

BUILDING MODEL CAPACITY FOR ECOSYSTEM RESTORATION AND MITIGATION PLANNING

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Lilium michiganense (C Value 8)
Photo Credit: Robbie Sliwinski



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How to measure ecosystems?

- “You can’t manage what you can’t measure”
- Restoration and environmental mitigation projects require evaluating potential environmental impacts, ensuring environmental compliance and/or benefits, and comparing restoration alternatives
- Floristic Quality Assessment can do those things



Geum triflorum (C Value 10)
Photo Credit: Robbie Sliwinski

What is Floristic Quality Assessment?



- FQA evaluates the level of disturbance in an area of interest based on the plant species that are present
- FQA works by assigning each plant a Coefficient of Conservatism (C Value) from 0-10. 0 = high tolerance for disturbance, while 10 = high fidelity to undisturbed habitat. These scores are then used to calculate metrics
- Typically introduced species are assigned a C value of 0



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FQA Terms



- FQA / FQAI
- FQA database / FQA model / FQA list / FQAI
- Introduced / non-native / invasive

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FQA in different regions

- There are numerous regional FQA databases of flora and their associated C values covering various geographic areas
- C values are assigned to some or all species in a region by a group of expert botanists



Pinus Ponderosa
C Value = 0 (Kansas)
C Value = 4 (Wyoming)
source: inaturalist user
taitsougstad

FQA metrics

- Species Richness: total number of species
- Native species richness: total number of native species
- **Mean C**: Mean coefficient of conservatism
- **FQI**: Mean C multiplied by the square root of species richness
- Adjusted FQI: 100 multiplied by the Native Mean C over 10, multiplied by the square root of Native Species Richness over Total Species Richness.

FQA example



Ranunculus sardous

C Value = 0

source: inaturalist user mjpluskids



Arnoglossum plantagineum

C Value = 8

source: inaturalist user timarcus

Species Richness: 2
Native species richness: 1
Mean C: 4
FQI: 5.66
Adjusted FQI: 56.57

The state of FQA

- FQA widely used by state & federal agencies, and others
- No central repository for FQA databases. Universal FQA calculator has some but not all databases
- FQA databases have varying quality and/or levels of documentation



Project goals

- Evaluate quality of FQA databases and decide which ones are good enough for use in USACE planning
- Create a centralized repository of all approved databases
- Develop a FQA calculator to calculate metrics based on approved databases



Opuntia humifusa
Photo credit Robbie Sliwinski

Phase 1 goals

1. Identify current FQA databases to be reviewed
2. Formulate a comprehensive review plan in coordination with Ecosystem Restoration National Planning Center of Expertise (ECO-PCX)
3. Review and certify eligible regional databases
4. Create a factsheet for each approved regional database

ECO-PCX review

A score of 1-5 was assigned per regional FQA database based on five review criteria:

1. Accessibility
2. Well documented
3. Limitations described
4. Good methodology when assigning C values
5. Published case study

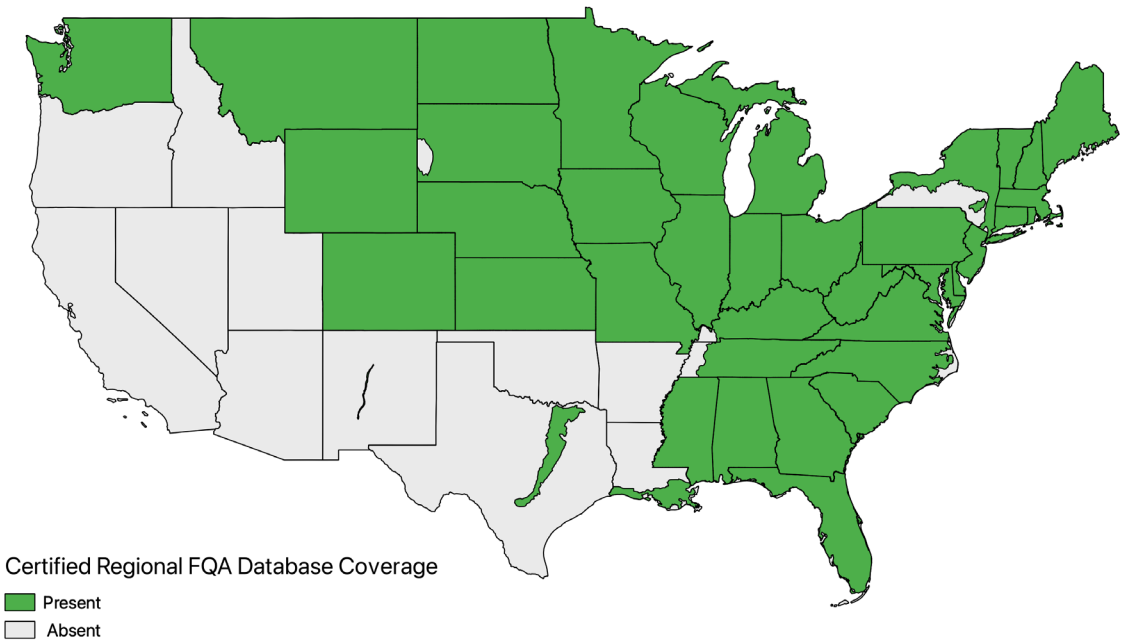
Those with scores of 4 or 5 are recommended for approval. Those recommended with reservations did not have published applications or had another regional database that overlapped part of the same area/region of concern and was found to perform better.

