

THE WETLAND VEGETATION CONDITION INDEX (WVCI) TOOLBOX A DATA-DRIVEN APPROACH TO ENHANCE WETLAND MONITORING

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U.S. ARMY



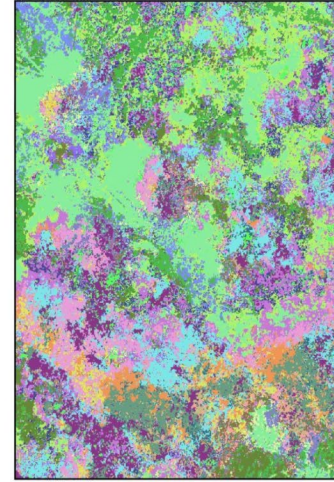
US Army Corps
of Engineers®



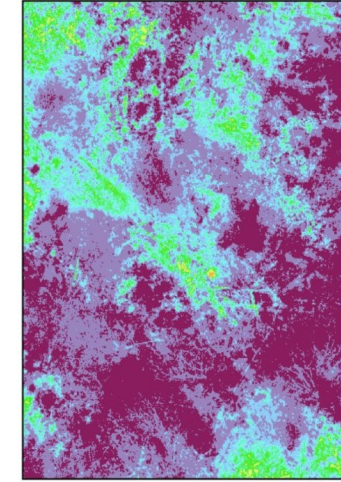
ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER



Grainger Woods Conservation Preserve, IL



Species Classification



NDVI



WVCI

Geoprocessing

Wetland Vegetation Condition Index Calculator

Parameters Environments

1 Select User Workspace Folder for Storing Output Files

Output Project Name (added as prefix to output file names)

2 ProjectArea

* Draw Or Select AOI polygon

3

* Input Species Classification Raster File

Select the raster field containing the species class value

4

* FQA Data Table for mapping species class to Coefficient of Conservation (C-value) values as csv

5

Select the FQA table field containing the species class values

6

* Select the FQA table field containing the Coefficient of Conservation value (C-value)

7

8a

Select input species from raster file for crosswalk to the csv table species

Parameter Value 8b CSV Value 8c

* Input Multispectral or Hyperspectral Raster File

9

* Select Red Band (~680nm) from Multispectral or Hyperspectral Raster File

10

* Select Near Infrared Band (~950nm) from Multispectral or Hyperspectral Raster File

11

Output Spatial Reference (projected coordinate system)

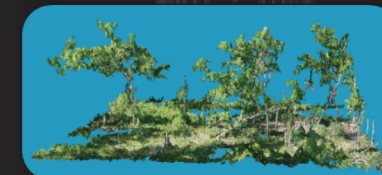
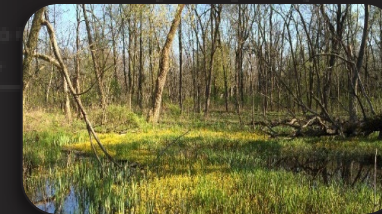
12 North_America_Lambert_Conformal_Conic

13 Run

WVCI_Toolbox.pyt

Wetland Vegetation Condition Index Calculator

WVCI Algorithm Evaluation





AGENDA



- Introduction & Background
- The WVCi Toolbox: An in-depth look at the tools and concepts
- Case Study: Applying the toolbox to Grainger Woods, IL
- WVCi Calculator Tool
- WVCi Algorithm Evaluation Tool
- Conclusion & Future Directions
- Q&A





BACKGROUND



- **Floristic Quality Assessment (FQA):**

- Field-based method for assessing wetland condition
- Ecological integrity based on plant species composition
- Quantity based on cover values (%)
- Quality based on coefficients of conservation (CC, 0-10)

Key Metric: The Floristic Quality Index (FQI)

Mean C multiplied by the square root of Species Richness (N)

$$FQI = \overline{C}_t \sqrt{N_t}$$

- **Core Limitations:**

- Limited to small, physically accessible areas
- Time-consuming and resource-intensive
- Survey challenges - project delays and slow response to environmental changes





INTRODUCTION



- **Purpose:**
 - To develop a new method that leverages remote sensing data to extend wetland condition assessments to larger, regional areas for faster, more informed decision-making. Developed to support ecologists, planners, or practitioners engaged in floristic quality assessments.

- **Approach:**
 - Wetland Vegetation Condition Index (WVCI) Toolbox
 - Provide a user-friendly interface with an automated workflow that modernizes the traditional FQI concept
 - Transitions from manual field surveys to a repeatable, remotely-sensed process
 - Enables rapid and consistent assessment over vast landscapes

Wetland Vegetation Condition Index (WVCI) assesses floristic quality by combining vegetation quantity and vegetation quality at a pixel level.

Formula: $WVCI = (NDVI \times C) \times 10$

$$WVCI = (NDVI \times C) \times 10$$

WVCI (The Score):

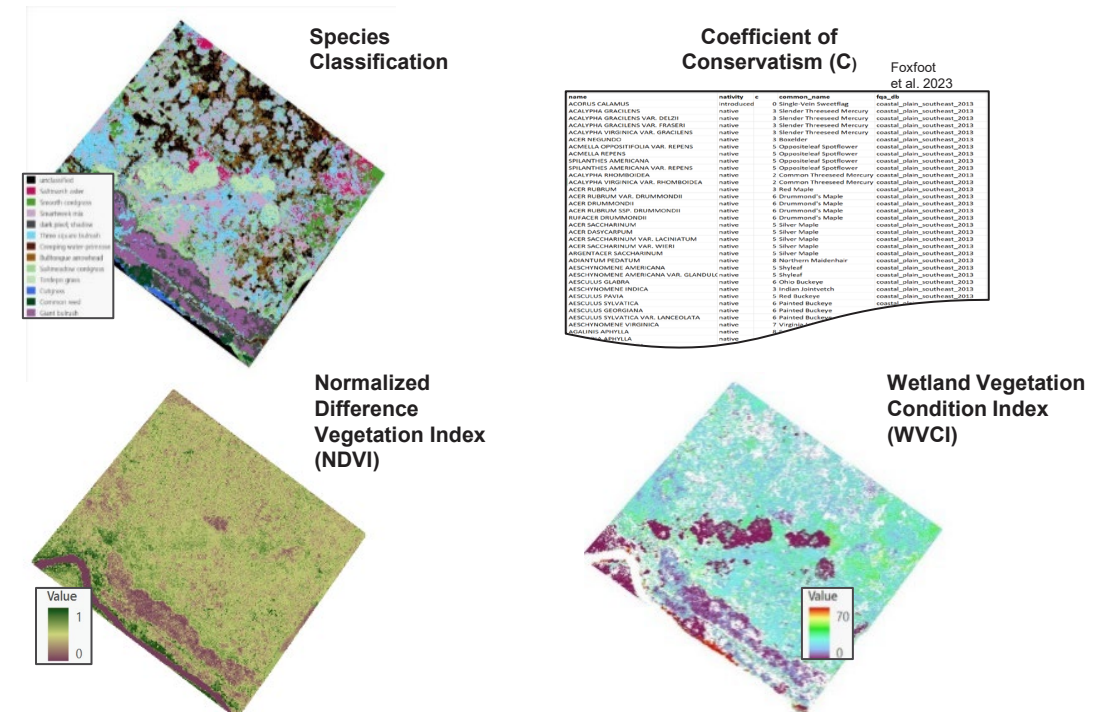
Wetland Vegetation Condition Index, standardized 0-100 scale

NDVI:

Normalized Difference Vegetation Index calculated from imagery (Red and Near Infrared [NIR] bands) and proxy for vegetation biomass

C:

Coefficient of Conservatism value (C-Value) assigned to the dominant species identified in each pixel

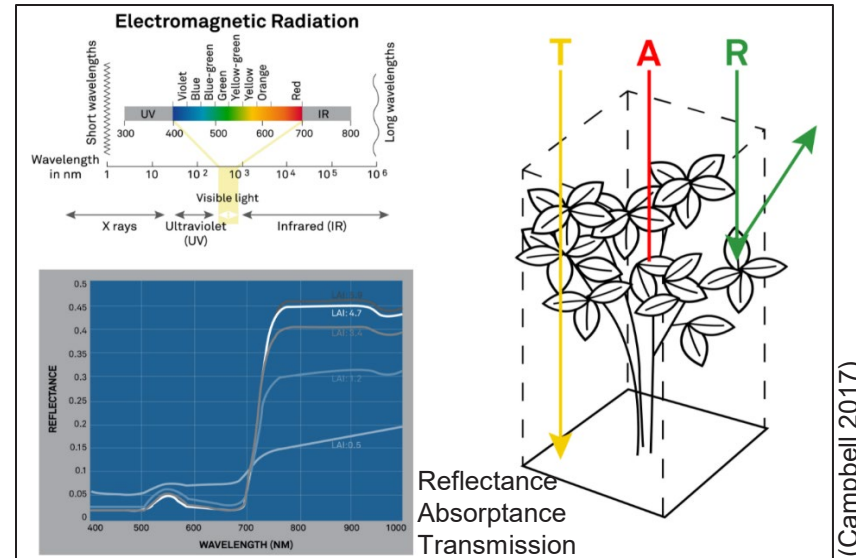
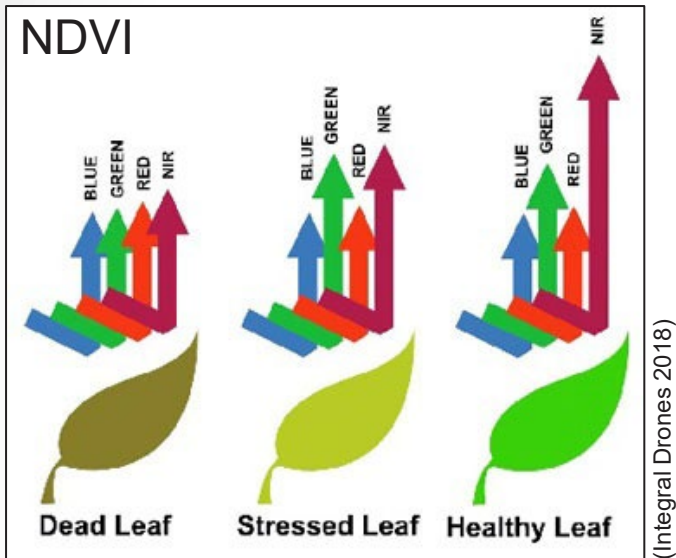
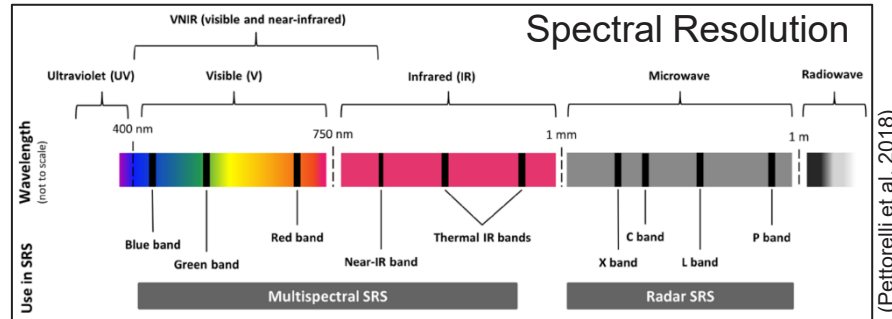




