Unified Captive Reared Caterpillar Tracker

Final Report

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SE 492

INTRODUCTION/BACKGROUND

Problem Statement

The current way our client tracks caterpillar data involves collecting data on paper, which is then stored on spreadsheets. It is a slow, difficult process. Our clients want a more efficient way of collecting and analyzing data.

Intended Users and Uses

The primary users of this application are members of the On Sacred Ground Organization, engaging in captive propagation and rearing of the Island Marble Butterfly species, located on San Juan island. The application will provide a convenient space for lab members to complete and file records relating to chrysalids and caterpillars, and complete required check ups to their related chrysalid/caterpillar. With additional functionality of importing/exporting csv files for data manipulation in excel sheets if the user desires. Users will also be able to see historical data of all the previous records/checks, as well as records filed by members in their group.

Related Products

There weren't any previous applications suited for our clients. Before adopting this application, all data was collected by hand on paper and saved to an Excel form later for long term storage. Below are examples of their previous records.

Lava Rearing Data

JAR # _____   START DATE _____   JAR # _____   START DATE _____

Date	# Alive	Instar	Comments		Date	# Alive	Instar	Comments

Reiman Gardens has come to Iowa State for many projects in the past. The Unified Caterpillar Tracker is a unique project in that the true client is someone that works with Reiman Gardens.

React Web Application VS Pen and Paper

React Web App	Pen and Paper
PROS: - Fast and easy to access on any device with a internet connection - Access to long term historical data - Pleasing to look at with Island marble color schema	PROS: - Foolproof, almost every person should be familiar with how to use a pen and paper - Cheap, if you're only paying for printing paper and ink

- Vast array of functionality/use cases in one location	
CONS: - Costs to maintain app hosting/data storage - Not accessible without an internet connection - Non tech savvy individuals may not be comfortable with navigating through an app	CONS: - Very slow compared to typing or digital input - Paper could get damaged or lost - Frustrating for long term storage - Spelling mistakes or bad handwriting can be hard to read on peer review - Constant form taking and variety of forms leads to large amounts of used paper over the year. - Hurts Trees

REVISED DESIGN

Functional Requirements

1. Application should be usable on both mobile and desktop.

2. Gather data automatically whenever possible (APIs)

3. Faster than hand-tracked data (Excel sheets, paper documents, etc.)

4. Must be able to scale well with large amounts of data

Non-Functional Requirements

5. Intuitive UI

6. Gamified program that leaves users feeling rewarded for contributing data.

7. Entirety of service must be relatively cheap (<$30 Monthly).

8. Text should be minimal and accessible for all users.

Engineering Standards

Programming Languages: NodeJS, ReactJS, HTML and CSS.

Backend and Data Storage Solution: AWS-Amplify,Cognito,S3,Route53

ISO/IEC/IEEE 23026:2015:focuses on system engineering and management requirements for the life cycle of websites

ISO/TS 23029:2020: defines the framework, function, and protocols for an API ecosystem.

Security

The app will not be handling extremely confidential or sensitive data but measures are taken to prevent users unrelated to the Island Marble conservation effort from seeing data and fields filed by members of the On Sacred Ground organization. All user account information such as email, name and password are dealt using the AWS Cognito service which encrypts and handles user login data.

Design Evolution:

PREVIOUS UI FLOW:

Previous: **Current:**

Above is our prior design document illustrating the UI flow of the application. Compared to our current design a few flows were modified. For import records, we now give the option to export saved records on the web application to a CSV file, and only one option for importing as forms were differently formatted than we originally thought in excel. The second most prominent change is the change to settings, originally our requirements were to make a somewhat fluid form generation and modification process in the event outside organization wished to utilize the app. However we ran into a lot of data modeling issues with this attempt while also trying to format it to the Island Marble program.

PREVIOUS SCREEN CONCEPTS:

Above is our previous figma screen designs for the application. The structure of the pages where records are viewed and created is
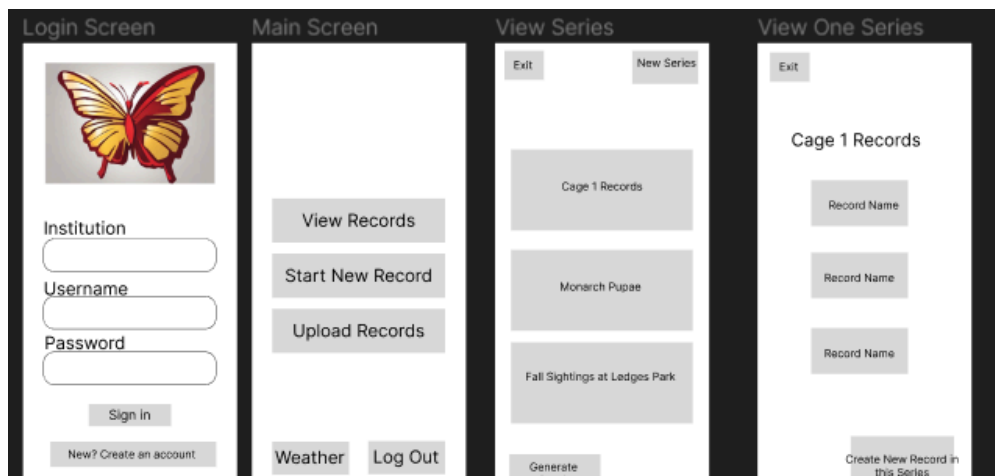
different as shown below.

