no member state is asked to carry out a duty it is unwilling or unable to conduct.

CMF was formed following the events of 11 September 2001, in response to United Nations Security Council Resolution (UNSCR) 1373 [2]. Since 2006, analysts have been embedded in various parts of the organization as it has evolved along with its mission. Of the authors, Mr. Wardrop has been involved with CMF since 2006, both through a longer term posting at CMF and providing analysis during periodic visits. Mr. MacLeod recently served as the OA for a joint Canadian-Australian command of CTF-150. They jointly identified a lack of available documentation on the role analysis has played at CMF, which can make it difficult for analysts and their associated Naval staffs alike to understand and plan for the effective use of scientific support. This paper aims to provide members of the community of military operational researchers who may be considering a deployment to CMF with a general guide to the types of analysis that are most frequently requested in this setting. It may also be of interest to researchers with organizations which share common interests with CMF – particularly NATO and the European Union (EU), which also deploy counter-piracy patrols in the same region. Ultimately, as CMF is a very much an intelligence-driven organization, there is scope for analysts to enable that process through better analysis of intelligence and operational data. The authors hope that this paper kindles interest and discussion amongst the operational research community, with the ultimate goal of enabling improved operational outcomes for CMF.

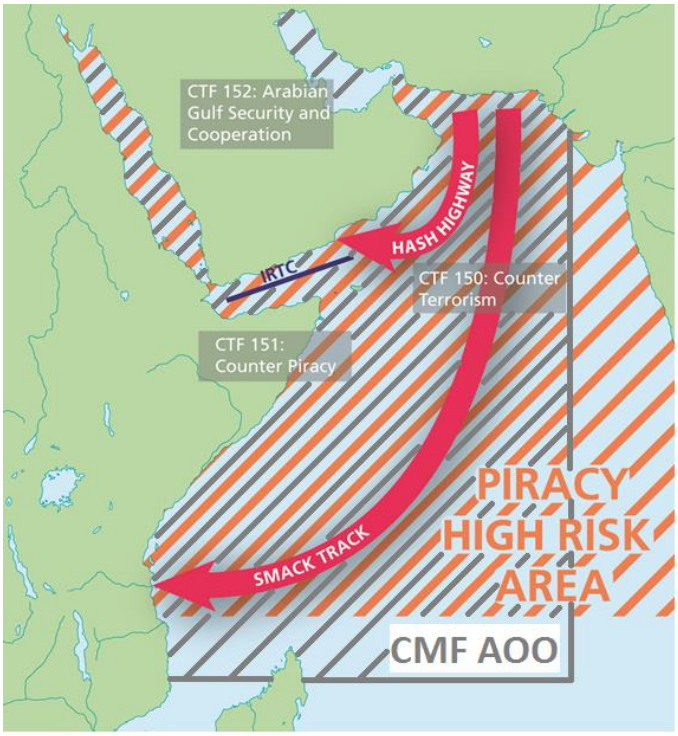

Figure 1: Map of the CMF Area of Operations (AOO). IRTC = Internationally Recognized Transit Corridor.

Counter Piracy and CTF-151

Ongoing instability in Somalia throughout the late 1990s and early 2000s created the conditions and the motivations for piracy to flourish. Following sporadic attacks in the early part of the millennium, Somali pirates began to successfully capture major vessels in 2005, ultimately leading to the adoption of UNSCR 1816 in June 2008 authorizing foreign naval vessels to enter Somali territorial waters and otherwise use 'all necessary means' to repress acts of piracy at sea [2]. Various organizations responded, with CMF announcing the creation of CTF-151 on 8 January 2009 [3][1], NATO instituting CTF-508 patrols under Operation Ocean Shield in August 2009 [4], and the EU Naval Forces (EUNAVFOR) launching Operation Atalanta (CTF-465) on 8 December 2008 [5]. At the time of writing the last successful pirating was in May 2012 (see Figure 2), although 26 hostages remain.

