University of California, San Diego
GlobalTIES
ENG 100D Spring 2018
Brandon Reynante

Wildlife Image Viewer - Design Report

Team Name: Alfalfa Spotted Cheetah (ASC)

Team Members: Emil Kirov, Haley Dahlberg, William Jiang, Brian Nguyen, Ren Salvania, Sophia Sun, Youli Pan, Zhi Teoh

Community Partner: **San Diego River Park Foundation**
Client Contact: Shannon Quigley-Raymond, River Ecosystem Manager

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Executive Summary

The organization that we are partnered with is the San Diego River Park Foundation (SDRPF), recipients of the 2017 California Nonprofit of the Year. Their goal is to protect and enhance the San Diego River's valuable natural and cultural resources and encourage communities to embrace this legacy and to celebrate it with the creation of a river-long park system.

Our main user, Shannon Quigley-Raymond, has a responsibility of keeping records of the animals encountered around San Diego River area. She receives hundreds of images captured by the motion-detective cameras on a regular basis. Through our interview with Shannon (Appendix B), we discovered that there is no efficient tool currently to assist her on this task. Currently she is visually identifying the animal type, age, and health condition through the images, then recording the data for future research.

The initial solution to use Wildbook is not realistic given the time constraint and the team's knowledge. Instead, a pivot solution, I.D. Wild, a web application for performing image comparisons was chosen. The pivot solution was proposed to Shannon and was accepted as a good alternative. Furthermore, I.D. Wild was designed in such a way that all members were able to contribute equally based on their individual skill set, thereby allowing each member to have freedom on their designated tasks and thus improving its quality.

Analysis on the user tests' results have shown that our application is able to solve the intended problem which is to perform quick image comparisons. Additionally, users were able to understand the application without much context, implying that the design is user-friendly.

The final design includes two images, each serving as the default and target picture that is supplemented with detailed information. Additionally, the design includes a scroll view of multiple images for quickly changing the selected image, a search tool to find picture by animal ID, animal type or date taken. Features based on users' feedback were implemented as well such as being able to zoom in and out of picture and importing multiple pictures at once as a folder. The application uses ReactJS framework for the front-end and Oracle Cloud for the back-end and storage.

1. Project Management

1.1 Goals & Objectives

Our client, San Diego River Park Foundation (SDRPF), is a non-profit that is dedicated to fostering stewardship and appreciation of the region's namesake waterway. One of the ways in which they do this is by tracking wildlife in the regions neighboring the waterways. They capture images of the animals by using motion sensored cameras that are also equipped with infrared capabilities. The existing method of identifying the animals our client utilizes is manually reviewing each image. However, this is a long process and it can be difficult to accurately identify a specific animal by its physical features by eye. In order to make that process much quicker and more efficient our client has tasked our team with creating a software. We plan on designing a solution that will make the task of identifying the animals much more efficient for the ecologists at SDRPF. We will be modifying and improving upon our solution to build a software that is modular, and applicable for the San Diego River Park Foundation's needs and expectations by the end of the quarter.

1.2 Approach

We plan to start by connecting with our contact at the San Diego River Park Foundation to develop a baseline understanding of their needs and expectations. We will then research the software that was recommended to us by our client, Wildbook, to understand what functions are available, how it works, and what modifications we can make to the software to meet our requirements. As a team, we will then divide up responsibilities pertaining to the software project and work towards our goal, both as individual team members and as a group. Much of our project timeline will be dedicated to developing and modifying the software. Once we have our base software working and developed, we will spend time testing its functionality. Should a problem arise we will have to plan and be prepared with a secondary solution or a pivot in strategy. We will also keep our representative from the San Diego River Park Foundation updated with our progress. Feedback and reflection is also an important part of our developmental progress and success. We will be able to make changes/fixes to our software after it is completed and tested. After necessary adjustments are made, we will work to ensure the interface is intuitive and easy-to-use for our clients as well as any additional stakeholders. Upon completion of the project, we will be prepared to debrief the SDRPF on our final solution.

To help us approach the problem posted by SDRPF we each interviewed two people with various expertises which included backgrounds ranging from software to ecology. We have included the interview question for three of these people: a key stakeholder at SDRPF, a wildlife researcher who has worked with Wildbook, and a software engineer with experience building web applications. (See Appendix B）

1.3 Schedule

Our project timeline was divided into two distinct phases. The first was to analyze the Wildbook Software to learn its nuances before we began designing a solution. This included understanding the software's main functions, its limitations, as well as any licensing issues that may have arose as there are already multiple projects that use Wildbook. [2] We accomplished this through interaction with researchers of existing Wildbook projects, as well as individual research of the existing projects and the Wildbook website. [13]

After all the research, weighing out the pros and cons, feedback from researchers, and evaluation of resources we decided on a pivot from Wildbook. The second phase of the project was to design a proprietary solution based on the things that we learned in the first phase and from the expectations and needs of the San Diego River Park Foundation. Here, we were able to use some of the techniques that the IDEO designers employ to generate and filter through multiple possible solutions. These techniques included multiple facets of design such as a chaotic-yet-ordered brainstorming where the team welcomes outlandish solutions and encourages them to be demoed, as well as ways to build empathy with the SDRPF through methods such as interviews and observations. We then came up with multiple design concepts of our proprietary web application and rated each one based on different features and from there we could identify the best solution. Lastly, we did user testing with multiple people of different backgrounds to get an outside look on our solution and having the user rate their experience with a Likert Scale test. After satisfying feedback we proposed our solution to SDRPF for comments and approval.

In *Figure 1.1* you can find a snippet of our Gantt Chart where we have a very detailed schedule of our tasks. A link to the full sized version can be found in the appendix. (See Appendix A).

						Week 3						
Project Stages	Start Date	End Date	Days	Task Lead(s)	Description	M	T	W	Th	F	S	Su
Project Management	4/16/18	4/22/18	7									
Goals & Objectives	4/16/18	4/17/18	2	Emil, Haley	What we want to accomplish							
Approach	4/17/18	4/18/18	2	Brian, William	How we are going to accomplish it							
Schedule	4/19/18	4/20/18	2	Ren, Zhi	Schedule in how things are to be completed							
Team Bios	4/21/18	4/22/18	2	Individual	Member Biographies							
Stakeholder Analysis	4/21/18	4/22/18	2	Sophia, Youli	Analyze stakeholders in our scenario							

Figure 1.1 - Gantt Chart

1.4 Team Bios

Emil Kirov - Team Leader
ekirov6@gmail.com
4th Year, Graduating Spring 2018 | Major: Computer Science

Emil's role is to ensure the project is on schedule, set up and run team meetings, monitor progress or tasks and mitigate risks. Through his 4 years at UCSD, Emil has technical experience with machine learning and databases.

	**William Jiang** wzjiang@ucsd.edu 4th Year, Graduating Spring 2018 | Major: Computer Science William's role is to raise constructive objections and offer alternative explanations and perspective to different situations and solutions. Through different coursework and internships, William has experience designing user experiences and solutions based on users' needs.
	**Youli Pan - Innovator** yopan@ucsd.edu 3rd year, graduating Spring 2019 | Majors: Cognitive Science w/HCI & Japanese Studies Youli is responsible for coming up with unique and specific solutions for the needs of our client and research into the field as a whole. She will get familiar with user needs, and attend meetings with group and client to keep teamwork on track.
	**Haley Dahlberg - Community Liaison & Editor** hdahlber@ucsd.edu Major: Cognitive Science w/ Specialization in Design & Interaction Graduating 2020 Haley is responsible for communications with our partner contact, Shannon, by maintaining a record of feedbacks and updating each party with project progress and potential issues. Additionally, she will be acting as an editor to ensure all team documents express concepts clearly and grammatically.
	**Brian Nguyen - Mediator/Harmonizer** bdn003@ucsd.edu Major: Cognitive Science w/ specialization in Human Computer Interaction, graduating Spring 2019 Brian is responsible for mediating/reconciling differences and/or disagreements between team members. Brian has prior software and quality engineering experience. He uses a combination of his computer science experience along with his cognitive science knowledge to help develop a functional, user friendly application.

	**Zhi Jia Teoh - Technical** zteoh@ucsd.edu Major: Computer Science Graduating in Fall 2018 Zhi Jia is responsible for contributing to the technical needs of the project including designing and coding the required problems. He has prior experiences with machine learning as well.
	**Ren Salvania - Facilitator** rsalvani@ucsd.edu Major: Computer Engineering 4th Year Graduating Spring 2018 Ren is in charge of making sure that the workflow of the project proceeds swiftly and securely by rating different facets of the project in terms of importance so that the more critical elements of the project get addressed first. Ren has experience with multiple languages as well as a little bit of management from prior classes.
	**Sophia Qi Young - Recorder** qyoung@ucsd.edu 3rd Year, Graduating Spring 2019 | Major: Computer Science Sophia is in charge of taking meeting minutes and making sure that all team members are updated with the decisions made in the meeting and commitments made by participants. Her knowledge in Adobe Creative Suites will help the team with design needs.

1.5 Stakeholder Analysis

Below we analyze individuals and groups we believe are most influential to and/or impacted the most by our project.

Brandon Reynante (Ally - High Influence): Brandon is the instructor of ENG 100D and oversees all projects in this class. He has high authority and interest in all the projects of ENG 100D. We manage the project while learning Human Centered Design methodology from him. He is an experienced and knowledgeable resource when seeking advice and expert input. We report to him every week with our progress and milestones.

Shannon Quigley-Raymond (Ally - High Influence): Shannon is our main contact and acting project manager at the San Diego River Park Foundation. She provides necessary background information and expectations that are critical to the success of the project. Any important decisions or potential issues regarding the final product should be communicated to her, via the

community liaison, for necessary approval or input. Her position will provide important insight and she will be responsible for maintaining the software following the end of the quarter.

San Diego River Park Foundation (SDRPF) (Ally - High Influence): The final product will increase the productivity and accuracy of the data collection process at the organization. Staff at SDRPF are the main users of the final product. Prototypes should be presented to the designated staff for feedback.

Wildlife Researchers (Ally - Low Influence): The data collected will be used for future research in wildlife, with the ultimate goal of supporting conservation. Researchers' needs should be taken into consideration while implementing the final product.

SDRPF Volunteers (Ally - Low Influence): Wildbook allows citizen scientists to contribute to research. Hence, volunteers are also users of the final product. We should increase the awareness of wildlife extinction to keep volunteers motivated and engaged.

In *Figure 1.2* there is a visual representation of our stakeholders based on their power/influence on our project versus their interest in the project.

