Citizen Science in a Changing World

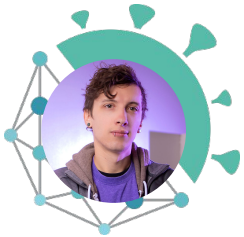
Grant Foster

About Me

Grant Foster

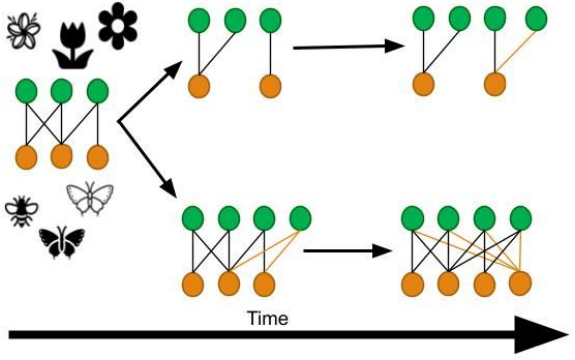
PhD Student, University of South Carolina
Department of Biological Sciences

Mentor: Dr. Tad Dallas



Research Interests: Quantitative Ecology; Assembly and Breakdown Dynamics of Species Interaction Networks

Locally involved with **Columbia Audubon** and **Gills Creek Watershed Association**



Self described **Citizen Science Nut!**

@grant226
@Riverman12 eBird

Citizen Science is Growing

Participation in citizen science is higher now than ever!

1 in 10 Americans have participated in a citizen science project in the last year (Thigpen, and Funk, 2020)

Citizen Science provides an **unique opportunity** to gather data in a **rapidly changing natural environment**, and engage local communities with the natural world

Citizen Science Happening Locally

Richland County

eBird: 34,000+ checklists, 3449 observers

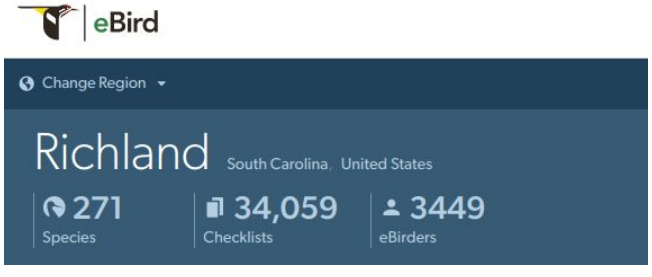
iNaturalist: 73,000+ observations, 3,802 observers

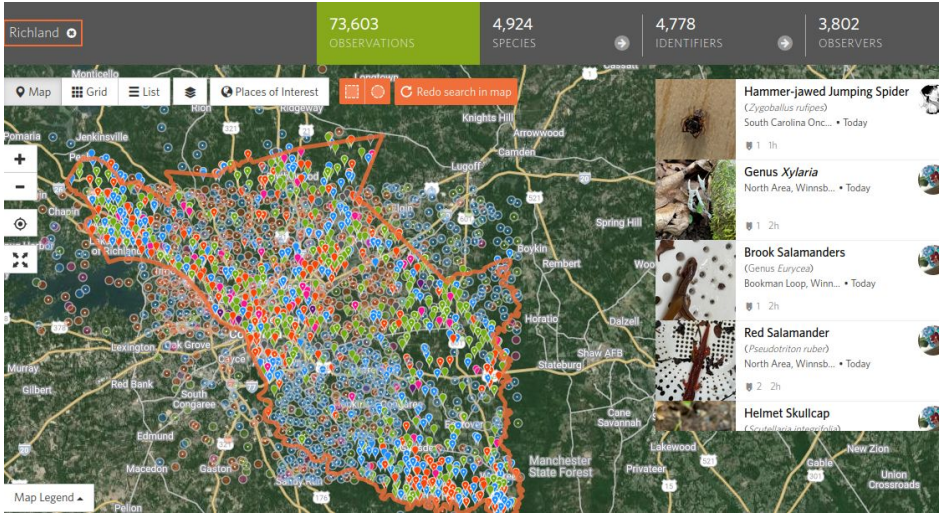
SC Adopt-a-Stream: Dozens of sites across Richland

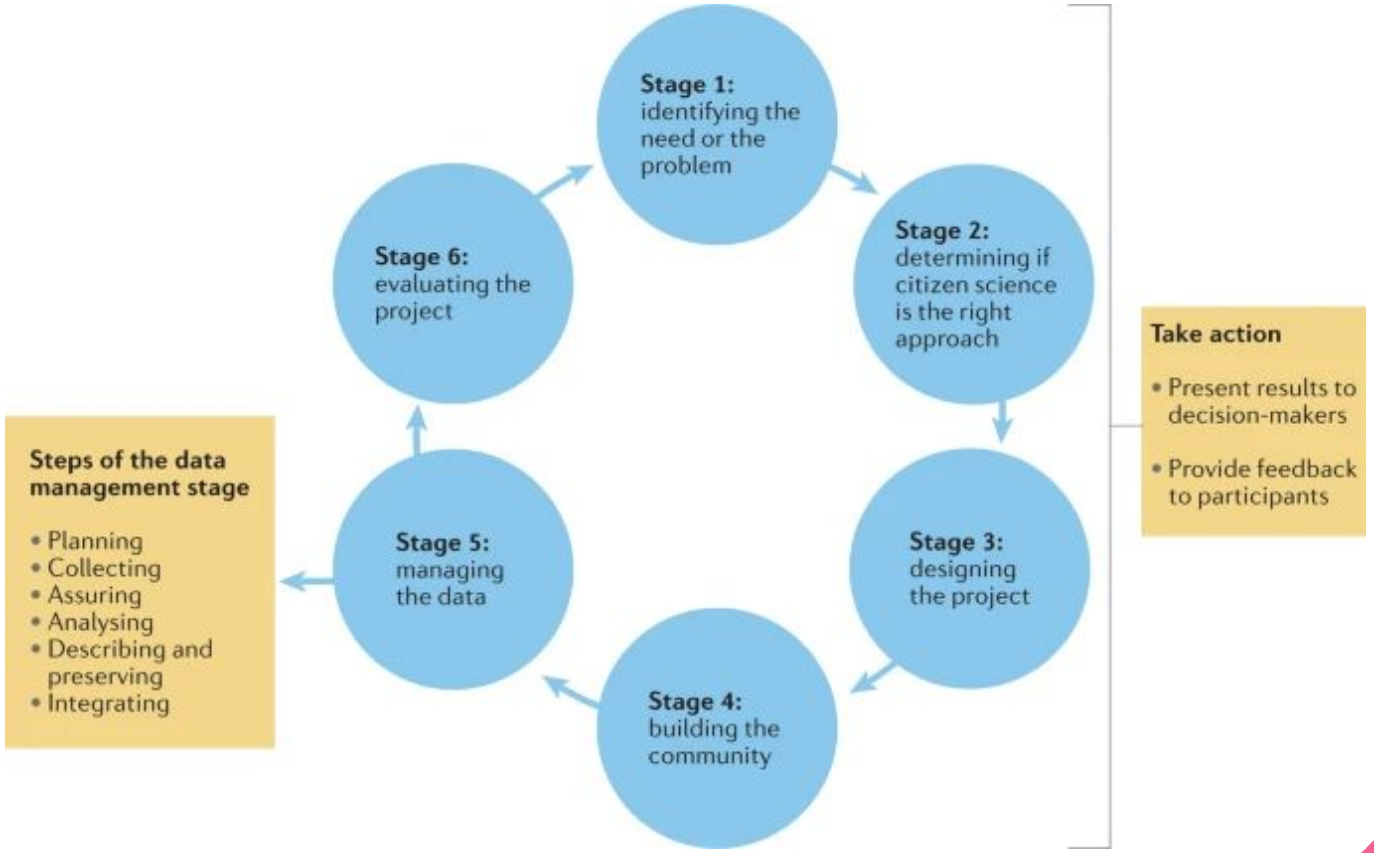
South Carolina

Litter Journal: 12,800+ observations; 3.25 million pieces of litter collected

Nature's Notebook: 1,105 observations

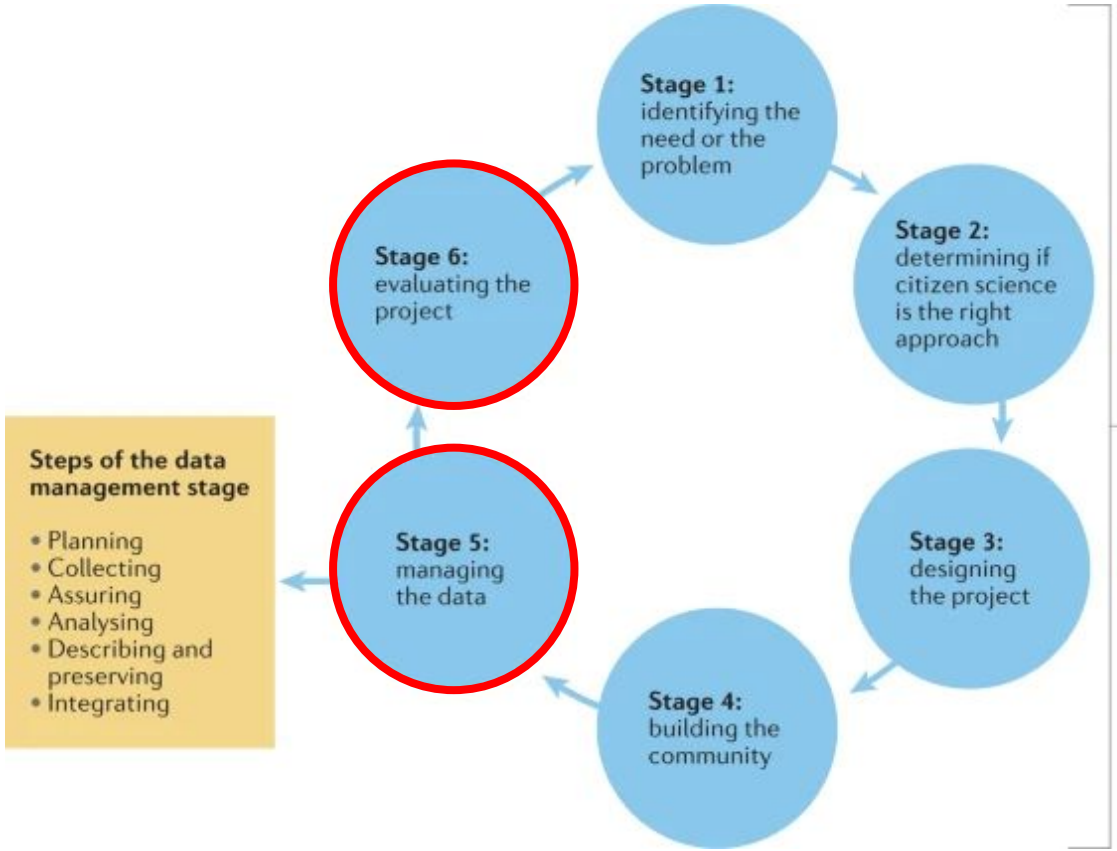






From Fraisl et al., 2022

“Citizen science in environmental and ecological sciences”



iNaturalist

The Cornell Lab of Ornithology

eBird

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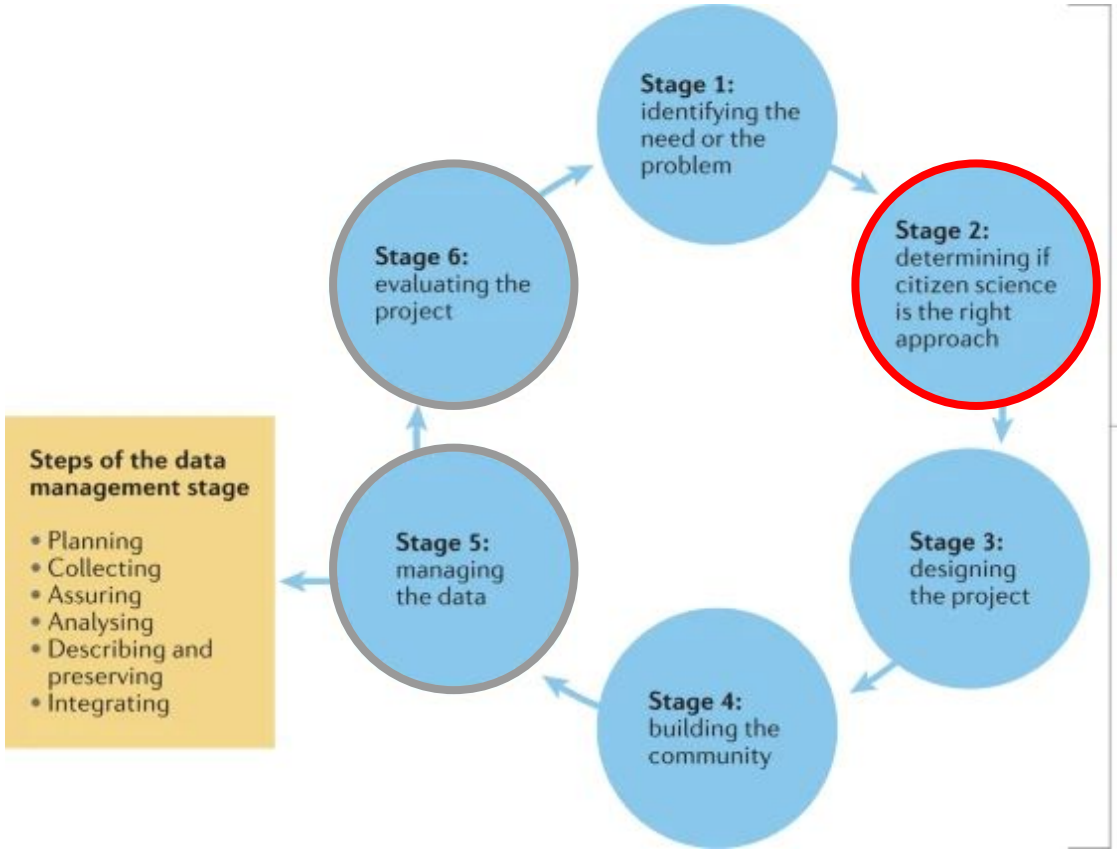

