

TERRAIN³⁶⁰

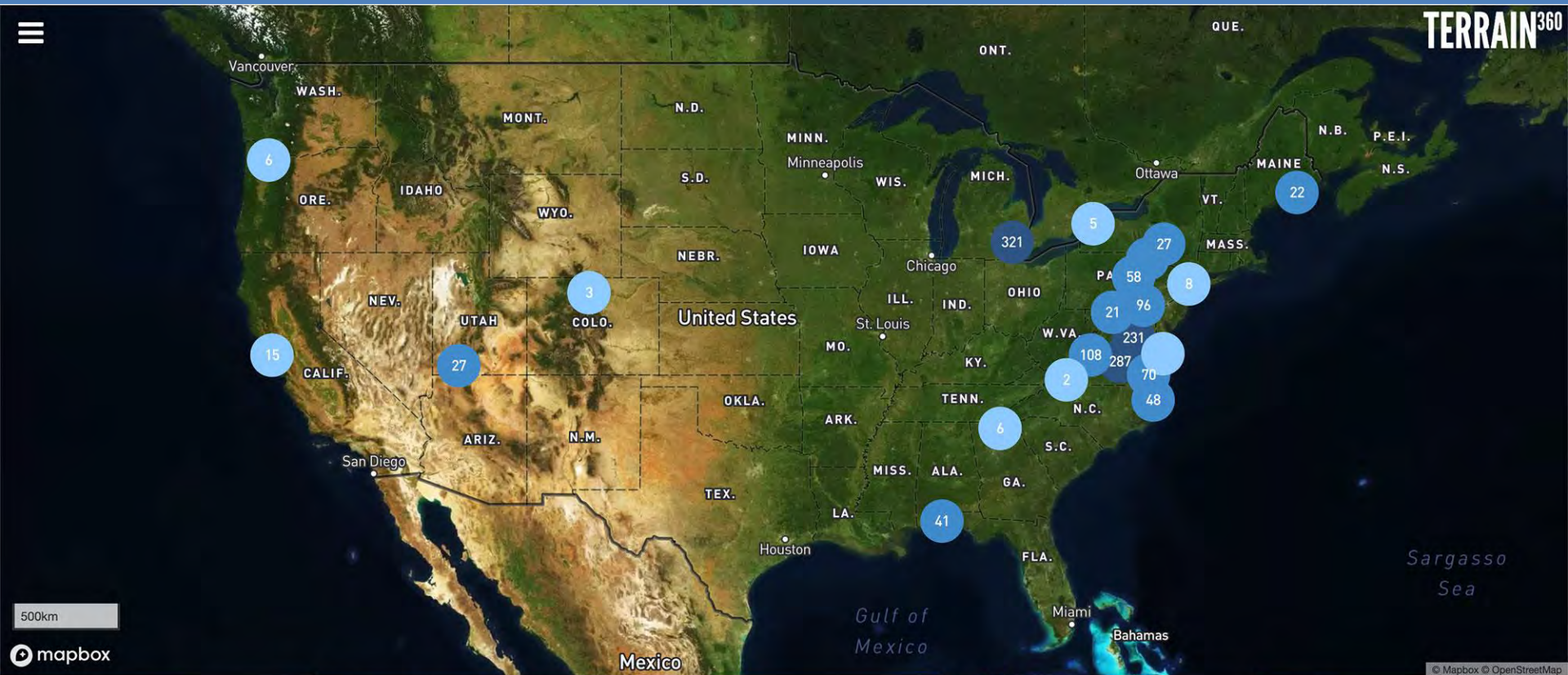
Brief Overview of Terrain360



- GIS/Spatially Referenced 360° Image & Data Mapping Platform (think a higher quality version of ‘google streetview’)

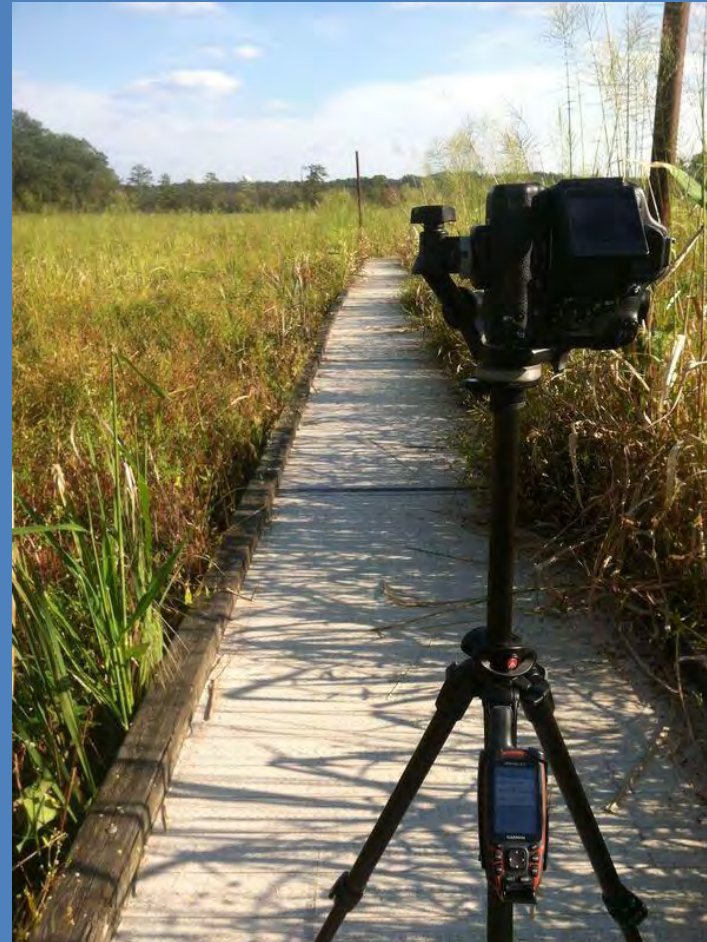


- To date mapped 8000+ miles of waterways & 3500+ miles of trails



TERRAIN³⁶⁰

- Mapping “Vehicles”
 - Simple camera & gps on tripod (long haul backpacking) – very manual
 - Weeks of on-board power
 - Simple Garmin GPS



Appalachian National Scenic Trail



AT Rt. 7 to Harpers Ferry

Appalachian National Scenic Trail

Shenandoah National Park

Potomac River 0.043 mi ↑



B&O — Harpers Ferry Bollman Bridge

300ft

mapbox

Elev: 314' | 39.32354, -77.72874

Distance Traveled: 99% 18.88 / 19.01mi

Conditions: 71° Wind: 3mph Rain



Object & Label Detection

Get Directions

About

TERRAIN³⁶⁰

TERRAIN³⁶⁰

- Mapping “Vehicles”
 - Fat-Tire Mapping Trike– Fully automated capture process
 - Lithium ion Powered (72+ hours of power)
 - On board PC (atom processor)
 - Lighting Sensor
 - IMU/GPS/Wx Sensors
 - Touch Screen
 - 5 Canon t5i cameras

