From Marine Pollution to Inland Wildfire Mapping

The Mobilization of the National Aerial Surveillance Program (NASP) in support of the Fort McMurray Wildfires

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Expert Technologist, MART Pacific
Overview

- What is the NASP?
- Capabilities of the NASP
- Support of Fort McMurray Wildfires
- R&D and Potential application
National Aerial Surveillance Program

- Coast Guard pollution patrols commenced over the Great Lakes in 1968
- Coast Guard expanded aerial surveillance operations in 1991 to cover Atlantic and Pacific coasts, thus creating the NASP.
- In 2003, the NASP moved to Transport Canada.
- In 2005, acquired remote sensor suite
- The NASP is Transport Canada’s primary method for detecting illegal discharges at sea.
- Current partnership between TC Marine Safety and Security, TC ASD and Environment Canada (EC) Marine Aerial Reconnaissance Team (MART) allows for multitasking and shared costs.
Marine Aerial Reconnaissance Team (MART)

- Group of Environment and Climate Change Canada – Canadian Ice Service employees who conduct the mission planning and execution on board TC NASP aircraft
- Created 2006 when the MSS-6000 was installed on the first Dash8
- MART role: observe, analyze, record and report primarily maritime, but also land-based phenomena, from an aerial platform.
Why does TC Conduct Surveillance?

- Accidental or intentional discharges of oil
- Increase in AIS traffic
- The prevention of oiled wildlife
- Identification of vessels in marine protected areas
- Our department’s role in maritime security
- Ensure public confidence in Canada’s Transportation System
Program Resources

3 TC Aircraft
- 3 teams that cover Canada’s 3 Oceans
- ~ 40 People across Canada

+ Private Industry contract aircraft
- Provincial Airlines (PAL)
- Surveillance in Newfoundland and Labrador
NASP & PAL Surveillance Effort
Fiscal Year 2015-2016

Effort is measured as area observed (field of view - blind spot) by aircraft.
Values are km² observed per 5 km² area.

Surveillance Effort (km²)

- ✅ NASP Primary Base
- 🟢 NASP Secondary Base
- --- NASP Sub-Regions
- ---- Canadian Economic Exclusive Zone
NASP Activities

- Detection of Illegal Discharges
- Emergency Response
- Ice Reconnaissance
- Marine Security
- Fisheries Patrol
- Wildlife Monitoring
- Air Quality Monitoring
- Science
- Participation In Exercises
- Search & Rescue / Search & Assist

NATIONAL AERIAL SURVEILLANCE PROGRAM
Marine and land-based SAR support as secondary resource

Search for downed aircraft in northern Quebec 2015

Search for downed Russian helicopter in Davis Strait 2015. Provided ice data to response vessels
Ice Reconnaissance
Support During Emergency Response Situations

May include events such as:

• Public Safety
• Ships stuck in ice
• Marine Casualties
• Floods
• Support to OGDs
• Response to Pollution Incidents
• Wildfires

The MX-15 camera and the live streaming video were vital with this operation
Support during Environmental Emergencies

• Lac Mégantic rail incident
• Gogama train derailment
Providing support during emergency response

Mapping the total spatial extent of surface oil over large areas like this example from 2010.
Marine Security

Migrant Vessels

Verifying that vessels inbound to Canada appear on an approved list

Identifying suspicious vessels
The Integrated Satellite Tracking of Pollution (ISTOP) Program

June 17, 2012 Incident
The Integrated Satellite Tracking of Pollution (ISTOP) Program

Category 1A

ISTOP detected an anomaly originating from the Hibernia platform. 306 litre spill confirmed by the aircraft the next day.

June 17, 2012 Incident
Arctic Fisheries and Wildlife Monitoring
Marine Mammal Surveys

Whale Researches on board conducting transects to determine populations and

Red = fin whale
Orange = large unidentified whale or like fin whale or unidentified baleen whale
Yellow = humpback
**Blue stars** = blue whale
Smaller yellow star = baird’s beaked whale
Purple = sperm whale
Grey = Risso’s dolphin, pacific white sided dolphin, northern right whale dolphin and all other dolphin/porpoise
Black = killer whale
Lime green = grey whale
White = Cuvier’s beaked whale
MSS-6000 and MX-15

Capabilities of the NASP with the Surveillance System
NASP Surveillance System Components

- SLAR
- AIS
- SATCOM
- EO/IR
- IR/UV
- Cameras
Digital Still & Video Camera Systems

GPS Annotated Data:

- Mission #: TC951_2010_086
- Date: 2011-03-23
- Time: 16:41:25
- Latitude: N44°15.05
- Longitude: W123°29.49
- Altitude: 1489 ft
- Speed: 202.0 kts
- Image #: 0026
Documenting Hydrocarbons on the Water

DISTINCTIVE RAINBOW COLOUR PATTERN

COLOURS BECOME MORE TERRA-COTTA AND TURQUOISE AS THICKNESS INCREASES
Images for Wildfire support
Wildfire Support – Damage Assessment
Electro Optical Infrared (EO/IR)

WESCAM MX 15 EO/IR – 4 sensors

- **Infrared Camera** w/ high magnification 4 step zoom
- **Colour Daylight Camera** with continuous Zoom Lens (EOW)
- **Dual Channel Spotter Lens** – Fixed focal length (Daylight Camera & Low Light Camera) (EON)
- **Laser illuminated Night Spotter** (Illuminates the target in total darkness)
Electro Optical Infrared (EO/IR)

• Primary use: Identification and analysis of targets from far away.