iNaturalist

The Cornell Lab of Ornithology

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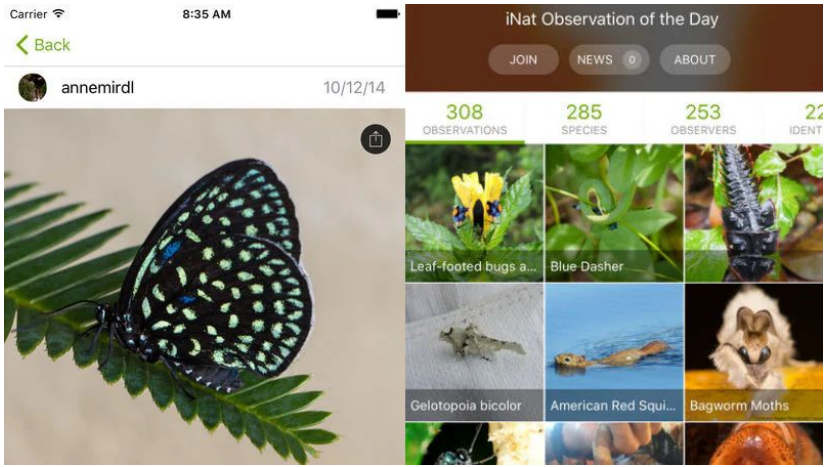
"Citizen science in environmental and ecological sciences"

What is iNaturalist?

- Online repository for wildlife observations
- Crowdsourced Species identification tool
- Social network of people sharing biodiversity information
- Started as a Master's project of Ken-ichi Ueda, Nate Agrin, and Jessica Kline at UC Berkeley's School of Information in 2008
- Became an independent non-profit in 2023
- **5.9 million users**, **124 million+ observations**



Submitting an observation: iNaturalist

Opportunistic/Incidental observations

An “observation” includes…

Who you are
You’ll need to make an **iNaturalist account** and please only post your own personal observations

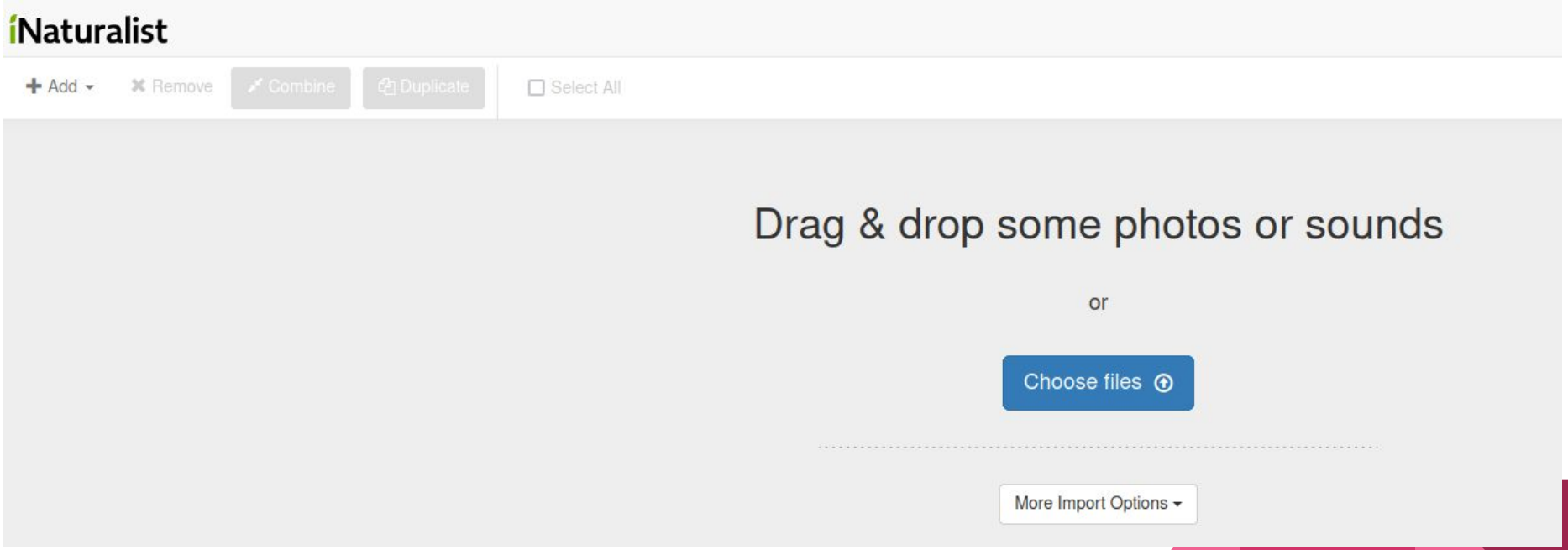
Where you saw it
Record both the coordinates of the encounter as well as their accuracy. You can obscure the location from the public

What you saw
Choose a group of organisms like **butterflies** or better yet a specific organism like the **Monarch butterfly**. If you provide evidence you can leave this blank and the **community can help**

When you saw it
Record the date of your encounter, not the date you post it to iNaturalist

Evidence of what you saw
By including evidence like a **photo or sound**, the community can help add, improve, or confirm the identification of the organism you encountered. Help the community by taking clear well framed photos, by including multiple photos from different angles

Submitting an observation: iNaturalist



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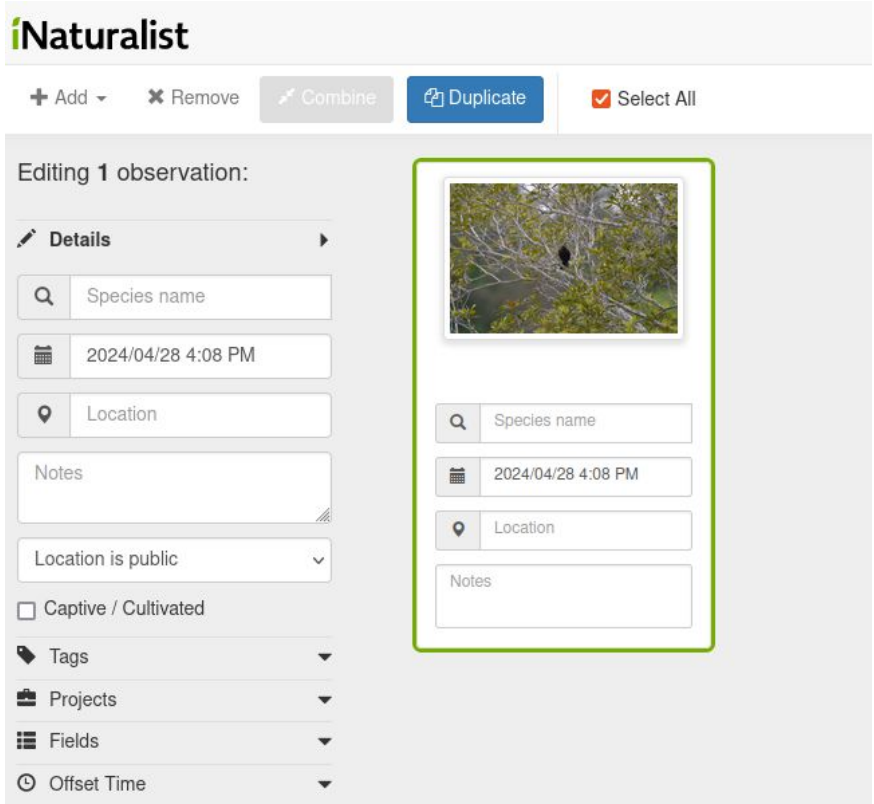

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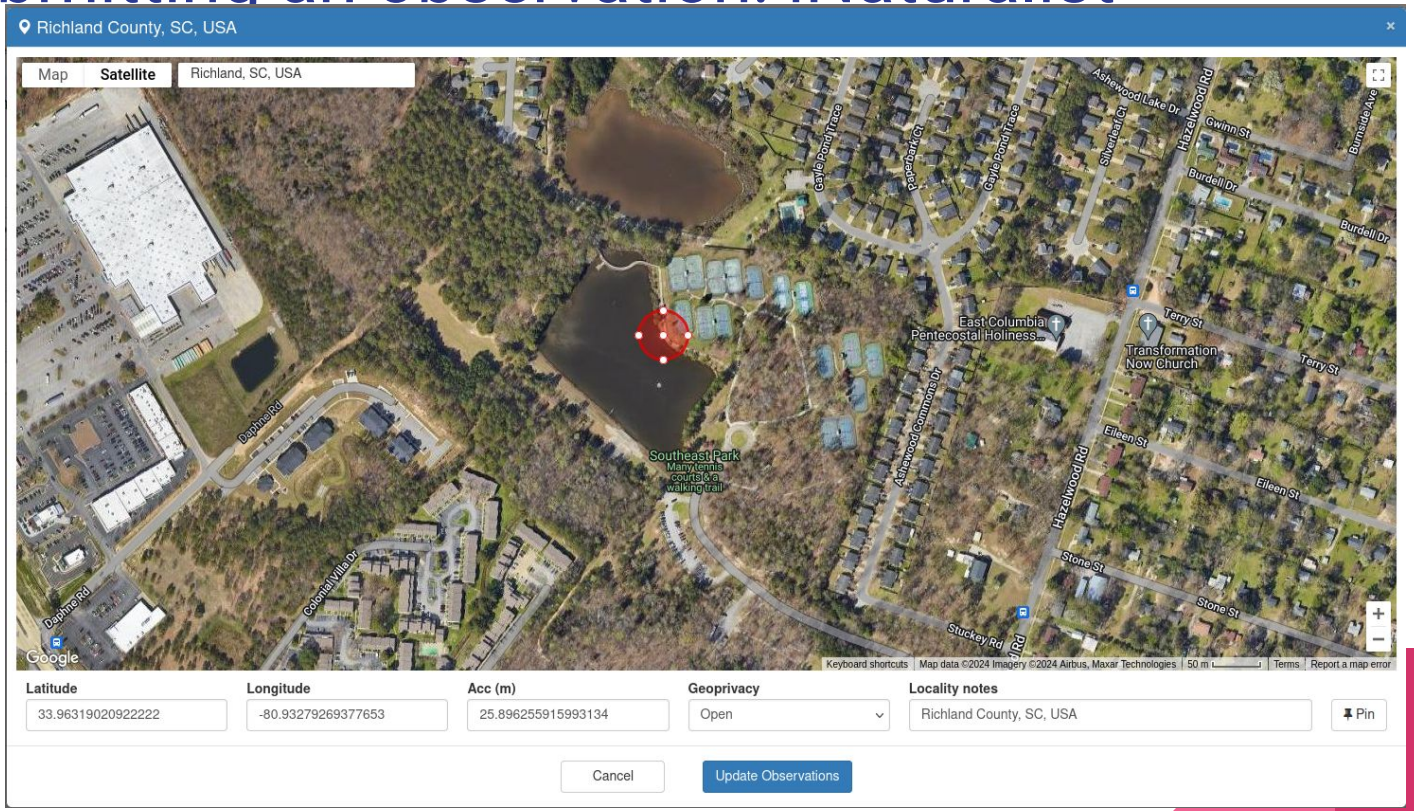

