Marine Debris Program

Debris Detection:
Background, Efforts, & Lessons Learned

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Outline

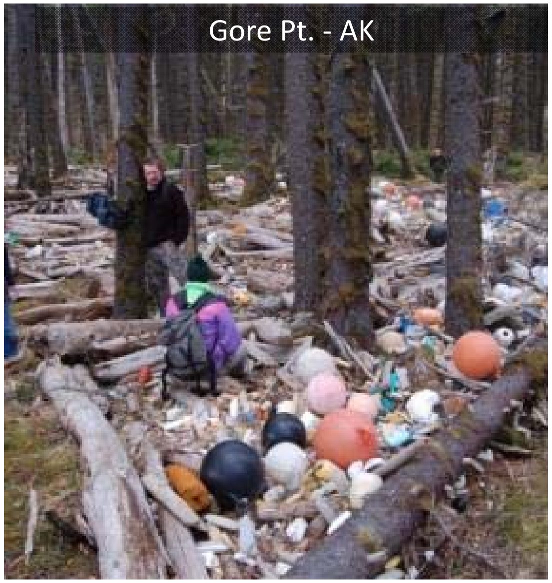
- Marine Debris Issue
  - Types
  - Distribution
  - Impacts
- NOAA Marine Debris Program
- Detection Efforts
- Overall Detection Challenges / Needs

Debris on Alaska shoreline

Debris removed from Yakutat shoreline - 2012

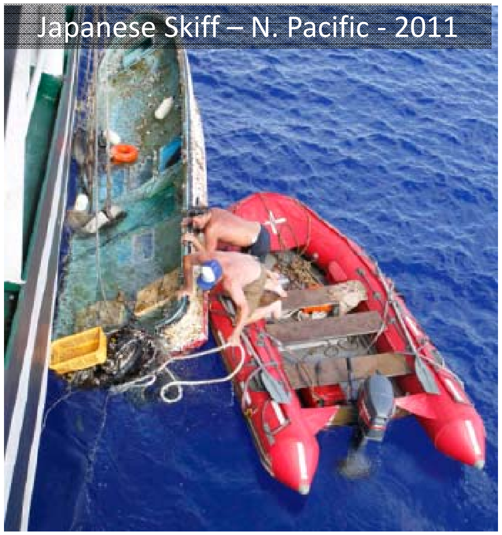
Marine Debris Issue

- **Debris Types**
  - Size
  - Composition
- **Debris Distribution**
  - Shoreline
  - At-Sea
- **Debris Impacts**
  - Entanglement
  - Ingestion
  - Habitat Impacts