Phase 1 results

Summary	# Regional Lists
Reviewed	76
Recommended	42
Rec with reservations	6
Previously Cert	4
Not Recommended	24

48 regional FQA databases approved for regional use by ECO-PCX

A factsheet was produced for each regional FQA database



Phase 2 goals

1. Create a repository of all approved regional databases
2. Develop a consistent and reliable calculator
3. Create a document describing FQA background, demonstrating FQA calculator, and acting as a user guide

Data acquisition & cleaning

- Acquired all approved regional databases
- Data cleaning and formatting



Koeleria macrantha
C Value = 6
116 Synonyms!!!
source: inaturalist user [kaiserlu06](#)

R package development

- Developed two R packages: fqacalc and fqadata
- Both hosted on CRAN
- R is popular with ecologists
- Can connect with other R packages
- R packages/CRAN enforces structure, documentation, and testing standards
- Comes with user guide, help files, data documentation



R user guide

fqacalc: Calculate Floristic Quality Assessment Metrics

A collection of functions for calculating Floristic Quality Assessment (FQA) metrics using regional FQA databases that have been approved or approved with reservations as ecological planning models by the U.S. Army Corps of Engineers (USACE). For information on FQA see Spyreas (2019) <[doi:10.1002/ecs2.2825](https://doi.org/10.1002/ecs2.2825)>. These databases are stored in a sister R package, 'fqadata'. Both packages were developed for the USACE by the U.S. Army Engineer Research and Development Center's Environmental Laboratory.

Version: 1.1.0
Depends: R (≥ 2.10)
Imports: [dplyr](#), [fqadata](#) (≥ 1.1.0), [magrittr](#), [rlang](#)
Suggests: [knitr](#), [rmarkdown](#), [testthat](#) (≥ 3.0.0)
Published: 2023-09-26
DOI: [10.32614/CRAN.package.fqacalc](https://doi.org/10.32614/CRAN.package.fqacalc)
Author: Iris Foxfoot [aut, cre], U.S. Army Engineer Research and Development Center [cph, fnd]
Maintainer: Iris Foxfoot <iris.r.foxfoot@usace.army.mil>
License: [MIT](#) + file [LICENSE](#)
NeedsCompilation: no

Materials: [README NEWS](#)
CRAN checks: [fqacalc results](#)

Documentation:

Reference manual: [fqacalc.pdf](#)
Vignettes: [Introduction](#)

Downloads:

Package source: [fqacalc_1.1.0.tar.gz](#)
Windows binaries: r-devel: [fqacalc_1.1.0.zip](#), r-release: [fqacalc_1.1.0.zip](#), r-oldrel: [fqacalc_1.1.0.zip](#)
macOS binaries: r-release (arm64): [fqacalc_1.1.0.tgz](#), r-oldrel (arm64): [fqacalc_1.1.0.tgz](#), r-release (x86_64): [fqacalc_1.1.0.tgz](#), r-oldrel (x86_64): [fqacalc_1.1.0.tgz](#)
Old sources: [fqacalc archive](#)

