NOAA
Unmanned Aircraft Systems (UAS)
Oil Spill Testing and Evaluations

Presentation to the
2015 OSPR/Chevron Oil Spill
Response Technology Workshop

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25 February 2015

Maritime Surveys (Oil Spill)

FY09

FY10

FY11

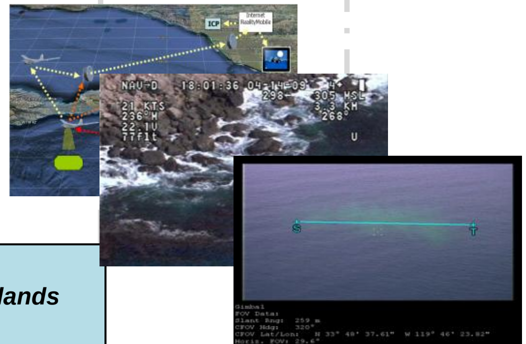
FY12

FY13

FY14

FY15

Puma Oil Spill Testing in Channel Islands (2008-2011)



Puma AE (LASE)

Puma Oil rig security Coastal Trident (2013)

Puma Oil Spill SB Channel & Vandenberg AFB (2014)

Arctic Shield 2013-2015
Conducted Shipboard Launch & Recovery Successful Flight Deck Recoveries Successful Net-Capture Recoveries Conducted ERMA Integration Testing

Fixed-Wing UAS Capabilities

High Altitude Long Endurance (HALE)

- Maximum Altitude 65,000 ft
- Maximum Endurance 25 hrs
- Maximum Payload Weight 1200 lbs

Medium Altitude Long Endurance (MALE)

- Maximum Altitude 40000 ft
- Maximum Endurance 24 hrs
- Maximum Payload Weight 400 lbs int, 2000 lbs ext

Low Altitude Long Endurance (LALE)

- Maximum Altitude 19,500 ft
- Maximum Endurance 24 hrs
- Maximum Payload Weight 13.5 lbs

Low Altitude Short Endurance (LASE)

- Maximum Altitude 1000 ft (operating altitude, higher capable)
- Maximum Endurance 2 hrs
- Maximum Payload Weight approx 2 lbs

Other Unmanned Capabilities

Vertical Takeoff and Landing (VTOL)

- Maximum Altitude 3280 ft
- Maximum Endurance 1.4 hr
- Maximum Payload Weight 1.7 lb

Aircraft-launched UAS (ACL)

- Maximum Altitude 20,000 ft
- Maximum Endurance 1.5 lbs
- Maximum Payload Weight 0.9 lbs

Balloon-launched UAS (BL)

- Maximum Altitude 100,000 ft
- Maximum Endurance N/A
- Maximum Payload Weight 3 lbs

Surface Unmanned Vehicles (SUV)

- Maximum Altitude Sea Level
- Maximum Endurance 8.6 hr
- Maximum Payload Weight 15 lb