Gore Pt. - AK

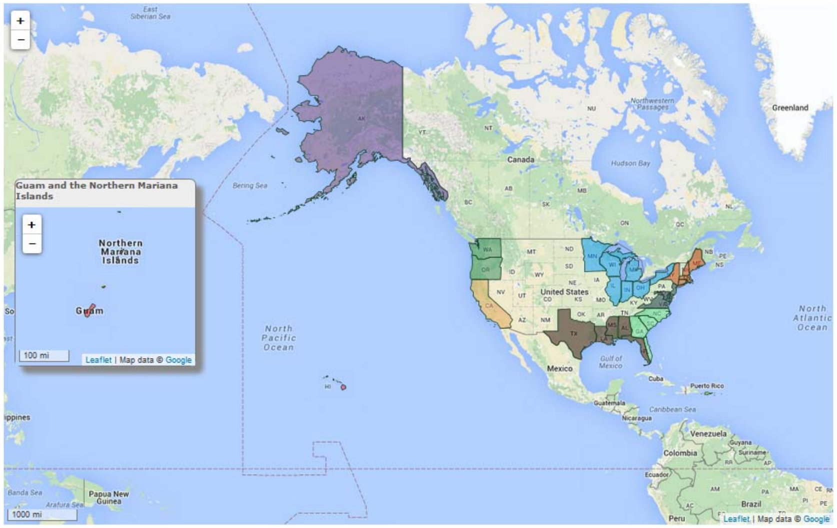

Derelict Fishing Net – N. Pacific


Montague Island, AK


Japanese Skiff – N. Pacific - 2011

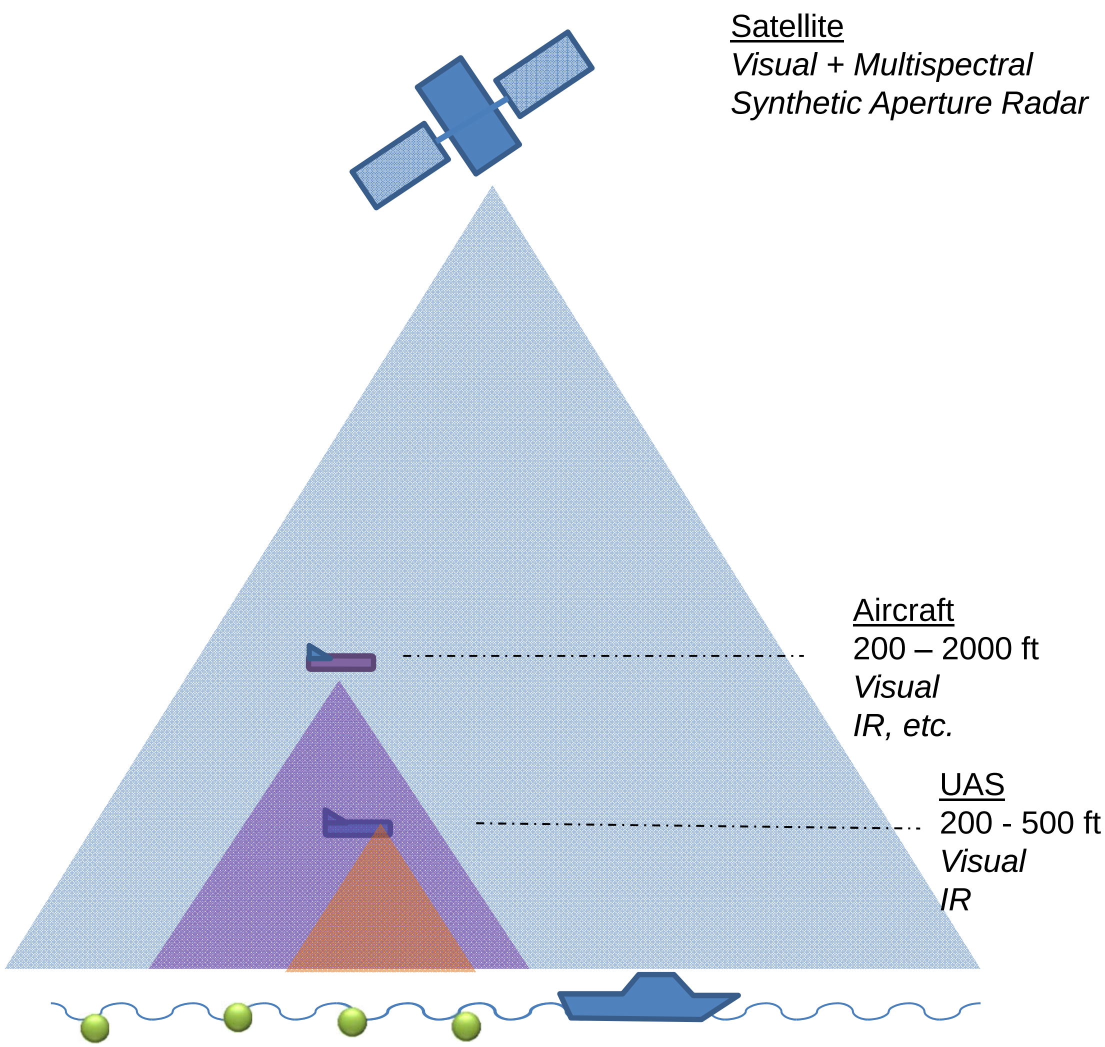
NOAA Marine Debris Program

- **Facts**
  - Established in 2005
  - Mandated by the Marine Debris Research, Prevention, and Reduction Act, Dec. 2006
- **Structure**
  - 15-17 member team
  - $4-6m national budget, historically
  - Regional Approach (9 Regions)
- **Three Pillars**
  1. Research
  2. Removal
  3. Prevention
- **Website:**
  - http://marinedebris.noaa.gov/



Detection Efforts

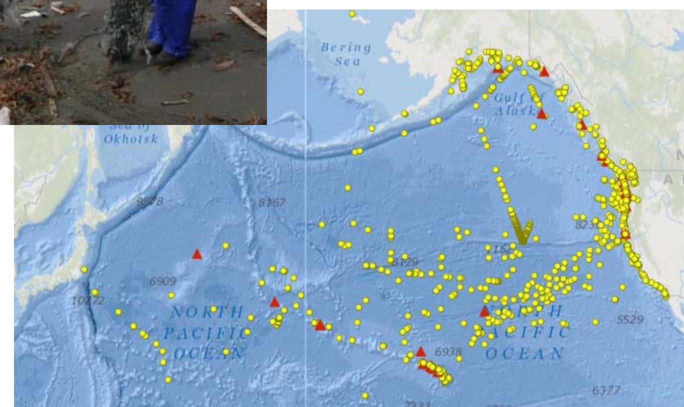