Linking:

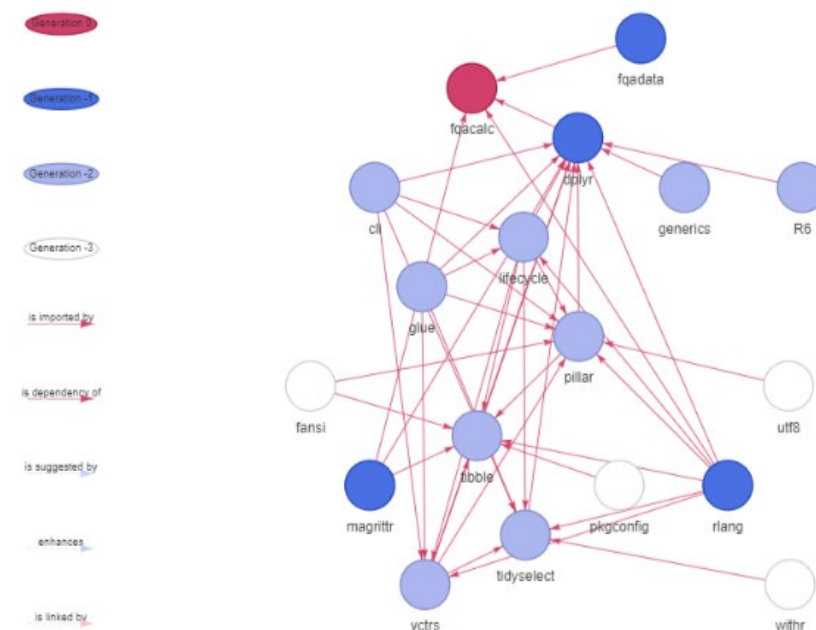
Please use the canonical form <https://CRAN.R-project.org/package=fqacalc> to link to this page.



Open source coding practices

- Open source code is code that anyone can view, change, and improve
- Part of NextGen strategy is developing more OS models
- Promotes transparency, interoperability, and advancement
- Open source environment is constantly changing

cranly dependence tree for package names with
"fqacalc"
CRAN database version
Tue, 13 Aug 2024, 15:01



- Fqacalc package downloaded 2938 times
- Fqadata package downloaded 3494 times
- Ecological Society of America conference 2023
- R packages cited in 1 paper
- Appears in one R blog (Top 40 R packages of April 2023)

Shiny app development

- Shiny app provides a graphical user interface for R both packages
- Developed by EcoMod, hosted by ITL
- <https://fqacalc.erdcdren.mil/fqacalc/>



Shiny app challenges

Challenges associated with creating a usable and shareable end-product

- Application testing with subject matter experts
- Personally identifiable information and saving data
- Aligning with branding guidelines
- Deciding when a project is complete

Shiny app results

Floristic Quality Assessment

Floristic Quality Assessment (FQA) provides a standardized way to rapidly assess the condition of a vegetated area based on the plant species that are present. FQA works by assigning each plant species a value from 0 to 10. This value is called a Coefficient of Conservatism, or C Value. Values of 0 indicate species that are highly tolerant of human activities and have general environmental needs, while higher values represent higher fidelity to a specific habitat and low tolerance to anthropogenic disturbances. Generally, C values are assigned to either an entire inventory or selected plant species in a region, which may be an entire state (e.g., IN), biome (e.g., Interior Plateau), or specific location (e.g., Middle Rio Grande floodplain) by a group of expert regional botanists. As a result, there are numerous regional FQA databases of flora and their associated C Values covering various geographic areas.