• Secondary use: To document (stored frames or video clips) targets for the records, both day and night, & during conditions of reduced visibility.

• Covert Operation: Positive subject identification (ship names) in total darkness

Images from this system can be live streamed, recorded and still images taken
Tasking to Support Wood Buffalo Wildfire
Live Streaming Video

- See what crew see while they are overhead
- Available to select TC and OGD staff
- Not secure
- Stream only when required as it is expensive
- Requires small software package to be installed on computer or ipad
IR/UV Line Scanner

- Detects oil on surface. (IR) - thicker sections (UV) - extent of oil spill
- Data are georeferenced
- Used to map spatial extent of oil spills and get area of coverage
- Draw polygon around the oil
- Assists in determining where are the heaviest concentrations of oil
NASP IR imagery – Night time fire mapping
Side Looking Aerial Radar (SLAR)

Microwave energy is reflected by microscopic waves on the ocean surface when enough wind is present. The lack of wind and these “capillary waves” prevents backscatter from returning to the SLAR antennas, thus creating a darker appearance on the display.

Swath width with visual surveillance (Naked Eye)
- 4 nm (2 nm each side)

Swath width using SLAR
- 90 nm (45 nm each side) – vessels
- 30 nm (15 nm each side) – oil detection
- 80 nm (40 nm each side) – strip map ice

Increases effectiveness by expanding window of opportunity for Surveillance. Can be used during conditions of reduced visibility.
SLAR target - Outbound tanker

SLAR anomaly/oil slick
SLAR target - Outbound tanker

SLAR anomaly/oil
Wood Buffalo Fire Support – Day 1

- Vancouver to Edmonton – picked up Dr. Josh Johnston (Forest Fire Research Scientist, Natural Resources Canada)

- Conducted early evening overflight (daylight) – gathered video, still images and some IR legs converted to GEOTIFFs
Wood Buffalo Fire Support – Day 2

- Conducted early evening overflight of Fort McMurray for IR scanning (daylight)
- Gathered video, still images and IR data converted to GEOTIFFs.
- Procedures needed to be refined to enhance data and also image resolution needed to be addressed.
Wood Buffalo Fire Support – Day 3

Tasking Received
Tasking results

Hot spot mapping

IR Line scans
Hotspot map made in-flight
Hotspot map made inflight
Wood Buffalo Fire Support – Day 4-5 Tasking
Raw, unprocessed IR imagery
How does NASP get here?
NASP Capability - IR Night time fire mapping
Process imagery
Process imagery
Processed imagery
NASP IR imagery – Day time fire mapping
Composite Image with GIS layers
Fire Progression Mapping
Fire Progression Mapping

1 Hour later

~750 m advance/1 hr
Fire mapping

- Process, orthorectify and mask raw imagery
- Determine and run cell classification
- Build maps of active fire burning
- Provide products useable to command centre and responders in a timely fashion.

Hot Spot mapping

- Georeference hot spots
- Associate spots to images
- Create maps and image catalogue/database for easy reference by command or responders
Tasking

Fire mapping
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**Tasking**

- **Fire mapping**
  - Process, orthorectify and mask raw imagery
  - Determine and run cell classification
  - Build maps of active fire burning

- **Hot Spot mapping**
  - Georeference hot spots
  - Associate spots to images

**Client Need?**

- Provide products useable to command centre and responders in a timely fashion.
- Create maps and image catalogue / database for easy reference by command or responders.
Fire mapping:
- Process, orthorectify and mask raw imagery
- Determine and run cell classification
- Build maps of active fire burning
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Hot Spot mapping:
- Georeference hot spots
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What we have – what we need

Have:
• Deployable aircraft with crew
• IR/UV linescanner
• EO/IR camera

Can get raw remote sensed data

Need to:
• Gauge stakeholders (clients) interest
• What can we do above and beyond private industry
• R&D to process files and streamline for operational use
• Need to develop SOPs and training for operators in data acquisition and processing
Future Initiatives

If this resource is of interest for wildfire support:

• Seek funding for R&D
• Possibly upgrade equipment (MX-15 and/or linescanner)
Thank You

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**Mission Planning for Wildfire - IR/UV Scanner**

<table>
<thead>
<tr>
<th>Altitude</th>
<th>Swath</th>
<th>Pixel Resolution</th>
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<tbody>
<tr>
<td>1500ft</td>
<td>~ 750 m</td>
<td>3 x 3 m</td>
</tr>
<tr>
<td>8000ft</td>
<td>~ 4km</td>
<td>14 x 14 m</td>
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