Operating sUAS from research vessels

Todd Jacobs
NOAA UAS Program
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NOAA sUAS aboard vessels

Overview

- NOAA and Small UAS (sUAS) aboard vessels – A Brief History
- sUAS for Marine Resource Monitoring, Emergency Operations & Enforcement
- 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:**
  - Smaller and quieter UAS don't disturb animals as much as a manned aircraft would
  - **Stealth** provides advantages for surveillance and enforcement
  - **Persistence**
  - **Better data resolution**
  - **Can be quickly deployed and positioned**

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

Payloads

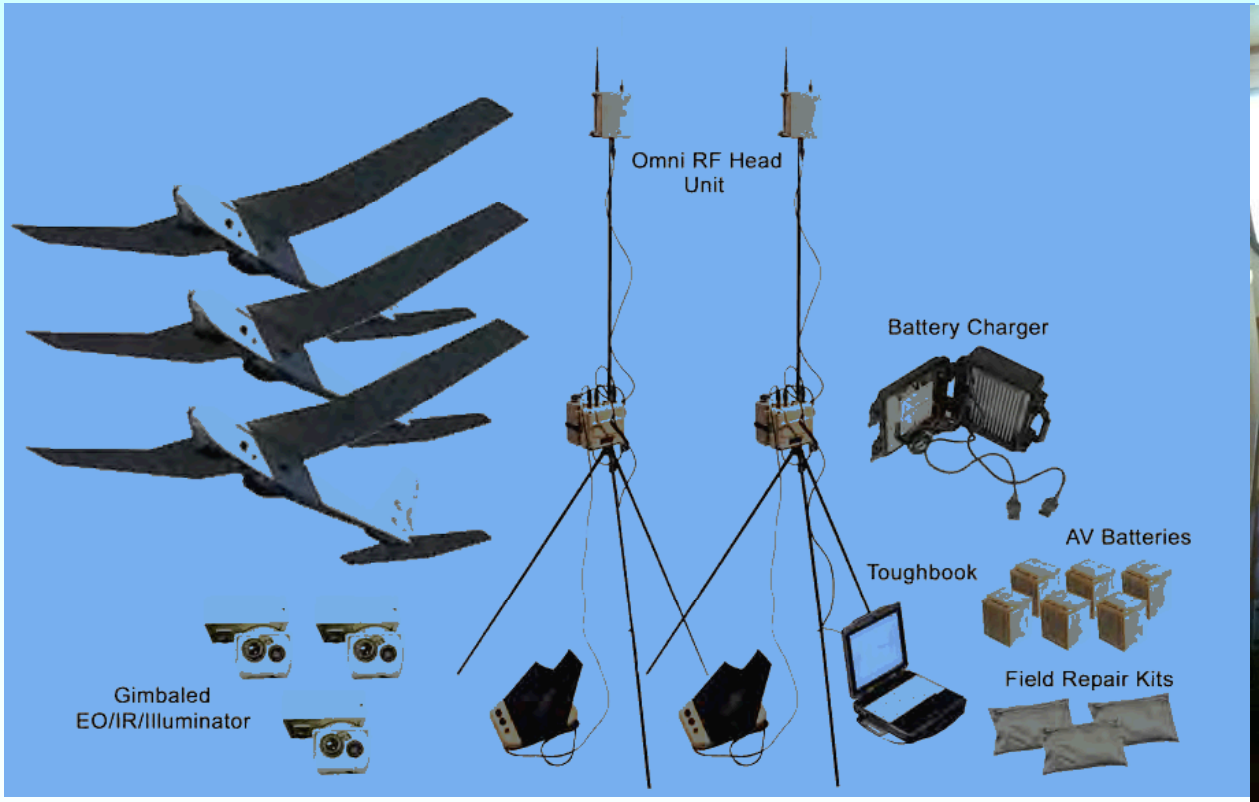
Common payloads:

- **EOIR** (Optical and infrared stills and full-motion video)
- Nadir high-resolution mapping
- LiDAR

Less common, but desired payloads:

- Multi and hyperspectral imagers
- Communications relays
- RDF
- Gas sampling or capturing
- Meteorological packages

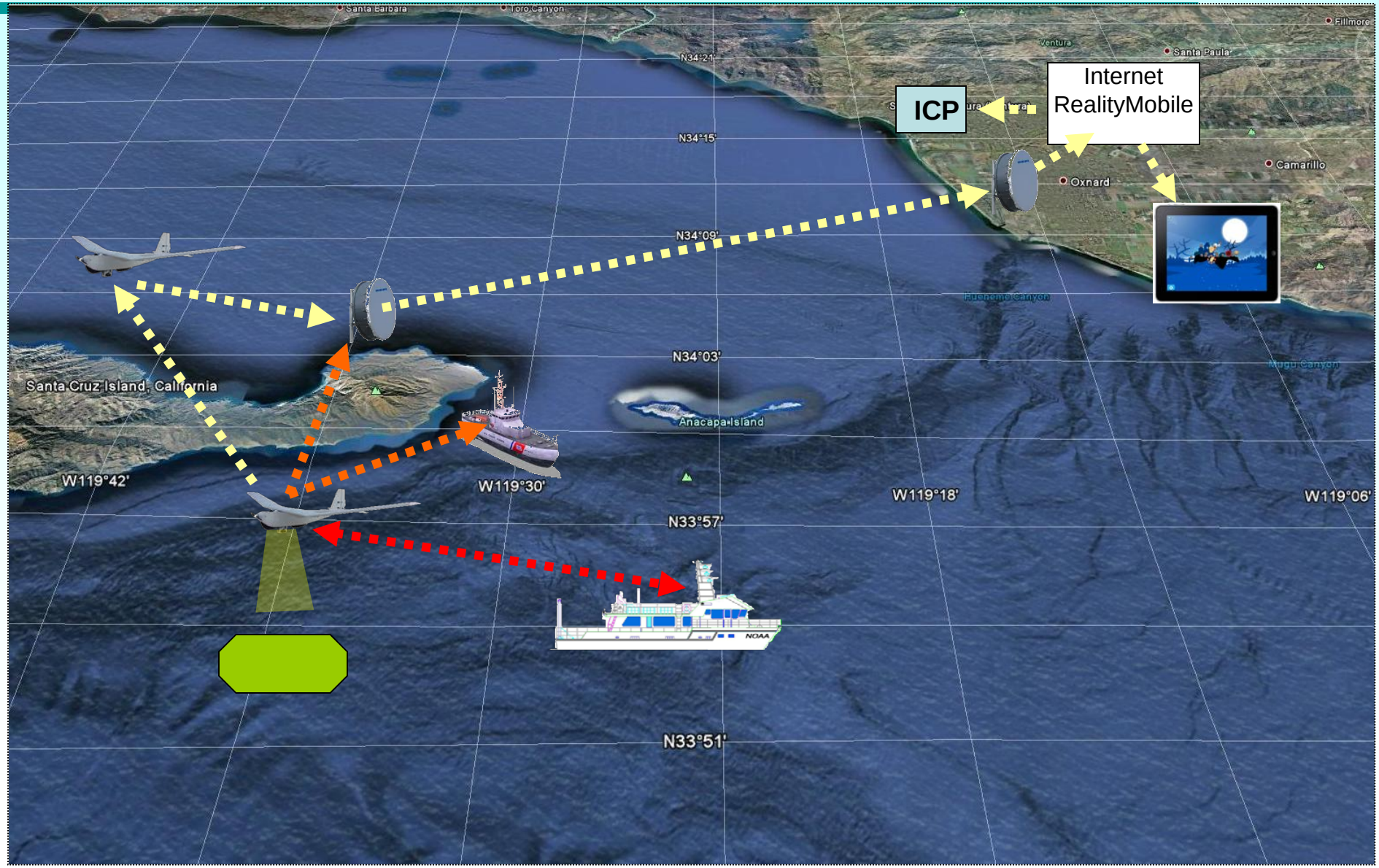
PUMA AE System



The “holy grail”: Launching and recovering at sea

AV GCS/RVT on R/V Shearwater

Data distribution architecture



Launch and recovery at sea

Marine Resource Monitoring

Blue Whale Tagging Support

Marine Resource Monitoring

Living Marine Resource Surveys