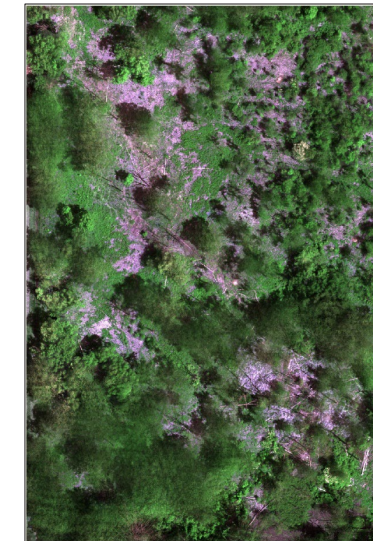
NDVI

UNCLASSIFIED

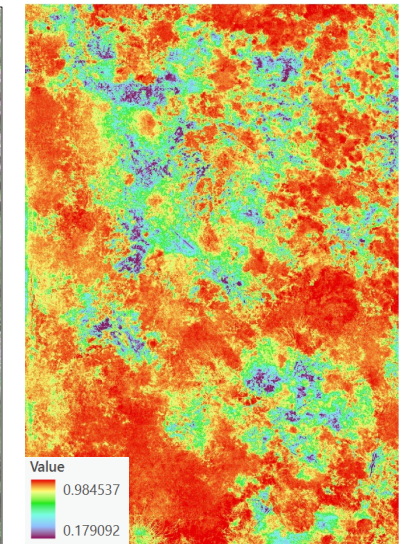
NORMALIZED DIFFERENCE VEGETATION INDEX



Multispectral Image



NDVI



$$NDVI = \frac{NIR - Red}{NIR + Red}$$

UNCLASSIFIED



COEFFICIENT OF CONSERVATISM (C-VALUE)



C	Criteria
0	Non-native with wide range of ecological tolerances. Often these are opportunistic of intact undisturbed habitats
1-2	Native invasive or widespread native that is not typical of (or only marginally typical of) a particular plant community; tolerant of anthropogenic disturbance
3-5	Native with an intermediate range of ecological tolerances and may typify a stable native community, but may also persist under some anthropogenic disturbance
6-8	Native with a narrow range of ecological tolerances and typically associated with a stable community
9-10	Native with a narrow range of ecological tolerances, high fidelity to particular habitat conditions, and sensitive to anthropogenic disturbances.

Bried et al., 2012

A	B	C	D	E	F	G	H	I	J	K	L	M	N
	name	name_origin	acronym	accepted_scientific_name	family	nativity	c	w	wetland_indicator	physiognomy	duration	common_name	fqa_db
1	ABELMOSCHUS ESCULENTUS	accepted_scientific_name	ABEESC	Abelmoschus esculentus	MALVACEAE	introduced	0	2	UPL	forb	annual	Okra	chicago_t
2	HIBISCUS ESCULENTUS	synonym	HIBESC	Abelmoschus esculentus	MALVACEAE	introduced	0	2	UPL	forb	annual	Okra	chicago_t
3	ABUTILON THEOPHRASTI	accepted_scientific_name	ABUTHE	Abutilon theophrasti	MALVACEAE	introduced	0	1	FACU	forb	annual	Velvetleaf	chicago_t
4	ACALYPHA GRACILIS	accepted_scientific_name	ACAGRA	Acalypha gracilis	EUPHORBIACEAE	native	4	1	FACU	forb	annual	Slender Three-Seed-Mercury	chicago_t
5	ACALYPHA RHOMBOIDEA	accepted_scientific_name	ACARHO	Acalypha rhomboidea	EUPHORBIACEAE	native	0	1	FACU	forb	annual	Common Three-Seed-Mercury	chicago_t
6	ACALYPHA VIRGINICA	accepted_scientific_name	ACAVIR	Acalypha virginica	EUPHORBIACEAE	introduced	4	1	FACU	forb	annual	Virginia Three-Seed-Mercury	chicago_t
7	ACANTHOPANAX SIEBOLDIANUS	accepted_scientific_name	ACASIE	Acanthopanax sieboldianus	ARALIACEAE	introduced	0	2	UPL	shrub	perennial	Palmate Hercules' Club	chicago_t
8	ELEUTHEROCOCCUS SIEBOLDIANUS	synonym	ELESIE	Acanthopanax sieboldianus	ARALIACEAE	introduced	0	2	UPL	shrub	perennial	Palmate Hercules' Club	chicago_t
9	ACER CAMPESTRE	accepted_scientific_name	ACECAM	Acer campestre	ACERACEAE	introduced	0	2	UPL	tree	perennial	Hedge Maple	chicago_t
10	ACER GINNALA	accepted_scientific_name	ACEGIN	Acer ginnala	ACERACEAE	introduced	0	2	UPL	tree	perennial	Amur Maple	chicago_t
11	ACER NEGUNDO	accepted_scientific_name	ACENEG	Acer negundo	ACERACEAE	native	0	0	FAC	tree	perennial	Ash-Leaf Maple	chicago_t
12	ACER NEGUNDO VAR. VIOLACEUM	synonym	ACENEGV	Acer negundo	ACERACEAE	native	0	0	FAC	tree	perennial	Ash-Leaf Maple	chicago_t
13	ACER NIGRUM	accepted_scientific_name	ACENIG	Acer nigrum	ACERACEAE	native	5	1	FACU	tree	perennial	Black Maple	chicago_t
14	ACER PLATANOIDES	accepted_scientific_name	ACEPLA	Acer platanoides	ACERACEAE	introduced	0	2	UPL	tree	perennial	Norway Maple	chicago_t
15	ACER PSEUDOPLATANUS	accepted_scientific_name	ACEPSE	Acer pseudoplatanus	ACERACEAE	introduced	0	2	UPL	tree	perennial	Sycamore Maple	chicago_t
16	ACER RUBRUM	accepted_scientific_name	ACERUB	Acer rubrum	ACERACEAE	native	5	0	FAC	tree	perennial	Red Maple	chicago_t
17	ACER SACCHARINUM	accepted_scientific_name	ACESAI	Acer saccharinum	ACERACEAE	native	1	-1	FACW	tree	perennial	Silver Maple	chicago_t
18	ACER SACCHARUM	accepted_scientific_name	ACESAU	Acer saccharum	ACERACEAE	native	5	1	FACU	tree	perennial	Sugar Maple	chicago_t
19	ACER X FREEMANII	accepted_scientific_name	ACEFRE	Acer X freemanii	ACERACEAE	native	0	2	UPL	tree	perennial	Freeman's Maple	chicago_t
20	ACHILLEA FILIPENDULINA	accepted_scientific_name	ACHFIL	Achillea filipendulina	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Fern-Leaf Yarrow	chicago_t
21	ACHILLEA MILLEFOLIUM	accepted_scientific_name	ACHMIL	Achillea millefolium	ASTERACEAE	introduced	0	1	FACU	forb	perennial	Common Yarrow	chicago_t
22	ACHILLEA MILLEFOLIUM CULT. ROSEUM	accepted_scientific_name	ACHMILR	Achillea millefolium cult. roseum	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Rose Yarrow	chicago_t
23	ACHILLEA PTARMICA	accepted_scientific_name	ACHPTA	Achillea ptarmica	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Pearl Yarrow	chicago_t
24	ACINOS ARVENSIS	accepted_scientific_name	ACIARV	Acinos arvensis	LAMIACEAE	introduced	0	2	UPL	forb	perennial	Mother-Of-Thyme	chicago_t
25	ACMISPON AMERICANUS	accepted_scientific_name	ACMAAM	Acmispon americanus	FABACEAE	introduced	0	1	FACU	forb	annual	American Deerweed	chicago_t
26	ACONITUM UNCINATUM	accepted_scientific_name	ACOUNC	Aconitum uncinatum	RANUNCULACEAE	introduced	0	2	UPL	forb	perennial	Wild Monkshood	chicago_t
27	ACORUS AMERICANUS	accepted_scientific_name	ACOAME	Acorus americanus	ACORACEAE	native	9	-2	OBL	forb	perennial	Several-Vein Sweetflag	chicago_t
28	ACORUS CALAMUS	accepted_scientific_name	ACOCAL	Acorus calamus	ACORACEAE	introduced	0	-2	OBL	forb	perennial	Single-Vein Sweetflag	chicago_t
29	ACROPTILON REPENS	accepted_scientific_name	ACRRREP	Acroptilon repens	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Russian Knapweed	chicago_t
30	CENTAUREA REPENS	synonym	CENREP	Acroptilon repens	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Russian Knapweed	chicago_t
31	ACTAEA PACHYPODA	accepted_scientific_name	ACTPAC	Actaea pachypoda	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Russian Knapweed	chicago_t
32	ACTAEA RUBRA	accepted_scientific_name	ACTRUB	Actaea rubra	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Russian Knapweed	chicago_t
33	ACTAEA RUBRA SSP. ARGUTA	accepted_scientific_name	ACTRUBA	Actaea rubra ssp. arguta	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Russian Knapweed	chicago_t
34	ACTAEA RUBRA	synonym	NA	Actaea rubra ssp. arguta	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Russian Knapweed	chicago_t
35	ACTAEA RUBRA SSP. RUBRA	accepted_scientific_name	ACTRUBR	Actaea rubra ssp. rubra	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Russian Knapweed	chicago_t

Foxfoot 2024

https://usace-ecomod.shinyapps.io/fqa_app/

WVCI TOOLBOX FOR ARCGIS PRO

A Python-based Wetland Vegetation Condition Index (WVCI) toolbox for ArcGIS Pro streamlines wetland condition mapping analysis using automated menus through two core components. Beta-tested by USACE Chicago District and ERDC staff.