Paint Creek Trail, Oakland MI



Wadhams to Avoca Trail, MI

TERRAIN³⁶⁰

- Mapping “Vehicles”

- Custom 16' Catacraft Boat– Fully automated capture process

- On board Generator
- On board PC i7 SSD
- Lighting Sensor
- IMU/GPS/WxSensors
- Touch Screen Controls
- 6 Canon t5i cameras
- Completely weatherproof



TERRAIN³⁶⁰

- Mapping “Vehicles”
 - Custom 13’ Catacraft Boat– Fully automated capture process



- On board Generator
- On board PC i7 SSD
- Lighting Sensor
- IMU/GPS/Wx Sensors
- Touch Screen Controls
- 5 Canon t5i cameras
- Completely weatherproof



TERRAIN³⁶⁰

- Mapping “Vehicles”
 - Backpack– Fully automated capture process



























- Lithium ion (72+ hours)
- On board PC i7 SSD
- Lighting Sensor
- IMU/GPS/Wx Sensors
- Touch Screen Controls + iPhone
- 5 Canon t5i cameras

Imagery

- 22 Million original Images
- 200+ Million geo tagged Image objects in AWS & Azure

GIS/Spatial + Image Data

- 23 TB to date of original image data
- 110 TB to date image objects (tiles)
- 100Gb Lidar (experimental)
- 10 Million Lat/Long points
- Fun Fact – 3 500GB SSD in field drives exceeded the read/write cycle of 800TB

Scene #	Thumb	Lat Long	Elevation
0		 39.623877  -78.384172	132.13
1		 39.624043  -78.384162	132.07
2		 39.624218  -78.384085	131.99
3		 39.624408  -78.383957	131.89
4		 39.624563  -78.383885	131.86
5		 39.62472  -78.383787	131.84
6		 39.624877  -78.383685	131.84
7		 39.625032  -78.383575	131.8

Utilizing Massive Ground Level Dataset

Automated Object & Label Detection

- Species detection
- Object detection
- label/sign detection

ways

Little

Gore Dr

Cloudy

cast

NTS

Sell Island

Analyzing Objects & Labels

Objects	Percentage
Building	82.5%
Hotel	82.5%
Pool	82.5%
Resort	82.5%
Swimming Pool	82.5%
Water	82.5%
Lagoon	78.3%
Lake	78.3%
Outdoors	78.3%
Beach	62.8%
Coast	62.8%
Nature	62.8%
Ocean	62.8%
Sea	62.8%
Housing	52.9%
House	52.8%
Villa	52.8%
Leisure Activities	52.0%
Marina	52.0%
Landscape	51.9%
Scenery	51.9%
Harbor	51.4%
Port	51.4%
Waterfront	51.4%
Backyard	50.9%

TERRAIN³⁶⁰

Training a Machine Learning Model to Detect Specific Objects in Imagery

Black River Canal
Blueways of St. Clair
Southeast Michigan Trails

Map Rotation

Objects

Phragmites	100.0%
Nature	100.0%
Outdoors	100.0%
Land	100.0%
Water	99.8%
Shoreline	96.8%
Ocean	93.7%
Sea	93.7%
Coast	85.1%
Plant	81.4%
Grass	81.4%
Bog	77.3%
Marsh	77.3%
Swamp	77.3%
Vegetation	56.6%

Elev: 585' | 43.01993, -82.44331
Distance Traveled: 42% 0.48 / 1.13mi
Conditions: 37° Wind: 10.4mph Partly sunny

SEMCOCG
SOUTHEAST MICHIGAN COUNCIL OF GOVERNMENTS

Object & Label Detection
Get Directions

TERRAIN³⁶⁰

Common Observed Problems:

- Trash/Pollution
 - Run-off
 - Styrofoam
 - Tires



Common Observed Problems:

- Trash/Pollution
 - Run-off
 - Styrofoam
 - Tires
- Invasive Species
 - Phragmites
 - Kudzu
 - Algae Blooms



Common Observed Problems:

- Trash/Pollution
 - Run-off
 - Styrofoam
 - Tires
- Invasive Species
 - Phragmites
 - Kudzu
 - Algae Blooms
- Negative Impact Land Use
 - Livestock in Watershed
 - Paved Parking Lots
 - Construction Run-off
 - Vandalism

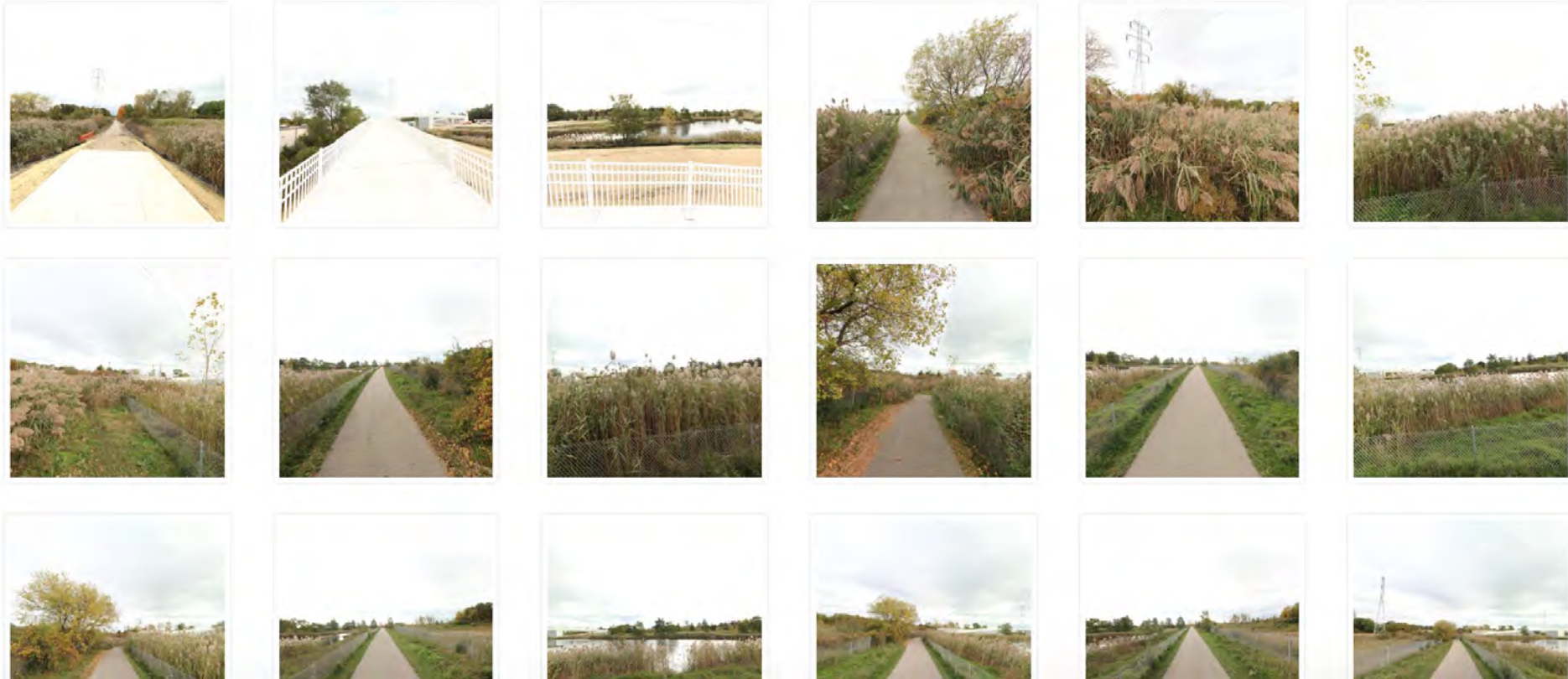


Detecting Phragmites

Invasive phragmites creates tall, dense stands which degrade wetlands and coastal areas by crowding out native plants and animals, blocking shoreline views, reducing access for swimming, fishing, and hunting and can create fire hazards from dry plant material.



