

Vernal Pool Science and Conservation: Inventorying and Mapping Vernal Pools in Michigan



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Acknowledgements

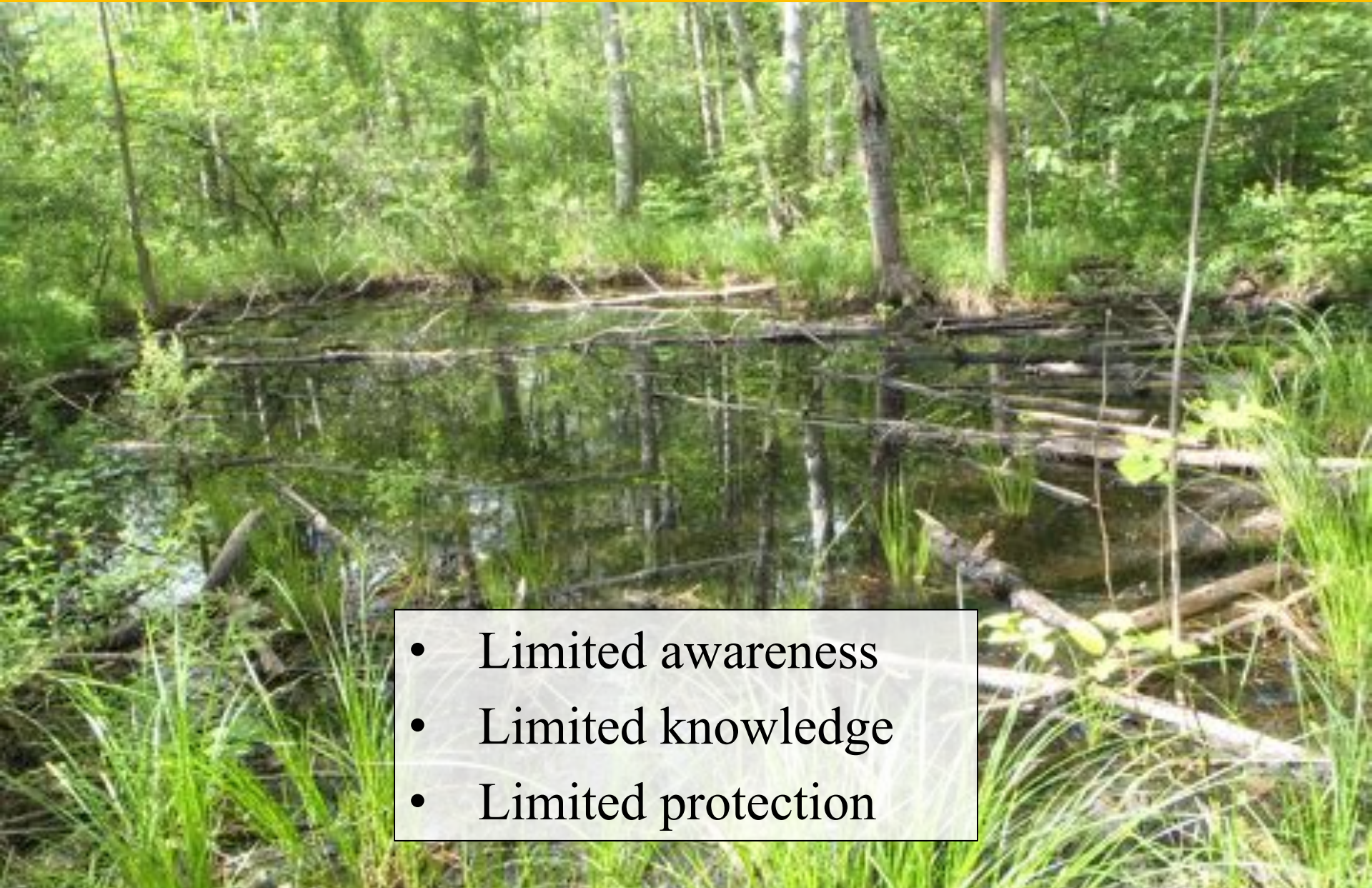
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- **Michigan Tech Research Institute** (MTRI) – Laura Bourgeau-Chavez, Kirk Scarborough, Michael Battaglia, Sarah Endres, and Zach Laubach.
- **Additional Partners** –MI Sea Grant, The Nature Conservancy, Huron Pines, Montmorency Co. Conservation Club, U.S. Fish and Wildlife Service, Grand Traverse Regional Land Conservancy, Little Traverse Conservancy, Kalamazoo Nature Center, Oakland County Parks, Oakland Township Parks, Pierce Cedar Creek Institute, Ann Arbor Natural Area Preservation, Herpetological Resource & Management, UM-Flint, ECT, and others AND numerous volunteers, teachers, and students!



Knowledge and understanding of wetlands is critical for successful protection, management, and restoration of these important ecosystems!



*Naturally occurring, seasonal wetlands in shallow depressions
in forested landscapes that lack fish*



- Limited awareness
- Limited knowledge
- Limited protection

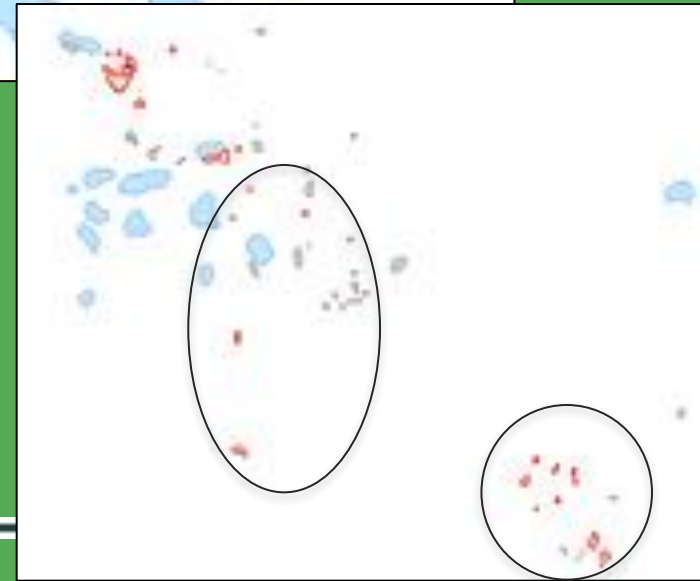
Limited Awareness

- Wetlands as “wastelands,” mosquito habitat
- “Puddles” in the woods
- Small, isolated, and temporary
- Often not recognized as a separate or distinct natural community / ecosystem



Limited Knowledge

- Hard to identify remotely and in the field
- Gap in National Wetland Inventory
 - < 0.4 ha/ ~ 1 ac (Tiner 2003)
 - Canopy cover, timing of photos
- Limited surveys and research on VPs in MI



Limited Protection

- Vulnerable to loss and degradation
- Limited protection at federal and state level b/c small and geographically isolated
 - Section 404 of CWA - navigable waters, tributaries, and adjacent wetlands
 - MI – connected to Great Lakes, lakes, rivers, streams, greater than 5 ac, or essential to natural resources preservation
- Voluntary protection



Vernal Pool Conservation

- Growing interest in and awareness of vernal pool significance
 - Critical habitat for wildlife
 - Multiple ecosystem services
 - Social/educational value
- Vernal pool mapping and monitoring – 15+ states
- Legal protection - 11 states
 - Significant wildlife habitat



Vernal Pools in Michigan

- MDEQ, MDNR, and others are interested in protecting and managing vernal pools in MI.
- Michigan's Wildlife Action Plan has identified ephemeral wetlands as critical habitat.
- Forest Certification Standards (FSC, SFI) and Michigan's Soil & Water Quality Guidelines protect vernal pools.
- BUT WE NEED INFORMATION ABOUT VERNAL POOLS!!!