- In-Situ Surveys
  - Shoreline
  - Vessel
- UAS Testing Surveys
- Aerial Surveys
- Satellite Surveys



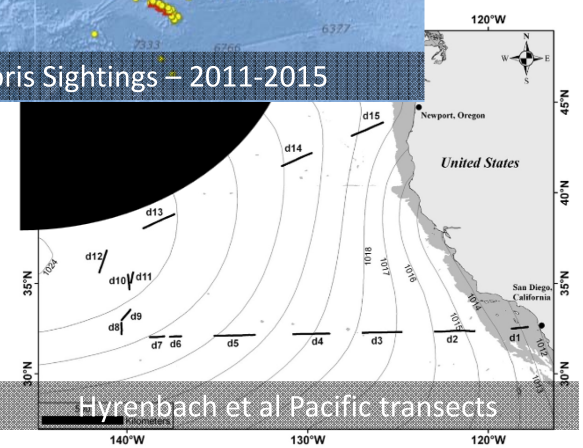
In-Situ Detection / Surveys

- **Efforts**
  - Shoreline Surveys
    - Shoreline Debris Monitoring
    - Opportunistic Reporting
  - Vessel Surveys
    - Transect based
    - Active observation
    - Opportunistic Reporting
- **Pluses / Opportunities**
  - Direct visual identification
  - Ability to return for investigation (shoreline)
- **Challenges**
  - Opportunistic - Lack of “null data”
  - Monitoring – targeted for concentration + composition analysis rather than detection classification