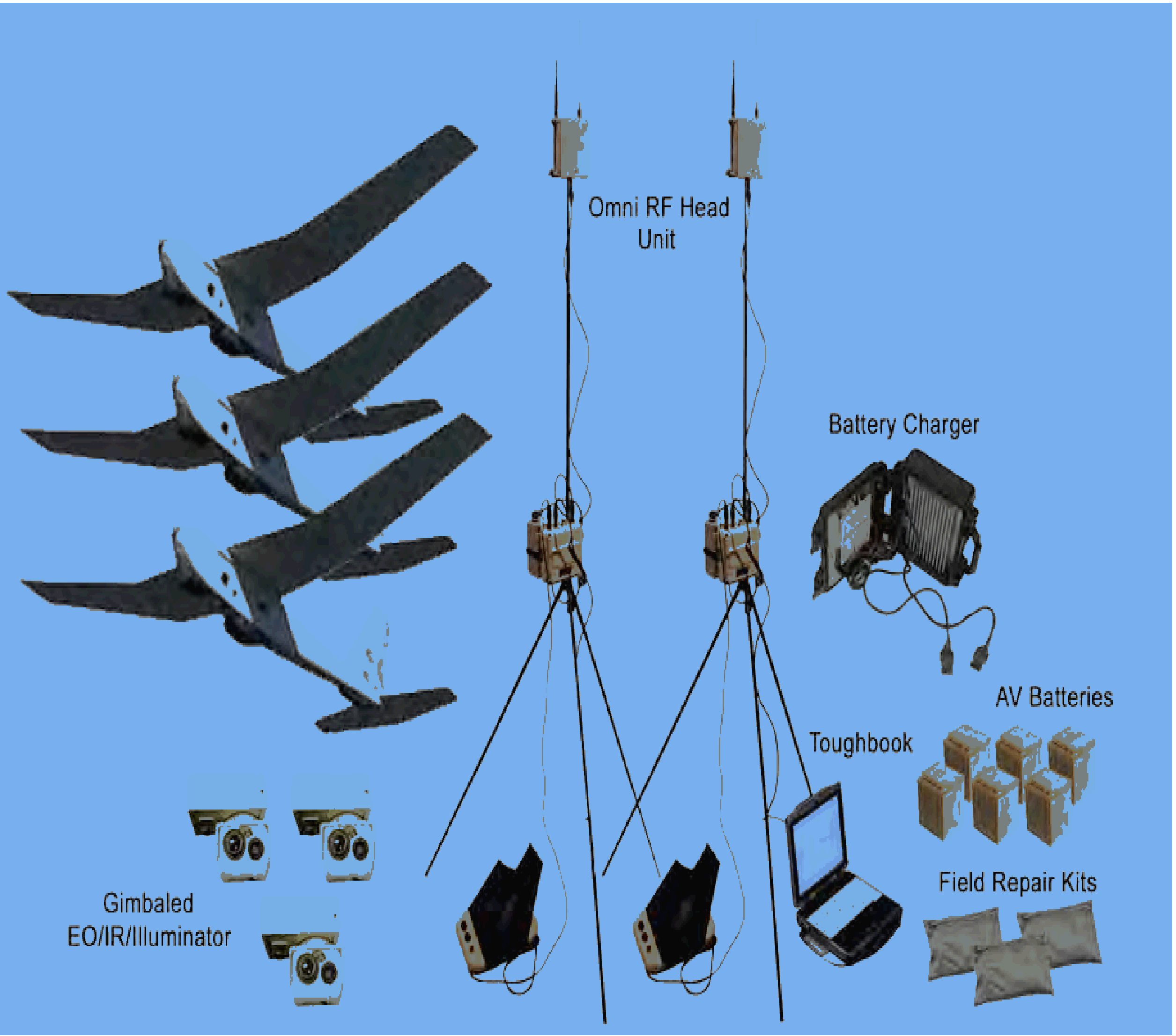
Tethered Balloons (TB)

- Maximum Altitude 25,000 ft
- Maximum Endurance N/A
- Maximum Payload Weight 2,200 lbs

Scan Eagle recovery at sea

The “holy grail”: Launching <u>and recovering</u> at sea

AeroVironment PUMA AE sUAS System



VTOL/Multi-copters

Md4-1000

- Very high resolution imaging
- Short duration flights
- Issues with gyro orientation and magnetometers on ships
- No proven "waterproof" equipment available yet
- Some priced low enough to be "expendable"
- The enabling technology is battery power

2008 aboard R/V Shearwater in Santa Barbara Channel.

Objectives included:

•Ability of the Puma system to operate at sea
•Coastal surveys for evaluation of the system's ability to determine the presence/absence of oil and survey to wildlife,
•Demonstrating the ability to function as a communications relay
•Operated BVLOS (SUA provided by Point Mugu)

Partners included: AeroVironment, USCG (USCGC HALIBUT and R&D Center), CA Fish and Wildlife/OSPR, NPS & USWFS

Marine Resource Monitoring

Living Marine Resource Surveys

Pinnipeds

Marine Resource Monitoring

Living Marine Resource Surveys

Seabird Surveys

2011 aboard R/V Shearwater in Santa Barbara Channel.

