Unified Butterfly Recorder: a New Take on a Standard Practice

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Abstract

Unified Butterfly Recorder (UBR) is an Android app that provides butterfly researchers and enthusiasts with a tool to use in the field to efficiently record butterfly sighting data. It was designed by a group of computer engineering students as part of a senior design class at Iowa State University in collaboration with the Entomology staff at Reiman Gardens. The purpose of the app is to allow the user a quick and efficient method to collect data across a variety of survey protocols traditionally used by researchers and citizen scientists in the field. Along with the user-entered data the app utilizes the device to automatically collect additional information such as weather, location, speed and time. Global-regional species lists are built into the app, but UBR is also capable of utilizing custom list created by the user. Users can also take photos of specimens to include with records. By collecting a super-set of data, both user-entered and automatically-captured, it will produce content which should greatly enhance our understanding of butterfly populations.

Introduction

The Christina Reiman Butterfly Wing is a 232 sq. m (2,500 sq. ft.) flight house, located at Iowa State University's Reiman Gardens, that exhibits live native and tropical Lepidoptera species. As a university public garden the Entomology staff at Reiman Gardens conducts or assists with a variety of native population surveys on Lepidoptera species. Working through these projects and partnering with a variety of different state and nation groups it became evident that there needed to be a better way to collect the population data across the different survey methods in a format that is easier to compile and manage.

The traditional method of collecting data on population numbers in the field is through the use of paper forms which can result in data which result in limited collected data. If the group collecting the data is a volunteer based group, such as those who participate in citizen science programs, data collected from these groups usually utilizes a very simple metric of data points to make collection easier on the participant.

With the increase in accessibility of mobile devices, their reduced cost yet increased functionality, it was believed that it should be possible to go away from the stagnate paper form to an automated digital platform. Using a mobile devise and its suite of built in tools would not only allow the device to collect user-entered data but it can also take advantage of built in sensors and web content to fill in extra data points automatically. This extra data could make the final collected product richer on mobile devices verses a paper form could ever be without the user carrying a wide array of potentially expensive devices.

The Proposal

This project utilized the Senior Design program, a yearlong class which is part of Iowa State University, College of Engineering's Computer and Electrical Engineering department. To obtain assistance from this program a proposal must be submitted to the program head that, after approving, makes it an option for the students in the class to view and then small groups of 3 or 4 students vote on and select the program they want to work on. Below is the project proposal that was submitted to the program for consideration.

> Butterflies are great indicator species; from monitoring climate change to determining quality of habitat restoration, butterflies are used a lot to help answer scientific questions. Across the nation and around the world, however, there is a lack of information on native butterfly species, their annual dispersal and numbers. To help with this annual task the scientific community has begun relying on citizen scientist programs, which use volunteers of different backgrounds, to go out in the field and do the surveys. Currently, there is no one national or global standard for how surveys are conducted and this probably will not be overcome in the foreseeable future. Each of the different methods conducted have their own pros and cons and each method may answer one type of question better than the other. This variation in methods causes issues, however, when you attempt to standardize the data and take a national or global look at populations, the data becomes problematic. Many of the variations in methods could be overcome if there was a mobile app which could work on tablet or smart phone devices. This application could record data sets that a particular method may ignore traditionally, making standardization of data possible at the end. It is very possible, if the application is developed properly, it might cause a paradigm shift.
>
> Some of the items this application will need to be able to do include:
>
> (1) Record:
>
> a. Survey route – Some methods follow set routes but others do not, even the methods that utilize a set path stray from time to time, the addition of this element would be a huge asset to data standardization.
> b. Distance – common equation used is time/number with the distance walked which allows for a more in-depth analysis.
> c. Speeds – Start and end times are often taken but this measurer pays no attention to where hot spots may be located, having the speed over the route at different times matched up with numbers observed at those time would be a huge asset.
>
> (2) Method of quickly entering multi species count while on the move, each point entered would require latitude and longitude location.
> (3) Acquire locations' weather data: possibly multiple records during run.
> (4) Automatic upload of recorded data to centralized database.
> (5) Ability to work with route maps: so it would be possible to analyze habitat type and transect distance lengths.

