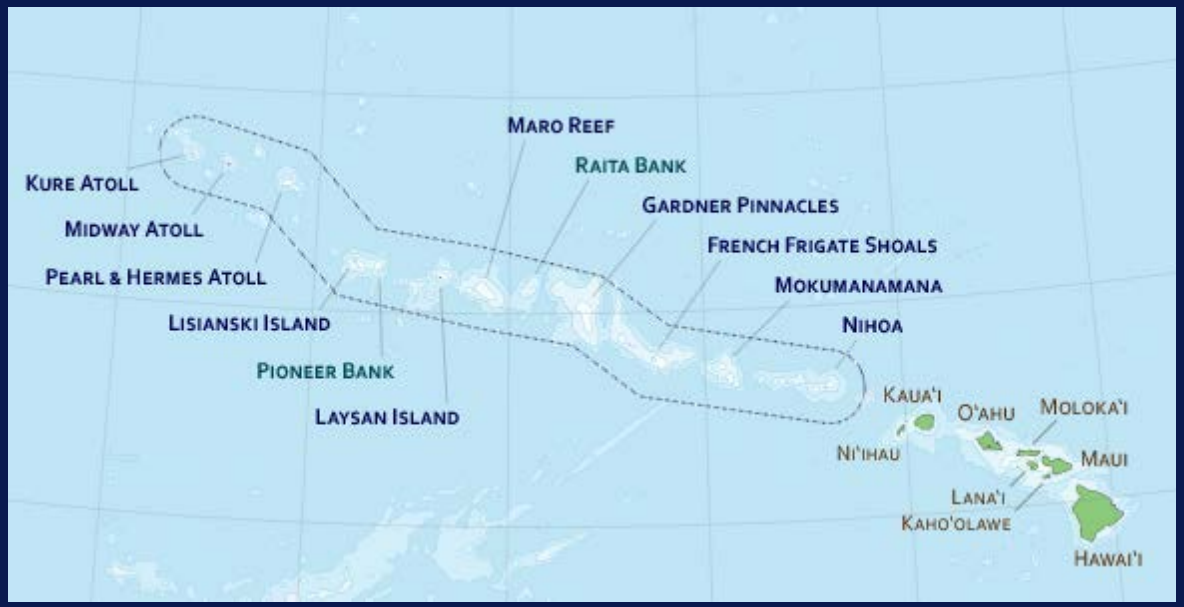
NOAA UAS Program

Demonstrating UAS Capabilities in the Rim of the Pacific Exercise

Northwest Hawaiian Islands Papahanaumokuakea Marine National Monument 2014 & 2015



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Operational Goals & Science Objectives

Implement ONMS UAS Strategy & Support NOAA's Missions with Inter-Agency Partners

- ❖ Requirements & Capture Analysis
- ❖ Multi-Agency/Multi-Aircraft/Multi-Mission – Value Tree
- ❖ Accomplishments: Requirements Capture & Ops Assessment
- ❖ Multi-Platform Operational Assessment
  - ✓ Ikhana (2014)
  - ✓ Puma-AE (2014-15)
  - ✓ APH-22 (2015)
  - ✓ NOAA R/V with UAS Support (2012 to Present)
    - ✓ NWHI 2014 – *R/V Hi'ialakai*
    - ✓ NWHI 2015 – *R/V Oscar Elton Sette*

Requirements Study and Analysis of Alternatives informed Platform, Sensor and Application Decisions

Observation Requirement Crosswalk

June 2014 NWHI

Puma AE (LASE)

Sensor

NOAA Ship Hi'ialakai
June 16-23

July 2014 NWHI

Ikhana Predator B (MALE)

Sensor

Seven Priority One Requirements – NOS / NMFS 5 / 2
Puma AE LASE – 6 of 7 Requirements
Ikhana MALE – 7 of 7 Requirements

Visible Imagery (3)

Near Infrared (3)

Streaming Video (3)

NOS.NGS.002: Coastal Mapping, Near Infrared Imagery (Airborne) **(2)**

NOS.NGS.004: Emergency Response, Visible Imagery (Airborne) **(2)**

NOS.NMS.003: Enforcement Papahanaumokuakea (Airborne**) (4)**

NOS.NMS.015*:* Visual Surveys: Pacific Hawaiian Islands Humpback Whales (Marine Resources, Vessel Traffic, Marine Debris) (Airborne) **(1)**