1. Creating & Collecting a Robust Dataset



2. Define Objects within Dataset (Ground Truth)

Draw Bounding Box around observed Phragmites



Labels

Phragmites 1



Box



Delete



Undo



Redo



Zoom



Fit image

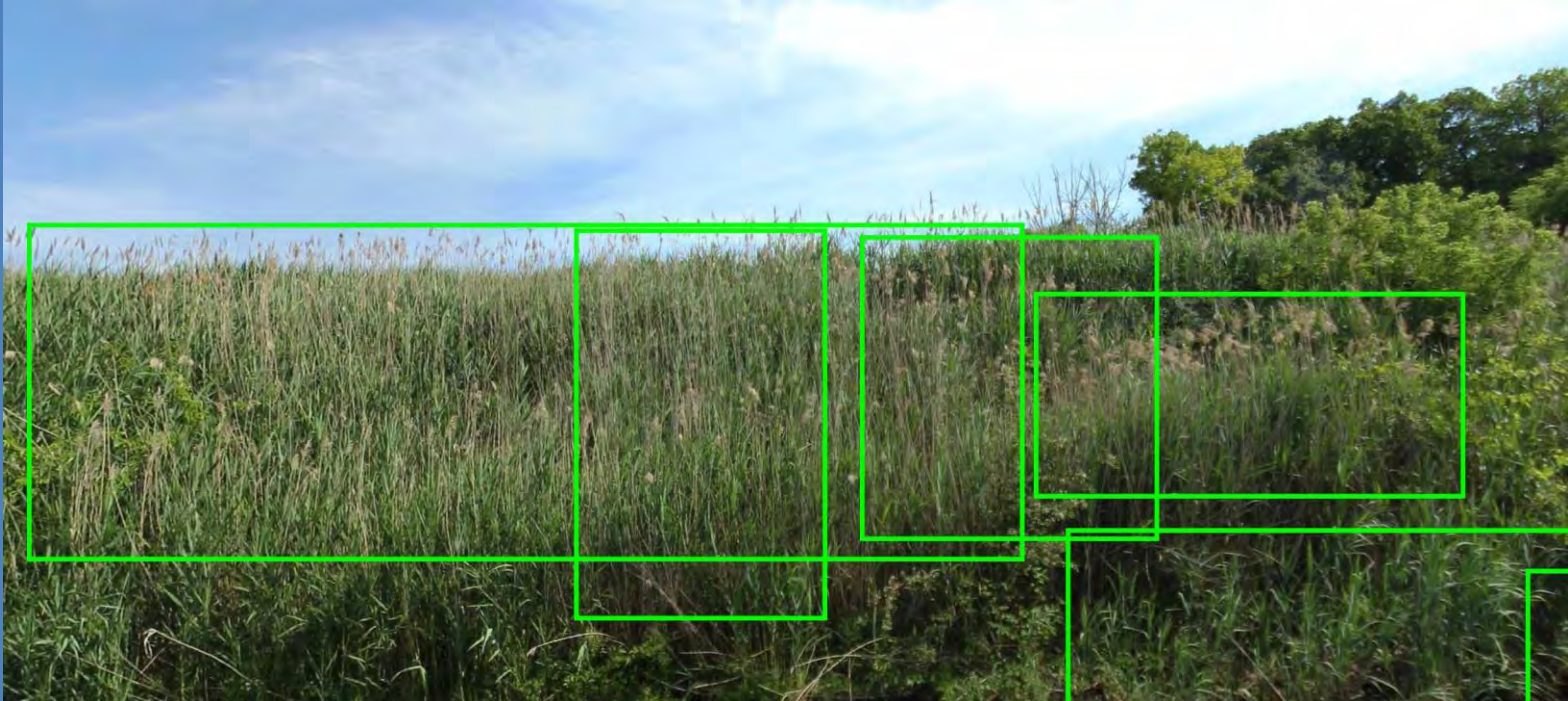


Move

Nothing to label

Submit

3. Train Machine Learning Algorithm (Tensor Flow)



Trained Machine Learning Model Dissemination

360° Viewer

Black River Canal
Blueways of St. Clair
Southeast Michigan Trails

Map Rotation

200ft
mapbox

Elev: 585' | 43.01993, -82.44331
Distance Traveled: 42% 0.48 / 1.13mi
Conditions: 37° Wind: 10.4mph Partly sunny

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SOUTHEAST MICHIGAN COUNCIL OF GOVERNMENTS

Objects

Phragmites	<div style="width: 100%; height: 10px; background-color: green;"></div>
Nature	100.0%
Outdoors	100.0%
Land	100.0%
Water	99.8%
Shoreline	96.8%
Ocean	93.7%
Sea	93.7%
Coast	85.1%
Plant	81.4%
Grass	81.4%
Bog	77.3%
Marsh	77.3%
Swamp	77.3%
Vegetation	56.6%

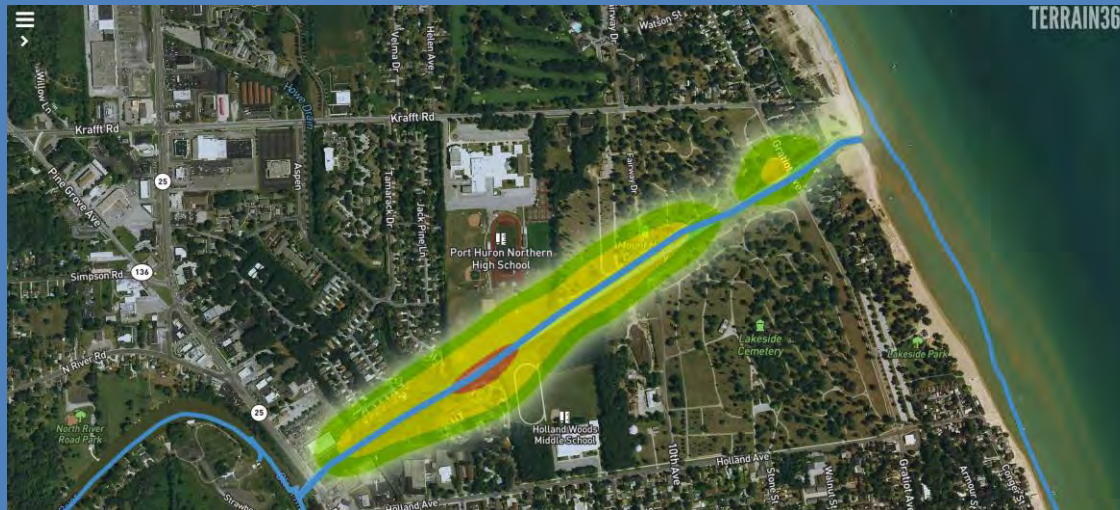
Object & Label Detection
Get Directions
TERRAIN360