(6) Some method to adjust start location on base maps after the fact to adjust for GPS error or inconsistence.
(7) The application would need to utilize Google Maps including the new offline map feature, as a whole the technology needs to utilize open source technology as much as possible to increase the usability of the data across the many potential partners.
(8) The application would need versions which could be utilized on Android and i-platform devices.
(9) The application would need versions which were scaled so the interface, content and functionality fit a variety of different sized devices.
(10) The application needs an easy method for adapting species list for each site.
(11) There would need to be a way for the survey participant to see and manipulate their data.

Some of the other elements if the application had the functionality to do but would not be essential include:

(1) Voucher photos taken with device could be tagged with pertinent information then uploaded the next time the device is in a Wi-Fi environment.
(2) An administrative level method for identifying and sorting observer data based on their survey method and experience level.
(3) A Windows 8 version of the program, now with the introduction of their tablets and phones.
(4) The ability for the application to create a potential species list for a habitat or location based on distribution maps and seasonality.

Both of the above lists are items that were identified by the Reiman Gardens staff but we don't pretend to know all of the potentials of an application of this sort so we are defiantly open to additional suggestion and functionalities.

While this program would be designed for butterfly surveys, if this application worked it could be a model for other groups which do animal surveys, such as those for reptiles, birds, mammals and other insects. If this program truly worked well it would see worldwide utilization and be a model for other biological programs.

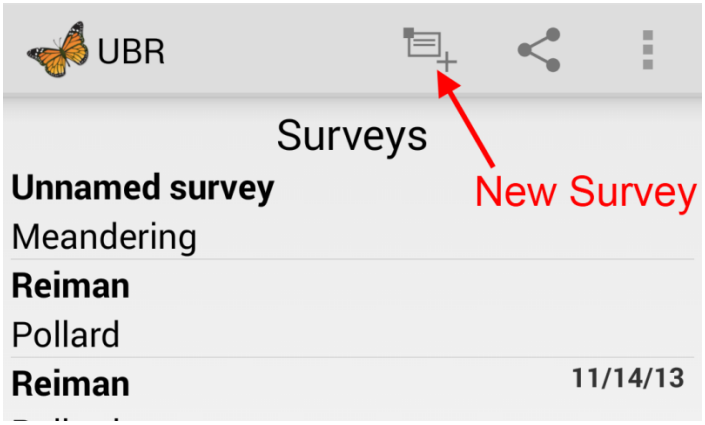
Application Design

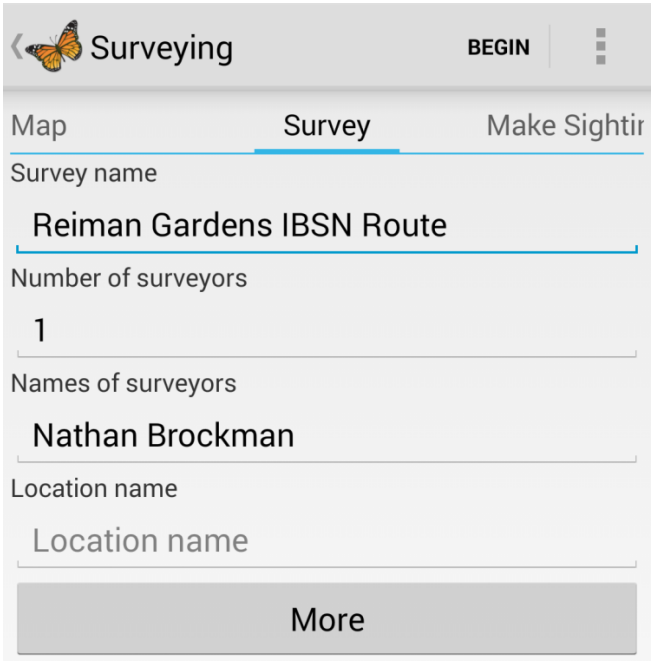
Mobile applications can be very powerful tools but with many programing projects is in important to keep any eye out for unnecessary project creep. Since the plan of this project was to create an application that several different groups could utilize, over a variety of survey methods, one of the first things the programming team did was pull together a user survey. This survey was sent out to 50 individuals that do field butterfly population surveys. From the survey, 16 responses were received and the groups had three conference calls with different professionals discussing elements needed in an app. From the surveys, the conference calls and specifications from the Reiman Gardens' Entomology Staff the programing team divided the work load and broke it up in two week sprints.

