2017 Conference and Exhibition

Results of Recent Technology Evaluations and Applications Development on the Use of Unmanned Aerial Systems (UAS) for Oil Spill Response

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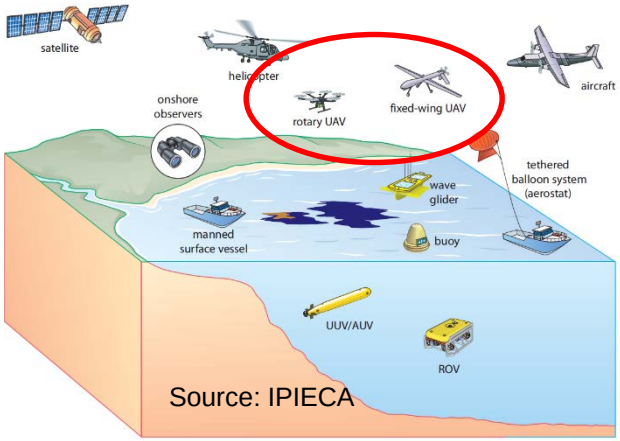
UAS for offshore oil spill response

Offshore oil spill mapping + tracking

Mapping oiled coastline (reconnaissance, SCAT)

Situational awareness

UAS within hierarchy of remote sensing observational platforms



Benefits:

Rapid, local deployment

Eyes in the sky: high spatial resolution

Reduced safety exposures

Challenges:

Beyond Visual Line of Sight (BVLOS) operations

Integration with ICS; airspace deconfliction

Understanding of use-cases + data workflows

Acceptance by oil spill response community

Timeline of Chevron UAS tests

2006

- Carpentaria, CA: offshore test of Aerovironment (AV) Raven over natural oil seeps

2007: new FAA rules on commercial ops stopped testing

2013

- Astoria, Oregon: offshore/coastal test with AV Puma
- Trieste, Italy: AV Puma test with oil spill drill

2014

- NOAA-led Santa Barbara + Vandenberg AFB, CA: offshore/coastal test with AV Puma

2015

- NOAA-led: Santa Barbara + Carpintaria, CA: offshore/coastal test of AV Puma, Lockheed Martin Indago, 3DR multirotors
- Richmond Refinery, CA: test as part of oil spill drill involving PrecisionHawk Lancaster + Indago