Vernal Pool Mapping & Monitoring in MI

- 2011 - 2014
- Funded by MDEQ through U.S. EPA Wetland Program Development Grant
- Develop an effective & efficient approach for identifying, mapping, assessing and monitoring vernal pools
- Baseline data and foundation for statewide vernal pool mapping and monitoring



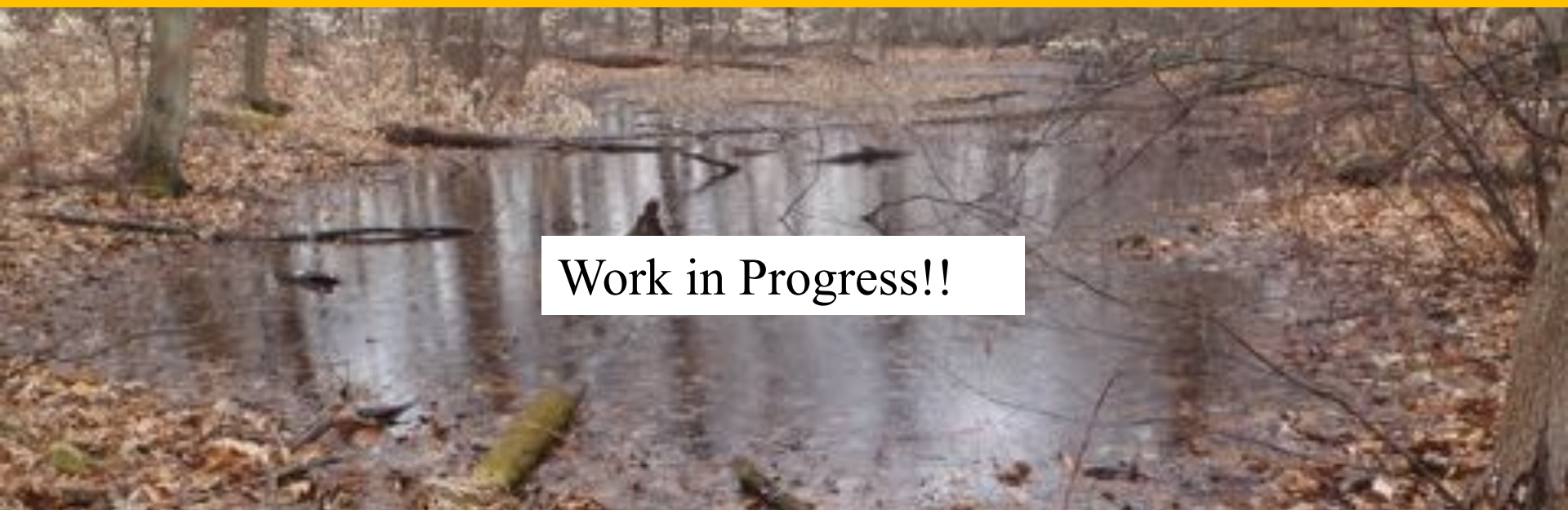
Project Components

- Evaluated different methods for identifying and mapping vernal pools (VPs) / potential vernal pools (PVPs)
- Developed a standard definition of a vernal pool
- Developed a statewide vernal pool database
- Other project components



Standard Definition of a Vernal Pool – Required Attributes

- Origin Naturally occurring
- Size Small (typically < 1 ha/ 2.5 ac) (no size limit)
- Hydrology Seasonally flooded; typically fill in spring & dry in summer; hold water for ≥ 2 months most years; incl. semi-permanent
- Geomorphology Confined basin; no permanent inlet/outlet or surface connection to permanent waterbodies; may be part of/connected to other isolated wetlands
- Substrate Hydric soil
- Biological Fishless / no permanent fish population; may have indicator species



Work in Progress!!

Open Pool



Shrubby Pool



Forested Pool



Marshy Pool



Detecting and Mapping VPs

- Evaluated different methods for detecting and mapping VPs
 - Air photo interpretation
 - Radar / Lidar
 - GIS modeling
 - Field sampling
- Assessed accuracy / error rates
 - 3 study areas (SE LP, NE LP, W. UP), public lands

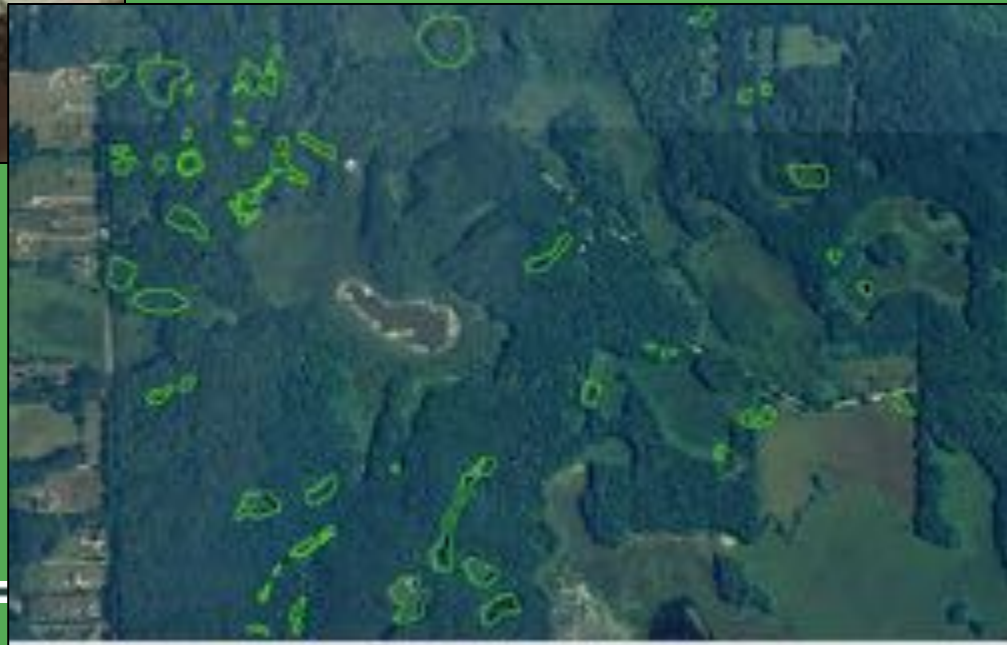


Mapping PVPs using Aerial Photographs



- Color Infrared, Spring Leaf-Off
 - 1:12:000
 - NAPP 1998 / USGS Digital Orthophoto Quadrangles (DOQ)
 - March – May, 1997-2000
 - 1-m resolution

- Natural Color, Summer Leaf-On
 - 1:12:000
 - NAIP 2005
 - June - September
 - 1-m resolution



Results 2012-2013 – Air Photo

	# Surveyed test cells - with VPs in the field	# Surveyed test cells – with no VPs / not VPs in the field
# Surveyed test cells with PVPs SLP – 40 NLP – 40 UP - 30	<u>Accuracy / True Positives</u> SLP – 29/40 (73%) NLP – 34/40 (85%) UP – 18/30 (60%)	<u>Commission Error/ False Positives</u> SLP – 11/40 (27%) NLP – 6/40 (15%) UP – 12/30 (40%)
# Surveyed test cells w/o PVPs SLP – 85 NLP – 128 UP - 79	<u>Omission Error/ False Negatives</u> SLP – 10/85 (12%) NLP – 4/128 (3%) UP – 20/79 (25%)	<u>Accuracy / True Negatives</u> SLP – 75/85 (88%) NLP – 124/128 (97%) UP – 59/79 (75%)

*Lathrop et al. 2005 – NJ – 88% accuracy rate, 12% commission, 30% omission

Vernal Pool Mapping & Monitoring in MI

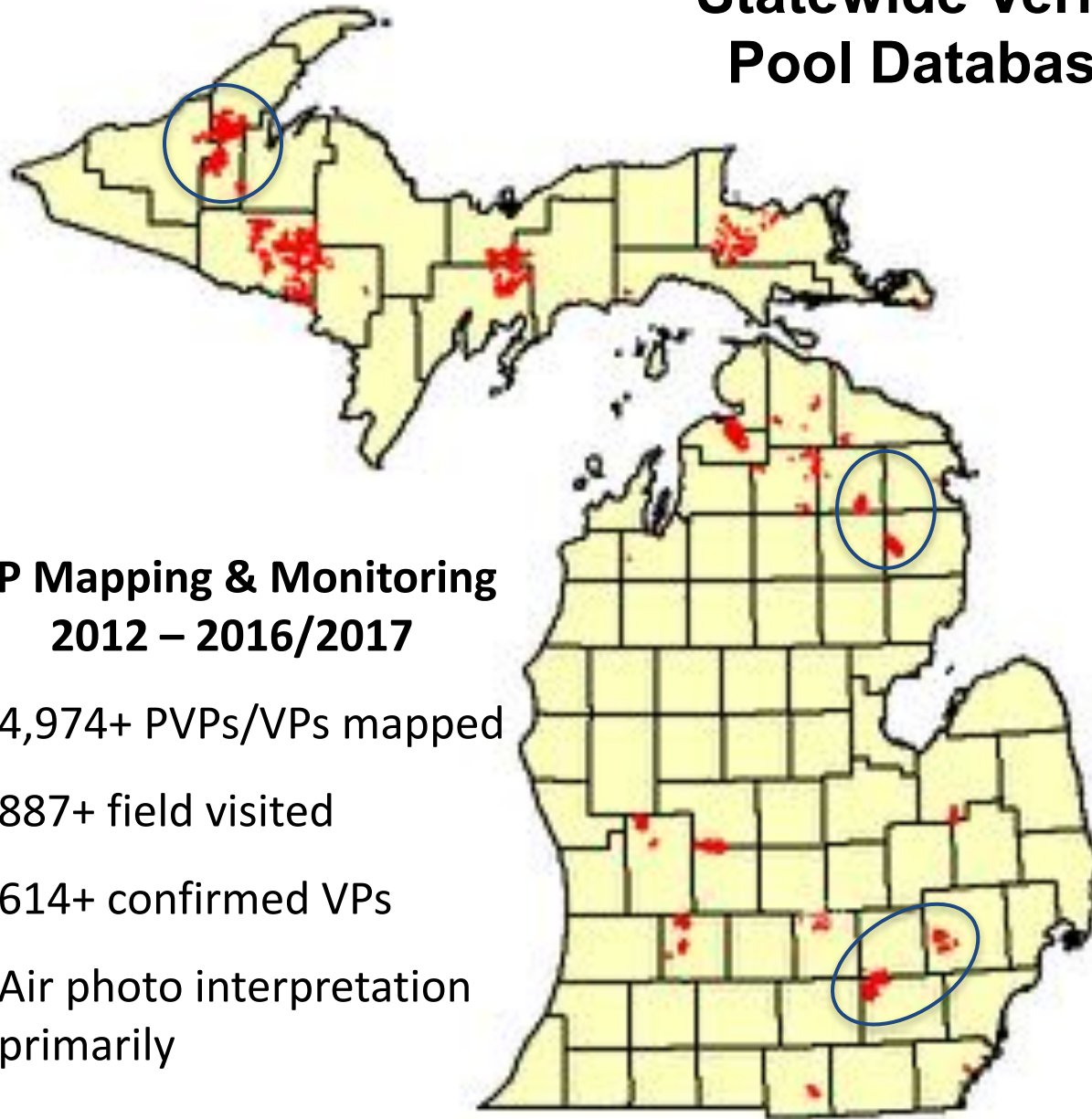
- 2014 – 2017
 - MNFI – State forest lands, state game areas, Hiawatha National Forest
 - Partners – MTU - Pictured Rocks, PCCI, GTRLC, Oakland County Parks, etc.
 - Vernal Pool Patrol - Citizen Science Program