Tool Requirements:

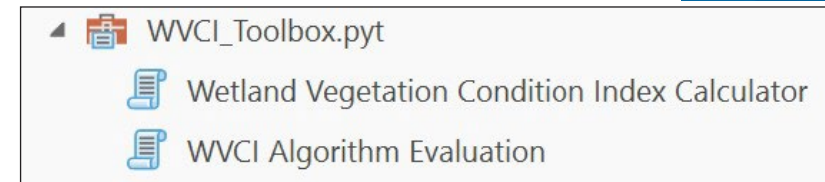
- ArcGIS Pro 3.5+
- Advanced License
- Spatial Analyst Extension
- Python 3.11.11+
- Windows OS

Data inputs:

- Area of interest polygon
- Thematic species classification raster
- Multispectral/hyperspectral image
- Regional FQA database table (csv)

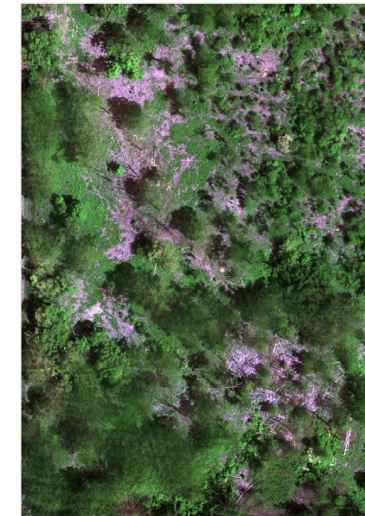
Available Tools:

1. Wetland Vegetation Condition Index Calculator
2. WVCI Algorithm Evaluation

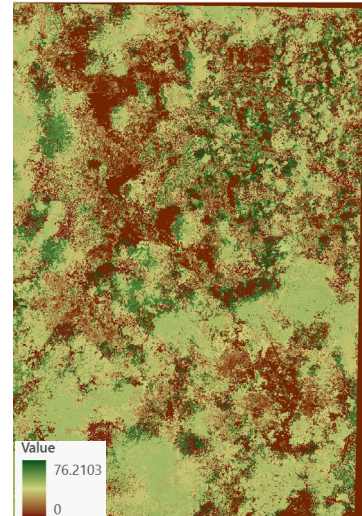


Output:

- Wetland Vegetation Condition Index
- Linear regression statistics and report



UAS-Multispectral Imagery
Grainger Woods, IL



WVCI
Grainger Woods, IL

WVCI Toolbox Download Link:
<https://dx.doi.org/10.21079/11681/50181>



CASE STUDY: GRAINGER WOODS, IL



Data Origin: Grainger Woods Conservation Preserve, Illinois.

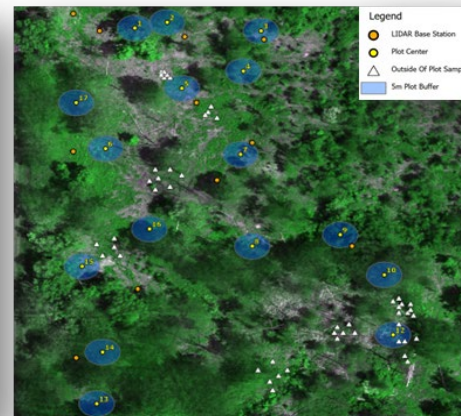
Data Collection (June 10, 2025):

- High-resolution (4cm) multispectral imagery captured via an Unmanned Aerial System (UAS)
- Concurrent field-based measurements to identify species and calculate FQI values at the quadrat level

Goal: Demonstrate the full workflow of the WVCI toolbox



UAS RGB Imagery (1cm)



MicaSense 10-Band Imagery (4cm)





WVCI CALCULATOR PURPOSE AND INPUTS



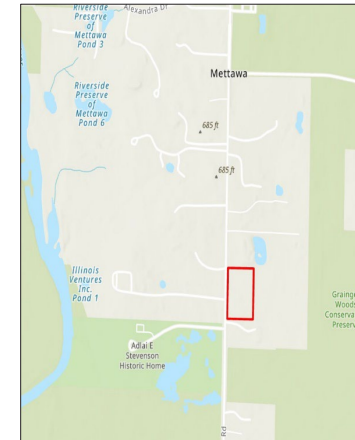
Purpose: To quantify wetland vegetation condition by calculating the WVCI score for each pixel across a defined area

Required Inputs:

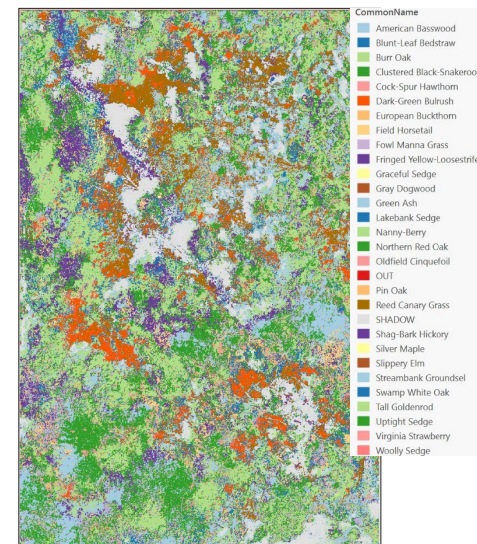
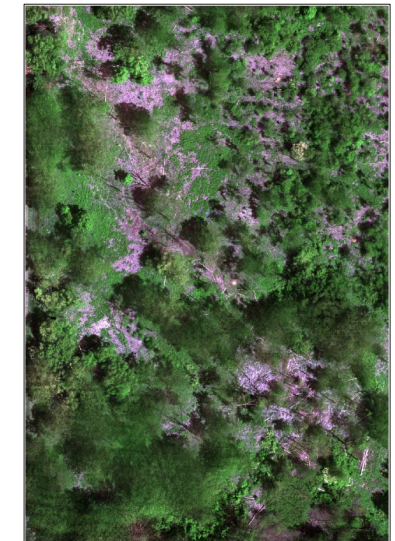
- Area of Interest (AOI):
Polygon shapefile or feature class defining the study area
- Thematic Species Classification Raster:
Raster where each pixel value represents a dominant plant species
- Multispectral/Hyperspectral Imagery:
Red and NIR bands
- FQA Data Table (.csv):
A regional table that maps species names to their corresponding C-values

https://usace-ecomod.shinyapps.io/fqa_app/

AOI



Multispectral Image



Species Classification

name	name_english	accepted_name	family	native	status	abundance	comment	file
11	11	11	11	11	11	11	11	11
12	12	12	12	12	12	12	12	12
13	13	13	13	13	13	13	13	13
14	14	14	14	14	14	14	14	14
15	15	15	15	15	15	15	15	15
16	16	16	16	16	16	16	16	16
17	17	17	17	17	17	17	17	17
18	18	18	18	18	18	18	18	18
19	19	19	19	19	19	19	19	19
20	20	20	20	20	20	20	20	20
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96	96	96	96	96	96	96	96	96
97	97	97	97	97	97	97	97	97
98	98	98	98	98	98	98	98	98
99	99	99	99	99	99	99	99	99
100	100	100	100	100	100	100	100	100

FQA database



WVCI CALCULATOR WORKFLOW

1. **Define Workspace & AOI:**
Set project name and define the analysis boundary
2. **Generate C-Value Raster:**
The tool "crosswalks" species names from the classification raster to the FQA table to create a raster of C-values
3. **Calculate NDVI:**
The tool calculates NDVI from the Red/NIR bands of the input imagery
4. **Calculate WVCI:**
It multiplies the NDVI and C-Value rasters and standardizes the result to a 0-100 scale

Geoprocessing

Wetland Value Condition Index Calculator

Parameters Environments

* Select User Workspace Folder for Storing Output Files

1

Output Project Name (added as prefix to output file names)

2

* Draw Or Select AOI polygon

3

* Input Species Classification Raster File

4

Select the raster field containing the species class value

5

* Data Table for mapping species class to Coefficient of Conservatism (CC) values as .csv

6

Select the CC table field containing the species class values

7

* Select the CC field containing the Coefficient of Conservatism value

8

Select input species from raster file for crosswalk the csv table species

Parameter Value CSV Value

* Input Multispectral or Hyperspectral Raster File

9

* Select Red Band (~680nm) from Multispectral or Hyperspectral Raster File

10

* Select Near Infrared Band (~950nm) from Multispectral or Hyperspectral Raster File

11

Output Spatial Reference (projected coordinate system)