Analysts at CMF contributed to counter piracy operational planning, specifically through: spatial analysis of piracy attacks; forecasting of piracy risk based on historical rates of attack, density of traffic and weather conditions; and definition of patrol areas in the Internationally Recognized Transit Corridor (IRTC). A simple model was developed to calculate the recommended patrol area size. The method was based on the need for coverage of the patrol area to be dense enough that a military asset would be able to intervene within a critical time period from the start of an attack. The process would involve the warship receiving a distress call from a merchant vessel, then directing a helicopter to the vessel's position. On arrival warning shots were expected to be sufficient to deter the attack. The dimensions of the patrol boxes allowed a typical helicopter to reach the targeted vessel within 30 minutes of a distress call. The warship often could subsequently intercept the pirate vessel. Although this work done in support of CMF is unfortunately only internally documented, if at all, publically available related work done as reachback support to Canadian ships can be found at [6] and [7], and NATO Centre for Maritime Research and Experimentation (CMRE) researchers have also published in this area [8] [9].

The reduction in piracy has been linked to a combination of factors including the presence of CMF, NATO, and EUNAVFOR forces, merchant shipping adoption of the BMP (Best Management Practices) [10], as well as increasing security forces ashore and nascent coast guard capability in Somalia itself. That said, many of the root causes remain, and maritime military presence is gradually reducing (e.g. NATO notes it "now deploys vessels intermittently. During periods without surface ships, maritime patrol aircraft fly sorties and links to situational awareness systems and counter-piracy partners remain in place" [11]) whilst Somalia itself remains

[1] The announcement went on to quote the CMF Commander VADM Bill Gortney as saying "Some navies in our coalition did not have the authority to conduct counter-piracy missions. The establishment of CTF-151 will allow those nations to operate under the auspices of CTF-150, while allowing other nations to join CTF-151 to support our goal of deterring, disrupting and eventually bringing to justice the maritime criminals involved in piracy events." This issue of differing mandates continues to be important at CMF.

unstable. There is thus still room for OA to play a role in counter-piracy analysis, in particular in assessing the factors affecting the likelihood of reoccurrence.

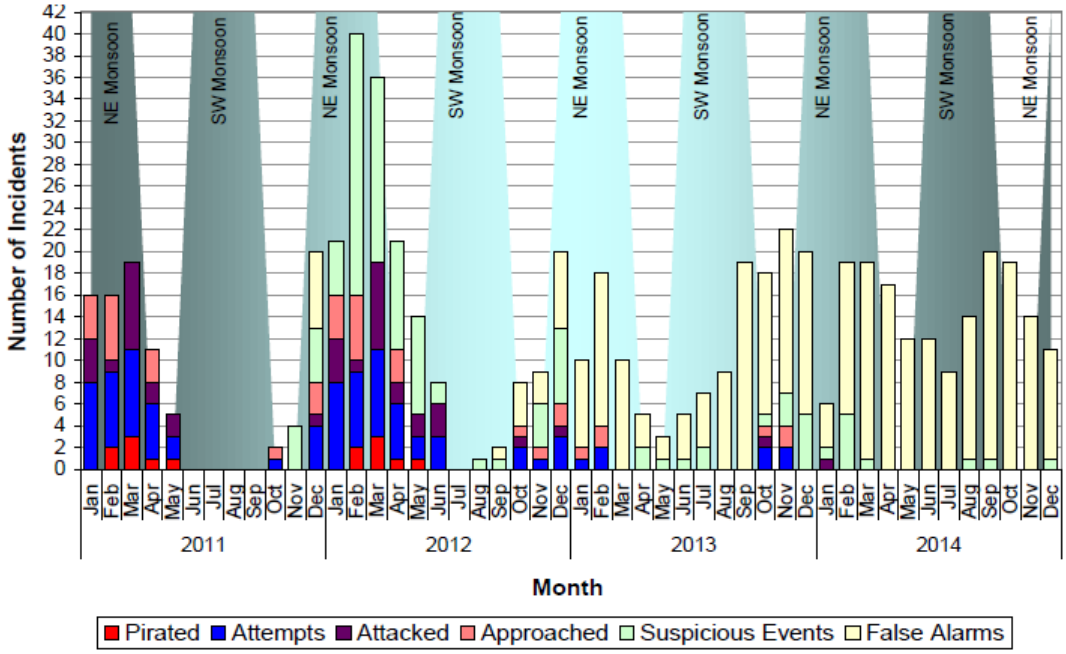

Figure 2: Piracy Incidents, 2011-2014 [12]

