Tracking Marsh Vegetation Communities Using UAV-Derived NIR Imagery

Presentation at UAS Mapping 2016 Palm Springs CA

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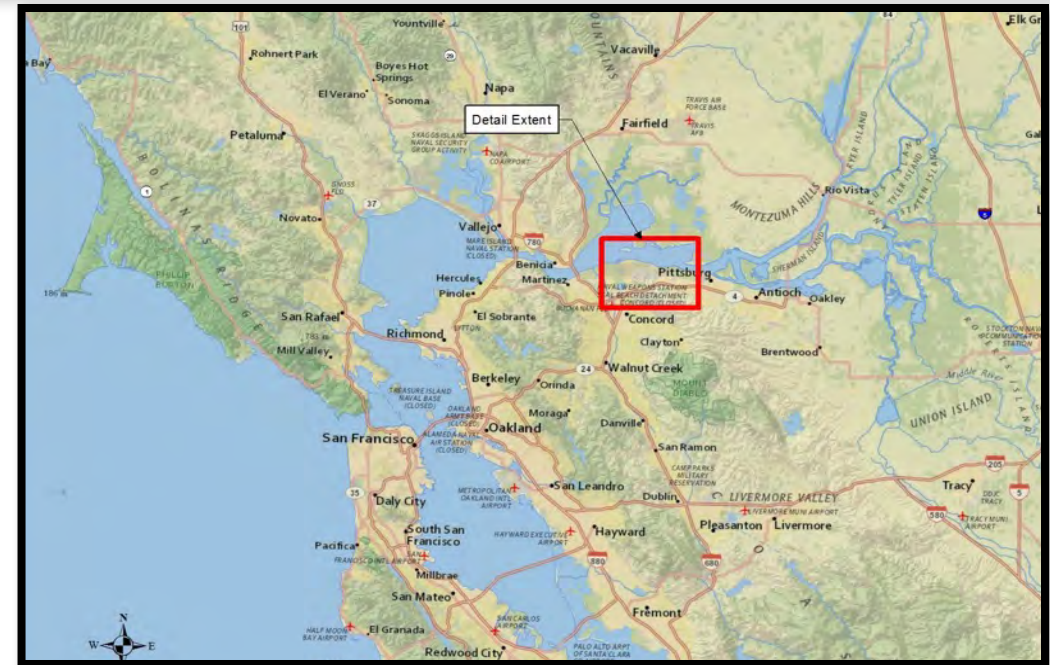
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Project Site & Background

REMEDIATION SITE VEGETATION MONITORING

Project Site: Military Ocean Terminal Concord (MOTCO), Suisun Bay CA

Salt Marsh Harvest Mouse

California Black Rail

- *Long-term Vegetation Mapping*
- *Special Status Species Habitat Monitoring*

Project Goals

- *Map Dominant Plant Communities*

- *Document the Composition and Extent of Plants Species.*

- *Compare the results of these mapping efforts to previous monitoring years (2005, 2008, 2011)*

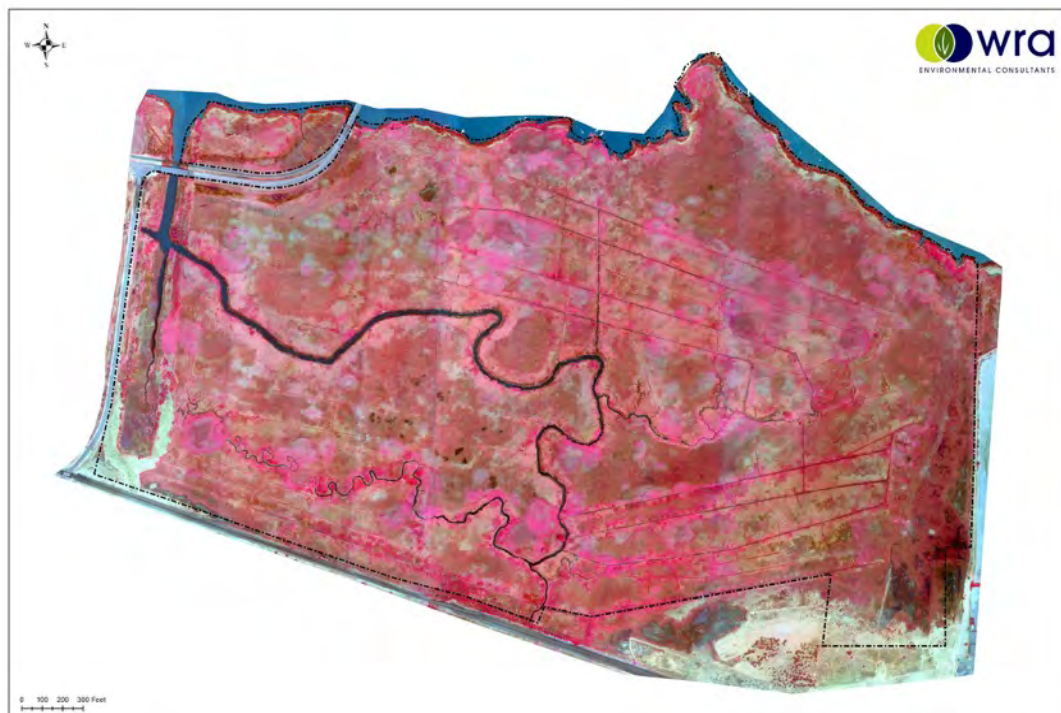- *Remote Sensing and GIS Spatial Analysis*

Methods

- *Ground-level Surveys*

- *Photograph monitoring*

- *A low altitude helicopter direct observation*

- *UAV-derived color (RGB) & color infrared (CIR) Aerial Imagery*

- *UAV-derived imagery as inputs to Trimble eCognition and Geospatial Information Systems (GIS)*

Unmanned Aerial Vehicle

- "Hex"Copter

- Nadir Camera (facing down)

