



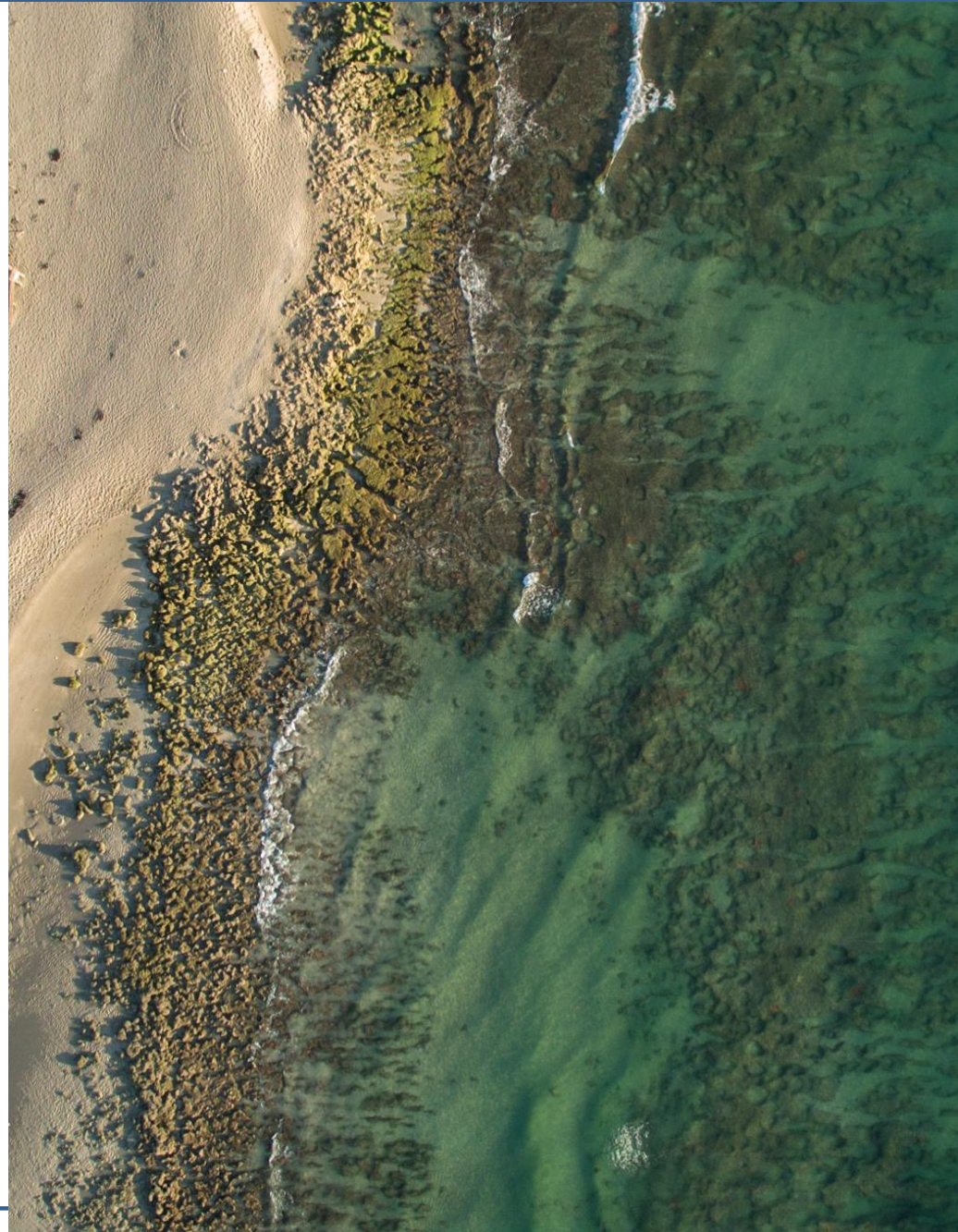
CSA Ocean
Sciences Inc.

Applications of Video Analysis in Examining Coastal and Nearshore Issues

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9 February 2017

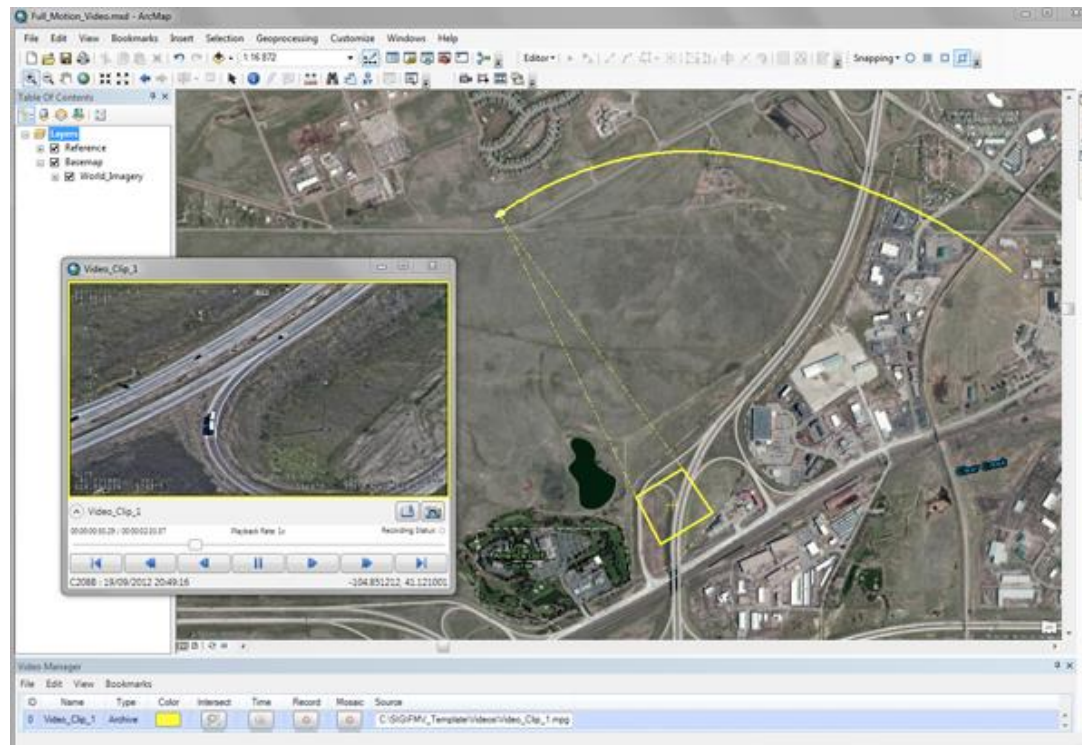
National Conference on Beach Preservation Technology
Stuart, FL

- Introduction
 - Full Motion Video (FMV)
 - Work Flow
- Environmental Applications
 - Coastal and nearshore issues
- Comparison Study
 - Testing hardware, firmware, and software capabilities for specific environmental issues
- Summary and Use Cases
 - Informing design and equipment selection



Full Motion Video (FMV)

- Add-In to Esri ArcGIS Desktop 10.x
- Positional metadata encoded (or injected) in video stream
- Enables spatial analysis of video imagery
- Creates bounding box around field of view in basemap



Full Motion Video (FMV) Metadata Requirements

From the GPS:

- **UNIX Time Stamp:** Coordinated Universal Time (UTC) represented in the number of microseconds elapsed since midnight (00:00:00), January 1, 1970. Derived from the POSIX IEEE 1003.1 standard. Resolution: 1 microsecond.
- **Sensor Latitude:** The latitudinal position of the sensor aboard the imaging platform. Based on WGS84 ellipsoid.
- **Sensor Longitude:** The longitudinal position of the sensor aboard the sensor platform. Based on WGS84 ellipsoid.
- **SensorAltitude:** The height above or below mean sea level of the sensor aboard the sensor platform.