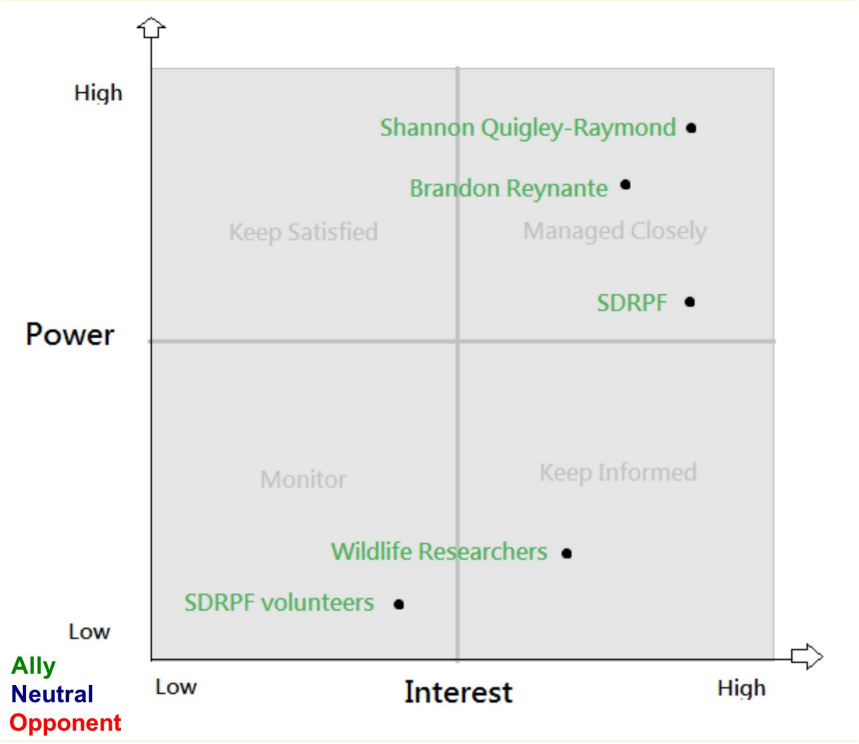

Figure 1.2 - Stakeholder Analysis Matrix

2. Problem Definition

2.1 Problem Statement

Ecologists at wildlife conservation organizations need a more efficient way to identify wild animals in pictures from wildlife camera footage because current manual identification is tedious, inconsistent, and inefficient.

2.2 Background & Context

In 2000, the largest sewage spill in California history dumped 34 million gallons of untreated sewage into the San Diego River. This spill ran uncontained for a few weeks. In response to this tragedy a group of concerned citizens formed the San Diego River Park Foundation on July 18, 2001. [4] The SDRPF has worked with communities to protect and enhance the San Diego river's natural and cultural resources. As part of conservation efforts they monitor wild animals' movement patterns as well as their population sizes. This is important not only because holding the animals' data accountable enables the ecologists to protect the wildlife, but also because the animals' behavior reflects the local environmental condition [*9*]. Their current workflow of accomplishing this takes requires a lot of manual involvement. Our goal is to minimize this and find a more efficient way their tasks of categorizing the animals and logging the wildlife movements. [4]

Cameras are set up around the various habitats which automatically snap photos whenever movement is detected. The brands of the cameras are *Bushnell* and *Covert Scouting cameras*. Occasionally, volunteers go out to retrieve the memory cards from each camera and upload the photos onto a Google Drive. An ecologist is then responsible for manually examining each photo in order to classify the animal as well as record its location. The motion- sensitive cameras are used for daytime and thermographic cameras for night time. *Figure 2.2.1* shows the example photo taken in daytime and *figure 2.2.2* is a photo taken at night. This problem is further exacerbated on windy days where cameras may snap up to 1000 pictures from motion caused by non-animal objects. These useless photos, or "noisy data", must then be filtered out by hand. [7]

Figure 2.2.1. Photo taken by motion-sensitive camera: A badger (provided by Shannon)

Figure 2.2.2 Photo taken by thermographic camera (provided by Shannon)

The goal of our project is to create an interface or system that can provide a more efficient way for the ecologists at SDRPF to identify wild animals in pictures from wildlife camera footage. The solution that our client recommended at the beginning is to develop a

program using Wildbook software which will take in an input of a folder of pictures. It will then sort through the photos and automatically detect different animal species in each photo. However, we pivoted from the this solution because after looking into the Wildbook codes, we found it unlikely to implement this software into the existing SDRPF database.

We tried to attack the problem at a different angle where instead of using a software to automatically filter out animals, we designed one that will be specialized in use for comparing images as well as taking notes along the way. It would reduce the workload by allowing for a much more fluid process of comparing/identifying images. Though we were not able to implement the AI feature to automatically identify animals, we were still able to design to make the animal identification process easier. With the current tedious, time-consuming task taken off the ecologists' hands, they can focus on more important aspects, such as ecological and environmental issues plaguing the San Diego River area. [2]

Stemming from the sewage spill in 2000, the SDRPF's eventual goal is to fully restore the river back to its originally prosperous state with safe trails and thriving wildlife, and to create an environment for the community to connect with. But the immediate objective is monitoring the wildlife: at least 20 large land animals would be affected by this project (*See Appendix B*). Currently, there is only one ecologist working actively on the program. Some resources they are leveraging include our Global TIES team, to aid in the development of a program to automate wildlife data collection and documentation. Another proposed resource to utilize would be to increase capital, either through fundraisers or donations, to be able to fund their endeavors *(SDRPF Page)*. [4]

2.3 User Profile(s)

Persona - Ecologist - Mrs. Goodall

Group Size: ~ 2

Bio:
Mrs. Goodall is a passionate advocate for wildlife research and conservation. She works an ecosystem manager at a non-profit park organization aimed at protecting wildlife and environments. She has little experience with technology and coding. She is a busy worker who wants to increase her productivity.

Needs:
- Reduce workload
- Better way to manage work documents
- Tracking wildlife patterns
- Tracking wildlife activity

"I always have too much work to do"

Age: 38
Role: Ecosystem Manager
Location: San Diego, CA

Ultimate Goals:
- Efficiently track wildlife in surrounding areas
- Understand wildlife patterns to predict changes in environment

Reletive Knolwdge, Skills:
- Administrative level computer skills
- Relevant knowledge of the area of ecology
- Knowledge of culture value of her work as protecting ecosystem

Figure 2.4 - User Persona

The Mrs. Goodall persona is based-off of in-person interview with Quigley-Raymond, Shannon, an ecologist at SDRPF

Table 2.1 User Empathy Map

Desire ● Tag wild animals in the pictures collected from the preserves ● Categorize animals and be able to track individuals ● Better record of ecosystem	*Hope* ● A software or a system that can relieve manual work ● "Make my work easier"
Do ● Have folders that saved the animal photos on computer	*Fear* ● Misidentify animals ● Lose track on individual animal ● Tedious work

Journey Map:

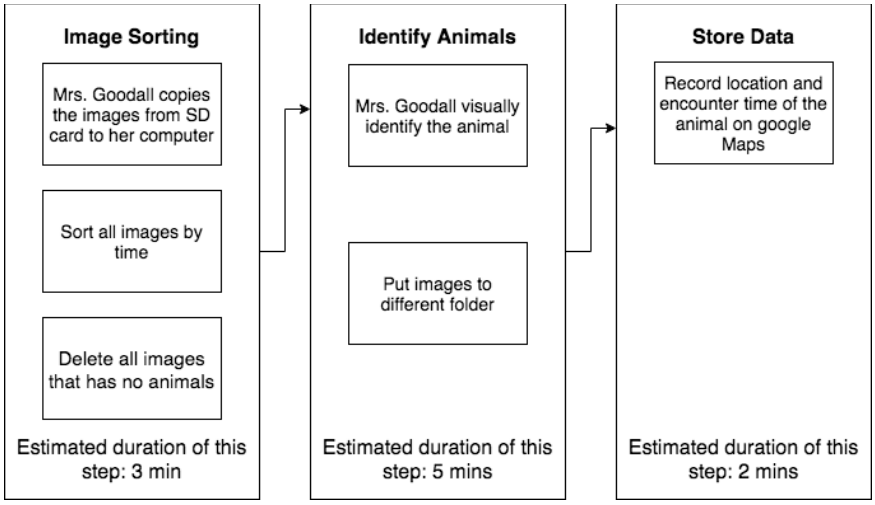

Figure 2.5 - Journey Map for Mrs. Goodall

Persona - Volunteer - Arial
Group Size: ~ 6

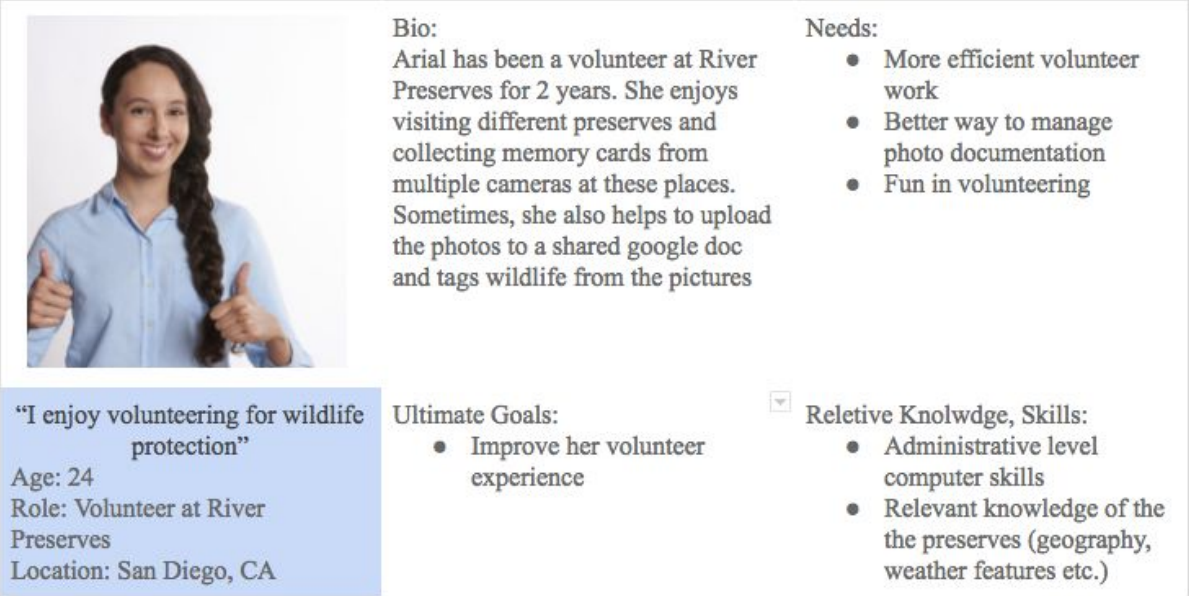

Figure 2.6 - User Persona
The Arial persona is based-off of remote interview with Coffman, Roy, a volunteer at SDRPF