Maritime Security, Counter Terrorism and CTF-150

Measuring CTF-150's overall success can be complicated, given its general mission to promote maritime security, and to deter and deny use of the maritime environment for terrorism. Where it becomes more concrete is in its intent to "directly influence events ashore, as terrorist organisations are denied a risk free method of conducting operations or moving personnel, weapons or income-generating narcotics" [13]. In recent years the most visible aspect of this has been the interdiction of large shipments of heroin and hashish, but it is important to note that these are being interdicted due to the connection to the funding of terrorism, not as an end in and of itself. Equally concerning is the movement of weapons to aid terrorism, and other trade funding (e.g. charcoal export from Somalia that the United Nations has identified as a major funding source for Al Shabaab [14], also leading to an UNSCR authorizing interdiction [15]).

The majority of narcotics seizures done by CTF-150 occur along the 'Smack Track' and 'Hash Highway' (see Figure 1). Some fraction of drugs produced in Afghanistan make their way to vessels along the Makran Coast, and from there are loaded into small cargo vessels (often various types of dhows) for onward shipment. Hash is primarily bound for the Arabian Peninsula, whereas heroin reaches East Africa from where it can be 'muled' to Western markets [16]. Amounts seized by CMF are found in Figure 3.[2]

[2] Whilst this document was being prepared, CMF made its first announcement of seizures for 2015. 981 kg of heroin was seized over six boardings [32].

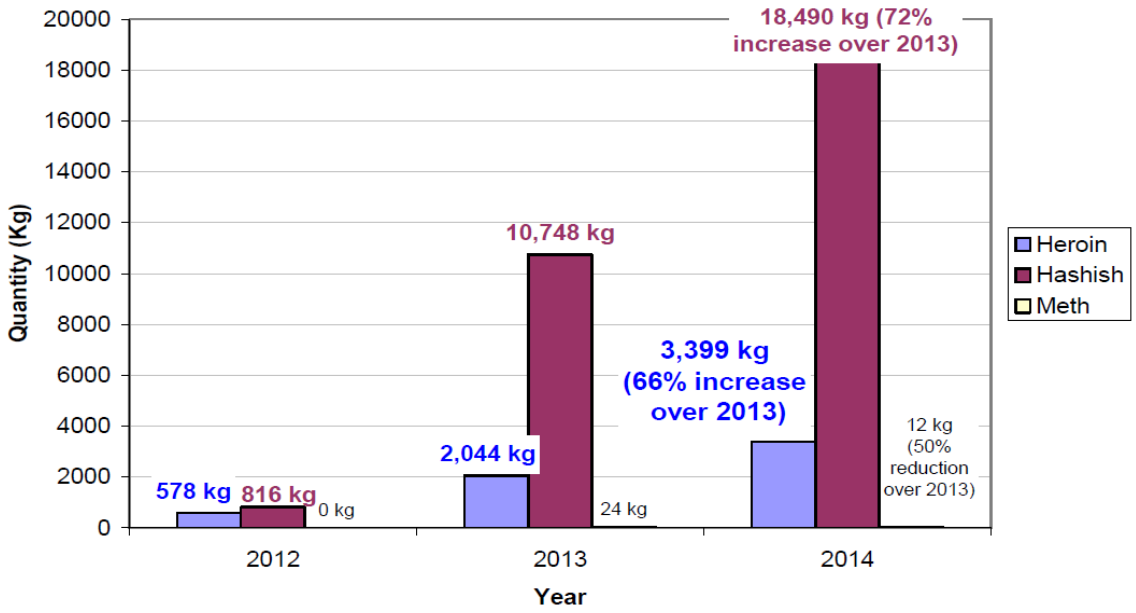

Figure 3: CMF Drug Seizures 2012-2014 [12]

While the increase in seizures itself is a measure of increased *performance*, as is typical measuring the actual *effectiveness* is more difficult. The most relevant question here is how effective CMF is in deterring the overall trade of narcotics through its AOO.[3] Data obtained from the United Nations Office on Drugs and Crime (UNODC) on Afghan opium production was used to generate Figure 4 and compared with CMF data in Figure 5. Some important notes before further analysis are: opium is more closely tracked, so only opium and heroin are considered here; area cultivated and opium produced are related but not directly correlated, due to a variety of factors (e.g. weather) affecting production rates; and, it is reasonable to assume that heroin production roughly tracks opium production, but is difficult to establish the exact correlation.