- 15 Minute Battery

- 60 Acres per Flight

- Navigation-grade GNSS

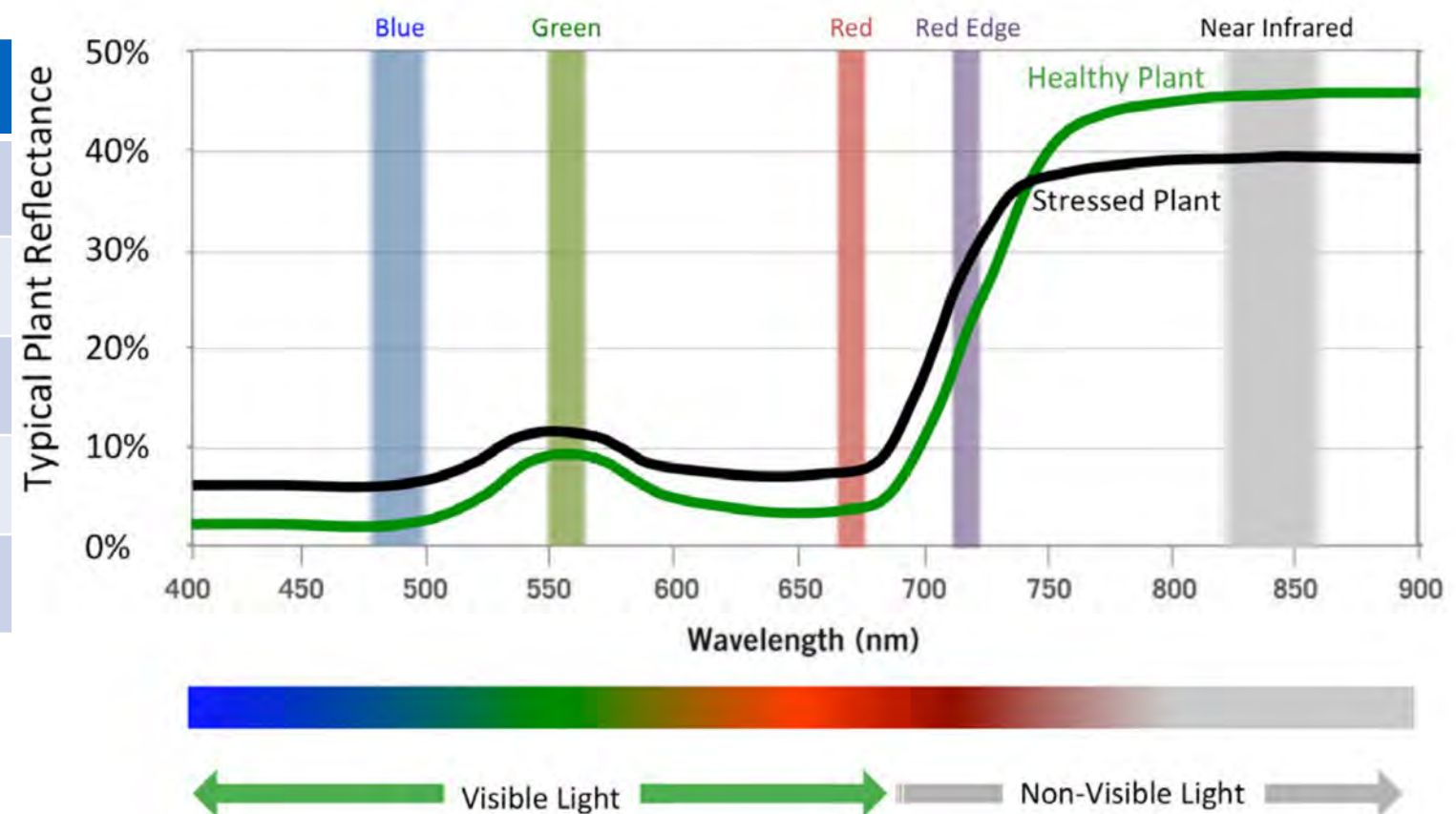- Autonomous Flight and Camera Trigger

- RTL Failsafes

Multispectral (NIR) Camera

- MicaSense "RedEdge"

- Powered and Triggered by the Drone

- Weight: 5.3 oz

Capture of discrete wavelengths of light:

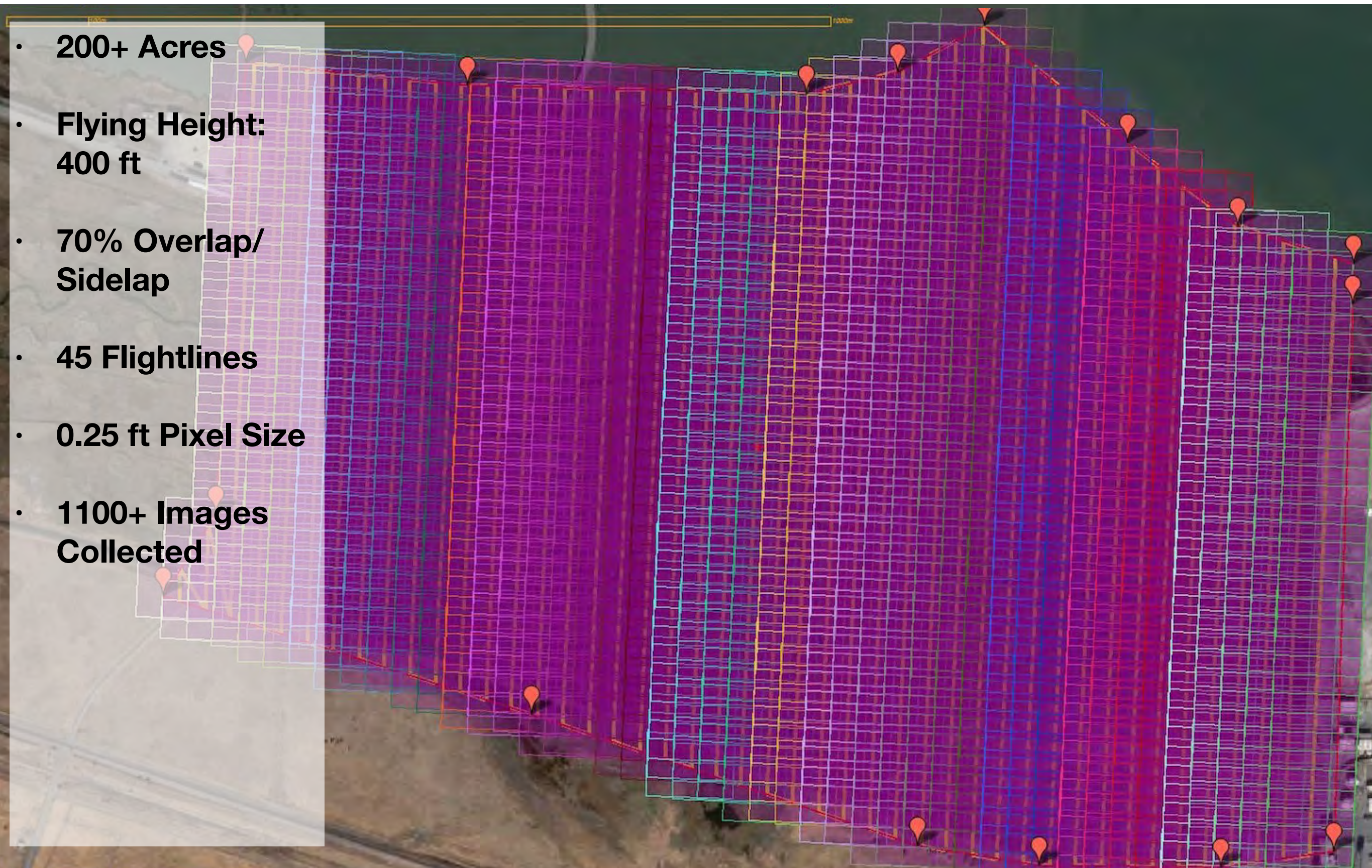| BAND	WAVELENGTH	BANDWIDTH
Blue Light	475 nm	25 nm
Green Light	560 nm	20 nm
Red Light	668 nm	10 nm
Red Edge	717 nm	10 nm
Near Infrared	840 nm	40 nm

Data Collection

- **Limited Access**

- **Multispectral Aerial Acquisition**

- **High Resolution Image Data**

- **One week total schedule**

Data Collection

- 200+ Acres

- Flying Height: 400 ft

- 70% Overlap/ Sidelap

- 45 Flightlines

- 0.25 ft Pixel Size

- 1100+ Images Collected

Challenges (First Flight)

- **Safety**

- **Mobilization**

- **Varying Cloud Cover (Data Consistency)**

- **Battery Life (2 Batteries)**

Success! (Second Flight)

