



Final Project Write-up

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Introduction



Explore! Learn! Record! iNaturalist.org is a place where you can record what you see in nature, explore the findings of others, and learn about the natural world.

iNaturalist.org encourages the participation of a wide variety of nature enthusiasts, including, but not exclusive to, hikers, hunters, birders, beach combers, mushroom foragers, park rangers, ecologists, and fishermen. By connecting these different perceptions and expertise of the natural world, iNaturalist creates extensive community awareness of biodiversity and promotes further exploration of the natural environment.

iNaturalist is a Master's final project at UC Berkeley's School of Information. The project began with an interface that allowed birders and mushroom foragers to add their nature findings to a map and has progressed into an all-encompassing naturalist community that promotes exploring, learning, and recording. This report describes our project's purpose, the School of Information concepts that it addresses, as well as our overall progress and lessons learned. Enjoy!

Project Justification



Our Purpose

iNaturalist.org enables naturalists to record and share their observations from nature. Naturalists already do this in many ways, both on and offline, but iNaturalist provides a centralized, specialized environment for them, adding benefits like mapping functionality, automatically keeping lists of all the species they have seen, and linking observations with similar data through taxonomic associations. Unlike some of the more personal methods naturalists use to log observations, like the classic nature journal or perhaps a spreadsheet, iNaturalist is also a community, where people can not only record their own data, but share that data with friends and with the world. Lastly, iNaturalist helps people meet other naturalists, like expedition partners or experts on organisms in which they have a particular interest.

Aside from these data-driven purposes, we also want to help people become aware of the dazzling, spectacular diversity of life to be found not only in remote jungles or fragile coral reefs, but also in their own backyards. Human threats to nature are legion, and in a world of spreading stucco and concrete, it may become harder and harder to form meaningful attachments to the natural world (Turner, Nakamura, and Dinetti; Pergams and Zaradic). Even conservationist urbanites may not know much about the specific creatures they vote to conserve, about their intricate behaviors or their fascinating ecological relationships, a problem some researchers have called a crisis in “ecological literacy” (Brewer). On top of the threats of development and a deficit in ecological knowledge, the world is replete with life that goes unnoticed and worse, undescribed. There is a crisis in biology: untold species remain undiscovered or ignored, but the number of people studying such obscure creatures is dwindling, as is the number of people who might appreciate their findings (Wheeler, Raven, and Wilson).

Can a simple website do anything to mitigate these daunting threats to the precious and vital life of this world? We believe it can. By assembling the data collected by avid amateur naturalists in a single, accessible place, iNaturalist enables people who are simply curious about nature to learn about their local flora and fauna, where they can go to find them, and who they should talk to if they'd like to learn more. iNaturalist can address the issue of increasing awareness for obscure or less charismatic organisms by making sure to display such groups alongside more popular ones, for example showing the occasional spider on a map of birds.

Finally, we believe that the Web is full of naturalists and potential naturalists. Between birding listservs (e.g. SFBirds ("SFBirds:Birding in San Francisco") and EBB Sightings ("Sightings Info Page")), community blogging groups that focus on biology ("Class: Insecta"; *Nature Blog Network*), specialized hobbyist communities like BugGuide.Net (*BugGuide.Net*), and the nature photographers of photo sharing sites like Flickr (*Flickr*), there are already many avid nature-lovers using the Internet to record and share their findings. Additionally, the popularity of biologically relevant news stories among Web-users in the blogosphere and in popular news media suggests there is a broader interest not only in wildlife, but in obscure, less charismatic organisms. Take, for example, the several recent reports of giant and colossal squid sightings ("Technorati Search: colossal squid."; "Colossal squid's big eye revealed."; "Photo in the News: Giant Squid Captured, Filmed for First Time.") or the endlessly linked and adulated "yeti lobster" announced in 2006, an organism whose fandom extended to the point of hand-crafted plush toys ("Furry 'lobster' found in Pacific."; "Meet Tasty, the stuffed kiwa hirsuta."). These are all signs of a pervasive interest in the natural world. We hope iNaturalist will encourage people to act on that interest, to get outside and engage nature by seeking personal encounters with the creatures they find so fascinating.

How We're Different

There are several ways naturalists already record and share biological information online, including generalized tools like photo sharing web sites, specialized sites catering to the needs of certain kinds of naturalists (e.g. birders), and citizen science projects conducted by academics researchers. iNaturalist differs from all these kinds of sites in several ways.

- **User-focused** – Unlike similar projects created by engineers and/or biologists, we approach the development of iNaturalist from a user experience perspective. Through extensive requirements gathering and user testing, we are constantly attempting to validate our ideas and designs with the naturalist community, resulting in a site that meets the needs of naturalists first.
- **Not Citizen Science** – iNaturalist differs from many similar citizen science projects in several ways. Traditionally, citizen science projects have generally involved scientists recruiting non-scientists in an effort to collect research data and provide opportunities for the public to engage in science. We believe that traditional citizen science projects lack the ability to foster deep, long-term investment in the natural world among the general public, because they are discrete and do not directly benefit their participants. By focusing instead on facilitating a *lifestyle* of data collection, iNaturalist encourages data contribution through the self-interest of an avid hobbyist, not the altruistic desire to assist in someone else's work.

- **Scope includes all of life** – Whereas similar sites often focus on particular groups of organisms, like birds or mushrooms, we support observations of any living thing. Our scope is large because we wish to create a universal repository of biodiversity information, and to help people to learn about new and exciting forms of life.
- **Open Data** - Generally, the information that iNaturalist's community members contribute will be publicly visible and highly available to many individuals at once, as opposed to collected and stored privately. We believe creating an open resource of biodiversity information will encourage the use and reuse of the data by third parties, hopefully allowing the contributions of our users to address issues beyond personal data logging, like tracking invasive species or monitoring species distributions.
- **A Lasting Community** - iNaturalist fosters community through the input of information by like-minded individuals, and also through direct communication between these individuals. iNaturalist fosters this communication by providing tools to facilitate discussions about observations directly between users. This allows users to learn more about an organism in context directly from the individual who observed it, to question the general quality of the information within the system, and to build a distinct reputation within the system based on their particular interests or expertise.



Information School Concepts

The iNaturalist project addresses many of the concepts found in several of the School of Information's areas of concentration, including human-computer interaction, information assurance, and social studies of information. These concepts include incentivizing contribution, reputation and identity, needs assessment, interface design, usability testing, and information accuracy. The following describes these concepts in greater detail.

Human-Computer Interaction

“ “Stupid maps! The map thing really slows me down!” these are the remarks from one of our usability participants using the add observations page. During a different usability study, one of our participants compared a different variation of this page to “homework”, explaining that it was more interesting to see pretty things such as maps and photos than to fill in a bunch of forms.

These are quotes from usability study participants using variations of one of our main interfaces, the Add Observations Page. Usability studies were a significant part of our design process. They allowed us to evaluate and test our system for usability, usefulness, and overall enjoyability. They also enabled us to better understand our different types of users, their different recording habits, and their different interests in the iNaturalist system.

For instance, our studies revealed a divide between expert and casual naturalists; expert naturalists (such as the participant with complaints of the map) are more likely to record their findings and be concerned with the efficiency with which they add their data, while casual naturalists (such as the participant that compares the Add Observations Page to homework) are more interested in a fun service that allows them to easily explore the findings of others. We learned that birders often share their findings openly with fellow birders, while that mushroom foragers often do not, due to concerns over resource competition. And we also learned that there are wide ranging interests within the iNaturalist system. The card sorting activity of the final usability test found that there were no agreed upon set of features that people wanted the site to have.

iNaturalist encourages the participation of many different types of naturalists. However, in order to encourage this participation, iNaturalist needs to recognize the needs and interests of these different users. Our design philosophy was not to accommodate these divergent needs into every interface that we built, but rather to design each feature for its primary users while providing an assortment of features to appeal to this wide variety of users.

The influence of HCI on iNaturalist cannot be over-stated, and it has left its mark on almost all aspects of our work. In particular, see the "Needs and Persona Development" and "Usability Studies" sections below.

Information Assurance



Even experienced people can still be wrong with their ID's."

This was a quote from one of our usability participants addressing the issues of data quality and accuracy within the iNaturalist system. These issues are regularly discussed among our users and addressed in our usability studies. iNaturalist users have three main concerns regarding data quality and accuracy: inaccurate observations, uninteresting data (for example, one participant expressed concern that the sight might get flooded with the observations of pigeons or humans), and insufficient authoritative information (not all species names are included in the species databases that iNaturalist utilizes, particularly common names). This is a delicate issue: while we want to incentivize the creation of accurate data, enforcing data quality can create barriers to adding observations, as not all naturalists can properly identify their nature findings.

iNaturalist attempts to address some of these data quality and accuracy concerns by facilitating and encouraging correct species identification. It does this by suggesting species names based on partial data entered by users, aggregating observations in need of identification in a single view for community-based identification, and the ability to record alternative identifications by many different users (see the "Observations" and "Identifications" portions of the "iNaturalist Features" section below).

Social Studies of Information

iNaturalist can be thought of as a "community of practice", one fostered by users sharing information about the natural world and communicating to one another about their discoveries. The ability for users to share information and communicate exposes issues of reputation and identity, along with the issue of why individuals might contribute to an open information pool. To these ends, we have developed features that attempt to work within the framework of the Information School's teachings about information and communities. The system has the notion of identity, through persistent user logins, and reputation can be developed through identifications and internal communications via commenting. Finally, we have incorporated the concept of social psychological incentives to help users both understand that their contributions are important to the larger community and provide the user some validation for contributing through direct feedback. For further detail on our work on social incentives, see our section below on "Developing Social Psychological Incentives."

iNaturalist Features



We have designed and implemented six primary features of the iNaturalist system: Observations, Lists, Identification, Goals and Markings, Explorer, and Species Pages. These features encourage and facilitate nature exploring, learning, and recording as well as address the concepts of data quality and incentivizing contribution.

Adding Observations

Naturalists observe all sorts of wonderful things in their backyards, in their favorite parks, and in far-away places, and record these findings in what we call "observations." The Observations feature provides a place for naturalists to record these observations. An observation consists of the what, where, and when of a nature finding and generally include the species name (or other descriptive name), narrative text, photos, tags, the date and time of the observation, and the location of the observation (such as the location name, its annotation on the map, and/or its GPS coordinates).

Observations are the foundation upon which the rest of our features rest, so it was critically important that we make their creation simple, while meeting as many user needs as possible. The observation adding interface is a focal point of incentive and quality concerns, and possibly the one interface where the conflicting needs of casual and expert naturalists clash the most. Experts demand efficiency and rigor to express accuracy in their observations and do so quickly, while casual naturalists need to have the flexibility to express uncertainty, and may be more prone to give up when presented with excessive data validation. As a result, this interface saw the most revision over the course of our project (see Appendix A to see the interface's progression and Figure 1 for the most recent version of this page).