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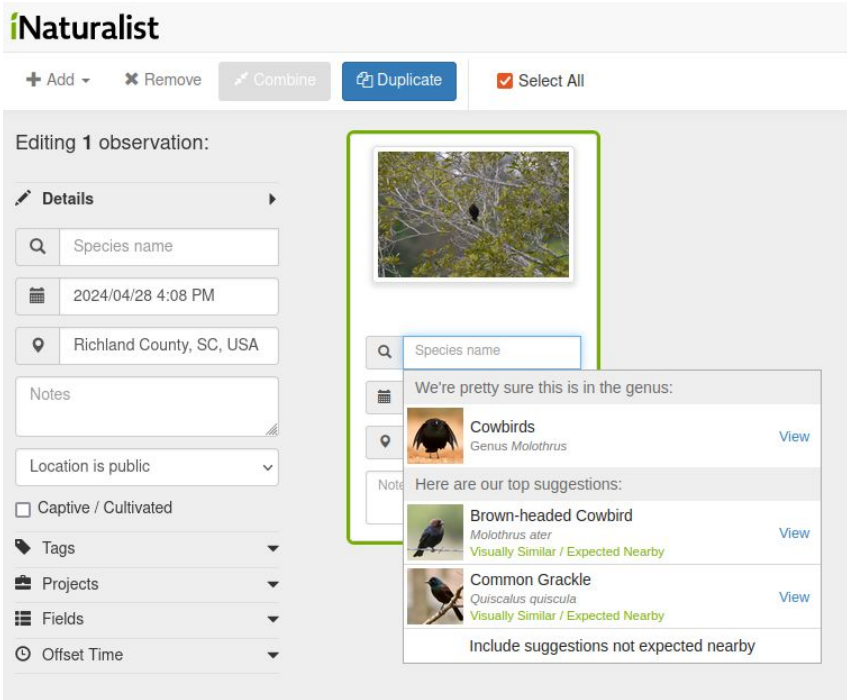
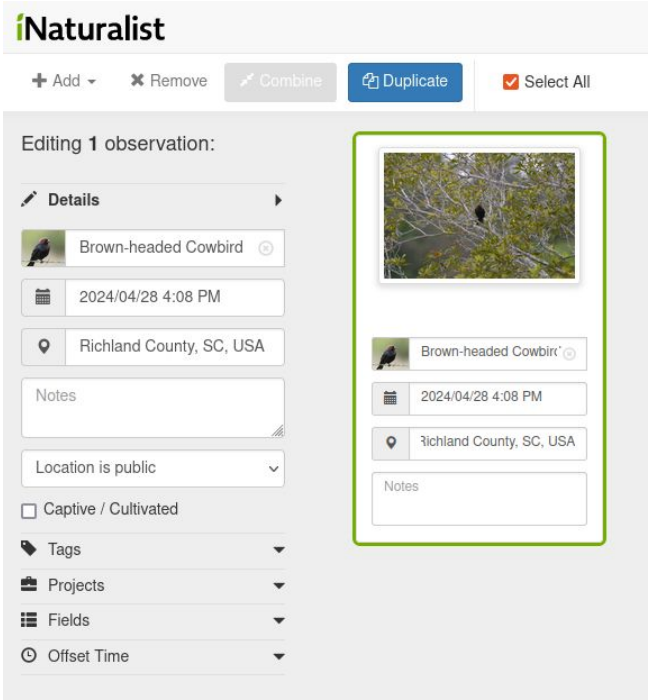


iNat has implemented computer-vision based ID suggestions since 2017!

Submitting an observation: iNaturalist



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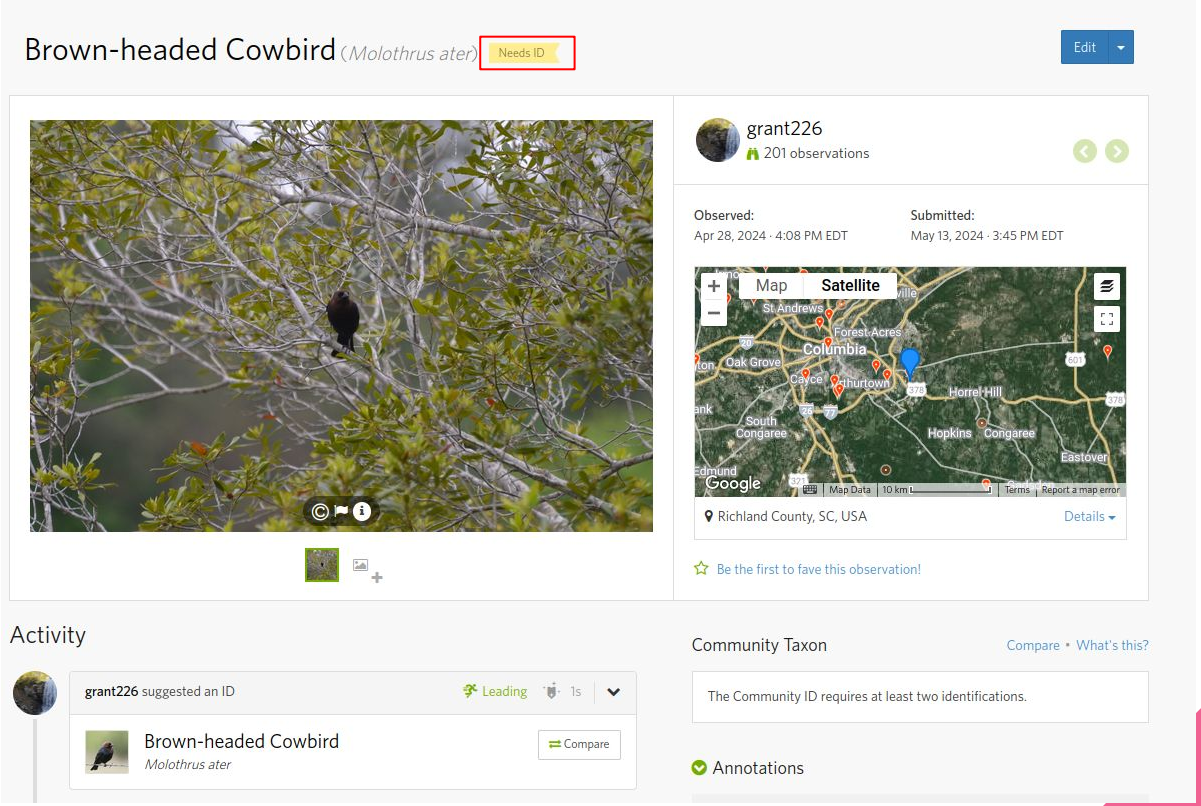
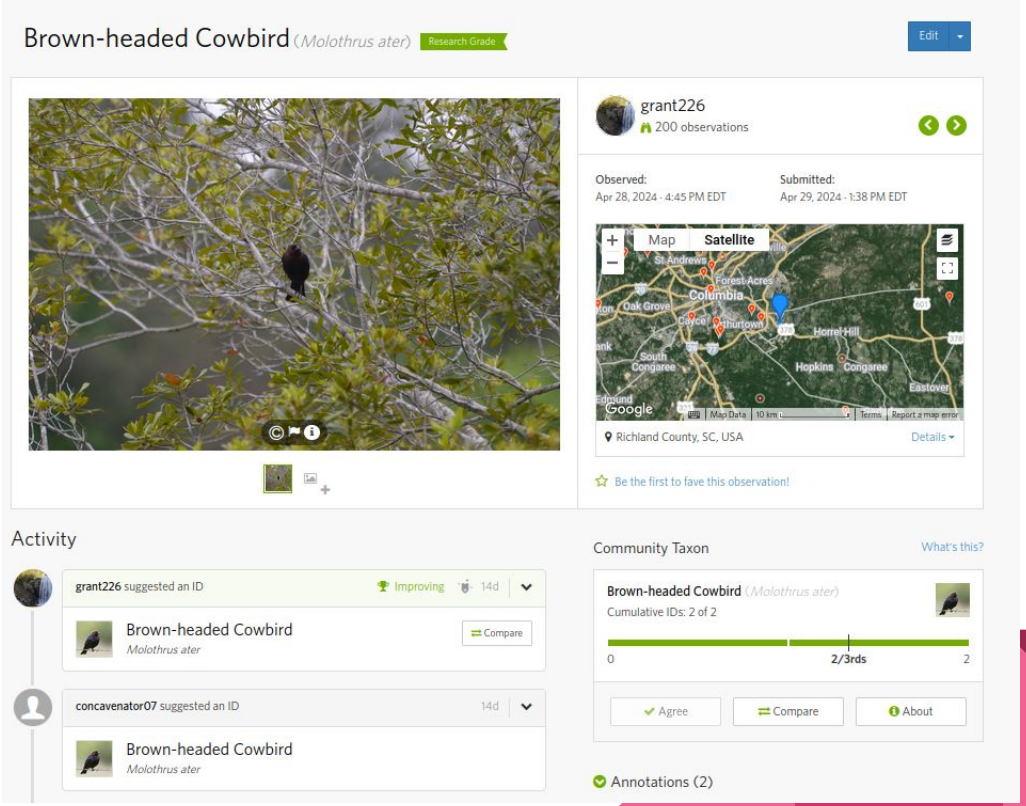


iNaturalist Community Identification

Community Driven!

Individuals are encouraged to ID other users observations to the lowest taxonomic level supported



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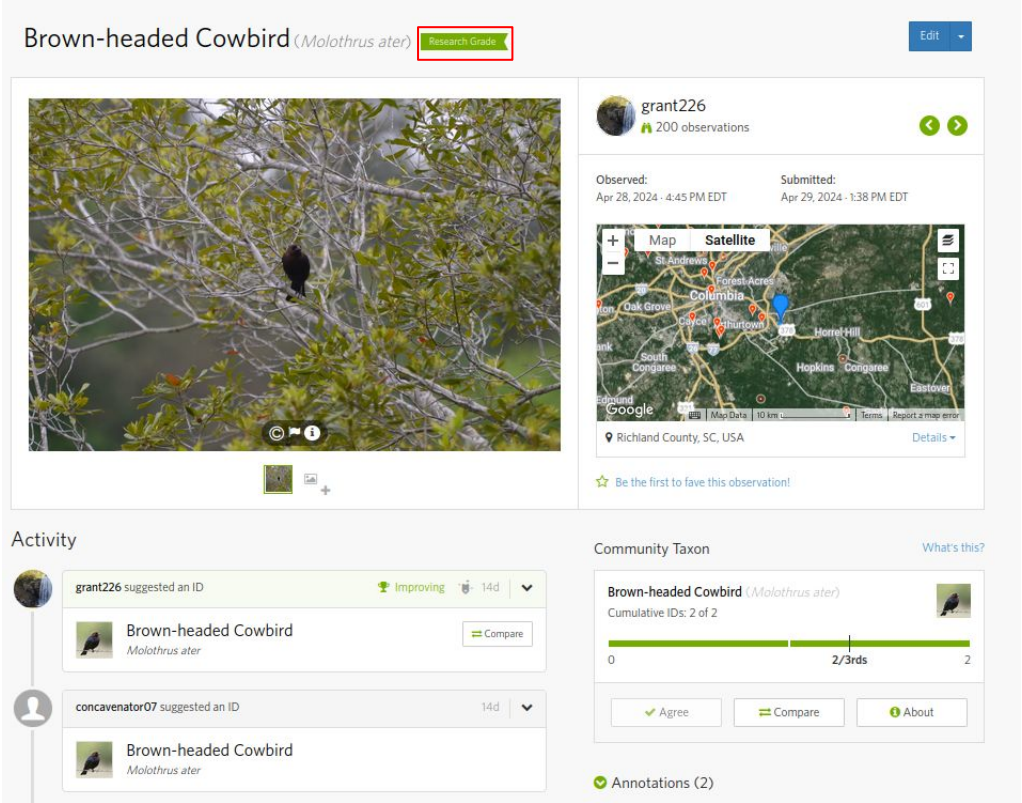


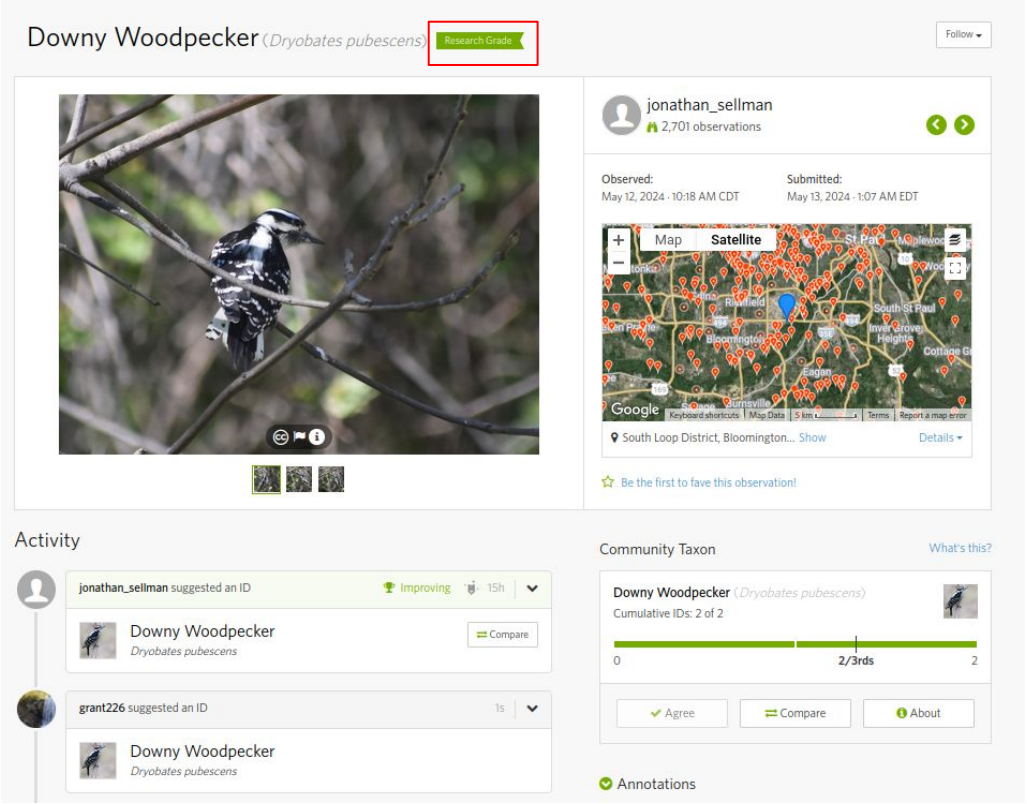
"Verifiable"