In the initial proposal the plan was to create an Android and iOS version at the same time. Early in the development process it was determined that attempting to create an application for both operating systems would be time prohibitive. Android was chosen due to its open source nature and code experience of the group. A proof of concept beta version was created and used through the development process.

Application Operations

Tap the New Survey button at the top and choose your desired survey type from the drop-down menu.





Fill out the survey information. If you selected an Incidental survey you will not be prompted for this information.

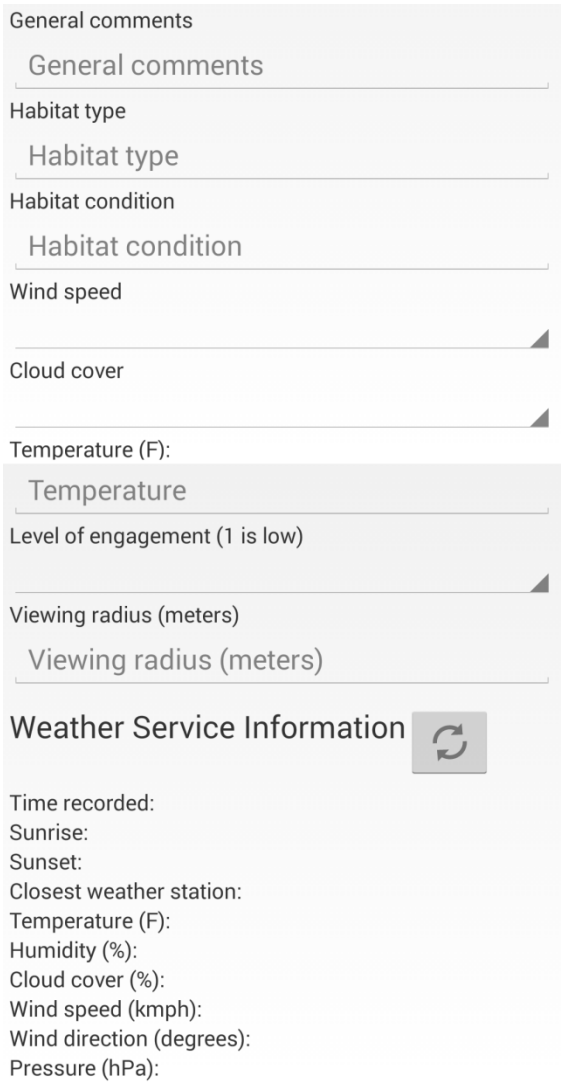
- Survey Name: What the survey will be saved as (could be name, route on a location, etc.)
- Number of surveyors: How many people are participating in the survey
- Names of surveyors: Names of each of the participants
- Location name: Name of the location that you are surveying

Pollard Only:

- Transect division format: How transects are distinguished. Is each habitat a transect, or is every x number of meters a transect? **Also be sure to change transect descriptions in Settings if you need to.**