These parameters will display the sensor ground track on the map

From the IMU:

- **Platform Heading:** Sensor platform heading angle. Relative between longitudinal axis and True North measured in the horizontal plane.
- **Platform Pitch:** Sensor platform pitch angle determined by the rotation around the side-to-side axis of the collection platform, also described as nose up or nose down.
- **Platform Roll:** Sensor platform roll angle determined by the rotation around the front-to-back axis of the collection platform. This occurs when one airplane wing is higher or lower relative to the other wing.

From the Camera manufacturer, and sensor internal electronics:

- **Horizontal FOV:** Horizontal field of view of selected imaging sensor, in milli degrees. This value will vary according to zoom level of the sensor.

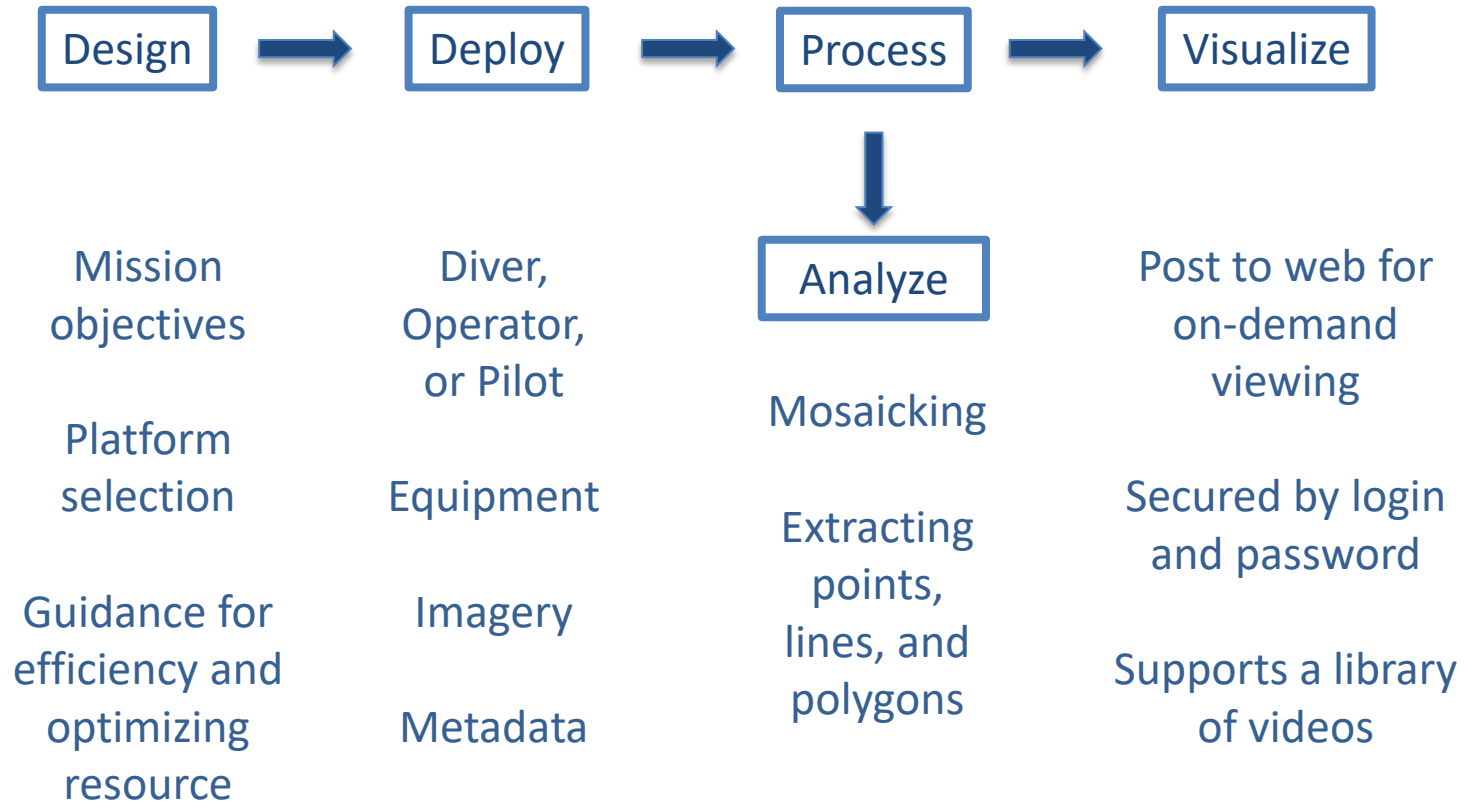
Assuming the sensor is fixed to the imaging platform (no gimbal is used), these parameters will be used to compute the 4 corners of the video frame on the map.

Esri (2016)

Full Motion Video (FMV) Metadata Requirements

GIS and Mapping Support	Video with MISB compliant metadata	Video with GPS only
Video footprint on map	yes	no
GIS features displayed in video	yes	no
Aircraft flight path shown on map	yes	yes
Measure features in the video	yes	no
Digitize/edit features in the video	yes	no
Mark features in the video	yes	no
Save video frame as an image	yes	yes
Export video clip	yes	yes
Create Powerpoint report	yes	no
Collect / label / save Bookmarks	yes	yes
Play video controls (pause, FF, etc)	yes	yes