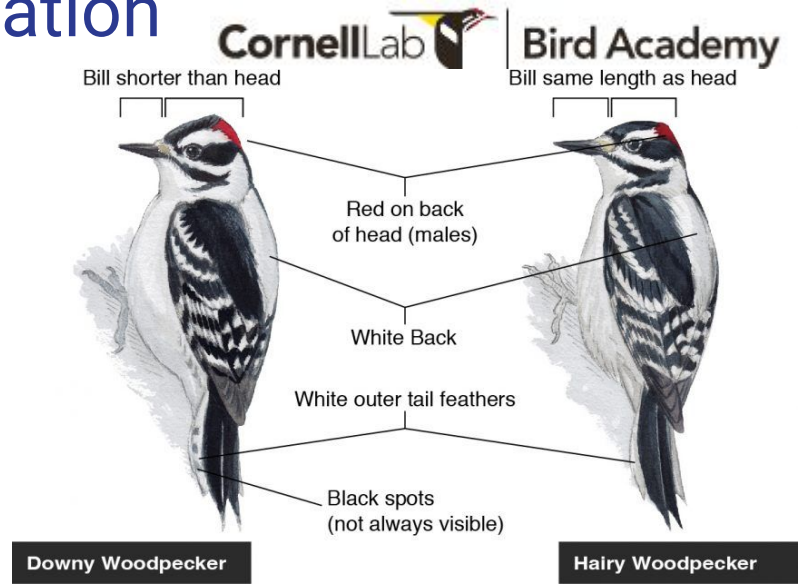
- Has a date
- Is Georeferenced
- Has Photo or Sound
- Is of a non-captive/cultivated organism

"Research-Grade"

- Verifiable
- Community taxon is at species level or lower, and has at least 2 IDs

iNaturalist Community Identification

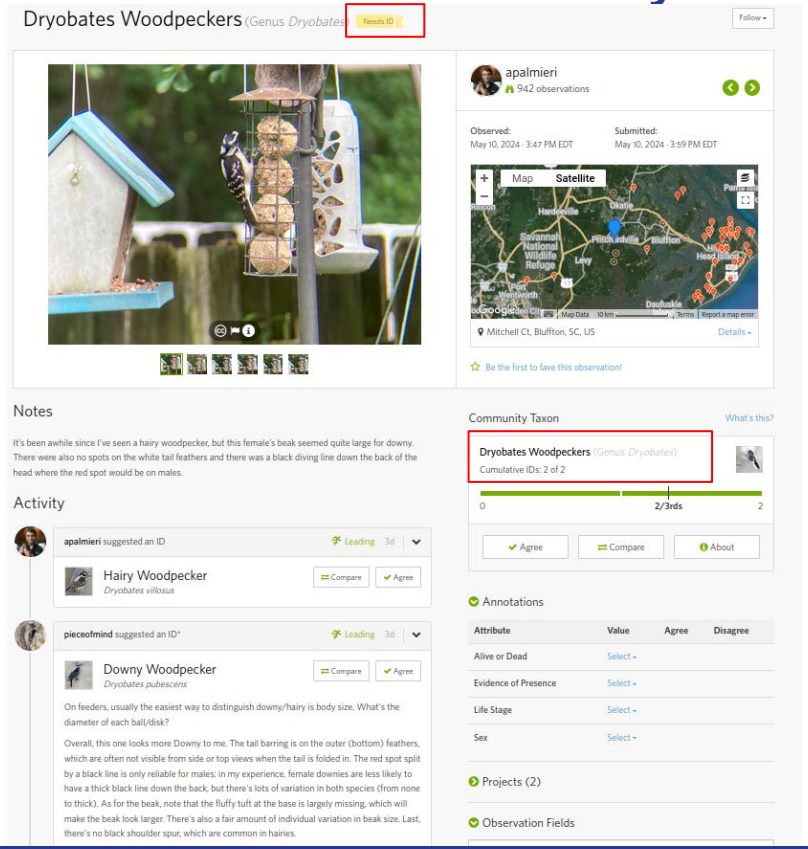


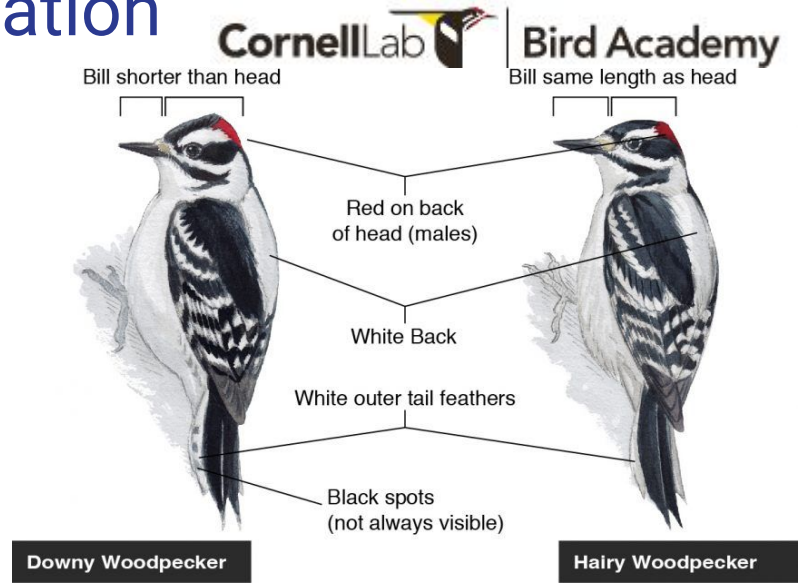


Dryobates pubescens

Dryobates villosus

iNaturalist Community Identification





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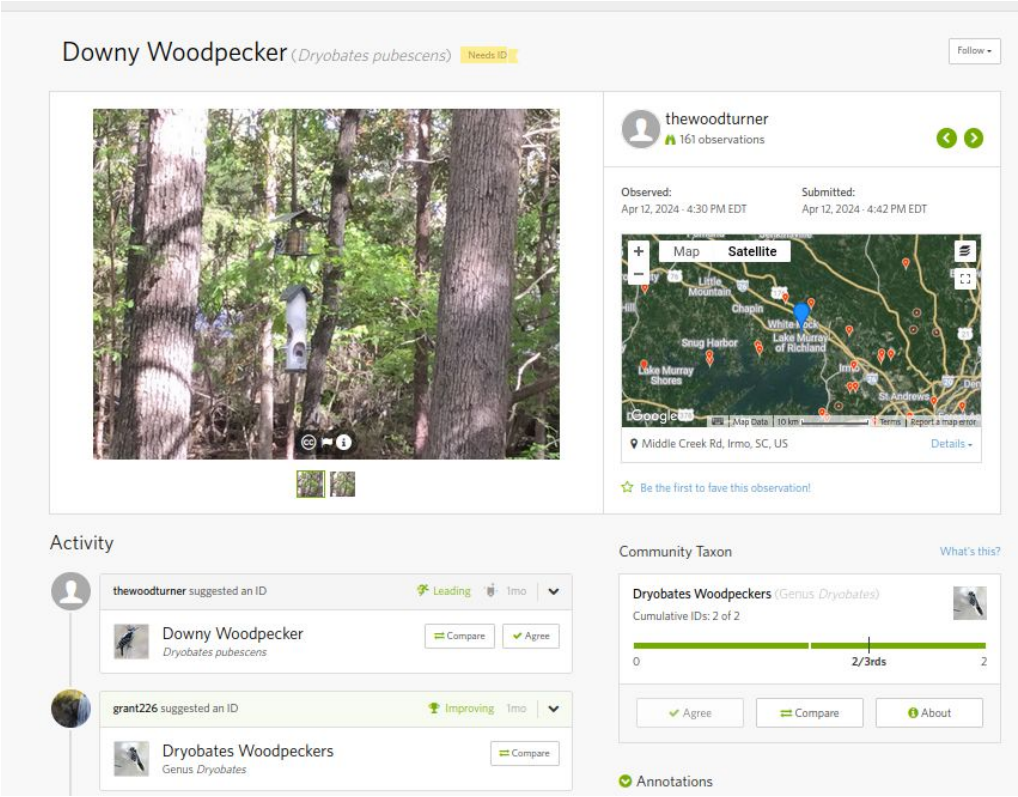

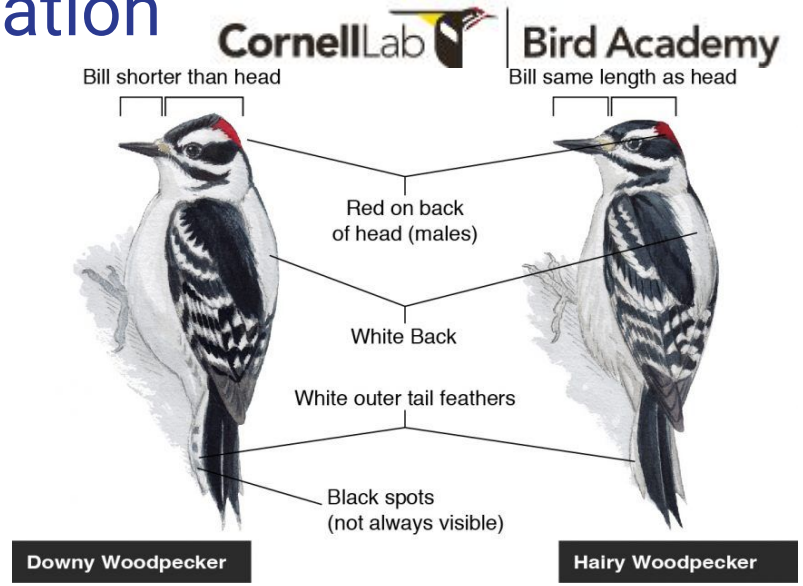

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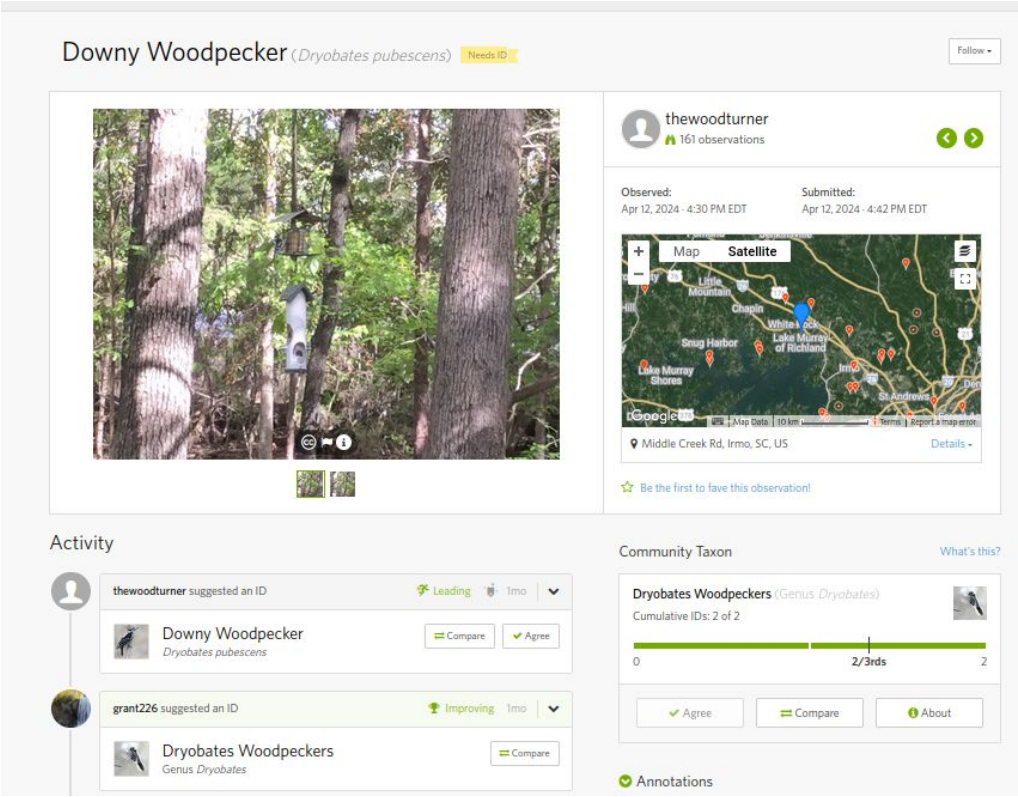