- **Split to 3 "Blocks"**

- **Uniform Overcast Sky (Data Consistency)**

- **Battery Life (3 Batteries)**

- **1.5 Hours**

- **Fly Fixed-Wing in Future**

Data Processing

Raw Imagery Issues:
- Vignetting
- Variable brightness
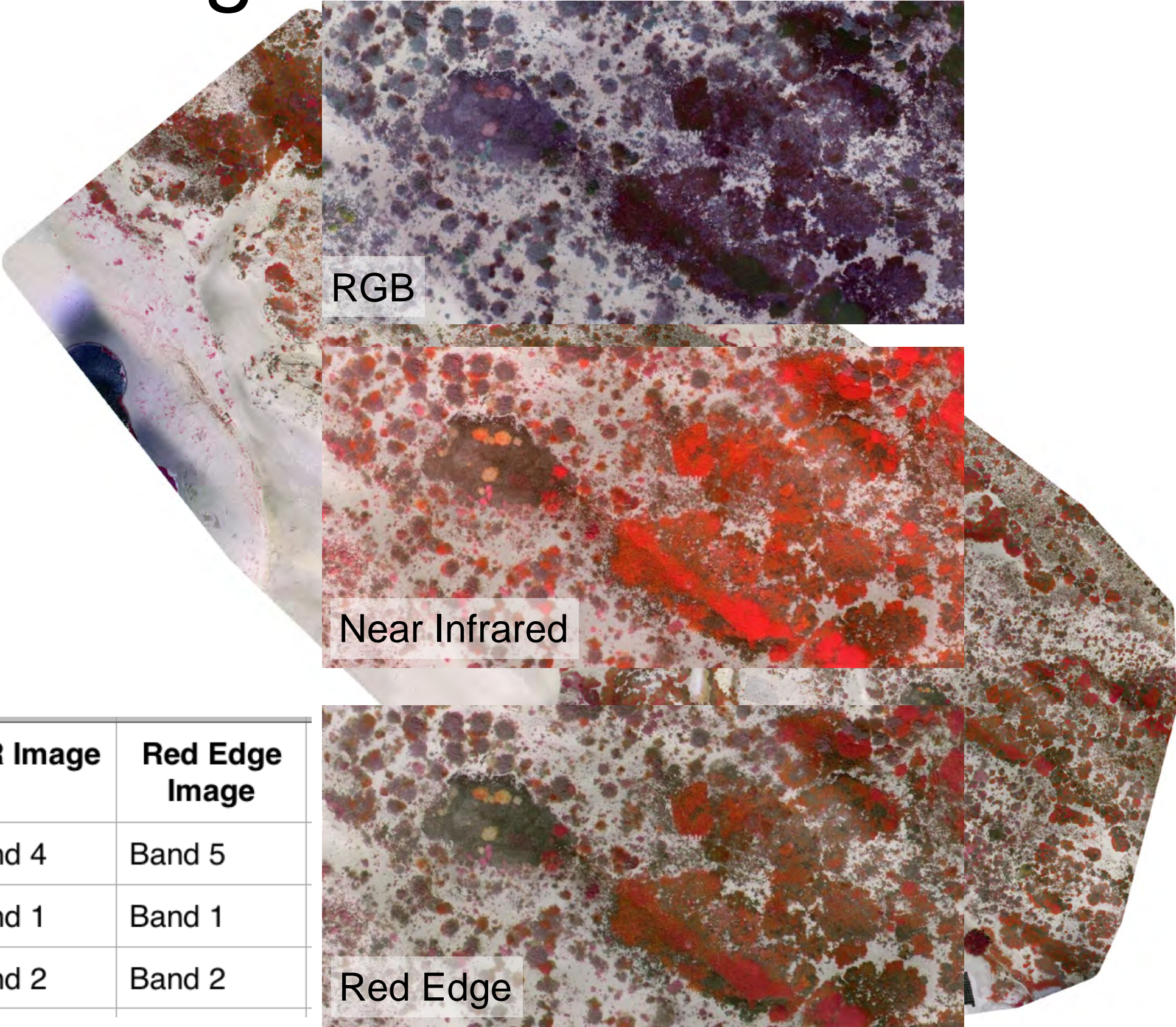- Co-registration

Raw Images – 5 bands

Composite Image

Problems reduced by:
- Avoiding sun angles >70° and <30°
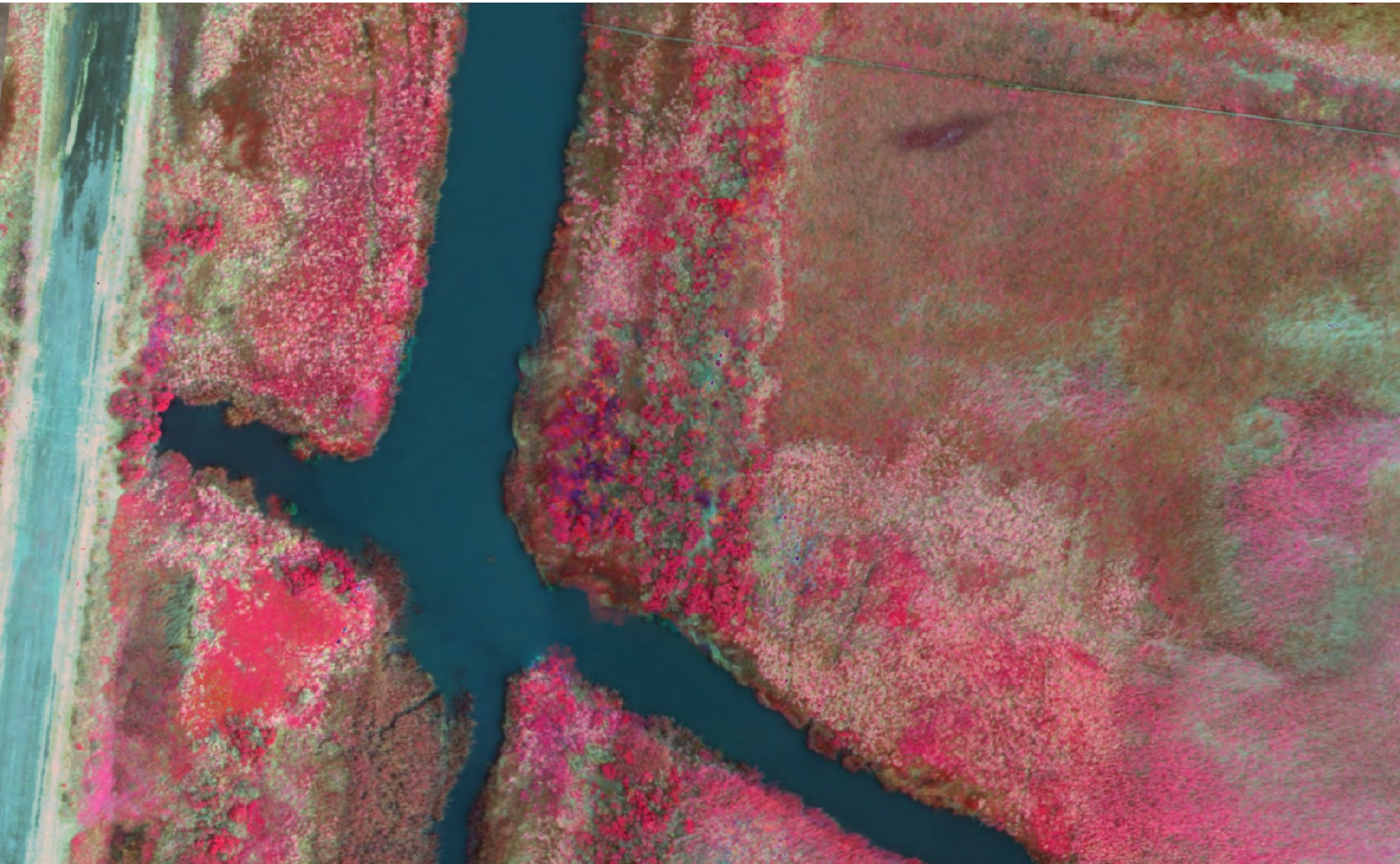- Uniform camera exposure and ISO settings