Objectives included:

•Microwave Internet data relay to Incident Command Center (FMV and still images with telemetry transmitted real-time to ICC over the Internet)
•Imaging oil simulant (fluorescein dye),
•Puma as communications relay
•Quantification of geographic scope of simulated spill over time
•Coastal surveys for evaluation of the system's ability to determine the presence/absence of oil,
•Operated BVLOS (SUA provided by Point Mugu)

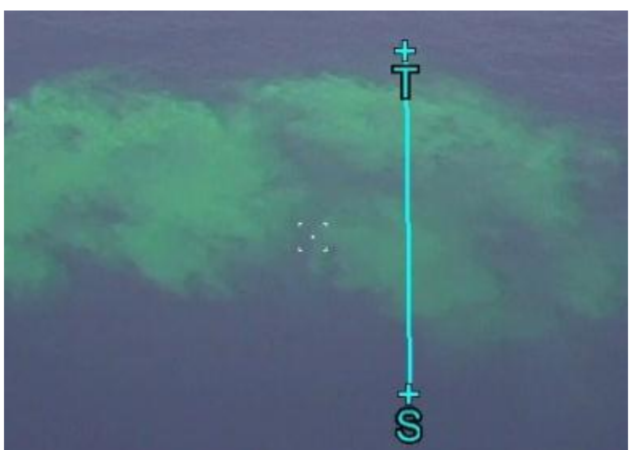
Partners included: AeroVironment, Chevron Shipping, Reality Mobile, USCG (Sector LA/LB USCGC BLACKTIP and R&D Center), NPS, USFWS, CA Fish and Wildlife/OSPR

Take aways:

Someone needs to document how to effectively apply fluorescein dye!

Emergency Response & Oil Spill Simulation

2011 NPREP Drill UAS study of oil spill monitoring in Santa Chevron



2013 aboard USCGC HEALY for Arctic Shield

Objectives included:
•Puma Data to ERMA
•System testing in Arctic environment
•First Arctic shipboard deployment of Puma

Take aways:
•Need ice sensing
•Need to simplify data ingest to ERMA
•Need autonomous shipboard recovery system
•Problems with accuracy of data when operating in areas without DTED
•Need more and better oil simulants for future testing

Partners included: USCGC HEALY & R&D Center, University of Alaska Fairbanks and Air Force Special Operations Command

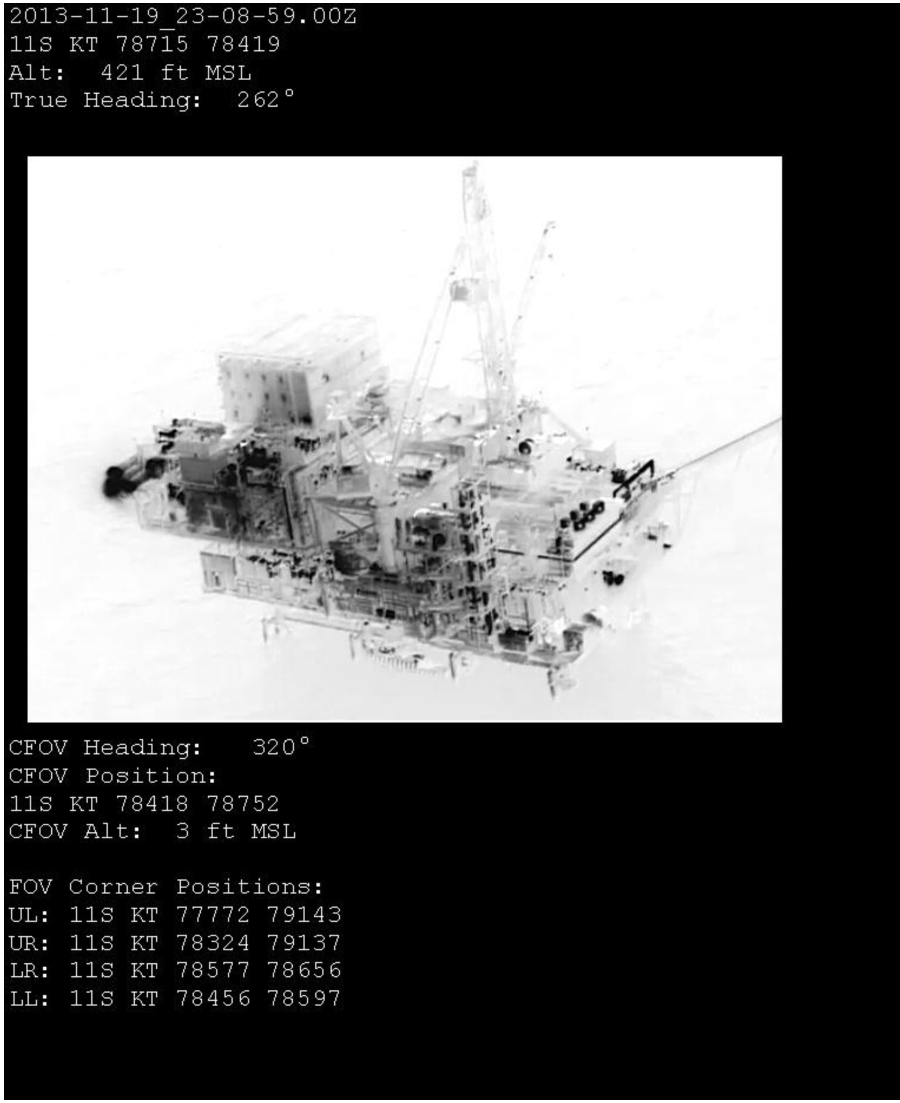
2013 aboard R/V Shearwater for oil-rig security and gas venting surveillance testing

