INTERNATIONAL COOPERATION ON AERIAL MARITIME SURVEILLANCE (ICAMS)

REPORT

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ARCTIC COUNCIL

EP PR

EMERGENCY PREVENTION, PREPAREDNESS AND RESPONSE

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ABSTRACT:

International Cooperation on Aerial Maritime Surveillance (ICAMS) is an Emergency Prevention, Preparedness and Response (EPPR) project co-led by Canada, Kingdom of Denmark, Norway, and the United States. The project's objective is to enhance understanding of the capacity and capabilities of aerial surveillance programs and activities across the Arctic to improve responses to emergencies.

For example, knowing what resources are available in different Arctic geographies or territories can:

(i) reduce the time needed to locate and save individuals in search and rescue emergencies; and,

(ii) limit the harms of oil spill and radiological incidents on inhabitants and the environment in

We have asked Arctic States, Permanent Participants, and Observers to participate in this survey to shed light on the use of aerial surveillance for emergency incidents at the regional, national, subnational, and local levels. A series of questions have been developed to understand assets, operating contexts, partnerships, trainings and qualifications, exercising, research and development, and opportunities and obstacles. All state authorities and organizational entities involved in aerial surveillance were invited to submit separate surveys.

This report will summarize detailed information on resources, experiences, lessons, best practices, as well as recommendations for future work, and will be disseminated broadly through the EPPR website.

International Cooperation on Aerial Maritime Surveillance (ICAMS) Report

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1. EXECUTIVE SUMMARY

The first project activity of The International Cooperation on Aerial Surveillance Maritime Project (ICAMS) was to conduct a survey to gather unclassified and publicly available information and insights from Arctic States, Permanent Participants and Observers (non-Arctic States, intergovernmental organizations, and non-governmental organizations (NGOs) on their use of aerial surveillance at regional, national and sub-national levels. The participation of the Arctic States included Canada, Kingdom of Denmark, Iceland, Norway, and the United States along with the participation of Spain and the United Kingdom for the non-Arctic State countries.

The survey allowed each participating country to identify different mandates of their aerial surveillance program. Assets and equipment for each participating country were identified, and most of the countries are using similar technologies. Training requirements for the crew was also part of the questionnaire. The training curriculum varies greatly from one country to the next and can be delivered in house, through partner organizations, or by private companies. Some of the participating countries offer some courses that are opened to international participants. Exercising was another key component of the questionnaire. Each country has an established exercising program. Some organizations also participate in exercises held by partner organizations. All countries are willing to have other international parties participate in or observe their exercises.

Canada, Norway, the United States, and Spain all conduct research and development activities. Areas of research are diverse, but appear to revolve mostly around AI and automation, as well as sensor and system development. In fact, amongst other projects, Canada, the United States, and Spain are all investigating the use of AI for detecting and identifying/classifying targets, whether they are oil spills, whales, or icebergs.

Recommendations were established based on the information provided by participating countries. It was highlighted that there is an opportunity for the different organizations to discuss best practices regarding commonly used sensors such as Electro-Optical/Infrared (EO/IR) cameras and Side-Looking Airborne Radar (SLAR) as well as to share information on lesser utilized equipment like line scanners and maritime surveillance radars. Furthermore, there is a definite opportunity for tapping into international crew exchanges as many countries are interested in this type of collaboration. There is also an opportunity for different States to exchange details to improve one another's exercise program and to provide information to other organizations interested in establishing such a program.

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2. INTRODUCTION

The International Cooperation on Aerial Surveillance Maritime Project (ICAMS) is an EPPR project co-lead by Canada, Kingdom of Denmark, Norway, and the United States. The project's objective is to enhance understanding of the capacity and capabilities of aerial surveillance programs and activities across the Arctic to improve responses to emergencies and prevent pollution.

This project aims to bring together experts from the Member States within the Arctic Council to enhance international cooperation of aerial surveillance programs over contiguous waters. The overall objectives of this project are as follows:

1. Improved knowledge of different aerial surveillance programs in the Arctic and improved understanding of the capacity to implement remotely-piloted aircraft systems (RPAS).

2. Improved understanding of shared experiences, lessons, and best practices from EPPR members' experience in responding to and monitoring pollution incidents, accidents, and emergency events in harsh Arctic conditions.

3. Improved familiarity of EPPR members' experiences, lessons, and best practices from RPAS operations.

4. Evaluation of potential mechanisms to share surveillance data between Arctic nations.

5. Developing potential operational procedures for remote and aerial surveillance.

6. Identification of opportunities to exchange personnel for crew familiarization and exercises.

7. Evaluation of the possibility of coordination of earth observation satellites to share imagery over contiguous waters.

8. Development and coordination of exercises with EPPR members to share lessons learned and best practices; and,

9. Produce a final summary report.

In 2015, The Arctic Council Ministers approved the Framework Plan for Cooperation on Prevention of Oil Pollution from Petroleum and Maritimes Activities in the Marine Areas of the Arctic. Canada selected initiatives under the marine activities category that fall under the heading of remote and aerial surveillance.

The timeline for this project was shift from its original planification due to several limitations, the first limitation was due to the pandemic and then most of the activities under EPPR were paused with the conflict between Ukraine and the Russian Federation, where only some projects, with limited resumption of cooperation, were able to continue up to some extent.

The first project activity uses a survey to gather unclassified and publicly available information and insights form Arctic States, Permanent Participants and Observers (non-Arctic States, intergovernmental organizations, and NGOs) on their use of aerial surveillance at regional, national and sub-national levels. This questionnaire is the first of a series of activities that will contribute to the objectives of EPPR's strategic Plan to improve prevention measures, to improve emergency preparedness and response programs at regional levels including arrangements for mutual assistance, promote information sharing and work to effectively implement relevant agreement among the Arctic States and arrangements of the Arctic Council to advance emergency prevention, preparedness, and response capabilities.

The participation of the Arctic States included Canada, Kingdom of Denmark, Iceland, Norway, and the United States along with the participation of Spain and United Kingdom for the non-Arctic State countries.

All answers were compiled and were further analyzed to identified opportunities and/or to make recommendations to enhance international cooperation. Since some countries didn't participate in filling the questionnaire it might create a gap in getting an accurate overview of the capacity and capability on aerial surveillance in the Arctic. All countries will have other opportunities to contribute to the objective of this project through other related activities including crew familiarization videos, panel discussion on best practices, on demonstration and lessons learned and others.

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3. SUMMARY OF RESPONSES

3.1 AERIAL SURVEILLANCE

3.1.1 Findings

The following table is a summary of the different elements link to the aerial Surveillance mandate from the participating Arctic States (Canada, Kingdom of Denmark, Iceland, Norway, and the United States) as well as the non-Arctic States (Spain and United Kingdom)

MANDATES	ARCTIC STATES					NON-ARCTIC STATES	
	Canada	Kingdom of Denmark	Iceland	Norway	United States	Spain	United Kingdom
Pollution Prevention	✓	✓	✓	✓	✓	✓	✓
Pollution Compliance and Enforcement	✓	✓	✓	✓	✓	✓	✓
Pollution Control	✓	✓	✓	✓	✓	✓	✓
Search and Rescue/ Search and Assist	✓	✓	✓	✓	✓	✓	✓
Natural Disasters and Civil/ Humanitarian Assistance	✓	✓	✓	✓	✓	✓	✓
Wildland Fire Monitoring	✓	✓	✓	✓			
Radiation/Nuclear Sensing	✓			✓			
Sovereignty Patrols	✓	✓	✓	✓	✓		
Border Control Compliance and Enforcement	✓	✓	✓	✓	✓		
Fisheries Compliance and Enforcement	✓	✓	✓	✓	✓	✓	
Ice Reconnaissance and Iceberg Detection	✓	✓	✓	✓	✓		
OTHER							
National Defence/Military Ops	✓				✓		
Marine Mammal Protection	✓						
Aerial Mapping	✓						
Land Use Monitoring	✓						
Cargo Transportation					✓		
Personnel Transportation					✓		

All Arctic States conduct activities related to pollution prevention, pollution compliance and enforcement, pollution control, search and rescue/search and assist, assistance for natural disasters and civil or humanitarian crises, sovereignty, border control compliance and enforcement, and ice reconnaissance and iceberg detection. In addition, Canada, the Kingdom of Denmark, Iceland, and Norway also do surveillance for wildland fires, while only Canadian and Norwegian respondents have indicated performing radiation and nuclear sensing tasks. As for non-Arctic States, they conduct patrols for pollution prevention, pollution compliance and enforcement, pollution control, search and rescue/search and assist, and assistance for natural disasters and civil or humanitarian crises. Spain also has a fisheries compliance and enforcement mandate. All respondent organizations, except Spain, have indicated that they collaborate with other departments, agencies, organizations, industry, or individuals to assist with their national mandate. Moreover, Canada, Norway, Spain, and the United Kingdom have all mentioned that some of their assets are dedicated to the aerial surveillance of marine oil pollution.