Data Processing

RGB

Near Infrared

Red Edge

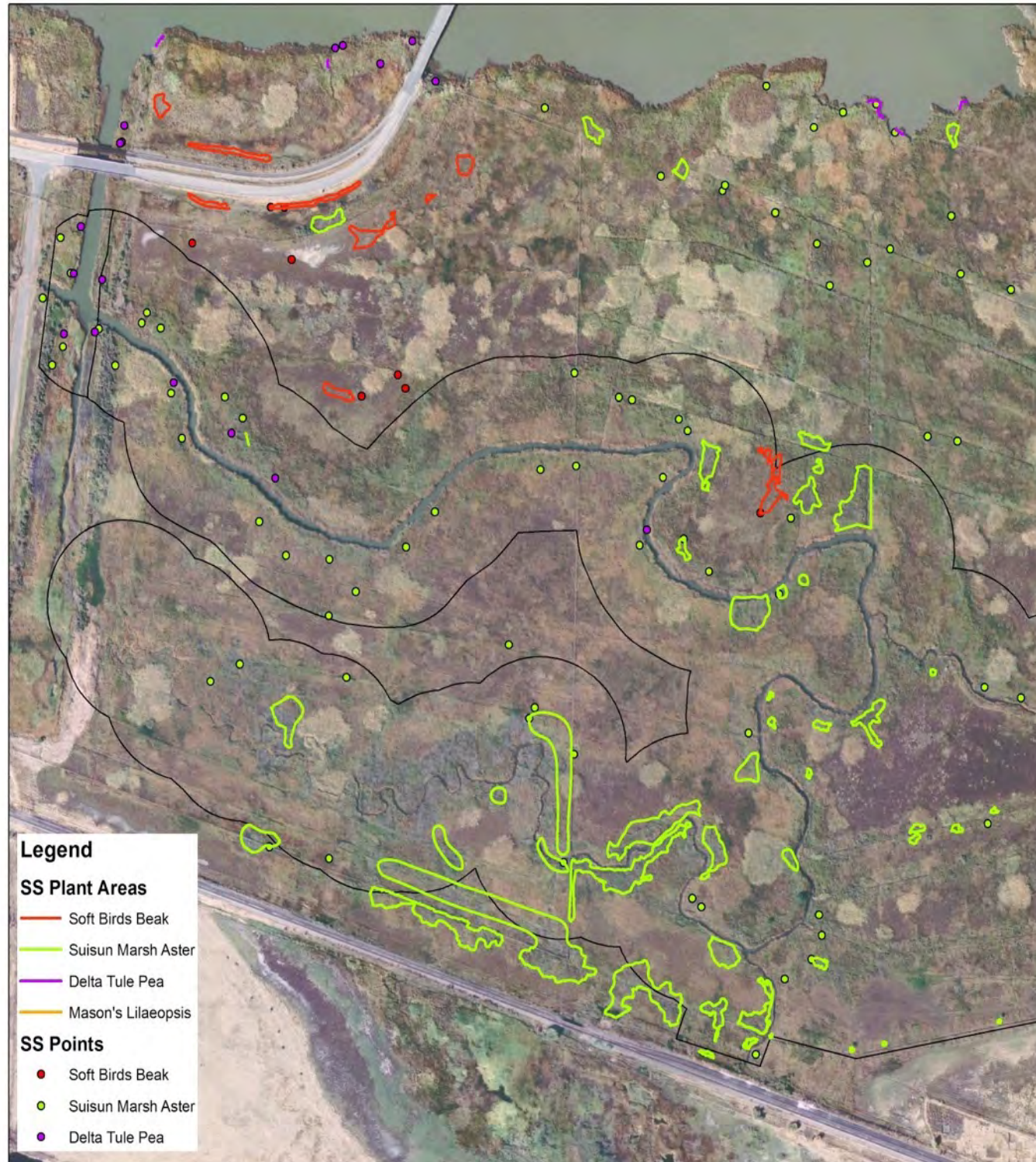| Display Colors	Color Image	NIR Image	Red Edge Image
Red	Band 1	Band 4	Band 5
Green	Band 2	Band 1	Band 1
Blue	Band 3	Band 2	Band 2

Resolution

Data Processing Results

- **900+ Images Used for Ortho Mosaic**

- **1 Day of Mosaic Processing**

- **3 Days of Data Management, QA/QC, Georeference, etc.**

- **4-Band Mosaic (RGB + NIR)**

- **UAV = fast turnaround hi-res data**

Remote Sensing Methods

Preliminary Ground-level Surveys:

- **Plant Communities Identified to Species**

- **GPS coordinates: Trimble Geo-7X**

- **Dominant plant communities (>20% cover)**

eCognition Workflow

1. Acquire Aerial Imagery

2. Load Aerial Image

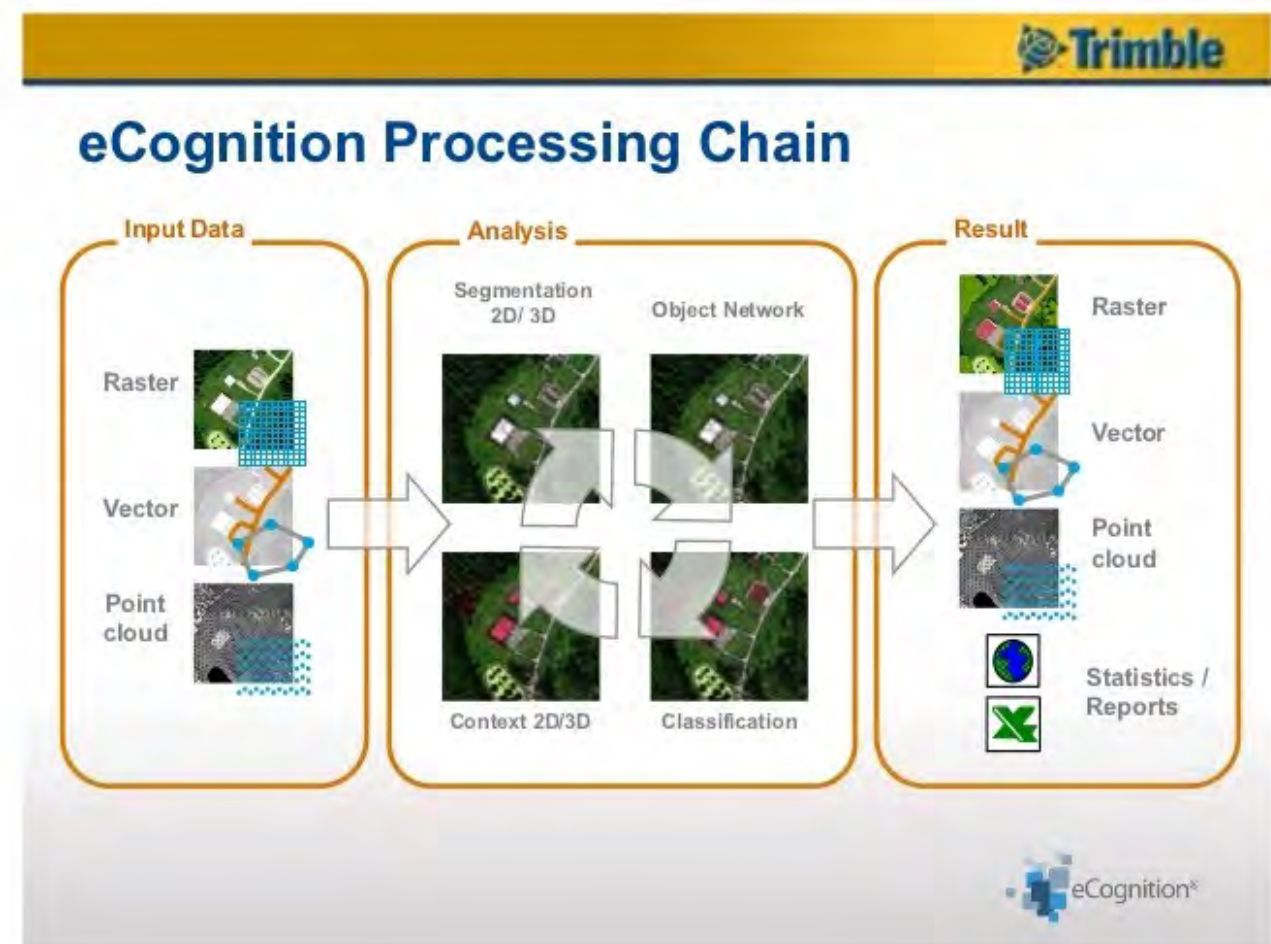**3. Segmentation Process**

4. Training Process

5. Classify

6. Re-classify

7. Export to GIS

Trimble eCognition (version 8)

➔ eCognition is a remote-sensing software package that allows users to classify different signature outputs of imagery at multiple scales.

Vegetation Mapping

- *Dominant Plant Communities Found:*
  - *- open water*
  - *- pickleweed*
  - *- bulrush/tule/cattail*
  - *- perennial pepperweed*
  - *- western goldentop*
  - *- common reed*
  - *-   Other*

- *RGB UAV imagery*

- *CIR UAV imagery*

- *ArcGIS → Further Refinement of Plant Communities to Vegetation Alliances and Species*

Vegetation Mapped

- **Vegetation Alliance**

- **Plant Community**

- **Acreage and % of Study Area**

- **Percent Change (2005-2015)**

- **Percent Change In the Last Three Years**

| Vegetation Alliance	Plant Community Classification	2005		2008		2011		2015		Change: 2005-2015		Change: 2011-2015	
		Acreage	% of Study Area	Acreage	% of Study Area	Acreage	% of Study Area	Acreage	% of Study Area	Acreage	% Change	Acreage	% Change
Pickleweed Mats	Pickleweed-Saltgrass Mats	27.3	13.5	29.8	14.8	32.3	16	1.6	0.8	-25.6	-94%	-30.7	-95%
	Pickleweed Mats	8.4	4.2	11.4	5.7	18.9	9.4	68.9	34.2	60.4	816%	50	365%
	Pickleweed-Brass Buttons Mats	7.7	3.8	9.9	4.9	3.2	1.6	N/P	N/P	-7.7	-100%	-3.2	-100%
Cattail Marshes	Cattail Marshes	36	17.8	3.6	1.8	17.2	8.5	2.7	1.3	-33.3	-92%	-14.4	-84%
	Cattail - California Tule Marshes	3.3	1.6	4	2	2.9	1.4	0.9	0.4	-2.4	-73%	-2	-70%
Common Tule Marshes	Common Tule Marshes	3.9	1.9	3.3	1.7	3.4	1.7	2.1	1	-1.8	-47%	-1.3	-38%
Olney's Bulrush Marshes	Olney's Bulrush Marshes	13.3	6.5	21.5	10.7	31.3	15.5	12.3	6.1	-0.9	-7%	-18.9	-61%
	Olney's Bulrush-Prairie Bulrush Marshes	0.9	0.5	1.4	0.7	0.5	0.3	0.3	0.1	-0.7	-72%	-0.3	-40%
Suisun Marsh Aster Patches	Suisun Marsh Aster - Marsh Gumplant Patches	1	0.5	2.2	1.1	7.6	3.8	1.7	0.8	0.7	172%	-6	-78%
Western Goldentop Patches	Western Goldentop - Marsh Gumplant Patches	2.6	1.3	12.7	6.3	21.7	10.8	9.5	4.7	6.9	366%	-12.2	-56%
Perennial Pepperweed Patches	Perennial Pepperweed Patches	23.6	11.7	21.2	10.5	2.6	1.3	6.8	3.4	-16.8	-71%	4.2	264%
	Perennial Pepperweed-Olney's Bulrush-Cattail Patches[†]	N/P[2]	N/P[2]	13.2	6.5	5	2.5	11.8	5.8	11.8	100%	6.8	238%
Marsh Gumplant Patches	Marsh Gumplant - Western Goldentop Patches	40.8	20.1	26.8	13.3	5.4	2.7	8.7	4.3	-32	-79%	3.3	162%
Baltic Rush Marshes	Baltic Rush Marshes	4.5	2.2	2.9	1.4	5.3	2.6	25.1	12.5	20.7	565%	19.9	478%
Common Reed Marshes	Common Reed Marshes	18.5	9.2	22.1	11	33.6	16.7	36.7	18.2	18.2	198%	3.1	109%
	Common Reed - Pickleweed Marshes[†]	N/P[2]	N/P[2]	5.3	2.6	1.9	0.9	0.7	0.3	0.7	100%	-1.2	-65%
California Rose Patches	California Rose-Coyote Brush Patches	2	1	3	1.5	1.6	0.8	2.4	1.2	0.3	117%	0.8	150%
Iceplant Mats	Iceplant Mats	0.3	0.1	0.2	0.1	0.3	0.1	0.3	0.2	0.04	113%	0.1	127%
Upland Mustard Patches	Upland Mustard – Ripgut Brome Patches	3.1	1.5	1.9	1	1.6	0.8	1.2	0.6	-1.9	-62%	-0.4	-24%
Wild Oat Grassland	Non-native Annual Grassland	2.1	1.1	1.7	0.8	1.8	0.9	2	1	-0.1	-5%	0.2	112%
Ripgut Brome Grassland													
Soft Chess Grassland													
Italian Rye Grass Grassland													
	Non-vegetated Community Classification	Acreage	% of Study Area	Acreage	% of Study Area	Acreage	% of Study Area	Acreage	% of Study Area	Acreage	% Change	Acreage	% Change
N/A[3]	Open Water	1.9	0.9	2.6	1.3	3	1.5	4.3	2.1	2.4	228%	1.3	143%
N/A[3]	Bare Areas	1.1	0.6	1.2	0.6	0.7	0.4	1.6	0.8	0.5	146%	0.9	230%