Shoreline Monitoring - AK



Disaster Debris Sightings – 2011-2015



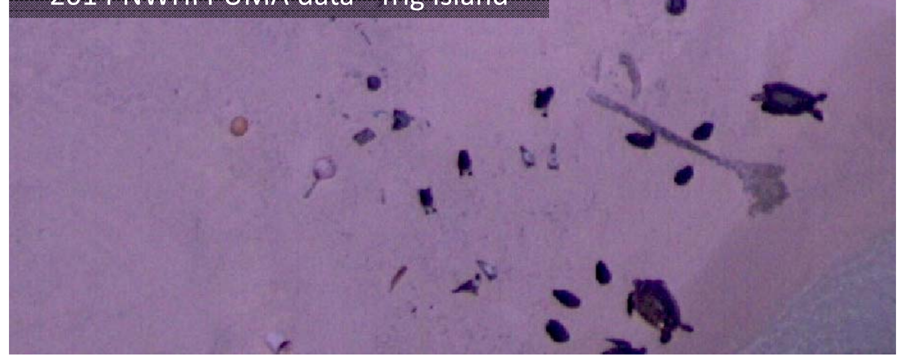
Hyrenbach et al Pacific transects

UAS Testing Surveys

- **Efforts**
  - 2012 – Testing off Haleiwa
  - 2013 – Shoreline + At-Sea Testing in OCNMS, WA
  - 2014+ - Testing in NWHI
- **Pluses / Opportunities**
  - Access to sensitive or unsafe areas
  - Launch/flight from remote areas without fields
- **Challenges**
  - Regulatory requirements for operation
  - Wide range of systems – challenge of choice
  - Difficulty of reacquisition of targets
  - Imagery resolution (based on system)
  - Imagery not always set up for ease or speed of processing
    - Video, non-georectification

2012 PUMA Testing - Haleiwa

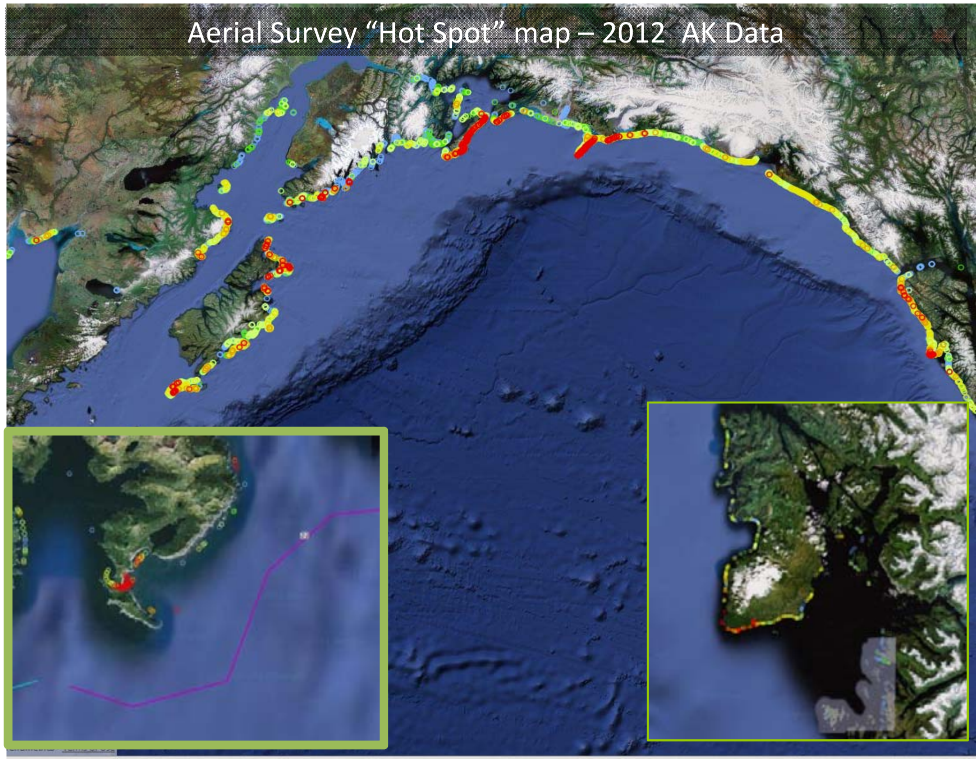
2014 PUMA – Nihoa Beach



2014 NWHI PUMA data– Trig Island

Aerial Surveys

- **Efforts**
  - Shoreline Aerial Surveys
    - Alaska – 2012, 2014, 2015
      - Oblique, qualitative
    - Hawaii – 2015 – 2016
      - Nadir, quantitative
  - At-Sea Detection
    - Individual, ad-hoc surveys (USCG C-130, NOAA P3)
- **Pluses / Opportunities**
  - Established approach and technology
  - Data can be applied to shoreline cleanup prioritization/targeting
- **Challenges**
  - Small debris difficult to detect/identify
  - Cost of survey and post processing
  - Aligning post-processing to immediate and long term data needs