Statewide Vernal Pool Database

VP Mapping & Monitoring 2012 – 2016/2017

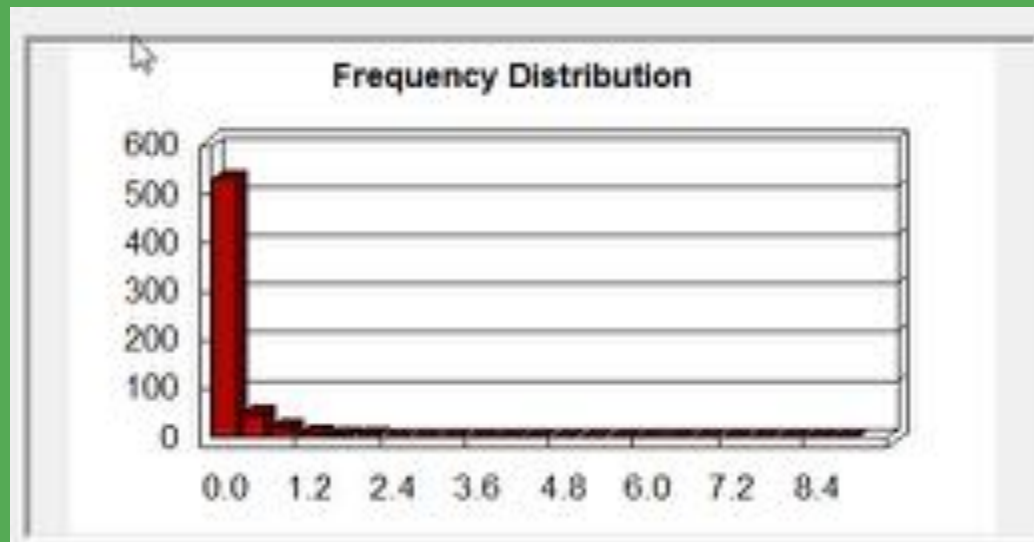
- 4,974+ PVPs/VPs mapped
- 887+ field visited
- 614+ confirmed VPs
- Air photo interpretation primarily



Additional VP Information

Based on 641 confirmed VPs

- Overall accuracy rate - ~70%
- Varied by project area – 65% - 100%
- Average area – ~0.23 ac (<0.001 – 9 ac)
- Total area – ~141 ac

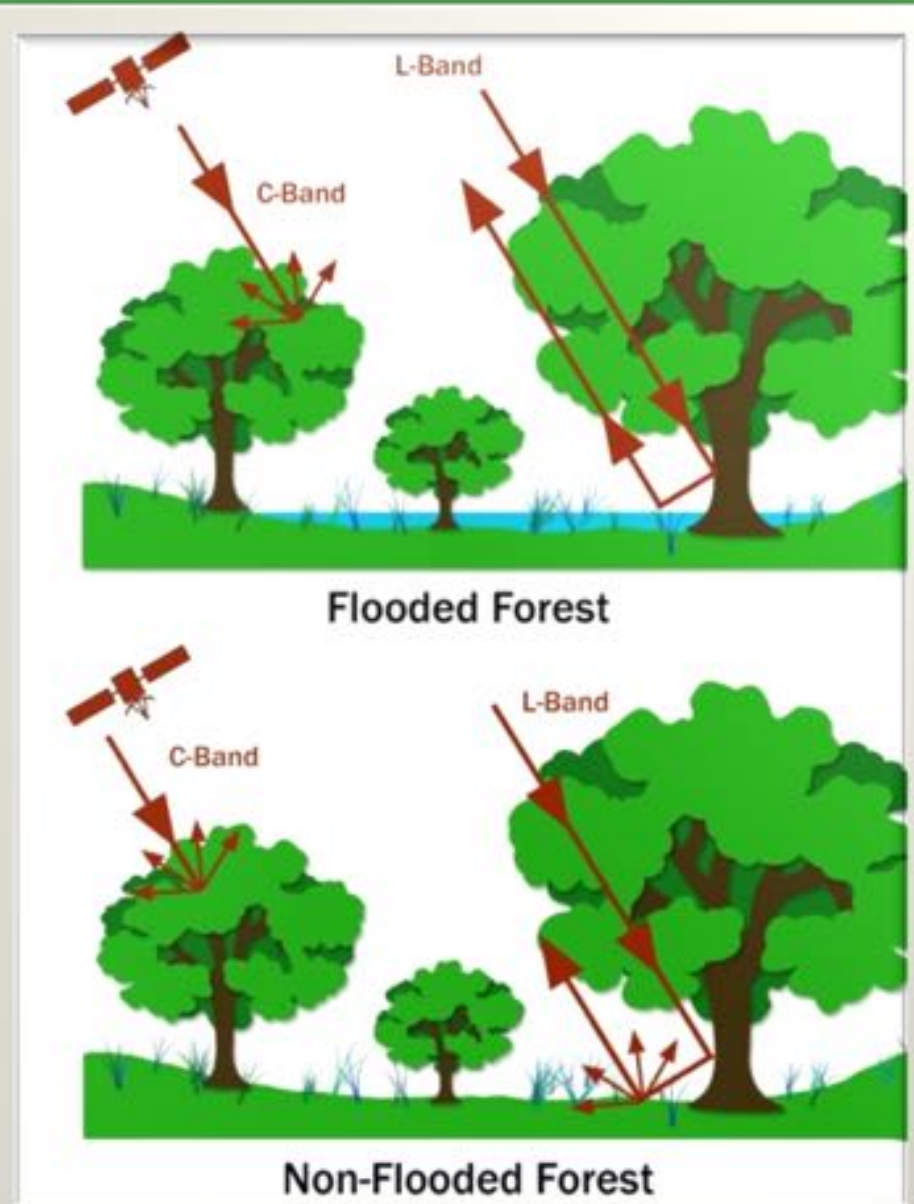


Pilot Radar Study - MTRI

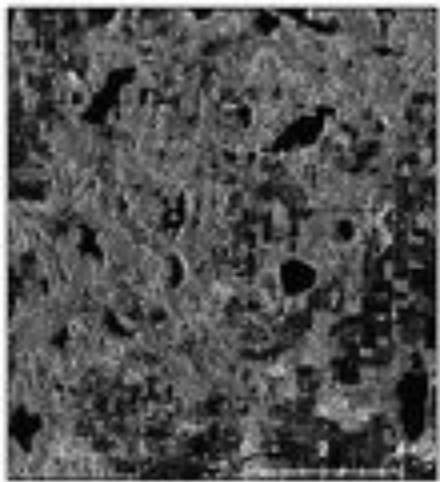
- Develop methods to detect vernal pools without a priori information using satellite radar imagery (PALSAR)
- Develop methods integrating PALSAR with other data sources
 - Evaluated use of SAR, LiDAR (light detection and ranging using laser) and 10 m DEM (digital elevation model) to identify vernal pools
- Compare mapping results against field data



- Japanese ALOS PALSAR Satellite –
 - L-band 24 cm wavelength
 - Penetrates a forest canopy
 - 10 m resolution FPS product
- Two season ALOS PALSAR data used – spring, summer (spring – summer)
- Assume that spring image will exhibit “bright” spots where vernal pools are located due to characteristic RADAR “double bounce” while that effect will be diminished in summer.