VIEW RECORDS TAB:
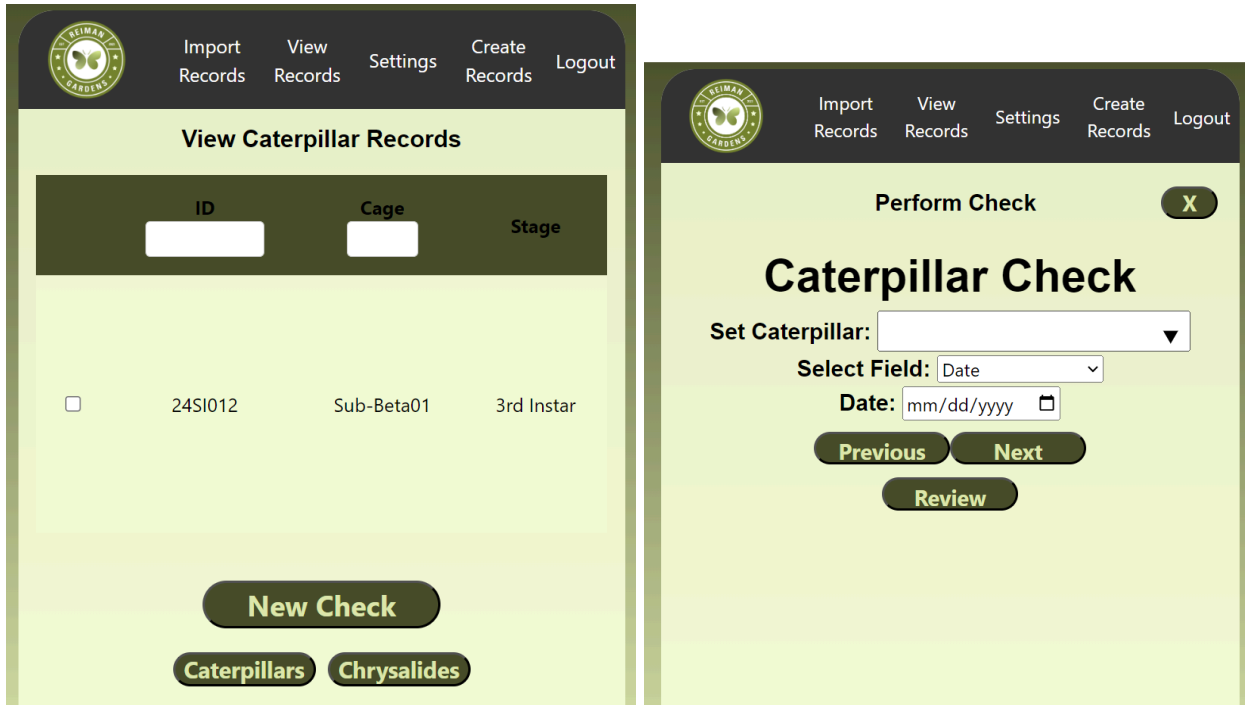
These two images show the View Records tab where records are viewed and caterpillar and chrysalis checks are performed. There is a separate tab called Create Records, where new caterpillars and chrysalis entities are created. The Create Records tab is also where release records are created.

CREATE RECORDS TAB:
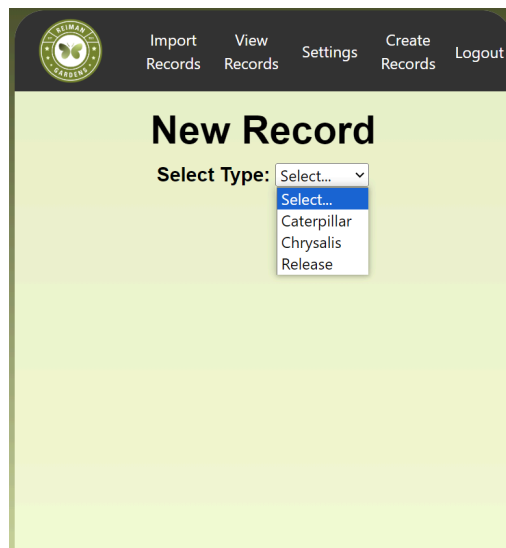
IMPLEMENTATION DETAILS

Detailed Design

The backend of our project is written using React.   This

encompasses all of the logic that handles navigating the website, viewing records, creating records, importing and exporting, and settings. The frontend of our project is written using HTML and CSS. The project is an amplify application hosted by AWS. User authentication is done using Cognito. The database used is DynamoDB.

Functionality

Login Screen: Users can login, create an account, or recover their account if they've forgotten their password.

Dashboard: Users will be prompted to share their location. After doing so, they can see a map along with current temperature and weather information. Also, users can see their total releases and collections.