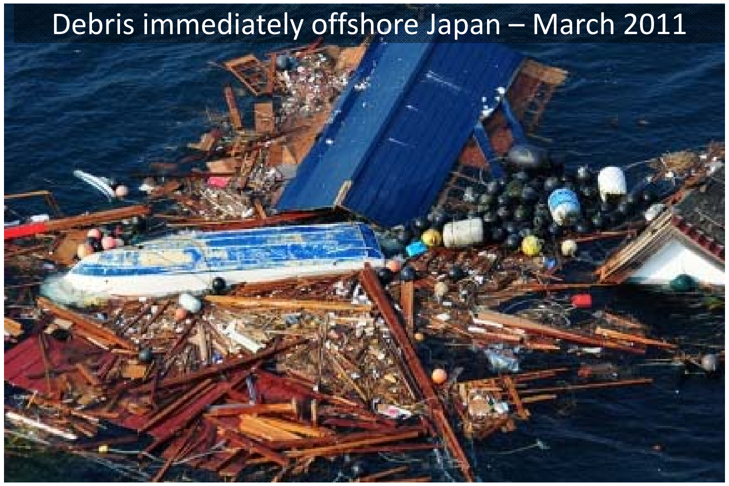


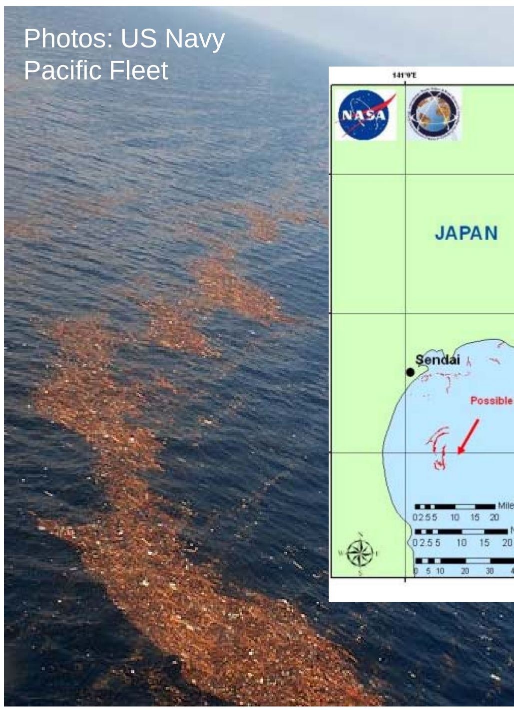
Satellite Survey / Collections

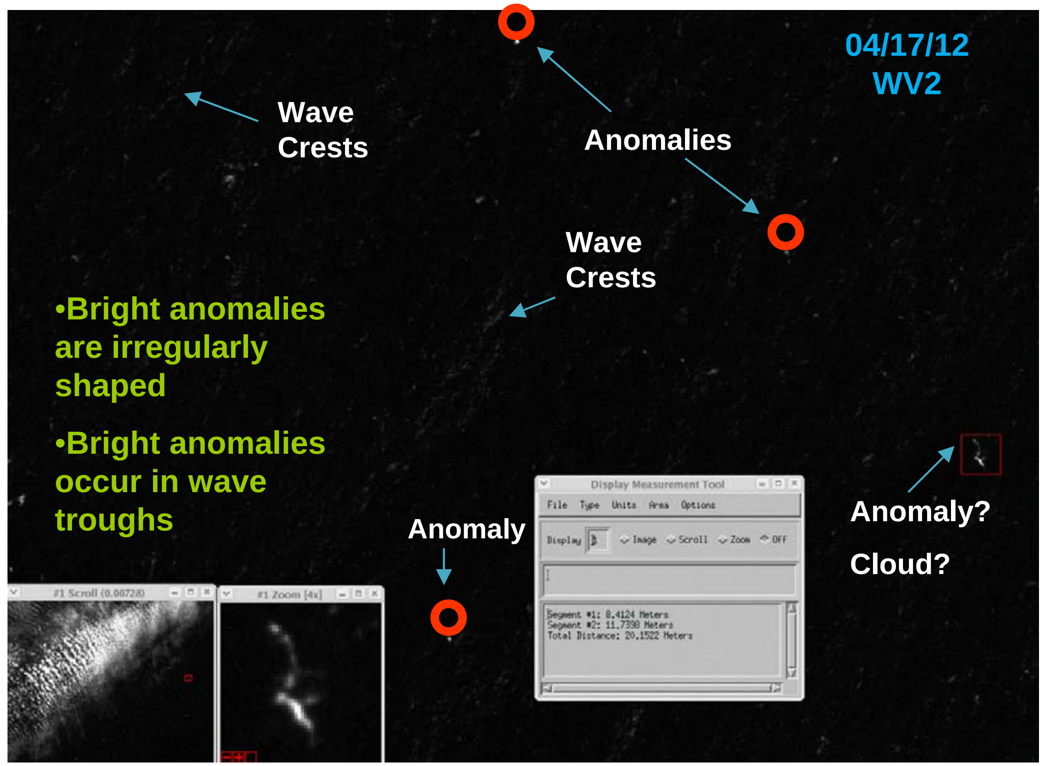
- **Efforts**
  - JTMD Satellite Detection (Led by NOAA NESDIS SAB)
- **Background**
  - 2011 – Early initiation
    - Disaster Charter
    - Debris Fields
  - 2012 – Ongoing collection and analysis
  - 2014-Present – Transition to ongoing analysis and support