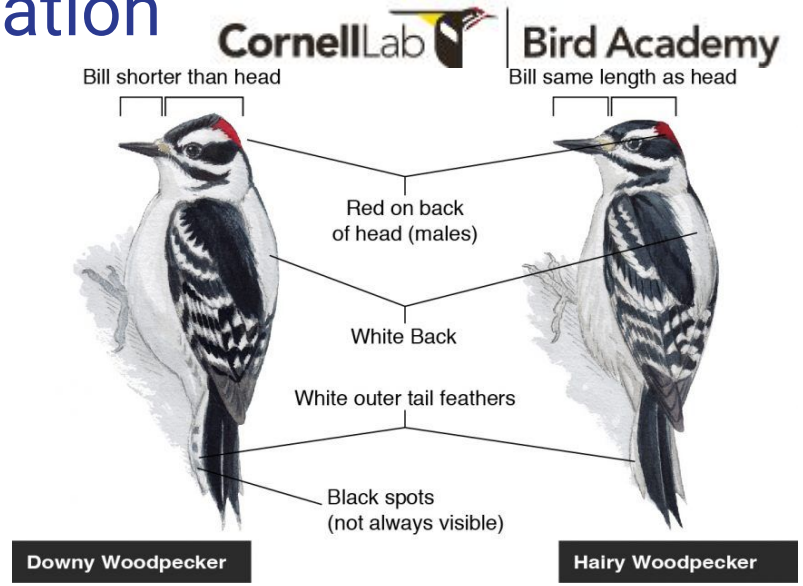

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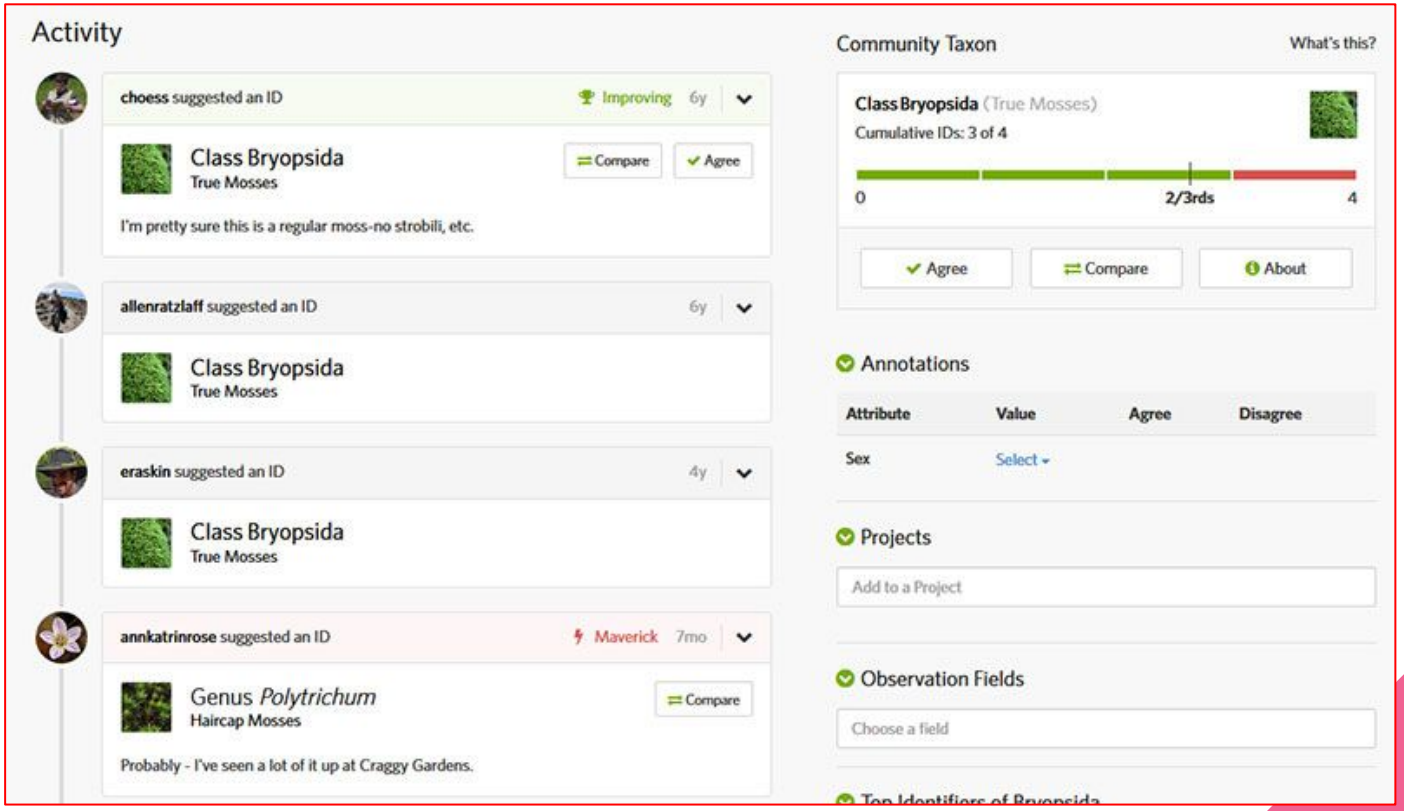
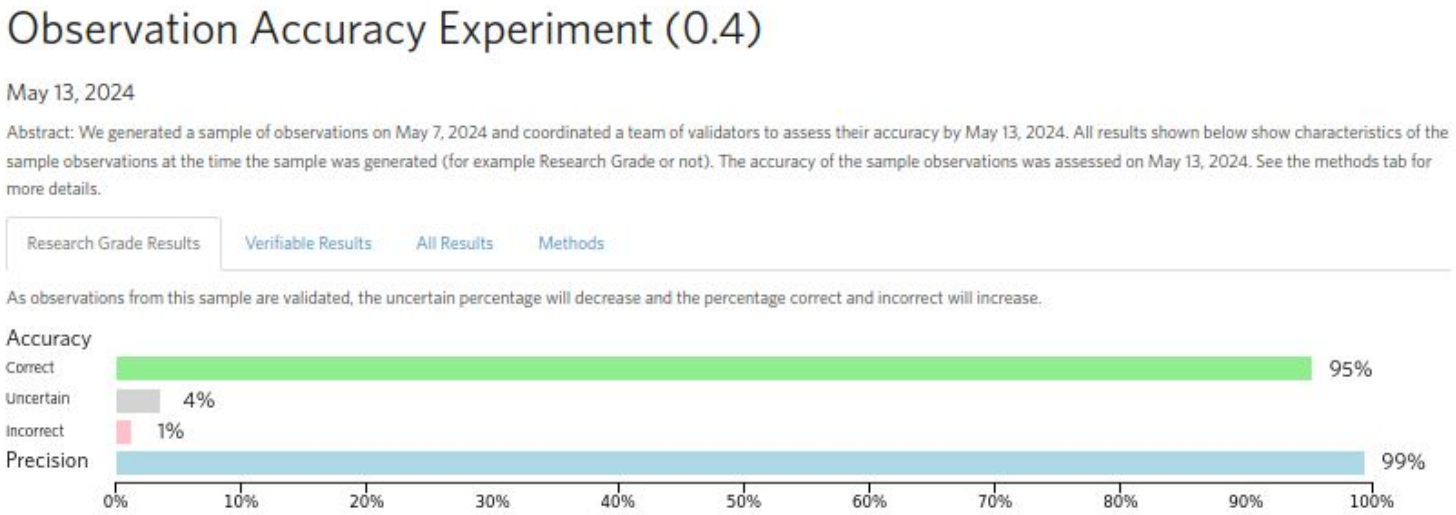


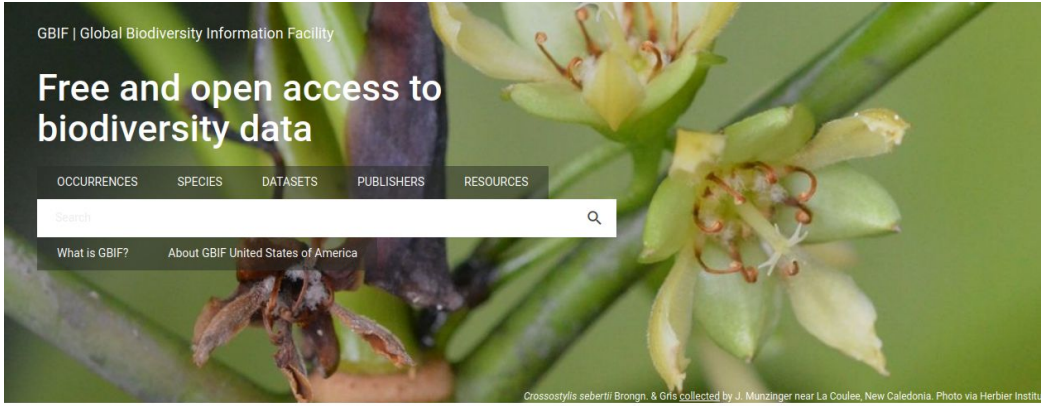
How well does this validation model work?

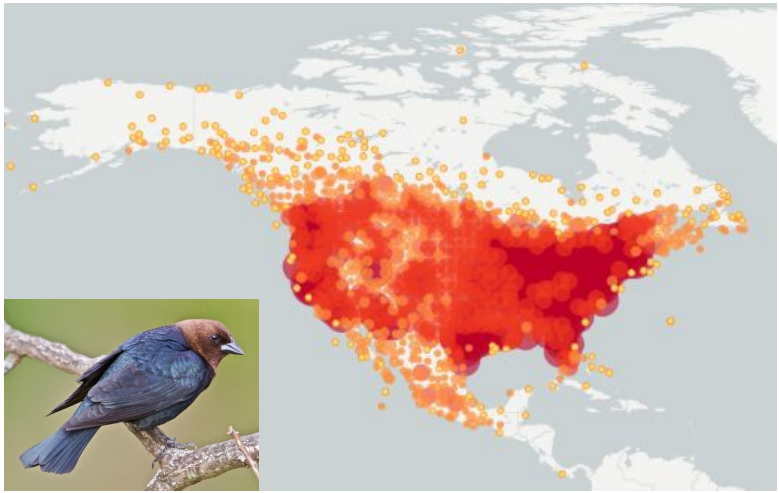
Data Quality Assurance is **Community-driven**

iNat conducts regular Quality Control Studies



How is iNat data used?