To these ends, we designed a form predominated by open text fields, where users can enter whatever they want. If what they enter corresponds to a vocabulary or format we recognize, then we make those structured associations, but if it does not, we still preserve their data. For example, someone could enter "small green bird" as a species name. This is not a recognized species name, so we would be unable to associate it with any known species, but we felt if we were to present an error message to this effect it would discourage use among casual users. Our solution was to save

“little green bird,” and simply display a notice that we were unable to recognize the name. If a user used the name “Green Heron,” we would recognize it as a known name, and display that the name had been matched. If someone entered the name “bluebird,” we would display a list of the different species of bluebird to choose from. We believe this strategy of accepting unstructured data while encouraging (but not requiring) the use of canonical names and formats meets the needs of both casual and expert users.

One interesting problem with our approach to matching species names to known taxa were misspellings of species names that corresponded to legitimate names of completely different species. For example, one of our users misspelled his observation of a Raccoon as “Racoon”. As a result his observation was associated with the species “Racoon”, a kind of fish. To mitigate this problem, we hope to provide better feedback about the actual species associated with a name when the system makes the association and notifies the user. For example, when a user observes a “Racoon,” the association notice might read “you've associated this observation with the species Racoon, a type of fish”.

Another unresolved problem was the abundance and taxonomic ambiguity of common names relative to scientific names. For example, the lizard *Sceloporus occidentalis* is variously known as a Fence Lizard, a Western Fence Lizard, and a Blue-bellied Lizard. Some of these are authoritative names from field guides, while others are more colloquial. The opposite problem can also occur: people use the name Daddy Long Legs to refer to a family of flies (Tipulidae; possibly others), a genus of spiders (*Pholcus*), and a whole order of non-spider arachnids (the Opiliones, also known as harvestmen). Given that most naturalists we have observed use common names almost exclusively, resolving these ambiguities could become important. In the future, we plan to support user-contributed names to build our vocabulary of common names, and to provide notification when a common name is ambiguous.

We followed the same approach of encouraging but not requiring structured data in adding dates and locations. Users can express dates in a variety of accepted formats, including many forms of English syntax like “yesterday at 4pm.” Locations can likewise be any text string, but we attempt to geocode that text against a large list of known places to associate it with geographic coordinates.

What did you see?

Where were you?
 [Search the Map](#)

Calypte anna ID Please!

When did you see it?

Description

What words best describe this observation?

Click on the map to place your observation.

Latitude

Longitude

[Cancel](#) [Add Another Observation](#) or [Save All](#)

Figure 1: Screenshot of the Add Observations page

Lists

“

It's really satisfying to see [all my species] in a list”

Many naturalists keep lists of things they've seen in nature. Birders often keep "life lists": lists of every bird they have ever seen. As demonstrated by the quote by one of our usability study participants, these lists often provide birders with a sense of pride, as the list's depth and breadth can signify one's expertise and experience. The other types of lists commonly used by naturalists are checklists, which are lists of species that occur in a specific area. Naturalists use checklists to validate observations, for educational purposes, and as goals (i.e. some naturalists seek to observe every kind of bird known to occur in their home county).

In iNaturalist, a "list" is simply a list of species or higher level taxa, and the site provides two kinds: a Life List, listing all species a user has seen, and a Checklist, a simple, arbitrary list of species. The Life List was derived from the same concept in the world of birding. However, rather than limiting this list to just one type of species, this variation includes *every* kind of species a user has seen. The list automatically updates as iNaturalist users add and identify new observations. One of our users informed us: "I LOVE the idea of a life list for keeping track of things that I've seen" (see Figure 2 for an example of this page).

The other component of the lists feature is checklists. In iNaturalist, these not only pertain to a particular region, but also pertain to specific taxonomic groups and time periods (such as "Birds", "Hawks in Alameda County", "Species in 2008"). These lists can also pertain to more arbitrary concepts (such as "Things that are Red" or "My Favorites"). While checklists have not yet been implemented, both types of lists provide a personal way to record, organize, and reflect on nature findings. Lists are a useful tool for both expert and casual naturalists in that they allow experts to demonstrate their knowledge and experience of nature and give casual naturalists a foundation to foster their nature interests.

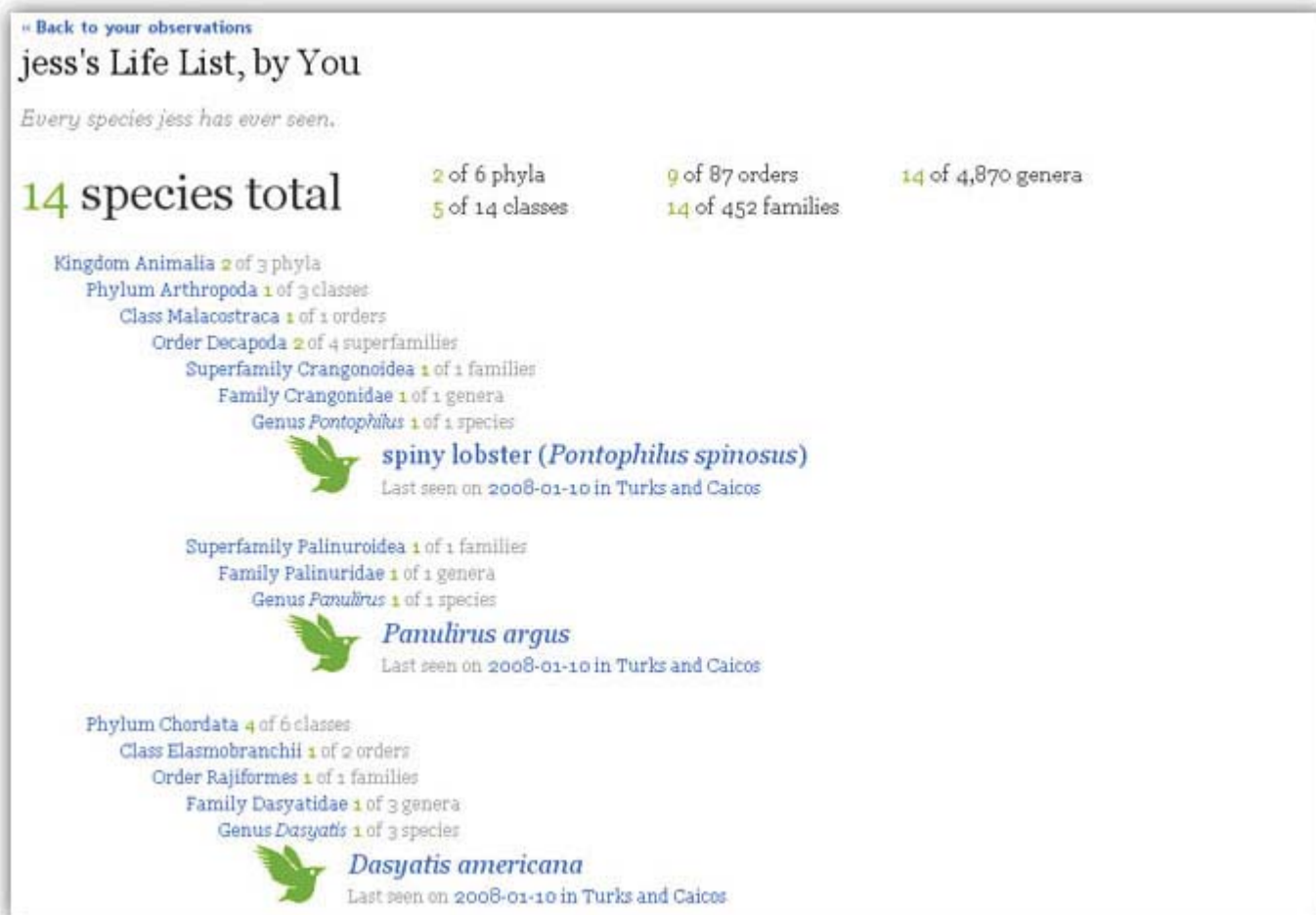


Figure 2: Screenshot of a life list page

Identification

“ “ A Green-winged Teal!” added one birder. “A Snowy Egret!” piped another. Birders, armed with binoculars and field guides were naming all the birds in view at the Albany Bulb. But when one birder added “A Cinnamon Teal” it was countered with responses such as “Where?” and “How so?” After determining the exact bird in question, the group conferred that it was actually a green-winged teal. Budding birders, like Nate and Jess of the iNaturalist team, learned the distinguishing features of each bird, but the original identifier seemed a bit embarrassed and did not contribute any new names to the list of birds in view.

The iNaturalist team went on a birding trip at the Albany Bulb with members of the Golden Gate Audubon Society. The experience demonstrated that naturalists make identifications of observations both individually and collectively. It also revealed that suggestions of alternative identifications can be educational for the original identifier as well as others. However, it is important that suggestions are made in a constructive manner, so not to discourage people from making identifications, such what occurred with the identifier of the Cinnamon Teal (see Figure 4 to see an example of these identification suggestions).

Identifications in iNaturalists are a way for users to identify species in their own observations and the observations of others. Using the same kind of open text field with name suggestions we use in the Add Observation Page, a user might identify an observation as a Great Egret, while another might identify it as a Snowy Egret. This serves several purposes:

1. It informs the observer that there might be some question over their identification. The observer can then start a dialogue with the identifier about the identity of the observed species.
2. It allows other viewers of the single observation to see that there is some question over the ID of the observation.
3. It provides a site-wide quality metric for observations. Observations in which there is consensus or majority agreement on an ID will most likely be more accurate, at least in their taxonomic association.

When creating an observation, users can also check the “ID Please!” check box. This adds their observation to the ID Please! pool (see Figure 3 to see a screenshot of the ID Please! page), which aggregates unidentified observations and encourages iNaturalist users to help identify them. This idea originated from similar resources on the Web, like the Flickr group ID Please (from which we borrowed the name) and the web site What’s That Bug (“Flickr: ID Please.”; “What’s That Bug”).

In addition to providing quality control, we also view identifications as a way to facilitate learning and developing ecoliteracy. Naturalists learn a great deal from each other in the physical world, and identifications in iNaturalist are simply a way of extending this practice online.

ID Please!

Inspired by the Flickr group *ID Please*, this is a place to post observations of things you don't know, and to help people identify mysterious creatures! To add an observation to *ID Please*, click this button:

[Add a New Observation to ID Please!](#)

Remember, it's a lot easier to ID something if you provide as much descriptive information as possible. Most importantly, please provide a **place**, a **date/time**, and some information about the **size**.

Guess / Description



ferns up a tree, observed by alan99
at 12:00 PM PST on January 16, 2008 in Muir Woods, CA

It was interesting to see these ferns growing on a dead branch of a live tree.

[View full observation »](#)

Where

Muir Woods, CA



Help Out!

Suggest an ID

Save

Species Unknown

No IDs yet

Leave a Comment

Save Comment

No comments yet.

Figure 3: Screenshot of the ID Please! page

[- Back to your observations](#)
Hopkins rose, observed by n8agrin on April 22, 2007
[Edit](#) [Delete](#)

Tags: pink, nudibranch, slug

Comments
 No comments yet.