Objectives included:

•Oil-rig security testing with Naval Post Graduate School's Center for Asymmetric Warfare (CAW)

•BSEE IR oil-rig gas venting surveillance and enforcement demonstration
•Microwave to Internet data transmission.
•Finding and tracking data marking buoys in windy conditions (~25 knots).

Partners included:
CAW**,** Clean Seas & BSEE



2014 aboard Shearwater and along the coast of VAFB

Objectives included:

1. <u>Shearwater:</u>

- Fluorescein dye application procedure development and documentation
- Imaging of dye and ability to use Puma UAS imagery to quantify spill
- Testing of 2d3 image processing software
- Real-time processing (mosaic and image optimization) and transmission of data (with telemetry) over 4G and Ku band satellite to remote locations.

2. <u>Vandenberg Air Force Base:</u>

- Testing ability to use Puma UAS imagery to support SCAT surveys using stuffed animals and black plastic sheeting as oil and wildlife analog
- Documentation of sensor resolution with calibrated targets
- Real-time processing (mosaic and image optimization) and transmission of data (with telemetry) over Ku band satellite to remote locations.

Partners included: NOAA HAZMAT & National Marine Fisheries Service, OSPR, Chevron Shipping, 2d3 and Ku satellite support by Ground Control.

Take aways: Need higher resolution optical sensor for SCAT and Damage Assessment

Dye Release (color enhanced)

2d3 Super Resolution Enhancement

Quadrat transects at VAFB

2014 aboard USCGC HEALY for Arctic Shield

Objectives included:
•Imaging various oil simulants and ingesting Puma Data to ERMA
•Testing 2d3 image processing software
•Testing of deck landing procedures and of beta Puma net capture system
•Exercising of NOAA's "Due Regard" policy in international airspace
•Operating in conjunction with Aerostat