Import Records Tab: Users can export records they've created or they can import CSV files.

View Records Tab: Users can view their caterpillar and chrysalis records. Also, they can perform checks on their caterpillars or chrysalides.

Settings Tab: Users can enter their initials in order to have them auto populate on their forms. Also, they can create new groups or accept invitations to join groups.

Create Records Tab: Users can create new caterpillar, chrysalid, or release records.

Logout Tab: Users can log out and be redirected to the login screen.

Notes

The biggest difference between our intended implementation in 491 and the actual implementation in 492 is the scope of users. Originally, the intention was to create a flexible application that could be used by any caterpillar rearing organization with completely customizable forms and record generation. After we started development, we realized this wasn't feasible and had complications trying to set up the database and backend to allow this. We pivoted to instead making an application specifically for our client and her organization. This allowed us to work

closely with her and deliver an application suited exactly to her team's needs. By sacrificing the flexibility of use for all organizations, we were able to create something catered to our client.

TESTING

USER TESTING:

The most prominent form of testing we applied during our development of the application was user testing, since this application is made specifically for the On Sacred Ground organizations captive rearing effort on the Island Marble butterfly. We found it very important that the lab members who would use it, were able to enjoy the application and have a relatively easy time navigating and interacting with the app. Once the app was in a prototype state, progress was communicated with Jenny Shrum, who is our main contact and customer for the application. Jenny would use the application in her lab environment and communicate back with the team on features she enjoyed, and features that needed to be reworked/removed or added. We followed an iterative process of having Jenny use the app in the lab and provide feedback and then pushing updates based on her feedback. We have toasts popup to indicate some error or completion of a request during this process so the user can better identify issues as well that are coming from our end and not a result of user error.

INTERFACE TESTING:

For Services used in AWS relating to our amplify hosted application, we enabled health reports and logging to help identify issues with website uptime, request counts, and used storage in our S3 Bucket and DynamoDB. This helped us resolve issues with certain GraphQL API calls over querying or failing, and objects not being stored correctly in the database.

We also enable commands in our build file to verify that both the front and backend environments could be built, cleaned, and installed upon any update to the main branch. In the event main failed it would host the prior committed branch, and notify the team of a build failure on the application.

UNIT TESTING:

For frontend functionality we used react library/jest tests to ensure that front end elements were rendered properly and that buttons linked to specific functionality would correctly call and complete their request. AWS mocking and injection was applied for some required functionality to ensure it would properly return a call from an AWS enabled service if needed.

Results

The sum of our efforts in testing, especially in our lengthy user interaction helped develop an application that our customer Jenny Shrum thoroughly enjoyed and can use on a daily basis in her lab environment in their organizations rearing efforts. Our interface testing gave us confidence in the reliability of our website's ability to stay up with minimal downtime or issues. The unit testing helped us ensure that functionality worked as expected and user inputs and requests would be handled properly and with urgency.

BROADER CONTEXT

Area	Description	Examples
Public health, safety, and welfare	The main stakeholder group for this project is the many groups around the country raising and tracking caterpillars and butterflies. By creating a digitized and centralized system for collecting data, these groups will have a faster, easier to use, and more reliable system than they had before.	There may be a chance that job opportunities may be reduced since they do not need as many people to record data. However, it will free them up to complete other important tasks.

Global, cultural, and social	Taking care of butterflies can be an important societal cornerstone. The health of butterflies can be an indicator on the health of the earth itself, which is important seeing as people live on it. Our project will help in monitoring this health. Our project aims to support the practices of the groups and workplaces that will be using it. Our project is intended to be a digitized version of their current system, improving on what they currently use and centralizing systems across the nation.	There may be a minimal change to existing processes due to this project. Each organization around the nation collects data slightly differently, so by centralizing this data collection some groups may have to change their processes slightly.
Environmental	Our project will help to support the environment by supporting butterfly conservation programs. Our project will be used by butterfly researchers to track caterpillars and butterflies. This will help them to understand more about their life cycle, and in turn work to improve conditions both in the environment and in captivity to improve the number of butterflies raised.	Our project has more benefit to the environment than harm. While there is some energy use that could have been derived from nonrenewable sources, overall these are negligible. Instead, our project is directly contributing to butterfly conservation.
Economic	While not directly helping in an economic way, the project will help determine what is the best conditions for taking care of the butterflies. This will prove useful when making changes to the settings of the butterflies and determining whether the cost of changing an aspect of butterfly care is worth it.	App can help determine whether a new lamp benefits or harms the butterflies; can be a deciding factor on if moving butterflies' location to another building is worth it by monitoring health of already moved butterflies

CONCLUSIONS

Progress

First, we designed our application and created mock ups for how our user interface would look. Then, we created a code skeleton and deployed it using Amplify Studio. From there we set up user authentication, designed the database, and began to develop our backend functionality. We created our frontend pages concurrently with backend development. This allowed us to test record viewing and creation. Once we had a viable product, we started having Jenny use it in her lab setting. Then, we began the cyclical process of having Jenny use the app, give us her feedback and requests, and then implement them. In the end, the result is a functional application that fulfills the client's needs.