Add a Comment

Identifications
 You think this is a Hopkins rose (*Hopkinsia rosacea*) [Remove](#)

tommy thinks this is a Hopkins rose (*Hopkinsia rosacea*)

Markings
 Beautiful
 You marked this Beautiful
 Bizarre
 Crikey!
 Cute
 Dangerous
 Rare

Figure 4: Screenshot of a single observation

Goals and Markings

Within iNaturalist we have developed the notion of goals. A goal is simply a concrete task that one can opt to complete, which may or may not have a specified deadline. Examples of goals include "Observe 200 types birds in one year", "Record every penguin species", or "Identify 100 observations in the ID Please! pool". Currently, only community oriented goals have been implemented, but in the future groups or individuals may be able to collaborate in custom tailored goals. To demonstrate the goal system and test the effectiveness of goal-setting we have implemented a community-wide goal asking users to take part contributing the first 1,000 observations. This particular goal highlights how contributions will be useful to the system, displays the goal's distinct value and status on the homepage, and recognizes individuals for contributing to this goal (see Figure 5 to see a screenshot of this goal).

Markings are adjectives used to describe observations of things in nature, including "beautiful," "bizarre," "crikey," "cute," "dangerous," and "rare"; each individual observation page includes a set of buttons labeled with these adjectives. This feature allows iNaturalist users to mark their observations and the observations of others with the adjectives most meaningful to them and

displays statistics of each observation's total number of Markings and individual Markings (see Figure 4 to see an example of Markings).

Goals and markings have the potential to incentivize iNaturalist users to contribute to the system. Research in social incentives finds that social approval has the ability to increase cooperative behavior. Therefore, we have designed markings to indicate social approval; the predetermined set of adjectives provides a way for naturalists to both describe observations and compare them with others of similar descriptions. Research in social incentives also finds that when potential contributors observe a high rate of cooperative behavior, they are more inclined to contribute to a public good. Therefore, we have designed goals to capture visitors and integrate them into the group of potential contributors. The goal bar displays cooperative behavior by displaying a tally of all the contributions received in the system prior to the visitor's arrival.

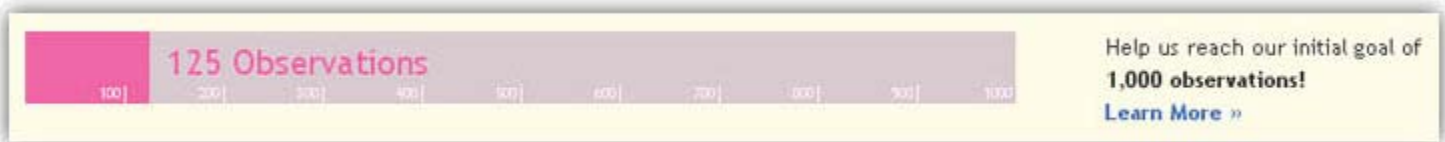


Figure 5: Screenshot of the community-wide goal

Explore Interface

“ Really I just want to be able to see the most recent birds in a given area.”

This was the response from one of our usability participants when we asked her about the iNaturalist feature most important to her. In essence, she described our Explorer feature. The Explorer feature allows naturalists to explore iNaturalist observations, whether it's exploring the observations of a particular area, exploring the observations of a particular time period, and/or exploring the observations of types of species. This feature includes a large interactive map, a timeline, and iconic representations of different types of species, including mammals, amphibians and reptiles, spiders, fungi, plants, fish, and birds. Through panning the map and the timeline, or selecting certain icons, iNaturalist users can learn more about the natural world (see Figure 6 to see the Explorer page). The participant quoted above can learn that a King Eider has been recently seen by other birders along the bay trail in Emeryville, that her favorite duck, a Ruddy Duck, can be seen across the bay in the Coyote Point County Recreation area, and that her friend recently saw a group of Magellanic Penguins in the Patagonia region of South America (what a lucky friend!). These learning experiences can also encourage additional exploration of the natural world, as these discoveries might prompt the participant to explore the Coyote Point area the following weekend or perhaps plan a trip to South America.

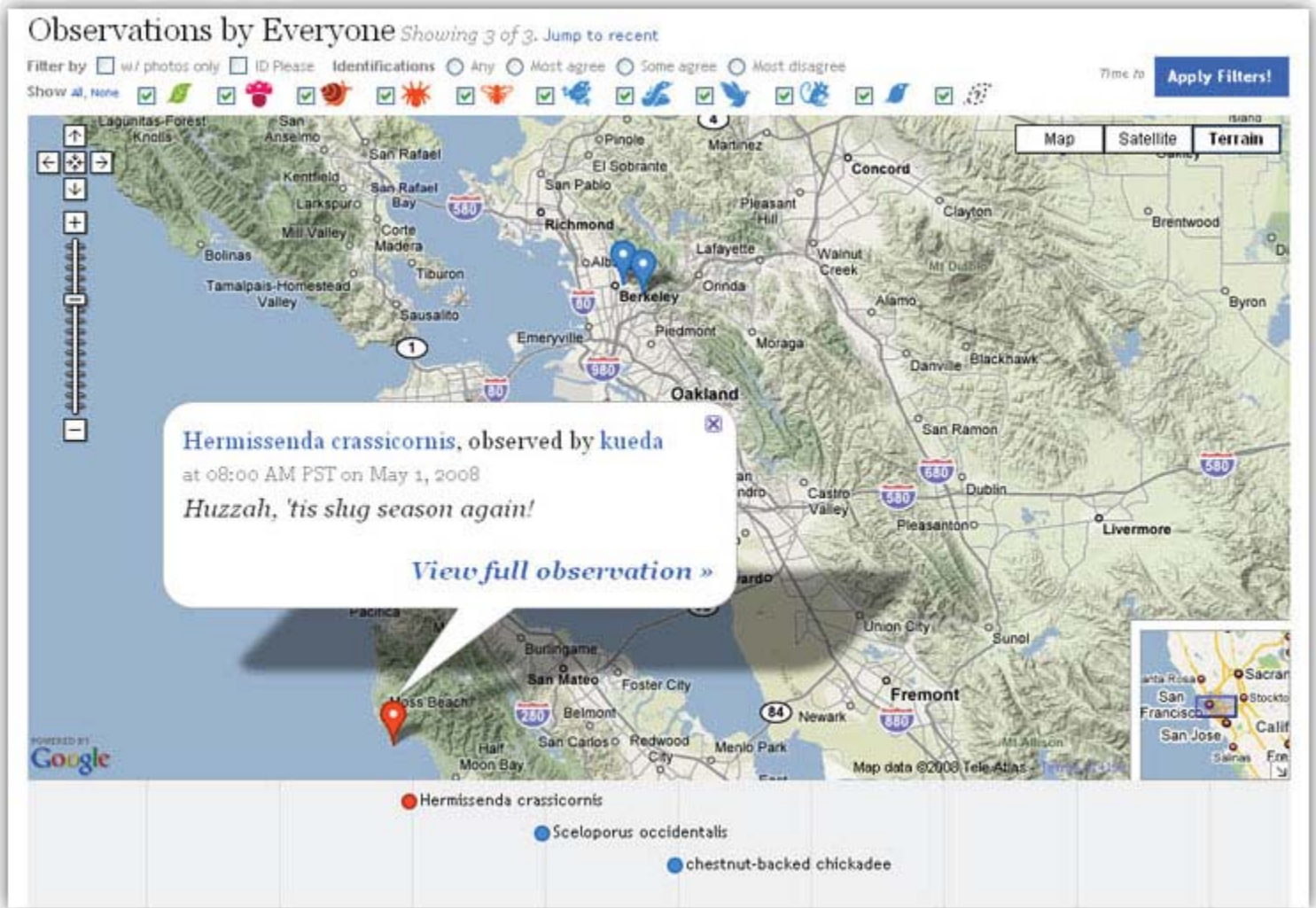


Figure 6: Screenshot of the Explorer Feature

Species Pages

He tilted his head to the right. He squinted. He looked long and hard at the picture of the bright orange flower. After some time he wondered out loud whether it was a poppy and explained that he would confirm with another resource. The participant opened up another tab in his browser, googled California poppy, and selected one of the first hits, a Wikipedia article. He examined one of article's photos: Yes! Indeed, it was a California poppy.

This was one of our usability participants as he tried to identify observations of another iNaturalist community member. Naturalists, like this participant, utilize field guides and online sources such as

encyclopedias and databases specific to particular groups of species (e.g. Fishbase (*Fishbase*), a database of fish, or CalFlora (*CalFlora*), a database of California plants) to identify and learn more about their observations. iNaturalist also provides a place for its users to learn about specific species: the Species Pages.

iNaturalist has species pages for all of the species listed in the Catalogue of Life (*Catalogue of Life*) data source that have been observed or searched for by iNaturalist users. Each species page includes the name of the species and other alternative names, Flickr photos tagged with the scientific name, its location within the taxonomic tree, and associated observations by iNaturalist users (see Figures 7 and 8 to see the Species Pages index and an example of a species page, respectively). These pages provide a way for iNaturalist users to identify their observation as well as learn more about the things they have seen in nature.

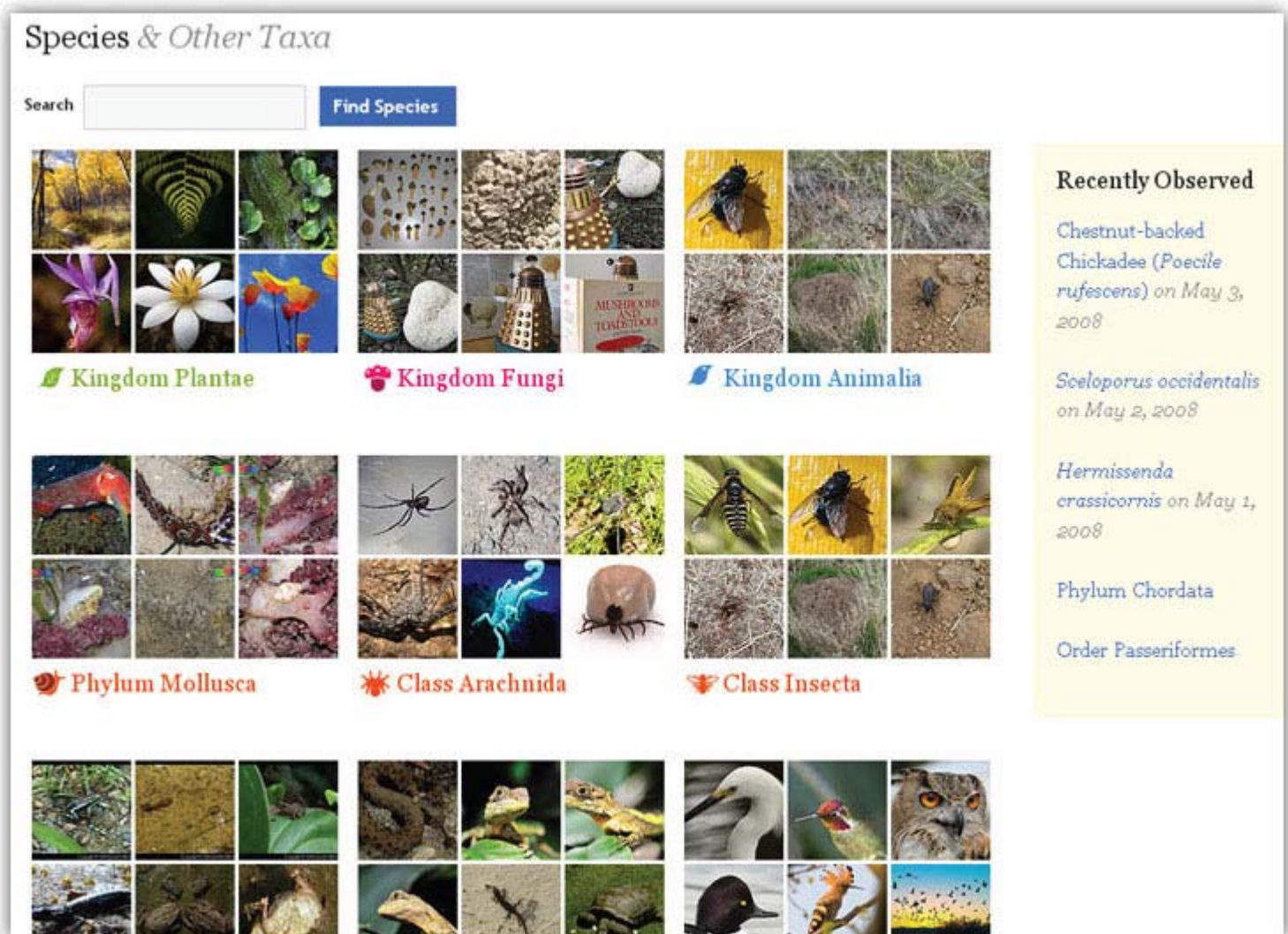


Figure 7: Screenshot of the Species Page index

[Back to All Species](#)