Table 2.2 User Empathy Map

Desire ● Contribute to conservation efforts ● Being part of wildlife research	Hope ● A solution that's easy to use for volunteers to contribute to wildlife protection
Do ● Collect footage from wildlife cameras ● Motivated to be more involved in volunteering ● Willing to learn to use a new software	Fear ● Intrude upon or harm the environment during collection ● Not being able to commit more time to volunteering ● Tagging wildlife manually from thousands of pictures reduces her enthusiasm

Journey Map:

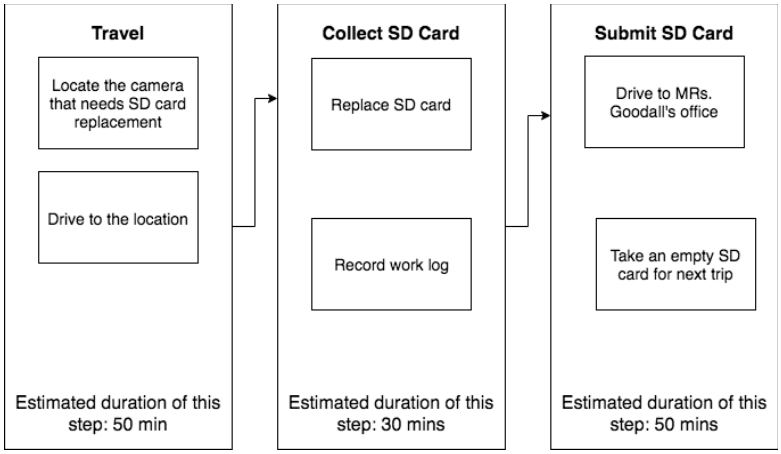

Figure 2.7 - Journey Map for Arial

2.4 Design Requirements

Table 2.3 - Measurable Design Requirements

Criterion	**Requirement**	**Primary/ Secondary**
Usability	User friendly rating need to be greater than 4 on a 5-point likert scale because user of this application may not be tech savvy.	Primary
Functionality	Functionality improvement rating need to be greater than 4 on a 5-point likert scale because the current time spend on this task is too long.	Primary
Flexibility	The ability to process different quality of images need to be greater than 3 on a 5-point likert scale because lighting of image may vary.	Primary
Sustainability	The sustainability rating of the application need to be greater than 4 on a 5-point likert scale because the SDRPF may install new cameras in new locations that use different software, and SDRPF may put multiple teams to work on this project in the future.	Primary
Accessibility	The accessibility rating need to be greater than 4 on a 5-point likert scale because SDRPF volunteers and staff must be able to upload and categorize their images from different devices.	Secondary

Insights are based on the following interviewees: Quigley-Raymond, Shannon (Ecologist at SDRPF), Coffman, Roy (Volunteer with SDRPF), Bapat, Pranav (Automation Engineer), Zhang,Xinyu (Senior Software Engineer).

3. Concepts

3.1 Existing Solutions Analysis

1. Wildbook

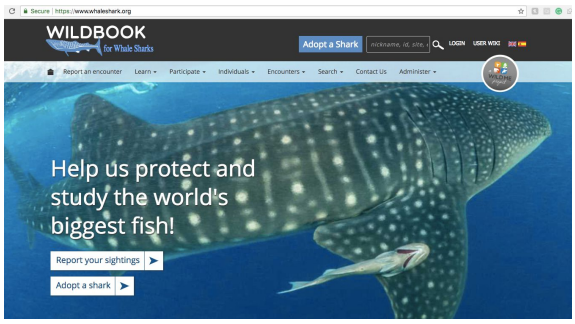

Figure 3.1 - An example project using Wildbook Software used to identify Whale Sharks

Description: Wildbook is an open source software designed to expand and support wildlife conservation efforts through encouraging community contributions. Wildbook's collaborative platform boasts features including a centralized image database, APIs, and computer vision. Images collected and submitted by citizen scientists are analyzed using Wildbook's software. Implementing this technology requires working closely with Wildme, the developers of Wildbook, to customize the software for our specific needs. This solution is out of our reach as we cannot dedicate the necessary time or resources for this concept to be achievable. [2][13]

Pros

- Advanced software uses pattern recognition
- Has a large community of other users
- Allows for contributions from the public
- Can be customized to identify a particular animal
- Tracks the locations of animal sightings

Cons

- Difficult to understand the documentation
- Hard to install
- Requires communication with the WildMe team - who is busy w/ other projects
- Can take months to implement
- Only be programmed to identify one species

2. Google Photos

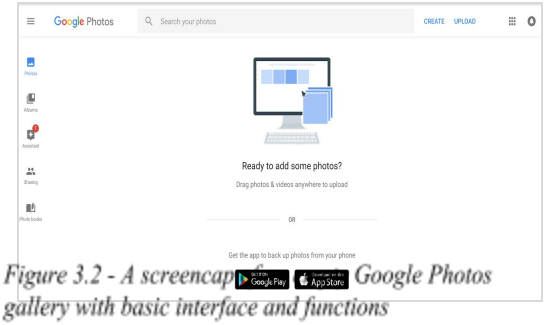

Figure 3.2 - A screencap Google Photos gallery with basic interface and functions

Description: Google photos, and google drive in general, is cloud storage service that allows users to upload, store and organize photos and other digital content across computers. Google stores photos in full HD and does not compress/use low resolution images. This solution allows for photo viewing between multiple computers and multiple google users via the "Sharing" feature. Google photo supports unlimited image storage, as well as features several editing capabilities. Automatically categorizes photos by date or location and allows users to search using these characteristics. [10]

Pros:

- Categorizes photos via machine learning
- Able to tag pictures with locations
- Free unlimited photo storage
- Great Deal of documentation available

Cons

- Auto-categorization not 100% accurate/reliable
- Searching through the photos could yield some undesired results due to the auto-categorization
- Unable to tag or add captions to pictures
- Side by side viewing is not available

3. Phototheca

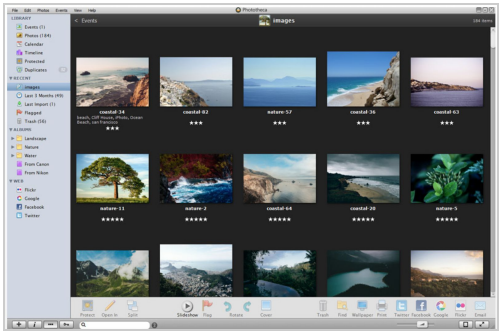

Figure 3.3 - Example screen of Phototheca filled with filler photos, file organization shown at left

Description: Phototheca is another photo management tool that allows users to upload, view, and organize images all in one place. The interface itself is very similar to that of iPhoto, but it is designed to be compatible for *Windows* systems. Users are able to label photos using tags, photo titles, or descriptions – all of these features can be used
when trying to search for photos. Phototheca is compatible with google photos and allows you to share photos via email as well. [10]

Pros

- After importing photos into the database, they can be sorted into Events/Themes
- Photos can be organized by theme or date
- Can add descriptions and tags
- Search results organized into a Smart Album
- Search by photo title, tags or descriptions

Cons

- Lack of sufficient online documentation
- Not many photo editing options
- Side by side viewing is not available
- Alternate interface to Apple's iPhoto application
- No viewing between computers - have to upload images to Google Photos to share.

3.2 Concept Generation

Since the already existing solutions only solve parts of the problems faced by the SDRPF, we have decided to create our own design and thus came up with the three concepts below. A basic mockup of all three can be seen at figure 3.4 below.

Concept 1 - *Animal File Viewer*
This software allows for easy viewing and organizing of animal images by identifying the ID numbers to the right. Upcoming images to be organized are on the bottom.This concept allows for an easy and intuitive interface for users to view and organize images. It allows for comparing multiple species. Images to the right may be difficult to view or see because it is small relative to the large image. It also does not show where the images were taken. Details of the images are not shown.

Concept 2 - *Drag and Drop*
This web application enables users to categorize new pictures of animals into either an existing category or new category. Users can import new folders from local repositories. The uploaded photos of animals (upper panel) will be displayed in a sliding-panel. Users use the pointer to drag the photos to the folders on the bottom of the screen, which are automatically saved. The hamburger menu (3 bars) is for switching between the animal categories. Animal descriptions are editable. By clicking on one of the ID-ed animals, a pop-up screen will show all the photos of that animal. Sliding panels enable the user to hover over pictures quickly and the drag-and-drop function makes it easier to categorize.

Concept 3 - *Animal Image Comparer*
This software allows for flexibility in viewing and comparing images. Underneath it provides details about the image and lets the user compare new images against existing identified animals. Using the green check users can verify the two images are of the same animal. This concept does not show which images will be appearing next. It can be tedious and difficult for users to switch between past and future images with only forward and back arrows.

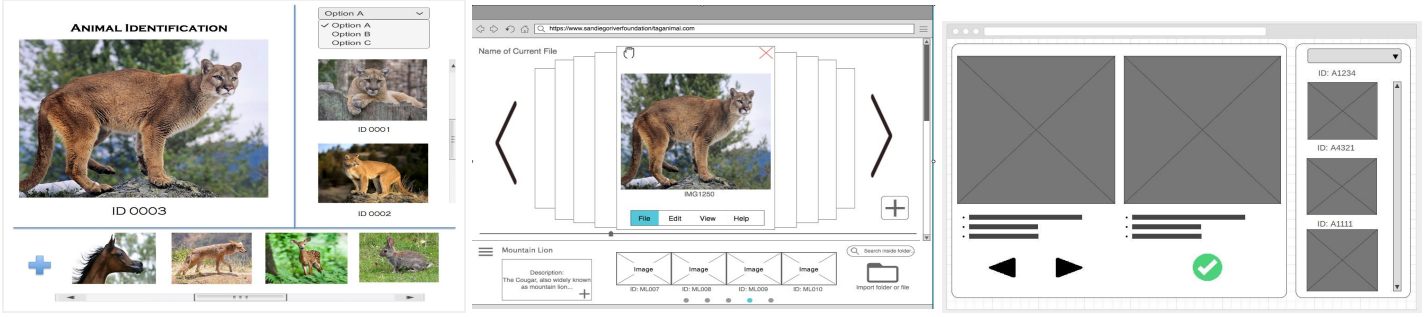

Figure 3.4 - Concepts 1, 2, and 3

3.3 Concept Evaluation & Selection

From these three concepts, we tested each of them based on five main criteria: Usability, Functionality, Flexibility, Sustainability, and Accessibility where each criterion has a weight from 1 to 3. **Usability** is arguably the most important criterion as it determines how well the software performs for users who are not tech savvy. As such, the software needs to be intuitive and hard to use well which gives this criteria a weight of 3. **Functionality** is another criterion where the software needs to be able to run efficiently to reduce resource consumption and is thus given a weight of 3. **Flexibility** was also chosen as the software should be able to work with different conditions such as image quality and size. As the SDRPF has a standard camera, this is

less important overall and only has a weight of 1. **Sustainability** needs to be taken into account as well; the software needs to adapt to changes that the SDRPF may make after its initial implementation and has a weight of 2 due to this. **Accessibility** is the final criterion as it would be nice to be able to work on different devices as the needs arise. Ultimately though, this criteria isn't as important to the overall health of the design as the other criteria and as such is only weighted at 1.