Value

The tedium of inputting data has been removed, which makes the process easier to do and worthwhile. Not only that, the simple design of the application allows users to complete work in a more timely manner, which means they can dedicate more time to analyzing patterns exhibited by the caterpillars. All someone needs is a computer, tablet or equivalent and internet access to record data. Also, this allows for all records to be stored in a centralized location.
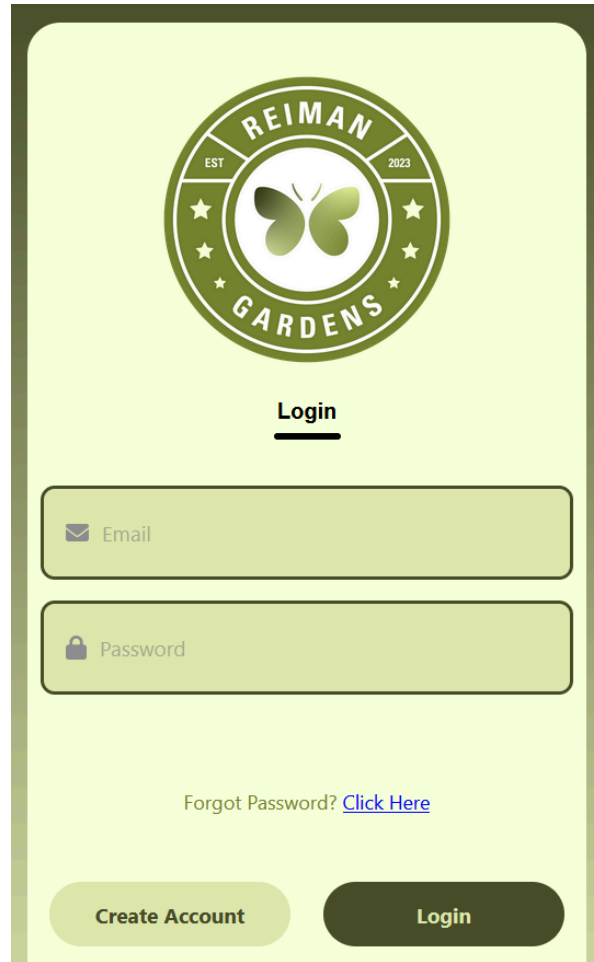
Potential Future Steps

Expansion and support for other organizations would be a likely next step. This would mean making sure multiple users can access the site without slowing it down and expanding the database to handle more records. Tougher security and encryption would also help to protect the data. Finally, while a small change, customization of the app's theme could add a fun way to make the app more unique to each user.

APPENDIX

Operation Manual

Login Page

Input your email and password associated with your account. If you do not have an account affiliated with the website, go to Create Account. If you forgot your password, click on the blue link. Otherwise, click on the Login button to access your account.

Create Account

Input your name, email address, and password to create your account. Be sure that the passwords match in both fields. Once done, click on Create Account.

Account Preferences

A verification code will be sent to the email address inputted in the previous screen. Input the given six digit code, along with the email address, to verify your account.

Input your preferences for how you would like to use the application. Input your initials (for record purposes) and your current location. These preferences can be changed at any time later in the settings.
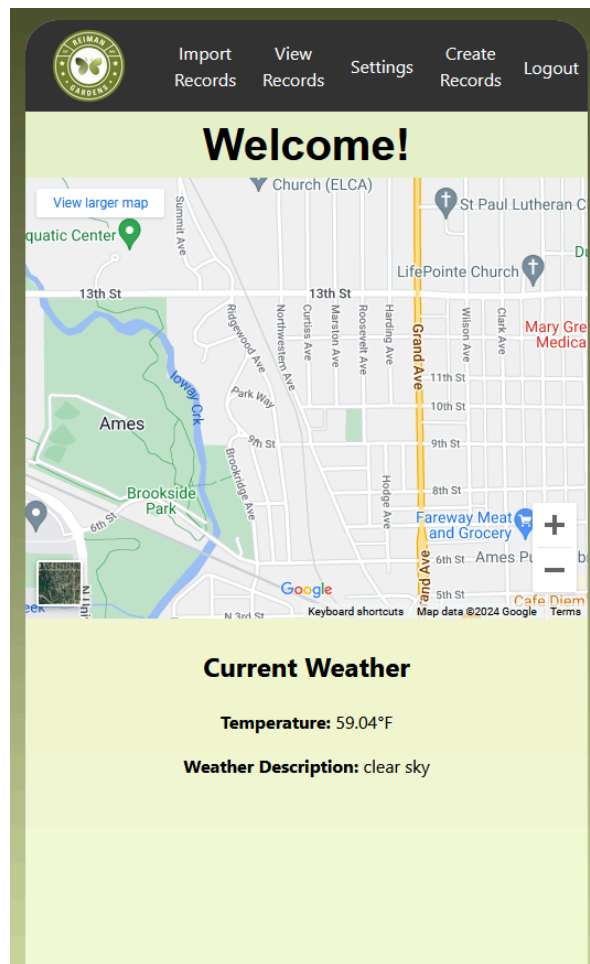
Once completed, you will be brought back to the login screen, where you will be able to login to your account.