Magellanic Penguin (*Spheniscus magellanicus*)

Source: Catalogue of Life



Photo: View original CC'd photo on Flickr by Ole Begemann

More Creative Commons Flickr Photos Tagged "Spheniscus magellanicus"



All Names

Spheniscus magellanicus
(scientific names)
Magellanic Penguin (english)

Taxonomy

within iNaturalist

- Kingdom Animalia
- Phylum Chordata
- Class Aves
- Order Ciconiiformes
- Family Spheniscidae
- Genus *Spheniscus*
- Magellanic Penguin (*Spheniscus magellanicus*)

Observations

Magellanic Penguin, observed by jess
at 12:00 PM PST on December 10, 2004 in Punta Arenas, Chile



I love penguins. I can't wa...
[View full observation »](#)

1 total »

Figure 8: Screenshot of all species page

Our Process



We started this project in January 2007 during the School of Information course "User Interface Design and Development." During this time we performed needs assessment interviews, developed personas, performed a comparative analysis, created initial interface sketches and designs, implemented several variations of a working prototype and tested our progress. We also applied this project to the courses "Document Engineering and Information Architecture" and "Computer-Mediated Communication." In "Document Engineering," we modeled the back-end system architecture, and in "Computer-Mediated Communication," we researched incentives to encourage contribution to our system.

Our interface and our back-end architecture have evolved since our initial coursework. In general our process has included sketching our ideas (see Figure 9 to see a picture of the iNaturalist team

sharing their ideas), creating wireframes and mockups of the interface, implementing our designs through modeling, incorporating existing data sources, and a great deal of coding, and finally testing our development before reiterating this process. By March 2008 we had developed the core features of iNaturalist and released our system to members of our Google group and other contacts in the naturalist community. The following describes much of our process in greater detail.



Figure 9: Members of the iNaturalist team working on design sketches

Needs Assessment and Persona Development

At the start of our project we interviewed two birders and two mushroom foragers, each with varying levels of experience. We asked questions about their activities in nature and their recording practices. Specifically, we asked how they plan these activities, who they go with, what they bring, when and where they make identifications, what and how they record their findings, and who they share them with. We found that birders share their findings among the community, and enjoy the recognition associated with rare findings and expertise. Meanwhile, mushroom foragers go in small groups or alone and have concerns with sharing information with the general public. We found that both groups make identifications both at home and in the field and recording habits vary wildly, ranging from detailed notes of everything seen, lists of rare and new findings, and mental notes. We

also heard inspiring stories from our interview participants about their identities as naturalists. For example,

It all started with one mushroom in the woods. It caught his eye. It was so beautiful, so intricate, and so mysterious. And he had no idea what it was. So he decided to bring it home and try to figure it out. He took photos of it, discovered the local mycological society, and posted his photos to its listserv. It was identified and the rest is history. Originally, he wasn't much of an outdoors person. But now, he's a frequent hiker, mushroom forager, mushroom cultivator, amateur cook, and environmental enthusiast. And none of this would have happened without the help of that one little mysterious mushroom.

In essence, the identification of one mushroom exposed this participant to his surrounding nature areas and to a lifestyle of healthy eating and exercise. Perhaps the most important lesson learned is the impact that nature can have on anyone and everyone. There's a world of potential naturalists. Hopefully, iNaturalist can encourage and inspire them, just like that one little mushroom.

We also used the information gathered from the needs assessment interviews to develop three personas: Ted Sinclair, Jenny Takahashi, and Adam Thompson. These personas represent our target users and their diverse nature interests, community participation behaviors, and information needs. Our target users include naturalists with a specific nature focus, such as birders and mushroom foragers, as well as hikers and ecologists with a broader interest in biodiversity. Our target users also include experts that help others identify their observations, as well as naturalists concerned about sharing their findings with the community at large. And our target users include naturalists that record a lot of information and want a fast and efficient way to add it to the site, as well as others that are more interested in exploring the nature findings of others. The development and continuous use of these personas was especially helpful in understanding these various user types and their different, and at times conflicting, needs. They also helped us communicate and provide a point of reference when discussing and making decisions about designs. We would ask questions such as "Would Ted like this and would it alienate Adam and Jenny?" or "Are we meeting Adam's needs and are those needs things we really need to focus on?" As the project progressed and we started to meet the real-life counterparts of Ted, Jenny, and Adam, our use of these personas decreased. Nonetheless, we still consider them accurate and, on occasion, still invoke them. More detailed descriptions of and justifications for each persona are found in Appendix B.

Comparative Analysis

When exploring the natural world, naturalists record their findings with pen and paper or a camera and learn about their surroundings through asking others around them and referring to field guides. Naturalists also continue the exploring, recording, and learning process once they return from the field, utilizing some of these same resources in addition to different variations of lists, online communities such as listservs and photo-sharing sites, as well as nature documentaries and television programming. Collectively, these resources provide opportunities for naturalists to share, organize,

and identify their findings as well as learn about local biodiversity and find others with similar interests. We analyzed specific resources such as *All that the Rain Promises and More* - a field guide to mushrooms (Arora), the American Birding Association checklist ("ABA checklist"), the Encyclopedia of Life (*Encyclopedia of Life*), Flickr, Geobirds (*Geobirds*), the Mycological Society of San Francisco listserv (*Mycological Society of San Francisco*), Planet Earth (*Planet Earth - the Complete BBC Series*), and our friend Zach Gillen's nature journal. This analysis brought awareness to the benefits of particular resources. Specifically, the rich visualizations of resources such as Flickr photos, nature documentaries, and television programming captivate many users, particularly casual naturalists. The scientific nomenclature of resources such as the Encyclopedia of Life and checklists are highly valued by expert naturalists but at the same time might intimidate casual naturalists. And the unconstrained nature of resources such as nature journals and blogs empowers many users to freely describe their experiences through text and illustrations. However, most importantly we realized that while there are other services operating in this space, there remains opportunity to develop a system that is comprehensive, fun, and user-focused rather than science-focused. Descriptions of each of these resources are found in Appendix C.

Implementation

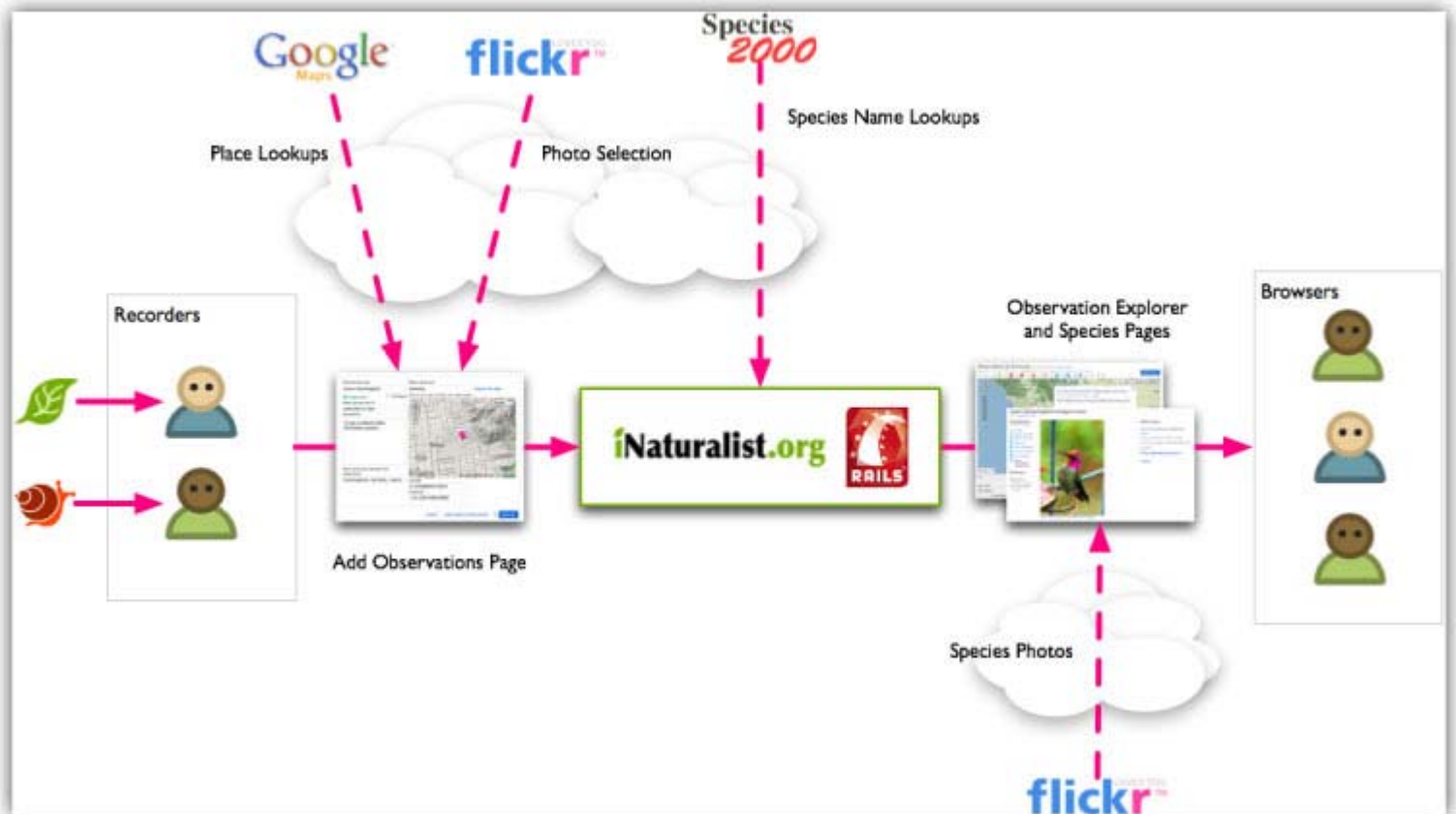


Figure 10: iNaturalist data flow diagram

We employed a variety of open source technologies and open data sets in iNaturalist. We adopted Ruby on Rails as our underlying development framework because it fit our needs for speed and an

agile approach to software development, and required little in the way of training, as the two developers on our team already had experience with it. We considered alternative frameworks, particularly ones written in Python, a language with stronger support among developers in the Geographic Information Systems community and among scientists, but the conveniences and development speed afforded by Rails made it stand out, and served us well over the course of the project.