Trained Machine Learning Model Dissemination

API to detect in (normal) imagery

```
Array
(
  [id1] => Array
  (
    [score] => 0.65530145168304
    [xmax] => 913
    [xmin] => 122
    [ymax] => 532
    [ymin] => 198
  )
)
```

Heat-map of Detected Object Density



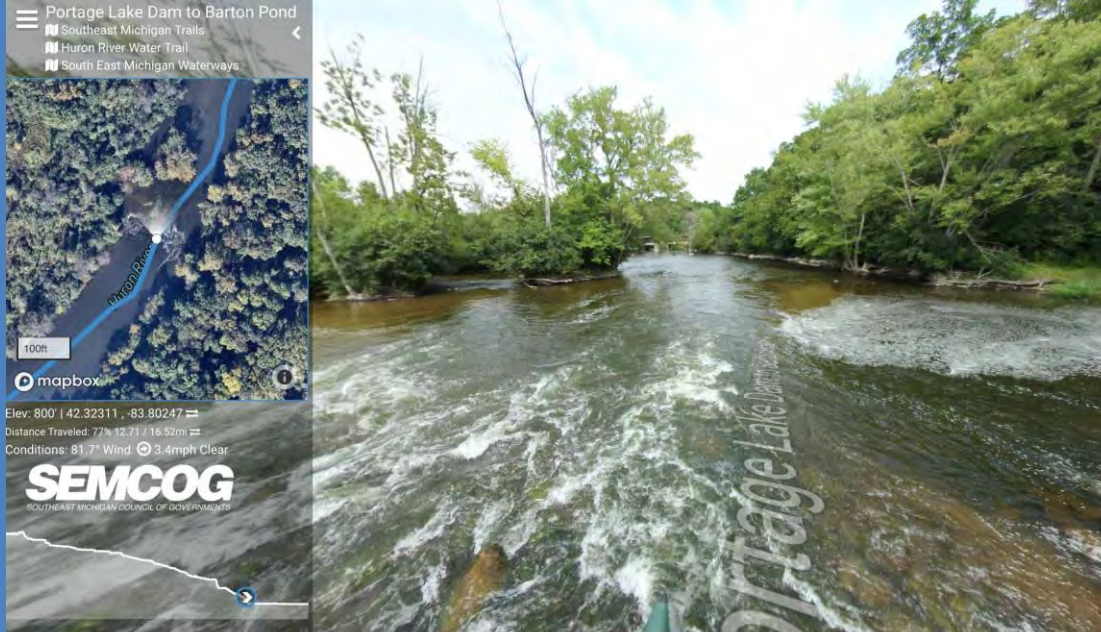
Further Applications



Apply same training tools on drone imagery for any specific



2018: Huron River National Water Trail



Mapped:

141+mi of waterways
22 Public access points

110,000+ images
189,000 GIS points
(lat/long/lux/IMU/Wx)

Conservation Partner:



Huron
River
Watershed
Council

Huron River - Delhi Mills, MI



2018: Huron River National Water Trail

Island Lake Area
Southeast Michigan Trails
Huron River Water Trail

Hiking/bicyclist trail
Map Rotation

200ft
mapbox

Elev: 868' | 42.51130, -83.69724
Distance Traveled: 20% 1.54 / 7.57mi
Conditions: 46° Wind: 6.8mph Partly sunny
Huron River at Milford USGS Discharge, ft/s³

Huron River
WATER TRAIL





2018: Huron River National Scenic Water Trail

Island Lake Area <

- Southeast Michigan Trails
- Huron River Water Trail

Map Rotation

200ft

mapbox

Elev: 867' | 42.51557, -83.68405

Distance Traveled:

Conditions: 46° Wind: 6.8mph Partly sunny

Huron River at Milford USGS Discharge, ft³/s

Huron River WATER TRAIL



Developing Regional Solutions



SEMCOG

Southeast Michigan Council of Governments

Southeast Michigan Trail Explorer

*Using Interactive Mapping and
360 Degree Imagery to
Promote Parks and Trails*



Southeast Michigan Trail Explorer

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails



- 360 degree imagery and high-resolution visual mapping
- **900+ miles of trails**
- Preview regional assets and outdoor adventures