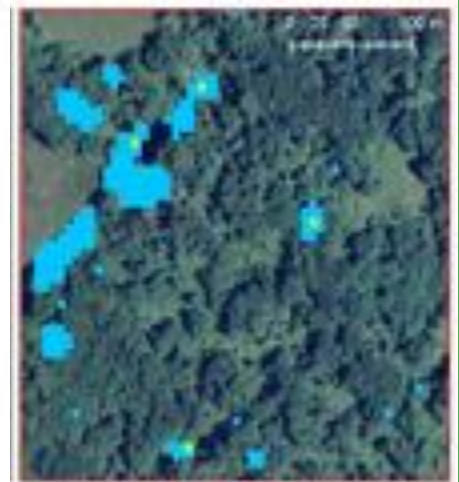
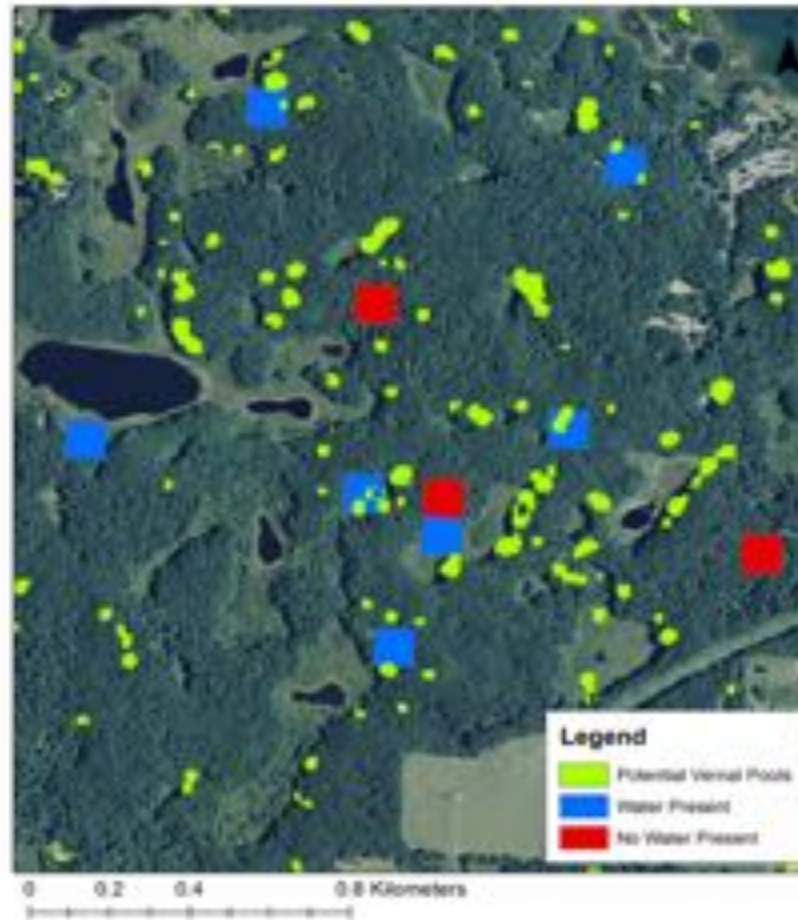
PALSAR – Unsupervised (no a priori)



Summer SAR image

Example of the Summer Image.

- Negative values (e.g., water)
- No change (e.g., forest)
- Positive values (e.g., bare ground)
- Confirmed vernal pools



Verified Vernal Pools Backscatter decrease

Seasonal Change

ker gray.

PALSAR - Unsupervised

Random Stratified Field Sampling		Unsupervised PALSAR PVP Map - SLP				
		PVP	NVP	Sum	Omission Error	Producer Accuracy
	PVP	32	5	37	14%	86%
	NVP	33	30	63	53%	47%
	Sum	65	35	100		
	Commission Error	False positives 51%	False negatives 14%		Overall Accuracy 62%	
	User Accuracy	True positives 49%	True negatives 86%			

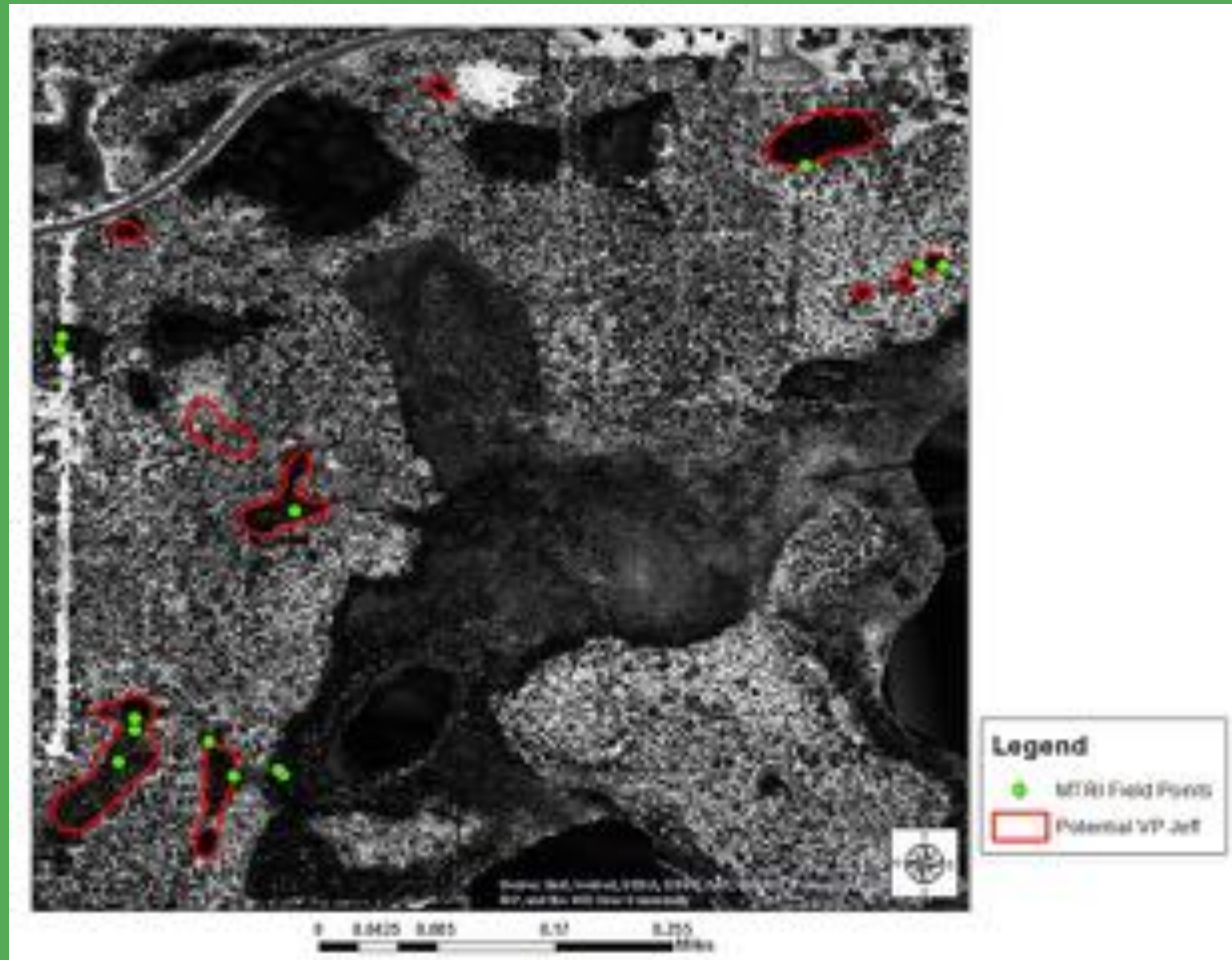
Random Stratified Field Sampling		Unsupervised PALSAR PVP Map - NLP				
		PVP	NVP	Sum	Omission Error	Producer Accuracy
	PVP	22	16	38	42%	58%
	NVP	72	58	130	55%	45%
	Sum	94	74	168		
	Commission Error	False positives 77%	False negatives 22%		Overall Accuracy 48%	
	User Accuracy	True positives 23%	True negatives 78%			

Both SLP & NLP Combined:

- Accuracy for true positives – 34%
- Accuracy for true negatives – 81%
- **Commission – 66%**
- Omission – 19%