- **Platforms / Sensors**
  - DigitalGlobe
    - Worldview-2, Worldview-3, Quickbird-2, Ikonos, and GeoEye
  - NGA requests through USGS

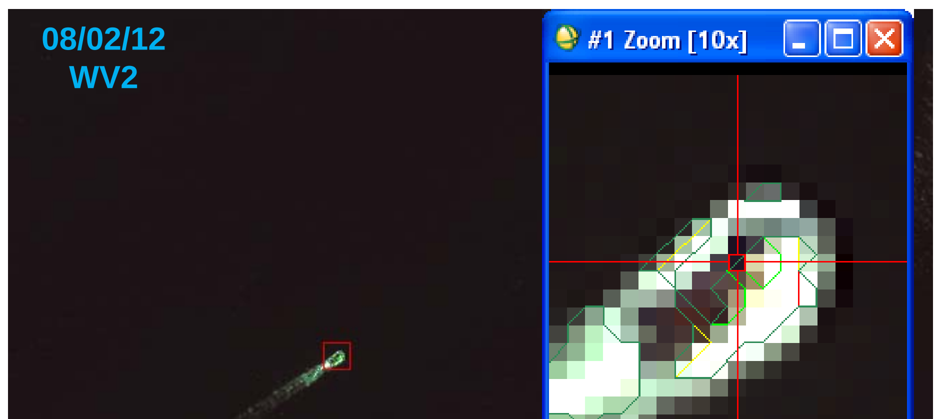
Platform/ Sensor	**World-view 1**	**World-view 2**	**World-view 3**
Revisit Time	1.7 d	1.1 d	< 1 d
Swath Width	17.7 km	16 km	13.1 km
Multispectral Resolution	n/a	0.46 m	0.31 m
Panchromatic Resolution	0.5 m	1.85 m	1.24 m