2016

- Richmond Refinery, CA: UAS test for SCAT

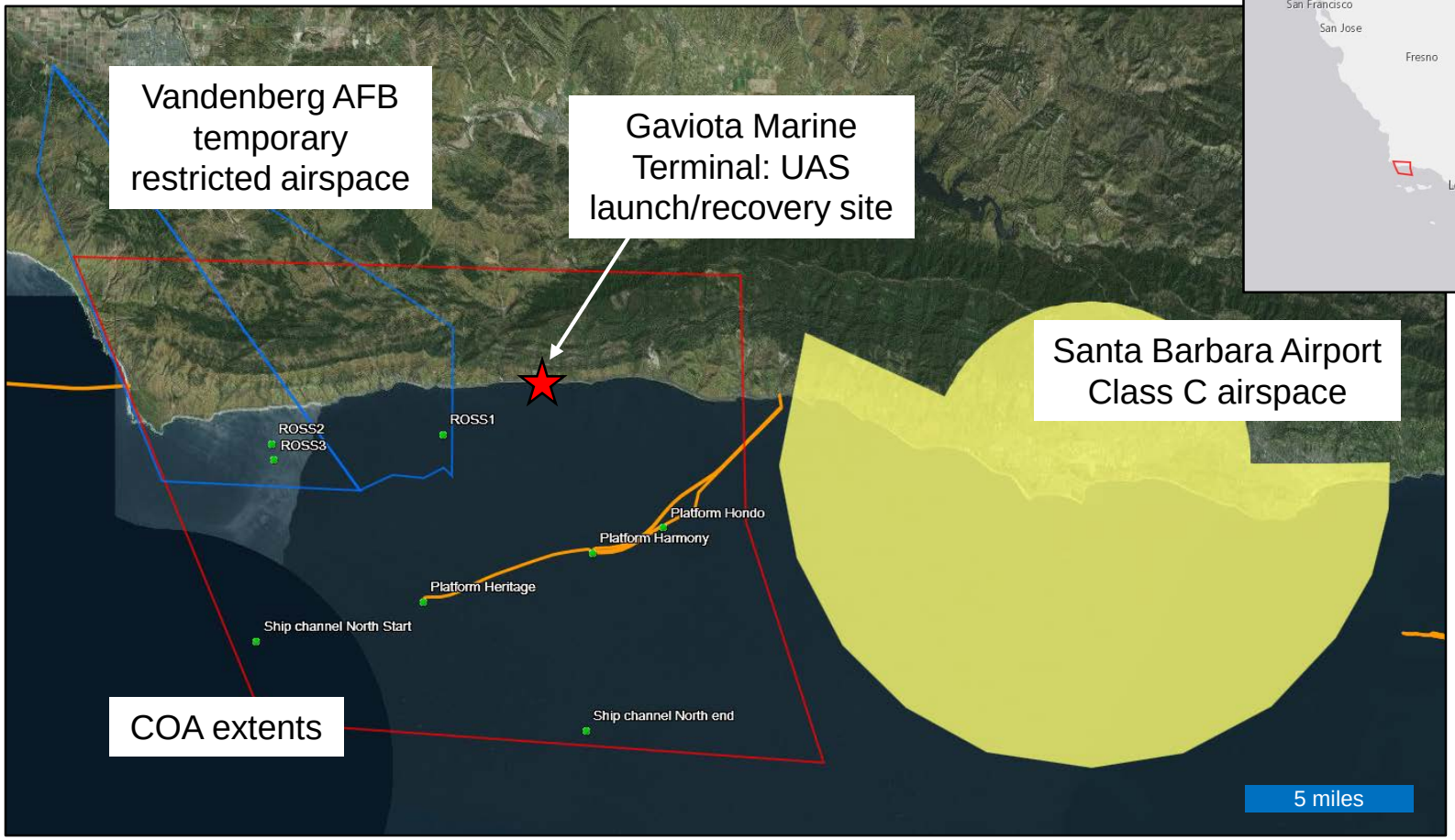
2017

- AV Puma testing as part of NPREP drill
- American Aerospace test of long-endurance UAS for BVLOS operations offshore Santa Barbara, CA

2017 Santa Barbara BVLOS UAS test

- Increasing use of sUAS for VLOS operations; orthos + video
- Test larger UAS platform with long endurance + heavy payloads:
  - BVLOS ops; large area + rapid coverage
  - Persistent surveillance; on-station 5-20 hours
  - Heavy payloads; more advanced sensors + comms hardware (real-time data)
- CVX + NOAA + American Aerospace week-long test at Gaviota, CA during late October 2017:
  - Arcturus Jump 20; hybrid VTOL/fixed-wing UAS
  - Offshore + onshore testing over ~175 square mile area
  - FAA Certificate of Authorization (COA) for BVLOS operations
  - InstiMaps high resolution imaging system + near real-time data
  - Shoreline Oiling Aerial Reconnaissance (SOAR) workflow

COA: airspace overview



Arcturus Jump 20 hybrid VTOL/fixed-wing

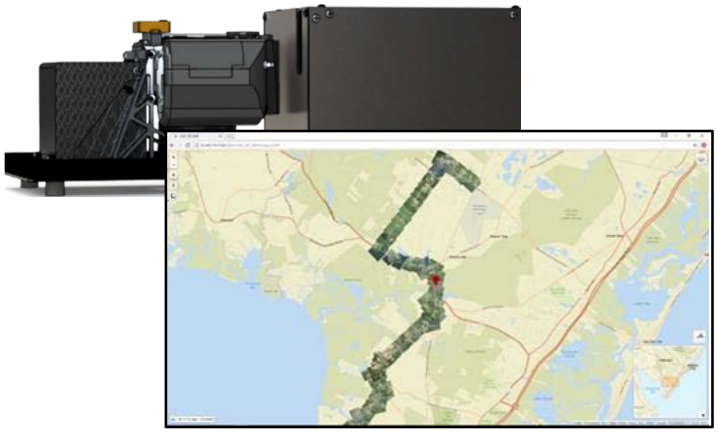
Specifications

- Vertical Take-off and Landing
- Wing Span 18' 6"
- Length 9' 5"
- Engine 190cc 4 Stroke
- Typical MTOW 210 lbs
- Typical Max Speed 72 kts
- Endurance 9-16 hours (Payload Dependent)
- Payload Capacity (Fuel + Usable Payload) 60 lbs
- Rated Ceiling 15,000’
- Range: 55 miles

Potential CONOPS: onshore/offshore operations including VTOL from platform or helopad on vessel

InstiMaps™ Payload

- 36MP visible DSLR + thermal IR cameras
- Direct geo-referencing: onboard GPS/INS
- Near real-time and post-processed image products delivered locally or to cloud as OGC compliant web-services (e.g. WMS, WMTS)
- UAS or fixed-wing deployment
- Visible image resolutions (near real-time):
  - 1000’ AGL: 2-4 inch
  - 2000’ AGL: 4-8 inch
- Image service latency to local command center: ~5-20 minutes