We evaluated each concept based on these guidelines where each individual of our group would go through each design and try to rate them based on the criteria listed above. Afterwards, we aggregated each response and listed the results below.

Table 3.1 - Concept 1 Capture Grid Feedback

What worked (+)	**What could be improved (△)**
● It shows a large picture of the animal ● Allows for easy access to multiple species to compare ● Access to individual animals of each species on the right	● Very minimalistic, can be difficult to figure out how things work ● Doesn't clearly say how to put animals into a folder ● The animals on the right are much smaller making it harder to compare with the bigger picture
Questions (?)	**Ideas (!)**
● What do you do after an animal is identified? ● What do the big plus button and folder icons do? ● What happens if you recognize the species but not the individual animal? ● How do you switch between photos for the ID animals on the right?	● Could click on the ID folders in order to view all the previous photos ● Clicking on a previous photo puts it into a comparison mode with the picture being looked at. ● The plus icon could be changed to something more recognizable such as a slider.

Table 3.2 - Concept 2 Capture Grid Feedback

What worked (+)	**What could be improved (△)**
● Image is well displayed. ● The search bar at the bottom ● X on top right of the picture is easy to understand. ● Description box is useful for the user to take notes.	● The directions for what to do after identified the animal. ● The comparison experience.
Questions (?)	**Ideas (!)**
● What is the big plus sign for? ● The menu button at bottom left, next to Mountain Lion, what is that for? ● Where do we drag the photo to?	● Make it easier to see bottom pics. ● A temporary id feature, to put the unsure pictures to the back of the queue.

Table 3.3 - Concept 3 Capture Grid Feedback

What worked (+)	**What could be improved (△)**
● Large target and comparison pictures allows higher fidelity in pattern recognition ● Simple/Clean UI allows a more gentle learning curve	● Have a helper link that explains step-by-step usage ● Include button to import external picture folder(s) ● Have better color contrast to improve readability
Questions (?)	**Ideas (!)**
● How do I change the target picture quickly without using the arrow buttons multiple times? ● Are the list details below the pictures editable to allow change of information?	● Enable zooming for higher precision in identification ● Allow quick changing in photos by search-by-ID, search-by-Date and search-by-Location

With Concept 1 as a baseline, we found that Concept 2 has good usability and accessibility in that it allows users to swipe and drag pictures making it easier to use on tablets and the like. It does falter in sustainability because multiple picture loading increases resource consumption. Concept 3 has comparison feature which increases the accuracy and the productivity of the task, which is the main task. Additionally, it does not implement too many functionalities and does not preload multiple pictures, which lowers resource consumption and improves the overall user experience of the program. In addition, lowered resource consumption allows slower or older devices to run just as well. Due to these reasons, we found that Concept 3 was the best overall in terms of solving the SDRPF's problem. Of course, there are flaws as can be seen in the decision matrix below but we can leverage some strengths from the other two such as including features to improve responsiveness. That being said, the SDRPF has signed off on the final version thus far as well as suggested some improvements for the future.

Table 3.4 - Decision Matrix

Criteria	Weight	Concept 1 (Baseline)	Concept 2	Concept 3
Usability	3	0	+	++
Functionality	3	0	0	0
Flexibility	1	0	+	0
Sustainability	2	0	--	-
Accessibility	1	0	++	+
+		0	6	7
0		10	3	4
-		0	4	2
Weighted total		0	2	5

4. Analysis and Testing

4.1 Overview

We tested our prototypes using our inVision prototype (Appendix X) with eight users that are tech savvy and another eight users who are not very familiar with new technologies as well as Shannon, our potential first user from SDRPF. We described the problem we are trying to solve with SDRPF and introduced the expected functionality of the application. Users are asked to think aloud and to answer follow-up questions based on the criteria listed below. The detailed rating is included in this spreadsheet. Through user testings, we aim to answer this question: How well can users use the prototype to identify the animal in a image and mark it with the correct ID number.

After collecting feedbacks from 16 diverse users, we compared the average rating with the target rating. We concluded that users are able to use this prototype to identify animals and organize images sufficiently well. However, one of the user's rating is lower than average (marked in the spreadsheet). We planned to have a follow-up interview with the user and to find out how to further improve the experience for similar users. Shannon gave several good feedback after trying our prototype. Overall, Shannon was able to identify the animal in a image using our prototype, which successfully met our goal of this prototype. We made several changes to the prototype to enable the features Shannon advised.

Table 4.1 - Assessment of Initial Concept Solution.

Evaluation Criterion	Metric	Target Value	Result	Evaluation Method
Usability	Rating on a 5-point Likert scale	> 4/5	4.1	User Testing
Functionality	Rating on a 5-point Likert scale	> 4/5	4.3	User Testing
Flexibility	Rating on a 5-point Likert scale	> 3/5	3.7	User Testing
Sustainability	Rating on a 5-point Likert scale	> 4/5	4.1	User Testing + Follow-up Questions
Accessibility	Rating on a 5-point Likert scale	> 4/5	4.4	User Testing + Follow-up Questions

4.2 Desirability & Usability

Introduction:

The main objective of our user testing is to determine the overall user-friendliness, and functionality of our customized web application. The I.D.Wild solution was found desirable based on the assessment table (Table 4.1). We used five indicators and let the users to rate the prototype after user testing. The results are well above the target values proving its desirability in solving the design problem. Our user feedback is designed to provide insight on how well our

current concept iteration addresses each aspect of our previously defined design requirements. The primary hypothesis we aim to evaluate through user-testing is:

Hypothesis: Customized web-application is user-friendly and effectively addresses the functional needs of the user.

Additional questions we are testing during this design phase include: How well is the user able to interact with the web application to complete the goal of categorizing animal pictures? Additionally, is the process of identifying and categorizing images intuitive?

Methods:

Prototype

We used InVision to create our prototype. The available action items are highlighted in blue to prompt users to interact with the prototype. Users were able to navigate from login page to the main page, then perform the image comparison task in a few clicks. User tests were conducted using an improved version of *Concept 3* outlined in the previous section. This prototype incorporates a side-by-side image viewing layout, which prioritizes the comparison aspect of the identification process. The left side-bar features a scrolling section of previously identified animals of the same species. The description boxes allow the user to make quick, visible notes, in order to facilitate image comparison and eliminate the need to take physical handwritten notes. This prototype is intentionally simple as it is designed to prioritize the testing of particular features.

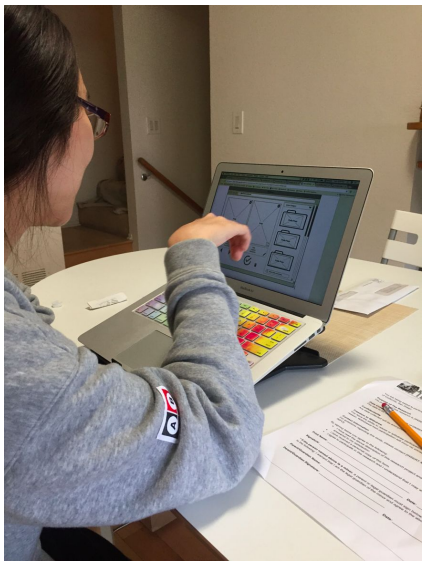

Figure 4.2 - A participant interacting with I.D. Wild

Procedure

The general procedure we followed during our user tests allowed for an initial period self-exploration, followed by task-based questions and a series of follow-up questions designed to elicit qualitative feedback from the participants. Prior to conducting the tests the users were educated on the overall objectives of the web-application and the intended function of their feedback. Task-based questions were designed to engage the user in the interactive component of the prototype, and provided a procedural way for observers to gain insight into the buttons and functions of the prototype that were unclear. Follow-up questions were subsequently generated by each test conductor in order to fill in any gaps in the feedback, and allowed for feedback to be given on aspects of the design that could not be addressed initially by the in-test questions. Each observer recorded the user's feedback in each design requirement category based on a 5-point likert scale such that responses are systematically collected and uniform.

Results:

Positive feedback:

- User interface and user experience is clear, intuitive, and easy to understand
- Every button is functional
- Application is straightforward and not cluttered

Negative feedback:

- Cannot zoom in on the photos
- Cannot create new animal folder; the meaning of "ID" is unclear
- Cannot delete existing pictures or folders
- Difficult to understand the step-by-step workflow
- Design is more conducive to vertical images when most of the pictures from the cameras are landscape/horizontal
- Cannot search descriptions to find similar characteristics off the bat

Discussion:

The intended users are ecologists and volunteers in SDRPF who are experienced in the wildlife field but do not necessarily have sophisticated computer skills. We tried to find participants with different area of knowledge, some have backgrounds that are related to technology and the others are not. Test users were able to grasp concepts and features of the application relatively quickly. Solution fulfills the need of categorization and comparison of pictures well. Users agreed that a drag and drop feature for pictures would be appreciated, as well as a file explorer feature for the pictures on the side bar. One constraint of our testing process is that none of the participants were familiar with wildlife or ecology. To counter this limitation, we tried to generalize the task in testing, aimed to test the participants' procedures of interacting with the interface without making the task strictly for wildlife recognition and comparison. The suggestions include recording the history of identification process such as the name of the ecologist who worked on it and implementing the functionality of identifying multiple animals in one image.

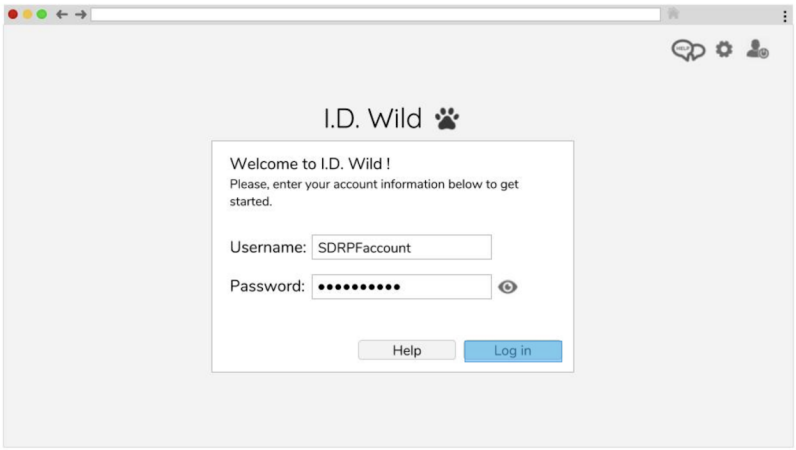

Figure 4.3 - New feature added to the prototype after collecting user feedback

4.3 Feasibility & Suitability

Our solution will provide the necessary tools and functions to view, mark, tag, and organize imported images. We believe it is feasible to design and test the prototype of the application by the end of this quarter. Based off of our user tests, our solution prototype was intuitive and user-friendly. Although some functionalities were vague and need further improvement, we will improve upon them so that the end product will be feasible and sustainable. After the design is complete, the program will need to be implemented by a experienced software development team. The program will require a website hosting service, database server service and website creation service. Engineers may use existing frameworks and application builders such as Wix, Squarespace, Duda, Simvoly, etc. to build the program. To host and integrate the program with the SDRPF's existing website, they may use Amazon Web

Services, Dreamhost, GoDaddy, etc. They can also use database servers to organize and maintain the website and images. These services are easily affordable and some are even free. If the SDRPF requires more flexibility and customization, they can use paid services that allow for extra features. There are a range of available services online that can be implemented to meet the SDRPF's needs for this program. If the SDRPF decides to integrate more functions, they can do so by updating the program. Once the program is online and live, it will be self-sustainable; engineers will only need to spot check periodically to ensure the software is operational. Our solution is designed to be easy to use for people with non-technical backgrounds. This is the ideal since the users of our application will likely be ecologists. This application has a simple, minimalistic user interface so that it will not only be easy to debug, but also easy to teach. Ease of teaching is a critical requirement since non-technical users will be teaching other non-technical users.