Full Motion Video (FMV) Work Flow



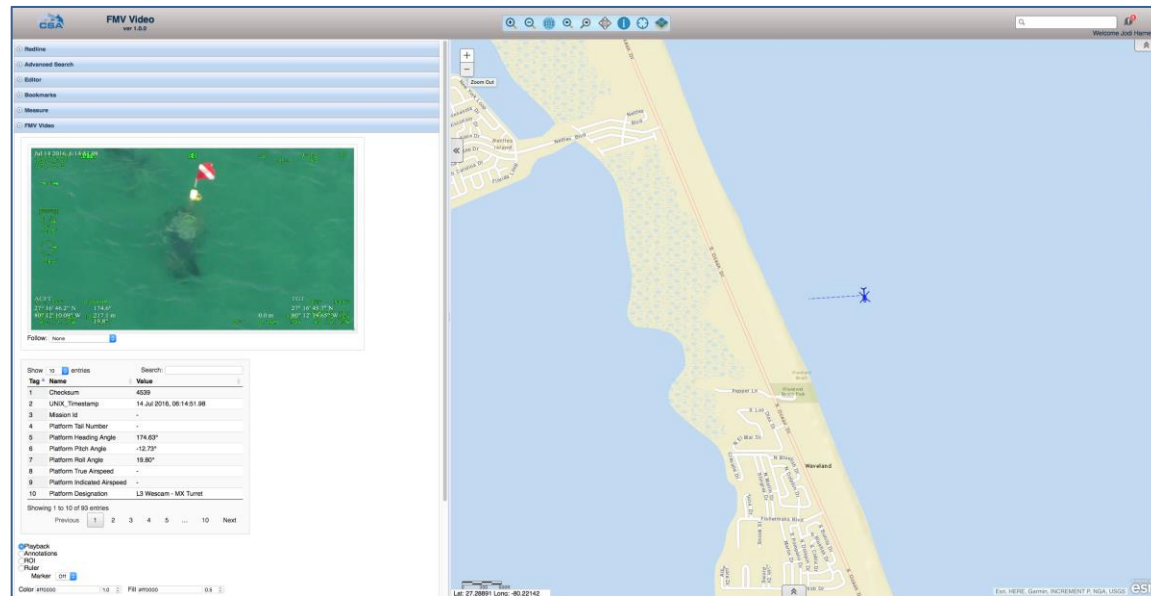
Design

- Identify appropriate subsea or aerial platform
 - Diver
 - Dropcam
 - Remotely Operated Vehicle (ROV)
 - Autonomous Underwater Vehicle (AUV)
 - Unmanned Aerial Vehicle (UAV; drone)
 - Manned aircraft (helicopter or fixed wing)
- Camera (stills or video)
- Airspace restrictions
- Additional payload



Deploy

- Safety and crew resource management
- Equip platform with appropriate payload
 - Still or video camera
 - Infrared or other sensors
- Navigational data and metadata integration
 - Collect nav separately and inject into imagery during processing
 - Use integrated system
- Communication



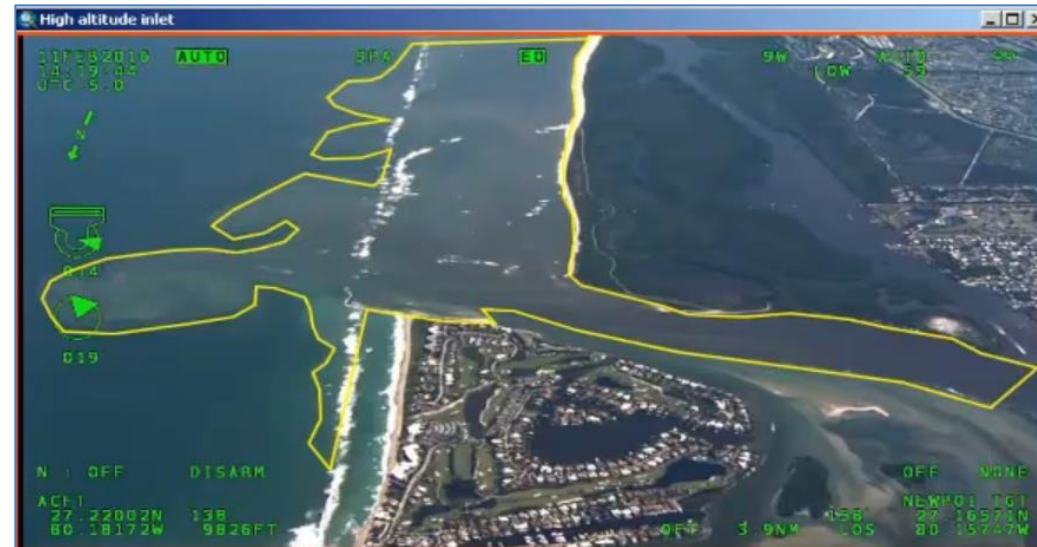
Process

- QA/QC
- Injection of nav data
- Software options
 - Batch injector
 - Esri FMV Add-in
 - Drone2Map
 - Custom and commercial options
- Publish to web server
- Create orthomosaic
 - Thousands of individual frames stitched together
 - Use as a raster basemap



Analyze

- Extract spatial features from video
 - Points, lines, polygons
 - Shapefiles
- Mapping and measurement over space and time
 - Point counts with XY locations
 - Mean high water line
 - Dune and beach width
 - Hardbottom polygons
 - PLS requirements
- Image classification
 - Seagrass coverage
 - Bottom type
 - Visible surface water quality issues (green algae, turbidity)



Visualize

- Play FMV-compliant video over basemaps and data layers in a web-accessible platform
- Streamline processing time with appropriate equipment and study design

The screenshot displays a web-based interface for visualizing FMV (First Person View) data. The interface is divided into several sections:

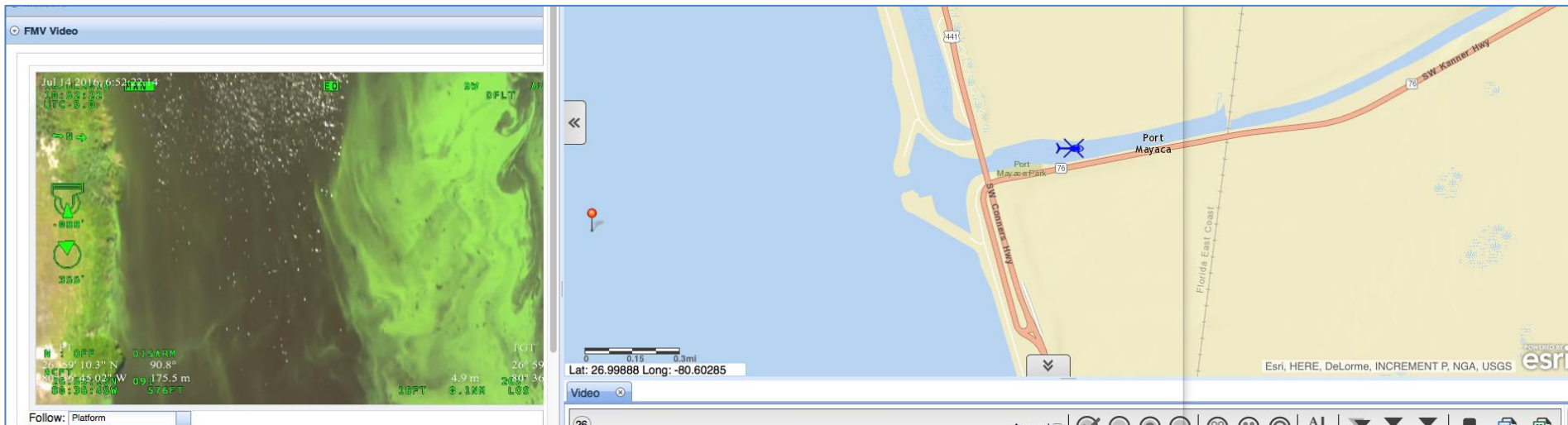
- Table of Contents:** A sidebar on the left lists navigation options: Redline, Advanced Search, Bookmarks, and Video.
- Video Player:** A large video player on the left shows a 3D aerial view of a coastal area. It includes a timeline at the bottom with a play button and a duration of 00:00:20.9. Metadata for the video is displayed below the player, including coordinates (27° 8' 8.83" N, 80° 9' 15.8" W) and a resolution of 640x360.
- Map:** A map on the right shows the same coastal area with a blue polygon highlighting a specific region. The map includes labels for 'Port Salerno', 'St. Lucie Inlet', and 'Miles Green Country Club'. Coordinates are shown as Lat: 27.13985 Long: -80.21858.
- Metadata Table:** A table at the bottom right lists video clips with their respective metadata. The table has columns for Select, Visible, Zoom, Pan, OBJECTID, NAME, Description, UploadTime, SecurityClassification, and Duration.