With those caveats in mind, we can then proceed to look at the observed trends. Overall the total weight of heroin seized in the general region has dropped in half since 2012 (to 20 000 kg) while the weight seized by CMF has gone up markedly to 3400 kg. While the overall picture is somewhat grim, it does indicate that CMF is playing an increasingly important role percentage-wise in disrupting the trade. Further, the average size of a CMF heroin disruption was found to be nearly 300 kg, compared to just over 20 kg on average – indicating that seizures may be more efficient than land shipments which have been broken up into smaller amounts.

[3] At a more strategic level the proper measure may be the reduction in the overall flow of terrorist-related drug trafficking by any route. However, since CMF's mandate is only to operate on the water outside of territorial waters, it has no direct influence on interdictions on land, and should only be measured on what it has control over.

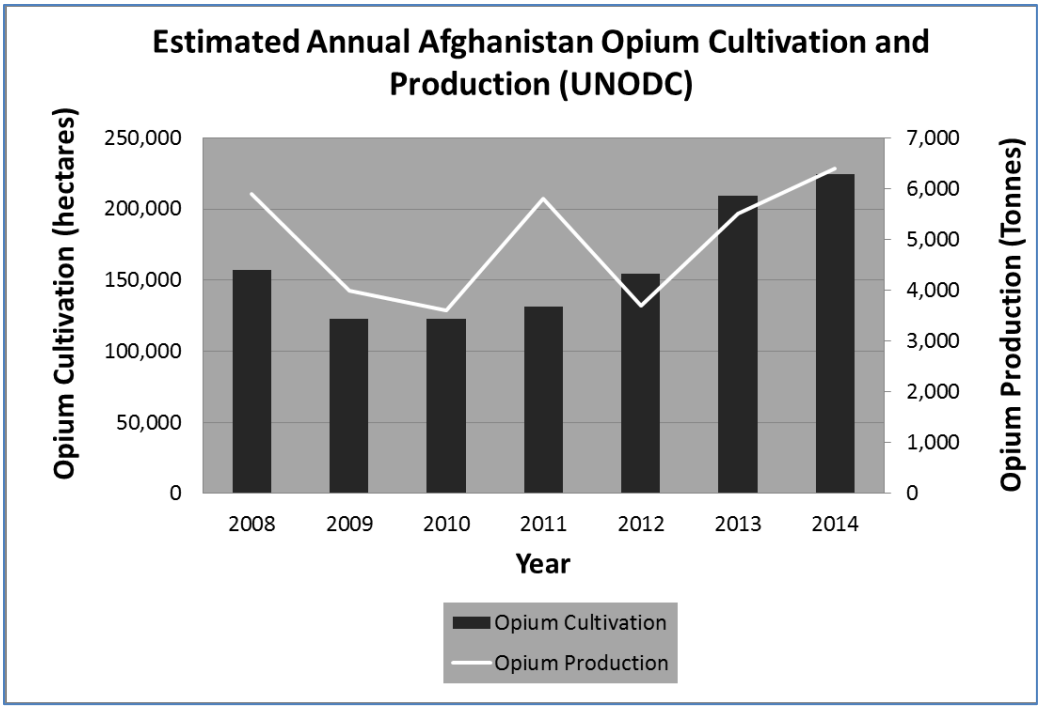

Figure 4: Estimated Annual Afghanistan Opium Cultivation and Production 2008-2014 [17].