Southeast Michigan Trail Explorer

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails



375 miles of greenways

- *Regional Trails*

Southeast Michigan Trail Explorer

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails

375 miles of greenways

- *Natural Trails*

Son Oaks County Park

Southeast Michigan Trail Explorer

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails

375 miles of greenways

- Park Trails

Matthaei Boardwalk

Object & Label Detection

Get Directions



TERRAIN360

Southeast Michigan Trail Explorer

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails



Image Training Tool
Trail 3903
Scene 226

550 miles of water trail

- National Water Trail

Display path and watermarks

Object & Label Detection
Get Directions  
  

TERRAIN360

Southeast Michigan Trail Explorer

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails

550 miles of water trail

- *Great Lakes Shorelines*

Southeast Michigan Trail Explorer

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails



Image Training Tool

Trail 3943 Score 92

Look At

View Images

Display both and view

Obj

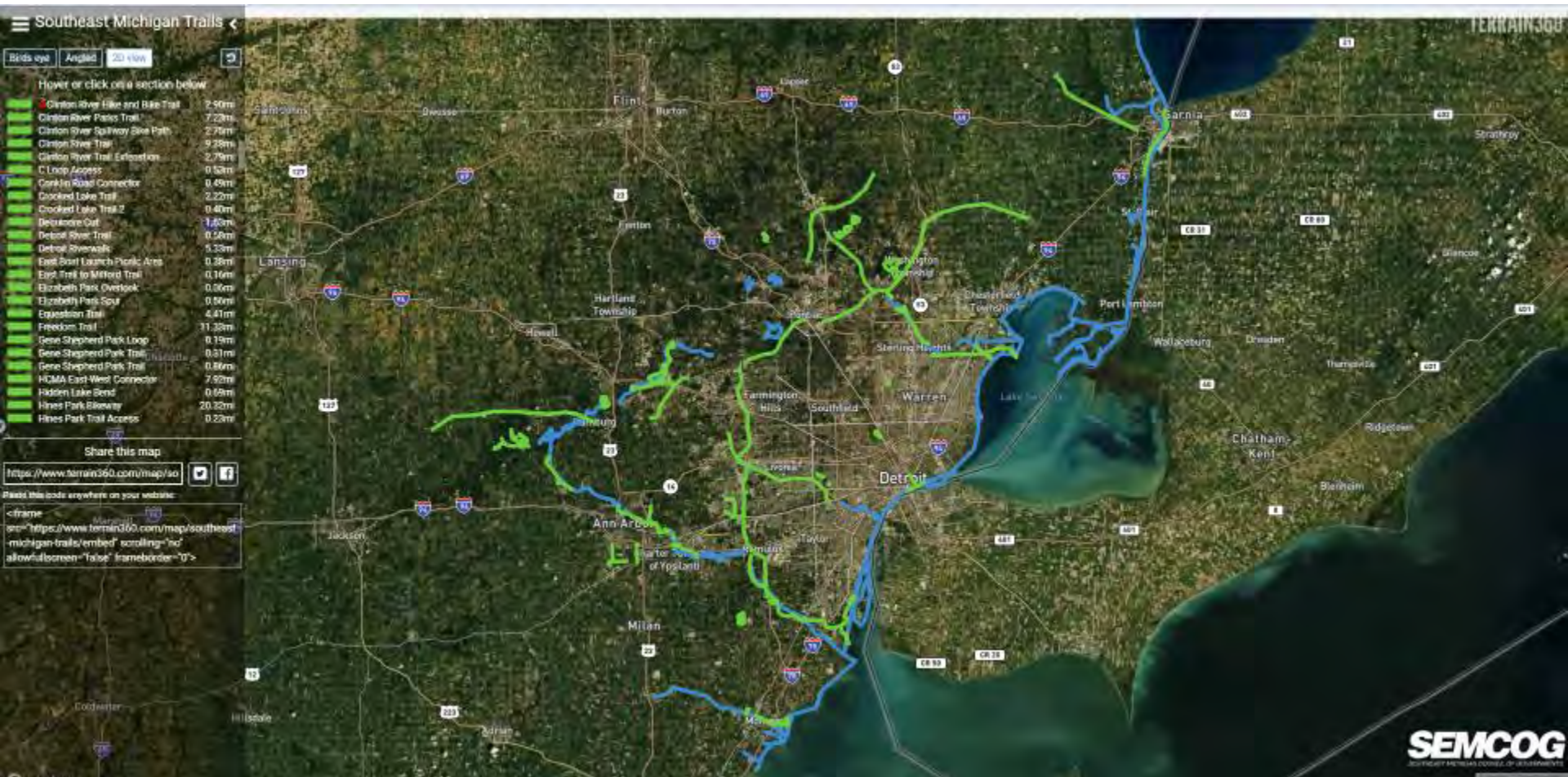
Get

550 miles of water trail

- *Streams and Canals*

Available Trails

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails



Planning to Capture

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails



Additional 370 miles of trails

- 250 miles of greenways
- 120 miles of water trails

Utilizing ArcGIS Online to Coordinate with Partners

- Sharing Spatial Data
- Information (Mileage, Label, etc.)
- Feedback/Recommendation on Proposed Trails

Trail Explorer Applications

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails

- **Marketing the region...**
 - *Showcasing our natural and recreational assets...*
- **Trip planning tool...**
- **Accessibility & planning resource...**
- **Benchmarking conditions...**
- **Invasive species & vulnerable areas resource...**
- **Others...**

Trail Explorer Applications

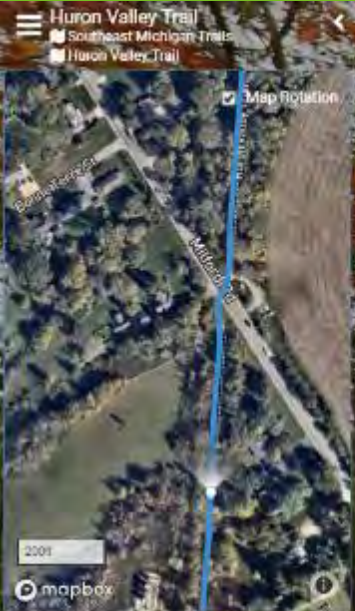
Showcasing Regional Assets & Promoting Outdoor Experiences



Detroit River Water Trail

Trail Explorer Applications

Showcasing Regional Assets & Promoting Outdoor Experiences



Elev: 930' | 42.50431, -83.61624
Distance Traveled: 63% 4.68 / 7.43mi est
Conditions: 74° Wind, 9.5mph Mostly cloudy