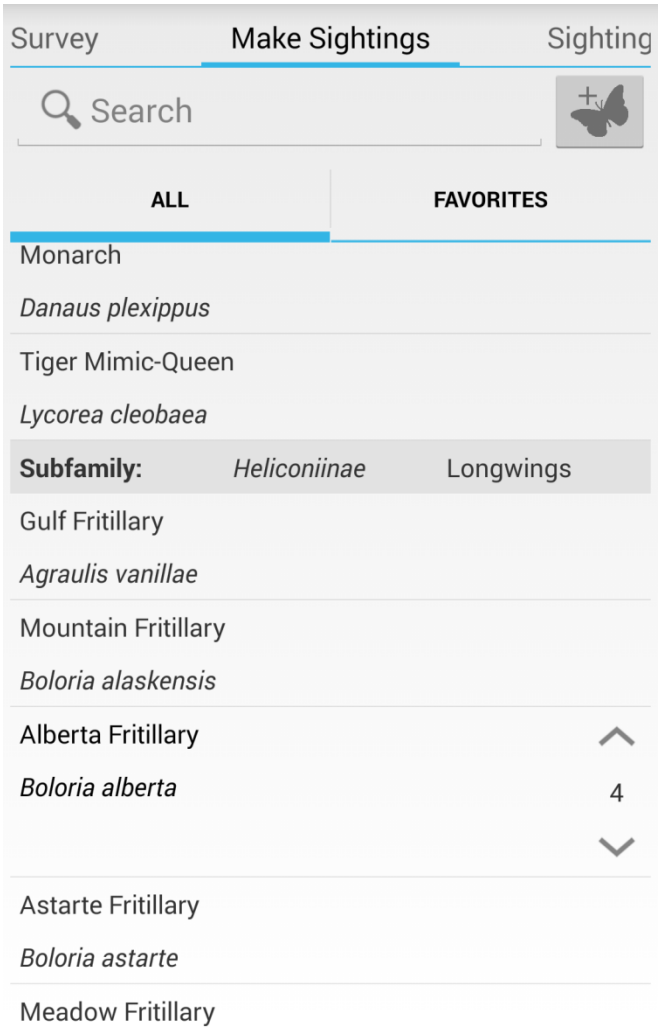
- Viewing radius (meters): The maximum distance from a surveyor that an individual will be counted. This distance can be infinite if you want.

More:



- General Comments: Any other information you would like recorded
- Habitat type: Description of the habitat being surveyed (i.e. Forest, prairie, etc.)
- Habitat condition: State of the habitat compared to normal (i.e. dry, flooded, recent burn, etc.)
- Wind Speed: Current wind speed
  - Calm: 0 mph, Smoke rises vertically
  - Light: 1-3 mph, Wind direction shown by smoke, but not by wind vanes
  - Light Breeze: 4-7 mph, Wind felt on face; leaves rustle
  - Gentle Breeze: 8-12 mph, Leaves and small twigs in constant motion; wind extends light flag
  - Moderate Breeze: 13-17 mph, Raises dust and loose paper; small branches move
  - Fresh Breeze: 18-24 mph, Small trees sway
  - Very Windy: 25+ mph, Large branches move
- Cloud Cover: Current sky conditions.
  - Clear: No clouds
  - Mostly Clear: Less than half cloud cover
  - Mostly Cloudy: More than half cloud cover
  - Cloudy: Full cloud cover
- Temperature: Current temperature. The default units (Fahrenheit or Celsius) can be changed in Settings
- Level of engagement: The amount of attention given to the survey
  - 5: You are out just for the survey. No distractions.
  - 4: Your main reason for being out is to survey, but there are some distractions (i.e. You are talking with someone)
  - 3: You are doing a survey alongside another activity (i.e. Walking a dog)
  - 2: You are mainly out for something other than the survey and are recording some butterflies along the way
  - 1: You are out for reasons other than surveying and happened to see a few interesting butterflies you wanted to record.

- Viewing radius (meters): The maximum distance from a surveyor that an individual will be counted. This distance can be infinite if you want.
- Below these is weather information automatically recorded from a station near you. Press “Refresh” to update this info.



Tap “Begin” at the top. Your start time will be recorded automatically and you can begin your survey. The program will also start recording your GPS coordinates as “Breadcrumbs”. These will track the general route that you take.

Slide one screen to the right to get to the *Make Sightings* tab.

Here you can use the search bar at the top to find a butterfly species, or look through the list of species. You can choose whether species are listed in order of common name or scientific name in Settings.

Use the tabs below the search bar to switch between the list of all butterflies and the list of your Favorites. If you see a particular species especially frequently you can add it to your Favorites to access it more quickly. Tap and hold on a species, then select “Add to Favorites” from the menu that appears. Alternatively, you can pin a species to the top of the list using the same menu.

In a Pollard survey there will be a Transect button at the top. Use this to choose which section or habitat on your route you are currently in. Each sighting will be recorded according to which transect you are in.