Furthermore, our prototype meets the functionality requirement well because the results have shown that users were able to perform multiple images comparison quick and accurately. Additionally, users have been observed to be able to understand the prototype easily with little information given implying that it has a user-friendly design. Next, our prototype is shown to be highly flexible as well because standard HTML5 image source tag which will be used in our application supports images of any format. Furthermore, our prototype is shown to be easily accessible because since it is implemented as a web application, it can be accessed with any devices be it a computer, tablet or even a mobile phone since all of them possess a web browser.

4.4 Sustainability

Ecological Sustainability

Since our current solution is a web application, the main resource necessary for the SDRPF to have access to is a computer with internet. The other resource necessary for this solution is a server, of which will be responsible for hosting our application, as well as storing data. As more data is uploaded to the server, however, more space may become necessary should maximum capacity be reached, this in turn means that more material and energy will be needed in order to create and maintain new servers. We minimize this by having users, upload the folders they want to use and only storing data as the user deems fit. As can be seen in Figure 4.3 there is only one output which is old data which is intended to minimize server space as well as the costs and resources necessary to maintain it.

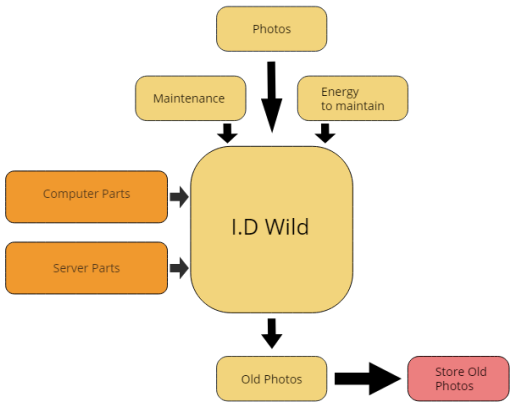

Figure 4.4 - An input/output diagram for I. D. Wild

Economic Sustainability

The cost to implement the web application is minimal because it is a simple application that does not involve a lot of technical complexities. Web developers are abundant in the market and since the application does not require challenging capabilities such as machine learning, the developers need not to be of high-end that requires a high cost. In fact, there is the potential for future ENG 100D teams to work on the website for zero cost. Professional software development may cost around $10,000 according to our research (Upwork). Next, the cost required to use the application is also minimal since a websites can be accessed anywhere and anytime as long as the user possesses a device with internet browsing capability. Therefore, the only true cost burden is in the server upkeep. Since all images have to be stored on a server, the cost could be on the medium-to-higher end. Alternatively, the application could use cloud storage to reduce the cost. A modern cloud storage service for a total of 1TB only costs $6.99 monthly (OneDrive). A storage of 1TB can store approximately 200,000 pictures, which is more than enough for our user's needs. Additionally, to reduce the amount of storage needed, users can choose to delete pictures on the cloud as they see fit.

The web application as a solution definitely improves the user's financial security. Since performing comparisons manually without any helper application takes many hours, using the website would definitely reduce the total cost in a long run because less hours are needed to spent on manual tasks. Besides, to further reduce cost, SDRPF can opt to use citizens to perform these comparisons by making the website application to be publicly accessible. Additionally, the web application is predicted to not have any major changes to its scope, therefore it can be said to be self-sufficient. This means it does not require future developers to make major changes to the application that requires major financial cost.

Socio-Cultural Sustainability

The solution is culturally appropriate and sustainable as the staff of SDRPF are easily able to work with programs with assistance as needed. Since our design is free of complicated features, it should be intuitive for them to quickly learn to use the application. Additionally, since their previous method already involves working with computers, our application would not change the required skills or experience. Furthermore, we took into account the features that they wanted as well as what they hoped to accomplish in order for the app to better fit their needs.

The SDRPF will be able to make changes in the future as we will be providing them with the UI designs as well as the source code. The source code is shared through Github which allows comments and version control. In addition, we will be providing a tutorial that will go through key steps and functions so they can both use and teach others ID Wild's usage. The main goal of the SDRPF is to maintain the San Diego River and one of the methods that they use is to monitor populations which renders data such as migration patterns, population changes and more. By using ID Wild, they can accelerate this process leaving more time to the other methods they use to preserve the river. It also promotes a social justice by allowing the SDRPF more time to other methods in preserving the river.

5. Design

5.1 Overview

The I.D.Wild website application is designed to provide ecologists and volunteers at SDRPF with an efficient tool for identification and categorization of wildlife pictures, as a supplement to the existing workflow of the organization. It would allow users to upload new pictures from local repository, match them with the existing animal profiles, add notes to images and finally, categorize them into folders by species. Our solution is adapted to the typical behavior of users; features include the comparison of two images side-by-side, the ability to add descriptions and a straightforward way of uploading pictures and files. The application simplifies the process of viewing pictures on screen and taking notes on a separate notebook.

5.2 Detailed Design

Our website application will ultimately provide an efficient and intuitive way for SDRPF staff and volunteers to identify and categorize wildlife images. We prioritized a desktop interface over a mobile design because our client works almost exclusively using a computer monitor, as viewing the images requires a large display for comparing animals. It was important for our client to be able to share images and make the application accessible on multiple computers. For this reason, a website is a more practical solution than an individual photo viewing application that is only compatible with a single system. Using an online implementation allows multiple contributors to work on the website at the same time, which provides a way for SDRPF staff and volunteers to tackle the identification process collaboratively.

Design Elements

Figure 5.1

The central function of our website revolves around the user's ability to compare two images side-by-side. We adapted our original concept in order reflect the typical horizontal orientation of the images received from SDRPF's wildlife cameras. Each image has an editable description box for recording information about the photographed animal. Using the pencil icon at the top right corner user's will open up a large window for changing the description associated with that image and a save icon will present itself in the same top right corner for the user to save any changes. This ability to add descriptions will eliminate the need for users to take handwritten notes while examining the images, making the process more efficient. Using

feedback from our user-testing we decided to implement a more powerful search function that can not only search by ID, but also by location, species, or keywords in the description. The tool bar at the top of the application includes an upload button which allows users to upload new images either individually or as entire files. Additionally, the tool bar features an undo button to quickly revert mistakes in categorization or accidental deletions of images.

The right bar features a scrolling section of *profiles* of previously identified animals, which feature a cover photo of the animal and act as files which contain all of the images of that individual. In order to add a new profile, users can simply click the large plus icon. Users can quickly switch between species using the drop down menu.

Our simple design is focused on ease of use, and aims to supplement the existing workflow at SDRPF. The clean interface provides an intuitive way to interact with the application, making it easy for users to learn how to use it. This is important because SDRPF relies on volunteers to help expedite the identification process. The framework we have established for ID Wild can ultimately be implemented in conjunction with the SDRPF website and provide an additional way for community members to learn about the San Diego ecosystem. Our solution could easily be adapted to add an educational component by removing the identifying process and simply featuring the existing species profiles and using the descriptions to provide information about each animal. A potential design for this branch of ID Wild is depicted in Figure 5.2, called I.D. Wild *explore*.

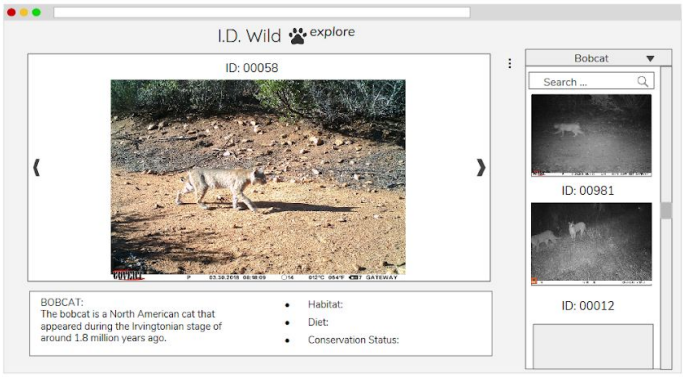

Figure 5.2 A prototype of I.D. Wild explore

Usage

In Figure 5.3, we describe how the application is meant to be used by the ecologists by following the listed steps in the flowchart.