Satellite Survey / Collections

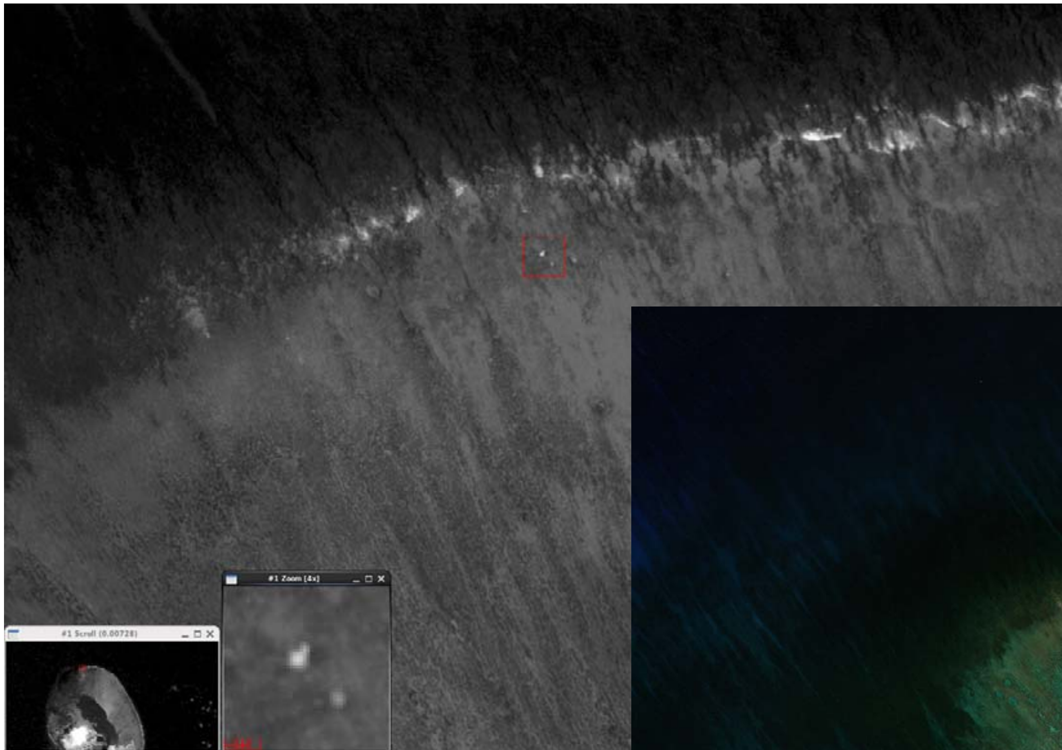

Debris immediately offshore Japan – March 2011


Photos: US Navy Pacific Fleet





Satellite Survey / Collections

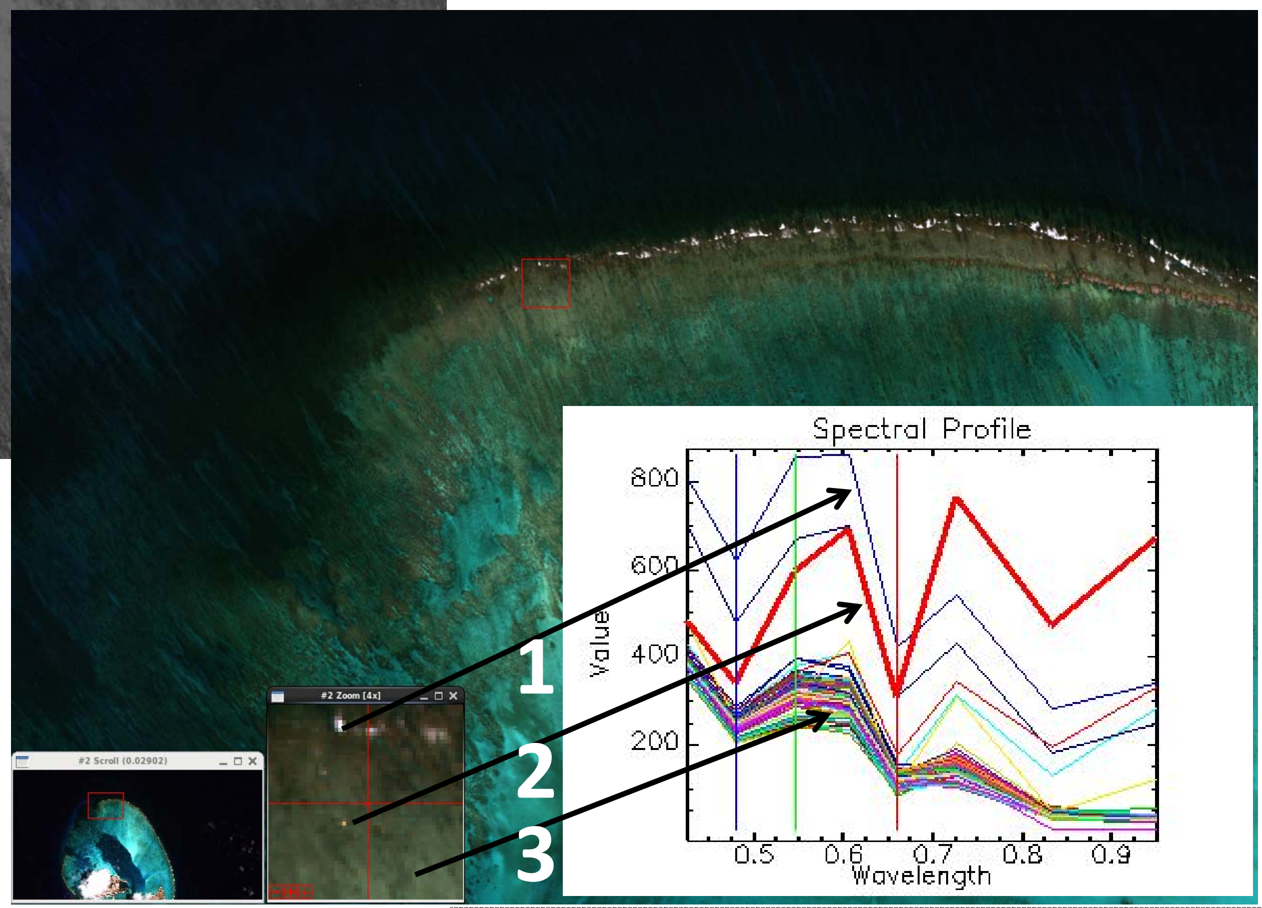


Midway Atoll - August 2015

Worldview 2

Detection in support of debris removal

1) Visual analysis
2) Spectral analysis of suspected debris



Satellite Survey / Collections

- Pluses / Opportunities
  - **Coverage Area** – ability to cover wider area than any other approach
  - **Developing Technology** – Ongoing advancements in sensor and analysis
- Challenges
  - **Weather dependency** – many applicable sensors for MD detection are impacted by cloud or sea-state
  - **Resolution limitation** – common debris size often below threshold for reliable identification/differentiation
  - **Processing Effort** – Data processing is labor intensive

Overall Detection Challenges/ Needs

1. **Encounter Rate** – Debris concentration is often unpredictable and variable, particularly at-sea
2. **Debris Size –** Most debris is relatively small (<1m in long dimension, often <0.3m)
3. **Debris Visibility** – Debris often awash or partially sub-surface, reducing target size. Many platforms and sensors are weather dependent.
4. **Detection v. Identification –** Noting the presence of "something" versus identifying what the anomaly is
   - Challenge increases as resolution decreases
5. **Resolution v. Coverage –** Trade-off between detail of imagery versus coverage of imagery
   - Post-processing is often labor intensive

Thank You!

Any Questions?

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