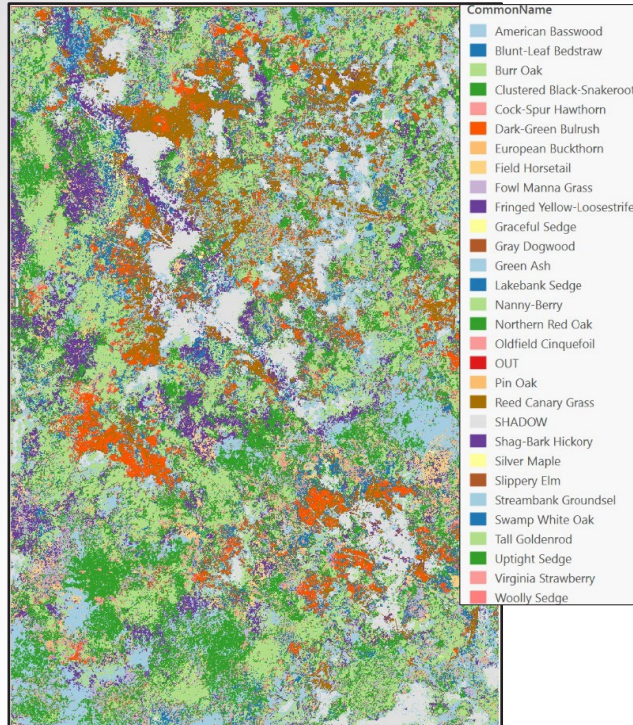
12

13



SPECIES CLASSIFICATION

UNCLASSIFIED



Species Classification

Field:  Add  Calculate Selection:  Select By Attributes  Zoom To  Switch 

	OID	Value	Count	Acroynm	SpecieName	CommonName
2	1	1	45721	ACESAI	ACER SACCHARINUM	Silver Maple
3	2	2	125448	CAROV	CARYA OVATA	Shag-Bark Hickory
4	3	3	208167	CORRAC	CORNUS RACEMOSA	Gray Dogwood
5	4	4	32601	CRACRU	CRATAEGUS ACUTIFOLIA	Cock-Spur Hawthorn
6	5	5	17877	CXGRAL	CAREX GRACILLIMA	Graceful Sedge
7	6	6	191459	CXLACU	CAREX LACUSTRIS	Lakebank Sedge
8	7	7	705859	SHADOW	SHADOW	SHADOW
9	8	8	96202	CXPELL	CAREX PELLITA	Woolly Sedge
10	9	9	87115	CXSTRI	CAREX STRICTA	Uptight Sedge
11	10	10	169894	EQUARV	EQUISETUM ARVENSE	Field Horsetail
12	11	11	30709	FRAPEN	FRAXINUS PENNSYLVAN...	Green Ash
13	12	12	15151	FRAVIR	FRAGARIA V...	Wild Strawberry

Geoprocessing

Wetland Vegetation Condition Index Calculator

Parameters Environments

Select User Workspace Folder for Storing Output Files

Toolbox

Output Project Name (added as prefix to output file names)

GW

Draw or select AOI polygon

GrangerWoods AOI

Input species classification raster

GW_SpeciesClass.tif

Select the raster field containing the species name value

CommonName

FOIA table for mapping species name to coefficient of conservation values (C-Value) as csv

Select the raster field containing the species name value

value

OID

Value

Count

Acroynm

SpecieName

CommonName

UNCLASSIFIED



COEFFICIENT OF CONSERVATISM (C-VALUE)



FQA Database Table (Regional)

A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	name	name_origin	acronym	accepted_scientific_name	family	nativity	c	w	wetland_indicator	physiognomy	duration	common_name	fqa_db
2	1 ABELMOSCHUS ESCULENTUS	accepted_scientific_name	ABEESC	Abelmoschus esculentus	MALVACEAE	introduced	0	2	UPL	forb	annual	Okra	chicago_r
3	2 HIBISCUS ESCULENTUS	synonym	HIBESC	Abelmoschus esculentus	MALVACEAE	introduced	0	2	UPL	forb	annual	Okra	chicago_r
4	3 ABUTILON THEOPHRASTI	accepted_scientific_name	ABUTHE	Abutilon theophrasti	MALVACEAE	introduced	0	1	FACU	forb	annual	Velvetleaf	chicago_r
5	4 ACALYPHA GRACILENS	accepted_scientific_name	ACAGRA	Acalypha gracilens	EUPHORBIACEAE	native	4	1	FACU	forb	annual	Slender Three-Seed-Mercury	chicago_r
6	5 ACALYPHA RHOMBOIDEA	accepted_scientific_name	ACARHO	Acalypha rhomboides	EUPHORBIACEAE	native	0	1	FACU	forb	annual	Common Three-Seed-Mercury	chicago_r
7	6 ACALYPHA VIRGINICA	accepted_scientific_name	ACAVIR	Acalypha virginica	EUPHORBIACEAE	introduced	4	1	FACU	forb	annual	Virginia Three-Seed-Mercury	chicago_r
8	7 ACANTHOPANAX SIEBOLDIANUS	accepted_scientific_name	ACASIE	Acanthopanax sieboldianus	ARALIACEAE	introduced	0	2	UPL	shrub	perennial	Palmate Hercules' Club	chicago_r
9	8 ELEUTHEROCOCCUS SIEBOLDIANUS	synonym	ELESIE	Acanthopanax sieboldianus	ARALIACEAE	introduced	0	2	UPL	shrub	perennial	Palmate Hercules' Club	chicago_r
10	9 ACER CAMPESTRE	accepted_scientific_name	ACECAM	Acer campestre	ACERACEAE	introduced	0	2	UPL	tree	perennial	Hedge Maple	chicago_r
11	10 ACER GINNALA	accepted_scientific_name	ACEGIN	Acer ginnala	ACERACEAE	introduced	0	2	UPL	tree	perennial	Amur Maple	chicago_r
12	11 ACER NEGUNDO	accepted_scientific_name	ACENEG	Acer negundo	ACERACEAE	native	0	0	FAC	tree	perennial	Ash-Leaf Maple	chicago_r
13	12 ACER NEGUNDO VAR. VIOLACEUM	synonym	ACENEGV	Acer negundo	ACERACEAE	native	0	0	FAC	tree	perennial	Ash-Leaf Maple	chicago_r
14	13 ACER NIGRUM	accepted_scientific_name	ACENIG	Acer nigrum	ACERACEAE	native	5	1	FACU	tree	perennial	Black Maple	chicago_r
15	14 ACER PLATANOIDES	accepted_scientific_name	ACEPLA	Acer platanoides	ACERACEAE	introduced	0	2	UPL	tree	perennial	Norway Maple	chicago_r
16	15 ACER PSEUDOPLATANUS	accepted_scientific_name	ACEPSE	Acer pseudoplatanus	ACERACEAE	introduced	0	2	UPL	tree	perennial	Sycamore Maple	chicago_r
17	16 ACER RUBRUM	accepted_scientific_name	ACERUB	Acer rubrum	ACERACEAE	native	5	0	FAC	tree	perennial	Red Maple	chicago_r
18	17 ACER SACCHARINUM	accepted_scientific_name	ACESAI	Acer saccharinum	ACERACEAE	native	1	-1	FACW	tree	perennial	Silver Maple	chicago_r
19	18 ACER SACCHARUM	accepted_scientific_name	ACESAU	Acer saccharum	ACERACEAE	native	5	1	FACU	tree	perennial	Sugar Maple	chicago_r
20	19 ACER X FREEMANII	accepted_scientific_name	ACEFRE	Acer X freemanii	ACERACEAE	native	0	2	UPL	tree	perennial	Freeman's Maple	chicago_r
21	20 ACHILLEA FILIPENDULINA	accepted_scientific_name	ACHFIL	Achillea filipendulina	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Fern-Leaf Yarrow	chicago_r
22	21 ACHILLEA MILLEFOLIUM	accepted_scientific_name	ACHMIL	Achillea millefolium	ASTERACEAE	introduced	0	1	FACU	forb	perennial	Common Yarrow	chicago_r
23	22 ACHILLEA MILLEFOLIUM CULT. ROSEUM	accepted_scientific_name	ACHMILR	Achillea millefolium cult. roseum	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Rose Yarrow	chicago_r
24	23 ACHILLEA PTARMICA	accepted_scientific_name	ACHPTA	Achillea ptarmica	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Pearl Yarrow	chicago_r
25	24 ACINOS ARVENSIS	accepted_scientific_name	ACIARV	Acinos arvensis	LAMIACEAE	introduced	0	2	UPL	forb	perennial	Mother-Of-Thyme	chicago_r
26	25 ACONITUM AMERICANUS	accepted_scientific_name	ACNAME	Aconitum americanus	FABACEAE	introduced	0	1	FACU	forb	annual	American Deerweed	chicago_r
27	26 ACONITUM UNCINATUM	accepted_scientific_name	ACOUNC	Aconitum uncinatum	RANUNCULACEAE	introduced	0	2	UPL	forb	perennial	Wild Monkshood	chicago_r
28	27 ACORUS AMERICANUS	accepted_scientific_name	ACOAME	Acorus americanus	ACORACEAE	native	9	-2	OBL	forb	perennial	Several-Vein Sweetflag	chicago_r
29	28 ACORUS CALAMUS	accepted_scientific_name	ACOCAL	Acorus calamus	ACORACEAE	introduced	0	-2	OBL	forb	perennial	Single-Vein Sweetflag	chicago_r
30	29 ACROPTILON REPENS	accepted_scientific_name	ACRREP	Acroptilon repens	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Russian Knapweed	chicago_r
31	30 CENTAUREA REPENS	synonym	CENREP	Acroptilon repens	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Russian Knapweed	chicago_r
32	31 ACTAEA PACHYPODA	accepted_scientific_name	ACTPAC	Actaea pachypoda	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Russian Knapweed	chicago_r
33	32 ACTAEA RUBRA	accepted_scientific_name	ACTRUB	Actaea rubra	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Russian Knapweed	chicago_r
34	33 ACTAEA RUBRA SSP. ARGUTA	accepted_scientific_name	ACTRUBA	Actaea rubra ssp. arguta	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Russian Knapweed	chicago_r
35	34 ACTAEA RUBRA	synonym	NA	Actaea rubra ssp. arguta	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Russian Knapweed	chicago_r
36	35 ACTAEA RUBRA SSP. RUBRA	accepted_scientific_name	ACTRUBR	Actaea rubra ssp. rubra	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Russian Knapweed	chicago_r

Foxfoot 2024

https://usace-ecomod.shinyapps.io/fqa_app/

Geoprocessing

Wetland Vegetation Condition Index Calculator

Parameters Environments

Select User Workspace Folder for Storing Output Files

Toolbox

Output Project Name (added as prefix to output file names)

GW

Draw or select AOI polygon

GraingerWoods_AOI

Input species classification raster

GW_SpeciesClass.tif

Select the raster field containing the species name value

CommonName

FQA table for mapping species name to coefficient of conservatism values (C-Value) as .csv

E:\ERDC_Workspace\Projects\2020\EMRRP_Understudied\Task3\Toolbox\FQI\Toolbox_2026feb02\SampleData\chicago_region_2017_2024-09-12.csv