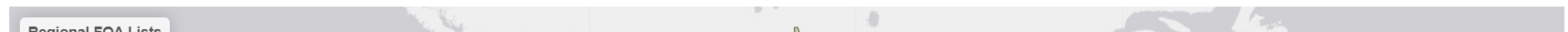
FQA Databases

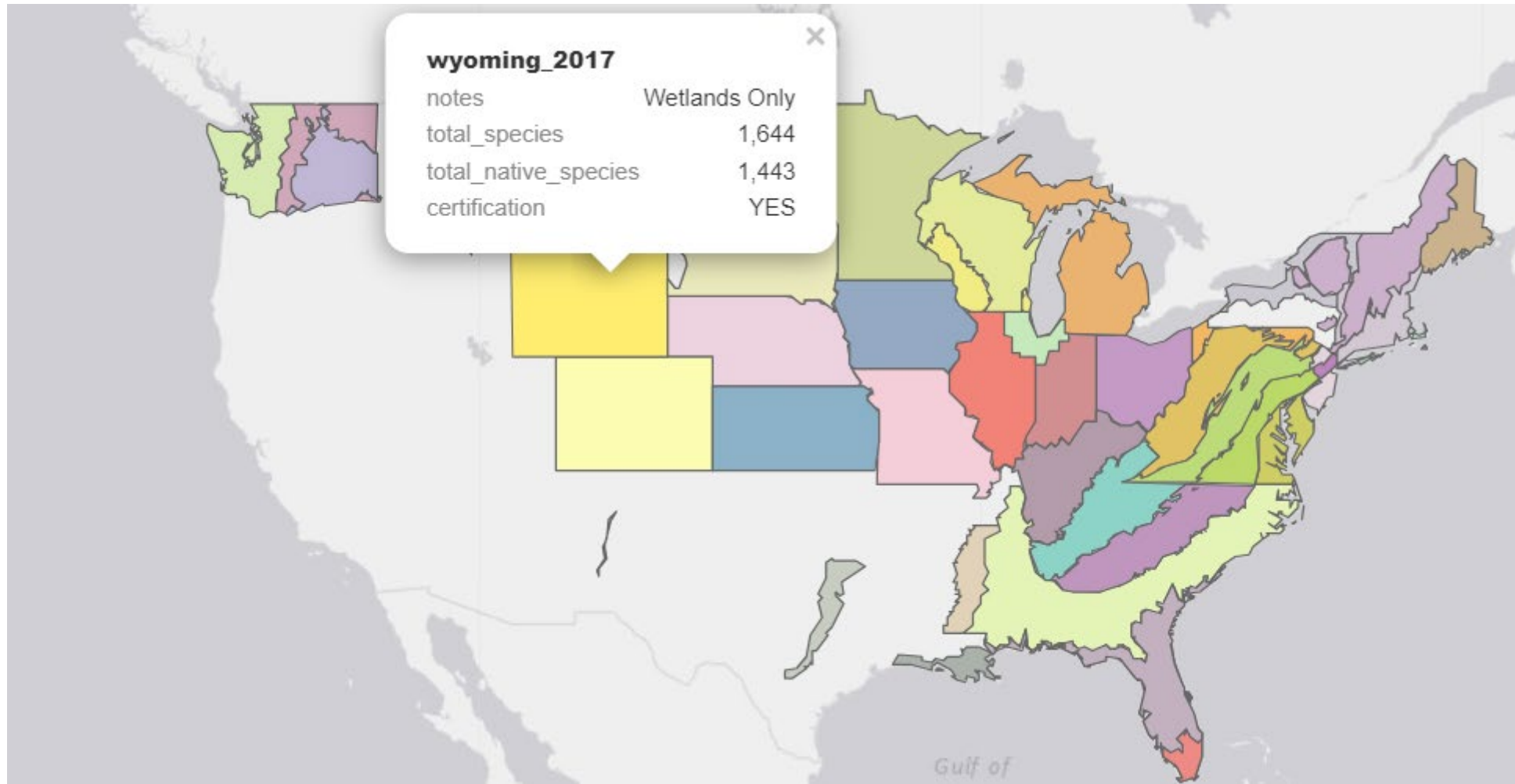
In 2022, published, accessible (e.g., Universal FQA Calculator or via Google search with key terms) regional FQA databases were reviewed by the U.S. Army Engineer Research and Development Center's Environmental Laboratory for use during the planning phase of water resource projects. FQA databases that had clear documentation of their methodology of assigning and testing/validating their C Values were recommended for planning model certification. Then the U.S. Army Corps of Engineers' Center of Ecosystem Restoration Expertise certified recommended regional FQA databases for USACE planning purposes. Certified regional FQA databases have been compiled and made available for rapid and consistent calculation of FQA metrics within this web application.

Note that *some* of the certified regional FQA databases have been altered slightly from their initial lists to reduce redundancies, indicate which species names are synonyms, or otherwise clarify the data. For a full description of data alterations, see Herman et al., 2023 (in review).