From: Bourgeau-Chavez et al. 2016

LiDAR Intensity

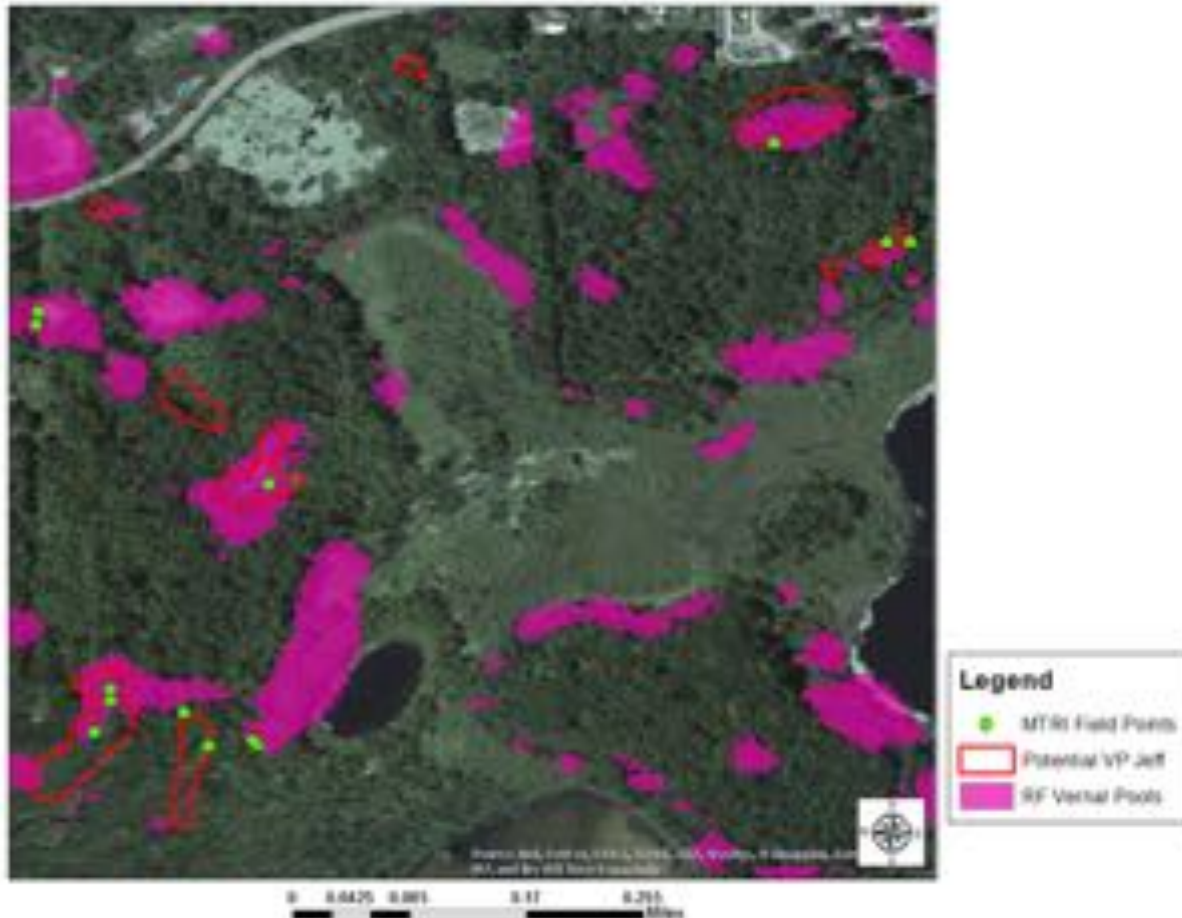


- Spring 2009
- Intensity is a measure of return strength of the laser pulse that generated the point
- High absorption by water – dark areas

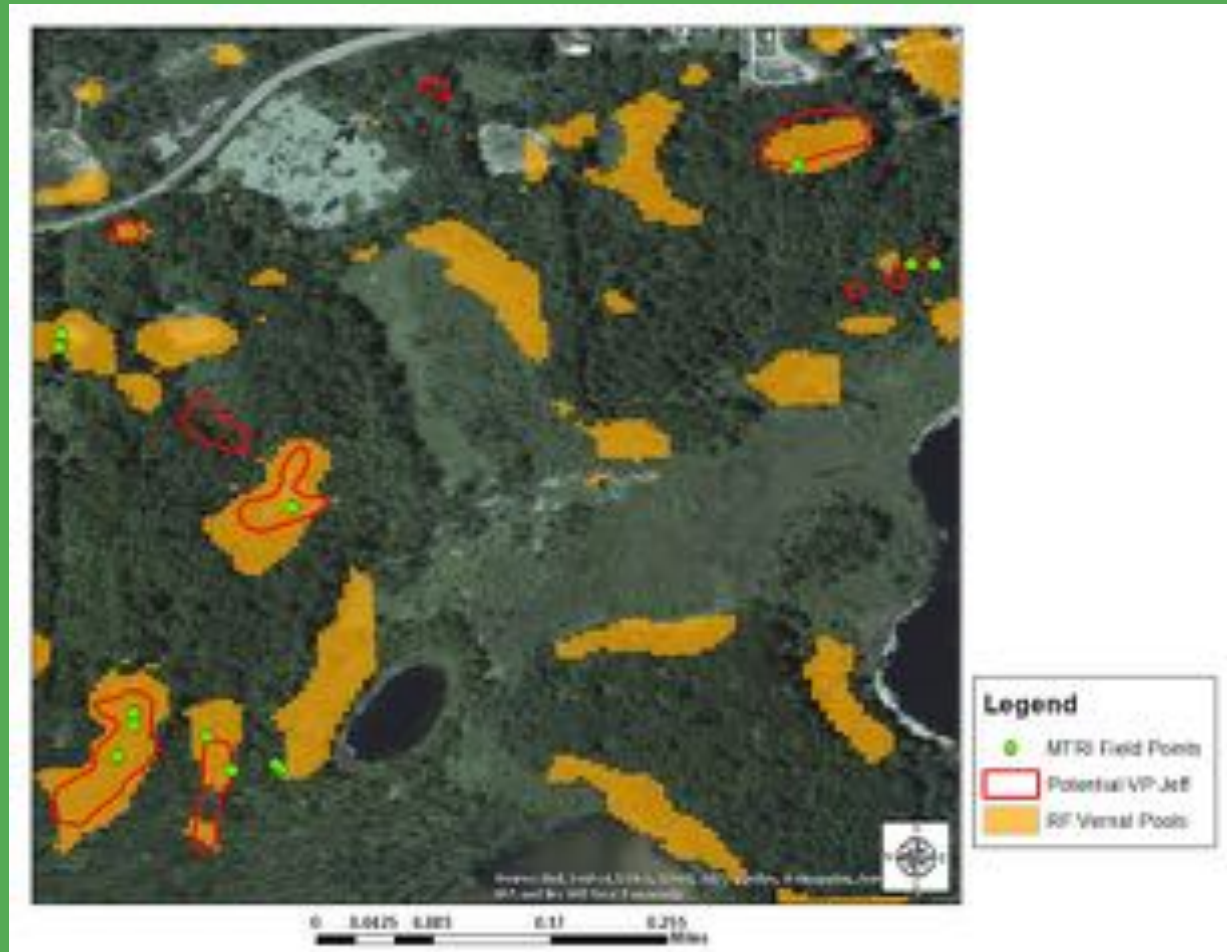
Random Forest – LiDAR and DEM

SLP

- Producers
Accuracy=39%
(OE=61%)
- Users Accuracy=86%
(CE=14%)
- Total Accuracy=67%



Random Forest – PALSAR and 10 m DEM



- SLP
- Producers
Accuracy=91%
- Users Accuracy=94%
- Total Accuracy=93%

- **PALSAR spring and summer imagery** provides a method for finding potential vernal pools across a 70 x 70 km region for further investigation with Air Photos or field data sampling
 - Advantage – freely available, independent of cloud cover or canopy cover;
 - Disadvantage – Not available statewide (yet)
- **LiDAR alone** provides indications of where vernal pools are with leaf-off imagery
 - Advantage – high resolution provides boundaries of vernal ponds
 - Disadvantage – high omission and commission errors in Random Forests, high cost and not widely available
- **PALSAR with 10 m DEM (or LiDAR)**
 - Provides improved mapping capability when coupled with field verified vernal pool sample data
 - 10 m DEM available statewide – most cost-effective
- **Need to explore different classification methods**
 - Random Forests, MCDA, etc.