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Huron Valley Trail

Trail Explorer Applications

Showcasing Regional Assets & Promoting Outdoor Experiences



Belle Isle Paddle Route

Trail Explorer Applications

Showcasing Regional Assets & Promoting Outdoor Experiences



Elizabeth Park Trail

Trail Explorer Applications

Showcasing Regional Assets & Promoting Outdoor Experiences



Black River Water Trail

Trail Explorer Applications

Showcasing Regional Assets & Promoting Outdoor Experiences



Lake Erie Metropark Trail

Trail Explorer Applications

Showcasing Regional Assets & Promoting Outdoor Experiences

Monroe County Water Trails_Central River Raisin

- Southwest Michigan Trails
- River Raisin Water Trails

Map Rotation

800ft

mapbox

Fluv: 604 | 41.93872, -83.47791

Distance Traveled: 42% 14.60 / 23.45mi

Conditions: 55° Wind: 0mph Cloudy

RIVER RAISIN NEAR MONROE, MI USGS Discharge, ft/s

05/19 10:45pm 19.90ft

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SOUTHEAST MICHIGAN COUNCIL OF GOVERNMENTS



River Raisin Water Trail

Trail Explorer Applications

Trip Planning



Lake Erie Metropark

Trail Explorer Applications

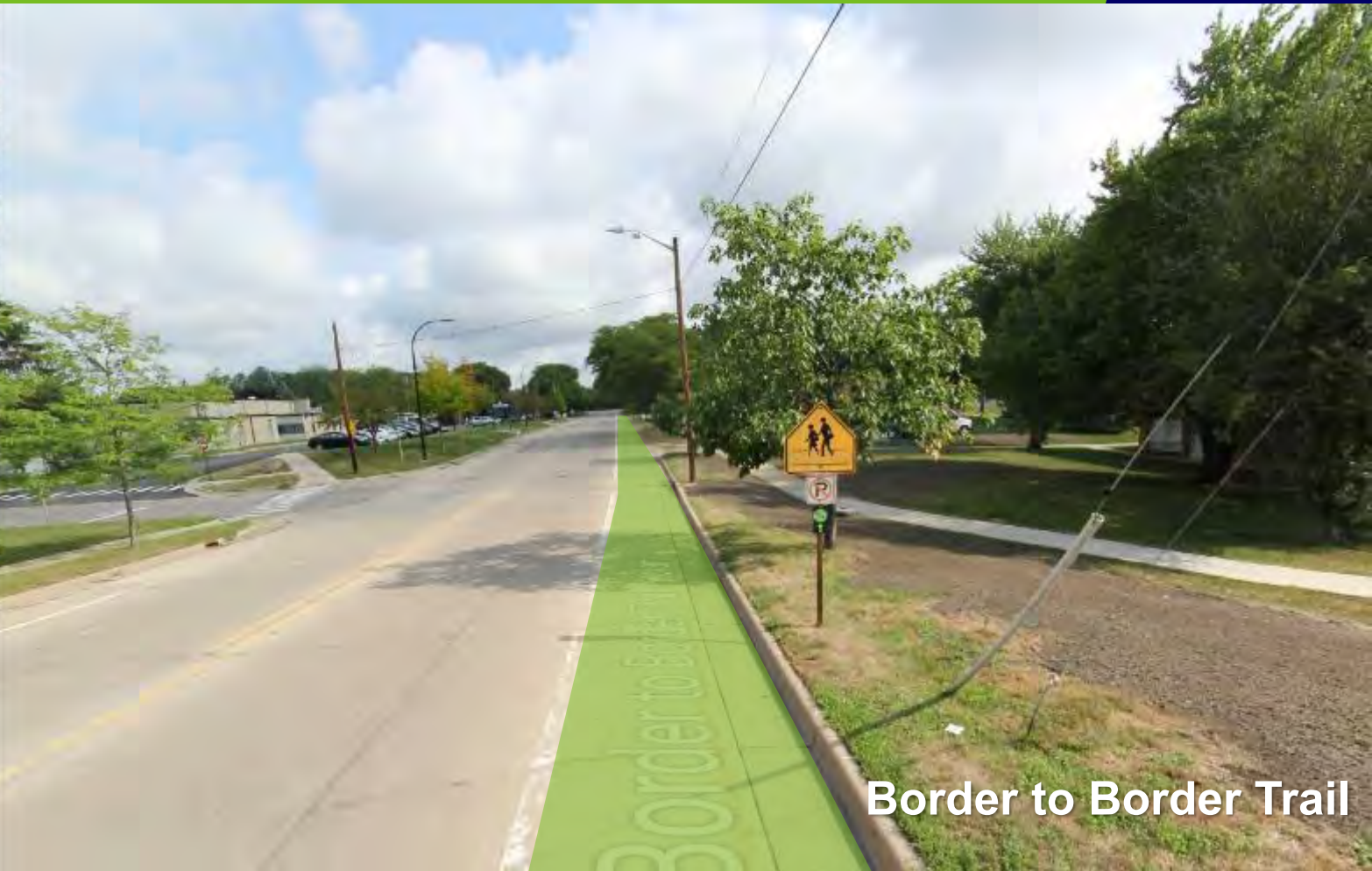
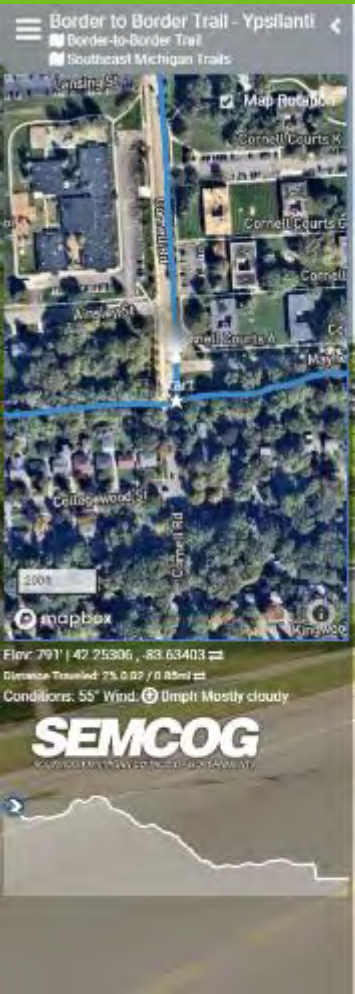
Trip Planning