Seabird Surveys

Marine Resource Monitoring

Living Marine Resource Surveys

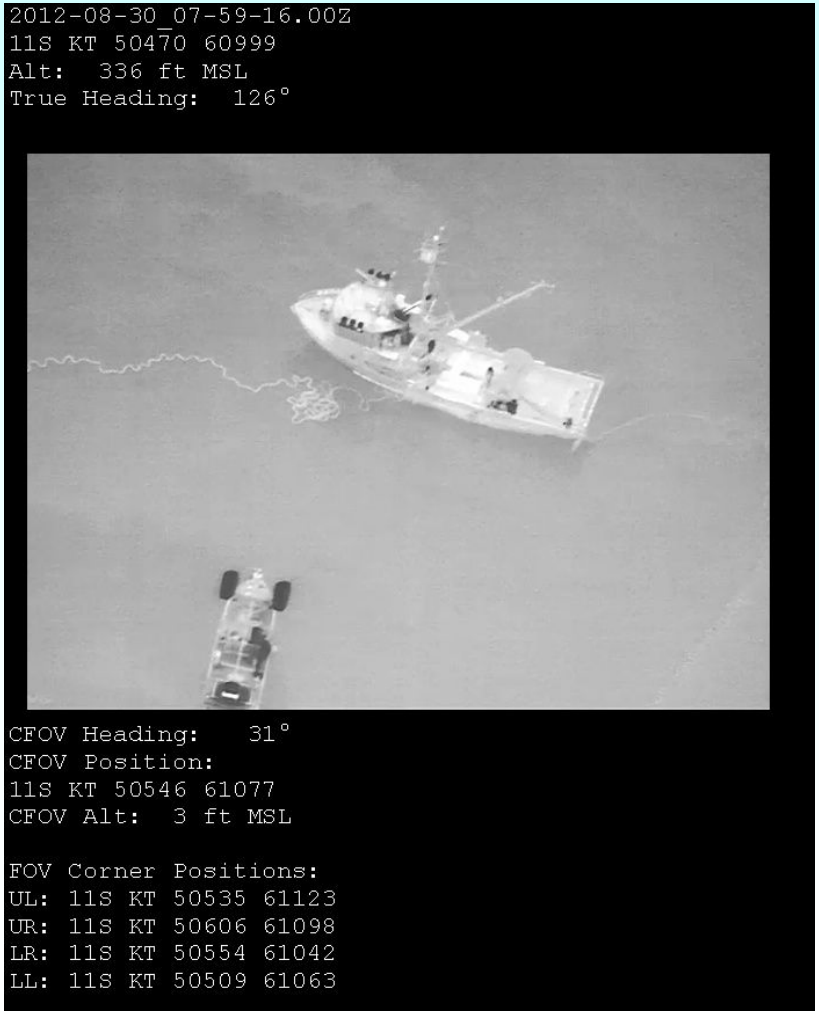
- Pinnipeds

Marine Resource Monitoring

Habitat Mapping

Marine Resource Monitoring

Enforcement



Simulated seal and turtle

Hawaii Marine Debris testing 6/12

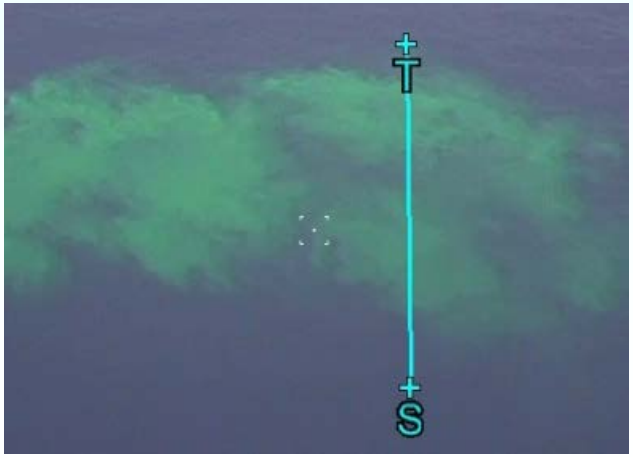
2012-06-20 21:06:10Z
Lat/Lon: N 21° 39.092' W 158° 10.676'
Alt: 344 ft MSL
Mag: 36°