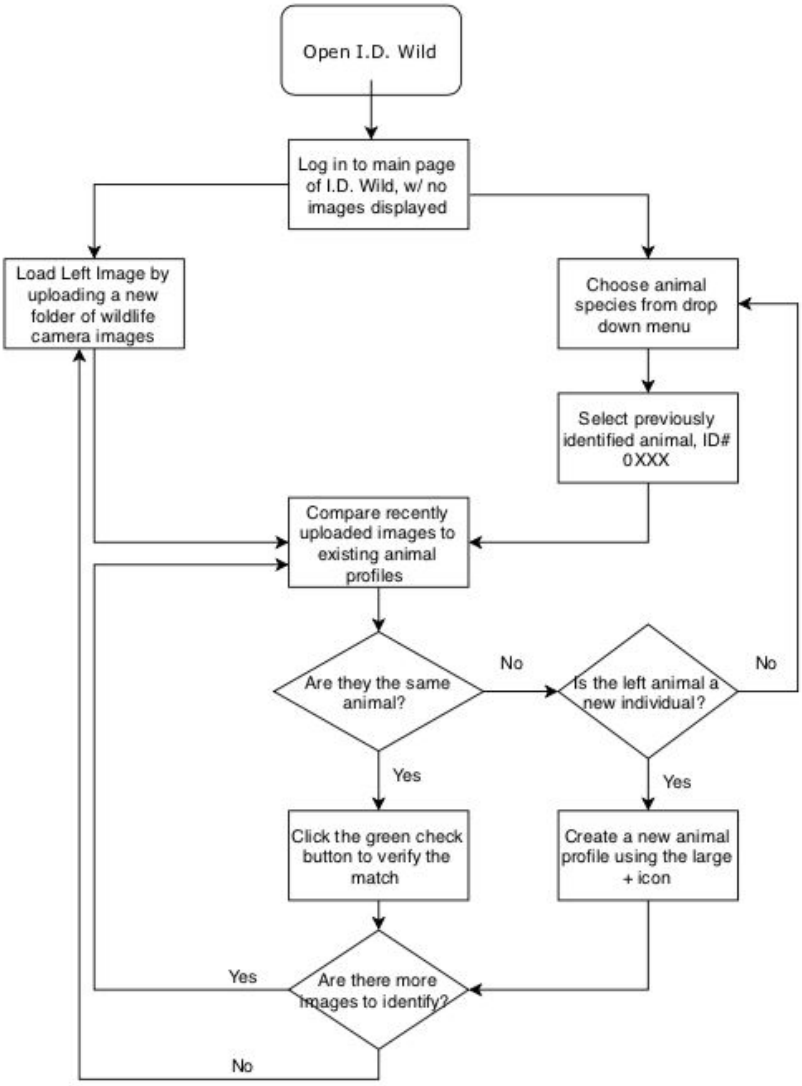

Figure 5.3 I.D. Wild web application flowchart

Future Strategy Overview

After our group has finished with the project, engineers will have to take over the project. For SDRPF, they must be mindful of a lot of things in order for the project, I.D. Wild, to move forward. For the app to be able to be live on the internet it will require a website hosting service, database server service, and website creation service. SDRPF must also make sure that the engineers that they have work on this project are proficient in certain programming languages that are related to back-end and front-end programming as well as web application software building tools and frameworks.

Data Storage

To host and integrate the program with the SDRPF's existing website, engineers can use Amazon Web Services (Amazon S3), Azure Cosmos DB, Oracle Cloud, etc. They can also use database servers to organize and maintain the website and images. Many of these services range

from free to affordable. If the SDRPF needs more flexibility and customization, they can use paid services that allow for extra features If the SDRPF decides to integrate more functions, they can do so by updating the program. Once the program is online and live, it will be self-sustainable; engineers will only need to spot check periodically to ensure the software is operational. Our solution is designed to be easy-to-use for people with non-technical backgrounds. This is the ideal since the users of our application will likely be ecologists. This application has a simple, minimalistic user interface in so far as it will not only be easy to debug, but also easy to teach. Ease of teaching is a critical requirement since non-technical users will be educating other non-technical users.

Bill of Material/Cost

Table 5.1 outlines the pricing of the various data storage and website hosting services options, in order to educate SDRPF's decision regarding project implementation. Storage price describes the cost of data storage per GB. Request pricing refers to the charge for sending instructions to the database. Data Transfer into the database is free for all options, however transferring out onto the internet requires a fee, per GB. On average, a picture takes 200 KB overall and thus the SDRPF can store around 5000 pictures per GB. From the cost analysis below, we estimate that Oracle Cloud is the most cost effective web host option assuming that there is an average of 200,000 requests per month as well as 5GB storage.

Table 5.1

Host Company	Storage Price (per GB)	Request Pricing (SQL Requests)	Data Transfer Pricing (per GB)	Total Estimated Cost
Amazon S3	$0.025	~$3.08 per month (~$0.0154 per 1000 Requests)	$0.09	$3.19 per month
Oracle Cloud	$0.0383	~$0.068 per month ~$0.0034 per 10,000 Request	$0.18	$0.102 per month
Azure Cosmos DB	$0.25 (SSD)	~$5.84 a month	$0.087	$7.53 per month

Back-end overview

Heroku and Django are both options to deploy and host the web app. We can connect these services with a GitHub account for easy updates and changes. Existing frameworks and application builders that engineers could uses are such as Wix, Squarespace, Duda and Simvoly. Javascript with NodeJS can be used to communicate with the front-end.

Front-end overview

React with Redux is used as the front-end framework because it offers highly-responsive design which is crucial since the application involves quick and many changes of picture. Furthermore, React offers a highly modular design that can help bug fixes and any potential

changes. The provided code is enough to form the entire front-end skeleton. Twelve modular components make up for the entire application. The snippets presented in Figure 5.5 require the engineers to be proficient in ES6 and JSX knowledge for React, as well as have experience with HTML.[1] Additionally, CSS3 knowledge is required for styling. Developers are recommended to use Axios from npm library for any request to the server, and NodeJS if Javascript is chosen as the back-end language.

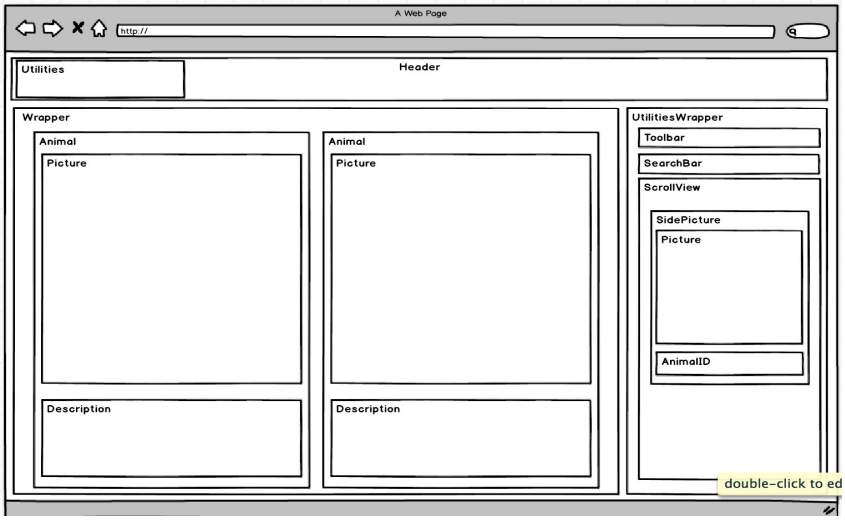

Figure 5.4 React Components Overview

Code Snippets

Link to entire code: [Complete code with documentation]

```
// Animal
import { Component } from 'react';
import Picture from './picture.js'
import Description from './description.js'

export default class Animal extends Component {
    constructor(props) {
        super(props);
        this.state = {
            animal: null
        }
    }

    render() {
        return (
            <div>
                <Picture id=
                    {this.state.animal.id}/>
                <Description info=
                    {this.state.animal.info}/>
            </div>
        );
    }
}

// SidePicture
import { Component } from 'react'
import Picture from './picture.js'
import AnimalID from './animalid.js'

export default class SidePicture extends Component {
    constructor(props) {
        super(props);
        this.state = {
            animal = null;
        }
    }

    render() {
        return (
            <div>
                <Picture id={this.state.animal.id}/>
                <AnimalID id={this.state.animal.id}/>
            </div>
        );
    }
}
```

```
// UtilitiesWrapper
import { Component } from 'react'
import Toolbar from './toolbar.js'
import SearchBar from 'searchbar.js'
import ScrollView from 'scrollview.js'

export default class UtilitiesWrapper extends Component {
    constructor(props) {
        super(props);
        this.state = {
            selectedType = "",
            topList = []
        }
    }

    render() {
        return (
            <div>
                <Toolbar onSelect={(e) =>
                    this.setState({selectedType: e})}/>
                <SearchBar onSelect={(e) =>
                    this.setState({topList: e})}/>
                <ScrollView animalType=
                    {this.state.selectedType}
                        topList={this.state.topList}/>
            </div>
        );
    }
}

// Toolbar
import { Component } from 'react'
import { Toolbar } from 'react-simple-toolbar'

export default class Toolbar extends Component {
    constructor(props) { super(props);}

    render() {
        return (
            <div>
                <Toolbar>
                    <Region>Animal type </Region>
                </Toolbar>
            </div>
        );
    }
}
```

```
// Header
import React from 'react';
import Uitlities from './utilities.js';
export default const Header = () => {
    return (
        <div>
            <Utilities />
            <span>Title</span>
        </div>
    );
}

// Utilities
import React from 'react';
handleImport() {
    //code to import folders
}

backPicture() {
    //code to back picture
}

export default const Utilities = () => {
    return (
        <div>
            <button>
                <img src = ""
                    onClick={this.handleImport}/>
            </button>

            <button>
                <img src = ""
                    onClick={this.backPicture}/>
            </button>
        </div>
    );
}

// Wrapper
import { Component } from 'react';
import Animal from './animal';
export default class Wrapper extends Component {
    constructor(props) { super(props); }

    render() {
        return (
            <div>
                <Animal animal="target" />
                <Animal animal="default" />
            </div>
        );
    }
}
```

Figure 5.5 Core React Components snippets

[1]Complete code with documentation via Dropbox. https://www.dropbox.com/s/3tw51174u50aj0c/snippet.js?dl=0

6. Implementation & Impact

6.1 Implementation

As a result of our previous setbacks and time limitations, we will not be able to implement a fully functional solution. Instead, we will provide our clients with a roadmap (*Table 6.1*) to assist them with future implementation. There are several milestones that need to be completed after we deliver the design plans and relevant documentation. The first of which is to find an experienced team to implement the design. This step should be rapid as the skills required to implement the software successfully are not very stringent aside from general knowledge regarding databases and web development. We estimate this should take 1 to 2 weeks, and could potentially involve a screening process in order to determine an appropriate eam for their needs. This milestone is completed when a team is found and a contract or agreement is signed. Development teams should create detailed plans and timelines to follow.

The next milestone is for the chosen team to begin the implementation phase, which can be further divided into two mini-milestones, back-end and front-end design. The SDRPF's main focus during the former is to choose a database service that they would like to use and providing the implementing team with that information such that they can take it into account when designing the back-end. As the application features a relatively simple design, the front-end should take around a week to get things up and running. The back-end however, will take longer to implement as it needs to be optimized to reduce the amount of instructions necessary to send to the database. Knowing this, the back-end will likely take nearly a month to complete. The front-end should be completed first such that the back-end can be best fit to support it.

After this, the only remaining step is for the software to be handed over to the SDRPF. This will conclude the implementation plan and the SDRPF will be free to start utilizing the solution for their purposes. This transition additionally might include an introduction to the application for the user to learn how it functions.