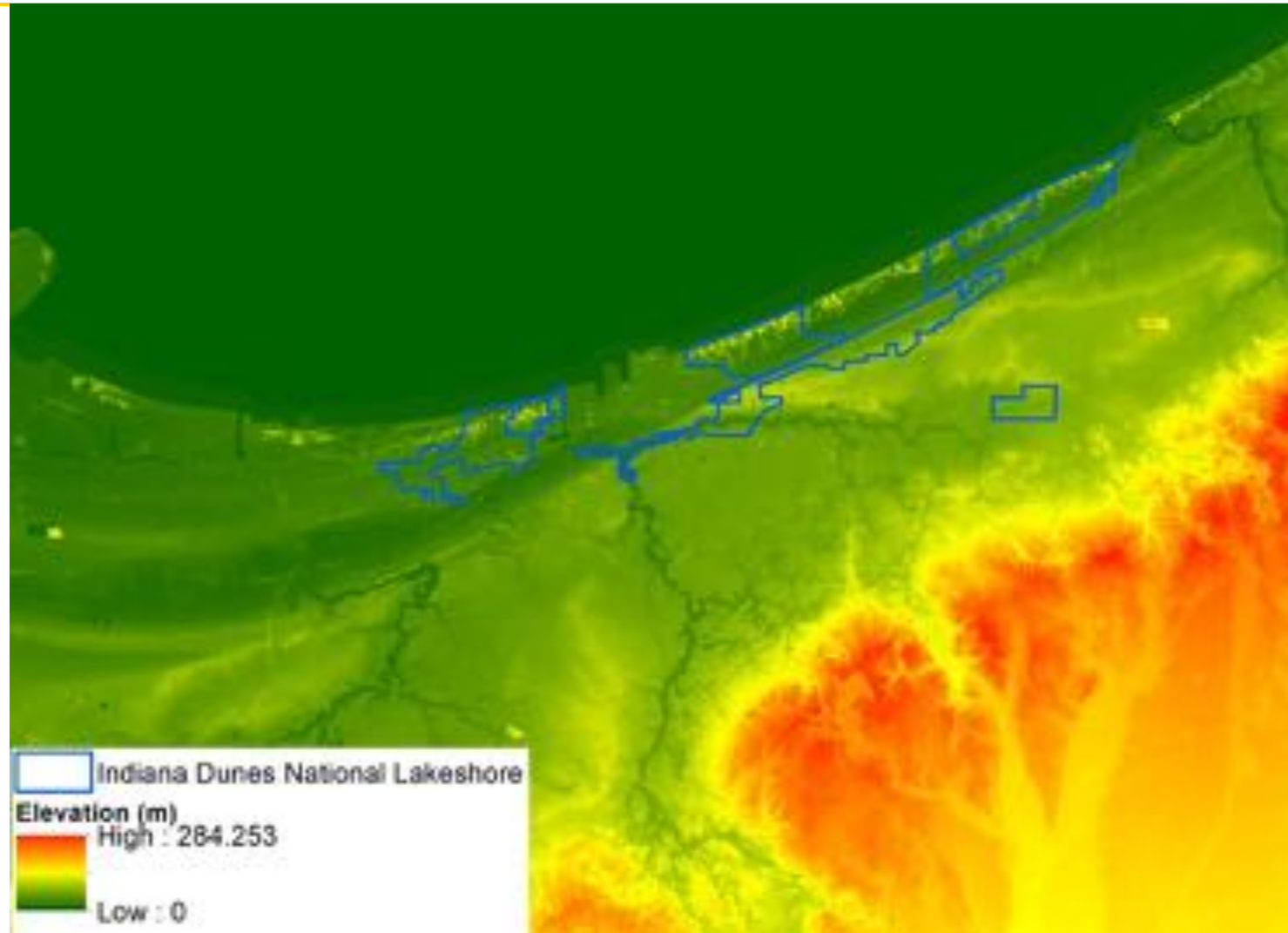


Indiana Dunes National Lakeshore



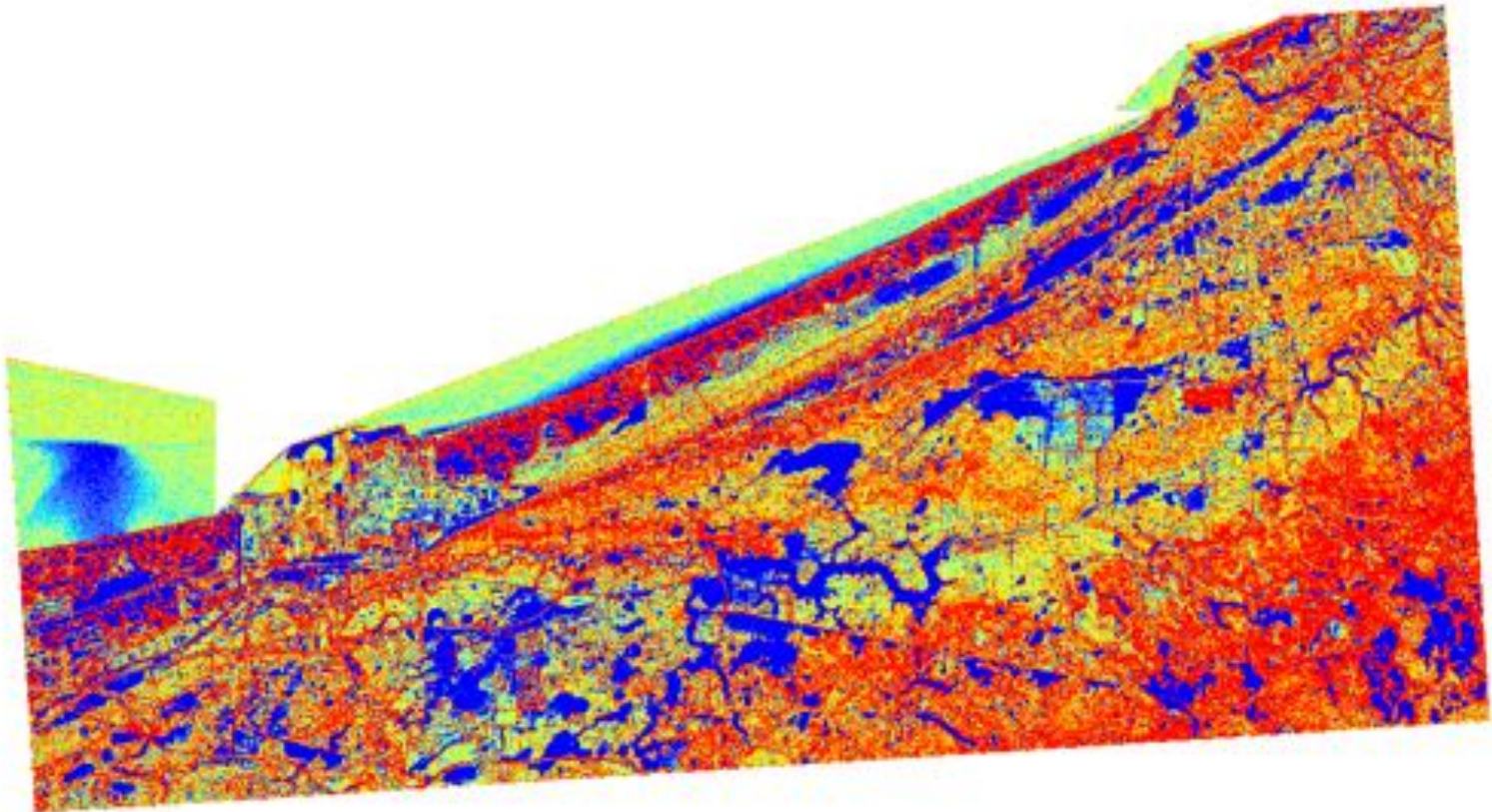
Vernal Pool Detection using LiDAR derived digital elevation model (DEM) and ALOS-2 PALSAR tested at Indiana Dunes National Lakeshore in 2016

LiDAR Derived DEM



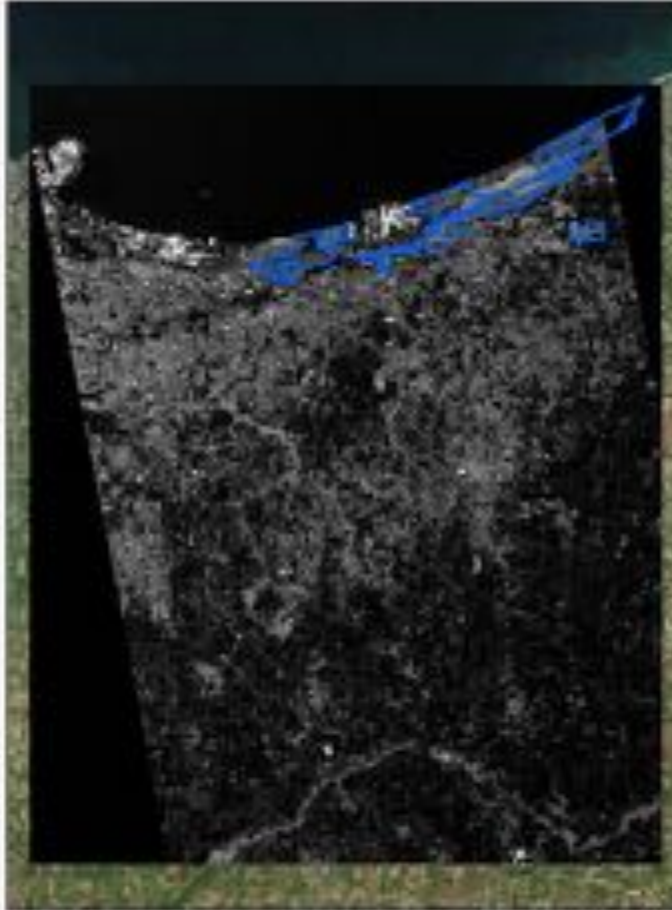
DEM has 1.5 m resolution, and ~30 cm vertical accuracy