Results
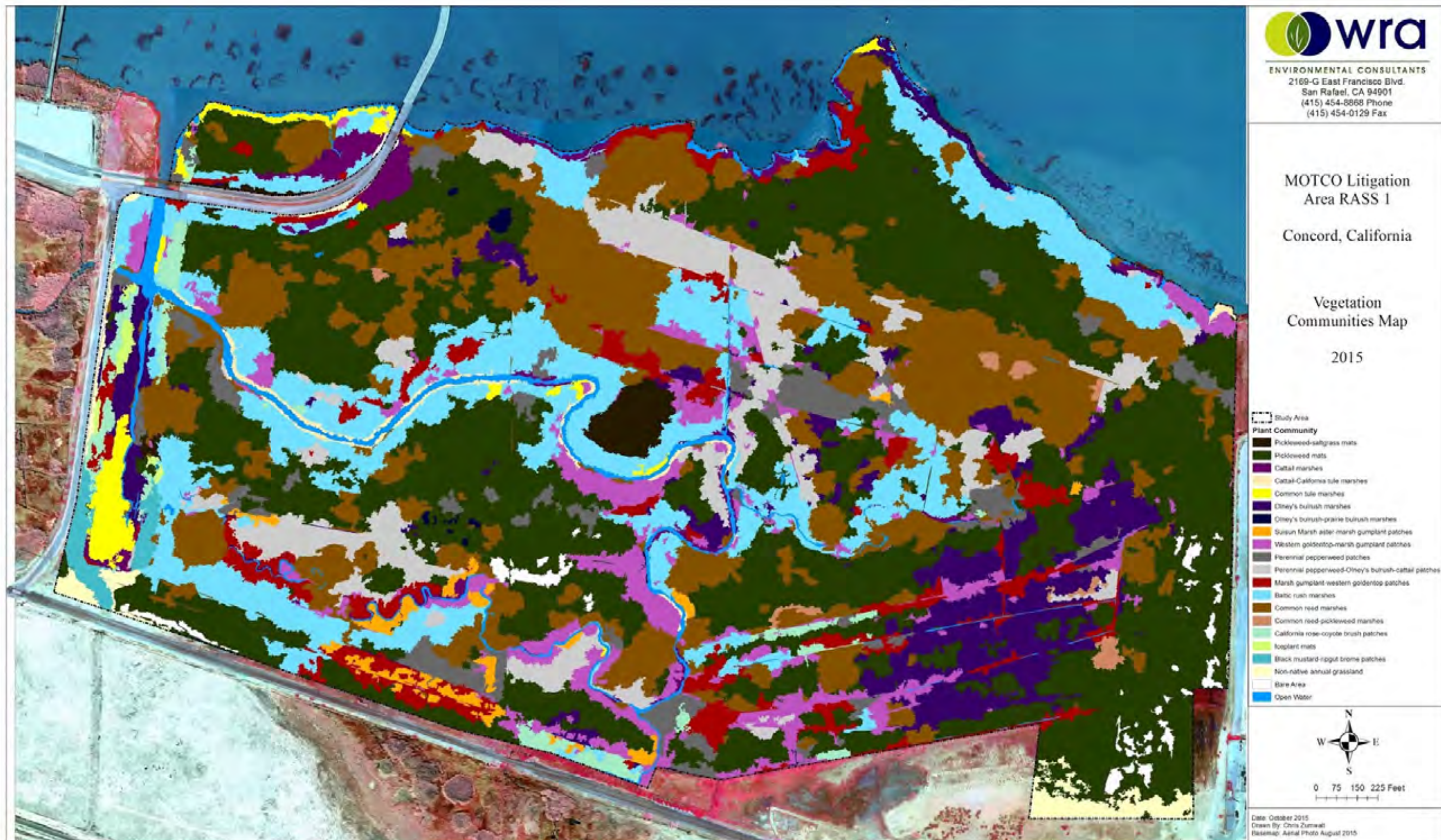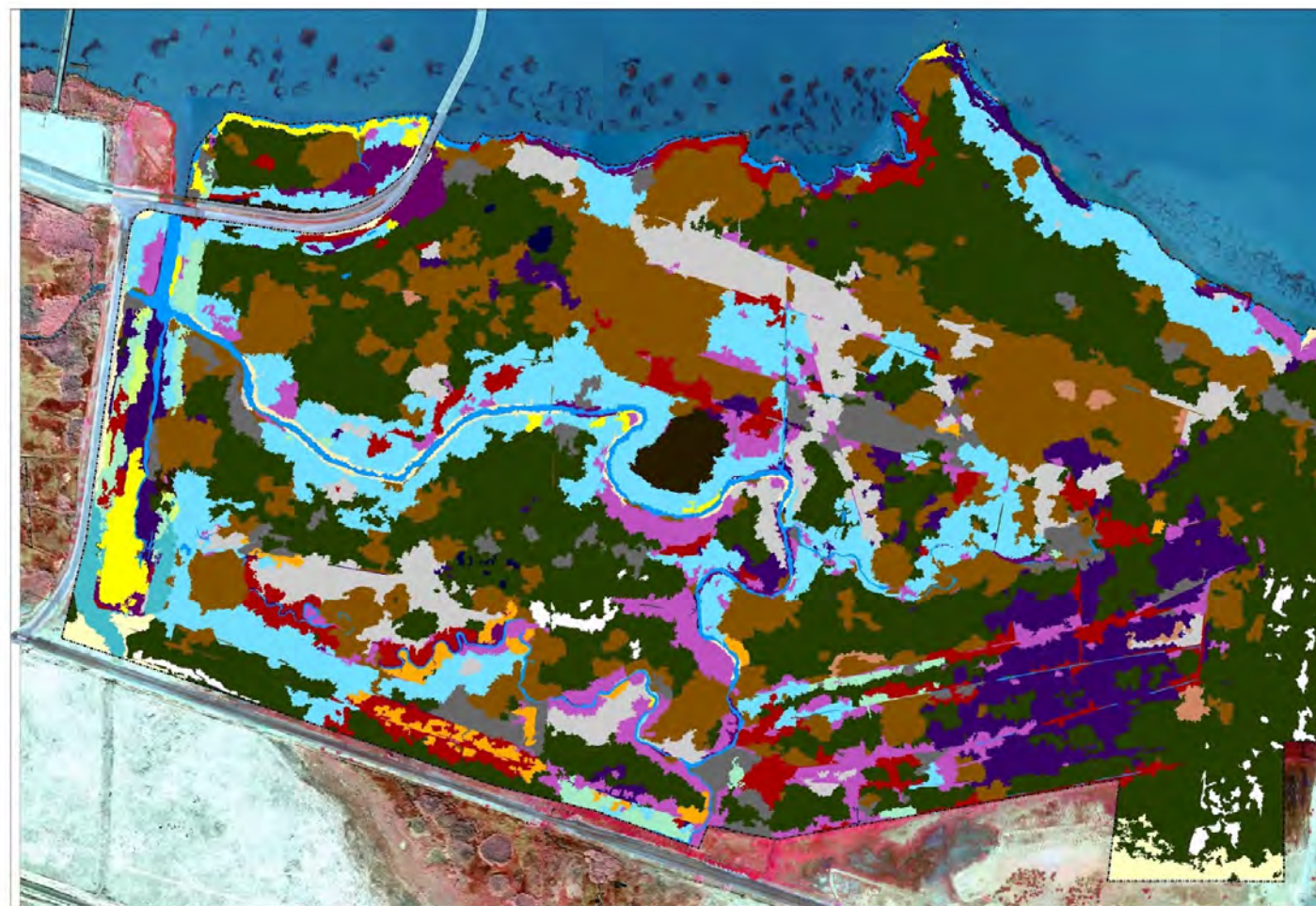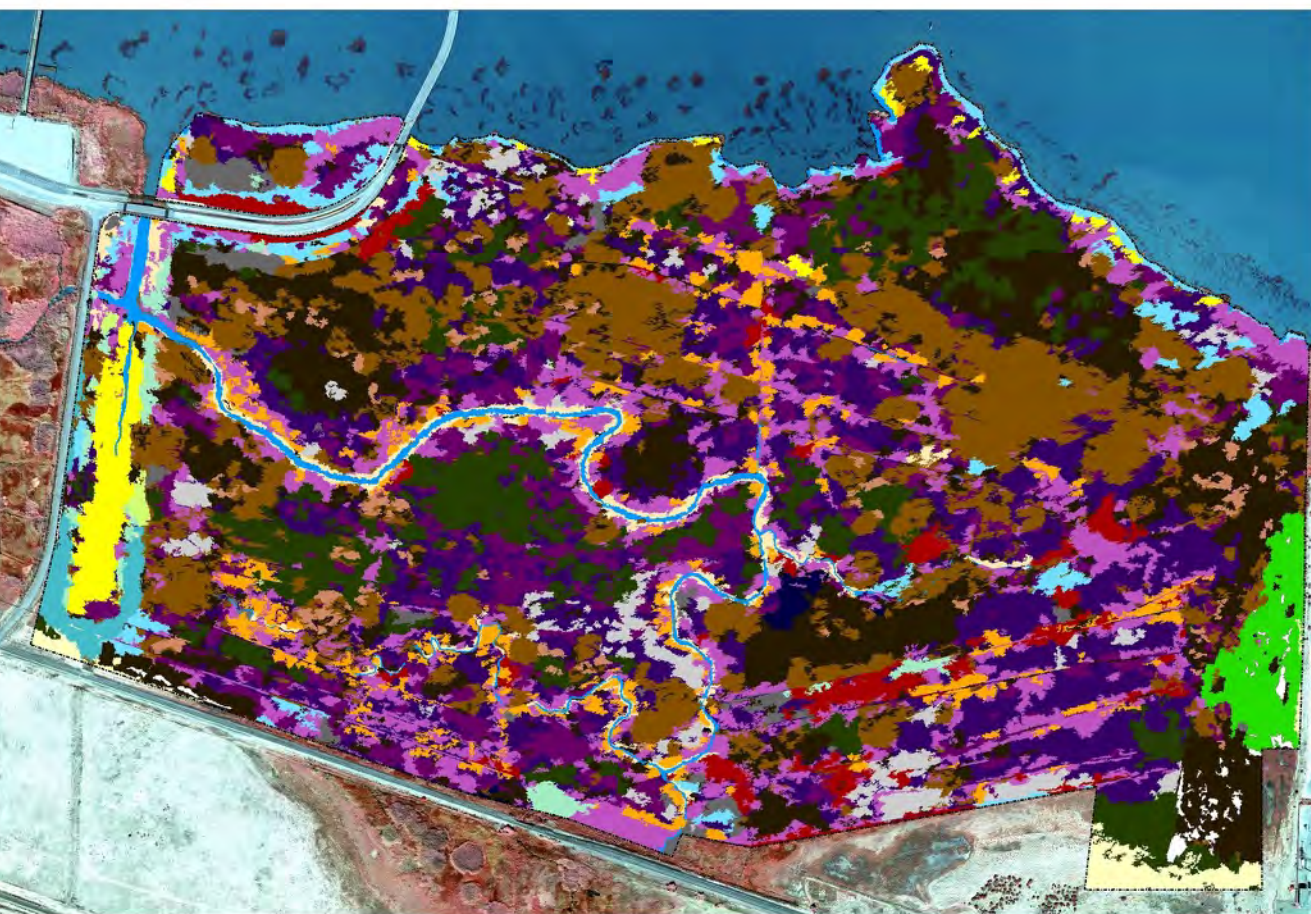