3.1.2 Opportunities and Recommendations

All participating states implement multiple mandates by combining oil pollution patrols with a wide array of other missions. This presents opportunities to explore how each one covers overlapping mandates, discuss and identify best practices that could improve efficiencies, as well as learn how competing priorities are managed across different contexts. Additionally, states could examine procedures and technologies associated with specific mandates, such as wildland fire and radiation/nuclear surveillance, and consider the possibility of knowledge exchanges to gain insight of respective operations. Finally, the different partnerships in place in most countries could inspire other countries to pursue this avenue or to strike up new alliances.

3.1.3 Arctic States

Canada

Mandates

Canada conducts aerial surveillance activities with aircraft, remotely piloted aircraft systems, and satellites, either owned by federal government organizations or leased from private companies to support various services. Four respondent organizations confirmed use of these assets to implement twelve mandates. Transport Canada, Fisheries and Oceans Canada, and Environment and Climate Change Canada all have aircraft, remotely piloted aircraft systems (RPAS) or satellites dedicated to aerial surveillance. However, only Transport Canada has assets committed to aerial surveillance of marine oil pollution. Natural Resources Canada does not have surveillance aircraft but owns platform-agnostic radiation sensor systems dedicated to aerial surveillance mounted on aircraft. Other purposes served by Canadian aerial surveillance assets include support for: search and rescue/search and assist, assistance for natural disasters and civil/humanitarian crises, wildland fire monitoring, sovereignty patrols, national defence, fisheries enforcement and compliance, marine mammal protection, ice reconnaissance and iceberg detection, radiation and nuclear sensing, aerial mapping, and land-use monitoring.

Partnerships

Canada has partnerships among its federal departments and agencies, as well as with various organizations, universities, private companies, and individuals to assist with its national mandate. Four respondents indicated supporting various objectives through partnerships. Transport Canada contracts out pollution patrols to a private company (Provincial Airlines Ltd), partners with academics (University of Alaska) to conduct surveillance flights in support of the endangered North Atlantic right whales and assists other government departments with their environmental protection mandates. For its part, Fisheries and Oceans Canada also shares its aircraft with Transport Canada and other federal government departments (Department of National Defense, Royal Canadian Mounted Police, and Environment and Climate Change Canada) to advance their respective mandates. Environment and Climate Change Canada also partners with the United States National Oceanic and Atmospheric Administration on North American Satellite Tracking of Oil Pollution, while Natural Resources Canada employs aircraft from other federal government departments for nuclear emergency response, and charters rotary-wing and fixed-wing aircraft from the private sector through a standing arrangement with the Government of Canada.

Kingdom of Denmark

Mandates

The Kingdom of Denmark uses aircraft, which are either owned by the government or leased from private companies, to perform various surveillance activities. One respondent organization reported using these platforms to fulfill eight mandates. This organization, the Joint Arctic Command (JACO) in Greenland, conducts dedicated aerial marine oil pollution patrol, as well as missions on search and rescue/search and assist, assistance for natural disasters and civil/humanitarian crises, wildland fire monitoring, border control enforcement and compliance, sovereignty patrols, fisheries enforcement and compliance, and ice reconnaissance and iceberg detection.

Partnerships

The Kingdom of Denmark partners with Danish and international organizations for various services. JACO receives oil spill satellite imagery from the European Maritime Safety Agency[1]. It also has a partnership with Naviair, which is part of JRCC Greenland.

Iceland

Mandates

Iceland performs aerial surveillance through the use of aircraft and satellites that are either owned by the government or organization or are shared with European Union (EU) members. One respondent organization confirmed using these assets to carry out nine different mandates. None of the Icelandic Coast Guard assets are dedicated to the aerial marine oil pollution surveillance program. They are also used for search and rescue/search and assist, assistance for natural disasters and civil/humanitarian crises, wildland fire monitoring, border control enforcement and compliance, sovereignty patrols, fisheries enforcement and compliance, ice reconnaissance, and iceberg detection.

Partnerships

Iceland has established partnerships among diverse organizations within the country. One respondent agency confirmed collaborating with other organizations to fulfill different mandates. The Icelandic Coast Guard is the country's only government organization which owns and operates aircraft for maritime law, search and rescue, and medical evacuations. As such, it partners with other organizations in Iceland like the Transportation Authority, the Environmental Agency, the Road and Coastal Authority, the Volunteer rescue organization, the National Commissioner of Police, local police districts, and health authorities, to name but a few, to assist them with their mandates, as needed.

Norway

Mandates

Norway uses aircraft, RPAS, and satellites that either belong to the organization or to the government or are leased from the industry for various aerial surveillance services. Two respondent organizations indicated employing these assets to deliver nine mandates. While all the Norwegian Coastal Administration's assets are dedicated to the aerial marine oil pollution surveillance program, this is only the case for two of the Radiation and Nuclear Safety Authority's assets. Other purposes served by the assets include search and rescue/search and assist, assistance for natural disasters and civil/humanitarian crises, wildland fire monitoring, border control enforcement and compliance, sovereignty patrols, radiation and nuclear sensing, fisheries enforcement and

1 The European Maritime Safety Agency's CleanSeaNet is a multi-use service offered free-of-charge to participating EU member states, candidate countries, and European Free Trade Association (EFTA) member states.

compliance, and ice reconnaissance and iceberg detection.

Partnerships

Norway partners with national and international organizations as well as with the private industry to assist with its mandate. Two respondent organizations mentioned supporting various objectives through partnerships. The Norwegian Coastal Administration makes their remote sensing aircraft available to the Norwegian Coast Guard and the Norwegian oil industry The Norwegian Clean Seas Association for Operating Companies (NOFO) remotely-piloted aircraft systems, with each partner assuming their share of service costs, including cost per flight hour. Their main aircraft is also equipped with sensors to support the Norwegian Radiation and Nuclear Safety Authority and the Joint Rescue Coordination Centre on a caseby-case basis. As for the RPAS, they are jointly operated by Norwegian Coastal Administration as owner of the assets and optical equipment with other in-country partners. RPAS are piloted and operated by the Norwegian Coast Guard and are equipped with sulfur sniffers and radiation sensors respectively belonging to the Norwegian Maritime Authority and the Norwegian Radiation and Nuclear Safety Authority. The Norwegian Coastal Administration also receives satellite imagery through its partnership with the European Maritime Safety Agency. It cooperates with the Norwegian Space Agency which provides near real-time multi-use satellite imagery service to governmental users at a fee. The Norwegian Radiation and Nuclear Safety Authority's partnerships extend beyond the Norwegian Coastal Administration to the Norwegian Defense and the Norwegian Geological Survey with a similar focus on deploying radiation sensors mounted on aircraft.

Unites States

Mandates

The United States conduct aerial surveillance using aircraft, RPAS, and satellites that are either owned by the organization or the government or leased from the industry. Two respondent organizations declared using these assets to fulfill thirteen mandates. Neither the United Coast Guard (USCG) (HC-130J Platform unit, Rotary-Wing Program, International Ice Patrol, and Unmanned Aircraft Systems) nor the National Oceanic and Atmospheric Administration's (NOAA) assets are dedicated to the aerial marine oil pollution surveillance program. The American assets also serve other purposes, such as search and rescue/search and assist, assistance for natural disasters and civil/humanitarian crises, wildland fire monitoring, border control enforcement and compliance, sovereignty patrols, military and paratroop operations, fisheries enforcement and compliance, ice reconnaissance and iceberg detection, weather prediction modelling, flood monitoring, cargo transportation, and personnel transportation.