Partners included: USCGC HEALY & R&D Center, AeroVironment, IGM Aerostat & 2d3

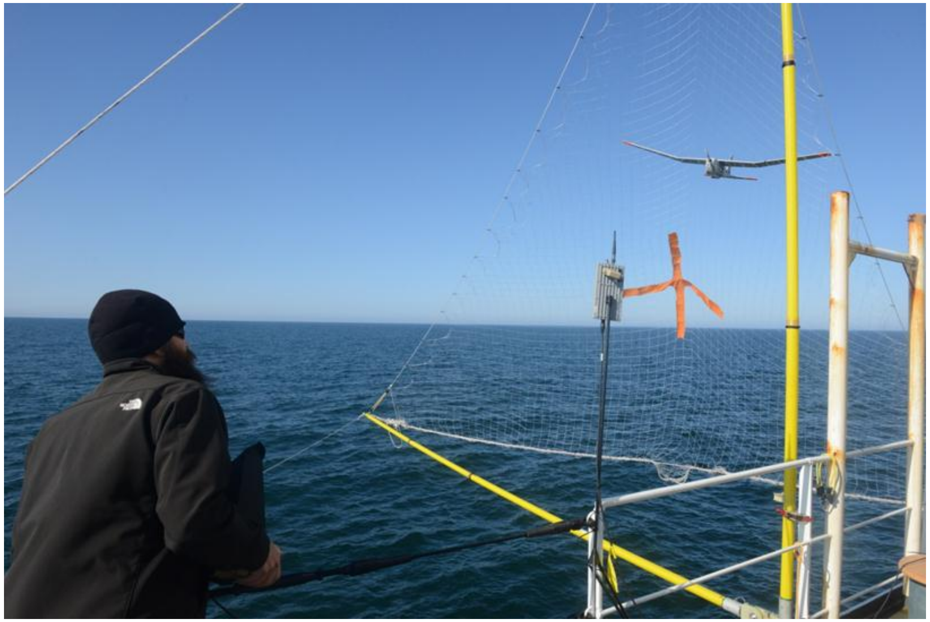
Take aways:
•Need autonomous shipboard recovery system
•Problems with accuracy of positioning when operating in areas without DTED (now solved by manufacturer)
•Need to fly BVLOS, change weather minimums and increase flight envelope
•Aerostat was great compliment to UAS by confirming the ceiling and providing truth for the imagery

Arctic Shield Oil Spill Testing

2014 Detection and monitoring of simulated oil spilled from ship

Puma "Due Regard" Ops & Recovery Testing

- ✓ **Due Regard Operations**
- ✓ **Water and Ice Landings**
- ✓ **Deck Landing**
- ✓ **Net Capture System**



2015: UAS Rapid Response for Emergency Operations

Deploying UAS in response to disasters: *Developing the capacity for UAS to respond to disasters and provide useful/actionable data to decision makers in the formats and resolutions that they require in a timeframe that is relevant.*

Prerequisites for UAS operations:

1. **Authority to operate**
2. **Access to airspace:**

• Domestically under FAA COA, Special Use Airspace (Military Warning and Restricted areas), MOA or under the new FAA sUAS rules once they become effective.

•In international airspace under “due regard” if “State Aircraft” or internationally in conjunction with the U.S Department of State

3. Access to equipment

4. Availability of operators and observers (if required) that are trained, certified, current and proficient

Unfortunately, at this point in time, there is nothing "rapid" about deploying UAS.

We are working on reducing planning and deployment time from weeks or months to hours... Working with NOAA HAZMAT to find and develop the right spill drill to exercise all of the elements necessary to truly respond to an oil spill or other disaster event.

•Contracts in place for surge capacity
•Emergency COAs or Temporary Flight Restrictions (TFRs)?
•Data accuracy and resolution
•Real-time data dissemination

2015: Arctic Shield aboard USCGC HEALY

Objectives:

•Oil spill support of USCG and NOAA HAZMAT:

•Working with industry to increase capacity by optimizing equipment

•Working with regulators and decision makers to develop rules & policies that allow the technology to be deployed and utilized in safe, relevant and useful ways

•Testing new high-resolution gimbal and autonomous net capture system on Puma,

•High-speed communications and data relay through aerostat

•Hand-off and/or data downlink with ScanEagle

•Operating BVLOS under “due regard”

Challenges

- Current lack of spontaneity in deployment reduces utility
- Lack of dedicated non-DoD bandwidth for domestic operations
- FAA airspace limits for BLOS operations
- Political concerns/public perceptions
- Policies

Take aways

The more remote you are, the more it makes sense to use sUAS.

sUAS will be great tools for early-phase oil spill characterization and quantification and as tactical tools to support clean up operations **once the rules allow for them to be quickly deployed AND operated Beyond Visual Line of Site.**

Options to consider before planning to use a UAS today:

•*Should I just rent a manned aircraft?* (Cost, spontaneity, access)

•*Should I just bring binoculars?* (Can I fly beyond VLOS)

•*Is an aerostat a more simple solution?* (Operating spontaneously below 500')

This is a dynamic environment. Both equipment and the rules that govern its use are evolving rapidly.