NOS.NMS.017*:* Visual Surveys: Pacific Papahanaumokuakea (Marine Resources, Vessel Traffic, Marine Debris) (Airborne) **(6)**

NMF.PI.014: Hawaiian Monk Seal Population Assessment & Monitoring **(2)**

NMF.PI.019: Marine Debris Cleanup & Habitat Restoration (NWHI) **(2)**

SeaVue Maritime Radar
AIS Receiver (2)

Visible (MTS-B Skyball) (5)

Infrared (MTS-B Skyball) (3)

Priority One Observing Requirements Screened : NOS (180), NMFS (268)
TPIO provided NOSIA Input for NWHI / HI 1 May

Approach: Mission Value Tree

Current Systems

June 2014 NWHI

Alternative Systems

July 2014 NWHI

Ikhana Predator B (MALE)

NOAA Observing System Architecture (NOSA)

- EO Imagery
- IR Imagery
- EO Video
- IR Video
- EO Imagery
- IR Imagery
- EO Video
- IR Video
- Radar
- SAR Radar
- ISAR Radar
- AIS Data

Key Products and Services (KPS)

Targeted Mission Areas of Interest in Papahanaumokuakea

- Birds & Vegetation
- Terrestrial Habitat
- Cetaceans
- Turtles
- HIMSP
- Marine Debris
- Maritime Domain Awareness

Consolidated Observing Requirement List (CORL)

- NMF.PI.014 Hawaiian Island Monk Seal
- NMF.PI.015 Humpback Whale
- NOS.NGS.002 Coastal Survey
- NOS.NMS.017 Visual Surveys
- NMF.PI.019 Marine Debris
- NOS.NGS.004 Emergency Response
- NOS.NMS.003 Enforcement

Global Change Master Directory (GCMD)

- Habitat Mapping and Characterization
- Marine Resources, Vessel Traffic, Marine Debris
- Enforcement
- Socio-Cultural

Mission Service Area (MSA)

- Ecosystems
- Marine Transp
- Coastal Water Qual
- Habitat
- Climate Mitigation, Adaptation
- Protected Species
- Resilience (hazards, climate change)

NOAA Goals

- Climate
- Healthy Oceans
- Resilient Coasts
- Weather Ready Nation

Accomplishments: Requirements Capture & Ops Assessment

Implement ONMS UAS Strategy & Support NOAA's Missions with Inter-Agency Partners

Area	Priority Objectives	Puma	Ikhana	TBD
Maritime Domain Awareness	• Observe non-cooperative vessel traffic in the monument • Evaluate the ability to support hazard analysis and enforcement	✓ ✓	✓	 ✓
Marine Debris	• Support planning for the fall marine debris removal cruise • Evaluate the ability to locate marine debris ashore, in reefs and at sea • Evaluate ability to improve efficiency of field operations	✓ ✓	✓ ✓	 ✓
Hawaiian Island Monk Seal	• Count seals at haul-outs • Evaluate ability to monitor haul-outs when human observers not present • Evaluate ability to improve efficiency of field operations	✓ ✓	 ✓ ✓	 ✓
Green Sea Turtles	• Evaluate ability to observe night-time nesting and hatching events			✓
Cetaceans	• Observe cetaceans of opportunity • Evaluate ability to survey populations	✓ ✓	✓ ✓	
Birds and Vegetation	• Estimate soil moisture content on Nihoa island • Evaluate ability to monitor bird communities when observers not present • Evaluate ability to improve efficiency of field operations			✓ ✓ ✓
Terrestrial Habitat	• Determine field camp conditions before deployment • Evaluate ability to observe dynamic changes in terrain	✓	✓	 ✓

Initial objectives refined by early feedback from demonstrations to focus on high-value future capabilities

* Numerous 2014 Objectives were accomplished during the 2015 campaign with advanced payloads.