Nikon D810FX 50 mm								
Alt	Image Footprint		Pixel Size/GSD		Coverage Rate UAS (65 kt)		Coverage Rate Cessna 206 (110 kt)	
AGL (ft)	Vertical (ft)	Horizontal (ft)	HiRes (in)	LoRes (in)	Linear (mi/hr)	Area (mi^2/hr)	Linear (mi/hr)	Area (mi^2/hr)
1000	481	721	1x1	2x2	75	10	127	17
2000	963	1443	2x2	4x4	75	20	127	35
3000	1444	2164	4x4	8x8	75	31	127	52
4000	1926	2885	5x5	10x10	75	41	127	69

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Remote ‘command center’

- Gaviota Marine Terminal
- UAS operations trailer
- GIS trailer with feed from UAS trailer
- Satellite internet

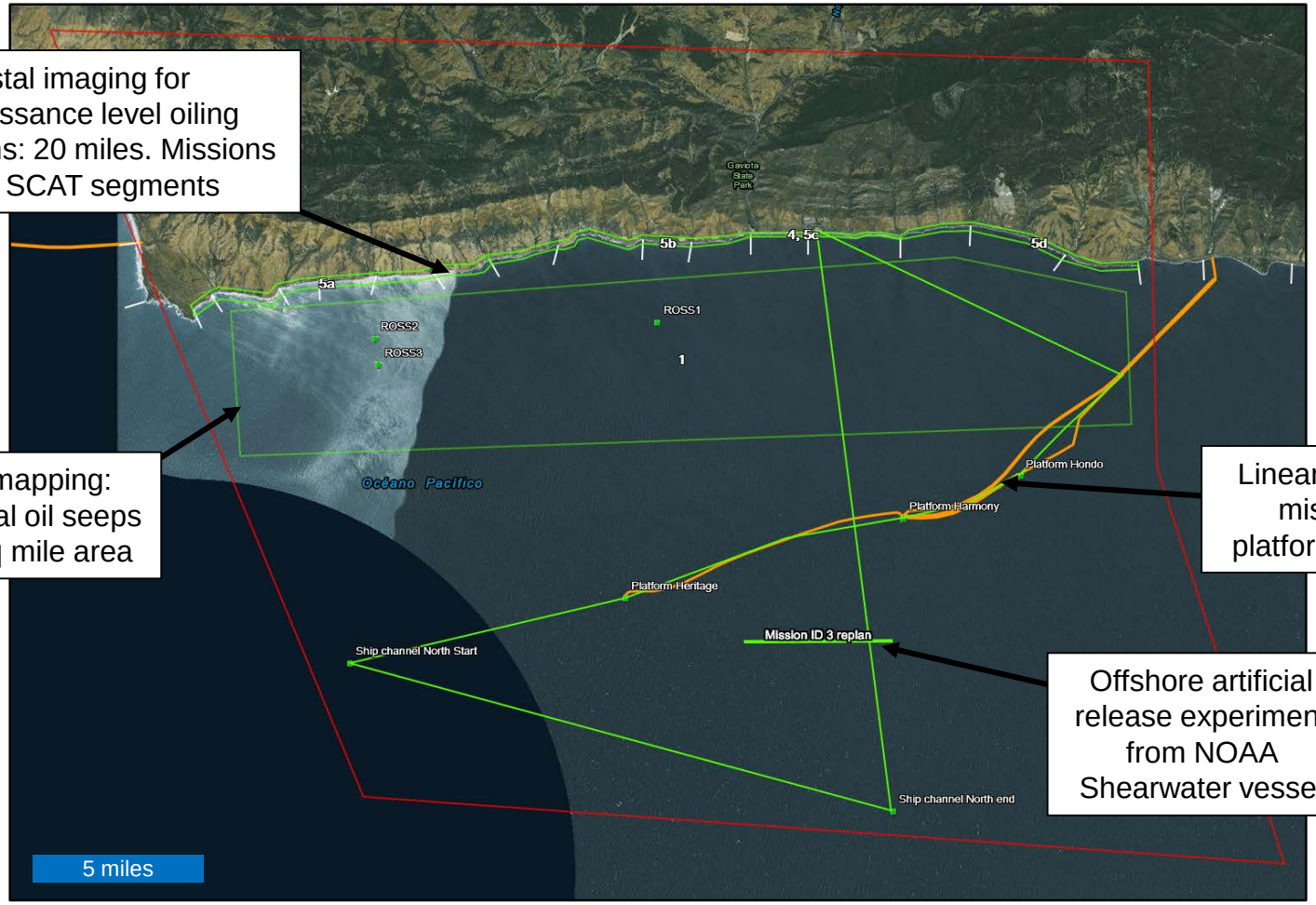
UAS test: missions overview

Coastal imaging for reconnaissance level oiling observations: 20 miles. Missions split by SCAT segments