Currently, the technology is ahead of the rules. The draft sUAS rules were published by FAA earlier this month.

sUAS within VLOS is just over the horizon

Back-up slides:

New Draft sUAS rules from FAA out for comment (Final rule expected late 2016)

- VLOS and daytime only
- 55 pounds or less (Everything up to and including a ScanEagle)
- Operations below 500’
- Certification of operators
- No certification of equipment
- No flying over people
- Possible follow up with relaxed rules for "micro" (under 4.4 pound) UAS

Agencies can still secure COAs

Favors VTOL (Multi-copters) for land-based work (We are still searching for a true ship-capable VTOL)

Should start to see a sUAS service industry evolve...

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1. Authority to operate

2. Access to airspace:

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Technological areas for development:

•Simplified operator interfaces

•“Easy button” outputs to quickly export data into GIS systems to make maps and products

• Advances in compression technology to allow higher resolution imagery to stream with limited bandwidth

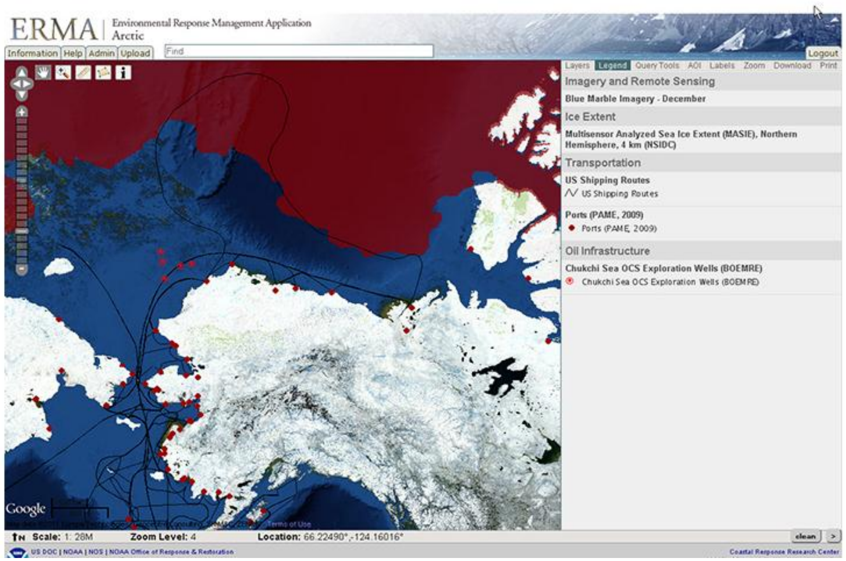
•The development of new schemes to aid in the transmission of data from point to point or to the Internet from remote locations

•More and higher resolution sensors

ERMA Coordination

ERMA® is an online mapping tool that integrates both static and real-time data, such as Environmental Sensitivity Index (ESI) maps, ship locations, weather, and ocean currents, in a centralized, easy-to-use format for environmental responders and decision makers. ERMA enables a user to quickly and securely upload, manipulate, export, and display spatial data in a Geographic Information System (GIS) map.

Visit Arctic ERMA.



Software and Datasets

- ADIOS, oil weathering model.
- ERMA®, online mapping tool for environmental response data, adapted to a variety of regions.
- GNOME, oil spill trajectory model.
- GOODS, a tool that helps GNOME users access base maps, ocean currents, and winds.
- NUCOS, a unit converter that includes units unique to oil spill response.
- Spill Tools, a set of three programs: the Mechanical Equipment Calculator, the In Situ Burn Calculator, and the Dispersant Mission Planner.
- Trajectory Analysis Planner, oil spill contingency planning software.
- Environmental Sensitivity Index (ESI) maps and data, concise summaries of coastal resources that may be at risk in a spill incident.