Figure 6.1 Software Implementation Roadmap

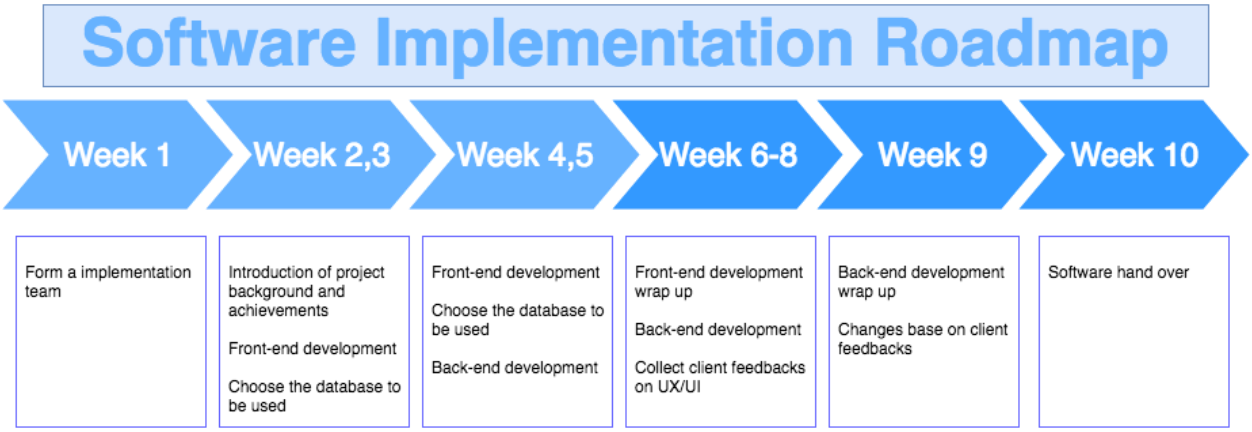

Table 6.2 Resource Assessment Worksheet

Resource Assessment Worksheet							
Distribution	**Activities**	**Capabilities**	**Responsibilites**				**Still Needed?**
			Design Team	**Implementation Org**	**Funders**	**External**	
We plan to finish the design based on the requirements of the SDRPF and at the end hand the design plans to them. From there, we plan to have another Gloabl TIES team implement the process making changes as they see fit. However, the SDRPF will be using the software ad will be in charge of managing the software in terms of costs and direction.	Hardware	Computer		X			
		Servers	X	X		X	
		Cameras		X			
	Design phase	UI Design	X				Total Available Budget
		Predicted Costs	X		X		
		Documentation	X				
	Implementation Phase	Getting a team	X	X	X		Recommending possible implementation teams from design team
		Implementation	X				
		Procuring Server		X	X		
	Identifying Animals	Getting Pictures		X		X	Wildbook Integration for more automated process
		Storing Pictures		X			
		Comparing Pictures		X			
	Managing Data	Track animal location		X			
		Sending Data to Research		X			
		Interpreting Data		X			
	Performance tracking	Data evaluation		X			Quality tracking Cost metrics + effectiveness
		Feedback loop		X			
		Data software			X		
	Maintenance	Keeping Code up-to-date				X	Need effective Troubleshooting Process for smaller errors
		Maintaining Servers		X		X	
		Pay Services		X	X		

Strategy for Engaging Stakeholders

The strategy to get our primary stakeholders engaged in our solution is to acknowledge them the detailed function of the web application that we designed for implementation and let them co-design the project's long-term plan. In our case, the stakeholders are the ecologists at SDRPF. They have incentives to use our solution giving the reason that, once our prototype is implemented, they will be able to quickly manage the wildlife picture collected from motion sensor cameras in different preserves that SDRPF manage. They will be able to quickly identify the animals that are in the images through our interactive user interface which will meet their need of categorizing wildlife in their routine work.

The disincentives are that the stakeholders might be unwilling of implementing a new system which will be a big shift from their original routine; misunderstanding or disagreement may arise when we handover the project to the next developers. To mitigate these disincentives, we want to get our stakeholders involved in setting up the project's long-term plan. We need to meet some consensus about design, goal, time schedule and other requirements with our stakeholders before this quarter ends. In-person meeting(s) can be used for consultation about the details of our design and the roadmap leading the future project ensuring that at least one ecologist can give her insights about how we can implement the application in the future.

6.2 Failure Analysis

Failure Modes and Effects Analysis (FMEA) was conducted to assess the application in-depth for any potential failures, risks and action(s) to be taken for failure mitigation. We evaluated each risk by its severity, occurrence and detection equally. Failure modes that have higher risk scores are studied to a greater extent for the best course of action to prevent such a breakdown from occuring. These can be reduced by surveying users, communicating and testing.

Table 6.3 Failure Modes and Effects Analysis

Failure Mode	Effect(s)	Severity (1-10)	Occurrence (1-10)	Detection (1-10)	Risk Score (S*O*D)	Action
User rejects solution	User productivity fails to improve	8	5	2	80	N/A
Application is never created	User forced to use old, slow ID method	8	4	6	192	Develop long-term roadmap to make implementation easier
Application is incomplete/ lacks features	User productivity fails to improve	5	8	3	120	Study user's pattern for potential features
User prefers old methods of identification	User productivity fails to improve	6	5	6	180	Gather user feedback to best meet user needs
Application itself has bugs/errors	Decreases user productivity	7	6	7	294	Perform unit tests on code
Images are difficult to view	Increase in Identification errors	6	3	4	72	Implement zoom feature OR increase image size
Cloud service terminated or down	Unable to use application	9	2	3	54	Migrate data to new cloud service

6.3 Monitoring & Evaluation Plan

Upon completion of the proposed web application, ecologists at SDRPF will have the ability to quickly manage the images sent to them from the motion sensored cameras out in the wildlife preserves that they manage. They will be able to do this through the database which will store all the images sent to them in an organized and easy to view interface. As well as being able to manage the images, SDRPF will be able to quickly identify the animals that are in the images through our interactive user interface which will give the ecologists a clean way to compare different animals and the images associated with them. We believe that this will vastly improve the current process of which the ecologists at SDRPF operate. For the first week of use we would like to record the total time it takes for an ecologist at SDRPF to finish their tasks of identifying the animals using the web application that we have designed. We would then compare that time to the time it took the ecologists at SDRPF to identify and manage the animals

the old way. After comparing the times we hope to have at least a 25% improvement. We will also track the usage of the web application to make sure that it is being used on a weekly basis. This will determine whether the application is an easy to use tool for the ecologists. The web application also hopes to be an educational tool for children and any other people that wish to be informed and educated about the animals that live in the preserves.

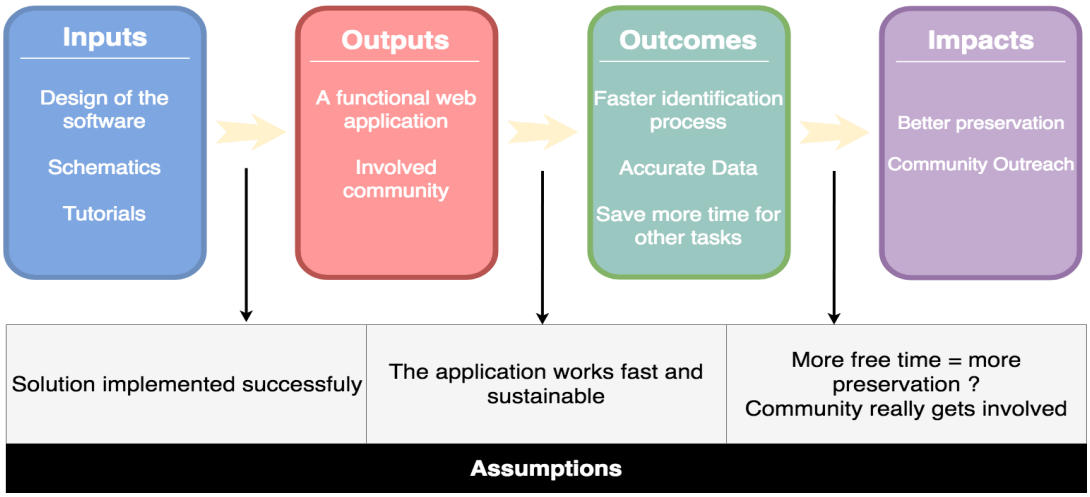

Figure 6.3 Theory of Change

Below is a monitoring and evaluation table to determine effectiveness of progress and impacts. These values were determined by analyzing and estimating how many users will work on the application, how many users will use the application, and expectations from the SDRPF.

Table 6.4 Monitoring and Evaluation

	Objectives	Indicators	Baseline	Target	Datasource	Frequency
Inputs	Have I.D. Wild developed and implemented	# of developers working on the software	2	5	SDRPF management	Monthly
Outputs	Functional software that SDRPF uses	% of SDRPF members using the software	25%	70%	Survey SDRPF members	Quarterly (3 months)
Outcomes	Faster identification process	% of time saved using I.D. Wild	0%	25%	Survey SDRPF members	Monthly
Impacts	Preserve nature and increased community involvement	# of community contribution to identification	100	500+	Database check	3-6 Month Checks

6.4 Ethical Analysis

The ecologists at the San Diego River Park Foundation are tasked with the job of monitoring the wildlife's movement and population growth around the San Diego River. This is currently being done with cameras strategically situated around the habitat with motion sensors to dictate when to snap a picture. Volunteers then periodically go out to collect the memory cards from the cameras and upload them. At this point the ecologists will have to sit down to manually compare each photo one-by-one with existing, documented photos to detail them. Our solution addresses the inconvenience and inefficiencies the SDRPF have to deal with on a frequent basis when it comes to photo categorization. Also, animal identification errors can lead to inaccurate data about wildlife preservation, environmental changes, and habit patterns. Our solution seeks to reduce these errors by increasing efficiency and accuracy. I.D. Wild, our solution, benefits SDRPF by increasing the efficiency at which they can work. Our web application will allow for a streamlined workflow for which they can compare and categorize photos with ease. By freeing up more of the ecologists' time, they will be able to focus more of their attention at fixing the underlying problems impacting the river habitats. Our design is an integrated solution since it also addresses the root problem of low community involvement. Once fully implemented, there will be a link on the SDRPF's website where anyone can upload photos, thus getting the community more involved. This will in turn raise more awareness for the San Diego River.

One potential future pitfall for our proposed solution is that since it is software, it is possible that it will need maintenance. Should the bugs go unchecked, not only will the ecologists suffer, since they will need to go back to the old tedious manual categorization of photos, but the environment will also suffer as the ecologists lose more time. However, our web application is fairly lightweight so maintenance, if any, should be quick. Future developers will have complete access to our work notes and code, so fixing potential future bugs should come with little involvement.

Another potential pitfall is if the SDRPF decides to not use our web application at all and go with another third-party software, our solution will become irrelevant. Assuming that the San Diego River Park Foundation accepts and implements our solution, the main burden of the project will just be to maintain the website and to educate users. Our web application, through extensive user testing, is designed to be intuitive and user friendly; however, we will also provide documentation and notes to minimize technical burdens. Our web application will run on existing servers so there will be minimal environmental impact. Furthermore, should this web application fail, it will not hurt SDRPF or the environment associated with them since this solution did not cost them anything. Therefore there should be no social impact either.