Select	Visible	Zoom	Pan	OBJECTID	NAME	Description	UploadTime	SecurityClassification	Duration
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			572305c5d35139a410d7dd65	Video_Clip_1	ESRI Video_Clip_1	2016-04-29T06:27:45.044Z	UNCLASSIFIED	152.98
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			5723065e63f32c4803ce1689	Video_Clip_2	ESRI Video_Clip_2	2016-04-29T06:59:30.628Z	UNCLASSIFIED	123.606
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			572306d963f32c4803ce169a	GOPR1989_TT_Beach	CSA group	2016-04-29T06:59:30.628Z	UNCLASSIFIED	374
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			57230765f02d11640be7814f	GOPR1998_TT_Valley	CSA group	2016-04-29T07:03:48.978Z	UNCLASSIFIED	497.95
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			57230765f02d11640be7815b	Inlet_area_St_Lucie_River	Inlet area St Lucie River	2016-04-29T07:03:48.978Z	UNCLASSIFIED	277.36899999
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			572308baf02d11640be7816b	Locks_to_St_Lucie_inlet	Locks to St Lucie Inlet	2016-04-29T07:03:48.978Z	UNCLASSIFIED	885.871
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			57230cb95c5414240ce42b33	ArcVideo_clip	ArcVideo_clip	2016-04-29T07:22:32.087Z	UNCLASSIFIED	72.574
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			67414767c7c446a80a702964	SiaetaKav	SiaetaKav	2016-05-20T15:14:07.300Z	UNCLASSIFIED	150.06000000

ENVIRONMENTAL APPLICATIONS

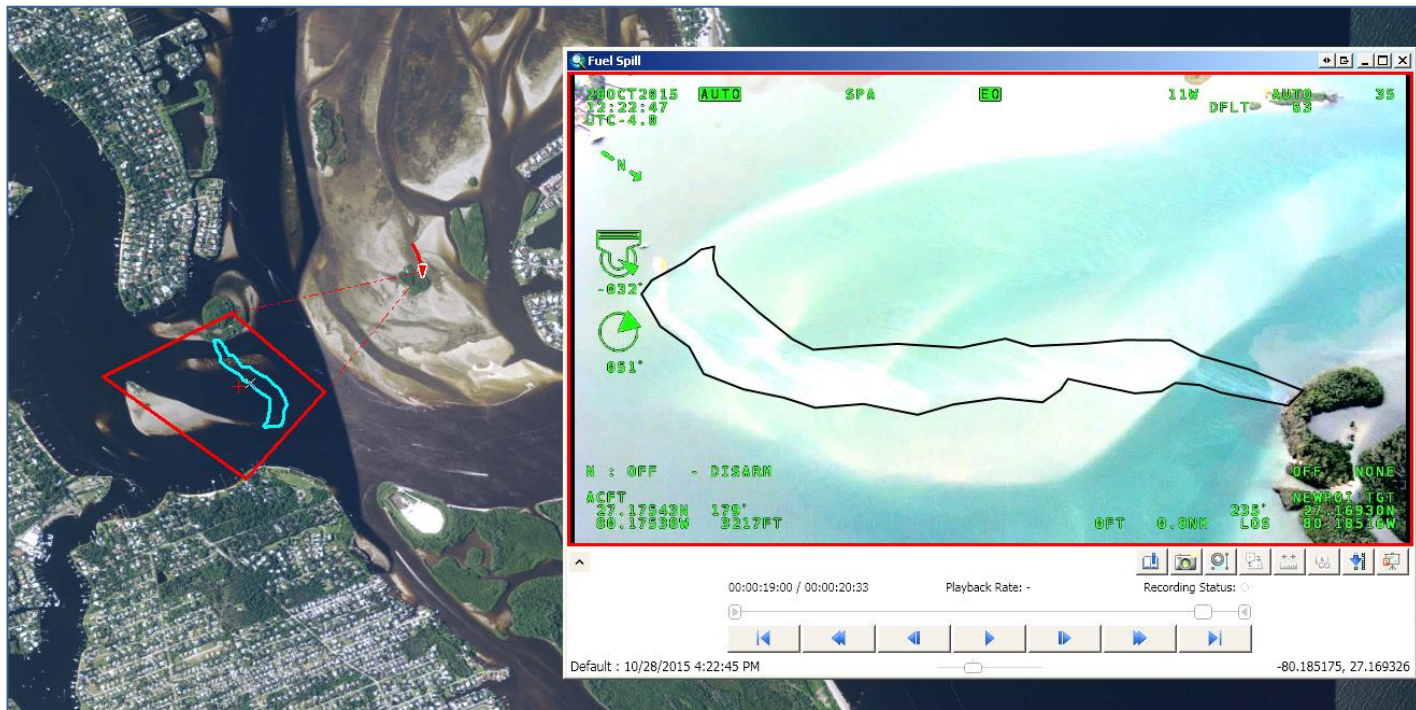
Water Quality

- Map the distribution of visible water quality issues
 - Green algae
 - Turbidity plumes
- Inform sampling design for field teams
- Track distribution over space and time
- Web-accessible playback for stakeholders



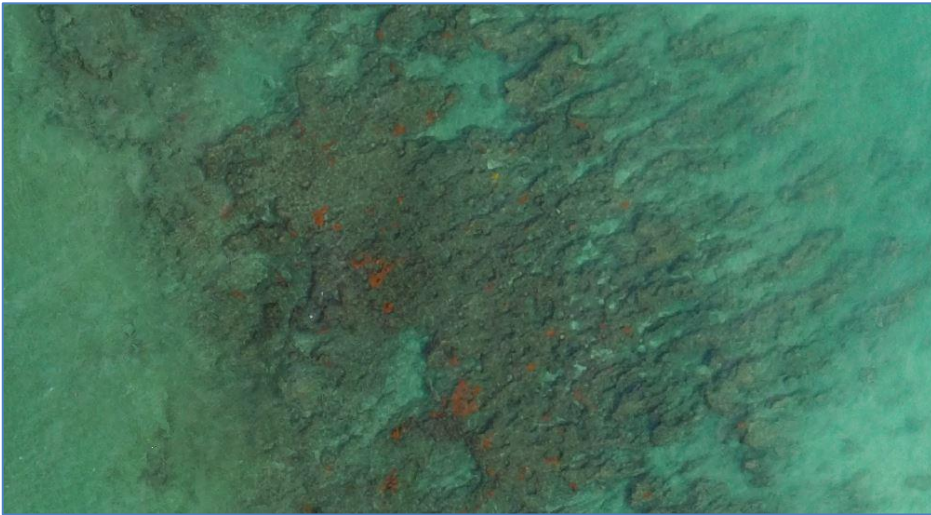
Oil Spills

- Track the surface distribution of visible oil over space and time
- Improve situational awareness with web-based Common Operating Picture