Select the FQA table field containing the species names

common_name

Select the FQA table field containing the C-Value (0-10)

c

Select the FQA table field containing the species names

name

name_origin

acronym

accepted_scientific_name

family

nativity

wetland_indicator

physiognomy

duration

common_name

fqa_db

Select the FQA table field containing the C-Value (0-10)

Field1

name

name_origin

acronym

accepted_scientific_name

family

nativity

c

w

wetland_indicator

physiognomy

duration

common_name

fqa_db



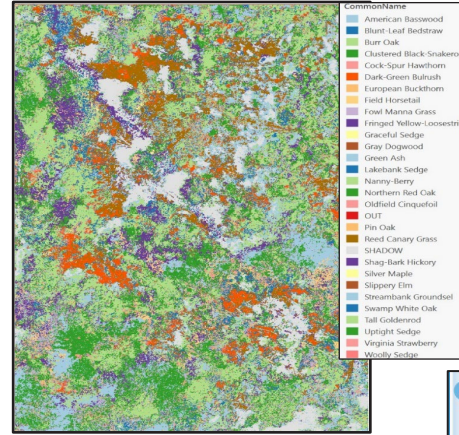
CROSSWALK SPECIES CLASSIFICATION TO FQA TABLE – ASSIGN C-VALUE

UNCLASSIFIED



Species Classification

Field:	Add	Calculate	Selection:	Select By Attributes	Zoom To	Switch
OID	Value	Count	Acronym	SpecieName	CommonName	
1	1	45721	ACESAI	ACER SACCCHARINUM	Silver Maple	
2	2	125448	CAROV	CARYA OVATA	Shag-Bark Hickory	
3	3	208167	CORRAC	CORNUS RACEMOSA	Gray Dogwood	
4	4	32601	CRACRU	CRATAEGUS ACUTIFOLIA	Cock-Spur Hawthorn	
5	5	17877	CXGRAL	CAREX GRACILLIMA	Graceful Sedge	
6	6	191459	CXLACU	CAREX LACUSTRIS	Lakebank Sedge	
7	7	705859	SHADOW	SHADOW	SHADOW	
8	8	96202	CXPELL	CAREX PELLITA	Woolly Sedge	
9	9	87115	CXSTRI	CAREX STRICTA	Upright Sedge	
10	10	169894	EQUARV	EQUISETUM ARVENSE	Field Horsetail	
11	11	30709	FRAPEN	FRAXINUS PENNSYLVANICA	Green Ash	
12	12	15151	FRAVIR	FRAGRARIA VIRGINICA	Wild Strawberry	



FQA Database Table (Regional)

A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	name	name_origin	acronym	accepted_scientific_name	family	nativity	c	w	wetland_indicator	physiognomy	duration	common_name	fqa_db
2	1 ABELMOSCHUS ESCULENTUS	accepted_scientific_name	ABEESC	Abelmoschus esculentus	MALVACEAE	introduced	0	2	UPL	forb	annual	Okra	chicago
3	2 HIBISCUS ESCULENTUS	synonym	HIBESC	Abelmoschus esculentus	MALVACEAE	introduced	0	2	UPL	forb	annual	Okra	chicago
4	3 ABUTLON THEOPHRASTI	accepted_scientific_name	ABUTHE	Abutilon theophrasti	MALVACEAE	introduced	0	1	FACU	forb	annual	Velvetleaf	chicago
5	4 ACALYPHA GRACILIS	accepted_scientific_name	ACAGRA	Acalypha gracilis	EUPHORBIACEAE	native	4	1	FACU	forb	annual	Slender Three-Seed-Mercury	chicago
6	5 ACALYPHA RHOMBOIDEA	accepted_scientific_name	ACABIO	Acalypha rhomboides	EUPHORBIACEAE	native	0	1	FACU	forb	annual	Common Three-Seed-Mercury	chicago
7	6 ACALYPHA VIRGINICA	accepted_scientific_name	ACAVIR	Acalypha virginica	EUPHORBIACEAE	introduced	4	1	FACU	forb	annual	Virginia Three-Seed-Mercury	chicago
8	7 ACANTHOPANAX SIEBOLDIANUS	accepted_scientific_name	ACASIE	Acanthopanax sieboldianus	ARALIACEAE	introduced	0	2	UPL	shrub	perennial	Palmarie Hercules' Club	chicago
9	8 ELEUTHEROCOCCUS SIEBOLDIANUS	synonym	ELESIE	Acanthopanax sieboldianus	ARALIACEAE	introduced	0	2	UPL	shrub	perennial	Palmarie Hercules' Club	chicago
10	9 ACER CAMPESTRE	accepted_scientific_name	ACECAM	Acer campestre	ACERACEAE	introduced	0	2	UPL	tree	perennial	Hedge Maple	chicago
11	10 ACER GINNALA	accepted_scientific_name	ACEGIN	Acer ginnala	ACERACEAE	introduced	0	2	UPL	tree	perennial	Amur Maple	chicago
12	11 ACER NEGUNDO	accepted_scientific_name	ACENEG	Acer negundo	ACERACEAE	native	0	0	FAC	tree	perennial	Ash-Leaf Maple	chicago
13	12 ACER NEGUNDO VAR. VIOLACEUM	synonym	ACENEGV	Acer negundo	ACERACEAE	native	0	0	FAC	tree	perennial	Ash-Leaf Maple	chicago
14	13 ACER NIGRUM	accepted_scientific_name	ACENIG	Acer nigrum	ACERACEAE	native	5	1	FACU	tree	perennial	Black Maple	chicago
15	14 ACER PLATANOIDES	accepted_scientific_name	ACEPLA	Acer platanoides	ACERACEAE	introduced	0	2	UPL	tree	perennial	Norway Maple	chicago
16	15 ACER PSEUDOPLATANUS	accepted_scientific_name	ACEPSE	Acer pseudoplatanus	ACERACEAE	introduced	0	2	UPL	tree	perennial	Sycamore Maple	chicago
17	16 ACER RUBRUM	accepted_scientific_name	ACERUB	Acer rubrum	ACERACEAE	native	5	0	FAC	tree	perennial	Red Maple	chicago
18	17 ACER SACCCHARINUM	accepted_scientific_name	ACESAU	Acer saccharinum	ACERACEAE	native	1	-1	FACW	tree	perennial	Silver Maple	chicago
19	18 ACER SACCCHARINUM	accepted_scientific_name	ACESAU	Acer saccharum	ACERACEAE	native	5	1	FACU	tree	perennial	Sugar Maple	chicago
20	19 ACER X FREEMANII	accepted_scientific_name	ACEFRE	Acer x freemanii	ACERACEAE	native	0	2	UPL	tree	perennial	Freeman's Maple	chicago
21	20 ACHILLEA FILIPENDULA	accepted_scientific_name	ACHFIL	Achillea filipendula	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Fern-Leaf Yarrow	chicago
22	21 ACHILLEA MILLEFOLIUM	accepted_scientific_name	ACHMIL	Achillea millefolium	ASTERACEAE	introduced	0	1	FACU	forb	perennial	Common Yarrow	chicago
23	22 ACHILLEA MILLEFOLIUM CULT. ROSEUM	accepted_scientific_name	ACHMILR	Achillea millefolium cult. roseum	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Rose Yarrow	chicago
24	23 ACHILLEA PTARMICA	accepted_scientific_name	ACHPTA	Achillea ptarmica	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Pearl Yarrow	chicago
25	24 ACINOS ARVENSIS	accepted_scientific_name	ACIARV	Acinos arvensis	LAMIACEAE	introduced	0	2	UPL	forb	perennial	Mother-Of-Thyme	chicago
26	25 ACNISPON AMERICANUS	accepted_scientific_name	ACAMAME	Acnispom americanus	FABACEAE	introduced	0	1	FACU	forb	annual	American Deersweed	chicago
27	26 ACNISPON UNICATUM	accepted_scientific_name	ACOUNC	Acnispom uncatum	RANUNCULACEAE	introduced	0	2	UPL	forb	perennial	Wild Monkshood	chicago
28	27 ACORUS AMERICANUS	accepted_scientific_name	ACOMAME	Acorus americanus	ACORACEAE	native	9	-2	DBL	forb	perennial	Several-Vein Sweetflag	chicago
29	28 ACORUS CALAMUS	accepted_scientific_name	ACOCAL	Acorus calamus	ACORACEAE	introduced	0	-2	DBL	forb	perennial	Single-Vein Sweetflag	chicago
30	29 ACROPTILON REPENS	accepted_scientific_name	ACREPR	Acroptilon repens	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Russian Knapweed	chicago
31	30 CENTAUREA REPENS	synonym	CENREP	Acroptilon repens	ASTERACEAE	introduced	0	2	UPL	forb	perennial	Russian Knapweed	chicago
32	31 ACTAEA PACHYPODA	accepted_scientific_name	ACTPAC	Actaea pachyoda	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Black Cohosh	chicago
33	32 ACTAEA RUBRA	accepted_scientific_name	ACTRUB	Actaea rubra	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Red Cohosh	chicago
34	33 ACTAEA RUBRA SSP. ARGUTA	accepted_scientific_name	ACTRUBA	Actaea rubra ssp. arguta	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Red Cohosh	chicago
35	34 ACTAEA RUBRA	synonym	NA	Actaea rubra ssp. arguta	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Red Cohosh	chicago
36	35 ACTAEA RUBRA	accepted_scientific_name	ACTRUBR	Actaea rubra ssp. rubra	RANUNCULACEAE	native	8	1	FACU	forb	perennial	Red Cohosh	chicago

Select input species from raster for crosswalk to the FQA table species

Species Name (v) FQA Table Value

Input Species Name: American Basswood, Blunt-Leaf Bedstraw, Burr Oak, Clustered Black-Snakeroot, Cock-Spur Hawthorn, Dark-Green Bulrush, European Buckthorn

Select input species from raster for crosswalk to the FQA table species

Species Name (v) FQA Table Value

Input Species Name: American Basswood, Blunt-Leaf Bedstraw, Burr Oak, Clustered Black-Snakeroot, Cock-Spur Hawthorn, Dark-Green Bulrush, European Buckthorn