Offshore mapping: locate natural oil seeps over ~90 sq mile area

Linear surveillance mission over platforms + pipeline

Offshore artificial release experiment from NOAA Shearwater vessel



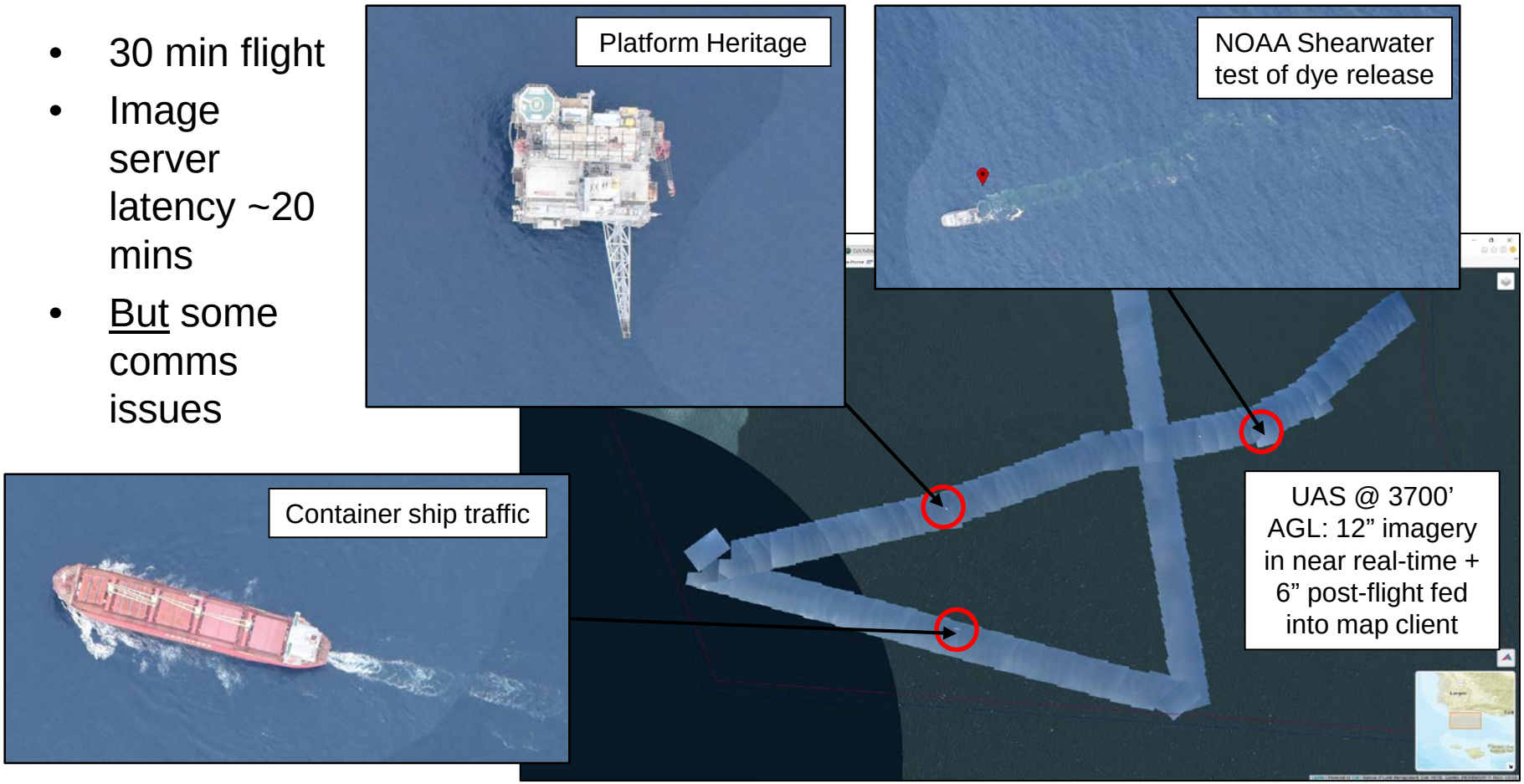
Arcturus Jump 20 operations

- VTOL launch/landing from ~60’ ‘pad’
- Offshore flights at 3700’ & 2000’ AGL
- Coastal flights at 2000’ & 1000’ AGL
- Chase plane required for BVLOS