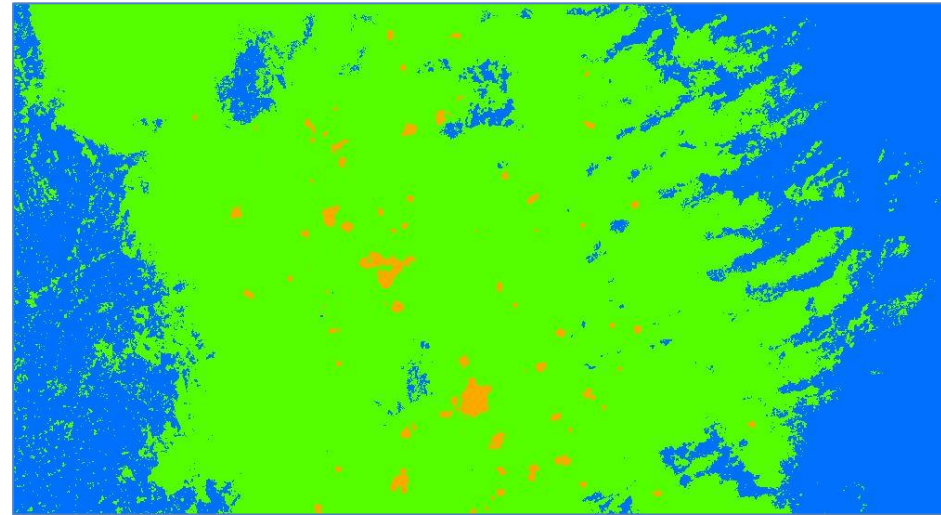


Hardbottom Delineation

- Aerial Imagery
 - Example of unsupervised classification of orthomosaic created from FMV-compliant imagery collected using a UAV



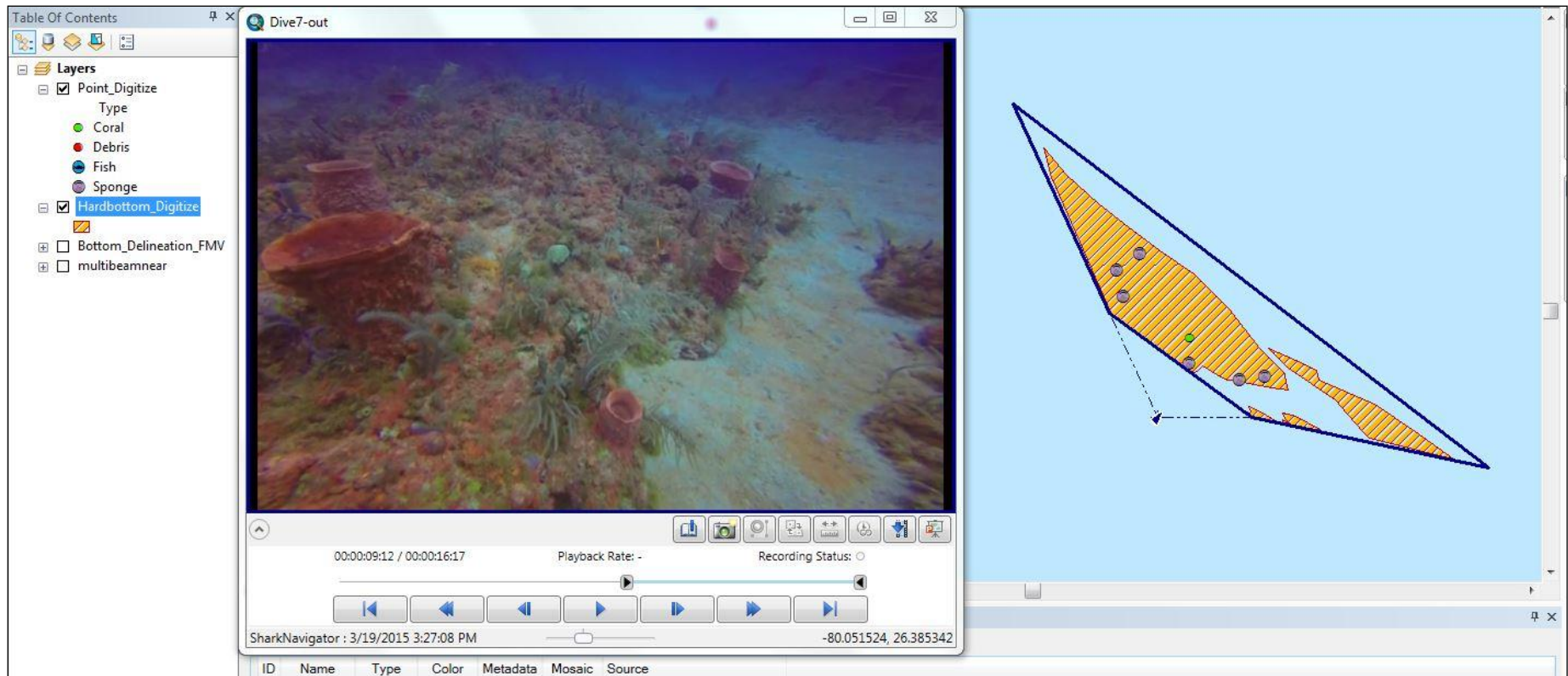
Orthomosaic of imagery collected using UAV (Martin County)