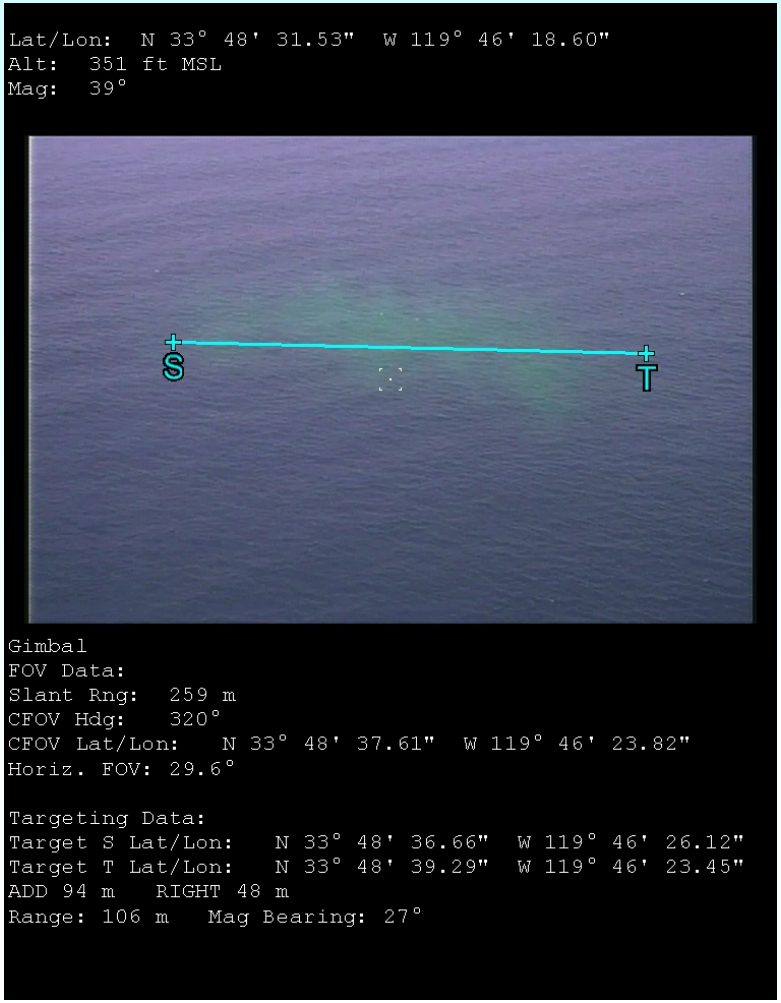
Gimbal
FOV Data:
Slant Rng: 184 m
CFOV Hdg: 339°
CFOV Lat/Lon: N 21° 39.203' W 158° 10.720'
Horiz. FOV: 6.3°

ORIGIN Lat/Lon: N 21° 39.386' W 158° 10.509'
RANGE -> HOME: 0.1 km
BEARING -> HOME: 176°
WIND SPEED: 00.0 kts
WIND DIR: 68°

Emergency Response & Oil Spill Simulation

Coast Guard UAS partnership study of oil spill monitoring in Santa Barbara channel