Partnerships

The United States collaborates with various federal, state, and local agencies, foreign organizations, and the private industry. Two respondent organizations indicated that partnerships help them support diverse objectives. The United States Coast Guard's HC-130J Platform unit and Rotary-Wing Program have surveillance partnerships with federal, state, and local agencies in Alaska, including the North Slope's Search and Rescue and the State of Alaska, as well as in the North Pacific, the Bering Sea, the Chukchi Sea, and the North Atlantic. The International Ice Patrol is one client of USCG aerial operations. It contracts ice patrols out to PAL Airlines, a commercial reconnaissance company based out of Newfoundland, Canada, and provides data to Environment and Climate Change Canada (ECCC) Canadian Ice Service for operational ice charting for the public, but not limited to the Canadian public, anybody can access those data, as they are useful for Canadian but also international mariners transiting in ice-infested waters in Canada. The International Ice Patrol is a member of the North American Ice Service, along with the United States National Ice Center, the Canadian Ice Service, and the Danish Meteorological Institute (by proxy of Greenland), with whom they share systems and data. Finally, the USCG Office of Aviation Forces' Unmanned Aircraft Systems works with a variety of other governmental agencies to test emerging USmade "BlueUAS". As for NOAA, they have partnerships with NASA, the United States Department of Defense, European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), and Environment and Climate Change Canada.

3.1.4 Non-Arctic States

Spain

Mandates

Spain makes use of aircraft and satellites that belong to government organizations to perform various aerial surveillance activities. One respondent organization confirmed using these assets to implement three mandates. The Spanish Maritime Safety Agency's (SASEMAR) resources are dedicated to the aerial surveillance of marine oil pollution but are also employed for search and rescue/search and assist, and assistance for natural disasters and civil/humanitarian crises.

Partnerships

Spain does not have any partnerships.

United Kingdom

Mandates

The United Kingdom conducts aerial surveillance with aircraft and satellites under a contracted delivered service from private companies to support various roles. One respondent organization reported using these assets to carry out four mandates. The Maritime and Coastguard Agency (MCA) contracts satellites from KSAT that are dedicated to the aerial marine oil pollution surveillance program. It also utilises aircraft under a contract delivered service from Bristow under the United Kingdom (UK) Second-Generation Search and Rescue (UKSAR2G) Aviation Programme to fulfil multiple roles for multiple stakeholders across government departments and agencies, which, besides pollution surveillance, also include search and rescue/search and assist, assistance for natural disasters and civil/humanitarian crises, and fisheries enforcement and compliance.

Partnerships

The United Kingdom partners with other government departments to assist with their mandate. The Maritime and Coastguard Agency allows them to use any spare capacity or be tasked for nationally important tasks, through Memorandums of Understanding (MOUs).

3.2 ASSETS AND EQUIPMENT

3.2.1 Findings

All states surveyed operate aircraft for surveillance purposes. Canada, Norway and the United States also have remotely piloted aircraft systems, though only Canada and the United States possess their own satellites - most European states subscribe to shared satellite imagery services. Common sensors and equipment onboard the various aircraft platforms include electro-optical/infrared cameras, sidelooking airborne radars, Automatic Identification System (AIS) receivers, SatCom, and marine radios. Canada, Spain, and the United Kingdom have also reported use or IR/UV line scanners. In some countries, such as Iceland, aircraft are equipped with a maritime surveillance radar. Also noteworthy, Iceland, Norway, the United States, and the United Kingdom all have some experience operating their assets in extreme weather conditions, although the UK clarified that this is only done for search and rescue purposes.

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3.2.2 Opportunities and Recommendations

There is an opportunity for the different organizations to discuss best practices regarding commonly-used sensors such as EO/IR cameras and SLAR as well as to share information on lesser-utilized equipment like line scanners and maritime surveillance radars. Asset or sensor sharing is also an avenue worth exploring.

In this sense, the Norwegian Coastal Administration suggests considering regional ownership of assets or sharing special sensors, such as sulfur sniffers. JRCC North Norway adds that Search and Rescue (SAR) agreements allow for requesting assistance and resources from rescue services of other states, which implies that they can also request aerial surveillance, with the caveat that there might be legislative obstacles, from an air control perspective to crossborder operations as well as technical incompatibilities in the use of frequencies, means of communication, and aerial control systems. The Norwegian Radiation and Nuclear Safety Authority further states that as the RPAS is embarked on a military vessel, operated by military personnel, it might be an obstacle for international cooperation.

On another front, since the use of remotely piloted aircraft systems is currently limited to Canada, Norway, and the United States, there is potential for these countries to determine common best practices related to Arctic or near Arctic operations, as well as share their respective best practices with other countries interested in developing RPAS programs. For example, Spain indicated that they are interested in international cooperation opportunities on the use and operation of fixedwing RPAS.

On another note, as satellite imagery services are often shared amongst many States, Environment and Climate Change Canada mentions the possibility of sharing operational image processing and classification, while being aware that data sharing is difficult as imagery can be classified or sensitive and as partners must be cleared or prevetted before extensive sharing can take place. At last, there is an opportunity for the different States to learn from others' experience operating in extreme weather conditions and remote locations.

3.2.3 Arctic States

Canada

The Canadian fixed-wing surveillance fleet includes one Dash 7-150(IR), five Dash 8-100, and two King Air. Canada has also acquired a Hermes 900 RPAS from Elbit Systems and has been contracting a SeaHunter RPAS from the University of Alaska Fairbanks. It relies on imagery services from the Radarsat Constellation Mission (RCM) and from the European Space Agency's Sentinel 1A and 1B satellites. Finally, the country's asset inventory also includes multiple gamma spectroscopy and neutron count-rate radiation survey and mapping systems, as well as associated aircraft mounting equipment. Details on sensors and equipment onboard each asset is presented in the table below.

Platform Type	**Asset details**	**Sensors/Equipment**
Fixed-Wing Aircraft	1 Dash 7-150(IR) 3 Dash 8-100	Side-Looking Airborne Radar (SLAR) Wescam MX-15 Electro-Optical/Infrared Camera (EO/IR) Infrared/Ultraviolet (IR/UV) line scanner Still camera linked to MSS 6000 Maritime Surveillance System Automatic Identification System (AIS) SatCom Very High Frequency (VHF) marine radio Direction Finder (DF)
	2 DASH 8-100 2 King Air 200 (**Operated by PAL Aerospace**)	Radar Forward Looking Infrared Camera (FLIR) Cameras
RPAS	1 Elbit Hermes 900 (To be delivered in 2024)	Wescam MX-15 Camera ELTA ELM2022-ML maritime SAR radar Phase One still image system AIS
Satellite Services	Radarsat Constellation Mission (**operated by the Canadian Space Agency**)	Synthetic aperture radar (SAR)
Others	Multiple gamma spectroscopy and neutron count-rate radiation survey and mapping systems suitable for deployment within any aircraft or other mobile survey platform. Utility baskets and pods for external mounting of the radiation survey systems for some helicopter models.	High-sensitivity gamma spectrometers He-3 neutron detectors Basic global navigation satellite receivers Cellular or radio downlink Potential for additional laser and radar altimetry on some aircraft Potential for additional sensors for improved positioning on a best-efforts basis Potential photogrammetry on a best-efforts basis

Canadian organizations have experience using their surveillance assets in remote areas, but not in extreme weather conditions. Indeed, flights are not operated in extreme weather conditions to prioritize crew safety. Work can be performed in high wind and low visibility conditions, but only to the limit of aviation regulations and crew safety regulations. Fixed-wing air crew have learned that, to conduct successful operations in remote communities, missions must be planned to ensure the safe completion of mission requirements, including planning routes based on the location of alternative airports located at a significant distance from one another in the Arctic. It is also critical to prepare for the resolution technical and equipment issues while operating out of remote bases. Moreover, to land on gravel runways, some resources, such as the Dash 7 fixed-wing aircraft, are equipped with gravel kits. There is a lack of a comprehensive monitoring network in Canada North's due to its remoteness. As such, satellites are heavily relied upon for sea ice imagery in those areas.

Kingdom of Denmark

JACO operates one CL-604 fixed-wing aircraft and three rotary-wing aircraft (EC-225, Bell-212, MH60R). Details in the table below summarize sensors and equipment onboard each platform.

Platform Type	**Asset details**	**Sensors/Equipment**
Fixed-Wing Aircraft	1 CL-604	Radars Digital cameras Infrared technologies Transponders/Receivers Wi-Fi Communications Radios
Rotary-Wing Aircraft	1 EC-225 1 Bell-212 (**Contracted from Air Greenland**)	
	1 MH-60R	

JACO does not have experience using its assets for surveillance in extreme weather conditions or in remote areas.

Iceland

The Icelandic Coast Guard has one Dash 8 Q300 fixedwing aircraft and three Airbus H225 helicopters. It also subscribes to Copernicus and European Marine Safety Agency (EMSA) CleanSeaNet satellite services. Details of the sensors and equipment onboard their aircraft fleet are found in the table below.