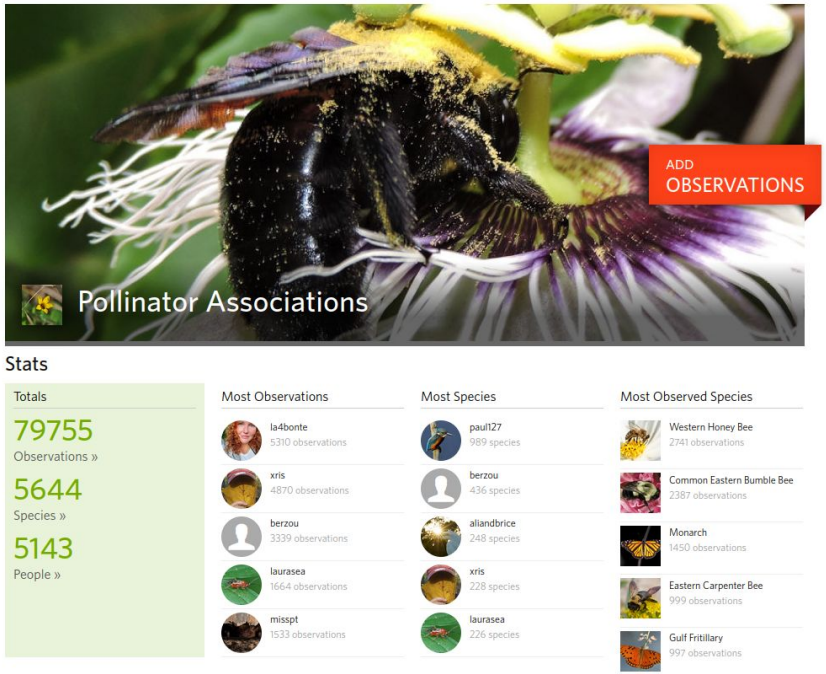
2,935,996,819
Occurrence records

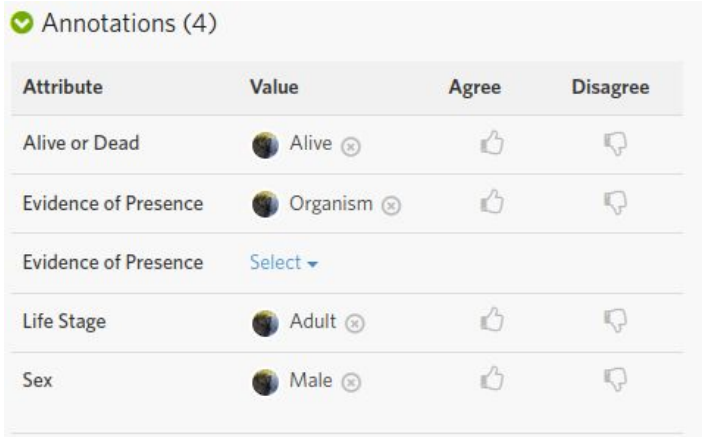
104,853
Datasets

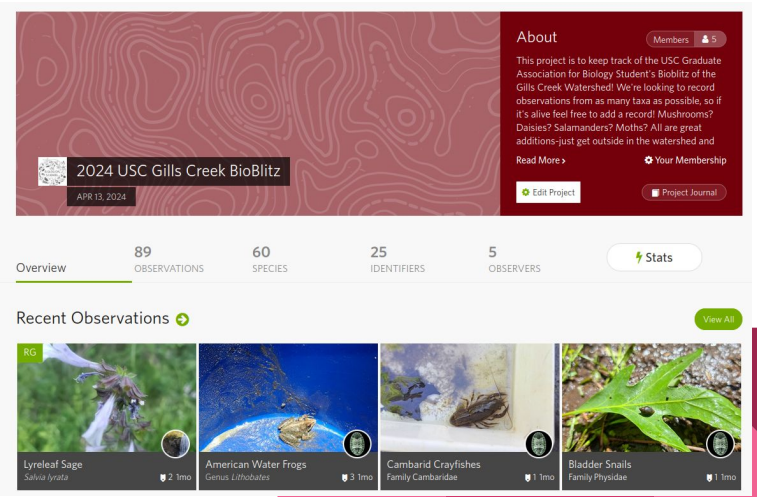
2,220
Publishing institutions

10,522
Peer-reviewed papers using data

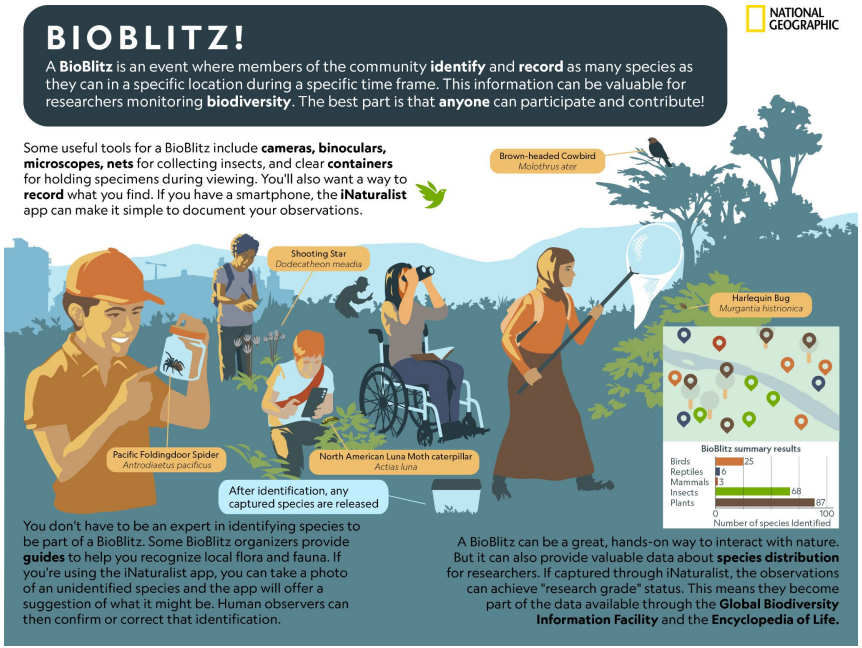
Observation Fields & Projects







iNat for Engagment

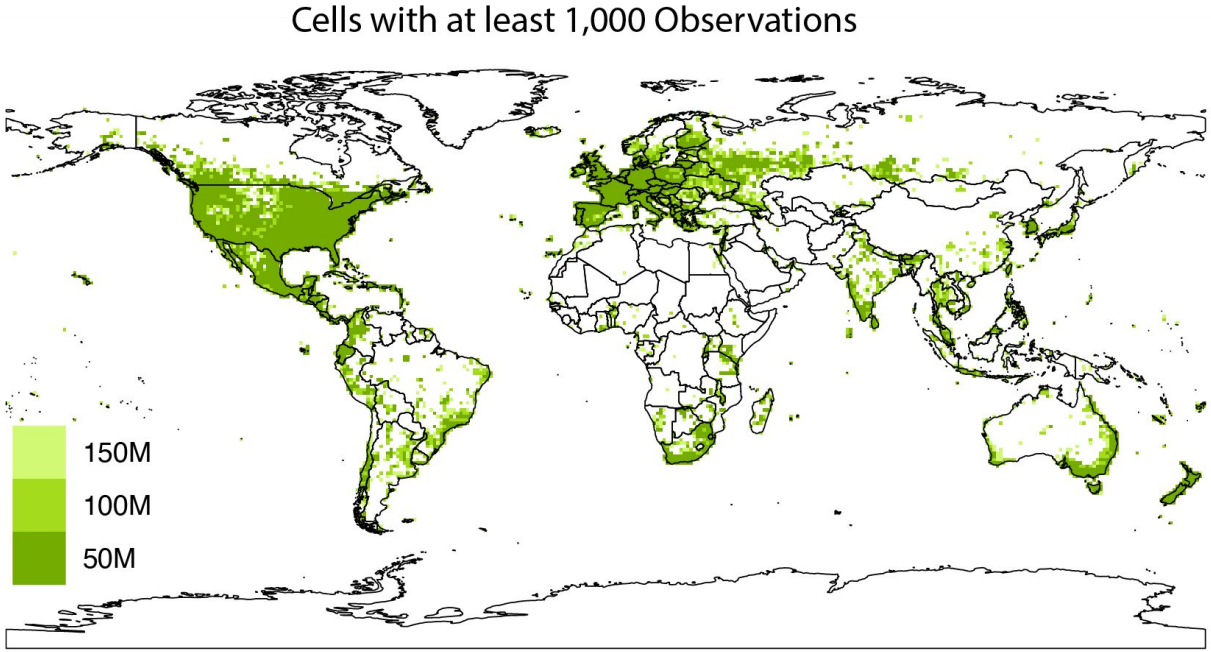


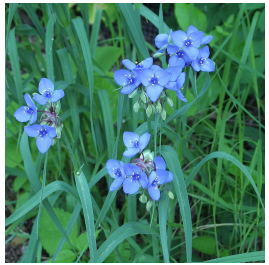
City Nature Challenge

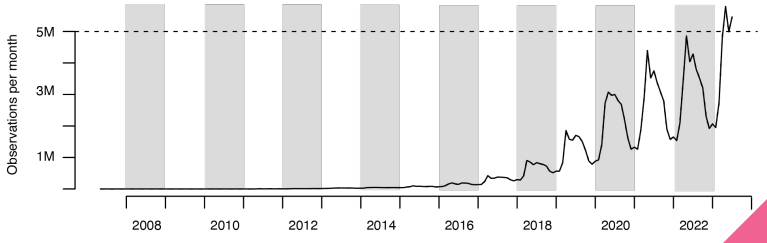
Participating Cities

In 2024, 691 cities
in 51 Countries

Biases in iNat Data







iNat observations are presence-only!

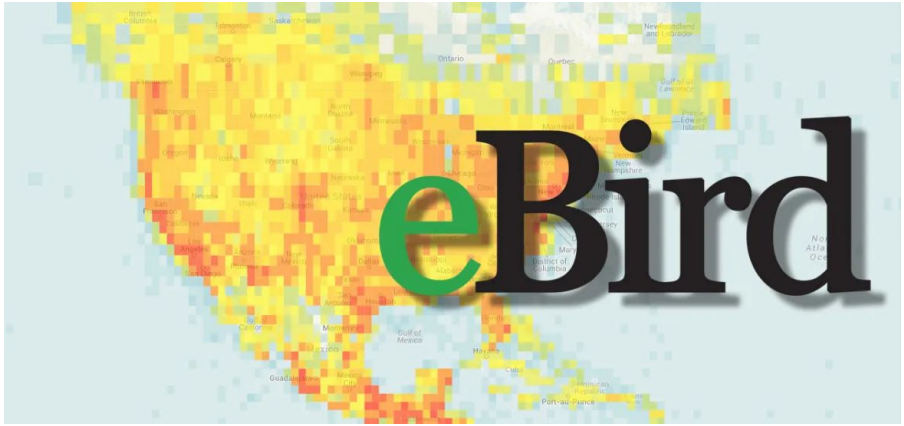
No straightforward way to measure sampling effort

Subject to large spatial, temporal, and taxonomic biases

https://www.inaturalist.org/blog/82561-150-000-000-observations-on-inaturalist

Another Citizen Science Model: eBird

- Worldwide project of bird checklists
- Developed and managed by Cornell Lab of Ornithology
- **13.3 million** checklists submitted in 2023 alone!
- Data submission styled after effort-controlled surveys
- Tracks data about sampling effort
  - Time spent
  - Number of observers
  - Distance Traveled



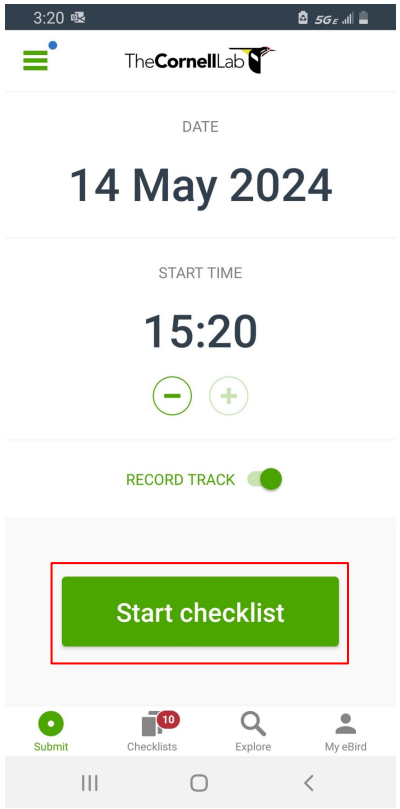
Cornell Lab

Submitting an observation: eBird

Data submitted in the form of checklists!

Most users interact through the phone app

Automatic time, date, location, and distance



eBird Mobile makes it easy to record the birds you find and seamlessly link observations with eBird–a global online database of bird records used by hundreds of thousands of birders around the world. This free resource helps you keep track of your birding activity, while making your data openly available for scientific research, education, and conservation.

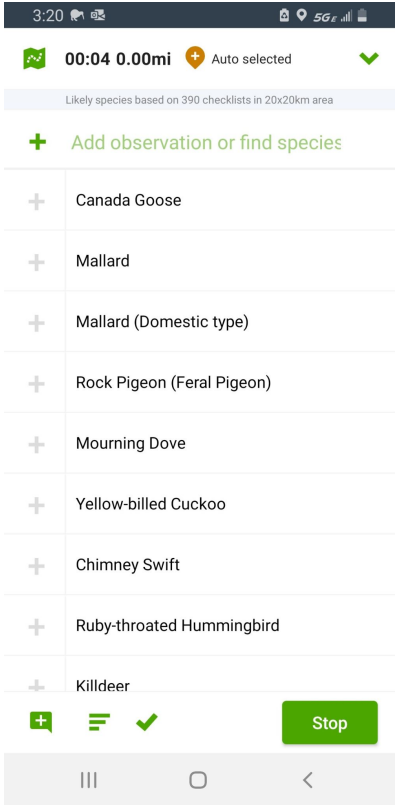
eBird Mobile is the only app that passes information directly from a your mobile device to your eBird account on the web.