Launch/recovery video

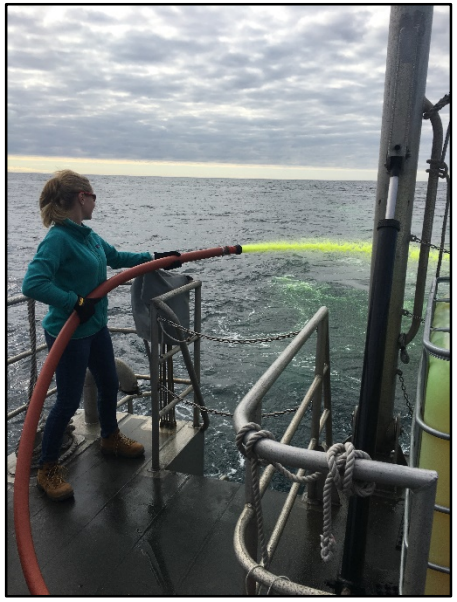
Offshore linear surveillance mission

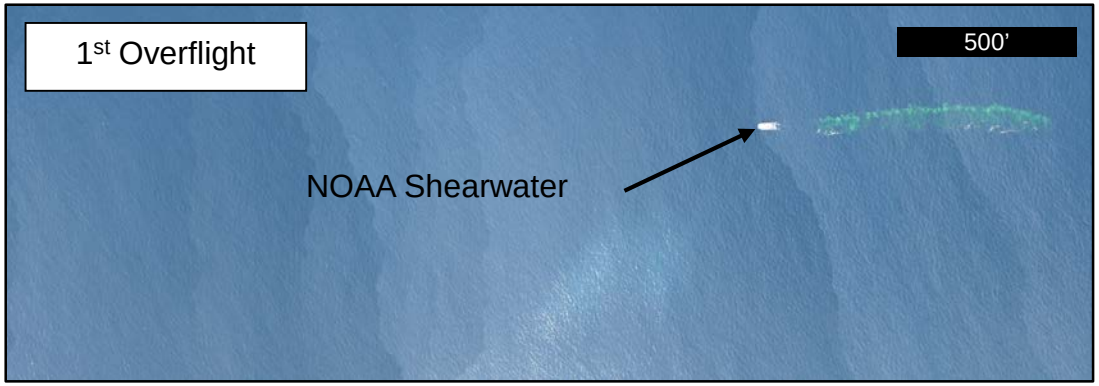
- 30 min flight
- Image server latency ~20 mins
- <u>But</u> some comms issues

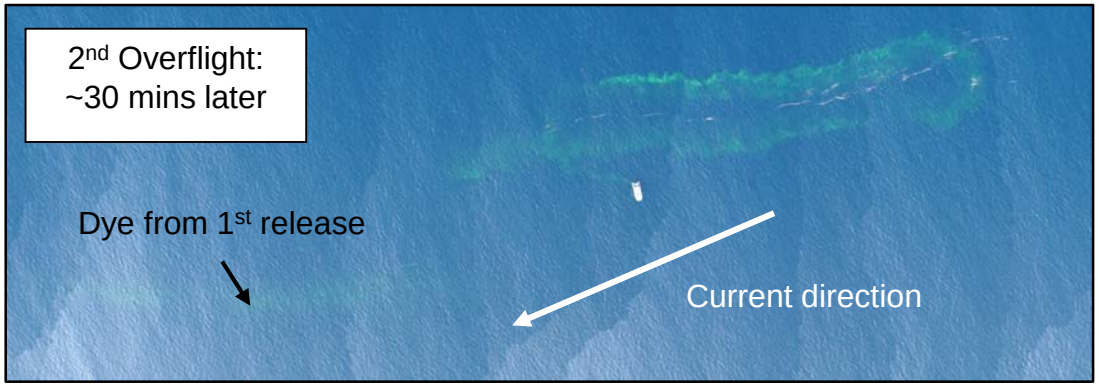


Offshore release test

- Dye and rice hull release with Jump 20 overflights at 2000’ AGL (8” real-time, 4” post-flight)