Several public web service APIs lie at the core of iNaturalist, primarily those of the photo-sharing site Flickr and of Google Maps. Flickr provides a robust API to their photo searching and retrieval systems, and we have used it to enable iNaturalist users to add photos to their observations by linking their Flickr accounts to their iNaturalist accounts and to display photos on the Species Pages. The Google Maps API allows developers to use and manipulate Google's excellent mapping software and geographic data. We use the Google Maps API to map observations on many parts of the site, including most of our observation browsing interfaces, and the form used to create new observations.

We also use taxonomic data from the Catalogue of Life (CoL), a part of the Species 2000 Programme, an organization whose mission is "to create a validated checklist of all the world's species" (*Species 2000*). Species 2000 provides the full CoL database for download, and also provides a web service API. We pre-populated our own taxonomic database with data from CoL on birds, reptiles, amphibians, and mammals. For species names we do not have in our database, we make calls to the CoL web service and add new names to our own database as users request them (see Figure 10 to see our data flow diagram).

We chose to use these services to reduce our development load so we could focus on the problems unique to iNaturalist, like the efficient recording of observations and inviting exploration of our data. Managing photos, displaying maps, and keeping track of biological nomenclature are complex tasks we view as critical to our system, but are not themselves at the heart of our mission. Because our service providers specialize in these areas, we did not feel compelled to duplicate their efforts, and decided instead to utilize their public APIs in order to incorporate their functionality into iNaturalist.

Our technological choices came with advantages and disadvantages. Our dependence on web services for some core features has largely been beneficial, as discussed above. These powerful services provide very high quality functionality, but at the same time, introduce some limitations. For example, several of our users do not have Flickr accounts and are not interested in getting them. They either manage their photos with different sites, or do not want to manage their photos online at all. Problems can also arise when trying to integrate code from a variety of sources with varying levels of documentation. For example, our Observation Explorer is based on a mashup of Google Maps and the MIT SIMILE Timeline package written by fellow School of Information student Nick Rabinowitz. While Google's code and Nick's integration code are very well-documented, the SIMILE Timeline is quite opaque and can be difficult to manipulate.

Using external data can be as difficult as using external code. It took some time for us to settle on a good way to use the CoL data. Initially, we simply used their database in its entirety, attempting to match our own data models to those present in their database. This eventually proved problematic when it became clear that we had slightly different modeling needs (e.g. the need to logically separate names from the taxa they describe), and when we began to have some performance issues (there are

many, many megabytes worth of weevil names that our users are unlikely ever to use).

In general, our engineering approach has been to do as little as possible without sacrificing what we see as our core design goals. To that end, we exploit many third party software packages and web services, but subsystems that absolutely need to perform well we tend to implement ourselves. For example, we store local copies of species names and photo metadata because our users need species name lookups and photo loading to be quick and responsive. We believe this was the right strategy given resource constraints and the tools at hand.

Developing Social Psychological Incentives

Social psychological incentives were developed as part of course work for the class Computer Mediated Communication. We used this class to discuss various studies of incentives and how the findings in those studies might apply to visual interfaces within the iNaturalist system. Because iNaturalist is a community oriented service, and not a social psychological experiment, we attempted use the findings of these experiments to define an array of incentives which we feel have the potential to positively influence the general iNaturalist community.

iNaturalist is an online community built around the creation of a large pool of biodiversity information. In order to grow and thrive, we must be concerned with capturing new users and retaining current members within iNaturalist. While we designed iNaturalist to inherently attempt to provide its members an incentive to contribute information by providing the best available tools to manage their own naturalist data, we recognized that we try to encourage users to contribute even more by providing incentives defined within the context of the broader iNaturalist community.

Socially oriented incentives, commonly referred to as "social psychological incentives", are low or no cost incentives that focus on individuals' perceptions of intrinsic rewards. Social psychological incentives can range from public recognition of contribution activity to publicly visible goals with clear rewards. Studies have shown that, although perceived to be relatively weak motivators, these incentives may have the ability to significantly influence a contributors' behavior in positive ways (Cheshire; Ling).

Within iNaturalist we have implemented a variety of social psychological incentives to stimulate activity and community participation. Currently, these include the creation of goals with highly visible completion metrics, implicit and explicit behavior metrics to give individuals insight into community activity and social approval, and reward badges for unique contribution behavior and quality moderation.

Studies in goal setting theory have shown that individuals and groups respond positively to goals when the goal is set neither too high nor too low (Ling). Finding the correct balance between making a goal unattainable and simply too easy is an imperfect science. When setting our initial community goal of reaching 1,000 observations we chose a sensible endpoint and confirmed our decision by qualitatively surveying a group of users for their reactions to the goal requirements. Interviewing users also revealed the need to clearly state why the goal was established, who it benefited and how a community member might contribute to it. By visually displaying the percentage of the goal completed through a goal bar and making it interactive (i.e. it automatically updates when a community member contributes to the goal), we provide methods for individuals to

receive instant gratification when they contribute observations, and thus a mechanism to encourage users to remain involved with iNaturalist. The goal bar used to visualize the initial goal also provides a window into cooperative behavior occurring within the community for new visitors to iNaturalist. This is a straightforward attempt at capturing new users who may be inspired to contribute their data to iNaturalist after visiting the site and observing many users actively contributing observational data.

Aside from iNaturalist's notion of goals, contribution activity in iNaturalist is made visible via a variety of distinct methods including the public display of the most recent contributions on the homepage to capture new users, commenting on observations to inspire discussion and retain users, and identifying organisms in the ID Please! pool to also attempt to retain users through the development of reputation. Revealing this behavior generates a sense of activity within a community and may inspire individuals to further participate and contribute their own information (Cheshire). Some of this behavior can be thought of as implicitly generated; displaying the number of unique views on a particular observation by iNaturalist community members provides the contributor a sense of how the community values their contributions. Interestingly, this may create a virtuous contribution cycle, one in which users who do not see extensive community activity on their contributions may be inspired to contribute more in order to gain notoriety, while users who receive significant community responses when they contribute are likely to continue contributing further in order to maintain status within the community.

We have also included the opportunity for users to show their approval of another user's contributions explicitly through the application of "markings". It has been shown that when individuals know they have the possibility to provide and receive explicit approval to others' contributions they are more likely to participate in an exchange of information (Cheshire). Markings are intended to be a mechanism that allows users to attach preselected positive adjectives to observations, thus providing explicit social approval. Markings differ from the concept of emergent tagging in several important ways. First, the total number of users who have marked an observation with a particular marking is made clearly visible to the community and the contributor. Tags, on the other hand, are generally applied to an object in a system only once and are not concerned with the identity of the individual who added them. The ability for multiple users to describe observations with the marking multiple times allows the community to build a consensus around the general, descriptive characteristics of an observation while also providing a form of social approval to the contributor by revealing activity around their contribution. Second, in other community based information systems, users can often note items within the system as favorites. For example, in Flickr the number of users who favorite a photo may positively influence a contributor to continue contributing more information. Markings have the capability to act as favorites in the sense that the individual marking an observation will be able to retrieve a list of their marked observations in the future. However, markings provide some descriptive context of why the user might have marked them in the first place; perhaps the observation was dangerous and beautiful. Thus, like favoriting in systems like Flickr, which may provide strong positive feedback to a contributor, marking an observation can explicitly reveal another user's interest in the observation. Finally, markings can be applied and removed quickly and do not require any explicit justification in their application. Unlike comments and identifications, they allow users who might otherwise not contribute to the community to become active participants. We feel that markings provide a means for adding valuable community driven metadata onto observational data, while also acting as a mechanism for

delivering explicit social approval to an observation's contributor, hopefully inspiring them to continue contributing more.

Implicit and explicit activity surrounding contribution behavior may sometimes be easy to identify and make visible, however, we expect there to exist many more types of activity individuals take within the iNaturalist community that might be less obvious by direct observation. Some individuals may be highly concerned with information quality and will spend little time contributing observations, but will often correct misreported identifications. Others may be motivated to submit few observations but when they do they submit very high quality information about a very specific group of organisms. Still others maybe interested in meeting other like minded individuals in their area through comments that incite discussion about a particular location.

We want to reward these individuals with publicly visible badges that they can choose to display on their profile. Some badges may be iconic representations of their particular reward. For example, a user may receive a bird wearing a crown to denote they consistently monitor the quality of observations by properly identifying bird observations. These badges serve two purposes throughout the site. First, they are a means of thanking the individual for behavior that might otherwise go unnoticed. Simply informing individuals that their contributions are appreciated has been shown to increase the rates of participatory behavior in certain scenarios (Ling). Second, these badges are meant to be rewarded for hidden, game-like tasks. We hope the hidden nature of these badges will make them more rewarding for individuals who receive them first, inspire others to search throughout the site for similar rewards and create a sense of playful fun within iNaturalist. Clearly this desire needs to be weighed against both the possibility of over-stimulating users with social rewards and against the frustration in making achieving rewards too difficult. Little research has been carried out in this area, and we feel that experimenting within iNaturalist may provide interesting and unexpected results, as well as opportunities for future inquiry.

This is a brief discussion of the social incentives systems we have put in place, or plan to put in place in the near future within iNaturalist. It is difficult to accurately predict how each incentive will affect the overall behavior of individuals within the community. It is possible that some of our proposals will not improve cooperative behavior or inspire individuals to contribute more. If this is the case we will need to actively pursue alternatives in how to motivate the community, especially considering the ability for improperly defined incentives to alienate a community. Nevertheless, we view social incentives as a powerful mechanism to tie a community together and reward behaviors that benefit the overall community.

Usability Tests

Throughout our process we performed several usability tests to evaluate our progress and test new designs with actual users. The tests consisted of a wide variety of accepted testing methods including paper prototypes, heuristic evaluation, interactive prototypes, and general user experience tests. The feedback and the personal stories provided by our usability participants guided many of our design decisions and called attention to usability issues, such as confusing instructions and interactions. Utilizing these qualitative methods allowed us to assess which types of users to focus our design energies on, address their needs and ultimately create a better overall experience within iNaturalist. Through this process we also learned that usability testing also comes at the cost of extensive time requirements. Transcribing test sessions, conferring with other test practitioners about a test's

results and interpreting a tester's feedback are all time consuming processes. Arguably, this drawback is outweighed by the benefits gained from usability testing, but it does suggest that a balance exists between designing heuristically and directly testing design concepts on users.