Preliminary unsupervised classification of orthomosaic

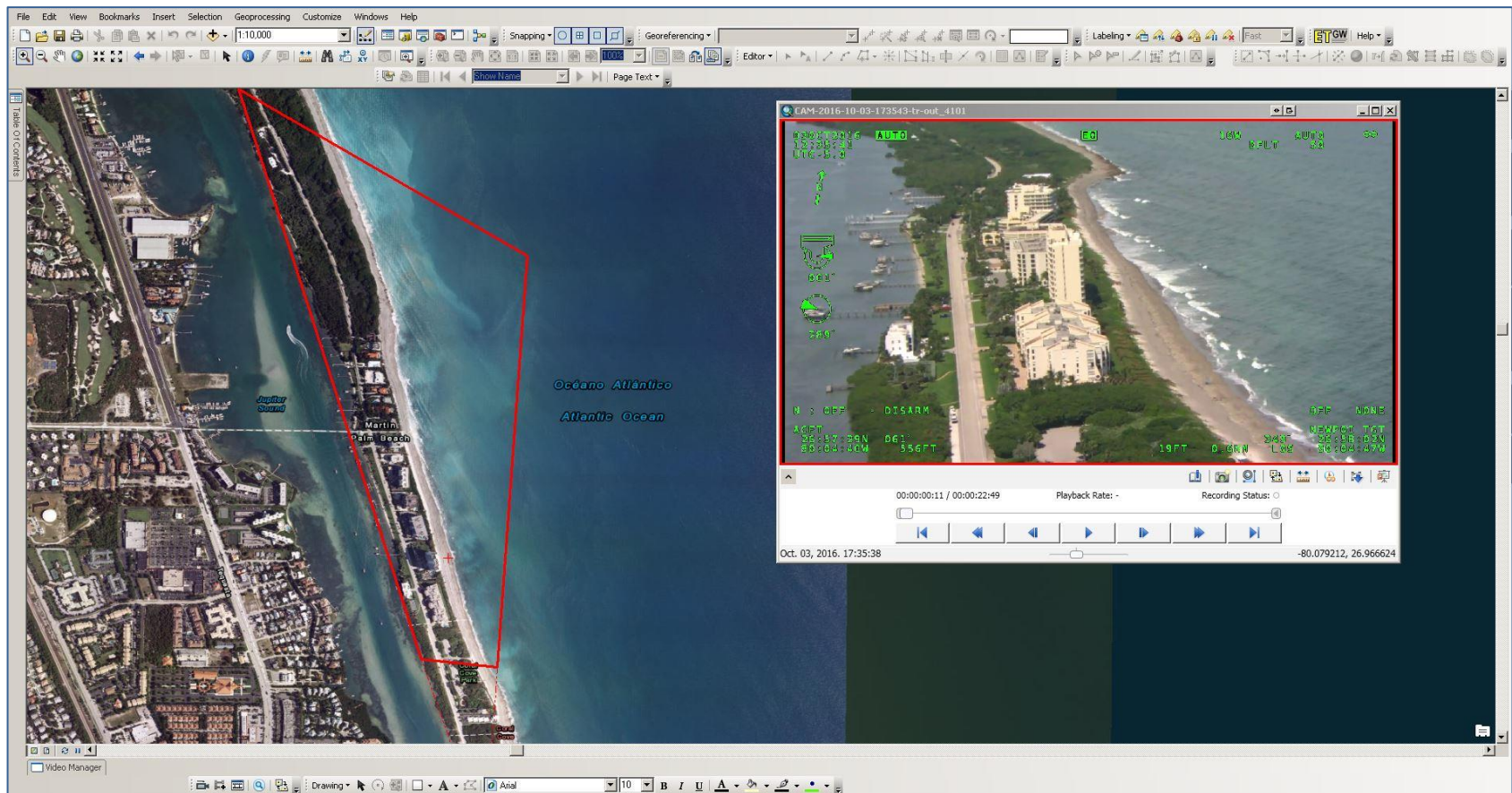
Hardbottom Delineation

- Diver Imagery
 - Example of user-digitized point, line, and polygon features directly in underwater video



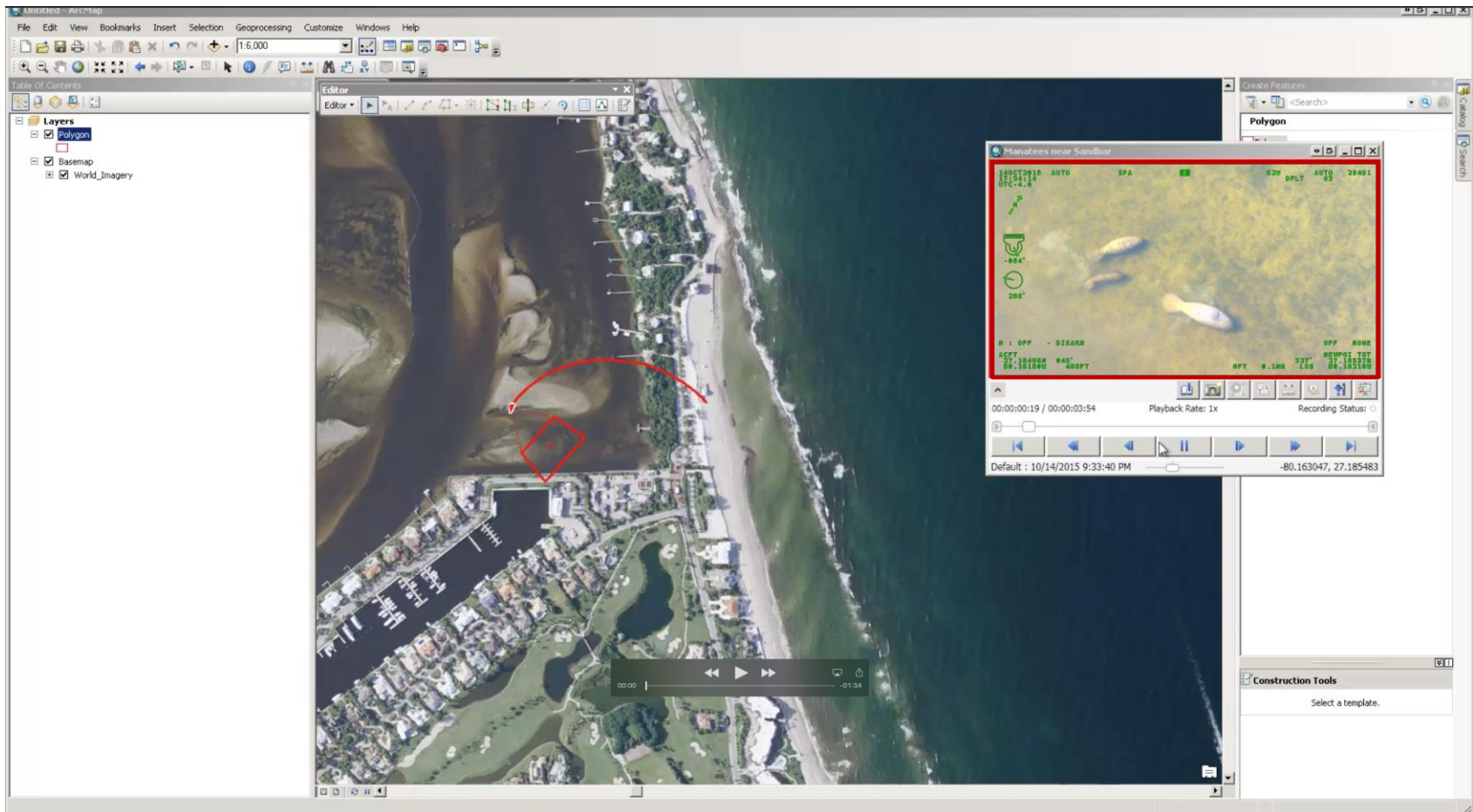
Beach Dynamics

- Collect and analyze FMV-compliant imagery before and after storm events or renourishment projects



Protected Species

- Record the spatial location, size, behavior, and other attributes during protected species observations



Seagrass Mapping

- Collect imagery during crucial stages (here, wall construction) to monitor restoration