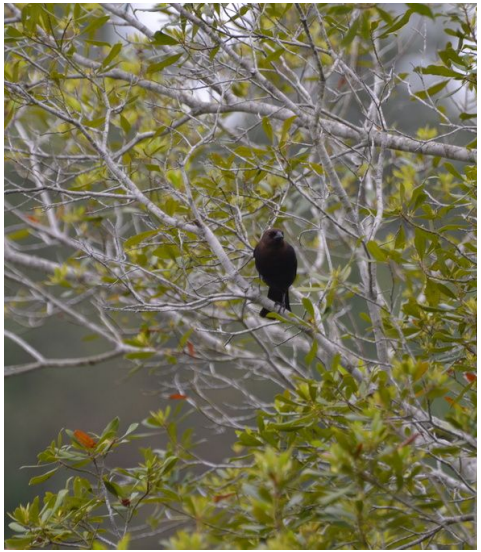
Get eBird Mobile

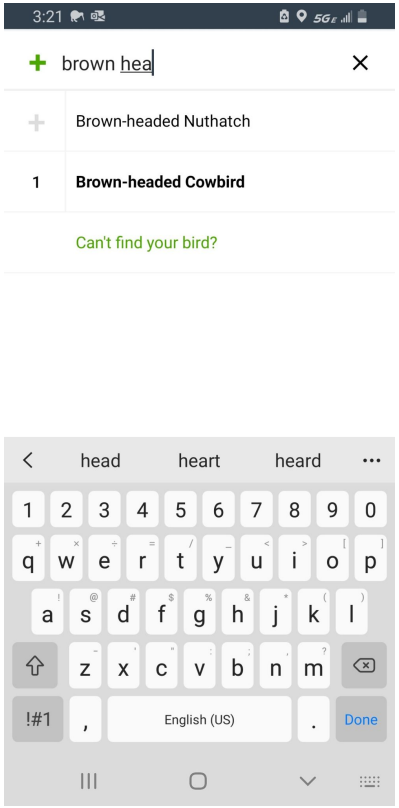
Download on the App Store

GET IT ON Google Play

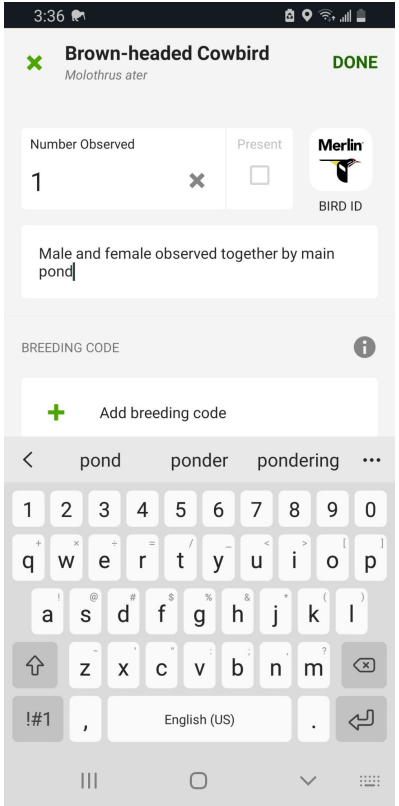
Submitting an observation: eBird





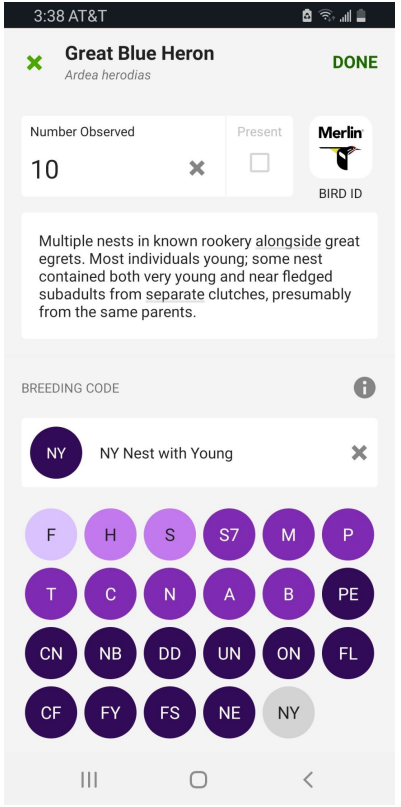


Submitting an observation: eBird



Observations can include **comments** + **Breeding/Behavior Codes**

Example
S: Singing males **C:** Courtship Display
T: Territory Defense **FY:** Feeding Young



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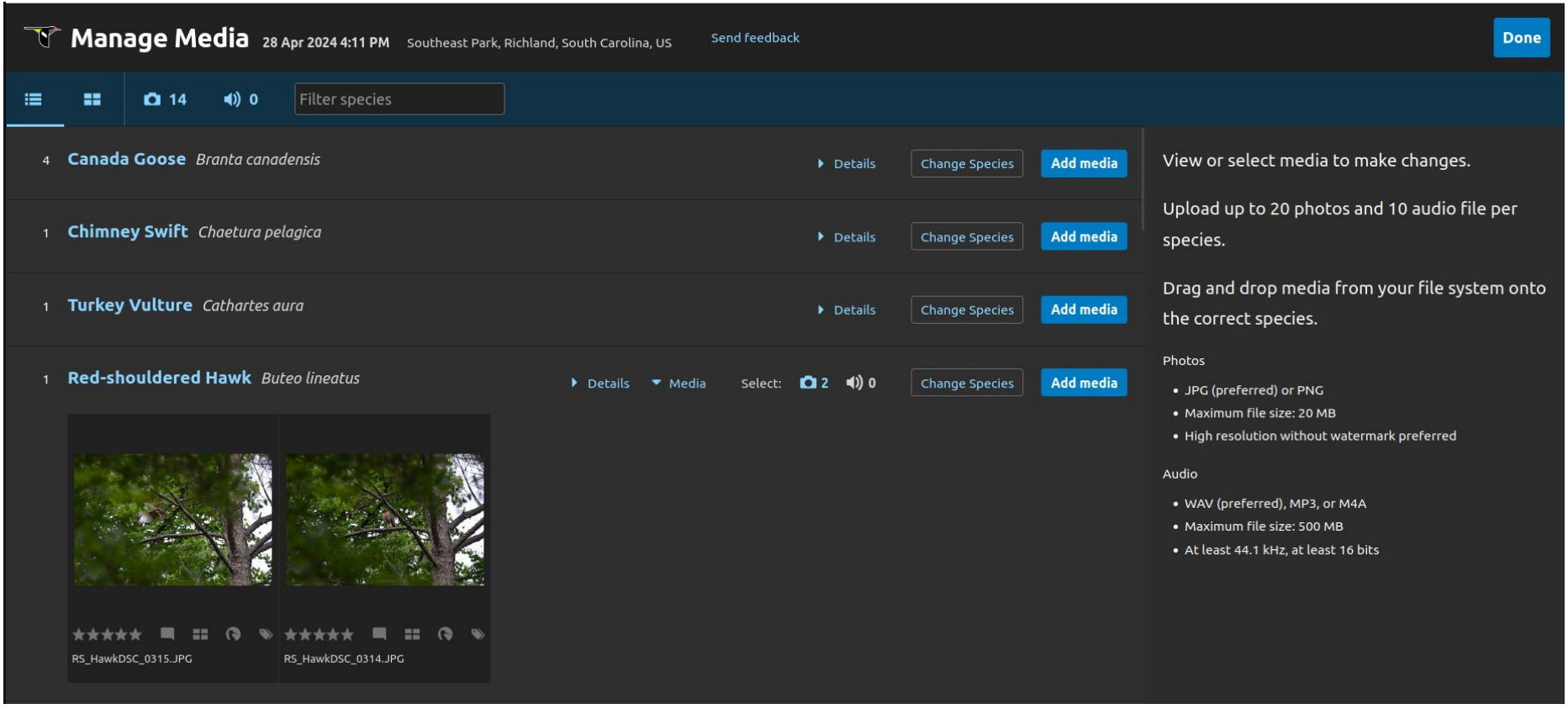

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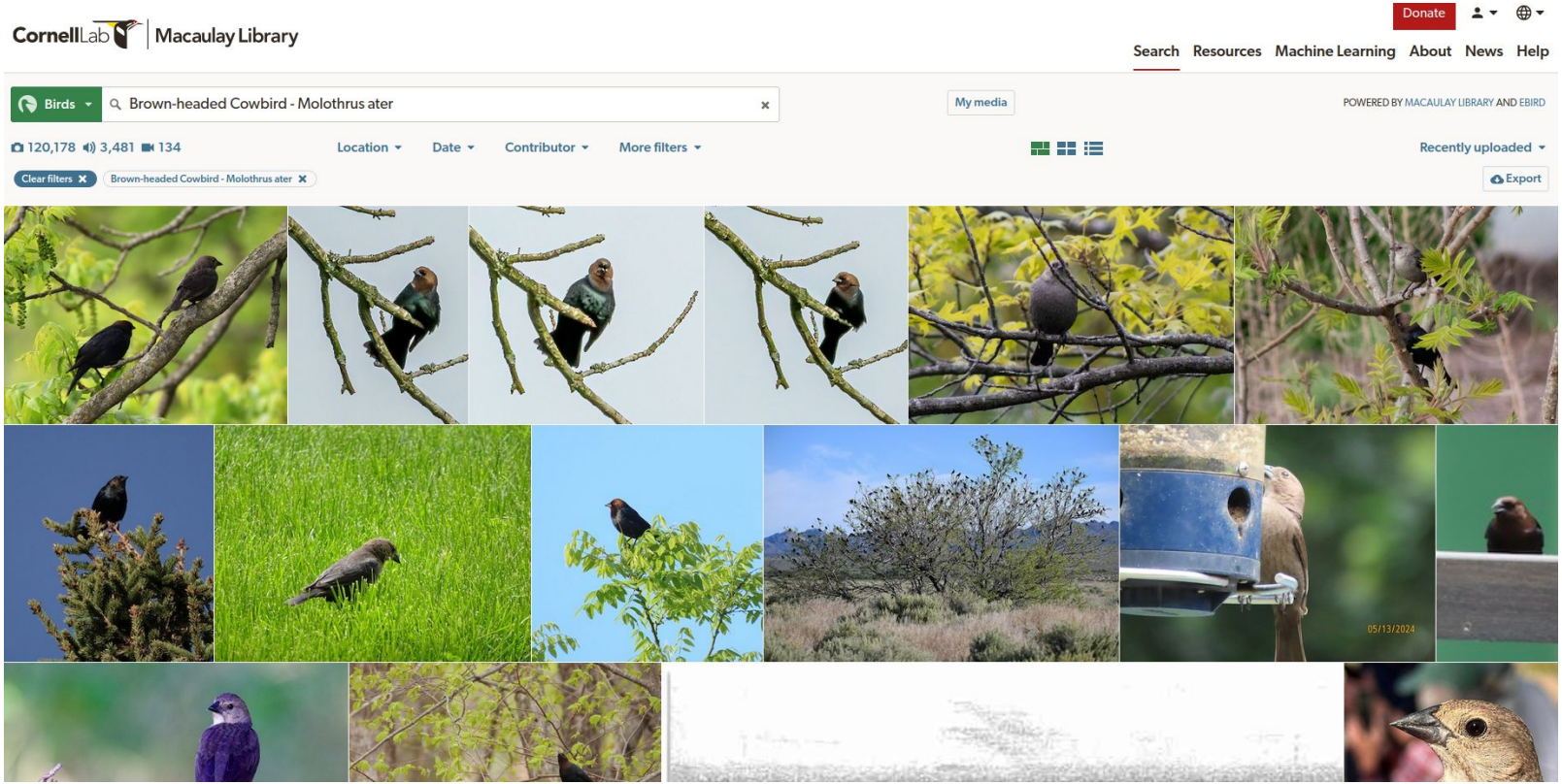