In a Point Count survey there will be a point selection and timer menu at the top. When you come to one of your points use this menu to select the point number, then press the play button to start the timer. Each sighting will be recorded according to which point you are at.

You can change the default time on the timer in Settings.

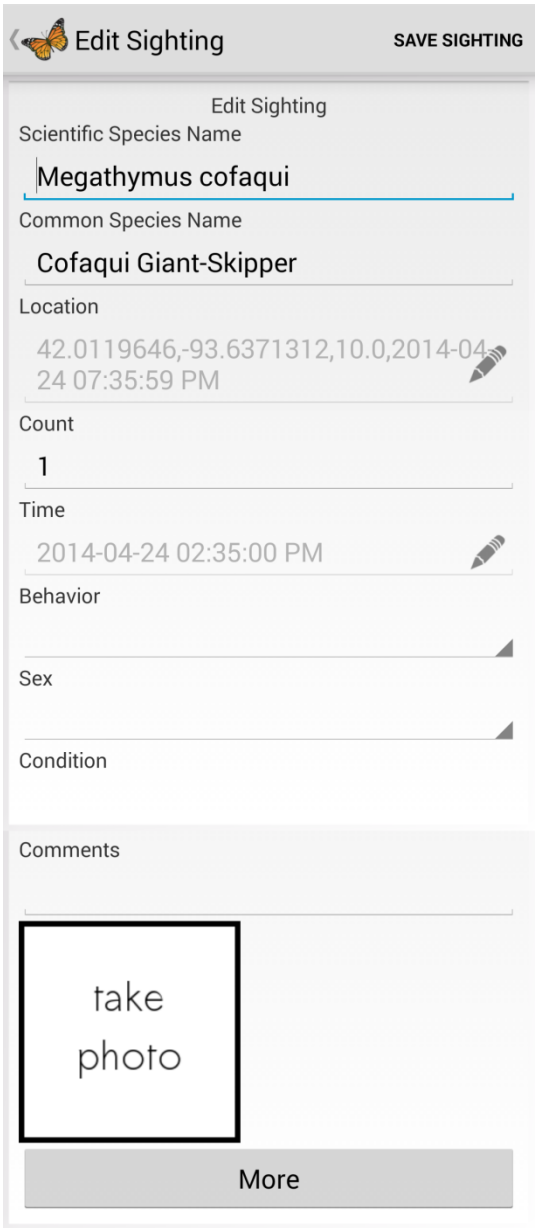
Tap a species to record a sighting. In survey types other than Incidental subsequent taps will record additional sightings. You can also use the arrows that appear to the right to add or subtract sightings. Multiple taps will be saved as a single record of multiple sightings. You do not have to wait for the number to disappear before recording another species; it will disappear and be recorded as soon as you

tap the next species. When a sighting is added the time is automatically recorded based on your system's time. GPS coordinates of the sighting are also recorded automatically.

If you cannot identify a butterfly there are Unknown species you can select instead. There is a general Unknown, as well as an Unknown for each family and subfamily if you can narrow it down.

You can use the + butterfly button next to the search bar to add a new species to your list. You can also edit a species' information by tapping and holding on it and selecting "Edit Species".

You can import a custom species list in CSV format by tapping the button in the top right, selecting "Import List", and selecting the file through one of the given options. You can also enable or disable regional species lists, as well as custom lists, in Settings.



In an Incidental survey the *Edit Sighting* screen will appear as soon as you select a species. In other survey types sliding one more screen to the right will bring you to the *Sightings* tab. This screen shows you all the sightings you have recorded.

Tap a sighting to edit it. Tap and hold to either edit or delete a sighting.

The *Edit Sighting* screen allows you to change the species name, the number of individuals, as well as adding extra information. You can note interesting or unusual behavior, sex of a butterfly, or the condition it is in, such as any wing damage it has.

In a Mark Recapture survey this is where you can add notes about marks found or placed on the butterfly.

In a Pollard survey you can also change the transect the butterfly was seen in.

In a Point Count survey you can change the point the butterfly was seen at.

