NOAA’s Marine and Arctic Monitoring UAS strategies

Todd Jacobs
John “JC” Coffey
NOAA UAS Program
18 December 2014
Overview

- NOAA UAS Program – A Brief History
- sUAS for Marine Resource Monitoring, Arctic and Emergency Operations
- Successes and Challenges
- Looking Forward
- Questions
NOAA Requirements for UAS

Missions that are:
• Dirty
• Dull
• Dangerous (Threat assessments)
• **Denied** or Impossible to get to and/or impossible to use a manned aircraft (Low ceilings, etc.):
  - Remote
  - **Unique mission requirements:**
    o Smaller and **quieter** UAS don’t disturb animals as much as a manned aircraft would
    o **Stealth** provides advantages for surveillance and enforcement
    o **Persistence**
    o Better data resolution
    o Can be quickly deployed and positioned
NOAA and UAS

- Altair at Channel Islands
- Global Hawk
NASA Global Hawk Operations Center
NOAA and UAS

- NASA Ikhana
- ScanEagle
- Manta
NOAA sUAS history

• NOAA tests various systems including **ScanEagle** in 2007 and 2009 and acquires two **multi-copters** in 2010 and two **Puma** UAS in 2011
• Development of protocols and procedures
• Missions:
  • Living Marine Resource Surveys
  • Habitat Mapping and Characterization
  • Enforcement
  • Emergency Response
  • Marine Debris
  • USCG Arctic Support
Scan Eagle on test deployment in Puget Sound 2007
Scan Eagle recovery at sea
Multi-copters

- Very high resolution imaging
- Short duration flights
- Issues with orientation and magnetometers
- No “waterproof” equipment available yet
- Some priced low enough to be “expendable”
- The enabling technology is battery power
PUMAAE System
The “holy grail”: Launching and recovering at sea
AV GCS/RVT on R/V Shearwater
Data distribution architecture
Marine Resource Monitoring

Blue Whale Tagging Support
Marine Resource Monitoring

Living Marine Resource Surveys

Seabird Surveys
Marine Resource Monitoring

Living Marine Resource Surveys

- Pinnipeds
Marine Resource Monitoring

Habitat Mapping
Marine Resource Monitoring

Enforcement

2012-08-30 07-59-16.002
119 KT 50470 60999
Alt:  336 ft MSL
True Heading:  126°

CFOV Heading:  31°
CFOV Position:
119 KT 50546 61077
CFOV Alt:  3 ft MSL

FOV Corner Positions:
UL: 119 KT 50535 61123
UR: 119 KT 50606 61098
LR: 119 KT 50554 61042
LL: 119 KT 50509 61063
Simulated seal and turtle
Coast Guard UAS partnership study of oil spill monitoring in Santa Barbara channel
Hawaii Activities

Papahanaumokuakea Marine National Monument

362,073 square kilometers of the Pacific Ocean
Puma Vessel Operations
Unofficial Species Counts

- Monk Seals: about 20
- Mother-Pup Pairs: about 6
- Turtles on Beach: about 200
- Turtles in Water: about 40
- Birds: about 200

* Derived from multiple images and video
Trig Island, Puma Flight 14-006
19 June 2014, 1110L

Flight 14-006, 19 Jun 2014, 1110L
Image 2014_06_19_21_10_58_3QUG73594061
Left half of image
Trig Island, Puma Flight 14-006
19 June 2014, 1148L

Flight 14-006, 19 Jun 2014, 1148L
Image 2014_06_19_21_48_42_3QUG72424081
Float in center of image
Best Image of a Mother-Pup Monk Seal Pair

Flight 14-006, 19 Jun 2014, 1108L
Image 2014_06_19_21_10_58_3QUG73594061
Closest edge of image
Turtle Counts, Morphology, Activity

Flight 14-006, 19 Jun 2014, 1108L
Image
2014_06_19_21_08_47_3QUG7349406
8
Edges, lower half of image
Tern Island Birds and Vegetation

Flight 14-006, 19 Jun 2014, 1206L
Image 2014_06_20_04_05_58_3QUG69674057
Left edge of image
EO to IR Comparison

Flight 14-008, 19 Jun 2014, 1840L
Image 2014_06_20_04_05_58_3QUG69674057
Entire image

Flight 14-008, 19 Jun 2014, 1840L
Image 2014_06_20_04_05_58_3QUG69674057
Entire image
Launch and recovery at sea
Arctic Support
NOAA USCG Healy Deployment, Operational and Scientific Goals

- Conduct Puma AE "due regard" operations from USCG (Icebreaker) Healy
  - Water and Ice Landings
  - Deck Landing
  - Net Capture System

- Conduct Intelligence, Surveillance, and Reconnaissance (ISR) Operations Stream Full Motion Video (FMV), EO and IR from Puma AE for
  - Detection and monitoring of oil spilled from ship or oil exploration
  - Detection and monitoring of marine debris from ship
  - Sea ice ridge detection/monitoring
  - Usefulness in search and rescue (emergency response) scenarios
  - Marine and marine mammal monitoring (opportunistically)
  - Producing a Digital Elevation Map (DEM) of ice ridge and surrounding area
    - Preparation for future boundary layer research from sUAS

- Utilize the Environmental Response Management Application (ERMA)

- Coordinate with ONR Marginal Ice Zone Experiment (MIZOPEX) FY14

- Coordinate with the UAF for ScanEagle flight operations coordination and data exchange

- Coordinate with the NOAA NMFS Manned Marine Mammal Survey Flights
Puma “Due Regard” Ops & Recovery Testing

- Due Regard Operations
- Water and Ice Landings
  - Deck Landing
- Net Capture System
ISR Missions
including Oil Spill & SAR

✔ Sea ice ridge detection/monitoring
✔ Usefulness in search and rescue scenarios
✔ Detection and monitoring of oil spilled from ship
✔ Detection and monitoring of marine debris
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.
- Second year participations through the UAS Program.
- Software demonstration/test with 2d3

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.
Arctic Shield Take Aways & Operational Assessment

• Arctic is a Challenging Environment
  – Platform flight envelope must be expanded
  – Platform recovery process and sensors must continue to be improved
  – “Due Regard” operations must be expanded

• Partnerships are crucial (Maritime Strategy)
  – People, property and platforms (data captured) are valuable
  – Must maximize operations and data sharing opportunities
Where the Puma excels

Puma is a great system. Important attributes for NOAA’s work include:

- **Durability**: Puma is tough and not overly complicated to repair and maintain. It takes a fair amount of abuse
- **Adaptability**: Puma’s ability to be operated in all environments (as long as it isn’t too rainy or windy…)
- **Transportability** and ability to be carried aboard, without modifications to the vessels
- Airworthyness documentation
- Spares and support
- Great support from AeroVironment
sUAS requirements for NOAA’s maritime and Arctic use

• High resolution optical and infrared imagery
• Additional payloads:
  • Nadir mapping cameras
  • LiDAR
  • Multispectral
• Simple, non-proprietary interfaces to quickly ingest data into GIS systems
• Ability to tap into high resolution data stream with metadata in real-time and relay data to incident command centers via ship’s satellite communication systems (Google Loon?)
• Ability to launch and recover aboard ship
• Ability to operate in up to 35 knots of wind
• Heated pitot tube
• Ability to sense icing or to de-ice the wings and control surfaces
The future looks bright

- Routine VLOS operations in the NAS under new FAA rules
- More equipment and sensor offerings from industry
- BVLOS operation in the Arctic and remote oceanic areas for agencies
- Emergency operations
- Enforcement
- Ghost Nets and other unique missions...