Common floristic quality metrics include Mean C (the mean of C Values for all species present in an inventory or along a transect) and the Floristic Quality Index (FQI, the Mean C multiplied by the square root of the total number of species).

Take a look at what regional FQA database might be applicable in your area:





Select Regional FQA Database

michigan_2014 ▾

 Download

Citation

Reznicek, A.A., M.R. Penskar, B.S. Walters, and B.S. Slaughter. 2014. Michigan Floristic Quality Assessment Database. Herbarium, University of Michigan, Ann Arbor, MI and Michigan Natural Features Inventory, Michigan State University, Lansing, MI. <http://michiganflora.net>

Search: _____

	name	name_origin	acronym	accepted_scientific_name	family	nativity	c	w	wetland_indicator	physiognomy	durati
1	ABELMOSCHUS ESCULENTUS	accepted_scientific_name	ABEESC	Abelmoschus esculentus	Malvaceae	introduced	0	5		forb	annua
2	ABIES BALSAMEA	accepted_scientific_name	ABIBAL	Abies balsamea	Pinaceae	native	3	0		tree	pereni
3	ABUTILON THEOPHRASTI	accepted_scientific_name	ABUTHE	Abutilon theophrasti	Malvaceae	introduced	0	3		forb	annua
4	ACALYPHA GRACILENS	accepted_scientific_name	ACAGRA	Acalypha gracilens	Euphorbiaceae	introduced	0	3		forb	annua
5	ACALYPHA	accepted_scientific_name	ACAOST	Acalypha ostryifolia	Euphorbiaceae	introduced	0	5		forb	annua

Enter Data



Select Regional FQA Database

mississippi_north_central_wetlands_2005 ▾

Select Data Entry Method

- ☒ Enter Species Manually
- ☐ Upload a File

Select Species

Add
Species

Delete Species

Delete All Entries

Calculate FQA Metrics →

	name	name_origin	acronym	accepted_scientific_name	family	nativity	c
1	ARNOGLOSSUM PLANTAGINEUM	accepted_scientific_name		Arnoglossum plantagineum	Asteraceae	native	8
2	RANUNCULUS SARDOUS	accepted_scientific_name		Ranunculus sardous	Ranunculaceae	introduced	0

Showing 1 to 2 of 2 entries



The screenshot shows the 'Enter Data' section of a web application. At the top, there are navigation links: 'About FQA', 'View Regional FQA Databases', and 'Calculate Inventory'. The main heading is 'Enter Data'. Below it is a dropdown menu for 'Select Regional FQA Database' with 'michigan_2014' selected. Under 'Enter Species Using:', there are two buttons: 'Scientific Names' (selected) and 'Acronyms'. The 'Select Data Entry Method' section has two radio buttons: 'Enter Species Manually' (selected) and 'Upload a File'. Below this is a 'Select Species' input field with an 'Add Species' button to its right. At the bottom, there are two buttons: 'Delete Species' and 'Delete All Entries'.

Inventory Instructions

Step 1. Select your regional FQA of interest. If you are unsure about which regional FQA database to use, consult the map on the 'About FQA' tab.

Step 2. Decide if you would like to enter observations manually or if you would like to upload a file.

Step 3. To upload a file, select a file from your device. The file must be a .csv, .tsv, or .xlsx file. The file must contain a column containing scientific names **or** acronyms. The file must be formatted such that the columns extend to the top of the spreadsheet, with row 1 containing column names. Select the name of the column that contains scientific names or acronyms. You may delete the file by clicking 'Delete Uploaded File'.