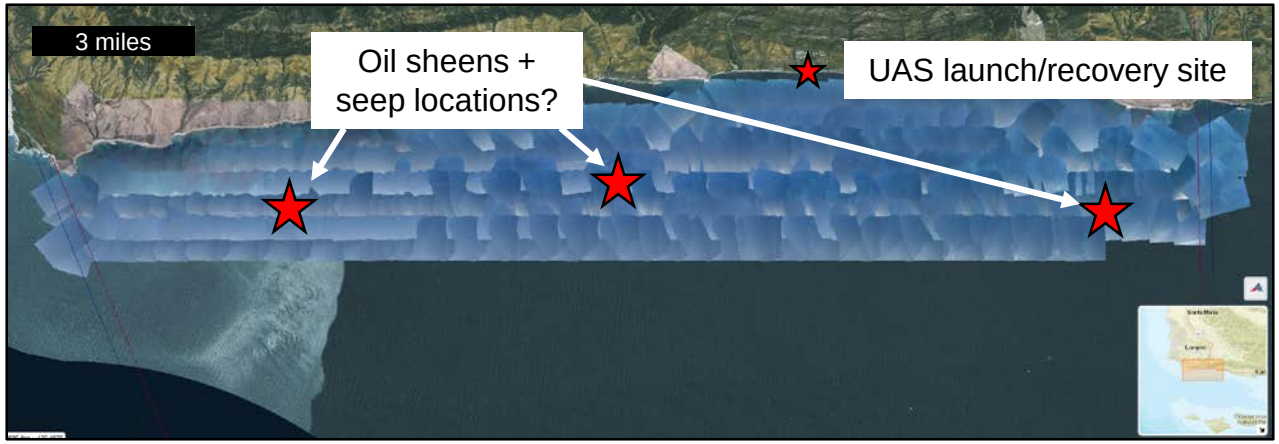


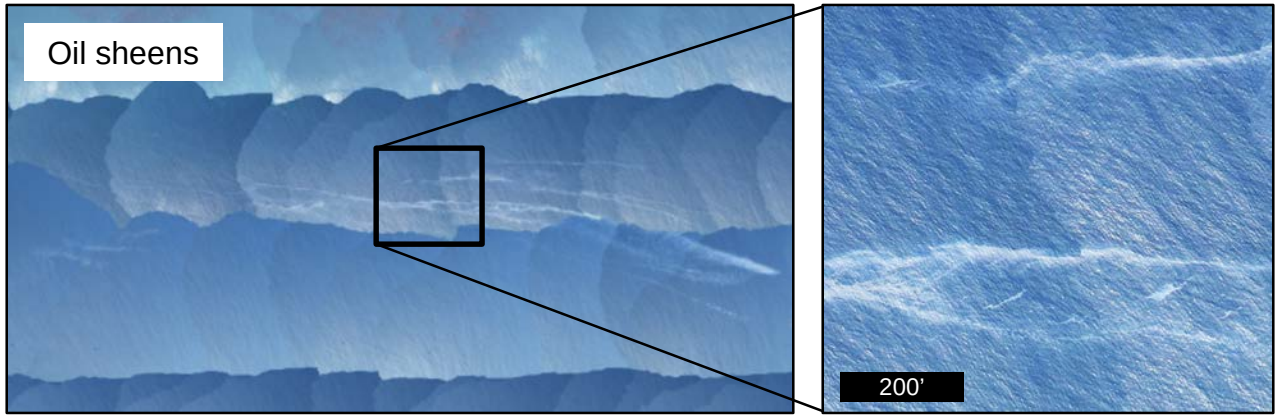




Offshore seep mapping

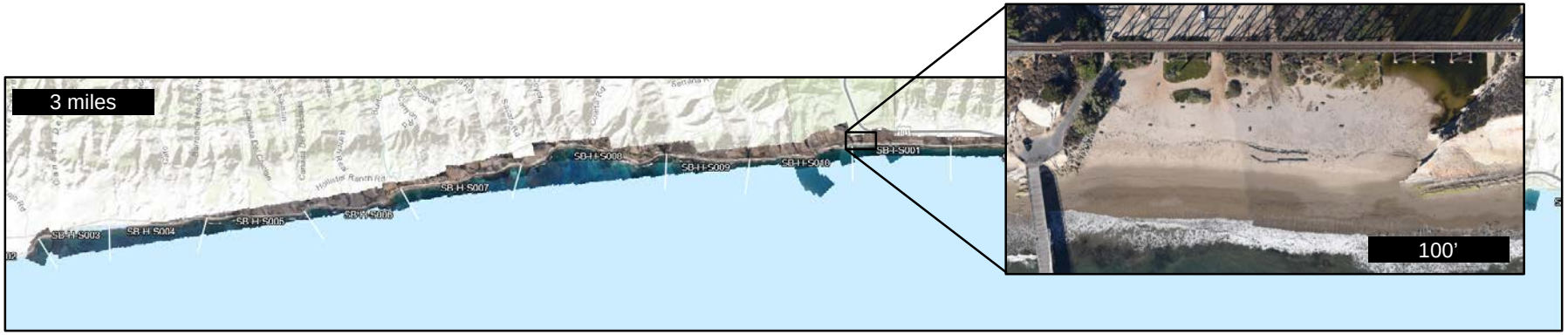
- ~90 square mile area imaged in 1.5 hours
- 12” RGB imagery in near real-time; 8” postprocessed
- Some comms issues affected UAS > ground data transfer
- Multiple oil sheens identified: same locations as mapped previously from satellite SAR