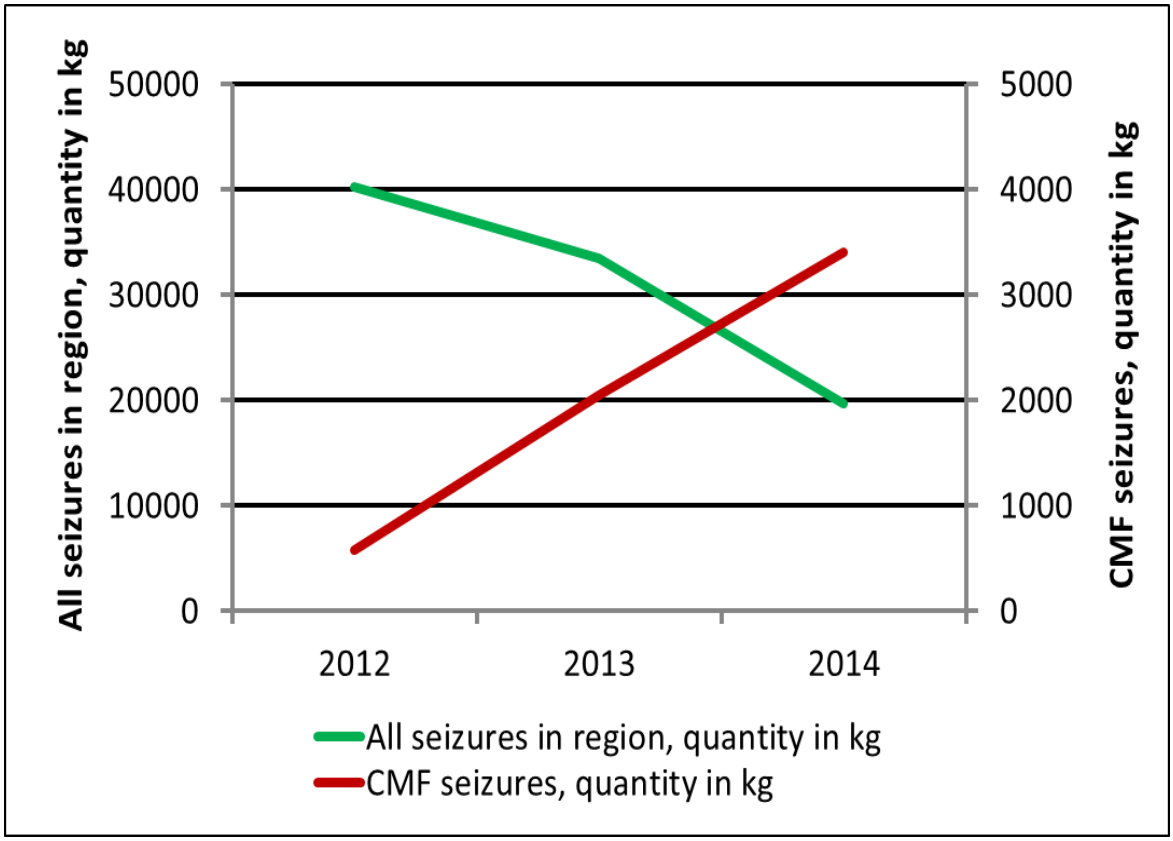

Figure 5: Regional and CMF heroin seizures 2012-2014. Note different scales.

To truly comment on the effectiveness and efficiency of CMF's seizures, a number of other factors need to be taken into account, which can be done with varying levels of accuracy and precision. The methodology UNODC uses for estimating overall opium production is quite sound, but estimating how much is related to funding of terrorism is more of a matter for police forces and intelligence organizations, and is sensitive. The same holds for the relative percentage of shipments going over sea and the various land routes, which is only imperfectly known; although there are concerns that the standing down of the NATO International Security Assistance Force in December 2014 may lead to an increase in production and land shipments, the ongoing conflict with the Islamic State of Iraq and Syria (known by various names) and increased border controls set up in response to the flow of refugees may make the overland route to Europe less attractive. When it is released, the UNODC Afghanistan Opium Survey of 2015 may provide insight into how some of these factors have influenced behaviour on the ground.

Whether or not the rate of smuggling across the AOO can be estimated, one could also consider various measures of return on the effort expended by CMF. For instance, one could look at the number of seizures or amount seized for a given number of patrol days by a specific unit, or in a specific area. Even assuming a perfectly accurate measure of the first could be developed, in a voluntary partnership it can be a delicate matter to report on exactly how effective a given ship or nation's contribution might be. Given that the underlying rate of traffic flow is hard to estimate, and that contributions may be for a relatively short period, the perils of reporting effectiveness to that level of detail likely outweigh any benefit they may provide, especially as it would be easy for critics to question whether they were simply patrolling during a period of low smuggling activity. As will be discussed further in the next section, not all assets are created equal, and a given unit may be providing valuable surveillance or other services that would not be directly reflected in seizures. Much more fruitful – and less controversial – has been work done by OA on which locations are the most effective to patrol, as well as minimum persistence to have any likelihood of success; unfortunately these cannot be elaborated upon in detail in this forum.