Geoprocessing

Wetland Vegetation Condition Index Calculator

Parameters Environments

Select User Workspace Folder for Storing Output Files

Toolbox

Output Project Name (added as prefix to output file names)

GW

Draw or select AOI polygon

GraingerWoods_AOI

Input species classification raster

GW_SpeciesClass.tif

Select the raster field containing the species name value

CommonName

FQA table for mapping species name to coefficient of conservatism values (C-Value) as .csv

E:\ERDC_Workspace\Projects\2020\EMRRP_Understudied\Task3\Toolbox\FQA\Toolbox_2020Feb02\SampleData\2\chicago_region_2017_2024-09-12.csv

Select the FQA table field containing the species names

common_name

Select the FQA table field containing the C-Value (0-10)

c

Select input species from raster for crosswalk to the FQA table species

Species Name (v) FQA Table Value

American Basswood American Basswood

Blunt-Leaf Bedstraw Blunt-Leaf Bedstraw

Burr Oak Burr Oak

Clustered Black-Snakeroot Clustered Black-Snakeroot

Cock-Spur Hawthorn Cock-Spur Hawthorn

Dark-Green Bulrush Dark-Green Bulrush

European Buckthorn European Buckthorn

Field Horsetail Field Horsetail

Fowl Manna Grass Fowl Manna Grass

Fringed Yellow-Loosestrife Fringed Yellow-Loosestrife

Graceful Sedge Graceful Sedge

Gray Dogwood Gray Dogwood

Green Ash Green Ash

Hop Sedge Hop Sedge

Lakebank Sedge Lakebank Sedge

Nanny-Berry Nanny-Berry

Northern Red Oak Northern Red Oak

Oldfield Cinquefoil Oldfield Cinquefoil

Pin Oak Pin Oak

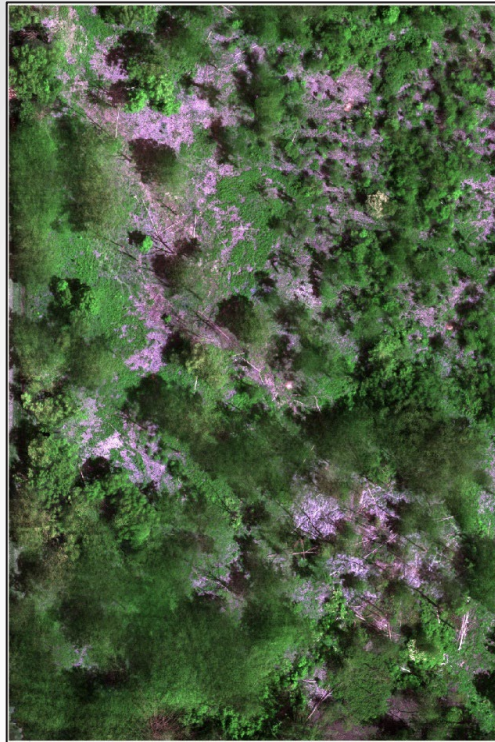


GENERATE NDVI

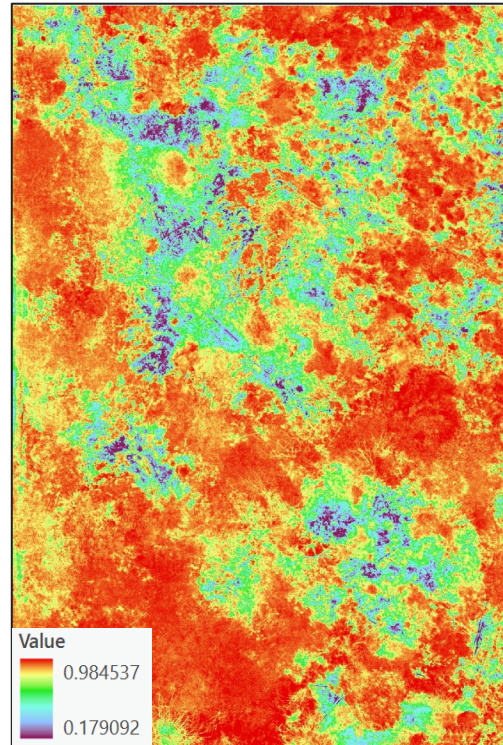
UNCLASSIFIED



Multispectral Image



NDVI



Input multispectral or hyperspectral raster
GW_5band_4cm_raw_10Jun2025.dat

Select red band (~680nm) from multispectral or hyperspectral raster
Red

Select near infrared band (~950nm) from multispectral or hyperspectral raster
NIR

Output spatial reference (projected coordinate system)
WGS_1984_UTM_Zone_16N

Run

Select red band (~680nm) from multispectral or hyperspectral raster

Blue

Green

Red

Red_Edge

NIR

Select near infrared band (~950nm) from multispectral or hyperspectral raster

Blue

Green

Red

Red_Edge

NIR

UNCLASSIFIED



WVCI CALCULATOR OUTPUT

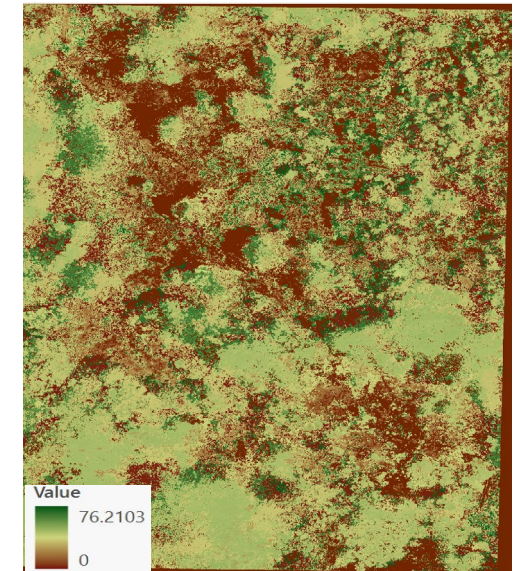


WVCI

Primary Output:

WVCI Raster:

Distribution map of vegetation condition, from 0 (low) to 100(high)



Secondary Outputs (Statistical Tables):

- AOI Statistics (.csv):

Area-wide metrics like Total Species Richness, Mean C-Value, and Mean WVCI

AOI Statistics		
	A	B
1	Total Species Richness	28
2	Native Species Richness	26
3	Introduced Species Richness	2
4	MeanC	3.892857
5	WVCI_mean	35.69318
6		
7		

- Species-Specific Statistics (.csv):

Details the area, percent cover, and C-value for each species in the project area

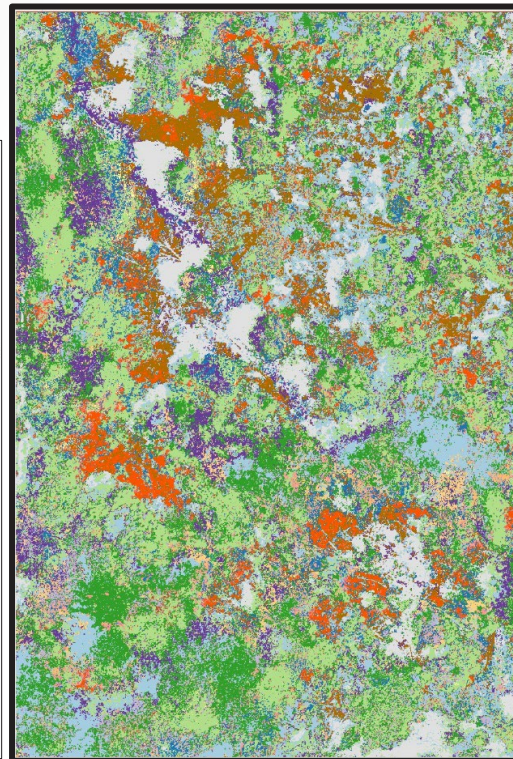
	A	B	C	D	E	F	G	H
1	OBJECTID	Value	SpecieName	CLASS_CODE	Count	Area	pct_cvr	cvalue
2	1	1	ACER SACCHARINUM	1	44832	102.7342	0.60027539	1
3	2	1	CARYA OVATA	2	124002	284.1552	1.66031739	5
4	3	1	CORNUS RACEMOSA	3	202417	463.846	2.71025037	1
5	4	1	CRATAEGUS ACUTIFOLIA	4	31734	72.71963	0.4249005	7
6	5	1	CAREX GRACILLIMA	5	17492	40.08356	0.23420809	7
7	6	1	CAREX LACUSTRIS	6	185400	424.8509	2.48240226	5
8	7	1	CAREX PELLITA	8	93424	214.0845	1.25089508	4
9	8	1	CAREX STRICTA	9	83258	190.7888	1.11477803	5
10	9	1	EQUISETUM ARVENSE	10	161702	370.5461	2.1650993	0
11	10	1	FRAXINUS PENNSYLVANICA SUBINTEGERR	11	29075	66.62644	0.38929798	4
12	11	1	FRAGARIA VIRGINIANA	12	14696	33.67643	0.19677122	0
13	12	1	GALIUM OBTUSUM	13	230698	528.653	3.08891713	5
14	13	1	GLYCERIA STRIATA	14	242866	556.5364	3.25183984	4
15	14	1	LYSIMACHIA CILIATA	15	490722	1124.508	6.57049299	7
16	15	1	PACKERA PSEUDAUREA VAR. SEMICORDAT	16	618517	1417.355	8.28159654	8
17	16	1	PHALARIS ARUNDINACEA	17	431693	989.2404	5.78012771	0
18	17	1	POTENTILLA SIMPLEX	18	150377	344.5944	2.01346389	3
19	18	1	QUERCUS BICOLOR	19	207636	475.8056	2.78012986	5
20	19	1	QUERCUS MACROCARPA	20	388191	889.554	5.19766028	5
21	20	1	QUERCUS PALUSTRIS	21	90770	208.0028	1.21535951	5
22	21	1	QUERCUS RUBRA	22	519290	1189.972	6.95300253	5
23	22	1	RHAMNUS CATHARTICA	23	51079	117.0494	0.68391923	0
24	23	1	SANICULA GREGARIA	24	709150	1625.043	9.49512169	5
25	24	1	SCIRPUS ATROVIRENS	25	315413	722.7805	4.34512169	5
26	25	1	SOLIDAGO ALTISSIMA	26	69455	156.455	0.86512169	5
27	26	1	TILIA AMERICANA	27	156455	351.455	2.1650993	0
28	27	1	ULMUS RUBRA	28	156455	351.455	2.1650993	0
28	28	1	VIBURNUM LENTAGO	28	156455	351.455	2.1650993	0