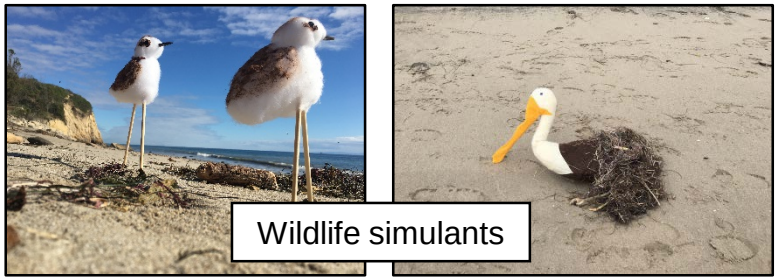




Onshore testing

- Broad-area shoreline oiling reconnaissance tests:
  - 2 overflights of 20 miles coastline @ 2000’ AGL = ~1 hour/flight
  - Image services delivered to GIS trailer in ~5-20 minutes for 4 x ~5 mile segments: 8” resolution RGB in near real-time
- Local low-altitude flights to assess imaging capabilities:
  - 2 miles coastline @ 1000’ AGL = 5 minute flight
  - 4” resolution in near real-time





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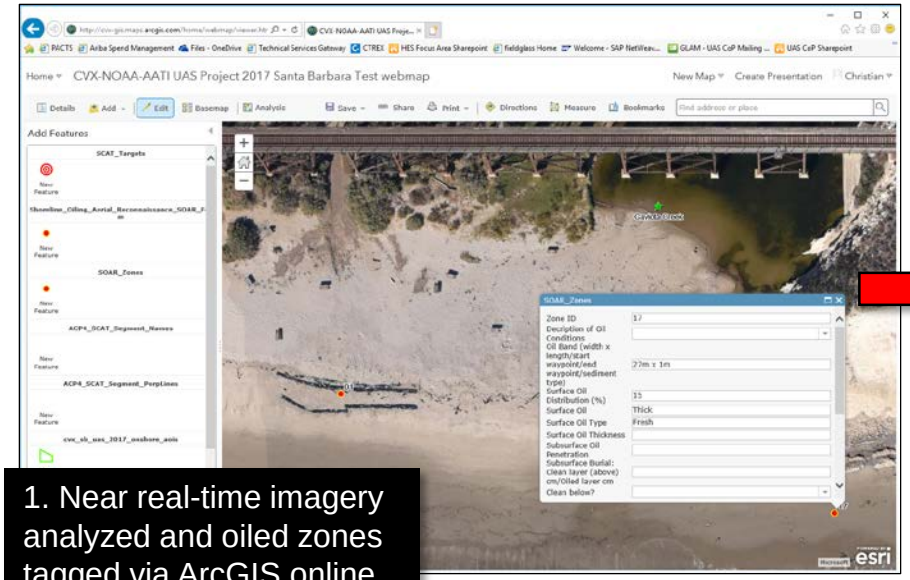
Onshore testing: beach ‘targets’

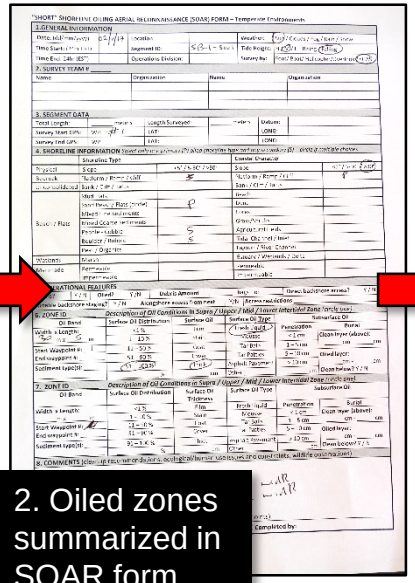
- Fabric swatches, strips, & wildlife simulants; varied % oil cover to assess imaging capabilities; big targets moved between overflights

Shoreline Oiling Aerial Reconnaissance (SOAR) workflow

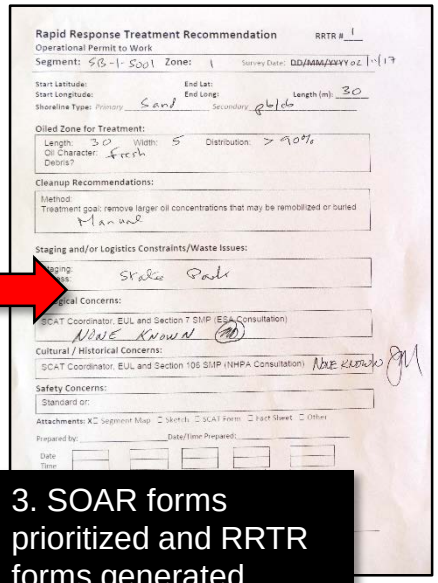
- Imagery → SOAR form → Rapid Response Treatment Recommendations
- ‘Blind’ test using beach targets
- Rapid turnaround of imagery for heavy + moderate oiling → target cleanup