Platform Type	**Asset details**	**Sensors/Equipment**
Fixed-Wing Aircraft	1 Dash 8 Q 300 fixed wing aircraft	EO/IR camera 360° maritime surveillance radar SLAR
Rotary-Wing Aircraft	3 Airbus H225 helicopters	EO/IR camera Weather radar

Iceland has experience using its surveillance aircraft in extreme weather conditions; however, only with equipment designed to withstand extreme conditions. Moreover, operators receive specifically trained and required to devise an escape or fall-back plan before proceeding in such conditions.

Norway

The Norwegian Coastal Administration contracts two Beech King Air fixed-wing aircraft (350ER, 200) from the Norwegian civil aircraft operator, Sundt Air. It operates six Skyranger R70 remotely piloted aircraft systems and receives satellite imagery services from Radarsat 2, Sentinel 1A and 1B (it stopped delivering data in 2022 due to failure on satellite and it was declared end of mission), COSMO-SkyMed1, COSMO-SkyMed2, COSMOSkyMed4, TerraSAR TSX-1, and TerraSAR TDX-1.

The Norwegian Radiation and Nuclear Safety Authority (DSA) has radiation sensors mounted on Norwegian Coastal Administration aircraft and RPAS, and on aircraft operated by Norwegian Defense and the Norwegian Geological Survey. Details on the national assets are listed below.

Platform Type	Asset details	Sensors/Equipment
Fixed-Wing Aircraft	1 Beech King Air 350ER (On long-term lease contract)	SLAR EO/IR/Laser (illuminator) Droptube for drift/sampling buoys Maritime Broadband Radio SATCOM (Phone/Data) 4G (Data) VHF/HF
	1 Beech King Air 200 (On long-term lease contract)	SLAR EO/IR/Laser (illuminator) Droptube for drift/sampling buoys SATCOM (Phone/Data) 4G (Data) VHF/HF
RPAS	6 Skyranger R70	EO/IR (HD/SD) camera 30 X zoom + EO/IR pilot camera Radiac Sensor Sulfur Sensor Maritime Broadband Radio
Other	RAD sensors	Advanced RAD sensors

The Norwegian Coastal Administration has experience using its surveillance assets in extreme weather conditions and in remote areas. These situations have led to icing issues on fixed-wing and rotarywing aircraft and sensors, and RPAS and aircraft equipment malfunctions due to low temperatures, as well as problems related to logistics, lack of coverage for communications, and GPS and compass use.

United States

The United States have 14 HC-130J fixed wing aircraft, 51 MH-60T and 84 MH-65E helicopters, as well as Contractor Operated Shipboard Unmanned Aerial Systems, and small commercial off the shelf quadcopter unmanned aerial systems. They also own and operate various polar-orbiting and geostationary operational environmental satellites. As capabilities improve in the coming years, the United States Coast Guard International Ice Patrol plans to gradually reduce, and eventually discontinue use of fixed wing aircraft for reconnaissance purposes, solely relying on search and rescue satellites from then on.

Platform Type	Asset details	Sensors/Equipment
Fixed-Wing Aircraft	14 HC-130J	EO/IR camera system 360° belly-mounted surface search radar Nose-mounted weather radar Minotaur mission suite (integration and live feed transmission of all sensors)
Rotary-Wing Aircraft	51 MH-60T 84 MH-65E	Radars Digital cameras Infrared technologies Transponders/Receivers Satellite communications Radios
RPAS	Contractor-Operated Shipboard Unmanned Aerial Systems for use on NSC for reconnaissance/ISR missions	Radios EO/IR camera Transponders/Receivers/IFF Sentient Vision ViDAR (Visual detection and range) Radios
	~300 small, commercial off the shelf, quadcopter Unmanned Aircraft System (UAS)	EO/IR camera *These systems have limited capability in arctic environment
Satellites	Polar-Orbiting Environmental Satellites (POES) Geostationary Operational Environmental Satellites (GOES)	Real-time imagery Derived products such as sea ice extent, cloud cover, wildfire detection, and flood extent over the Arctic Search and Rescue Satellite Aided Tracking (SARSAT) Visible Infrared Imaging Radiometer Suite (VIIRS) instrument

The United States Coast Guard and National Oceanic and Atmospheric Administration have learned from diverse experiences operating surveillance assets in extreme weather conditions and in remote locations. In such conditions, survivability is a critical issue, which is why crews undergo survival and rescue training. It is also common practice to send out two helicopters or one helicopter and a SAR-equipped aircraft together on a mission to ensure self-rescue capability. In addition, weather can create challenges for both aircraft and RPAS. Some aircraft, like the HC-130J, have a low tolerance for icing and can be grounded when winds on the ground are sustained at speeds over 30 knots. High wind conditions on the ground or in the air will also trigger a substantial aircraft material inspection to ensure the absence of damage. RPAS are equally vulnerable to icing, and to turbulence, with cold temperatures greatly reducing operational flight times for battery-powered systems. Moreover, communications are sparse in the Arctic due to limited satellite coverage, which can impact, among other things, RPAS command and control in beyond lineofsight operations. As coverage can be deficient, the United States must rely on a variety of devices and sources to acquire satellite data and services that yield timely and accurate information essential for surveillance in extreme weather conditions and in remote areas. Other issues associated with operating in extreme weather conditions and in remote locations include logistics hurdles.

3.2.4 Non-Arctic States

Spain

The Spanish Maritime Safety Agency operates three CN235-300 aircraft, which are equipped with the sensors indicated in the table below.

Platform Type	Asset details	Sensors/Equipment
Fixed-Wing Aircraft	3 CN235-300	SAR Radar SLAR Microwave Radiometer (MWR) Laser fluorosensor Electro-Optical cameras IR/UV line scanner

The Spanish Maritime Safety Agency does not have experience using its aircraft for surveillance in extreme weather conditions or in remote areas.

United Kingdom

The Maritime and Coastguard Agency relies on two King Air 200 aircraft operated by 2Excel Aviation, and on satellite imagery services from KSat. Sensors and equipment onboard British aircraft are listed in the table below.

Platform Type	Asset details	Sensors/Equipment
Fixed-Wing Aircraft	2 King Air 200 (Operated by 2Excel)	EO/IR camera Radar Line Scanner Radio homing Sat comms and streaming

The Maritime and Coastguard Agency has experience operating its assets in extreme weather for search and rescue purposes, but not surveillance.

3.3 TRAINING

3.3.1 Findings

The training curriculum varies greatly from one country to the next and can be delivered inhouse, through partner organizations, or by private companies. Canada, Denmark, and the United States already offer some courses that are open to international participants. These countries, as well as Iceland and the United Kingdom, also have other courses that they could consider opening to interested foreign partners. While the United States and Spain have both a recruitment program and an apprentice program in place, Canada and Iceland respectively have a recruitment program and an apprentice program for some positions. Moreover, Canada is currently considering implementing an apprentice program for its surveillance officers. In addition, most countries have indicated that they would be interested in participating in international crew exchanges.

3.3.2 Opportunities and Recommendations

As the level of detail provided by the different survey respondents on their training curriculum is relatively disparate, a further investigation into each State's program would be necessary to facilitate a thorough comparison. Besides, there is a definite opportunity for tapping into international crew exchanges as many countries are interested in this type of collaboration.

3.3.3 Arctic States

Canada

Crew onboard Transport Canada's (TC) National Aerial Surveillance Program (NASP) aircraft consists of two pilots and two to three surveillance officers. When aircraft are deploying to a different location, one or two aircraft maintenance engineers will travel with the crew as well.

Surveillance officers are responsible for operating the sensors and equipment on the NASP's fixed-wing platforms. They have varied backgrounds, ranging from law enforcement to military personnel and university graduates in fields such as geomatics. New surveillance officers undertake a 4 to 9 months in-house program consisting of classroom, simulation, and on-the-job training on topics, including oil pollution observation and reporting, mission system operation, mission procedures, and weather. Surveillance officers must meet the training standard before they can hold a position without supervision on an aircraft. Once proficient, they also undergo refresher training, both on the ground and in the air. The NASP's one-day Aerial Observation of Oil course is also provided to other Canadian partners, specifically to other TC and Canadian Coast Guard staff. TC would consider opening courses to international partners, subject to approval by the Superintendent of the Intelligence, Surveillance, and Reconnaissance Division, which oversees the NASP.