A Note on Force Flow

Probably the most frequently talked about numbers at CMF are the 'force flow' – defined as the number of ships in support to each task force on a given day. Since contributions are voluntary, force flow often serves as a proxy for measuring the commitment of member nations to CMF. Asset numbers are generally plotted as a rolling average of available assets per day, and reviewed regularly as part of Campaign Effectiveness Assessments. Records are also kept of the name of each vessel and its respective nation, allowing some further analysis to be done.

The regularity with which force flow numbers are discussed and plotted makes them a tempting topic for analysts. It is immediately clear that not all assets are created equal, and both analysts and Commanders have at times expressed interest in developing a more effect or capability based metric. This has been

complicated not only by the difficulty in representing the large variety of units and their mandate constraints, but also by the much more pragmatic issue of the perceived fairness of judging the relative worth of nations' contributions – particularly in what is a voluntary construct. So while the authors judge that it is unlikely that the presentation of force flow data will move past the current simplistic method, it is useful for an OA who will be spending time at CMF to be familiar with some of the ideas that have been proposed in the past.

Two main branches of thought could be followed: one that elaborates the current system of counting the number of assets assigned with some sort of multiplier or modifier to reflect their capability; and, one that replaces the asset focus with a focus on coverage.

Taking the first branch, it is difficult to conceive of a system of a multiplier system judging relative capability that would be satisfactory and fair, and cover every possible situation, e.g.: would a destroyer be worth 20% more than a frigate? What if the frigate had a helicopter and the destroyer did not? What if one nation's frigate was the same size as the other's destroyer? What if one nation had two of the same ships assigned, but one's helicopter has been upgraded with a longer-range radar and imagery system? It is easy to see that the combinations are endless, as is the potential for dispute. Currently, it is at least tracked whether or not helicopters are embarked, but even that simple record is challenged by considerations of capability and serviceability, and complicated by the increasing prevalence of embarked uninhabited aerial vehicles to also be tracked. One of the more practical and simple methods proposed to modify the current system is to simply subtract out required travel time between port visits from the time devoted to conducting the work of their CTF [18]. While this can work when rolling up statistics over weeks or months, it is unclear how it would be applied to the rolling per-day average.

Looking at the second branch, a relatively simple proposal (again in [18]) is to – at least for specific focused operations – plot the amount of time spent in each of the assigned operations areas, vice transiting between them or other background activity. While CTFs are not always conducting a specific operation, they will generally at least have areas of higher priority. This option is perhaps the least controversial to pursue. However, it still does not really get to the real question of coverage, as again different ships may have wildly different sensor ranges and embarked aircraft. It also does not necessarily account for the difference between a ship in an operations area but simply transitting at high speed, versus a ship truly on station and ready for tasking. As an example, Figure 6 shows five ships in support of CTF-150 on a given day: an RN air-defence destroyer, USN patrol boat, an Australian replenishment vessel, a United States Coast Guard cutter, and a USN guided-missile destroyer. Even visual inspection will make clear that these vessels have very different capabilities.

Figure 6: Foreground to background: HMS Dauntless, USS Firebolt, HMAS Success, USCGC Maui and USS Dewey [19].

Pattern of Life

As noted above, a wide variety of units serve in the CMF AOO from various nations. They often may only serve for a short period of time, and so there is a need for products to introduce them quickly to the expected 'pattern of life' (POL) in their area, so they may understand what is and is not anomalous, and what should be reported to their CTF and ultimately CMF. Analysing the existing POL data and considering potential improvements to the collection and analysis process quickly became the primary task of Mr. MacLeod's deployment with CTF-150 [20]. Given Canada's large maritime approaches and relatively small population, making maximum use of limited assets in a large AOO is a familiar and ongoing research problem for many Canadian OAs, which provided many opportunities to connect back with colleagues at home.