You can tap the "Take Photo" button to take a picture of the butterfly with your device's camera. This photo will be displayed next to this sighting on the sightings list.

Tapping the "More" button allows you to edit specific climate conditions, as well as the family and subfamily information of the butterfly.

Tap “Save Sighting” in the top right when you have finished editing to save your changes. In an Incidental survey this will also end the survey.

The tab farthest to the left is the *Map* tab. This displays a map of the world with the GPS data of your survey plotted on it.

Press the crosshair button in the top right to zoom in on your survey location.

The grey line is your breadcrumb data, the general route you have taken.

The dots are the locations of each sighting you have recorded.

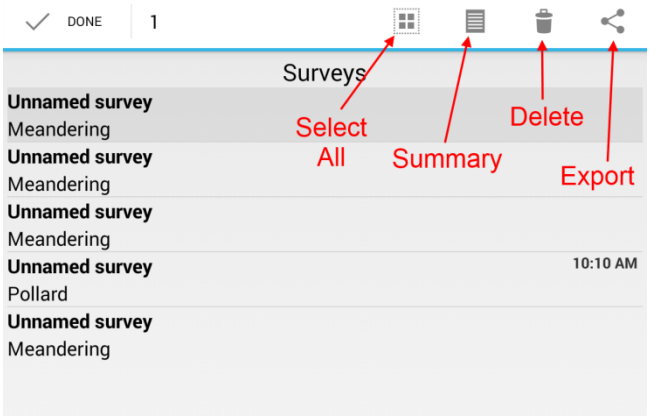
A blue dot with a circle around it marks your current location.

To return to the *Survey* tab, tap its name at the top.

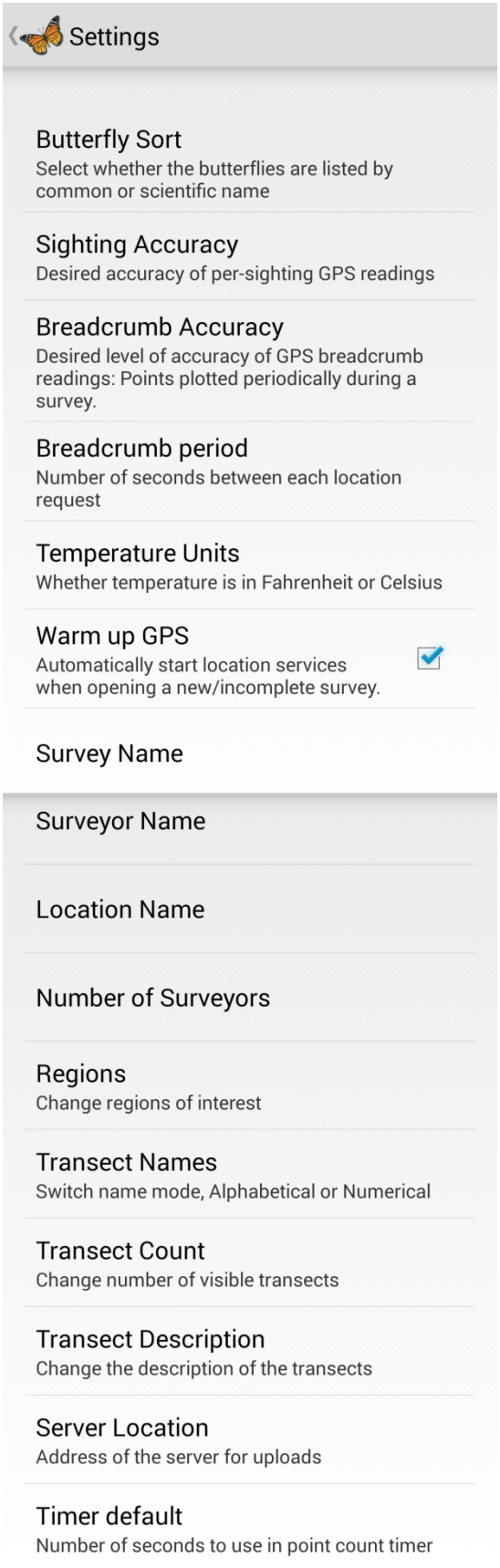
When you have completed your survey, navigate back to the *Survey* tab and tap “End” at the top. This will stop recording of GPS Breadcrumbs and automatically record your end time. You can go back and change information any time if you need to.