With respect to TC's RPAS, the operation of its new asset, once delivered in 2025, will require two pilots, one maintenance engineer, and one sensor operator, and one telematics technician. As a prerequisite, RPAS pilots must have a valid Airline Transport Pilot license. Sensor operators must have experience as qualified operators while telematics technicians must have five years of experience in relevant communications and network development work. All these crew members will undertake a 6 to 8 weeks training in their relevant specialty, provided by the manufacturer.

Crew for Fisheries and Oceans Canada (DFO) aircraft comprise two pilots, a Data Management System (DMS) operator, a radar operator, and a fishery officer. While the DMS and radar operators are from a private aviation company and, as such, no information is available on the required skill sets/education and on the training curriculum. DFO fishery officers receive approximately 10 hours of online training, from the aviation company, on the data program onboard the plane, which includes a virtual walkthrough and a question-and-answer

session on systems and procedures. They also partake in a flight with a senior fishery officer. DFO does not provide training courses that are open to international participants.

The Environment and Climate Change Canada (ECCC) Canadian Ice Service employs pollution analysts to interpret satellite imagery with the aim of detecting potential pollution incidents and contacting emergency response agencies, when necessary. These analysts have diverse backgrounds, including remote sensing, geography, cryosphere studies, geographic information systems, and glaciology. ECCC does not provide its analysts with a dedicated training program, nor does it offer training courses to international partners.

The Natural Resources Canada's (NRCan) Nuclear Emergency Response team is composed of qualified technicians, scientists, and researchers selected for their ability to perform field work, operate radioactivity sensors, and prepare map. They are trained internally, and through multi-agency exercises in designing aerial survey parameters (altitude, flight line orientation and spacing), installing and operating survey systems, as well as interpreting detected radioactivity signals and preparing map products. They also receive mandatory training on radiation safety, helicopter safety, wilderness first aid, predator awareness, ergonomics and lifting, and forklift operation. Additional training courses can include advanced spectrum analysis, simulation of radiation propagation, radiation detector design, radiation detector calibration, RPAS operations, and aviation radio operations. At NRCan, training occurs on a continuous basis. Team members will typically undertake a few weeks of training each year. NRCan offers some courses on aerial radiometric survey to international participants on an ad-hoc and as-needed basis. These courses, which have been delivered near Ottawa in Canada and near Vienna in Austria in the past, are tailored to participant needs and are not offered on a recurring basis. International parties interested in setting up such courses require an agreement with NRCan, which could include financing for the agreement and training.

In terms of recruitment programs, only DFO has such a system in place for its fishery officers. It entails online questionnaires to assess skills and work experience, language testing, an interview process, psychological and physical assessments, security clearance, as well as seven weeks of theoretical classroom training and nine weeks of in-class law enforcement officer training at a policing academy. No Canadian respondents have apprentice programs, though TC is considering establishing a program. On another note, while ECCC is already involved in international crew exchanges with the United States National Oceanic and Atmospheric Satellite Analysis Branch; TC, DFO, and NRCan are all interested in exploring opportunity to participate in broader international crew exchanges, subject to a simple arrangement with TC, security clearance, training, and funding for DFO, and a cooperation agreement between NRCan and the international party to commit the resources to the task and to assure the members' safety.

Kingdom of Denmark

Each Joint Arctic Command (JACO) aircraft is manned by one or two pilots. Additional crew members differ based on the aircraft: two system/sensor operators and one technical engineer on the CL-604; one tactical control officer, one system/sensor operator, and, depending on the mission, one rescue swimmer and one doctor on the MH-60; and one hoist operator and one rescue man on the EC-225 and the BELL-212. System/sensor operators working onboard the CL-604 and the MH-60 must accumulate 50 supervised flight hours, pass system/sensor operator flight and academic tests, and obtain civilian radio telephone certificate. JACO relies on the Danish Air Command and Naval Command for its aerial surveillance program and training. The training, which is conducted for individuals, for units and as on-the-job training at national schools in Denmark, covers the ability to execute all tasks related to the different aerial surveillance mandates. It can range from six months up to four years, depending on the function of the operator. Moreover, while JACO does not provide training courses that are open to international participants, the responsible authorities in Denmark do.

JACO has no recruitment or apprentice program.

Iceland

Crews onboard the Icelandic Coast Guard Dash8 Q 300 consist of two pilots and two mission specialists/ coordinators, with the possibility of adding two visual observers. Helicopter crews include two pilots, a navigator/ rescue man, a mechanic/hoist operator and, on the primary crew, a medical doctor. Mission specialists have a four-year educational background as navigation officers from the Iceland Maritime School, followed by two years of sea training. Before becoming fully qualified crew members, operators also receive approximately six months of onthejob training. As mission specialists are also recue men onboard the helicopters, they first receive strenuous training in search and rescue, as well as training on law enforcement, and on the operation of sensors and navigation equipment. They then progress to the fixed-wing side, where they undergo 100 flight hours of on-the-job training to operate sensors and other equipment onboard. Iceland does not currently provide training courses to international participants but interested parties could potentially join on a cost-recovery basis.

The Icelandic Coast Guard does not have a recruitment program but does have an apprentice program for some positions. Moreover, there is interest in international crew exchange opportunities, and welcome opportunities for international partners to fly together.

Norway

Crew onboard the Norwegian Coastal Administration's fixedwing aircraft include two pilots and one system operator. Operators receive in-house training from the Norwegian Coastal Administration, the Norwegian Coastguard, and NOFO (oil industry). From the Norwegian coastal administration/NOFO, operators will need a 1-week training, mostly theory on oil spills and acute pollution at sea. EMSA also provide 3-4 days courses for operators on Oil spill monitoring from aircraft (Based on Bonn Agreement Aerial Operation Handbook and systems). NOFO also have a 2 day "remote sensing" course where operators attend. We also use the "Oil on Water" trials to learn/test/calibrate system operators on real oil, released in known quantities. Also, Bonn agreement counties have been invited many times for participation over the years. The Norwegian Coastguard mostly do an onsite job training, where Coastguard officers join flights and missions. The pool of operators is only 4 people, so the training is individual and customized. New operators will also fly some weeks with an experienced operator before doing missions alone, however, there has been very little turnover of system operators.

They also undertake a separate training on radiation sensors from the Maritime Authority and Radiation Authority and take part in exercises. The Bonn Agreement Aerial Operation Handbook constitutes the basis of the operation and reporting on oil spill and pollution. Additionally, countryspecific requirements also form part of the curriculum. Additional external training is also provided by EMSA (one-week course) and the sensor/ system industry. As for the RPAS, it is operated by Norwegian Coastguard personnel. When the Norwegian Coastal Administration uses the RPAS, it is for the purposes of supporting the Coastguard's operations and training activities.

In-house training on the RPAS is offered by the Norwegian Coastal Administration, the Norwegian Coastguard, the Maritime Authority, and the Radiation Authority. At the Norwegian Coastal Administration, there is a 1-day course, on the theory of oil spills, including estimation of oil at sea, best practice use of sensors, and data handling. This part is now available as e-learning modules, also to include learning of COP (Common Operational Picture) software. For radiation sensor, a general CBRNE training as part of crew education, 2-3 days of Software, setup and training is required in order to be able to operate the RPAS with the sensor. In Sulfur sniffing, there is also 2-3 days of Software, setup and training is required for operating the RPAS with the sensor. The industry also provides the RPAS pilot course as well as training on common operational picture used for data management and exchange. As for the oil spill alerts from satellite services, they are routed through the Norwegian Coastal Administration's One Vessel traffic service (VTS VARDØ), which follows up based on environmental risk, possible polluter, and possible environmental impact. The Norwegian Coastal Administration will also involve the correct authority on a case-by-case basis. Their personnel receive inhouse training as well as a two-day training course from EMSA.

The Norwegian Coastal Administration does not have a recruitment or an apprentice program. They would however be interested in international crew exchanges. The Norwegian Radiation and Nuclear Safety Authority

also believes that there are opportunities for international cooperation through joint projects, workshops, and technical exchanges. Norway could accommodate short-term exchanges (less than a week), where the number of international guests would be limited based on the host's capacity and where the visiting crew would tag along with the host country's crew on their preplanned day-to-day operations (required planning should be minimal for the host crew) and be responsible to cover all their food and accommodation costs. There might also be some restrictions as to the surveillance tasks that international guests can perform, due to national regulations.