COMPARISON STUDY

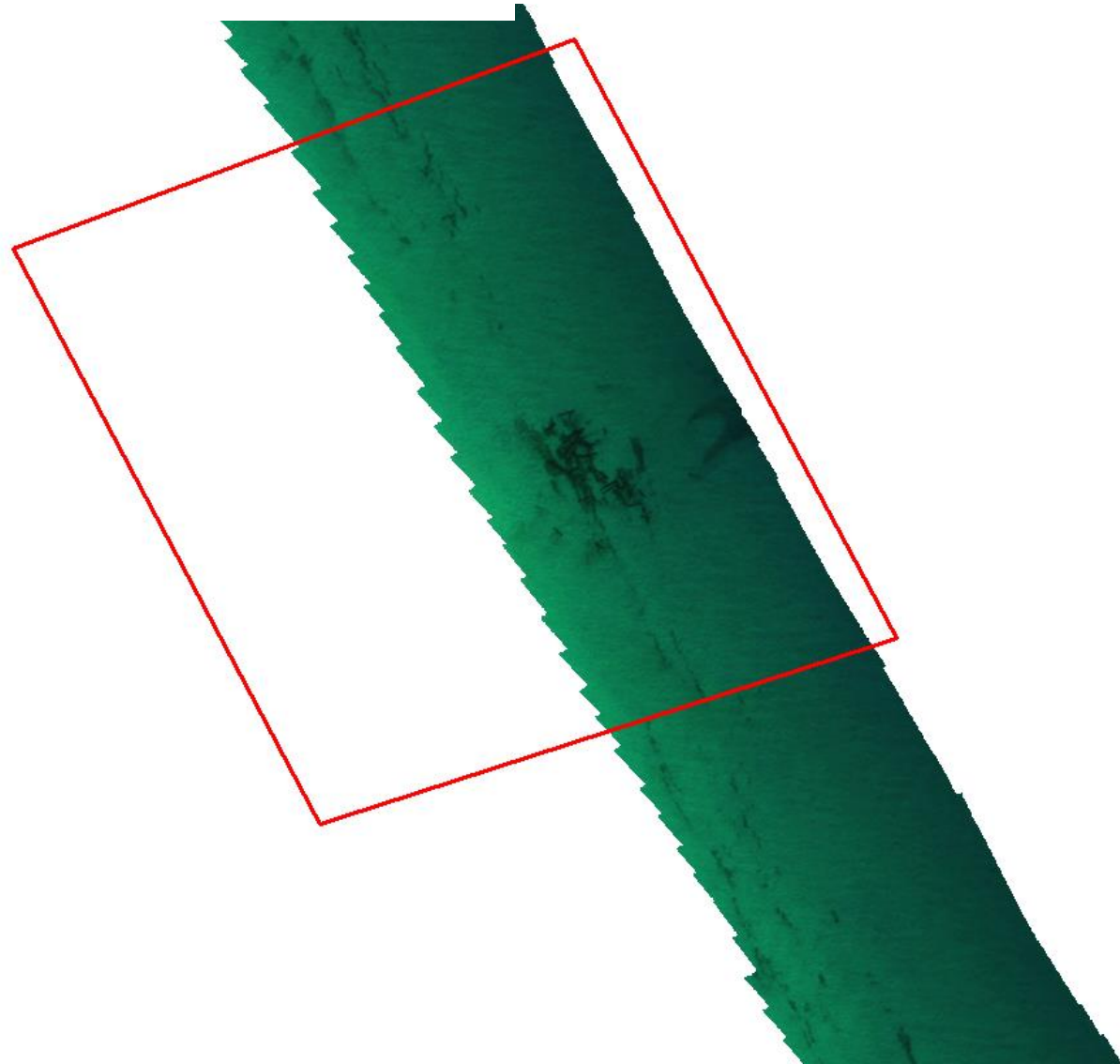
Study Area – Joe's Point Road

- Objective: Compare and evaluate platform, hardware, firmware, and software appropriate for image analysis
- Platforms
 - Unmanned Aerial Vehicle (drone)
 - Helicopter
- Software
 - Esri FMV Add-in
 - Esri Drone2Map
 - Drone Deploy
- Video vs. Still
- Quality
 - Resolution
 - Completeness
 - FMV Compliance



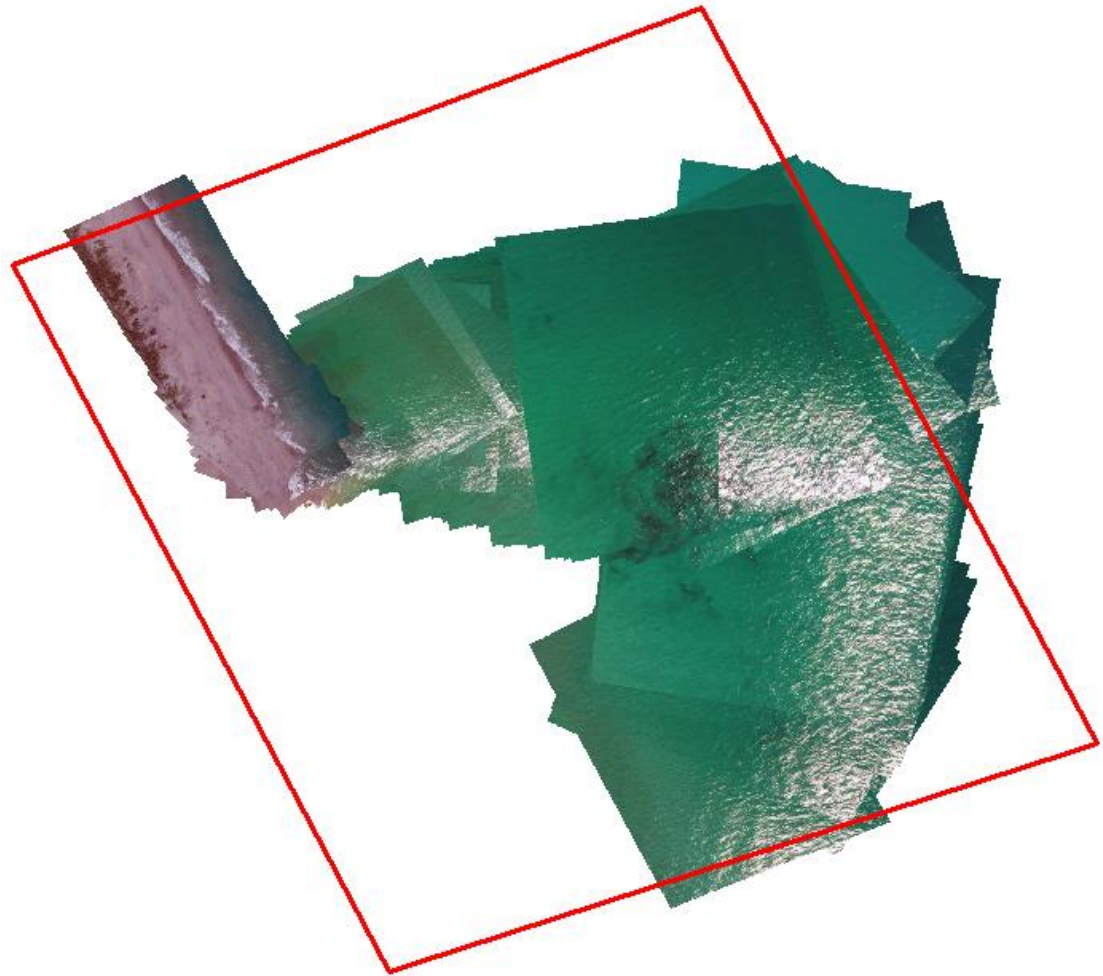
Platform – Helicopter

- Video imagery collected at 500'