CMF officially defines POL as *observable human activity described as patterns in the maritime domain related to the CMF mission at a specified period and location*. That is to say there is both a temporal (e.g. monthly or seasonal) and geographical component (e.g. a given body of water, a given fishing area). While this definition is relatively broad, in the CMF context the collection of POL information has generally been distinct from the process for tracking vessels in the Recognized Maritime Picture (RMP).

Pattern of life information is important in several different contexts at CMF. For CTF-151, it can be seen in Figure 2 that there are a large number of false alarms for piracy in a given year – it is important for CMF units to understand what is 'normal' behaviour in these regions both to avoid misunderstanding themselves, but also to be able to communicate that clearly to merchant vessels they encounter. In CTF-150, as smugglers use largely the same vessel types as legitimate traffic,

understanding signs of aberrant behaviour is more crucial for successful interdictions. In the sometimes volatile surroundings of the Arabian Gulf, it is important for CTF-152 to understand patterns of behaviour, if only to avoid accidental escalation of a routine situation.

There are several challenges inherent to collecting, processing and learning maritime traffic patterns on any scale – many of which are magnified in the CMF context. For instance, a NATO CMRE study using 50 day windows of Automated Identification System (AIS) tracks found that only 40% of Indian Ocean tracks could be automatically categorized and clustered, compared to 70% in the North Adriatic and 95% in the Strait of Gibraltar [21]. From the start, this indicates that even the voluntarily reporting vessels in the region – in general more likely to behave in both regulated and regular ways – follow a wide variety of relatively unique routes. This indicates that even in a world of universal self-reporting categorizing the background picture would be difficult.

What also becomes apparent in a literature search (see e.g. [22], [23], [24]) is that most automated traffic pattern work has been focused on relatively contained areas such as coastal approaches, or even single harbours, and in a defence context one is generally most concerned only with inbound tracks. With its high-seas only mandate, and with over two dozen countries bordering its AOO (only some of which are CMF members), the problem for CMF is to understand traffic criss-crossing its waterspace for any number of legitimate and illegitimate regions. Although the natural chokepoints of the Suez Canal, Bab-el-Mandeb Strait, and Strait of Hormuz constrain routes for transiting traffic in particular, and the IRTC puts additional structure on traffic in the Gulf of Aden, both legitimate (e.g. small fishing craft) and illegitimate local traffic have a large variety of routes available.

There are also practical issues. Canada has for many years been evolving its infrastructure and analysis capabilities (see e.g. [25], [26], [27], [28]) to keep up with the increasing number of positional reports available from space-based and coastal assets – easily running into millions per year. Discussions with Maritime Forces Atlantic personnel indicate that not only is the CMF AOO larger than theirs, but they estimate it has roughly 4-5 times the number of unique vessels in it at any given time. As CMF increases its ability to gather a large number of reports per vessel, they will therefore have an even greater data and infrastructure challenge than Canada.

A further practical issue is the wide variety of reporting units. Most nations conducting their own homeland defence use relatively few types of vessels and aircraft, the crews of which are very familiar with their own region, and which are trained over time to use common equipment and reports in a relatively uniform fashion. These assumptions simply do not apply to CMF units. At the same time a new CMF unit is coming up to speed on the region by digesting past POL information, they must also be brought up to speed on how to report it. Due to the various constraints involved, reports generally must be requested in very commonly available formats – generally spreadsheets and the like. Even though the vast majority of the reported information is unclassified observations, they come in over an operational network, which can then complicate combining the information with other unclassified sources (e.g. ship registries).

In its most recent rotation Canada also conducted a short evaluation of the applicability of space-based radar data to the CMF POL process [29]. One of the primary challenges with current systems is the need to correlate with other sensors in order to achieve an identification. The practical challenges of doing so in some of the crowded waterspaces patrolled by CMF can be seen in Figure 7: the circles represent the distance travelled by a 10 knot vessel in an hour and in ten hours. It is easy to see that even if POL reports from multiple sources are separated by even an hour or two, the ambiguity can be quite high. Many of the vessels in this area are travelling in essentially the same direction and are of similar size, which can stymie even the most advanced matching algorithms.