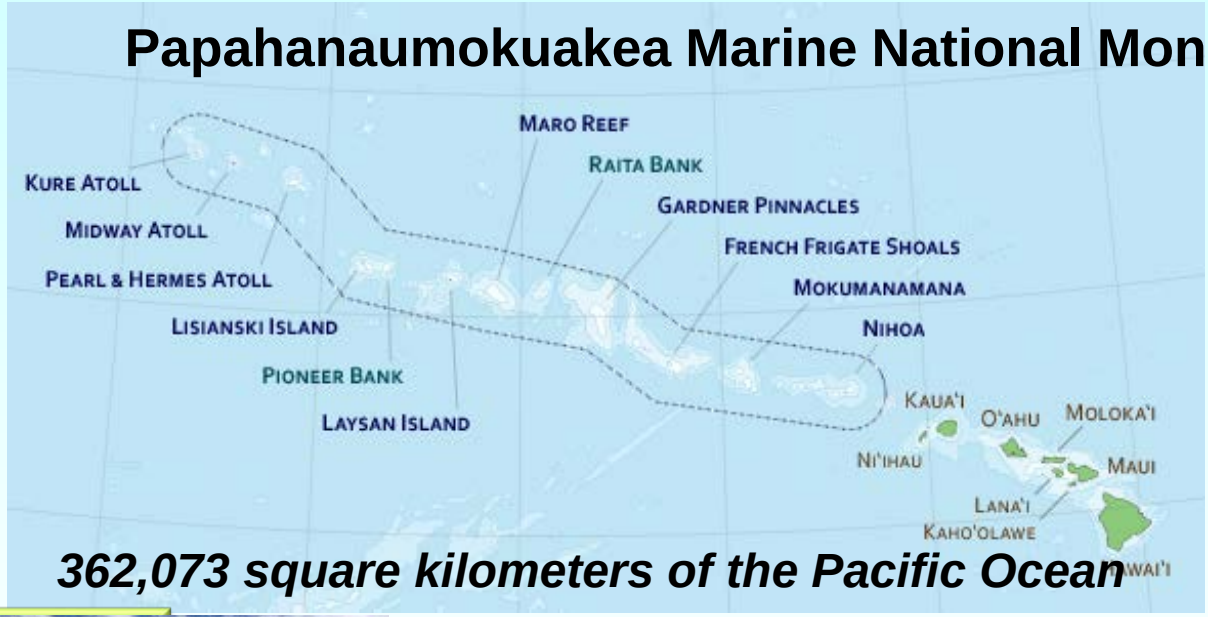




Arctic Support

Hawaii Activities

Papahanaumokuakea Marine National Monument



362,073 square kilometers of the Pacific Ocean

Puma Vessel Operations

Trig Island, Puma Flight 14-006
19 June 2014, 1102L

2014_06_19_21_02_39_3QUG73564056
-File Size: 1.74 MB (1,828,802 bytes)
-Dimensions: 2592 x 1944 Pixels
-Resolution: 96 x 96 dpi
-Bit Depth: 24 (16777216 colors – 256 each RGB)