Completed Survey Options: Tap and hold on a survey to select it. You can then tap other surveys to add or remove them from your selection. The buttons at the top of the screen allow you to perform actions on selected surveys.

- Select All: Adds all surveys to your selection.
- Summary: Gives a list of each species and how many individuals of each were recorded in a survey.
- Delete: Delete the selected survey(s).



- Export: Export the selected survey data in a zip file. You can either save this data to your system, or share it online. Selecting the share option will present you with several options of how to send your data, including as an email attachment through Gmail.



To change program settings, tap the settings button, or tap the button in the top right corner, and select Settings.

- Butterfly Sort: Determines whether the species list is sorted by common name or scientific name. Set to scientific name by default.
- Sighting Accuracy: Determines the accuracy of GPS coordinates recorded per sighting. Default is High.
  - Low: Coordinates accurate to within 500m; will wait 20 seconds for an accurate reading
  - Medium: Coordinates accurate to within 100m, will wait 30 seconds for an accurate reading
  - High: Coordinates accurate to within 10m, will wait 40 seconds for an accurate reading
- Breadcrumb Accuracy: Determines the accuracy of the Breadcrumb coordinates recorded. Default is High.
  - Low: Coordinates accurate to within 500m
  - High: Coordinates accurate to within 50m
- Breadcrumb Period: Determines the interval (in seconds) between recording each Breadcrumb coordinate. Default is 60 seconds.
- Temperature Units: Determines whether temperature is recorded in Fahrenheit or Celsius. Default is Fahrenheit.
- Warm up GPS: If turned on, will begin tracking your coordinates before the survey has started to improve initial accuracy. Default is On.
- Survey Name, Surveyor Name, and Number of Surveyors determine default information for each survey.
- Regions: Select which species list(s) you would like to use in your survey.
- Transect Names: Determines whether transects are named as letters or as numbers. Default is Alphabetical
- Transect Count: The number of transects you can select in a Pollard survey. Default is 5.
- Transect Description: Allows you to enter short descriptions for each transect.

- Server Location: The URL entered here determines the server that survey data is uploaded to when you choose to upload a survey from the survey list.
- Timer default: The amount of time given per point in a point count survey.

Application Testing and Implementation

At time of this paper UBR is just in its first summer of use. In spring of 2014 a formal test of the app was conducted at Reiman Gardens. This test invited volunteers of varying backgrounds to come in and test out the app. Participants were asked to randomly draw one of the survey types, found on the app, from an envelope. The participants were then instructed on how to conduct that particular survey and briefly informed on how the app worked then sent out on the Gardens ground to run a survey. Of the 38 individuals that participated in this test, only 24% had some experience doing field work and while 25% said they were unfamiliar with mobile devices 90% said using the app to conduct the trial survey made them want to conduct more surveys. From a user interface stand point this was nice to see as it showed that regardless of the participant background the majority of participants enjoyed the app experience. Several of the participants commented on the post survey that "it was really fun".

There are currently, summer 2014, a variety of individuals that are using the app in the field to survey butterfly populations and there is an active effort to promote the existence and functionality of UBR to interested groups. UBR was created as a data collection tool not as a data repository so it can be used by any individuals or groups and the collected content can be shared with as many or as few individuals as possible. UBR can be downloaded from the Google Play store at https://play.google.com/store/apps/details?id=edu.iastate.ece.butterflies&hl=en and in January of 2015 it will be available for iOS devices on the App store.

Conclusion

The Unified Butterfly Recorder app has the potential to be a very powerful tool for butterfly conservationists around the world. It may take some time to make potential users aware of its existence and functionality but once that occurs the impediments to adoption into a program should be low. The ease in which data can be collected, both user entered and automatically populated, should greatly enhance the data's usability in conservation and research. Since UBR allows for custom species list to be added there is also no reason that it could not be utilized for any flora and fauna.