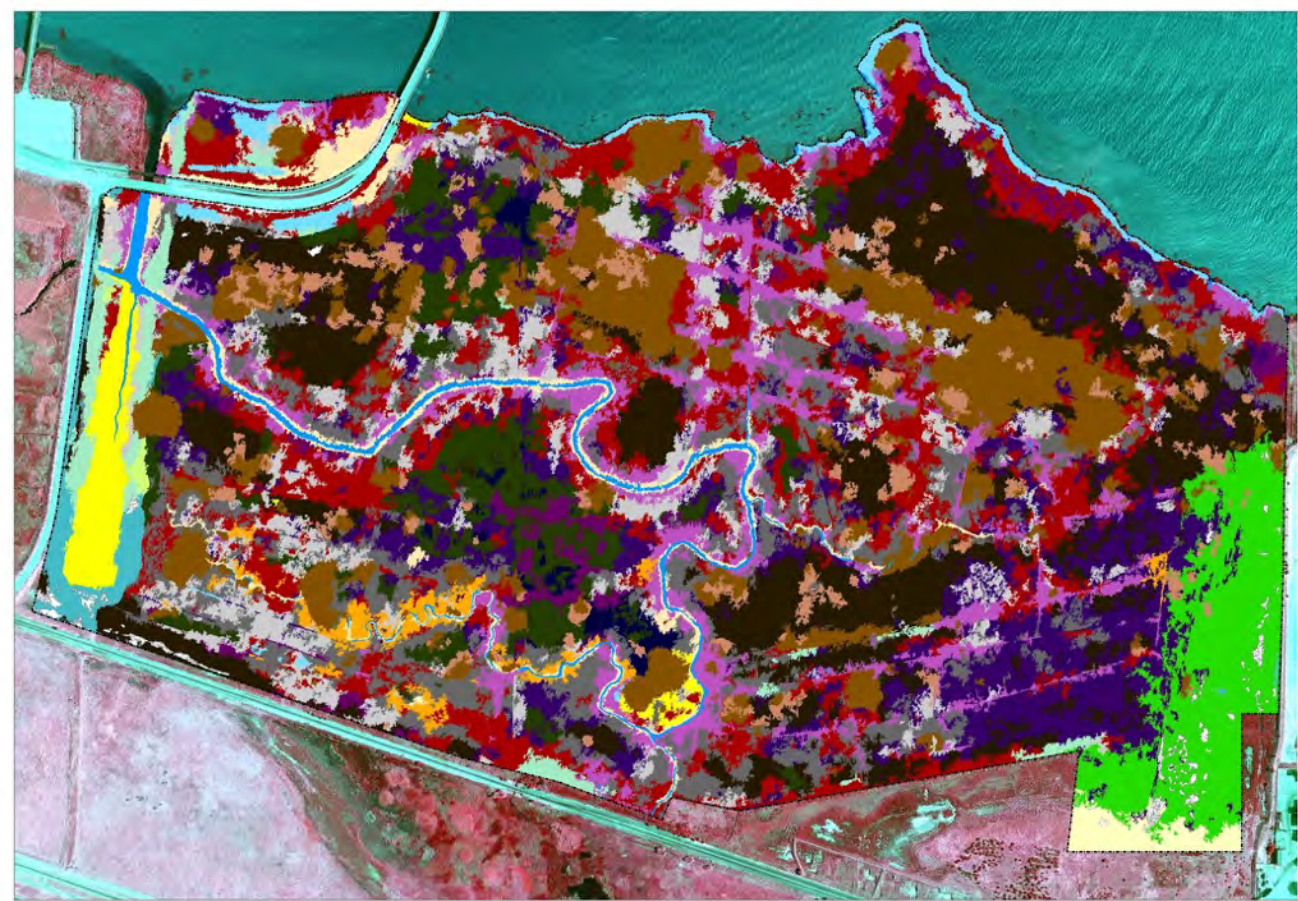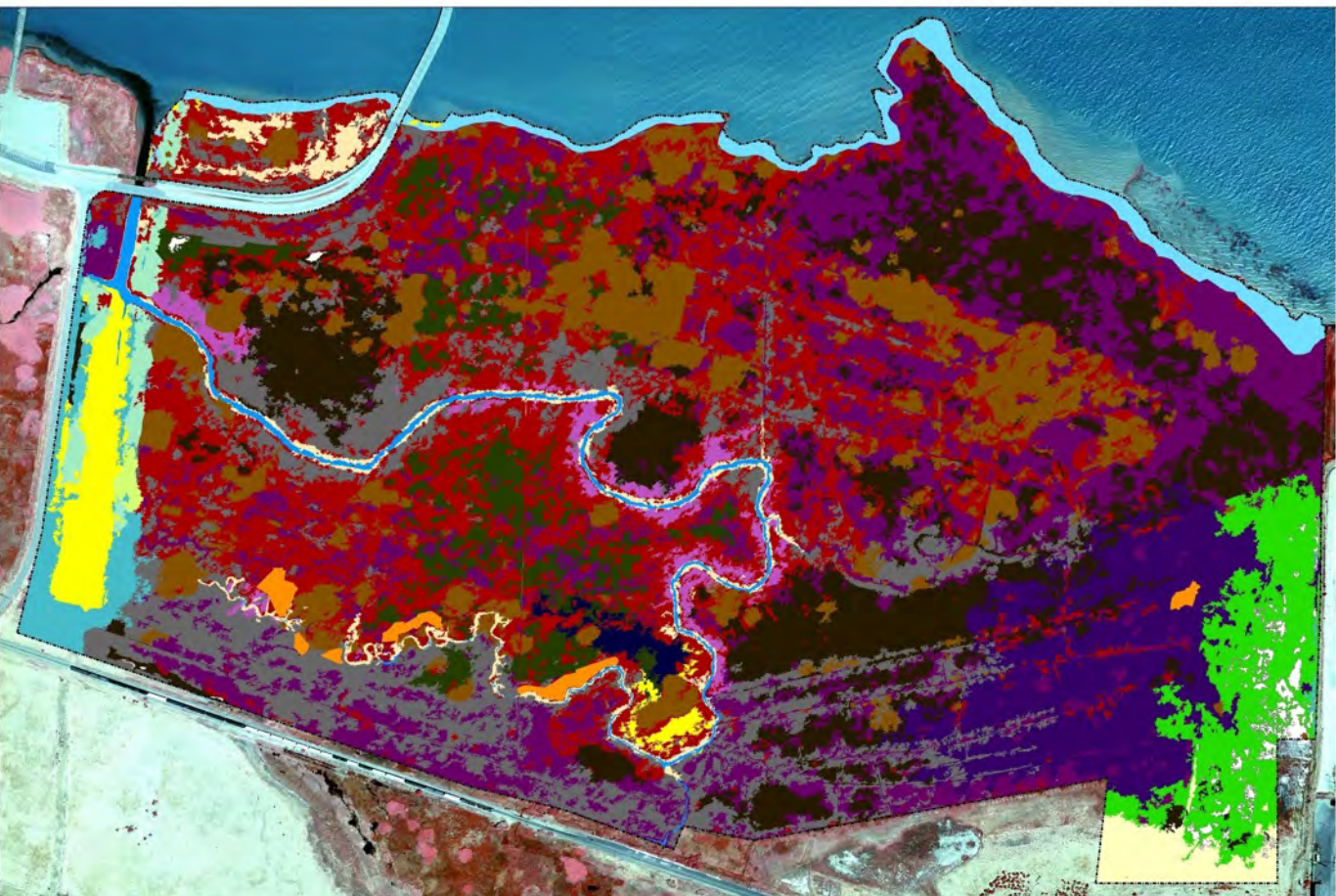
Impacts to Plant Communities

