Debris Detection: *Background, Efforts, & Lessons Learned*

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NOAA Marine Debris Program
Outline

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

• **Debris Types**
  – Size
  – Composition

• **Debris Distribution**
  – Shoreline
  – At-Sea

• **Debris Impacts**
  – Entanglement
  – Ingestion
  – Habitat Impacts
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
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
Aerial Surveys

• **Efforts**
  – Shoreline Aerial Surveys
      – 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

<table>
<thead>
<tr>
<th>Platform/ Sensor</th>
<th>World-view 1</th>
<th>World-view 2</th>
<th>World-view 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revisit Time</td>
<td>1.7 d</td>
<td>1.1 d</td>
<td>&lt; 1 d</td>
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<tr>
<td>Swath Width</td>
<td>17.7 km</td>
<td>16 km</td>
<td>13.1 km</td>
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<tr>
<td>Multispectral Resolution</td>
<td>n/a</td>
<td>0.46 m</td>
<td>0.31 m</td>
</tr>
<tr>
<td>Panchromatic Resolution</td>
<td>0.5 m</td>
<td>1.85 m</td>
<td>1.24 m</td>
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</tbody>
</table>
Satellite Survey / Collections

- Bright anomalies are irregularly shaped
- Bright anomalies occur in wave troughs

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
• 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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