Dashboard

Google maps and Meteomatic Weather API widgets were integrated into the dashboard, upon entering a permission request for accessing location will appear in the browser, if the user accepts will enable the maps and weather functionality. We primarily use this integration to grab Latitude Longitude data relative to the user that is then fed into the weather API to potentially use in auto filled forms requiring such information. It also adds some more life to the dashboard.

Import Records

In the top left of the screen, you will see the Import Records tab. In this section of the application, you can import any CSV file with the pertinent data. Clicking the button "Select a File" will bring up your operating system file explorer. Select the file you wish to import and click enter. If the import is successful, you will see a table preview of your data and how it will be saved in the database. If everything looks good, click "Create into Record" to save. The "Clear Table" button allows you to clear the table.

Export Records

Click on "Import Records" in the top navigation bar. At the top of the screen is a "Click here to export a Record" button; click this link to get to the export page. For the time being, there are 5 buttons on the screen with the different types of data you can export. Clicking any of these buttons will download the respective data as a CSV file.

In the future, these buttons will most likely disappear and be replaced by a dropdown selection menu. There will be more filtering options for the data; for example, filter by: "Date Collected", "Date Found", and "Created By" are potential options.

View Records

Here, you can view the caterpillars and chrysalides currently under your care. You may choose to switch whether you are viewing caterpillars or chrysalides using the labeled buttons below. The upper table refers to the individual subjects while the lower table refers to the latest checks and notes made about the subjects.

View Caterpillar Records

	ID	Cage	Stage
☐	24SI3	A9	Yellow Egg
☐	24BR1		Orange Egg
☐	24SI2	A10	Orange Egg
☐	24SI1	A10	Blue Egg

ID	Date	Time	Status

New Check

Caterpillars **Chrysalides**

On the upper table, you can view a single subject by inputting the caterpillar's ID.

	ID	Cage	Stage
☐	24SI3		
☐	24SI3	A9	Yellow Egg
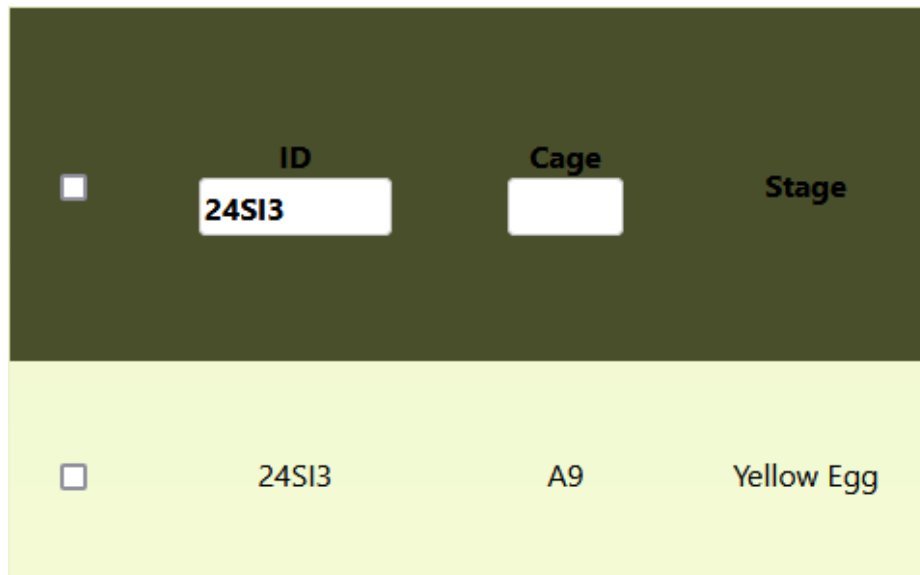
You can also view a single cage of subjects by inputting the cage's ID.

	ID	Cage	Stage
☐		a10	
☐	24SI2	A10	Orange Egg
☐	24SI1	A10	Blue Egg

Clicking on a single subject will bring up the various records attributed to that caterpillar.

View Caterpillar Records

	ID	Cage	Stage
⊟			
☑	24SI3	A9	Yellow Egg
☐	24BR1		Orange Egg
☐	24SI2	A10	Orange Egg
☐	24SI1	A10	Blue Egg

ID	Date	Time	Status
24SI3	2024-04-08	23:57	TEST
24SI3	2024-04-08	14:01	TEST1
24SI3	2024-04-09	15:16	TEST
24SI3	2024-04-13	21:30	Eating

New Check

Caterpillars **Chrysalides**

If you would like to view all the records of the subjects listed in the upper table, you can select the checkbox next to the searchbars.

View Caterpillar Records

	ID	Cage	Stage
☑		A10	
☑	24SI2	A10	Orange Egg
☑	24SI1	A10	Blue Egg

ID	Date	Time	Status
24SI2	2024-04-08	11:01	TEST
24SI2	2024-04-13	20:22	TEST
24SI1	2024-03-26	19:49	OK
24SI1	2024-04-13	22:17	Alert

New Check

Caterpillars **Chrysalides**

If you would like to create a new record, click on the New Check button to be brought to the Create Records screen.