United States

Aircrew onboard the United States Coast Guard's aircraft are numerous. For example, aside from pilots, the C-27J also carries a load/dropmaster, while the HC-130J crew can include a loadmaster, two mission system operators, a dropmaster, a basic airman, and one or two trainees, as well as a tactical commander, a radar ice observer, two ice observers, and one or two additional trainers in the case of the ice reconnaissance detachment. Mission system operators undergo a multiweek course at the US Coast Guard Aviation Training Center in Mobile, Alabama, which is followed by significant on-the-job training in the aircraft. The USCG also has a dedicated training on fisheries and other law enforcement topics. The one-week fisheries observation course is offered in Kodiak, Alaska. Some other courses span over multiple weeks or months. International participants can enroll in some USCG courses, based upon requests received, at the Aviation Training Center in Mobile. Interested parties are invited to reach out. As for the International Ice Patrol group within the USCG, their members are not aviators by trade, but complete the Aviation Mission Specialist syllabus at Air Station Elizabeth City in North Carolina, which covers ground and airborne phases. The ground phase includes aircraft familiarization, survival swim, emergency response, team coordination training, hypoxia exposure, and wilderness survival. The airborne phase involves aircraft familiarization, emergency response, and day/night operations. Training totals approximately one week but is often spaced out over several months. The IIP courses are not open to international participants. As for the USCG's unmanned aircraft systems, their operation requires an operator as well as a visual observer, which must obtain the Part 107 Remote Pilot Certificate granted by the Federal Aviation Administration (FAA) and undergo a USCG UAS training program. This one-week course, which covers FAA part 107 operations, airspace requirements, as well as USCG's specific requirements, is currently provided by a handful of instructors who travel to the individual unit requesting the training as well as host annual training conferences for qualified individuals. The USCG is moving toward setting up a dedicated training facility, but location is yet to be determined. It does not currently provide UAS-related training courses that are open to international participants, but this could probably be arranged through Coast Guard International Relations and would require a Letter of Agreement or similar document. For their part, NOAA's satellites are operated by engineers, from the Office of Satellite Products and Operations in Suitland, Maryland, who have several years of experience in command and control of space assets and are responsible for maintaining these spacecrafts 24/7. This personnel undergoes a dedicated training program on the interpretation and use of satellite data for meteorology and monitoring natural disasters, through a various virtual and in-person courses that are each one to three hours long. Courses open to international participants include COMET satellite modules (https://www.comet.ucar.edu/), Satellite International's training workshops, and the American Meteorological Society's training workshops, which have previously been delivered in-person and virtually. NOAA also notes that an increased awareness of training available as well as a greater number of training resources would facilitate other international parties joining their training courses.

The USCG has a recruitment program in place for many positions, details of which can be found on the GoCoastGuard.com website. However, for positions within International Ice Patrol (IIP), interested applicants must interview with a board from the International Ice Patrol. No recruitment program exists for the UAS program. The USCG also offers an on-the-job apprentice training. For the IIP specifically, new members must complete the Aviation Mission Specialist syllabus and participate, as a trainee, on ice reconnaissance detachments until they reach the expected qualification level (i.e., ice observer, senior ice observer, radar ice observer, or tactical commander), which typically takes one full ice season. There is no apprentice program for the UAS program. Countries interested in international crew exchange with the USCG should reach out to them. International crew exchanges with the IIP require the international passengers to be vetted and approved by the Coast Guard Atlantic Area and/or Air Station Elizabeth City, and to be cleared for entry into Canada. As for UAS operations, this type of exchange has been done in the past with Coast Guard aviation counterparts in Canada, the UK, and Australia and require a conversation between the offices of international affairs and aviation forces of

interested countries. At NOAA, several recruitment opportunities are in place for qualified personnel to support its mission and operations as civil servants and contractors. They do not however have an apprentice program and have indicated that international crew exchanges are not available/applicable.

3.3.4 Non-Arctic States

Spain

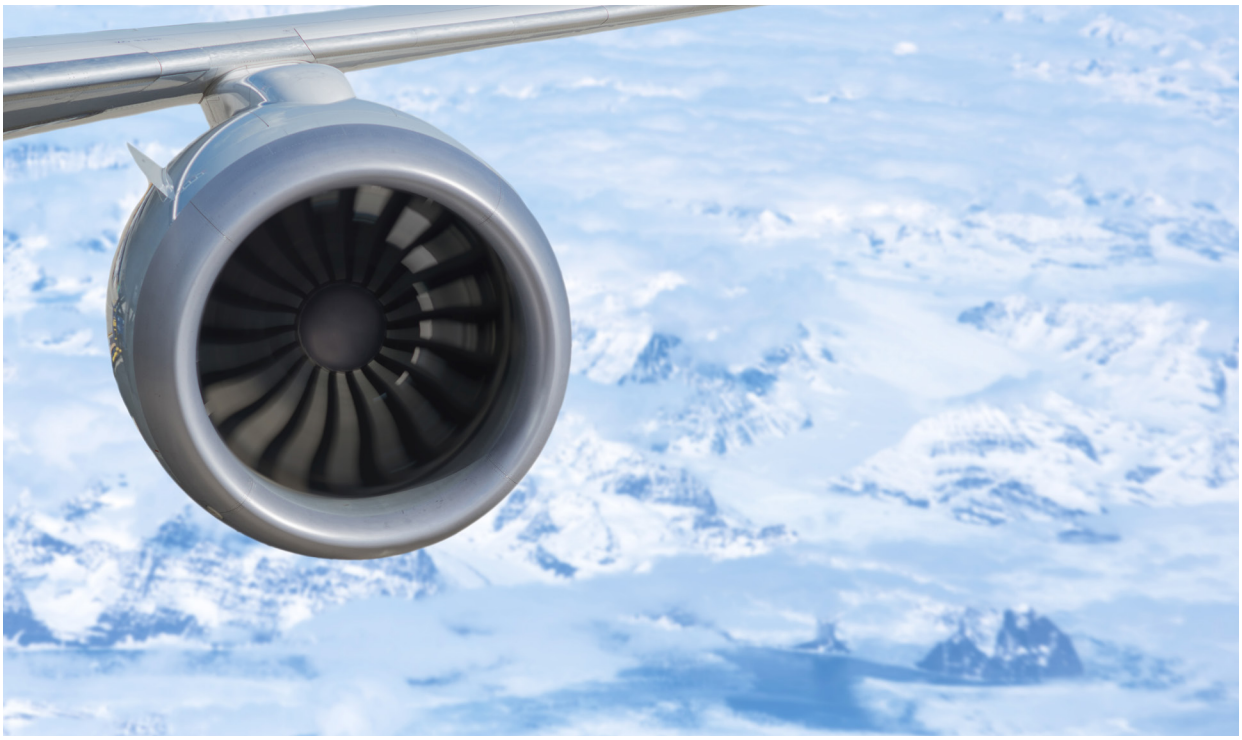
SASEMAR's aircrew is composed of two pilots, two mission console operators, and one observer. Mission console operators have a background as system engineers or in marine education or hold Biology or Maritime degrees. This Agency has a dedicated training program on search and rescue operations, which is planned and conducted by the subcontractor operating the aircraft and takes up four to six hours per month. They currently do not provide courses that are open to international participants and are therefore not sure what requirements it would entail.

The Spanish Maritime Safety Agency's subcontractor has recruitment and apprentice programs in place. The Agency would also be interested in international crew exchange opportunities, depending on the conditions. This type of arrangement, which would be new to them, does not involve any specific requirements.

United Kingdom

Surveillance crew onboard the Maritime and Coastguard Agency's aircraft includes one/two pilots (depending on aircraft) and one system operator. The Agency does not have information on the skill sets and educational requirements for system operators nor is it familiar with the surveillance training program as these elements fall within the responsibility of Bristow which provides a contracted service to the MCA. It does not provide training courses that are open to international participants but suggest that interested parties could discuss this possibility with the contractor.

The Agency does not have a recruitment or apprentice program for aerial surveillance. MCA indicates that if international parties are interested in crew exchanges with the United Kingdom, they should approach their contractor directly.



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3.4 EXERCISING

3.4.1 Findings

At least one respondent organization from each country has an established exercising program. Some organizations also participate exercises held by partner organizations. All countries are willing to have other international parties participate in or observe their exercises. They can also share exercise documents, to a varying extent. Indeed, sharing can sometimes be limited due to the confidential nature of documents or the language barrier.