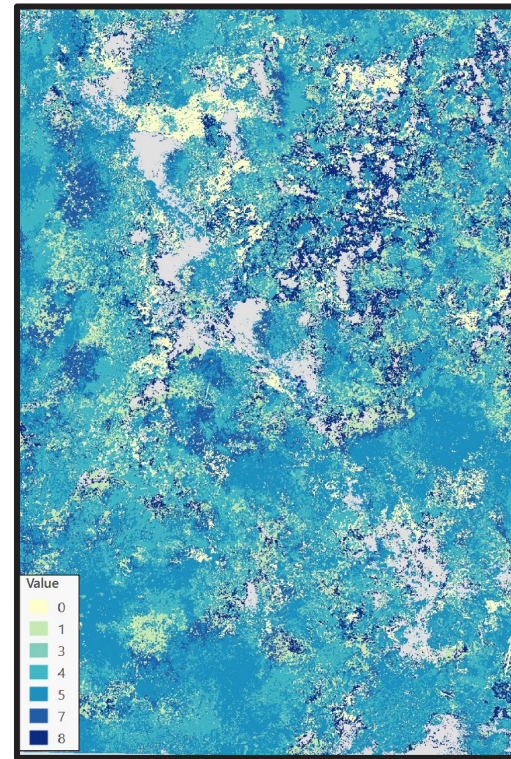
WVCI CALCULATOR OUTPUT

$$\text{WVCI} = (\text{NDVI} \times \text{C}) \times 10$$

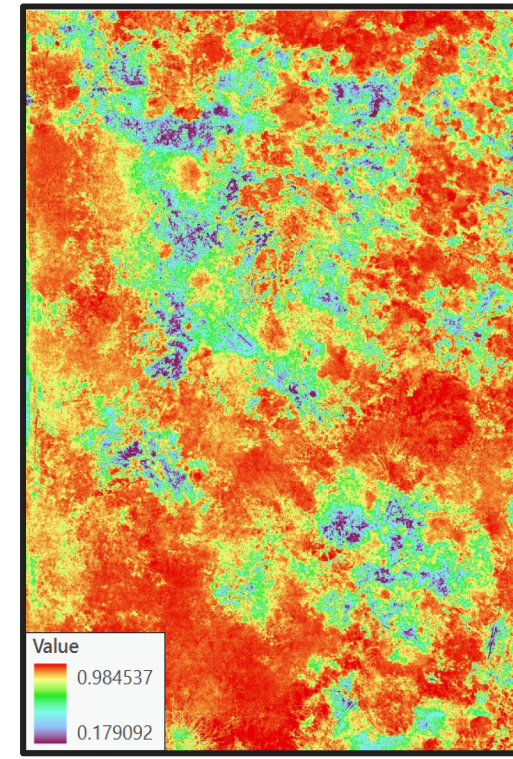
CommonName	
	American Basswood
	Blunt-Leaf Bedstraw
	Burr Oak
	Clustered Black-Snakeroot
	Cock-Spur Hawthorn
	Dark-Green Bulrush
	European Buckthorn
	Field Horsetail
	Fowl Manna Grass
	Fringed Yellow-Loosestrife
	Graceful Sedge
	Gray Dogwood
	Green Ash
	Lakebank Sedge
	Nanny-Berry
	Northern Red Oak
	Oldfield Cinquefoil
	OUT
	Pin Oak
	Reed Canary Grass
	SHADOW
	Shag-Bark Hickory
	Silver Maple
	Slippery Elm
	Streambank Groundsel
	Swamp White Oak
	Tall Goldenrod
	Upright Sedge
	Virginia Strawberry
	Woolly Sedge



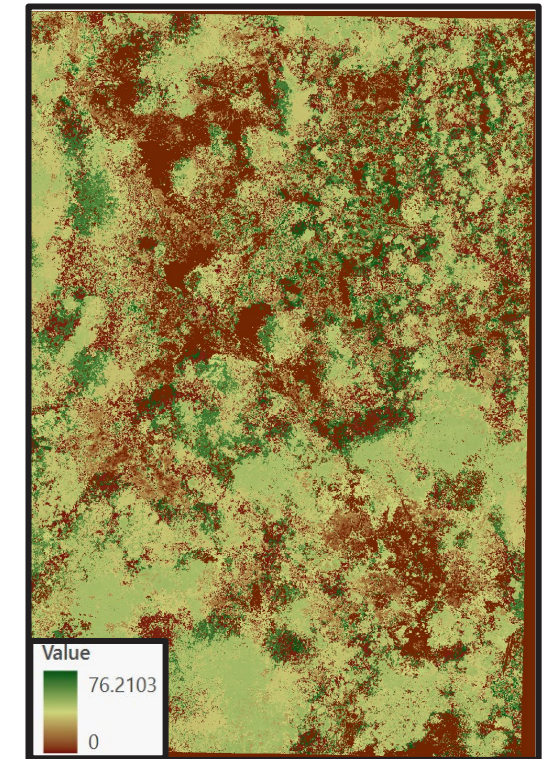
Species Classification



C-Value



NDVI



WVCI

Grainger Woods Conservation Preserve, IL



WVCI ALGORITHM EVALUATION

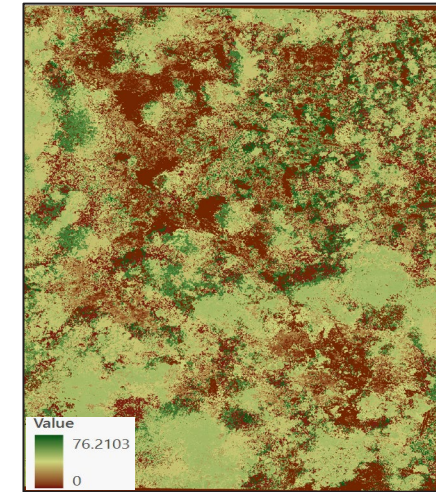
PURPOSE AND INPUTS



Purpose: To validate the remotely-sensed WVCI results against field-measured FQI values. Performs a linear regression to assess the statistical relationship between the WVCI raster values and FQI values from field plots.

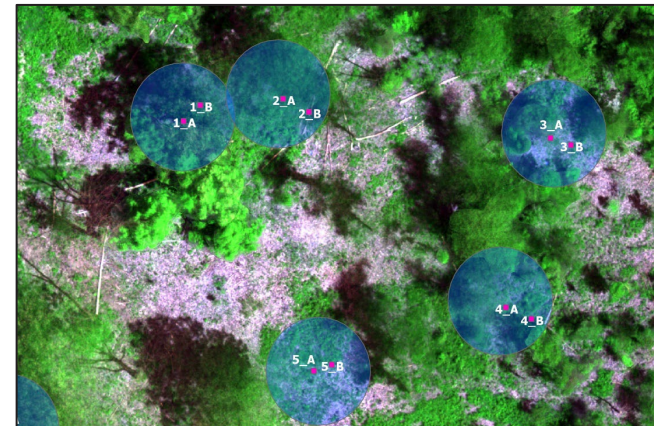
Required Inputs:

- WVCI Raster:
Calculator tool output
- In-situ Plot Feature Layer:
Polygon layer of field sample plots containing fields
 - Unique ID
 - Field-derived FQI value for each plot.



WVCI

Plot Locations



Plot Attribute Table

GraingerWoods_Plots						
Field: Add Calculate			Selection: Select By Attributes Zoom To			
FID	Shape *	UID	PlotNo	QuadratNo	FQI	
1	1	Polygon 1_A	1	A	4	
2	3	Polygon 1_B	1	B	10.1	
3	4	Polygon 2_A	2	A	7.8	
4	5	Polygon 2_B	2	B	10.3	
5	8	Polygon 3_A	3	A	7.3	
6	6	Polygon 3_B	3	B	8.8	
7	9	Polygon 4_A	4	A	10.3	
8	10	Polygon 4_B	4	B	13.6	
9	11	Polygon 5_A	5	A		
10	12	Polygon 5_B				
		Polygon 6_A				



WVCI ALGORITHM EVALUATION WORKFLOW



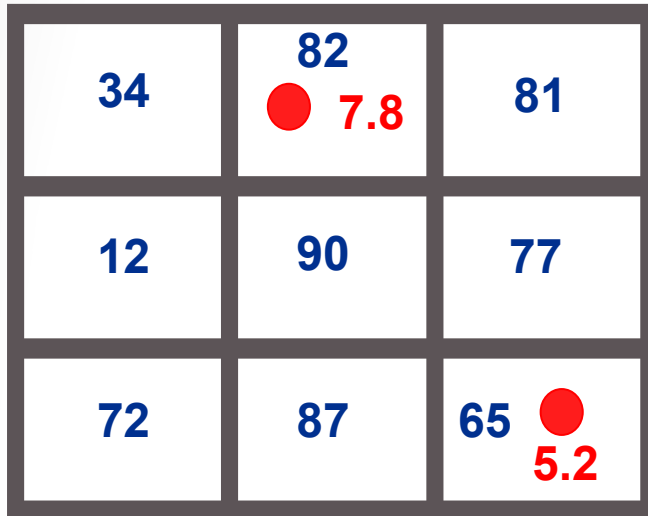
Workflow:

1. Locates centroid of each field plot polygon
2. Extracts the WVCI pixel value at each centroid location
3. Performs linear regression analysis comparing the plot's field FQI value to the extracted WVCI value

The screenshot shows the 'WVCI Algorithm Evaluation' tool in the Geoprocessing pane. It has two tabs: 'Parameters' and 'Environments'. The 'Parameters' tab is active, showing the following settings:

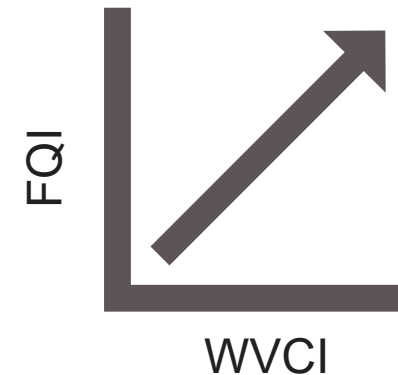
- 1. User Workspace Folder for Storing Output Files: [Empty text box]
- 2. WVCI Raster File: [Empty text box]
- 3. In Situ plot/quadrat feature layer (as a polygon): [Empty text box]
- 4. Field containing the unique station id: [Empty text box]
- 5. Field containing the FQI value: [Empty text box]
- 6. ☐ Create Ordinary Least Square Regression Report
- 7. Run button

WVCI Raster Grid



Polygon Attribute Table

	A	B	C	D	E
1	UID	PlotNo	QuadratNo	FQI	WVCI
2	1_A	1 A		7.8	82
3	1_B	1 B		5.2	65





WVCI ALGORITHM EVALUATION OUTPUTS



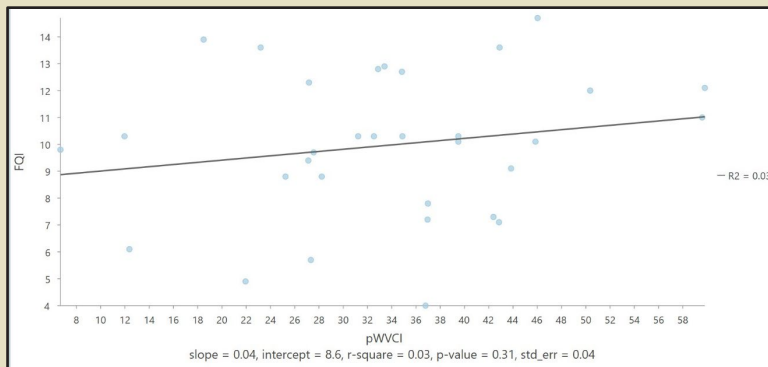
Key Outputs:

- Linear Regression Graph (.svg): Visualizes the relationship and provides key statistics (R^2 , p-value, slope)
- (Optional) OLS Report (.pdf): Detailed statistical report and point feature layer from an Ordinary Least Squares analysis for deeper diagnostic checking

STANDARD

POINT_X	POINT_Y	Depth	SpeciesNot	Shape_Leng	FQI	ORIG_FID	pWVCI	ptid
3835	30.051294	0	Torpedo grass dominant...	50.221709	7.156	0	1.250998	1
3631	30.053398	0	Mostly torpedo grass wi...	50.221695	12.86	1	21.39002	2
1876	30.053287	0	Mixed plot of laying do...	50.221652	13.82	2	18.61585	3
6198	30.051098	0	Mixed plot of spartina p...	50.22174	12.02	4	17.79629	4
2553	30.051239	0	Center is mixed mats of...	50.2218	10.96	5	23.07833	5
2763	30.05256	20	Plot center @ pond edg...	50.221748	14.43	6	18.95695	6
5429	30.05299	0	Torpedo grass dominant...	50.22157	9.39	7	9.396542	7

Point Layer
(All Plots with WVCI value)

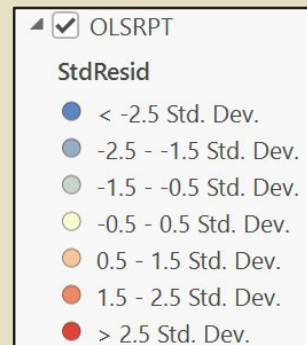


Linear
Regression
Graph
(svg)

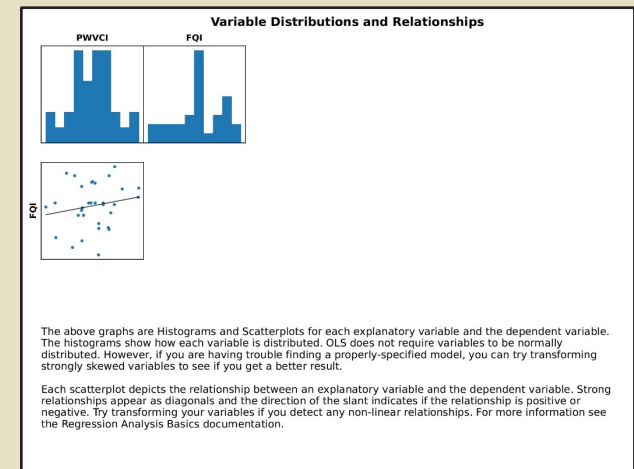
OPTIONAL

☒ Create ordinary least square regression report

Point Layer
(OLSR statistics)



OLRS PDF Statistical Report



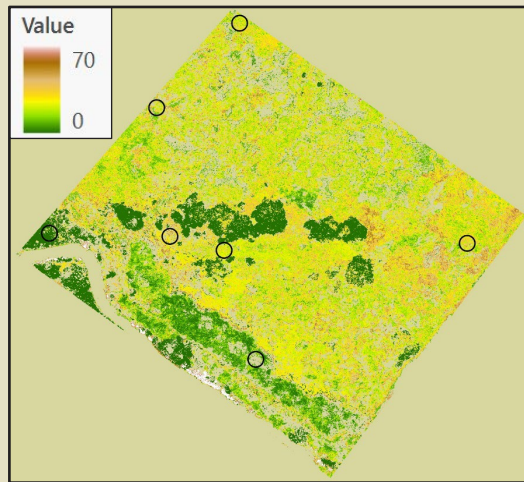


EXAMPLES

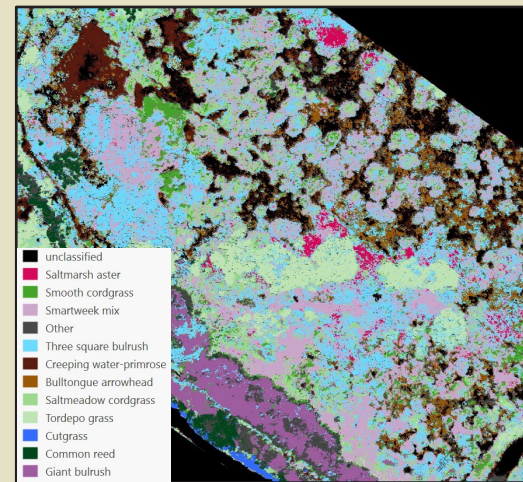
UNCLASSIFIED



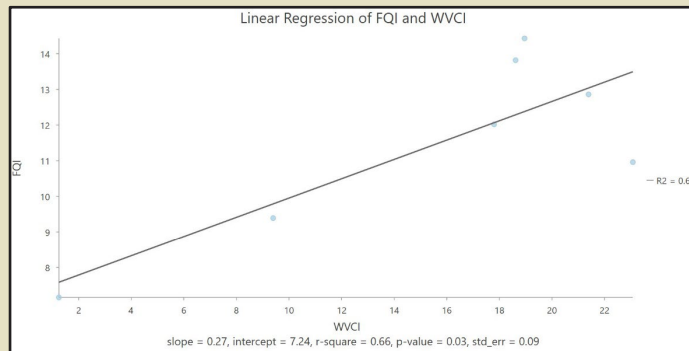
Labranche Wetland, Louisiana Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA)



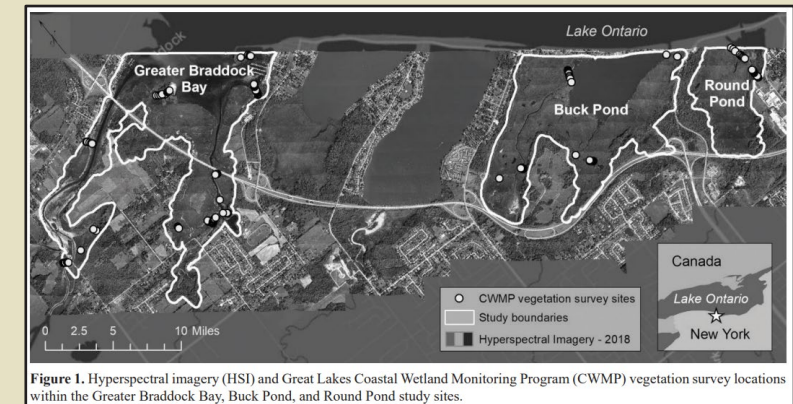
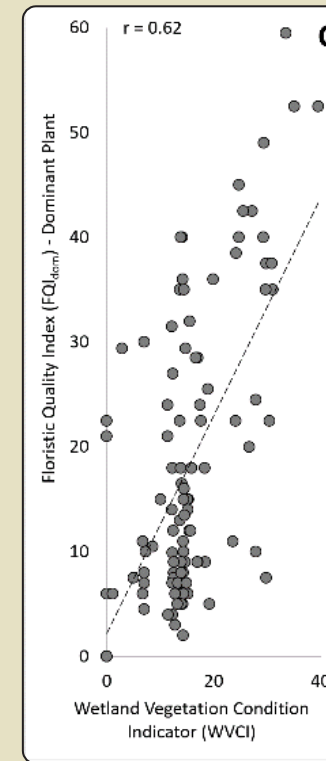
WVCI



Species Raster



Greater Braddock Bay, Buck Pond, and Round Pond study sites Great Lakes Coastal Wetland Monitoring Program (CWMP)





CONCLUSION & BENEFITS



The WVCI toolbox provides a scalable and repeatable workflow for wetland condition analysis

Key Benefits:

Enhanced Decision Making: Provides a comprehensive, synoptic view of an entire project area, highlighting areas of high or low quality

Increased Operational Efficiency: Automates manual workflows to optimize performance

Modernization & Standardization: Offers a data-driven, modern alternative that complements traditional field surveys



FUTURE DIRECTION



Future Enhancements:

- Higher Quality Data:
Integrating data from new satellite constellations with better temporal and spatial resolution to improve accuracy and timing.
- Machine Learning Integration:
Incorporating ML models to automate the initial species classification step—often the most challenging part of the workflow.

QUESTIONS AND DISCUSSION

WVCI Toolbox, draft user's guide, and sample data are available for download from the ERDC Knowledge Core

<https://dx.doi.org/10.21079/11681/50181>



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