- *Invasive Species: Phragmites australis, Lepidium latifolium*

- *Salt Marsh Harvest Mouse / California Black Rail Habitat Degradation*
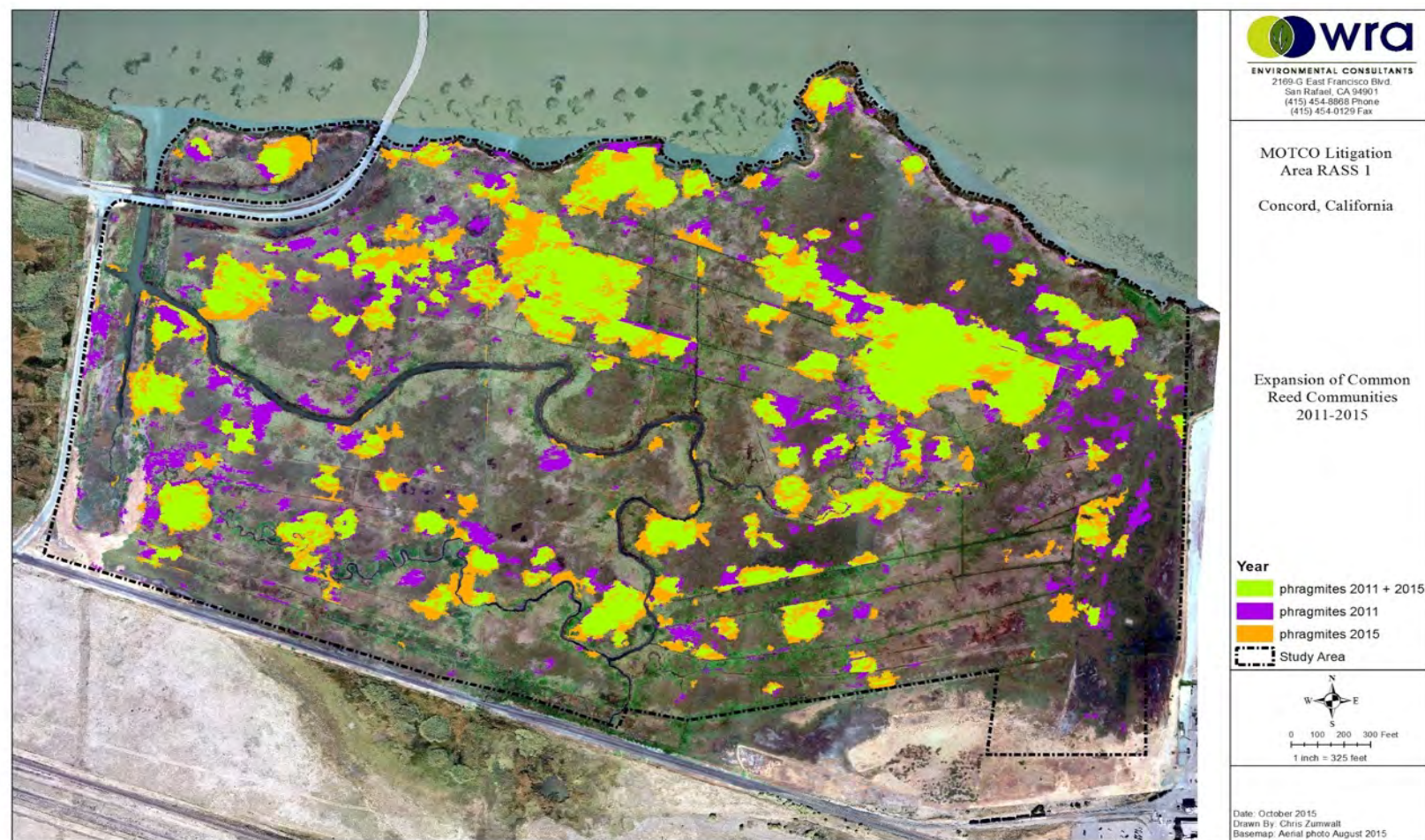
Conclusion

★ *Remote Sensing AND Ground-level Surveys*

★ **Climate, Hydrology, Salinity**

★ **Adaptive Protocols and Methods**

THANK YOU

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