3.4.2 Opportunities and Recommendations

As most parties have an exercising program in place, there is an opportunity for the different States to exchange details to improve one another's program and to provide information to other organizations interested in establishing such a program. The various countries should also take advantage of the possibility to partake in others' exercises and to consult their exercise documents. In that respect, Natural Resources Canada mentioned that it could be beneficial to conduct a joint international Arctic live-agent nuclear or radiological live-fly aerial survey exercise. They would especially be interested in exercising response to targets that are not normally available in Canada such as Arctic nuclear reactor incidents. However, it notes that scheduling could present a problem, since their Nuclear Emergency Response staff has ongoing obligations.

3.4.3 Arctic States

Canada

Among the Canadian respondents, only Natural Resources Canada has an established exercising program, which involves small-scale internal ground-based test and exercise with the mobile radiation survey systems on a biweekly basis. They also perform large-scale multi-agency nuclear emergency response exercises, including an aerial survey component, with their partners when opportunities arise, usually once or twice per year. NRCan would be willing to have other countries participate in or observe their exercises. In fact, it is common practice for a small number of observers, even from other countries, to attend large-scale field exercises. Interested international parties would need to self-fund their trip and be responsible for their own safety. NRCan can share highlevel exercise plans and recommendations with international participants, but not their detailed afteraction reports. While Transport Canada's National Aerial Surveillance Program does not have its own exercising program, it does participate in other Canadian agencies' exercises, including Department of National Defence (DND) exercises in the Arctic as well as Canadian Coast Guard exercises in support of their joint contingency plan with the United States. As such, it is not up to them to decide if other countries can participate in or observe the exercises, but they would be willing to work with invited guests and can share their afteraction reports with international partners.

Kingdom of Denmark

Even though the responsibility for education and training does not rest with JACO, they do hold numerous exercises every year to develop and maintain proficiency, which involve local participants, members of other units as well as international partners. They would also be willing to have other countries or organizations participate in or observe their search and rescue and environmental protection operations exercises in Greenland. JACO participates in at least three SAR exercises each year, both nationally and internationally. They value practicing as a means of learning and optimizing all procedures for future operations. They can share final reports from their SAR exercises.

Iceland

The Icelandic Coast Guard has an established exercising program that involves crews extensively practicing procedures and mission equipment use, on a weekly, monthly, and annual training cycle basis. They would be willing for other countries or organizations to participate in or observe their exercises and have a long history of such cooperation. They can share documents that are in English, such as the chapters on training from their Flight Operations Manual.

Norway

The Norwegian Coastal Administration, Joint Rescue and Coordination Centre (JRCC) Norway, and the Norwegian Radiation and Nuclear Safety Authority have a joint exercise program, where each contract partner's crew, service or asset is invited to participate in different yearly exercises. Training and verification are also done during the Norwegian "Oil on Water" trials, where oil in known quantities is used during different verification trials at sea. They do organize some exercises where observers can participate, mostly international exercises performed under some of their regional agreements. Norway values sharing knowledge through participation in others' training and exercise programs. They can share documents from international exercises, as they are likely translated into English. Moreover, exercise documentation from within regional agreements is often published on the appropriate partner's website.

United States

Different sections within the United States Coast Guard have an exercise program. For instance, the Coast Guard Air Station in Kodiak, Alaska, performs exercises in the Arctic and is willing to have other countries or organizations participate in or observe their exercises. It can share their exercise documents. The USCG's Rotary-Wing Program also has an exercise program, details of which are too numerous to list. Involvement of other countries or organizations in this group's exercises is arranged through the international division and external affairs program. They can also share exercise documents with international parties. As for the International Ice Patrol, its members must fly at least once every six months to maintain currency. As its name suggests, IIP represents all member nations that have a funding stake in its operations. It sends annual bills to countries based on the flag state's total tonnage of cargo transiting the IIP area of responsibility. An international exchange would allow them to demonstrate their operations and learn from organizations with similar goals. IIP can share their annual reports and their annual flight track atlas with external parties. As for the USCG's Unmanned Aircraft Systems group, they do not have an established exercising program. The same goes for the National Oceanic and Atmospheric Administration.

3.4.4 Non-Arctic States

Spain

Every month, SASEMAR dedicates four to six flight hours per aircraft to its exercising program. While it has never done so in the past, Spain would be willing to have other countries or organizations participate in or observe its exercises. They can share a description of exercises as well as final flight reports with external parties.

United Kingdom

The Maritime and Coastguard Agency conducts exercises on an ad hoc basis. Potential involvement of other countries or organizations in their exercises would have to be evaluated on a case-by-case basis to ensure that it provides a mutual benefit. The Agency would also consider sharing exercise documents with others on a case-by-case basis.

3.5 RESEARCH AND DEVELOPMENT

3.5.1 Findings

Canada, Norway, the United States, and Spain all conduct research and development (R&D) activities. Areas of research are diverse, but appear to revolve mostly around AI and automation, as well as sensor and system development. In fact, amongst other projects, Canada, the United States, and Spain are all investigating the use of AI for detecting and identifying/classifying targets, whether they are oil spills, whales, or icebergs. Moreover, Canada and Norway conduct research and development activities related to enhancing remote sensing of radiation, pollution (including oil thickness and new types of fuel oils), floods, and wildfires. Furthermore, Norway, the United States, and Spain are also working on developing different systems, whether it is for communications, connectivity, storage, display, or traffic deconfliction. The different respondents already share or are willing to share R&D information including peer-reviewed publications, presentations at conferences, discussions at meetings, bilateral discussions, and technical reports. However, it must be noted that sharing can be limited due to the confidential nature of the material or the language in which documents are written.

3.5.2 Opportunities and recommendations

There is an opportunity for international organizations conducting R&D on a common theme to exchange information to advance one another's knowledge and technologies on that matter. The different States can also gain awareness of each other's work, through the wide potential of R&D information sharing. For example, Fisheries and Oceans Canada has expressed an interest in sharing information and lessons learned with similar agencies, while the United States Coast Guard would welcome opportunities for international cooperation on satellite data validation and on the development of detectandavoid systems for maritime operations, and Spain would be interested in exchanging on new developments related to intelligence sensors for aircraft or satellites and to beyondlineofsight communications.

3.5.3 Arctic States

Canada

Among the Canadian respondents, only Natural Resources Canada has a dedicated research and development program, which currently focuses on designing advanced imaging and direction-capable detectors for ground-based and aerial radiometric survey, on algorithm development for radiation instrument calibration and characterization and localization of radioactivity, and on robotics and artificial intelligence (AI) for use with remotely-piloted aerial and ground-based vehicle-mounted radiometric sensor systems. NRCan shares information on research and development through a variety of means, including peer-reviewed publications, presentations at conferences, discussions at meetings, bilateral discussions, and field demonstrations. While Environment and Climate Change Canada does not have a R&D program dedicated to its Integrated Tracking of Oil Pollution program, they do have an applied science team that contributes to R&D. The work performed for the program is therefore dependent on their capacity. The current areas of interest are machine/deep learning for classification of potential spills, as well as modernization of production software. ECCC has well documented procedures in place for operational workflows that it is willing to share with those interested in implementing similar programs or those looking for efficiencies. As for Transport Canada's National Aerial Surveillance Program, they do not have a dedicated research and development program but do participate in R&D projects focused on enhancing their capability to detect pollution and to monitor floods and wildfires. TC is also exploring AI for its fixedwing and RPAS programs as a way to run algorithms to identify targets of interest to the program (i.e., whales or oil spills) during surveillance missions. Furthermore, TC prioritizes technological enhancements and developments to remain at the cutting edge of technology. It can share its reports with interested parties. For its part, Fisheries and Oceans Canada does not have a R&D program in place but would welcome any opportunity to share information and lessons learned with similar agencies.

Kingdom of Denmark

Joint Arctic Command does not have a dedicated research and development program.

Iceland

The Icelandic Coast Guard does not have a dedicated research and development program. However, as their aviation division has been in place for a long time (almost 70 years), they are willing to share stories of their experience.

Norway

The Norwegian Coastal Administration has a R&D program, of which remote sensing is a part. Their department focuses on developing systems for operational use, such as communication systems, operational systems for exchange, storage, and display of data based on the different remote sensing sensors on their operational platforms, RPAS software, and satellite use. Their research also aims to test different sensors (multi/hyper spectral) for oil thickness estimations. They also support research programs from universities and institutes, mostly by making experts and data available to them. In addition, the Norwegian Coastal Administration leads a vast EU-funded project, the IMAROS project, on new type of fuel oils, the results of which do influence the tasks for remote sensing capabilities. The IMAROS project part 1, here referred to is now finished, and some Low Sulfur Oils used now in shipping do have different characteristics and appearance than traditional Intermediate Fuel oils and Heavy Fuel Oils used before the SECA. The “true color” /thick oil appearance of the oil being brown/ black is in many cases now replaced with oil types that appears transparent in the thicker part of the spill. This is especially challenging for responder ships. A case in Spain/Gibraltar last year, there was a spill involving Very Low Sulfur Fuel Oil, not visible from respond vessels. Here drones and aircraft were used intensely supporting operation guiding the operation towards the thicker part of the oil slick.