Create Records

To begin, select whether you would like to create a new record of a caterpillar or a chrysalis.

For caterpillars, the following information must be entered: Date Found, Site Found, Location, Time, Host Plant, Stage, and Collected By. You may select which field you would like to fill in through the drop down menu or by selecting the Previous or Next buttons.

Date Found is the date this caterpillar was found, whether as an egg, from hatching, or from retrieval in the wild.

Site Found is the location where the caterpillar was found. These sites will be provided to you by your organization.

Location is the exact coordinates of the location where the caterpillar was found.

Time is the exact time the caterpillar was found, whether this is as an egg, from when the caterpillar is hatched, or when it is found in the wild.

Host Plant is the flowering plant where the caterpillar will be living. If Other is selected, you may specify the plant in the provided text box.

Stage is the stage of the life cycle the caterpillar is found in. If Egg is selected, you must select what color the egg is.

Collected By is the name of the person that collected the caterpillar. If your name isn't in the dropdown, you may select Other and write your name there.

Once you are finished with inputting the data on the found caterpillar, select Review to check that the data is correct. If it is not correct, select the Back button and correct the data. If it is correct, select the Submit button to log the caterpillar.

New Caterpillar

Form Data:

Date: 2024-01-01

Site: Eagle Cove

Location: N 42.026757 W -93.617045

Time: 00:00

Plant: Brassica

Stage: Egg

Egg color: Blue

Back   Submit

Cancel

If at any point you wish to stop inputting data for a new caterpillar, select the Cancel button.

For chrysalides, the following information must be entered: the Caterpillar's ID, Position, Orientation, Extra Features, Deformities, and Comments. You may select which field you would like to fill in through the drop down menu or by selecting the Previous or Next buttons.

Position is the way the chrysalis is positioned on the flowering plant.

Orientation is the way the caterpillar's head in the chrysalis is facing.

Extra Features are any notable features demarking the chrysalis.

Deformities are any notable features demarking the chrysalis that might be cause of concern.

Comments are any notes that cannot be otherwise communicated through the fields. Write the comment in the text box and press Enter to record them.

Once you are finished with inputting the data on the chrysalis, select Review to check that the data is correct. If it is not correct, select the Back button and correct the data. If it is correct, select the Submit button to log the chrysalis.

If at any point you wish to stop inputting data for a new caterpillar, select the Cancel button.

Initial Versions

Our initial version was a flexible application that could be used by any caterpillar rearing organization with completely customizable forms and record generation. After we started development, we realized this wasn't feasible and had complications trying to set up the database and backend to allow this. We pivoted to instead making an application specifically for our client and her organization. Our final application is an iteration of this second version.

Other Considerations

Our team learned how to work directly with an end user to produce a professional grade application. This was many team members' first time working directly with a client to produce software for their organization. We communicated

with our client and end user through Discord. Initially, Jenny had no experience with Discord and no idea how to use it. It was fun to see how over the course of the year she became an expert at voice chat and viewing our streams with our team's help.