For example, in most cases problems with a design can be simply discovered by examining an interface from the perspective of a user. Asking ourselves questions like "Is this process fast enough for me?", "Do the instructions make sense to me?", and perhaps the most powerful, "Would I be happy using this interface?" enabled us to quickly address issues without going through the extensive process of finding and testing users. Some call this "scratching your own itch" and using it as a design metric is advice well heeded.

When user testing was required it was initially difficult for us to understand our test participants. In effect they spoke another language, one which provided a detailed list of what they would and would not do with our designs, and of course how they would have conceived things differently. At first it was easy for us to return to our designs with these lists and attempt to address each concern they had, but that proved to simply be a moving target. Instead we learned that users were not giving us lists of what we should change, but describing deeper issues, in effect revealing the problems they were trying to solve through our designs. Finding the root of the problems our users faced transformed the results of user testing from informative to fruitful.

Many of our tests were run with relatively few participants, which proved to be beneficial in some respects and limiting in others. Using few participants allowed us to carry out tests quickly given the little amount of time we had to both produce a functional version of iNaturalist and manage our other commitments. It also allowed us to survey several different types of iconic users often with drastically differing points of view. However these conflicting user expectations caused confusion regarding which direction to take after the test was complete. Ultimately being able to run tests relatively quickly allowed us to take these differing points of view, return to the drawing board to make changes to designs through a heuristic process and test another small group in a relatively short amount of time. Often times these participants were our fellow School of Information cohorts who were tested in very informal settings as a means of getting on to the next design process.

Decoding what components of an interface worked well and which components did not after a testing session also proved difficult. In our final test, many users had similar issues with adding location data to observations by placing them on a map, a process that is only one small part of a larger interface. It was important to distinguish between the map interactions which did not work well, effectively rendering the interface impossible to use, and the other components of the interface that users found intuitive. Further, it was important to consider how changing the map might affect the flow of the overall interaction. When critical components of an interaction fail it might seem like the best solution to the problem is to drastically overhaul the entire design. We learned that this is often not the case. Instead it is usually more productive to attempt to retain those parts which worked well and to find the smallest possible change to a design which will make it work more intuitively. Sometimes one critical flaw was enough to make an entire interface unusable, and fixing that flow eases nearly all of the pain users experience with difficult designs.

Finally, perhaps the most useful result from direct user testing is not the analysis of the way in which users approach the designs one presents them, but rather the ethnographic quality of the interviews which inevitably come out of the one on one interview process. As a designer, meeting with users

provides a face and personality that you can refer back to in order to guide your design decisions. Unlike personas which attempt to be a combination of several different types of personality attributes, these are real-life individuals who have a stake in what you are designing. Not only can one see a participant's joy and frustration with a design, but that reaction is often put in a context related to that participant's prior experiences. Hearing those anecdotal stories provides the critical information fictitious personalities lack.

These lessons are the result of many hours of testing a relatively small group of very helpful individuals. Summaries of each of these usability tests, along with analysis and discussion of issues discovered and design choices made are found in Appendix D.

General Release

While we were still developing our core features we created a logo and a static webpage to establish our brand and provide information about our project's purpose. We also created a Google group that interested parties could subscribe to and receive announcements about our progress. On March 24, 2008 we released iNaturalist to members of our Google group and to our other contacts in the naturalist community. Over the first two days, 16 people created new user accounts and 33 observations were recorded. On the homepage we included the note: "iNaturalist is an egg! Help us emerge by telling us what you think!" with a link to our Google group to encourage feedback (see Figure 11 to see an example of this note).



Figure 11: Screenshot of general release note

We received a great deal of initial feedback, including bugs, suggestions for future features, usability concerns regarding confusing instructions and interactions, as well as many positive notes of encouragement. We not only learned about the positive and negative experiences of our users, but also learned about the benefits of releasing our system. We were originally apprehensive about releasing an unfinished product, but discovered that many of the imperfections that we viewed were not significant to our early users. In fact, it provided an opportunity to learn about other confusing elements in which we were previously unaware. Also, establishing this release date motivated us to set goals and complete as much work as we could. And lastly, it helped recruit potential iNaturalist users. When describing our project, we no longer pointed people to a static information page but rather an interactive working site.

Future work



Our next steps include implementing several features to improve the exploring, observing, and recording processes of iNaturalist users. These features include journal entries, checklists, a browse page of an individual user's observations, batch-adding, and groups.

- **Journals** – Journal entries are narrative records of experiences in nature, such as stories about dive trips or walks through local parks. This feature provides naturalists with the ability to associate these experiences with iNaturalist observations. Currently, users place narrative text in the description field of individual observation, at times reproducing the narrative in multiple description fields. Journal entries will provide naturalists with a single place to include these experiences and link them to observations.
- **Checklists** – Checklists are lists of species. These lists may pertain to a specific taxonomic group, a period of time, or a place (such as “Iguanas”, “May 2008” or “Point Reyes, CA”) or can be lists of arbitrary species (such as “My Wish list” or “Things that are Red”). These lists allow naturalists to organize their findings and can encourage further exploration of nature.
- **Enhanced Data Management** – naturalists need tools to manage their observations, so we plan to enhance views of an individual user's observations with statistics and filtering capabilities. Batch-adding is the ability to add observations with reoccurring elements, such as location and time, in an efficient manner. This will be useful for efficiency of observation creation, and for importing past observations from other formats.
- **Groups** – Groups are sets of individuals with common interests (such as Birders of the Albany Bulb). This feature provides a place for naturalist users to share their observations, make announcements, and request help with identification.
- **Simplified Observation Adding** – we hope to investigate means of parsing observational data from unstructured text like emails and blog posts, and to explore the possibilities of mobile apps for logging observations.

We also plan to send our appreciation to the early adopters of iNaturalist through distributing "Early Contributor" badges. These badges are a variation of the icons we have created for our system (these are displayed throughout this write-up and used on the Explore interface) and include an explanation about its significance and purpose. Wireframes of several of these features are found in Appendix E.

Conclusion



We look forward to the future of the iNaturalist system. Specifically, we look forward to facilitating and promoting data that is accurate and of high quality, evaluating the effectiveness of our incentives and creating future incentives, and designing an intuitive, enjoyable, and useful system for naturalists. We also look forward to other future challenges, such as the challenges associated with location specific information.

Despite the benefits of an open system like iNaturalist, revealing the exact location of consumed species, such as edible mushrooms and fish, can lead to poaching and exploitation. Furthermore, revealing the location of special status species can cause inadvertent habitat destruction by curious naturalists. On the other hand, this location information can aid local advocates in the conservation effort of such special status species. One of our users explained these conservation benefits: "Pikas, for instance, are not endangered but may be in trouble. More observations are needed to keep track of what's happening to them." Therefore, while there is no immediate solution to this problem we envision that we will automatically conceal the exact location of any special species observation as well as allow privacy-concerned naturalists, such as mushroom foragers and fishermen, to conceal their observation's location.

While we have spent much of our project addressing the issues of data quality and accuracy, incentivizing contribution, and user centered design, we have not forgotten the purpose of this project: to provide a place for naturalists to record their information, learn about and explore the natural world, and meet other naturalists. iNaturalist encourages the exploration of the of all living things, in one's neighborhood or in the deserts, mountains, jungles, and coral reefs of far-away locations. iNaturalist is a community, a place for experts, scientists, weekend observers, and budding naturalists to meet others with similar interests, share their findings and expertise, and seek out the help of others. We believe iNaturalist will generate awareness and appreciation of the natural world in all its awe-inspiring, exciting, life-changing glory. As one of our usability participants described, one little mushroom can make such a difference in a person's life. We at iNaturalist hope to make that difference. Therefore, we invite you and others to explore, learn, and record, at iNaturalist.org!

Thank You's

The iNaturalist team would like to thank our project advisor, Coye Cheshire, and the participants from our usability studies.

Appendix



Appendix A: Progression of the Add Observations Page

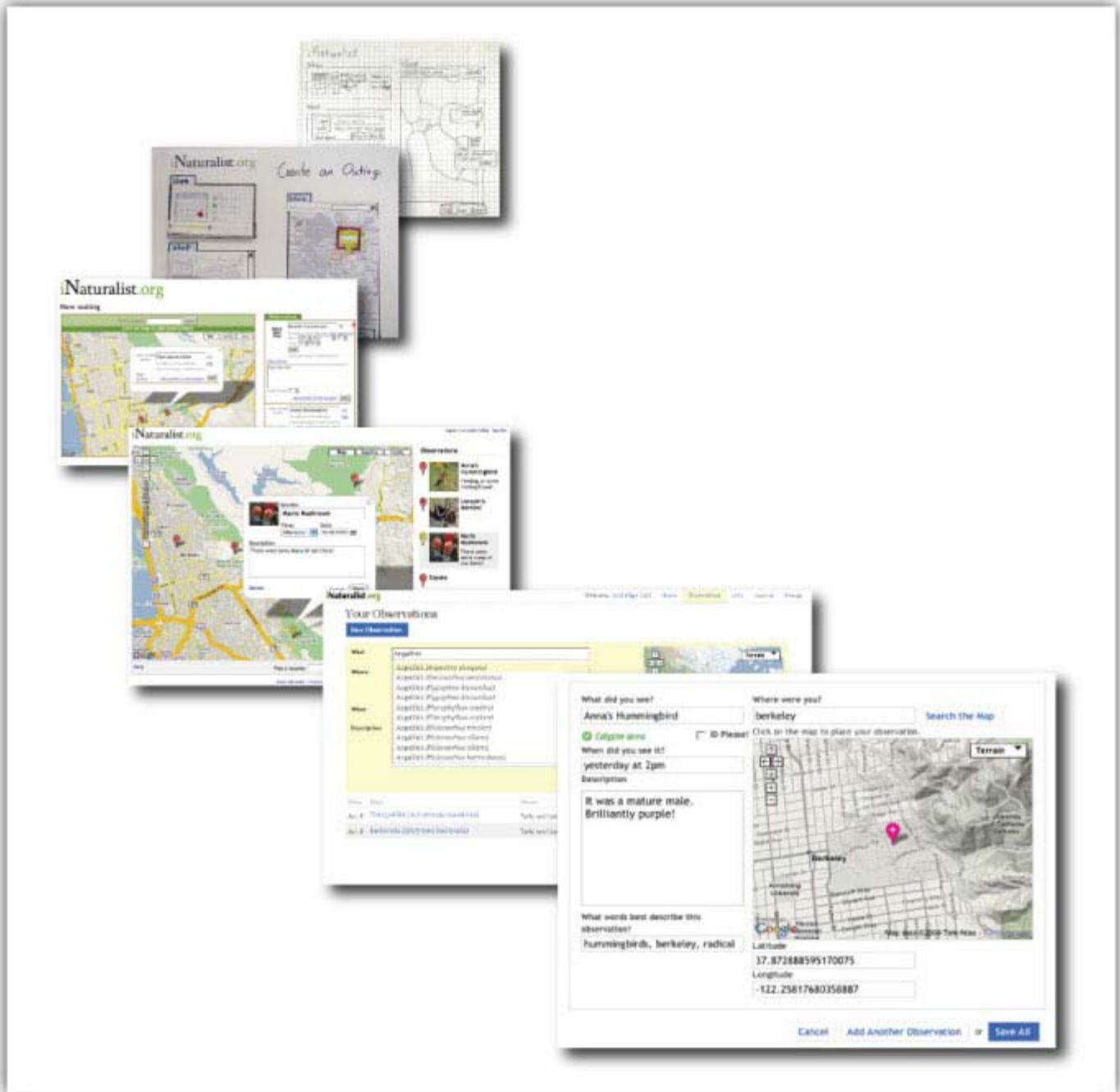


Figure 12: Progression of the Add Observations page

Appendix B: Personas

The following includes more detailed descriptions of the personas developed for this project and the justifications for their use.