R&D papers and reports can be shared, but as most of the reports are in Norwegian, sharing through virtual meetings or workshops might be more effective. While the Norwegian Radiation and Nuclear Safety Authority does not have a dedicated research and development program, they would be willing to share information on some of their projects that do include R&D aspects.

United States

The United States Coast Guard performs a vast quantity of R&D activities through its Research and Development Center located in New London, Connecticut. Information on the project portfolio can be found on their website (Research and Development Center (uscg.mil)). Projects related to the IIP’s mission include iceberg detection and classification (size and shape) from synthetic aperture radars as well as automated correlation of vessel AIS track data to satellite contacts. In terms of unmanned aircraft systems, the R&D primary focus is on developing a detect-and-avoid system (DAAS) to enable traffic de-confliction when operating beyond visual line of sight (BVLOS). BVLOS operations are currently completed using an air search radar, which limits UAS operations as not all cutters have this capability. The ideal solution would be to have a DAAS on the UAS so that a separate air search radar is not required. Sharing of USCG’s R&D information, which is performed through the Research and Development Center, can depend on existing international relationships in place (NATA, Five Eyes, etc.) as well as on the level of sensitivity. As for the National Oceanic and Atmospheric Administration, its R&D focus is on the use of satellite data for operational meteorology, situational awareness, supporting natural disaster monitoring and recovery, and Earth science. NOAA’s data and services are freely available to everyone. Their research and science activities are published in a variety of peer reviewed journals, magazines, and technical reports, and are presented in conferences and meetings.

3.5.4 Non-Arctic States

Spain

The Spanish Maritime Safety Agency has a research and development program that currently focuses on the use of AI sensors to detect and identify targets, on RPAS, and on connectivity. As far as they know, there is no objection to sharing their R&D information, unless it pertains to private military technologies.

United Kingdom

The Maritime and Coastguard Agency does not have a dedicated R&D program.

4. CONCLUSION

The analysis on the responses received from participants indicates a strong appetite for international cooperation.

Here is a summary of the preliminary findings and potential opportunities:

- Multiple mandates and mission from the aerial surveillance are executed by combining oil pollution patrols with support for search and rescue, natural and human-induced disasters, humanitarian assistance, ice reconnaissance and other activities unrelated to emergency incidents.
    - We have opportunity to explore best practices in how overlapping mandates are covered.
- Assets and equipment largely consist of aircrafts and satellites with some similarities across the types of fixed-wing aircrafts and the wide variety of helicopters used in several states. RPAS platforms are present in 3 of 7 Arctic States.
    - We have two potential opportunities. The first is examining the use of aircrafts in different weather climates. The second is examining lessons from existing RPAS programs to identify early best practices for creating and expanding RPAS programs.
- Training is carried out in-house, and supplemented by external training providers, but a notable difference between the North American and European approaches is regional agreements. For example, the Bonn Agreement is an important driver of training requirements and offerings. The Regional agreements play a large role, where standardization of reporting, methodology, campaigns, exercises and best practice is shared. This “standardization” and harmonization also apply between regional agreements, as Bonn Agreement, the Copenhagen Agreement and HELCOM for Baltic Sea.
    - In this instance, we have opportunity to further investigate requirements, by asset and mission types, to improve awareness of where comparative advantages exist between different states.
- Exercise programs exist across most states, and there is a keenness to increase the number of participants and observers, despite funding, security protocols, and resources constraints complicating international exercises.
    - As an opportunity, we could look at incorporating multiple aerial surveillance components into exercises that build understanding of integration across aerial surveillance assets, as well as with marine and ground assets.
- Research and Development on aerial surveillance is limited, but different efforts are looking at the detection of pollution, floods, and wildland fires, and the use of artificial intelligence in operations.
    - Exchanging information or interests, plans, priorities, and ongoing work presents an opportunity to promote awareness of programs across the Arctic.

The opportunities identified from completed questionnaires will be guiding the development of ICAMS activities to take place over the coming year. All results of this activity and the following ones, as well as summarize detailed information on resources, experiences, lessons, best practices and recommendations for future work, and will be disseminated broadly through the EPPR website.

5. ACKNOWLEDGEMENTS

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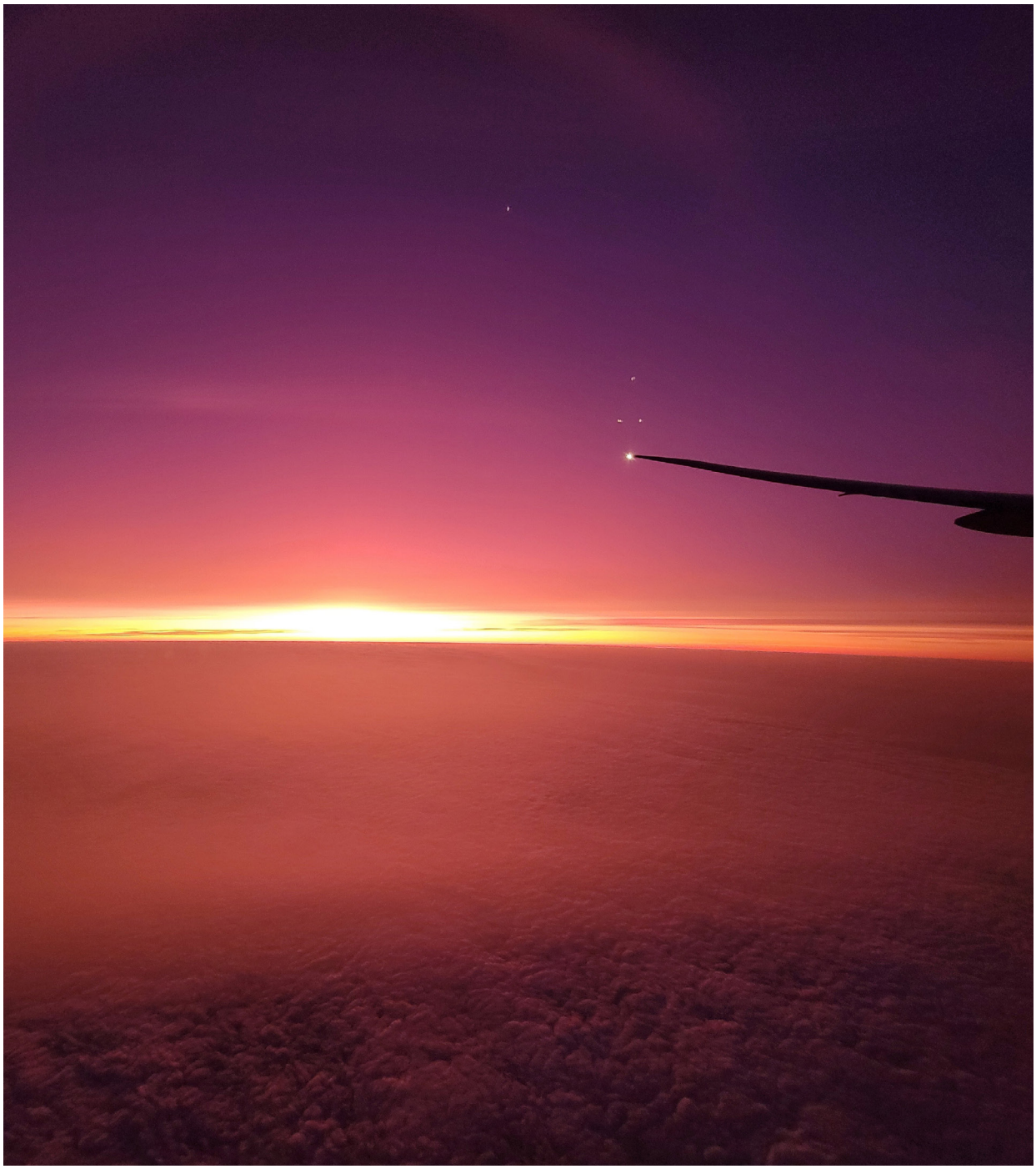

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