Stochastic Depression Analysis

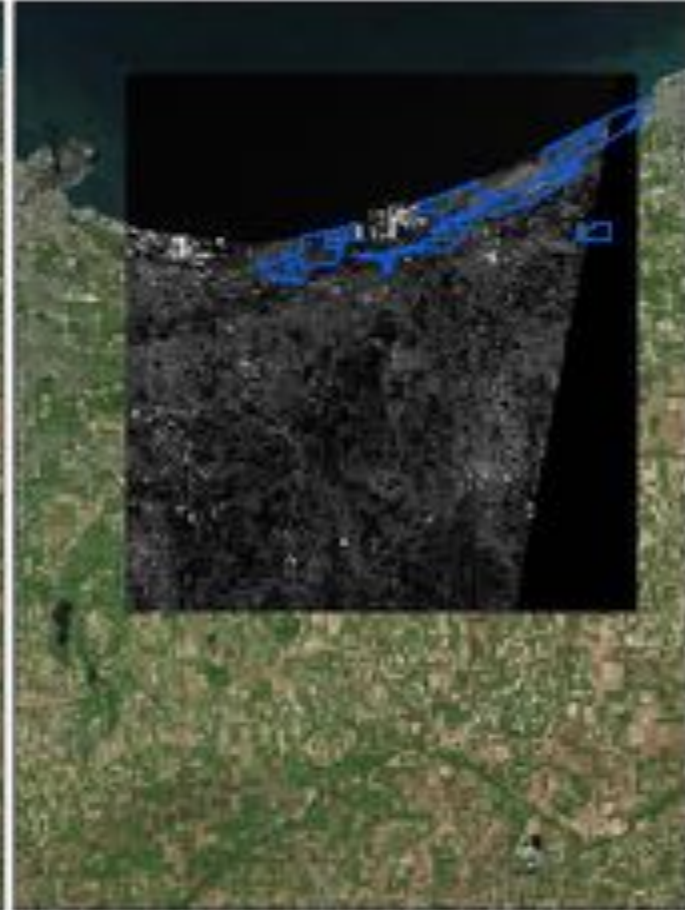


Stochastic Depression Analysis used to determine isolated depressions. Iterative process uses LiDAR error to determine if DEM depressions are “real” or results of LiDAR vertical uncertainty. Blue areas above are likely to be “real” depressions. This method for detecting potential vernal pools outlined in Wu et al. 2014.

ALOS-2 PALSAR



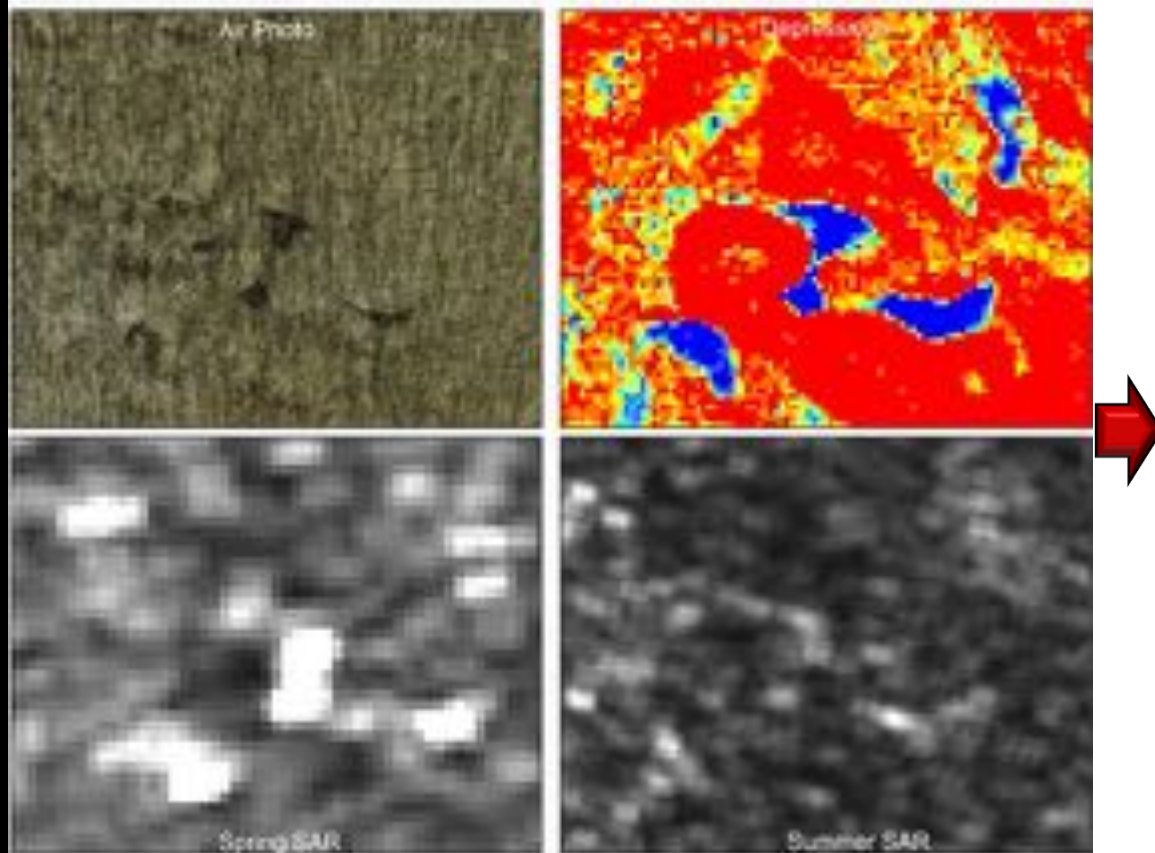
4 April 2015
5.5 m resolution



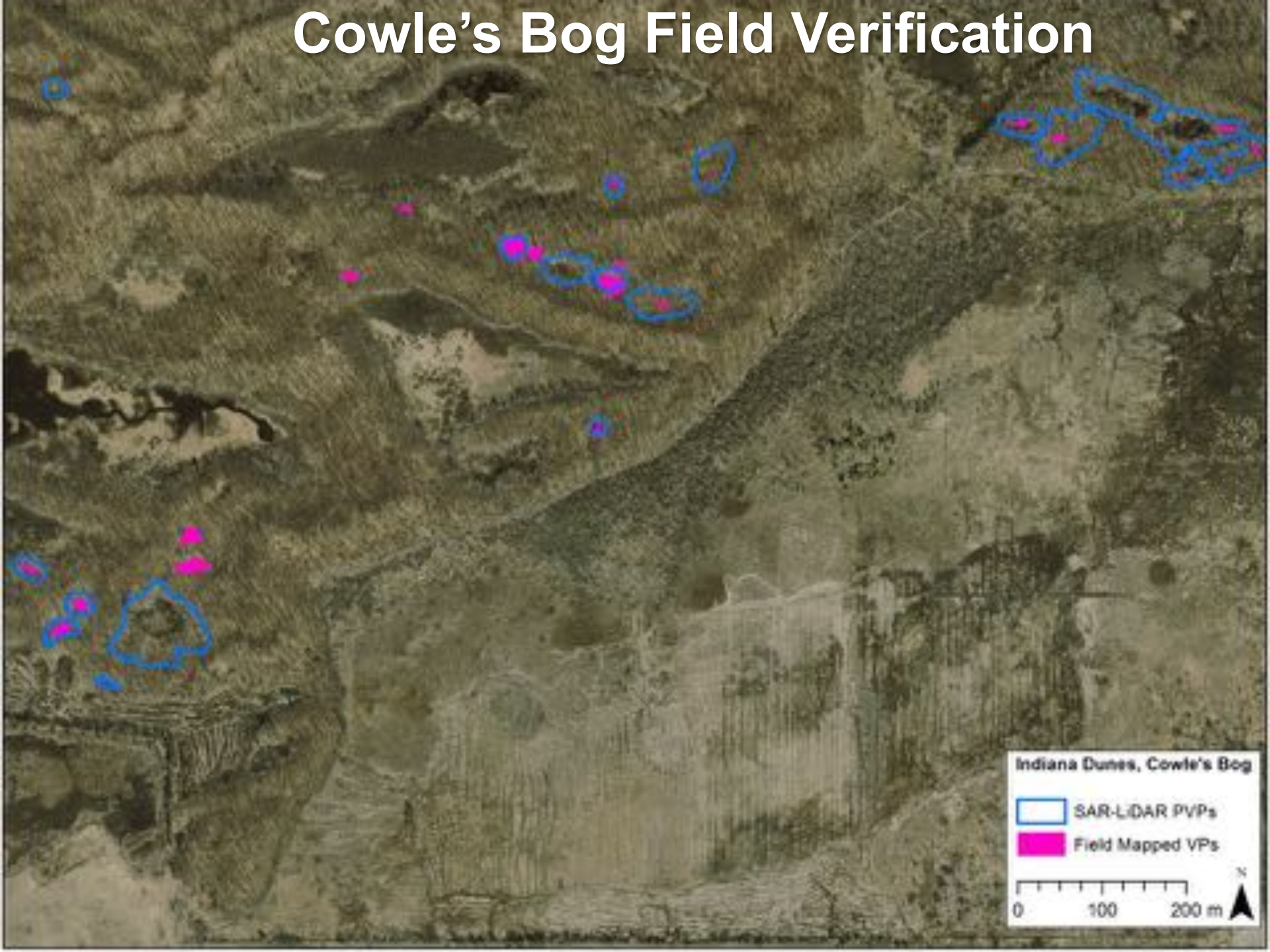
16 July 2016
2.7 m resolution

ALOS-2 PALSAR images were acquired to determine spring inundation and summer drying. L-band SAR (~24 cm wavelength) is able to penetrate forest canopy.