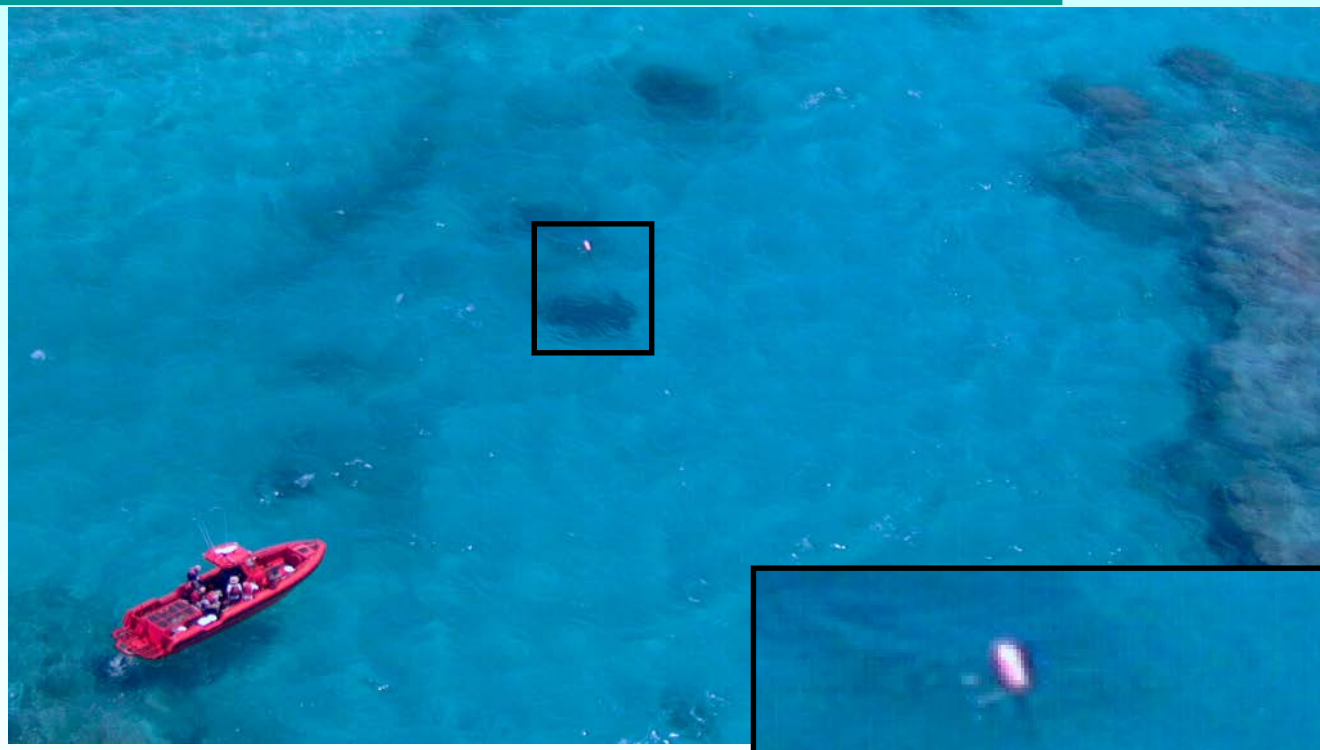
<u>Unofficial Species Counts</u>
Monk Seals: about 20
Mother-Pup Pairs: about 6
Turtles on Beach: about 200
Turtles in Water: about 40
Birds: about 200

* 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
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EO to IR Comparison