1. Near real-time imagery analyzed and oiled zones tagged via ArcGIS online



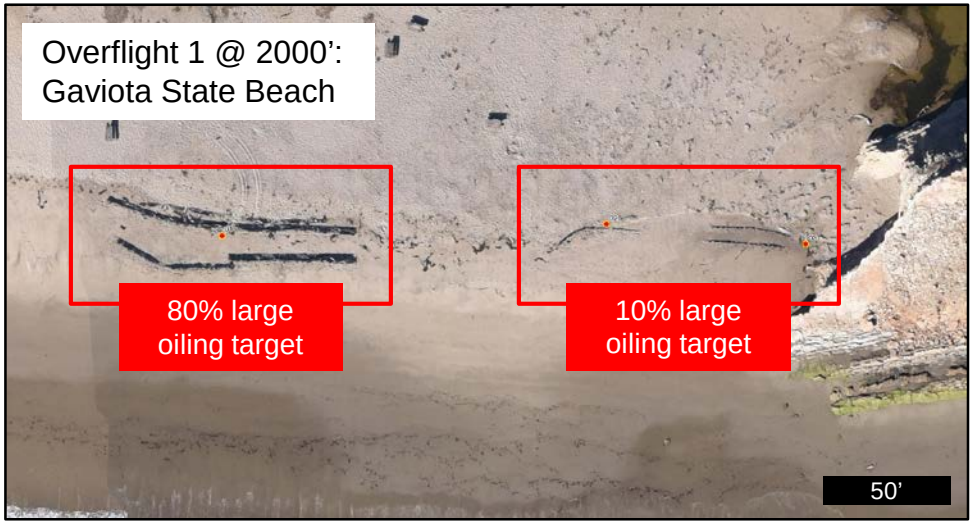
2. Oiled zones summarized in SOAR form



3. SOAR forms prioritized and RRTR forms generated

Onshore testing: results

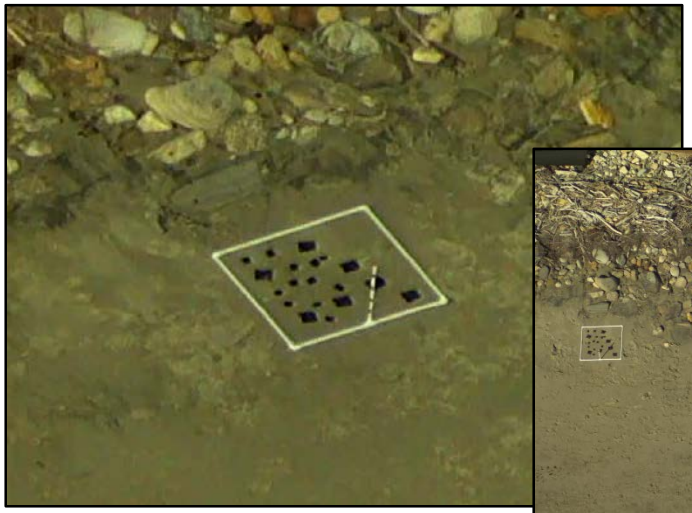
- All ‘large’ targets identified and tagged as oiled zones; some errors of commission → misinterpretations of imagery
- SOAR workflow testing: < 1 hour from over-flight to RRTR form
- Most small oil targets not found at 2000’ AGL; discernible at 1000’



Additional onshore UAS testing

- Detailed VLOS collect with AV Puma video: i45 zoom camera
- Test triage of platforms: Jump recon observations to target Puma


Aerovironment Puma


Video frame of small oil target

Still frame capture from i45 camera

Summary

- Successful first test in Santa Barbara COA: safe coordination in busy airspace
- Near real-time offshore/onshore imaging from UAS
- Tested workflow for rapid coastal assessment
- Issues:
  - Some data comms issues between UAS and GCS: resolvable
  - Data transfer to cloud
  - Visual analysis of nadir imagery for shoreline oil: job-aid?

Next steps

- Santa Barbara COA; 2 years; test-range?
- Further tests of Jump 20; integrate additional sensors, e.g. Ocean Imaging, Polaris
- Track record of safe COA operations to support Emergency COA
- Outreach + role into drills

Acknowledgements

- American Aerospace
- NOAA
- Owens Coastal Consultants
- Displayed Geographics
- California OSPR
- US Fish and Wildlife Service
- Aerovironment
- AECOM (Gaviota Marine Terminal)

Thanks!

Questions?