Ted Sinclair

Ted is a "hot birder." He is among the most avid members of his local birding community, and enjoys considerable respect for his expertise. He is 48, married without children, and works as an actuary. His wife enjoys birding as well, but nowhere near as much as her husband. Ted has very nice spotting scope and a camera to go with it, maintains a large and meticulously updated life list of all the birds he's ever seen, and enjoys going on birding vacations around the world. He also leads trips for his local Audubon Society.

Justification: Ted is an early adopter and frequent contributor. He not only consistently records his findings but also helps others make identifications of what they've seen. He's extremely knowledgeable about birds and birding and prides himself in his reputation as an expert. Ted is also competitive; competitive about spotting rare birds, taking great photographs, and beating records in birding events.

Jenny Takahashi

Jenny is an active member of the Mycological Society of San Francisco (MSSF). Every other weekend she hikes with friends she's met through the MSSF. While she enjoys the outdoors, she especially loves finding edible mushrooms, which she later cooks at home. Jenny is a foodie. As a nutritionist, she eats well, attends the gym daily, and plays soccer every Tuesday. Jenny is 30 and enjoys living alone (her San Francisco condo is well kept.) She also keeps good records of her mushroom findings.

Justification: Jenny is a casual, general user. She hopes to easily record and organize her nature findings as well as share her findings with her friends. She is representative of many mushroom foragers in that she is concerned about granting this access to the general public.

Adam Thompson

Adam is an instructor and trip leader with the National Outdoor Leadership School, and also freelances for various adventure tourism trips whenever and wherever he can. He's in his late 20s, has a BA in environmental studies from Colorado College, and has a favorite hat that is old, sweat-stained, and never leaves his head. He likes to learn about the areas where he leads trips so he can teach his students and clients about local natural history and biodiversity. He keeps up with his friends spread out across the country through his Facebook account.

Justification: Adam is a casual, general user. He is interested in the social aspects of this site as well as exploring and browsing the findings of other members of the community. He does not have a specific nature focus and instead is interested in taking a more holistic view of what can be observed in an area.

Appendix C: Comparative Analysis

The following includes descriptions of nature resources and their uses by naturalists.

American Birding Association checklist

The American Birding Association Checklist is list a of birds found in North America. This list organizes species into categories and includes information about their abundance and seasonality. Birders use this resource as a regional guide and as a system to record their findings over time.

Encyclopedia of Life

The Encyclopedia of Life is a resource that compiles information about the Earth's biodiversity. It designates a page for each of world's 1.8 million known species and keeps current on newly discovered and formally described species. Naturalists use this resource to explore the world's biodiversity and learn more about specific species.

All That the Rain Promises and More field guide

All the Rain Promises and More is a handbook about mushrooms. It provides information about a specific species, including a photo or illustration, common name, scientific name, description, habitat, life history, and distinguishing characteristics. Naturalists use this resource to make identifications and as a place to take notes).

Flickr

Flickr is a photo management and sharing application. Naturalists use this resource to post photos of things in nature, organize them using tags, plot their locations on a map, and submit them to natural history and identification groups (such as the Wildflower Field Guide, North America or ID Please groups).

Geobirds

Geobirds is an online birding community. Its community members add bird sightings, which includes the species name, age, and sex, as well as the number species seen, description, and location on a map. Naturalists use this resource to post these sightings, find birding hotspots and clubs, and identify bird species.

The Mycological Society of San Francisco listserv

The Mycological Society of San Francisco listserv is a discussion group based on cooking, cultivating, and identifying mushrooms. Naturalists use this group to share their findings, post announcements, and request help identifying species seen.

Planet Earth

Planet Earth is a nature documentary that provides visual and auditory information on particular groups of species and ecosystems. Naturalists use this resource to learn about the natural world, often in far away and exotic places.

Zach Gillen's nature journal

Zach Gillen's nature journal is a book that this naturalist has used to record his findings in nature, such as dates and locations, names, illustrations, narratives, and lists. He and other naturalists use this type of resource to record, organize, and reflect on their personal nature experiences over time.

Appendix D: Usability Tests

The following includes more detailed descriptions of each of our usability tests, specifically what we tested and the important lessons learned. During the course of our project we also held less formal reviews of our wireframes and mock-ups. However, because of the informal nature of these reviews, their descriptions are not included in this write up. Full transcripts of the tests described below as well as of the wireframe and mock-up reviews are available upon request.

Paper Prototype Test

In the User Interface Design and Development class we started the design process by creating initial sketches of our interface design and creating storyboards to describe the various interactions that would occur. To test these various designs we created prototypes made with paper materials. Using paper made it a fast and collaborative way to implement these designs. In the end we finalized two variations of the prototype. In one variation, the 'any order' interface, observations are created in a list form and then dragged, either individually or collectively, to a location on the map. This variation allows the what, when, and where of the observation to be added in any order. In the other variation, the 'map first' interface, observations are created by clicking directly on the map before displayed in a list form. This variation requires that where of the observation is added before the what and when of the observation.

We recruited three participants, one expert naturalist and two casual naturalists, to test two variations of our paper prototype. We gave each participant the same set of tasks for each prototype and followed with general questions about their experience. We also asked our participants to compare the two prototypes and state their possible preferences (see Figure 13 to see a photo of this usability test). Our goal was to understand the preferred method of adding the location of an observation as well as obtain a general qualitative understanding of the usability of each prototype.

This test found that our expert naturalist preferred the 'any order' interface because of its batch adding capabilities - the same location and time could easily be applied to all observations. It also found that our casual naturalists preferred the 'map first' interface because it was more interesting to interact with and as one participant said "less homework-like". We also discovered two confusing aspects of the interface: modality and the meaning a location. The prototype consisted of two modes, an editing mode and a viewing mode. Our participants found it confusing that they needed to click an 'edit' button to resume the editing process after they had initially completed adding an observation. It was also unclear to our participants about whether they were adding an observation to a named place, such as Tilden Park, or to an exact spot on a map. We found that our participants preferred adding something to an exact place with new or unique observations, but preferred adding something to a named place with common observations. This feedback brought awareness of the need to balance an efficient data entry process with the need to make data entry both fun and interesting. It also helped us decide to focus primarily on casual naturalists and develop the 'map

first' interface as well as eliminate these unnecessary modes and clarify whether an observation was added to a named place or a specific point.



Figure 13: The paper prototype test

Heuristic Evaluation

From the feedback from our paper prototype test we implemented our first working prototype. We had the Play it by Ear group from our User Interface Design and Development class perform a heuristic evaluation to find usability violations made by our prototype. The group used Jakob Nielsen's Ten Usability Heuristics, which are ten principles for user interface design. These principles include: visibility of system status, match between system and real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, flexibility and efficiency of use, aesthetic and minimalist design, help users recognize/diagnose/recover from errors, and help and documentation. They first evaluated the interface individually, and then met as a group to discuss their findings and compile a report to present to our group.

The Play it by Ear's heuristic evaluation found 19 usability violations made by our interface. While

the majority of these violations were either minor or cosmetic violations, there were several major or catastrophic violations that we gave a lot of attention. These major violations included important instructions that were not prominently displayed, the unintuitive use of the word "outing" throughout the interface, and missing or confusing labels of several form fields. We also took note of the minor and cosmetic violations determined by our evaluators. These minor violations included a delete action that did not ask for confirmation before deleting, form field tips that used a black font instead of the standard grey font, a bug where double clicking on the map created a non-deletable map marker, a save button labeled "edit" rather than "save", and a color choice that blended too much with the Google map colors.

The violation regarding the use of the term "outing" was the most important finding from this evaluation. We used the term "outing" to signify a group of observations. And is a term that is frequently used by avid naturalists but is less commonly used by casual naturalists. At first we considered including instructions that explained this vocabulary, but because our interface primarily focuses on casual naturalists we decided to remove the "outing" terminology altogether. Therefore, instead of requiring that observations be added to an outing, users can instead add any observation, both related and unrelated, to the interface.

Interactive Prototype Test

In response to both major and minor violations of the heuristic evaluation we made multiple changes to our interface. Even with these improvements we were concerned that with our current map interaction (clicking on the map adds an observation) users would accidentally add observations when navigating the map. In response we developed two alternatives to our current interaction: a right-click adding interaction and a modal tool selection adding interaction. We recruited three participants, each casual naturalists, to test these different map interactions as well as evaluate our interface as a whole. We hypothesized that our original map interaction would cause the most errors, but our test found it actually produced less errors than the other interactions. After asking our participants which interaction they preferred, we found that two of the participants preferred the original click interaction and one participant preferred the right-click interaction. Meanwhile no participants liked the modal interface because it required additional steps.

In our follow-up questions we learned that all of our participants could easily imagine situations in which they might use iNaturalist, but all of them described their use strictly in terms of data consumption, not contribution. In this study we also observed hesitation as participants hovered over button pairs and after clicking within text fields. We concluded that the former is due to a lack of distinction between a pair of buttons and will be resolved by emphasizing the primary button with a different color or changing the secondary button to a link. We concluded that the latter is due to little feedback from the text fields in the form and will be resolved by altering the color of the text fields when clicked.

Beginning of Semester Test

After completing the User Interface Design and Development and Document Engineering and Information Architecture courses, we compiled a list of features to include in the iNaturalist system. These features included observations, lists, journals, groups, friends, and dashboard. We created wireframes of each of our features and created mock-ups of the add observations and lists features. During this time we reviewed our original add observations interface and found that it was

inefficient to add multiple observations to this interface. Therefore, the add observations mock-up implements several changes to improve adding efficiency, such as a species autocomplete form field and a larger add observations form. During our semester break we began building these designs along with the login and sign up functionality. In the beginning of the semester we held a usability test to evaluate our recent progress.

We recruited two participants, an avid birder and a field biologist, to evaluate our progress to date. We had both participants perform a set of tasks that included creating and logging into an account, adding multiple observations to iNaturalist, viewing a list of observed species, and creating a taxa specific list. After our participants completed these tasks, we followed with general questions about their experience. The goal of this test was not only evaluate our recent work but to also observe our participants' reactions to adding identified and unidentified observations.

This evaluation found that the autocomplete interaction was not intuitive - it was unclear to our participants how to select one of the autocomplete suggestions. And if the participant did not select one of these suggestions it was unclear whether iNaturalist recognized the species of their observation. This evaluation also found that participants were confused about how to add a location as well as the preferred method of recording unidentified observations. And lastly the evaluation found that the descriptions field can be used to write lengthy and descriptive stories about observations, that the sign up and login functionality was intuitive, and that multiple observations could be added efficiently. Our follow up discussion also found that some naturalists might be sensitive to others questioning their identifications and that others worry that uninteresting data of pigeons and humans might decrease the value of the site. From these findings we determined that we need to improve both the feedback of the species association and the location-adding instructions. We also determined that we need an improved way to add unidentified observations and that the journal entry feature is not a high priority feature because the description field is a satisfactory place to add descriptive information.