Detroit River Walk

Trail Explorer Applications

Trip Planning



Border to Border Trail

Trail Explorer Applications

Trip Planning



Border to Border Trail

Trail Explorer Applications

Understanding Accessibility



Elizabeth Park Marina Access

Trail Explorer Applications

Understanding Accessibility

Huron Flat Rock to Lake Erie
Southeast Michigan Trails
Huron River Water Trail

mapbox

Huron River Water Trail



Huron River Water Trail

Trail Explorer Applications

Understanding Accessibility



Source: Southeast Michigan Bicycle Network

I-275 Metro Trail

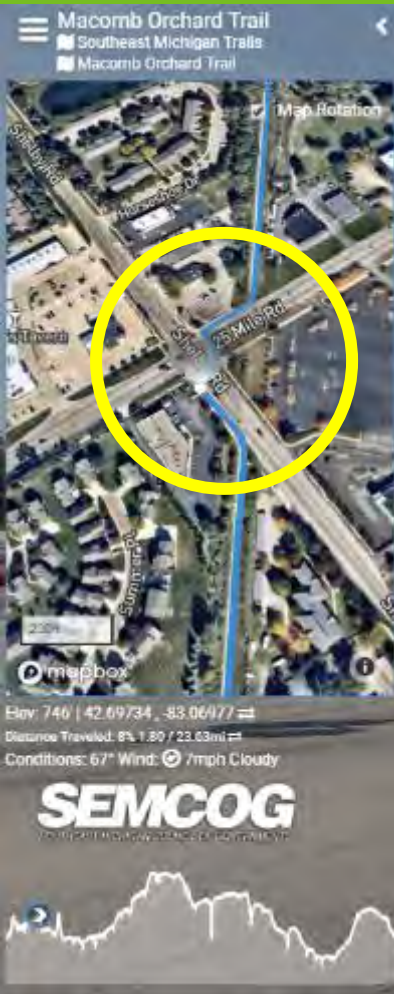
Trail Explorer Applications

Understanding Accessibility



Trail Explorer Applications

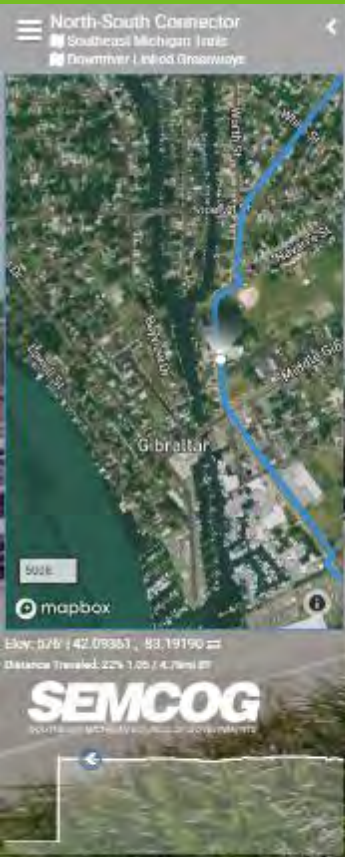
Understanding Accessibility



Macomb Orchard Trail

Trail Explorer Applications

Benchmarking Conditions



Downriver Linked Greenways

Trail Explorer Applications

Benchmarking Conditions



Grosse Ile Canal

Trail Explorer Applications

Benchmarking Conditions



Lake St. Clair

Trail Explorer Applications

Benchmarking Conditions



St. Clair River

Trail Explorer Applications

Benchmarking Conditions



Detroit Heritage River Water Trail

Trail Explorer Applications

Benchmarking Conditions



Downriver Linked Greenways

Trail Explorer Applications

Invasive species & vulnerable areas



Harsens Island Canal

TERRAIN360

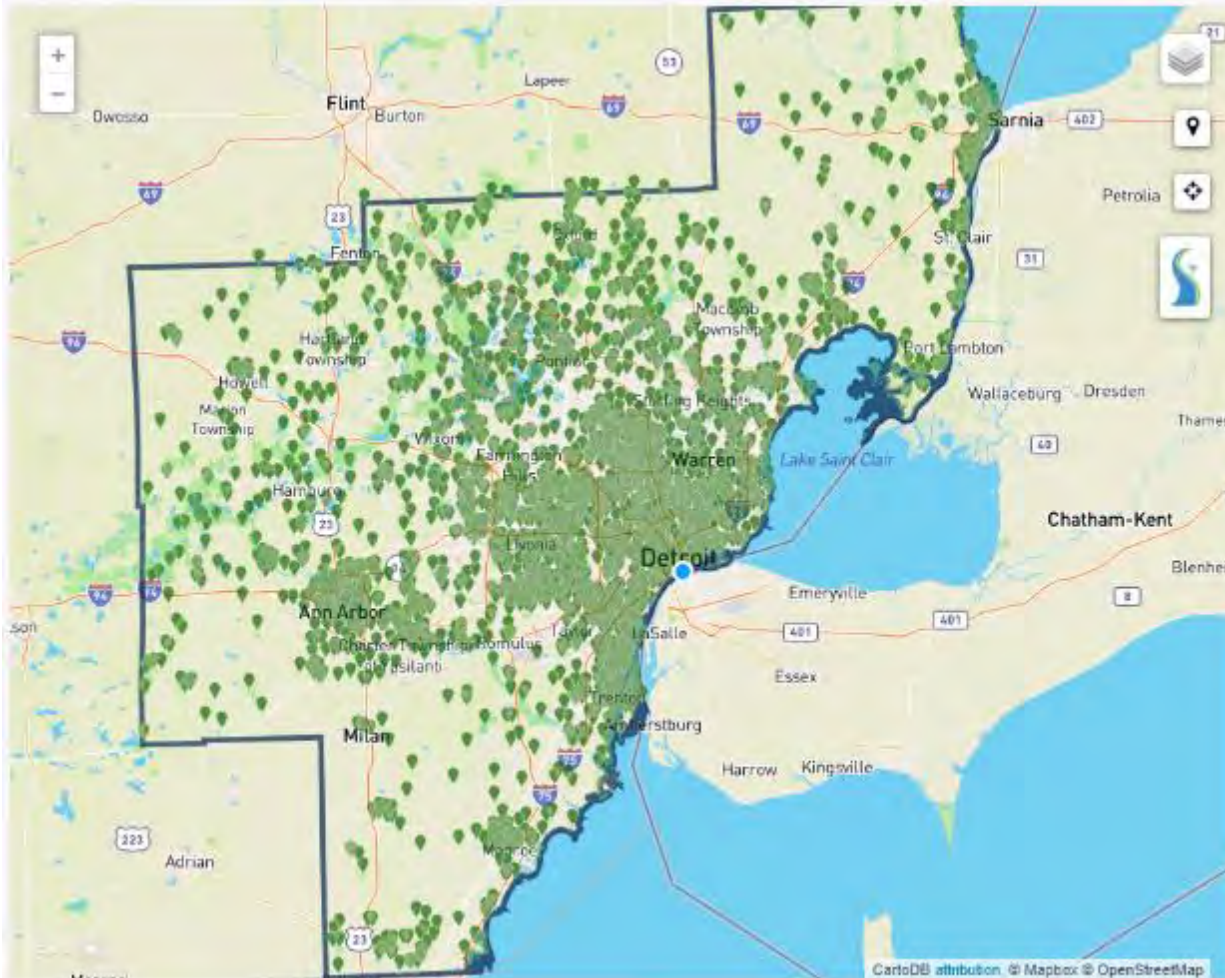
Southeast Michigan ParkFinder

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails



Southeast Michigan ParkFinder

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails



Clear All Filters

2,657 parks meet these criteria:

Location

Park Type

Park Size

Filter Amenities by:

Trails & Fitness

Sports & Games

Water Recreation

Outdoor Recreation

Winter Recreation

Amenities & Facilities



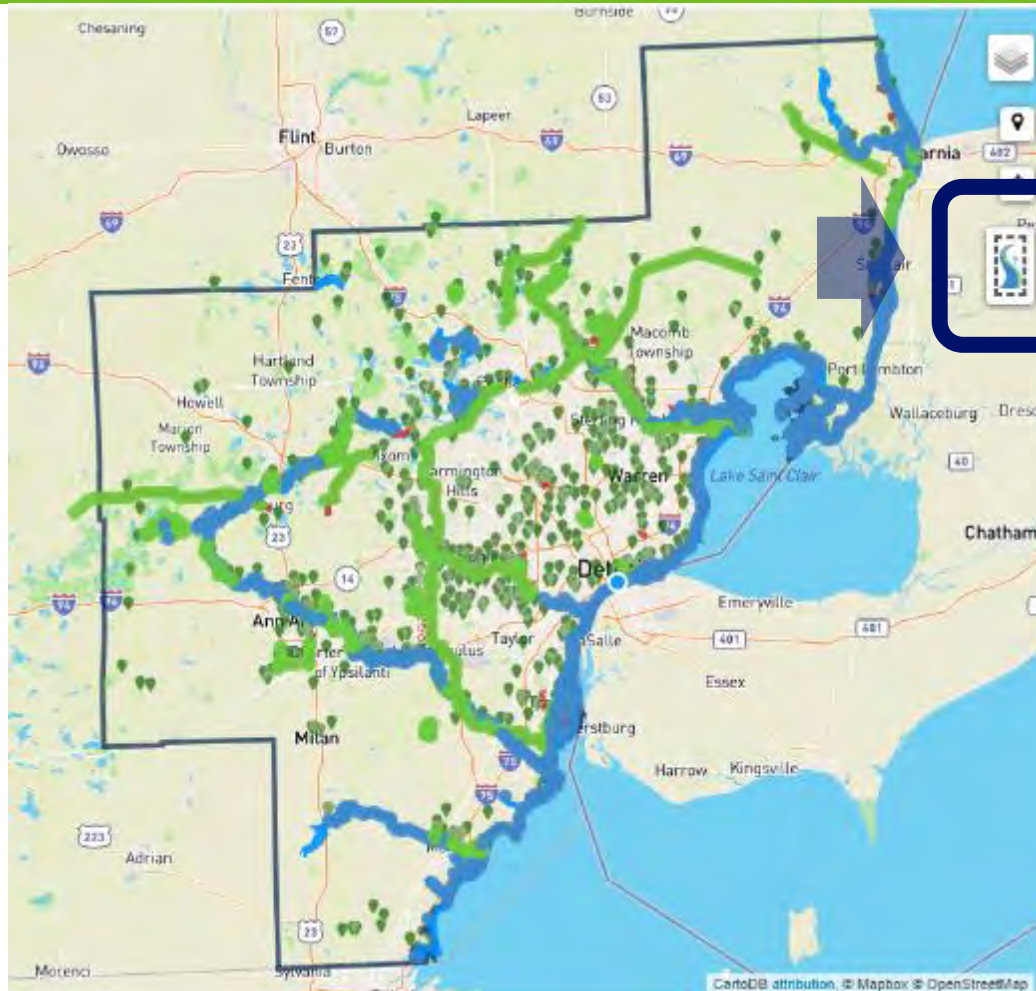
Southeast Michigan ParkFinder

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails

The screenshot displays the Southeast Michigan ParkFinder website. On the left is a map of the region with green tree icons representing parks. The central panel features the 'Park Finder' logo and a search bar. Below the search bar, a green button indicates '274 parks meet these criteria.' A 'Filter Amenities by' section is visible, with 'Nature Trail' selected and highlighted by a blue arrow. Other filter categories include 'Trails & Fitness', 'Sports & Games', 'Outdoor Recreation', and 'Amenities & Facilities'. On the right, a list of search results is shown, including 'William G. Milliken State Park And Harbor', 'Clark Park', 'Belle Isle Park', 'Maheras Park', and 'Patterson Park'. Each result includes a list of icons representing amenities and the distance from the user's location. At the bottom, there are links to download the app from the App Store and Google Play.

ParkFinder & Trail Explorer

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails



Clear All Filters

599 parks meet these criteria:

Location

Park Type

Park Size

Filter Amenities by

Trails & Fitness

Paved Pathways & Regional Trails

Sports & Games

Water Recreation

Paddling Launches & Water Trails

Outdoor Recreation

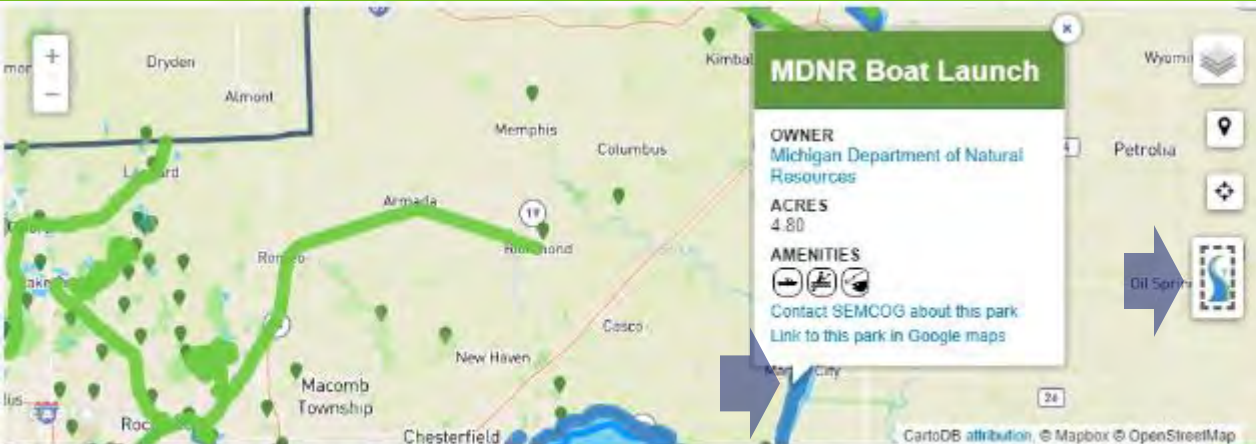
Winter Recreation

Amenities & Facilities



ParkFinder & Trail Explorer

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails



Clear All Filters

340 parks meet these criteria.

- Location
- Park Type
- Park Size

Filter Amenities by:

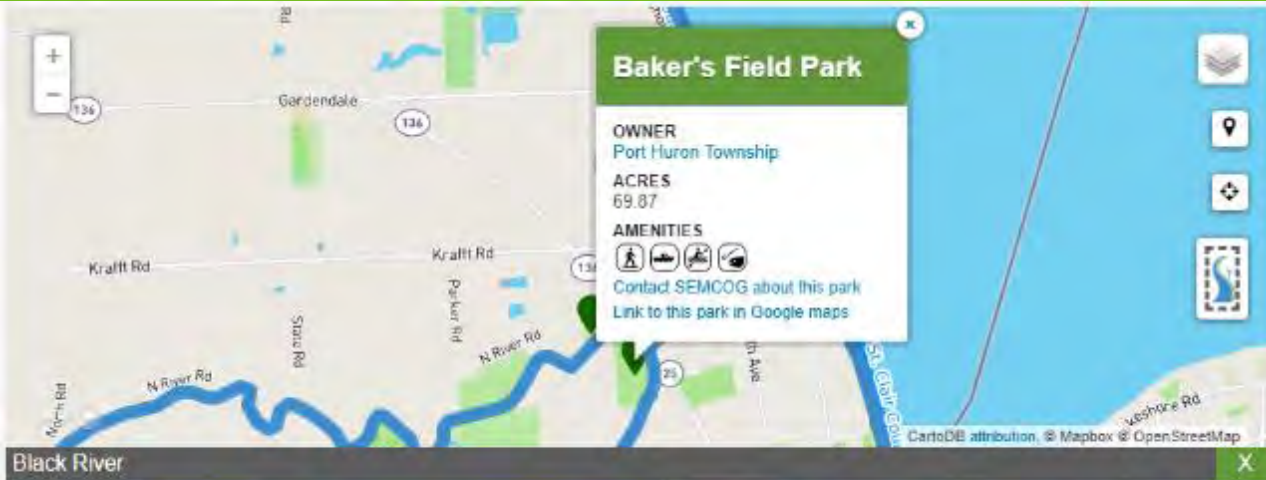
- Trails & Fitness
 - Nature Trail
 - Sports & Games
- Water Recreation
 - Paddling Launches & Water Trails

- Beach
- Boat Access
- Fishing
- Paddling Launches & Water Trails**
- Swimming Pool
- Water Park or Splash Pad

- Outdoor Recreation
- Winter Recreation

ParkFinder & Trail Explorer

Using Interactive Mapping and 360 Degree Imagery to Promote Parks and Trails



Clear All Filters

103 parks meet these criteria:

Location

Park Type

Park Size

Filter Amenities by:

Trails & Fitness

Sports & Games

Water Recreation

Paddling Launches & Water Trails



Beach



Boat Access



Fishing



Paddling Launches & Water Trails



Swimming Pool

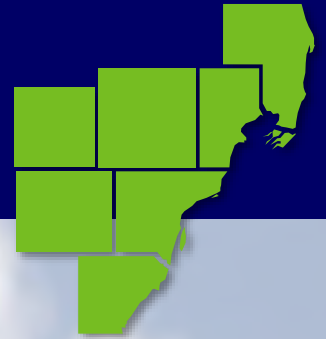


Water Park or Splash Pad

Outdoor Recreation

Winter Recreation

Developing Regional Solutions



Questions?

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(313) 300-4364 | makari@semcog.org*



Developing Regional Solutions



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