Flight 14-008, 19 Jun 2014, 1840L
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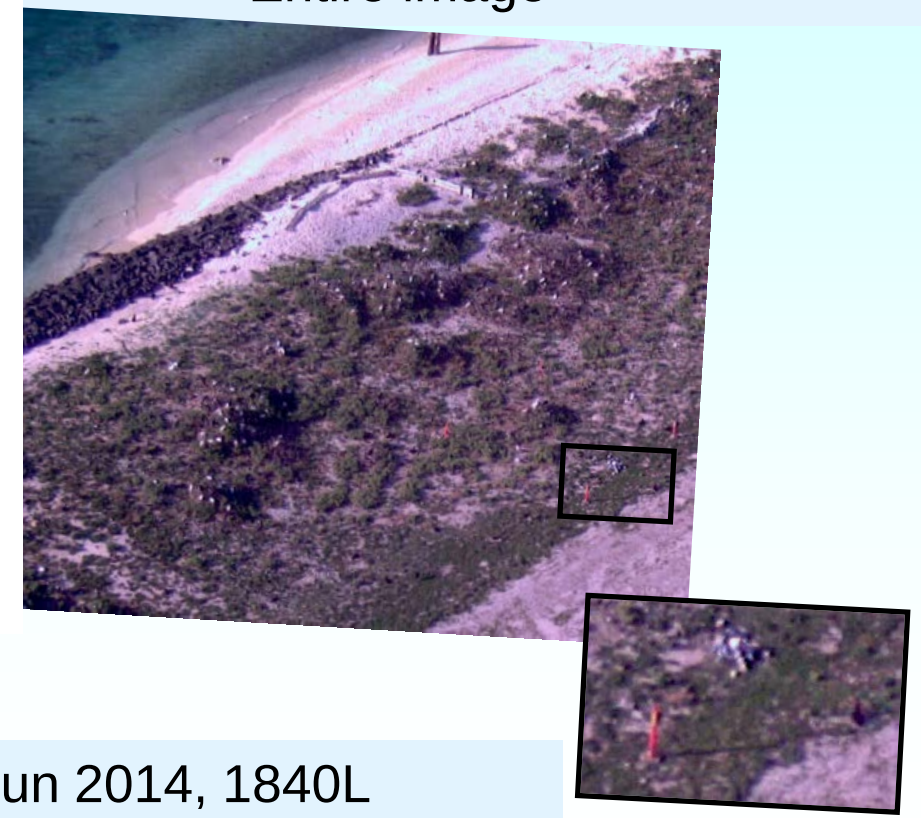
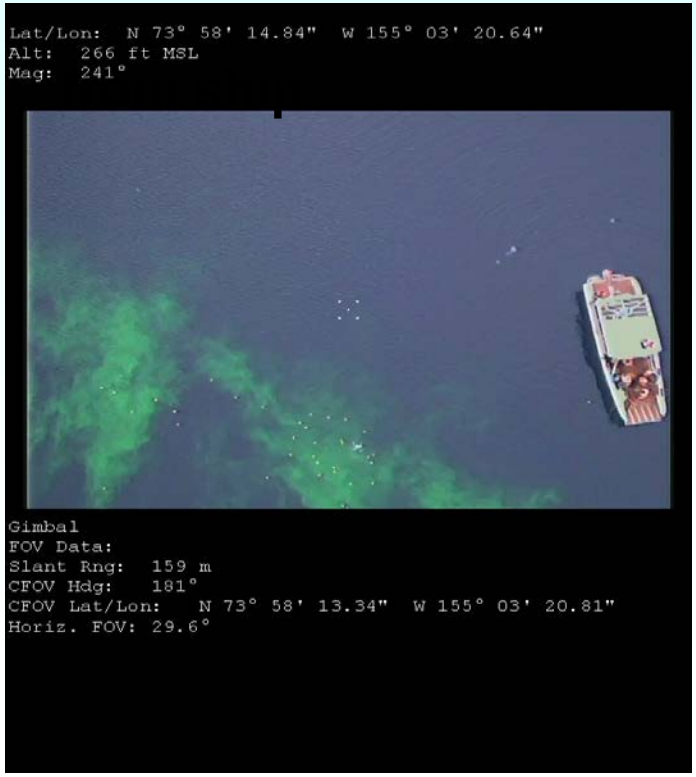


Flight 14-008, 19 Jun 2014, 1840L
Image 2014_06_20_04_05_58_3QUG69674057
Entire image