With all that said, the challenges are not insurmountable, particularly if effective collaborations can be established. The NATO CMRE work referred to above [21] continues to be developed to better learn routes and identify anomalies, and to work on a wider variety of sensor reports. Canadian and NATO researchers also continue to work on the cross-validation of different sensor types in the RMP, including space-based radar, (see e.g. [28], [30], [31]), which could help to better characterize the reports coming in from CMF units and allow the development of probability based estimates of traffic in the region. Also, the Radarsat Constellation Mission (to be launched in 2018) will directly integrate AIS sensors on its satellites, allowing identifying information to be matched directly with radar contacts at the same time and angle.

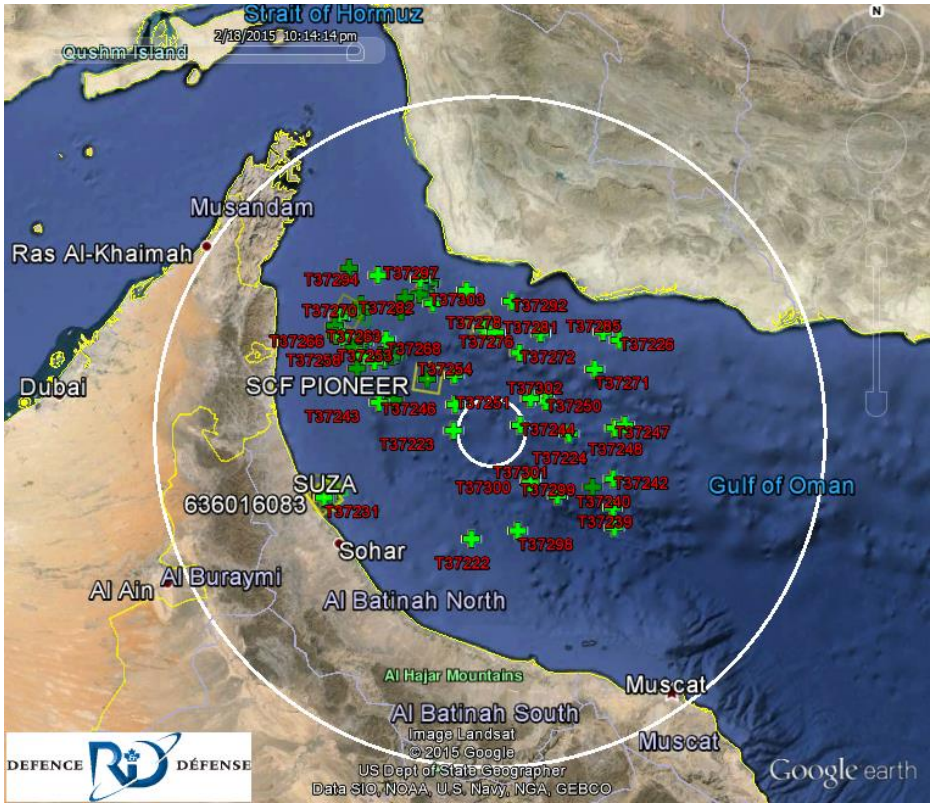

Figure 7: Example Space Based Radar Detections in the Gulf of Oman. The inner white circle has a radius of 10 nautical miles; the outer 100 nautical miles.

Summary

This paper has given a flavour of the types of analysis that are performed at the Combined Maritime Forces, and where there is room for more to be done in the future. In addition to the more specific examples here, OA informs CMF's processes for campaign assessment as well as setting and reporting on achievement of annual objectives. These reports and trend analyses inform Commanders and their nations when discussing how to allocate assets to CTFs to best meet objectives. In commenting on the work of OA in January 2014 Commodore Keith Blount noted that "the team provided in depth assessment of how CMF has performed in 2014 against the objectives set in the Annual Review Paper." The authors assess that in future years, there is room to further develop the yearly objectives to be more measurable and directly related to mission effect. In addition to the CMF level objectives, each CTF Commander will have his or her own unique objectives, which can often be supported by on the spot analysis.

As with many other military assets, OA can be a limited and sparse commodity in the region. The authors would stress that it is important that analysts communicate across rotations to make best use of limited time in theatre. Although so far the United Kingdom, Australia and Canada have provided analysts to CMF and to CTFs, there are also many other analysts in CMF, NATO and the EU who could be contributing directly or indirectly, either through deployments or remote support, and the authors would encourage them to get in touch.

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