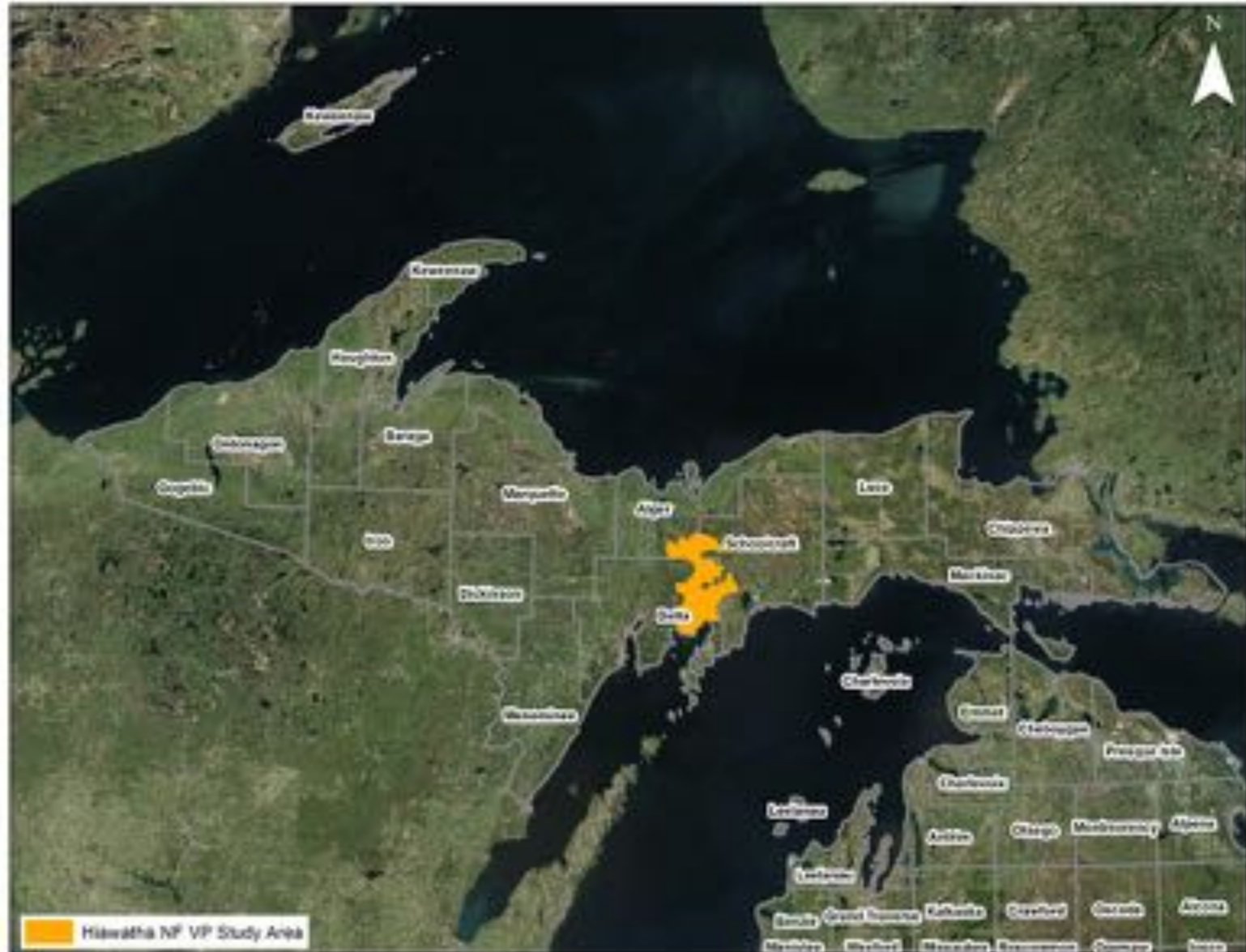
Example Area



Cowle's Bog Field Verification



Hiawatha National Forest Study Area

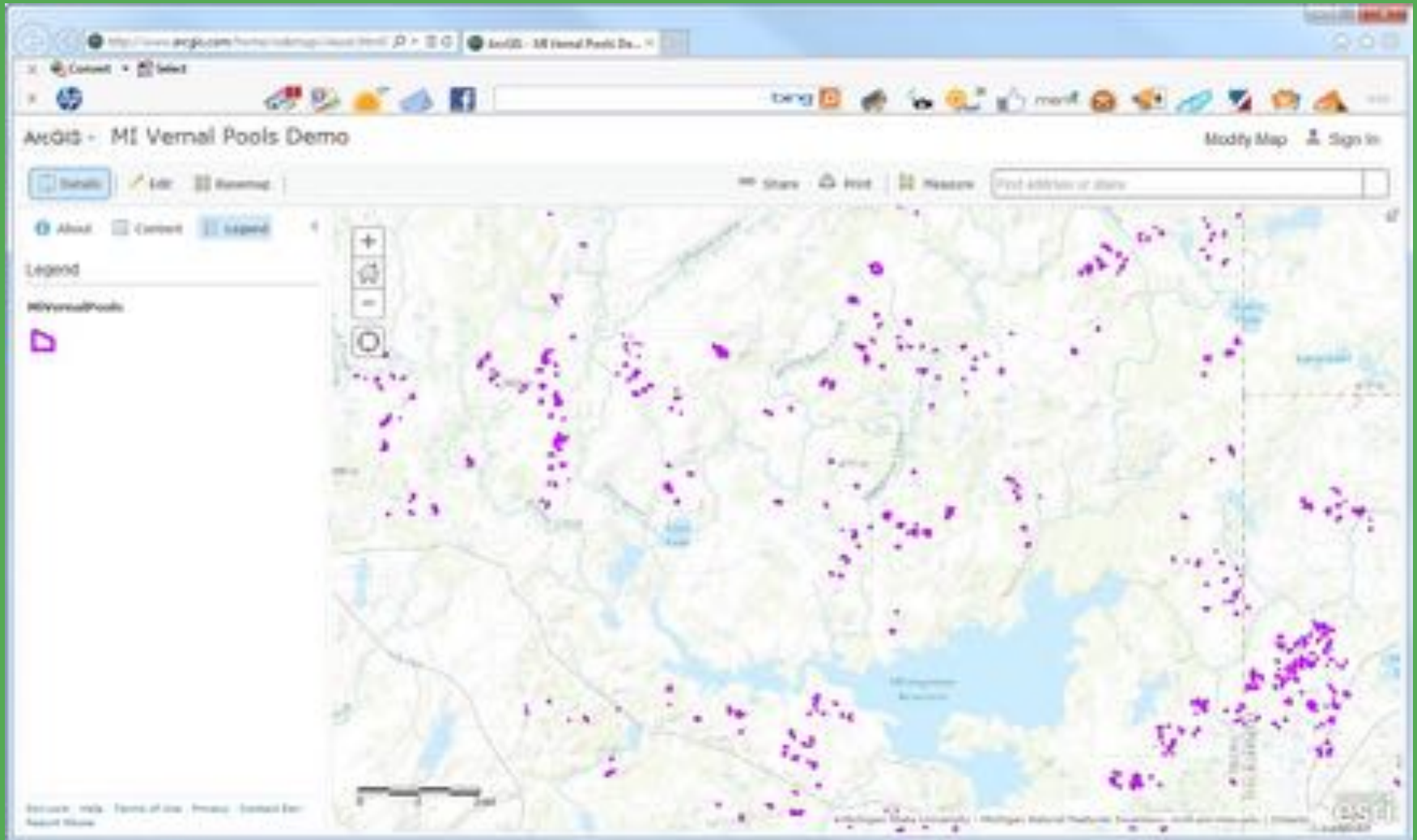


Summary & Next Steps

- Vernal pools are important wetland ecosystems that warrant additional protection.
- Continue and expand vernal pool mapping & monitoring
 - Goal – Map PVPs statewide, determine best approach & tools
- Continue & expand Vernal Pool Patrol and education & outreach efforts statewide
- Develop criteria and guidance/tools for VP protection
- Identify and collaborate with additional partners



Statewide Vernal Pool Database



Are we moving the needle?



- Increased awareness
- Increased collaboration
- Increased data
- Increased protection



We Need YOUR Help!

- Learn about vernal pools and help promote conservation of these unique and diverse wetlands.
- Become a local partner and help launch a vernal pool mapping and monitoring program in your community!
- Help map and monitor vernal pools in the state by becoming a trained volunteer! (Spring 2018)
- Provide information on vernal pools to MNFI for statewide database.
- Join the Michigan Vernal Pools Partnership – contact MNA/Garret Johnson, MDEQ/Amy Lounds, or MNFI/Yu Man Lee



Thank You! Questions?

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