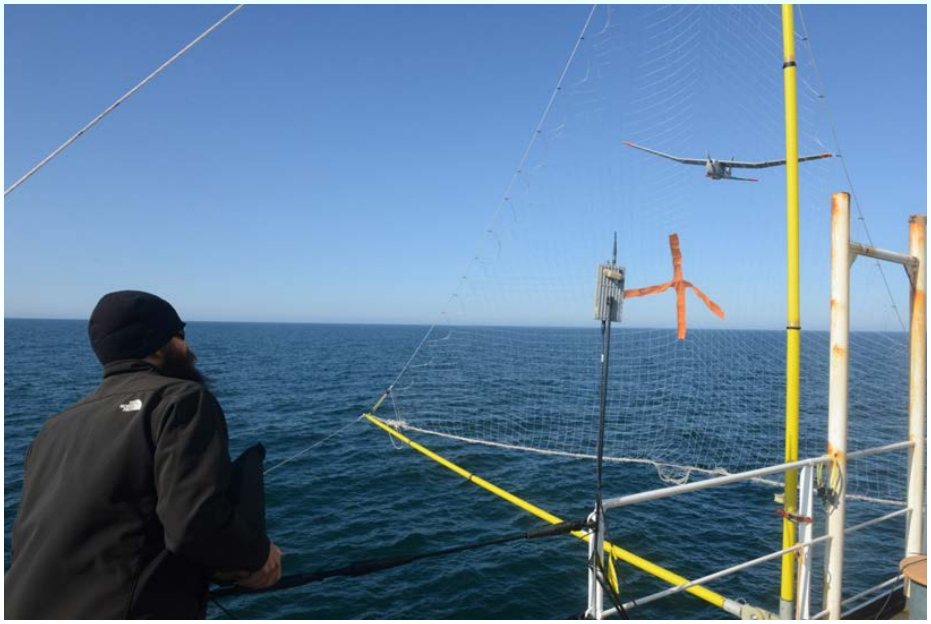
ISR Missions including Oil Spill & SAR

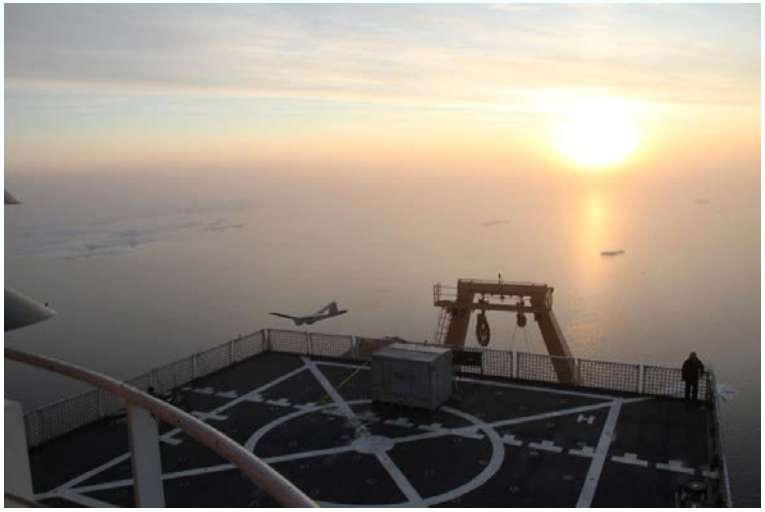
- ✓Sea ice ridge detection/monitoring
- ✓Usefulness in search and rescue scenarios
- ✓Detection and monitoring of oil spilled from ship
- ✓Detection and monitoring of marine debris



Puma “Due Regard” Ops & Recovery Testing

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





Scan Eagle on test deployment in Puget Sound 2007

Scan Eagle recovery at sea

Studying ice seals in the Arctic with ScanEagle aboard NOAA Ship Oscar Dyson 2009

Platform: ScanEagle (Boeing/Insitu)

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

Md4-1000

Prerequisites for UAS operations:

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

Access to equipment

Availability of operators and observers (if required) that are certified and proficient

Operating from various classes and sizes of vessels:

- **Ship** = the full Monty for comfort, but may tie up the ship during sUAS operations, likely at least when launching and recovering the air vehicle
- **SRV** is sometimes most convenient because:
  1. You can bring the whole system and spares
  2. You can keep the equipment, scientists and operators out of the spray and the sun
  3. You can often recover the air vehicle directly from the sRV without having to put a small boat over the side.
- **Small boat:**
  1. Crowded – lack of room for launching and for spares
  2. Hard to get out of the weather and sun
  3. More convenient for water recoveries
  4. Sea sickness issues magnified

Successes

- Vessel launch and recovery:
  - Small boat ops
  - Ship integration and ops
- Shallow water recovery
- Beach launch and recovery
- Arctic Operations
- Flight and data collection protocols
- FAA COAs
- FAA MOA
- Due regard flight in International airspace

NOAA has established itself as a leader in utilizing small UAS from vessels for Marine Resource Monitoring

Take aways

Questions to ask before committing to use a UAS?

- *Should I just rent a manned aircraft?* (Cost, spontaneity, access)
- *Should I just bring binoculars?* (Can I fly beyond VLOS)

sUAS may be better for some things, but not necessarily faster or cheaper quite yet! But, we seem to be getting there…

The technology is ahead of the rules. Stay tuned for the sUAS rules to be published by FAA by the end of next month.

If recurring/regular operations are envisioned, it may make sense to cross-train crew and/or scientists as operators if possible to not increase footprint aboard research vessels

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

The future looks bright

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