Image Assessments
Derby's Beach, Nihoa

Ikhana

Ikhana at 29,162 ft. slant range

Puma (Standard Payload)

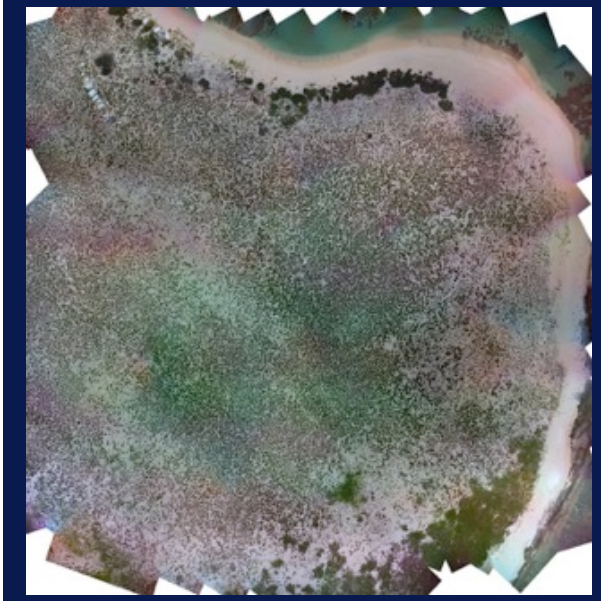
Puma at 4,377 ft. slant range

Accomplishments: Operational Assessments & Transition

System Spiral Development Lead to additional Requirements Capture

2015 Objectives:

- ✓ Surveys for Hawaiian Monk Seal
- ✓ **High resolution mapping of remote atolls for baseline**
- ✓ Surveys for marine debris removal teams (lost fishing nets)
- ✓ Collecting example data for bird surveys
- ✓ Collecting example data for sea turtle surveys



Observation Strategy Advancements were made with Inter-Agency & Industry Partners

Transition: Research > Development > Transition (RL Movement)

Implement ONMS UAS Strategy & Support OAA's Missions with Inter-Agency Partners

I45 Advance Payload Video & Lidar Survey

Requirements Capture moves the readiness levels towards an operational capability

Marine & Wildlife Monitoring (Including Marine Debris), Advanced Payloads – RL 8

Additional Partnerships (who have shared in our successes)

In close cooperation with the NOAA Line Offices, Government, Industry & Academia

NOAA

NOAA Unmanned Aircraft Systems Program

NATIONAL MARINE FISHERIES SERVICE

NOAA/NOS

OMAO

NATIONAL MARINE SANCTUARIES

State, Local & Academia

Federal

United States Coast Guard
U.S. Department of Homeland Security

NAVAIR

NASA

U.S. FISH & WILDLIFE SERVICE

Industry

AV aerovironment

GENERAL ATOMICS

Joint Operations have increased Maritime Services Interoperability

Puma-AE owned and operated by every maritime service – Readiness Level 9

Science & Technical Challenges and Solutions

These are from 2014 and 2015 missions

- Needed a full year to plan a project the scale of Ikhana
- Need Puma improvements – higher resolution sensor, operate in winds over 25 kts, net capture system
- Need to work regulatory relief for beyond-line-of-sight Puma operations
- Can't afford to chase an aircraft like Ikhana
- Need to understand the airspace evolution and continue to build confidence and understanding
- Need to understand SATCOM issues. NASA working on other communications options, like Inmarsat
- Consider a dedicated NOAA mission. Need more days to get good weather. Constrained by doing it "on the cheap."
- Understand transportation issues. Might be worth developing a smaller footprint alternative to the 32,000# ground station.
- This was a bit of a solution looking for a problem. Look at optimizing a system for specific missions.
- Consider other sensors, either NOAA or Science owned.
- Data analysis is a bigger task than anticipated. Need to engineer the right tools and procedures.
- AOC ability to support small UAS operations is limited.

Future Direction & Operations (Post 2014 & 2015 Mission)

Implement ONMS UAS Strategy & Support NOAA's Missions with Inter-Agency Partners

- Operating sUAS BVLOS – possibly with transponder (Mode C/ADS-B)
- Need for spontaneity in UAS operations – real-time response
- Remoteness and safety drives need for unmanned systems deployment
- Other Agency Partners (Army Grey Eagle, DHS)
- Alternative Ship or Island Based Platforms (Small VTOL)
- Alternative Long-Range Platforms (Flexrotor, Scan Eagle)

Deployment of UAS Assets for NMFS and ONMS for Marine, Shore & Wildlife Monitoring (Including Arctic), Advanced Payloads – RL 8