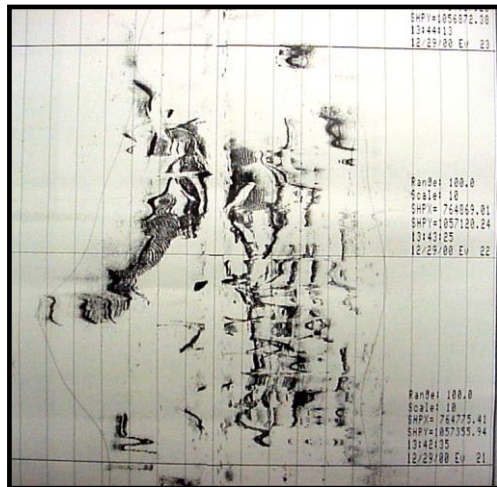
Platform – UAV

- Video imagery collected between 200' and 400'

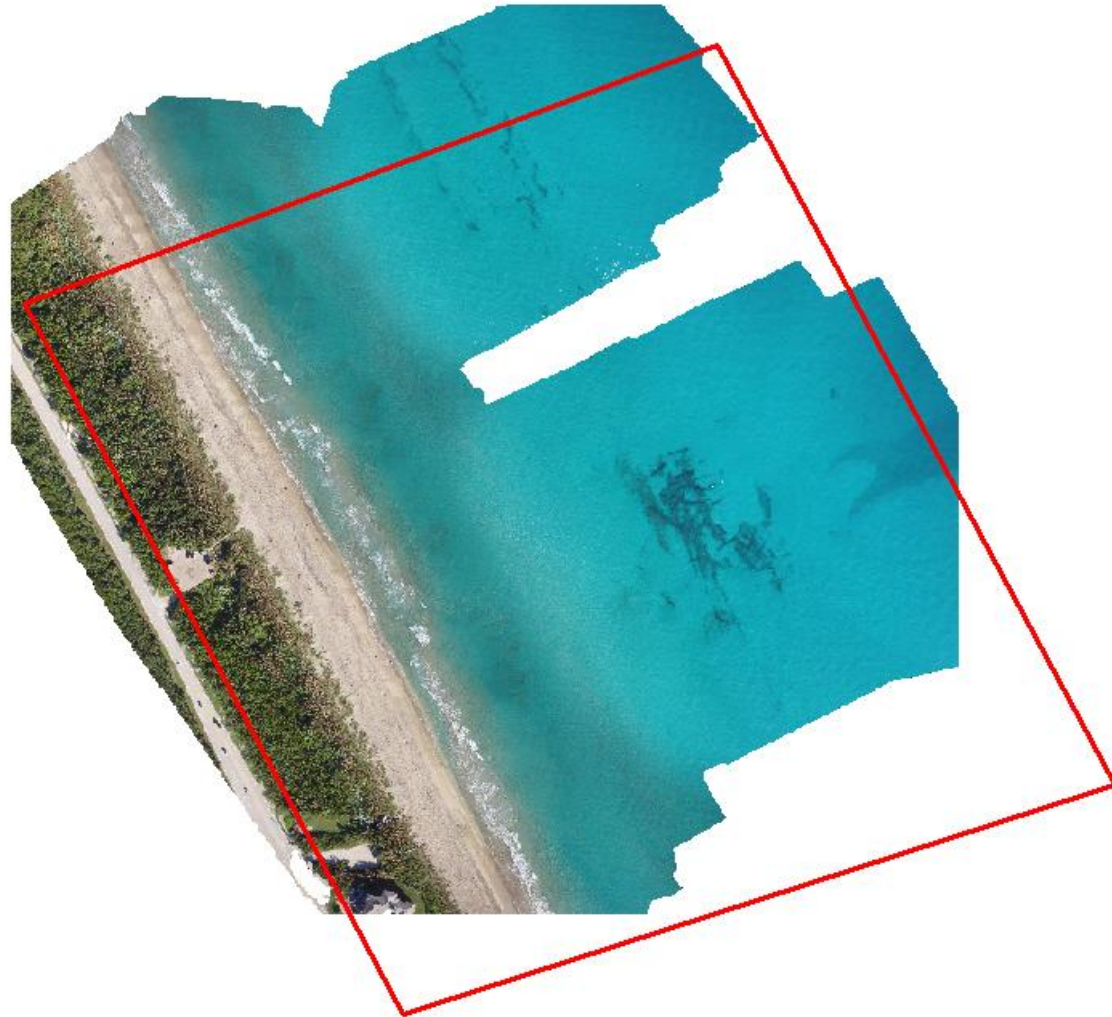


Platform – UAV

- Still images collected at 340'



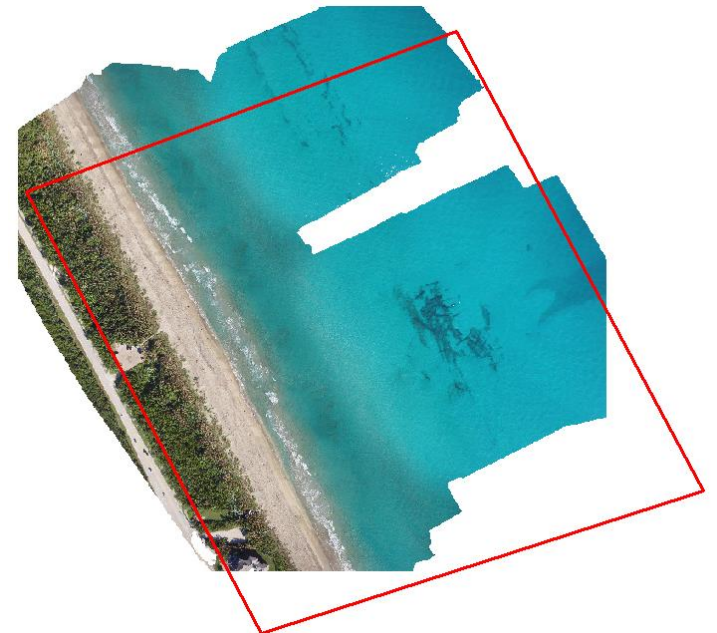
Dec 2000 sidescan survey



SUMMARY & USE CASES

Drone – Stills or Video

- Portable platform for rapid assessment
- Visualization on web within hours of collection
- Map spatial distribution of visible features over space and time (shapefiles)
- Cost-efficient and on-demand
- Stills are best for maximizing image quality and completeness in orthomosaics



Helicopter – Video

- County asset
- Advanced camera system
- Ideal for large study areas
- Flying over populated areas
- Mosaics possible but quality depends on collection methods
- Cost and availability concerns





Thank You!



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Questions?

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