Code
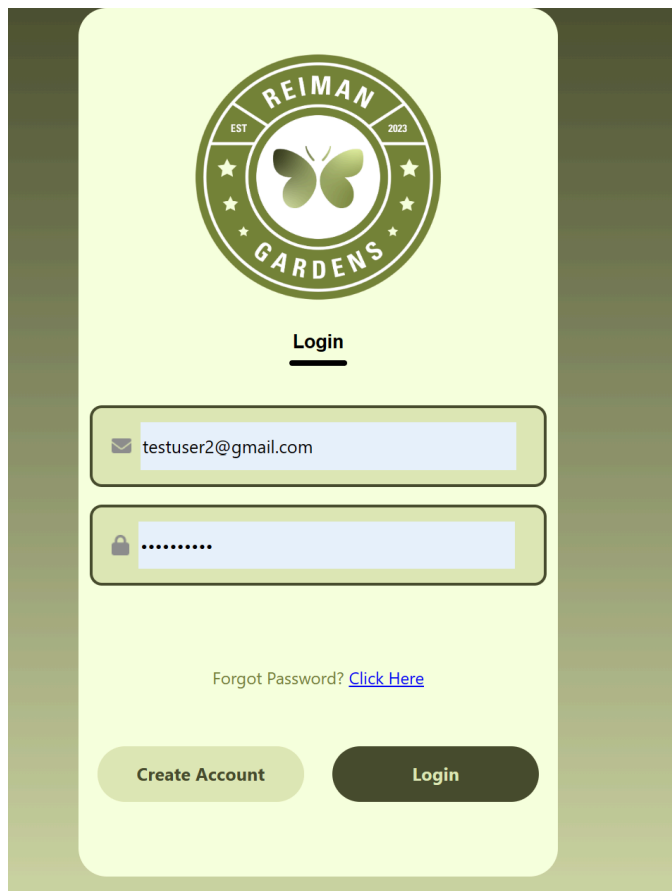
LOGIN AND CREATE ACCOUNT

For both the Login and Create Account, we use Amplify Cognito's API to make creating a user quick, easy, and secure. In the app, we first check to make sure all fields are inputted correctly, potentially saving us a bad API call. Then, the information is routed through the various Cognito API calls depending on the situation. After reading the response, we are able to then direct the user to the next page.
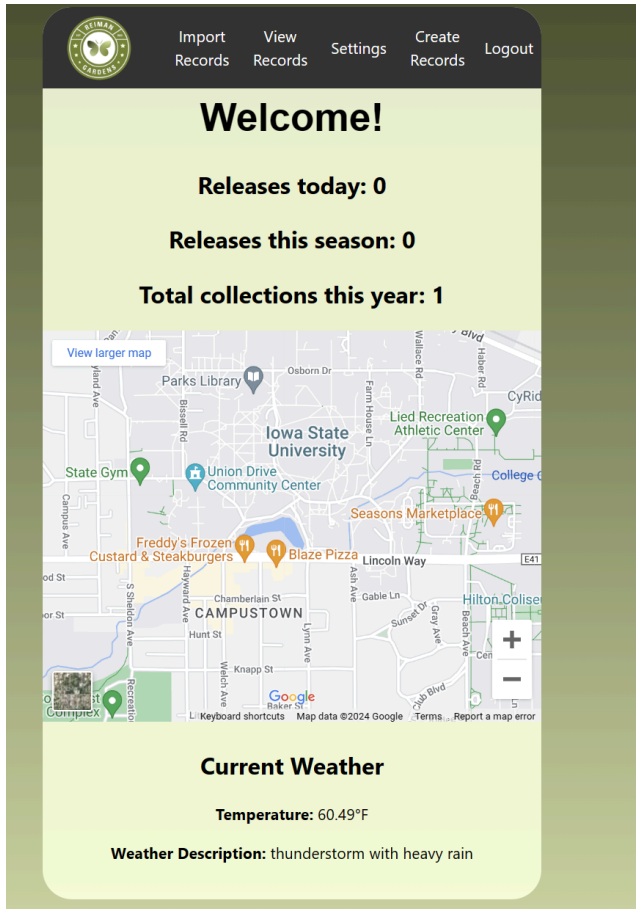
DASHBOARD: The Dashboard provides a space to easily view total butterfly releases and total caterpillar collections. Also, it showcases the map and weather APIs used for auto data collection. On top is the navigation bar used to move through the website.

IMPORT AND EXPORT:

For both importing and exporting data, we used a package called Papaparse to parse data from a CSV to JSON and from JSON back to a CSV.

IMPORT:

We are able to successfully take in almost any CSV file and turn it into a nice table that the user is able to preview. If it all looks good, the user then can submit the data to the database as a record.

EXPORT:

At this time, the user can select which type of data they would like to export. A download is started with the data they selected as a CSV file. This was a more recent addition to the app, and is still being worked on. For example, instead of just 5 buttons that export all the data within that category, we will condense the buttons into a drop down list and