Conclusion

Our team worked together with the San Diego River Park Foundation to design an easier way to identify and track wildlife in the regions neighboring the San Diego River so that they can foster stewardship and appreciation for the river. Our goal is to create a software to make the task of identifying the animals more efficient and streamlined for the ecologists at SDRPF.

We reached out to the SDRPF to understand the scope of the application. We interviewed our primary contact from the SDRPF to understand the problem, the impact, and potential solutions.We have maintained constant contact with SDRPF to keep them updated with our progress and roadblocks. Currently, SDRPF collects images taken from cameras around the area so that they can then manually identify and tag animal images using the animal patterns. An ideal solution would decrease their time tagging and identifying wildlife, allowing them to allocate time to work on other tasks. At a larger scale, we need an application that could be put online so that the community can get involved in preserving wildlife.

After ideating, we came up with three potential web application concepts, since the client's proposed idea of utilizing "WildBook" presented our team with some insurmountable roadblocks. The first potential concept was an animal file viewer. Next up was a web application which utilized a drag and drop feature to compare animal photos. Finally, and the concept we ultimately ended up going with, was an animal image comparer. We scored the three concepts against each other using relative scores on the design matrix. Furthermore we also reached out and user tested the concepts against potential end users. We prototyped our concept and began iterating on it, and finally finalized our design of I.D. Wild, after receiving approval from our client.

Our plan for implementation, unfortunately, will not provide our client with a fully functional end product. Due to the roadblocks mentioned earlier as well as our time constraints, we will not have the resources to properly implement I.D. Wild. Instead, we will provide our clients with a roadmap in order to assist them and a future team on implementing I.D. Wild. We'll leave the design plans and any relevant documentation with our clients so that they can work with an experienced team in the future. Finding a team with the ability to implement I.D. Wild should take one to two weeks. Next, SDRPF will need to decide on a database service they'd like to use for the back end of I.D. Wild. The back-end design is projected to take nearly a month to properly complete since it will need to be optimized to minimize the amount of instructions to send to the database. The front-end features a relatively simple design so it should take about a week to get up and running. Finally, I.D. Wild will be complete to be handed over to SDRPF.

Although our solution addresses the issue of inefficiency in animal tagging and identification, we have a few additional points to address. Since our solution does not incorporate pattern recognition software via Wildbook, the workflow cannot be fully automated. In order for this solution to be viable, and reach the community, it will need to be integrated with SDRPF's existing website. This is pivotal in taking our solution to the next level by preserving wildlife and promoting community involvement.

Overall, our web application design, proposed implementation, and operational processes will be effective in increasing the amount of free time our users will have after transitioning to it. The only task left is to properly implement I.D. Wild so that the ecologists at SDRPF will be more free to improve and promote the existing habitats around the San Diego River.

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Appendix A

Complete Gantt Chart:
https://docs.google.com/spreadsheets/d/1fv8ZbH1pUSovKffJb3SsoeW71k-coVga2yQmlqmhS94/edit#gid=0

Detailed Meeting Minutes:
https://drive.google.com/drive/folders/1e1xBfL2aDibr1I-cvAk2uiv3BPa3VL-N?usp=sharing

Summary of team meetings:

1. **Class Meeting** / 04-11-2018 / 12:30 PM / MANDE-B150
   Attendance: William Jiang, Brian Nguyen, Qi Young, Zhi Jia Teoh, Youli Pan, Haley Dahlberg, Ren Salvania
   Summary:
   - Members picked role for the project
   - Team meeting time set to every Monday after 7pm
   - Need to schedule a meeting with client

2. **Team Bonding /** 04-14-2018 / Tofu House
3. **Class Meeting** / 04-17-2018 / 12:30 PM / MANDE-B150
   Attendance: Emil Kirov, Brian Nguyen, Qi Young, Zhi Jia Teoh, Youli Pan, Haley Dahlberg, Ren Salvania
   Summary:
   - Client's email update by Haley
   - Discussed tasks regarding Project Management Draft

4. **Class Meeting** / 04-19-2018 / 12:30 PM
   Attendance: Emil Kirov, Brian Nguyen, Qi Young, Zhi Jia Teoh, Youli Pan, Haley Dahlberg, Ren Salvania
   Summary:
   - Discussed interview strategy
   - Meeting with Shannon confirmed

5. **Weekly Meeting** / 04-23-2018 / 7:30 PM / Library 1045
   Attendance: Emil Kirov, William Jiang, Brian Nguyen, Qi Young, Zhi Jia Teoh, Youli Pan, Haley Dahlberg, Ren Salvania
   Summary:
   - Discussed schedule of finishing Wildbook
   - Discussed tasks for Problem Definition Draft

6. **Weekly Meeting** / 04-30-2018 / 7:30 PM / Library 1040
   Attendance: Emil Kirov, William Jiang, Brian Nguyen, Qi Young, Zhi Jia Teoh, Youli Pan, Haley Dahlberg, Ren Salvania

Summary:

- Discussed challenges of implementing Wildbook
- Is there a better solution?
- Divide tasks for Concept Draft

7. **Weekly Meeting** / 05-08-2018 / 7:30 PM / Library outside 1045
   Attendance: Emil Kirov, Brian Nguyen, Qi Young, Zhi Jia Teoh, Youli Pan, Haley Dahlberg, Ren Salvania
   Summary
   - Feedback from Shannon
   - Brainstormed for ideas
   - Prepare for WIPP

8. **Weekly Meeting** / 05-14-2018 / 7:00 PM / Geisel 1042
   Attendance: Emil Kirov, William Jiang, Brian Nguyen, Qi Young, Zhi Jia Teoh, Youli Pan, Haley Dahlberg, Ren Salvania
   Summary
   - Plan for WIPP
   - Divided tasks for Testing Draft

9. **Weekly Meeting** / 05-23-2018 / 7:00 PM / Geisel 1042
   Attendance: Emil Kirov, Brian Nguyen, Qi Young, Zhi Jia Teoh, Youli Pan, Haley Dahlberg
   Summary:
   - Discussed resources we need to design our solution
   - Divided tasks for Design Draft

10. **Weekly Meeting** / 5-30-2018 / 10:00 AM / Library First Floor
    Attendance: Emil Kirov, William Jiang, Qi Young, Zhi Jia Teoh, Youli Pan
    Summary:
    - Plans for revising previous drafts
    - Prepare for final report

Appendix B

Interview Questions

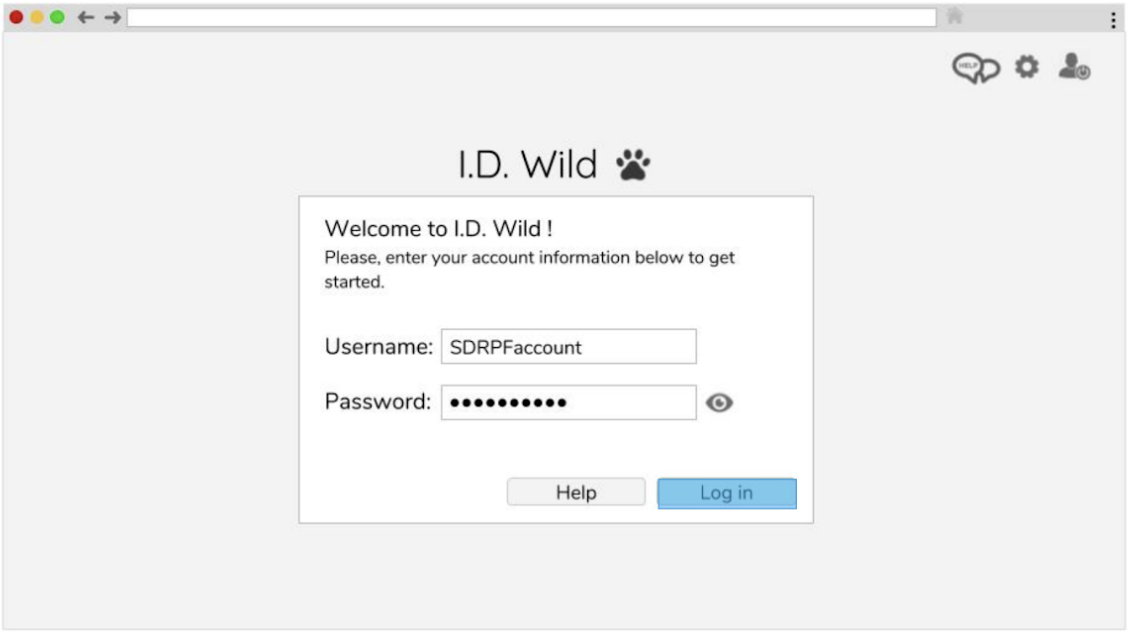
Stakeholder Interview. Shannon Quigley-Raymond. SDRPF
How does the client want us to implement the software to be able to identify animals? *What are the software constraints for this project? Predefined methods?* *Is there a database of existing animals we can use to match to the pictures pulled in from the camera? Also, how high quality will the pictures received from the camera be?* *How exactly are we getting the data? How much data do you guys look at in a single day?* *How exactly does the community help? Are they directly involved in analyzing/gathering data?* *What is the general process that is used when acquiring and analyzing pictures?* *What type of information is gathered with each picture?*
Personal Interview. Francis Joyce. Wildbook.
What is the background of your team? *What was the problem that your team tried to solve before working with Wildbook?* *Were there other alternatives to Wildbook that you considered?* *How did you go about beginning to implement Wildbook to solve your problem?* *How much coding goes into your project with Wildbook?* *I noticed that the projects listed on the Wildbook website each only are associated with one animal. Would it possible for Wildbook to support multiple animals in one application, such as the ones I mentioned above (mountain lions, foxes, deer).* *How much time and effort has gone into your project? My team only has another 6 weeks. Would this be a project that my team could accomplish in 6 weeks or would this be a project that my team could start and then have another team pick up?*

Environmental Questions
What are the ecological benefits of tracking and monitoring wildlife populations? *What are the difficulties with tracking and identifying wild animals, specifically by hand?* *What do you believe are some potential difficulties with using a software to automatically identify and classify animals?* *Do you think that using a software would be as reliable as examining photos by hand?* *Do you believe that promoting community involvement in data collection could translate to encouraging potentially dangerous interaction with Wildlife?* *Do you think are better ways to promote/support wildlife conservation?* *How important to you think education is for wildlife conservation?* *Follow-up: Do you think that the volunteers should be educated before going out to collect images from the cameras?* *Can you describe a time you had to raise awareness for a volunteer opportunity or a volunteer opportunity you've had and how the organization advertised?*

Appendix C

Link to our InVision prototype: https://invis.io/P4K1WBBH9VF

Screenshots of our InVision prototype:



User ratings of the prototype:
https://docs.google.com/spreadsheets/d/1lNUog0D4wluf07i_wuK3_s8Ac17ep1QIICR7AWdvxtA/edit?usp=sharing

Estimation of developer cost:
https://www.upwork.com/hiring/development/cost-hire-software-developer/