Step 4. To enter data manually, click on the field that says 'Select Species', then start typing in the Genus . As you type a pick list will appear. Click on the species you want, or when it is selected press the enter key. Click 'Add Species'. You may repeat this process multiple times. To delete a species, select the row and click 'Delete Species'. To delete all entries click 'Delete all Entries'. At this time, you may only select species based on scientific names or acronyms. If you are not sure


Calculate FQA Metrics →

About FQAView Regional FQA DatabasesCalculate Inventory MetricsCalculate Cover-Weighted FQA MetricsMore

← Go Back to Data Entry


Calculating metrics based on mississippi_north_central_wetlands_2005

Download




Species Richness

2



Mean C

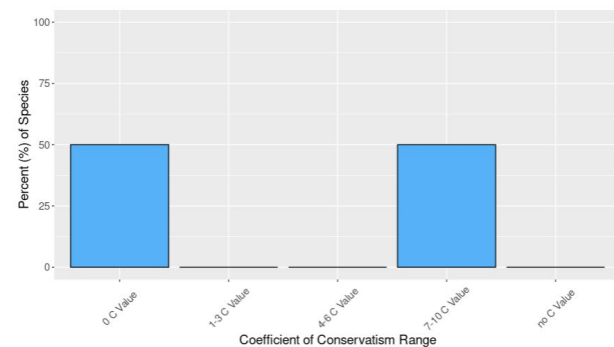
4



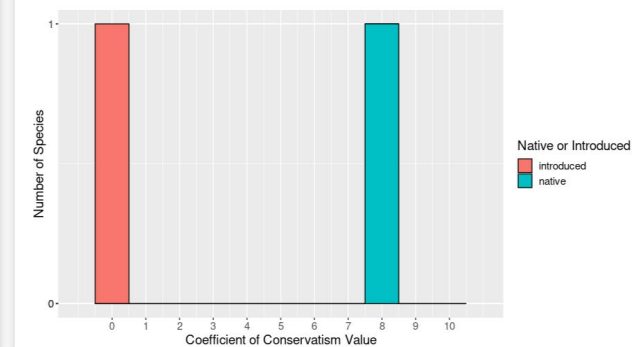
Total FQI

5.66

Binned Histogram of C Values



Histogram of C Values



FQI Metrics

metrics	values
Mean C	4.00
Native Mean C	8.00
Total FQI	5.66
Native FQI	8.00
Adjusted FQI	56.57

Wetness Metrics

metrics	values
Mean Wetness	1.00
Native Mean Wetness	1.00
% Hydrophytes	0.00

Species Richness Metrics

metrics	values
Total Species Richness	2
Native Species Richness	1

Physiognomy Metrics

physiognomy	number	percent
forb	2	100.00
tree	0	0.00
shrub	0	0.00
vine	0	0.00
grass	0	0.00
sedge	0	0.00
rush	0	0.00
fern	0	0.00
bryophyte	0	0.00

Duration Metrics

duration	number	percent
perennial	2	100.00
annual	0	0.00
biennial	0	0.00

C Value Percentages

metrics	values
% of Species with no C Value	0.00
% of Species with 0 C Value	50.00
% of Species with 1-3 C Value	0.00
% of Species with 4-6 C Value	0.00
% of Species with 7-10 C Value	50.00

- About This App
- Equations
- Cover Classes
- Additional Resources

Our Mission

The mission of the U.S. Army Corps of Engineers is to deliver vital public and military engineering services; partnering with federal, state, and local governments to strengthen our nation's security, energize the economy and reduce risks from disasters.

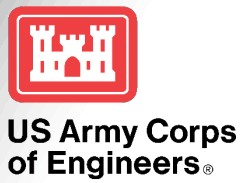
About This Application

This is an official public web application developed by the [U.S. Army Engineer Research and Development Center \(ERDC\)](#), the premier research and development facility of the [U.S. Army Corps of Engineers](#).

This web application was created with funding from the [Aquatic Nuisance Species Research Program](#) (ANSRP) under the [Next Generation Ecological Modeling Program](#) (Next Gen). ANSRP was established to address all invasive aquatic animals, as well as, harmful algae species that are problematic to the nation's waterways, infrastructure, and associated resources. Next Gen is an overarching collaboration between ERDC and Texas State University to develop both future modeling efforts and comprehensive data sets. There are many individual projects funded through Next Gen, led by both ERDC and our university partners.

Last Updated: 2023-10-02

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Project impact



- Provides **48 new certified models** to support ecosystem restoration and mitigation planning design
- Use of these models will increase the efficiency of project planning and monitoring, saving time and money nation-wide
- Developed new FQA calculator web application
- Brings FQA to R, allowing FQA users to improve workflow reproducibility, increase scale of analyses, and interface with other ecological models

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ACKNOWLEDGMENTS

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Trillium grandiflorum
Photo credit Robbie Sliwinski



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