add in more sorting/filtering options.
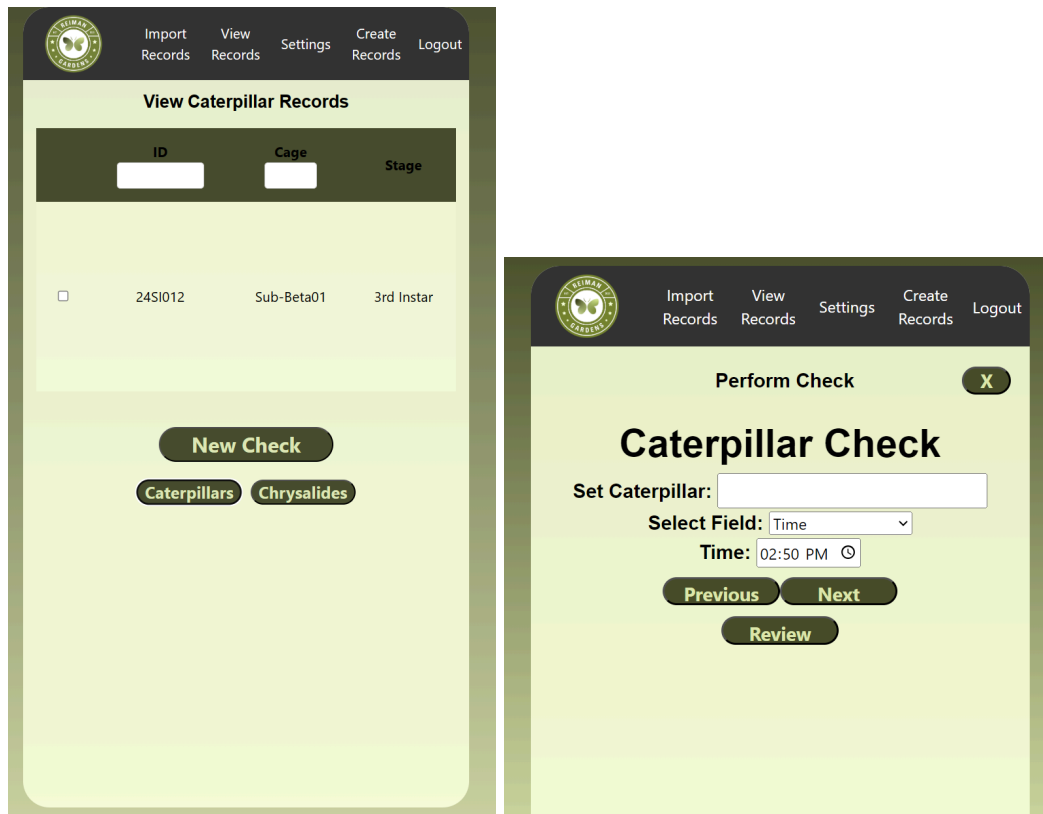
VIEW RECORDS: The View Records tab is where users will spend the majority of their time. On this page they can view current caterpillar and chrysalid records. They are stored in tables and switched using the buttons. The New Check button pulls up the user's caterpillars/chrysalides that need to be checked that day. From there, users fill out the corresponding forms. When filling out forms users view one field at a time. This data is cached locally until the user submits the form and all of the data is pushed to the database.
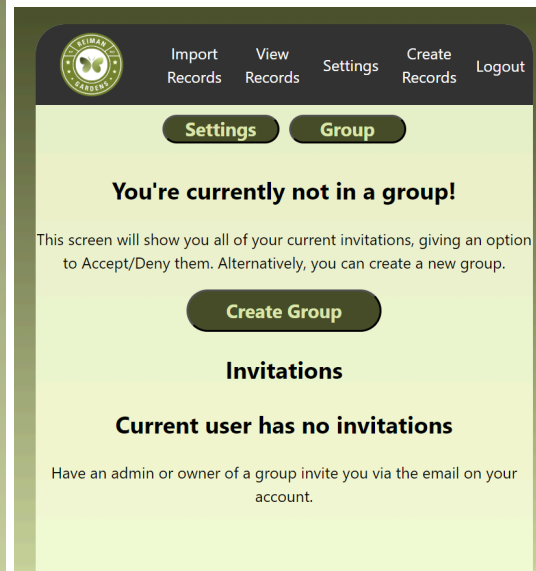
SETTINGS: The Settings tab is used by users to input their initials. These initials are stored and auto populated in forms. The Settings tab is also used for group management. Users can accept invitations to join groups or create their own.
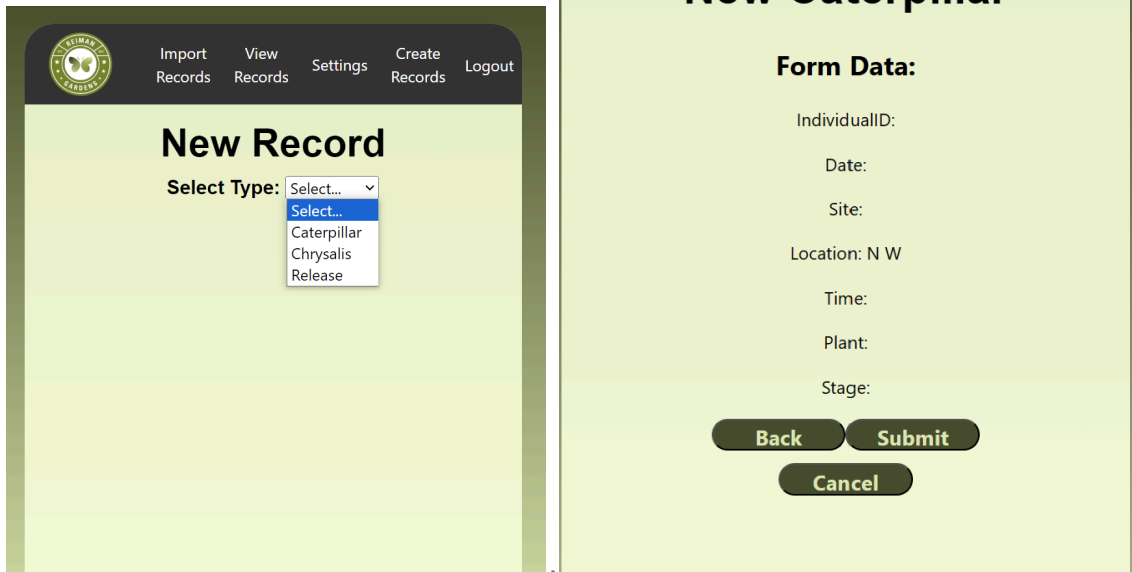
CREATE RECORDS: The Create Records tab is where users create new caterpillar or chrysalid entities. Also, it's where release records are created. Users select which type of record they are going to create which corresponds to a table within our schema. As with performing checks, users view one field at a time. This data is cached locally until the user submits the form and all of the data is pushed to the database.

WEBSITE: https://main.dbu0rfc0g49j2.amplifyapp.com/