End of Semester Test

Next we created mock-ups of the individual observations, ID please, and goals interfaces. After review within our group we implemented these features as well as other enhancements, such as a connection to Flickr photos and the ability to add comments and markings. At the end of the semester we held a usability test to evaluate these developments as well as our overall progress since the beginning of the project.

We recruited four participants: a biology student, an avid birder, a casual birder, and a casual naturalist. We had our participants perform a set of tasks that included adding identified and unidentified observations to iNaturalist, editing and suggesting identifications, and exploring and adding descriptions to the observations of other community members. After our participants completed these tasks, we followed up with a card sorting activity and questions about future features. In the card sorting activity, participants ordered cards representing existing features, future features, and components of accuracy and reputation by their order of importance. In the follow up questions, we presented the participant with mock-ups of the goal bar and contribution badges and gathered initial feedback and reactions to these future features.

This test found that the map interaction was inefficient – our participants were unable to navigate to their desired location without continuously dragging the map. This test also determined several confusing aspects of our interface. These confusing aspects included the use of the word “taxon” in the species lookup feedback, providing two locations to add or change the identification of an observation, and the inability to arrow through the autocomplete list. And lastly, it found that each participant favored different iNaturalist features and that features unique to the iNaturalist system, such as ID Please, markings, goals, and reward icons, each required further explanation.

The End of Semester usability test allowed us to conclude our final project work and assess our progress. It demonstrated that while the map navigation still requires improvement, as a whole, the add observations interface has improved in its efficiency and intuitiveness. The test also confirms the importance of providing multiple iNaturalist features; our usability participants have different levels of expertise, different nature interests, and different recording practices, and each feature has appealed differently to these various participants. And perhaps most importantly, it reinforces our understanding of our users’ needs and their desire for this very site.

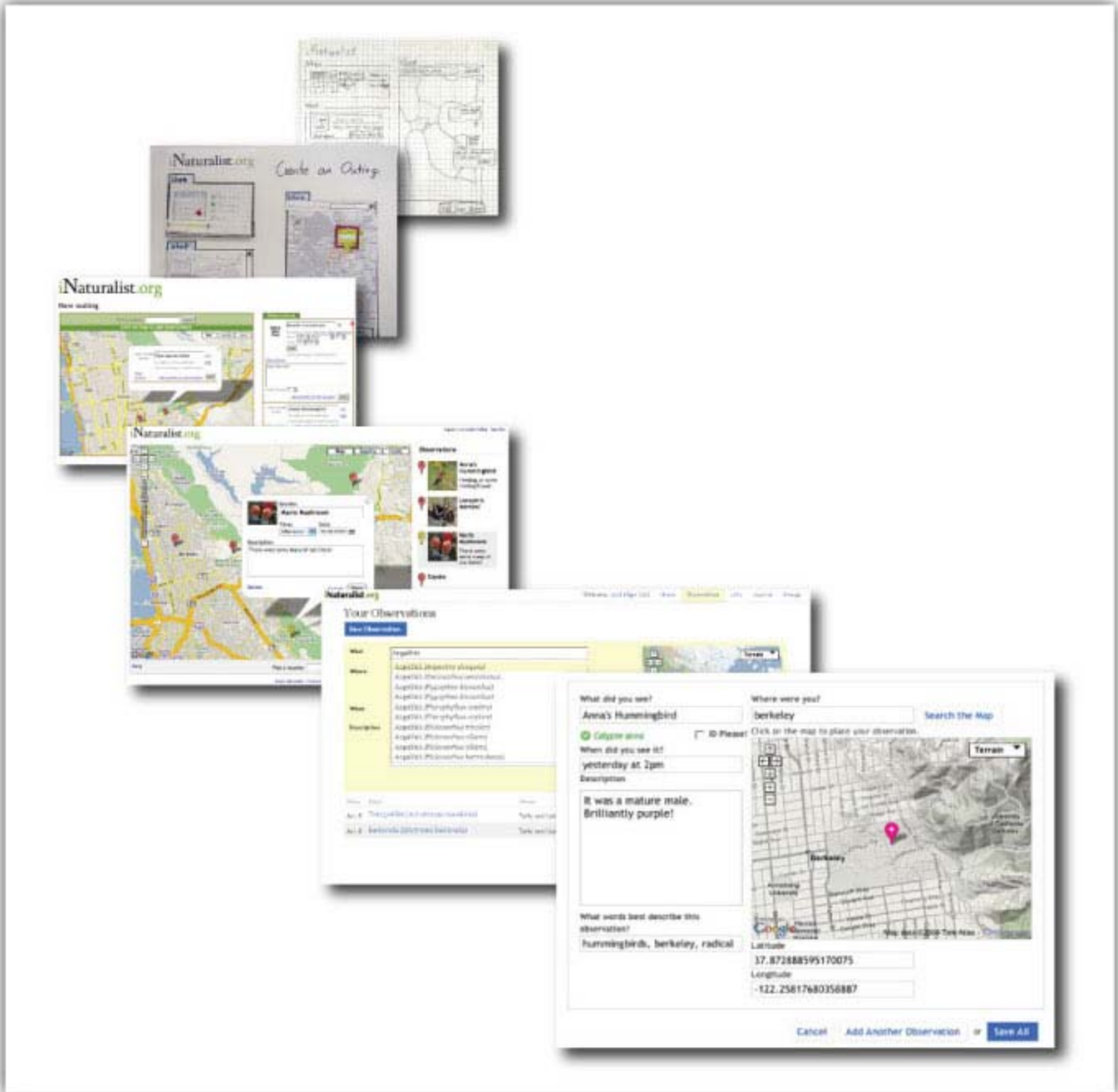


Figure 14: The Progression of the Add Observations page

Appendix E: Wireframes of Future Work

The following includes wireframes of certain features we plan to develop.

Ted > Lists >

Ted's Beasts of Berkeley

[Edit](#) Sort by [Iconic Taxon](#) [Taxonomy](#) [Last Seen](#)

These are all the animals I know have been seen in Berkeley, CA. One day, I will see them all!


Birds (Class Aves)

-  **Cinnamon Teal (*Anas cyanoptera*)**
Last seen on Feb. 12, 2008 in Berkeley Marina (Berkeley, CA) [Edit](#)
-  **Green-winged Teal (*Anas crecca*)**
Last seen on Feb. 12, 2008 in Berkeley Marina (Berkeley, CA) [Edit](#)
-  **American Avocet (*Recurvirostra americana*)**
Last seen on Feb. 12, 2008 in Berkeley Marina (Berkeley, CA) [Edit](#)
-  **Pygmy Nuthatch (*Sitta pygmaea*)**
Last seen on Feb. 12, 2008 in Tilden Regional Park (Berkeley, CA) [Edit](#)
-  **White-breasted Nuthatch (*Sitta carolinensis*)**
-  **Red-breasted Nuthatch (*Sitta canadensis*)**


Reptiles (Class Reptilia)

-  **Western Fence Lizard (*Sceloporus occidentalis*)**
-  **Northern Alligator Lizard (*Elgaria coerulea*)**

Ted has seen **22** of **87** species on this list.

 Birds **0** of **45**

 Reptiles **0** of **31**

 Insects **14** of **62**

Other people are working on this checklist, too!

Adam has seen **12** of **87**

Jenny has seen **38** of **87**

Figure 15: Checklist Mock-up

Ted's Observations

Observations Maps Lists Profile

Ted has recorded **38** observations, **33** of which are unique species.

Filter observations by:

- 6 Mammals
- 21 Birds
- 4 Plants
- 7 Unknown

Observed between

02/01/08 and 03/01/08

Anytime

Tagged

In the area:



4 of Ted's observations were found based on your filters:

-  **Cinnamon Teal (*Anas cyanoptera*)** 1
Last seen on Feb. 12, 2008 in Berkeley Marina (Berkeley, CA)
-  **Green-winged Teal (*Anas crecca*)** 2
Last seen on Feb. 12, 2008 in Berkeley Marina (Berkeley, CA)
-  **American Avocet (*Recurvirostra americana*)** 3
Last seen on Feb. 12, 2008 in Berkeley Marina (Berkeley, CA)
-  **Pygmy Nuthatch (*Sitta pygmaea*)** 4
Last seen on Feb. 12, 2008 in Tilden Regional Park (Berkeley, CA)

Hide Map

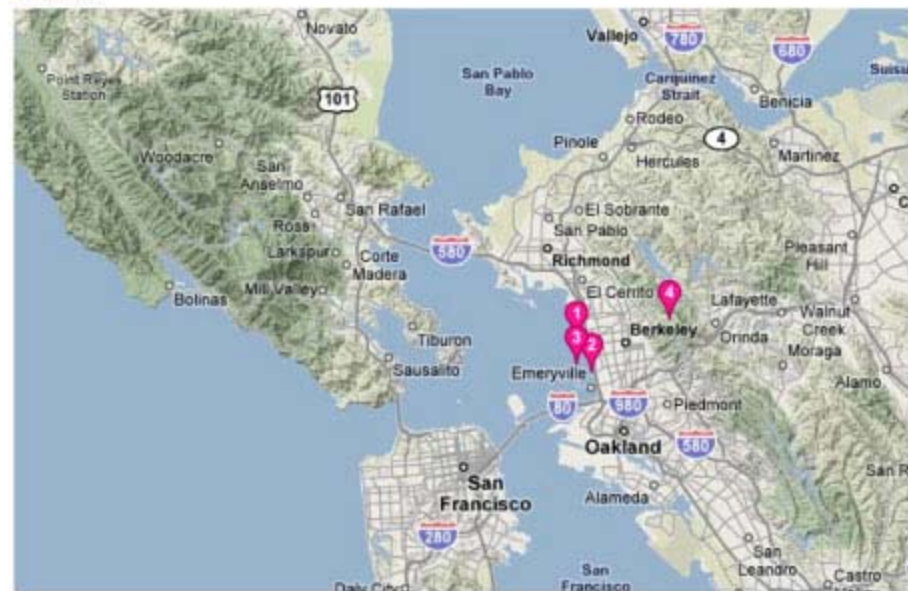


Figure 16: Your Observations Page



Figure 16: Examples of Rewards Badges

Appendix F: Cool Feedback and Press

The iNaturalist project is covered in the Fall 2007 Berkeley Science Review. The article “Location, Location, Location” features Ken-ichi’s work on web-based mapping and GIS products and with iNaturalist. The article discusses the potential benefits that iNaturalist could bring to the science community, such as bird migration records or the spatial and temporal habits of rare and endangered reptiles (De Chant).

We have also received some great feedback from our initial users. Some of our favorite quotes include: "Awesome idea, guys. This site will rock. Hope you're planning on keeping it going after you all graduate!", "Hugely terrific job you're doing", and "I love the site, think it's an awesome idea, and look forward to jumping right into the action. I have been saying that there needs to be a site like this for a long time".

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