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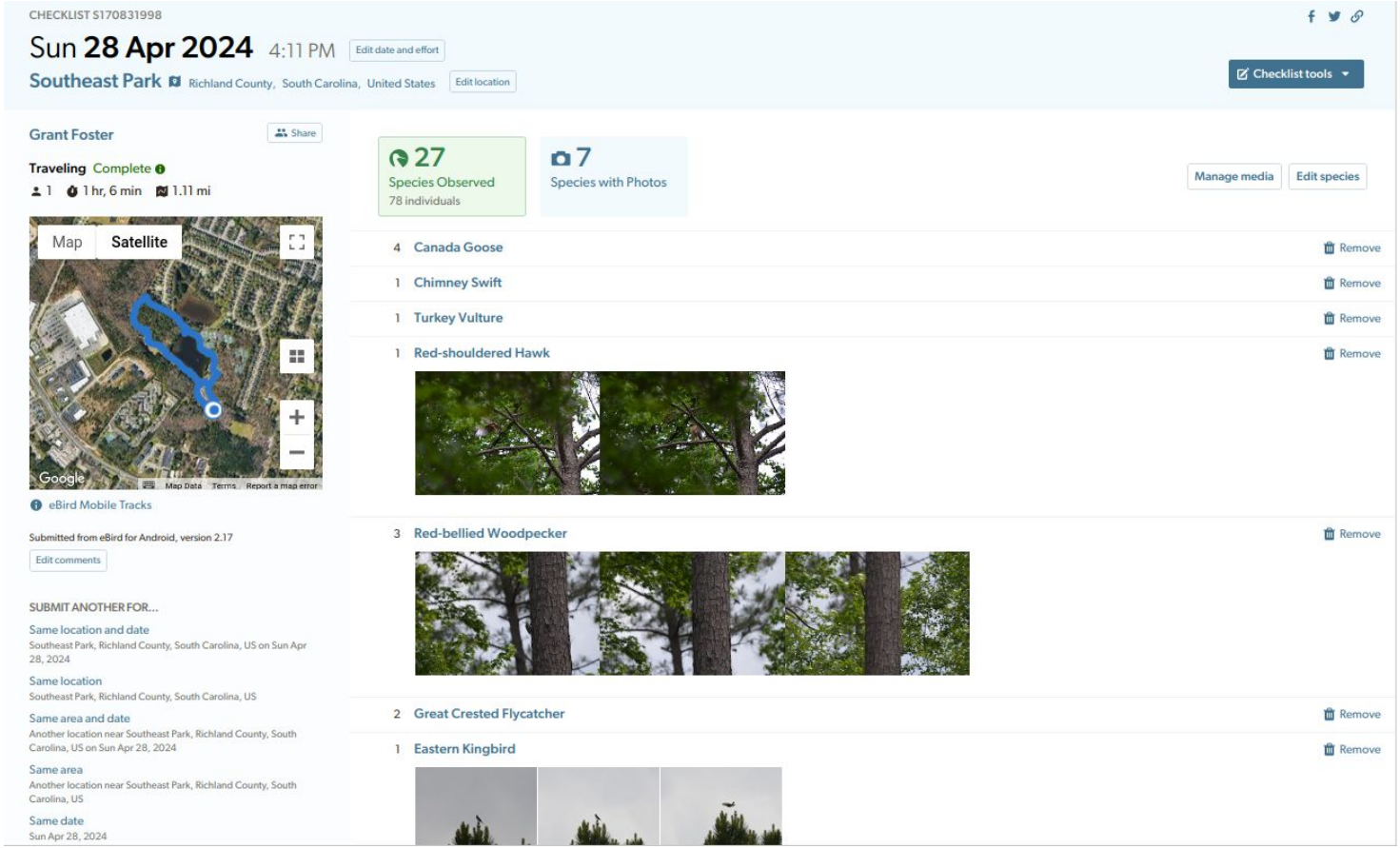
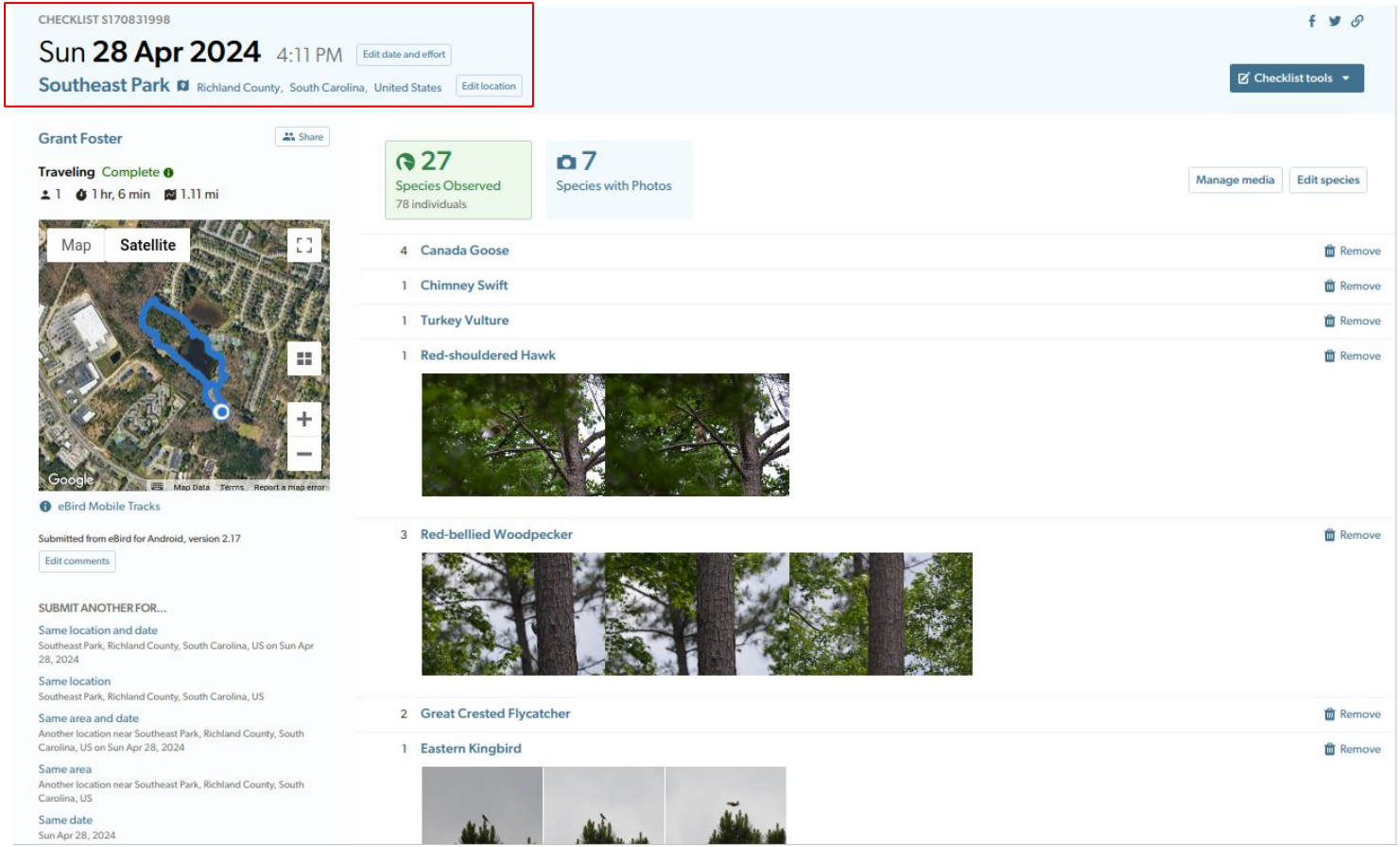
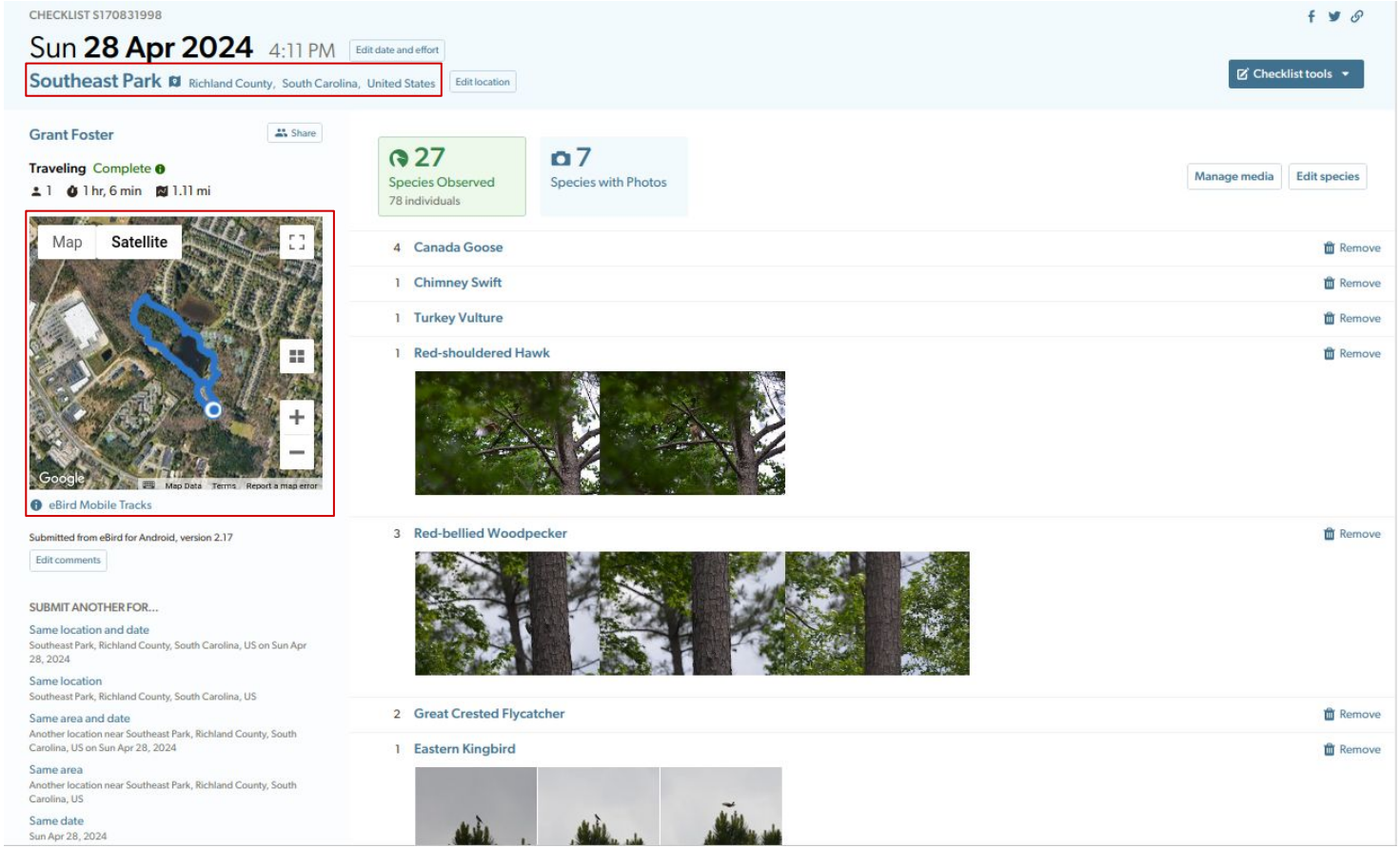


Submitting an observation: eBird



Time + Date

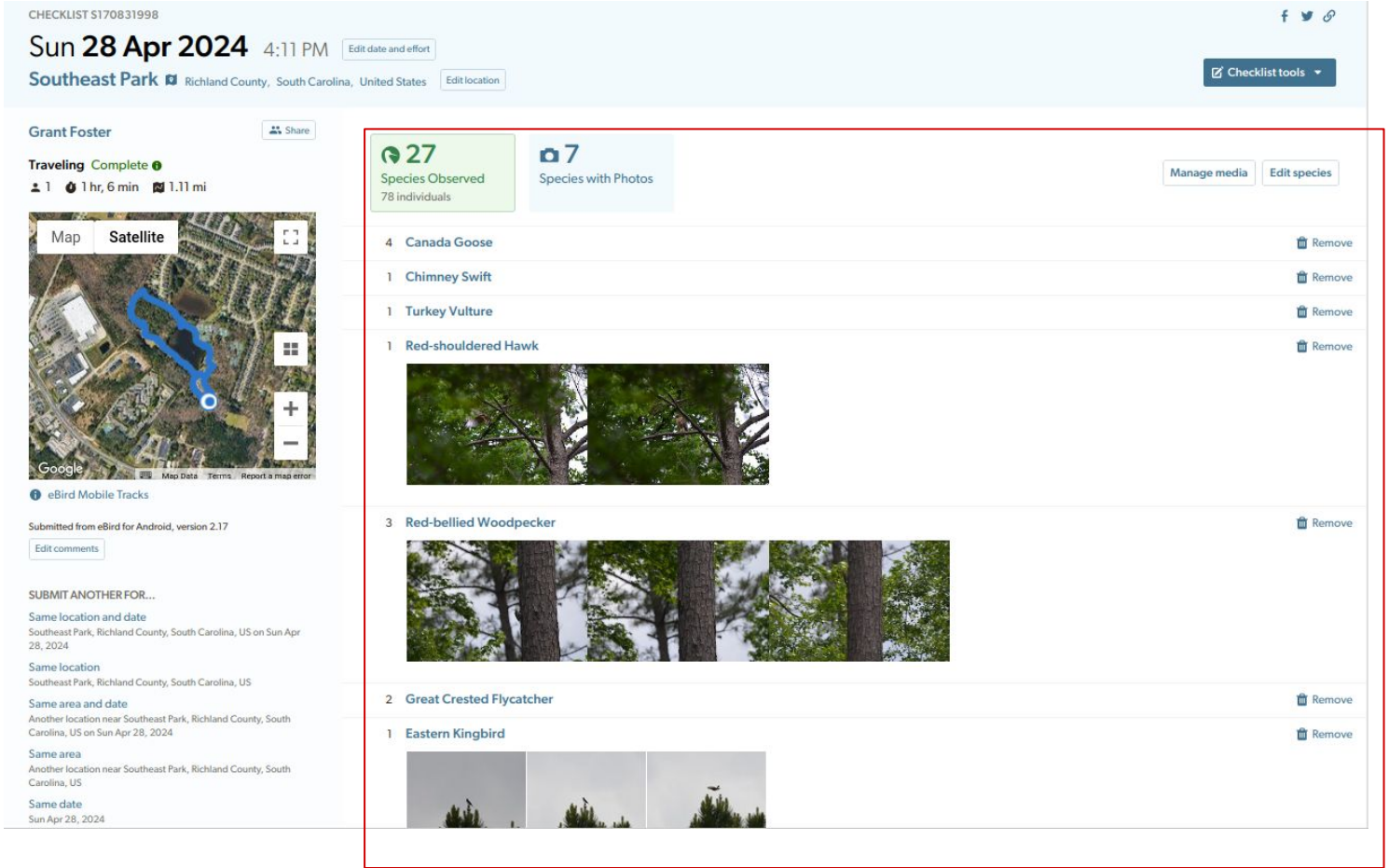
Submitting an observation: eBird



Time + Date

Spatial Extent

Submitting an observation: eBird

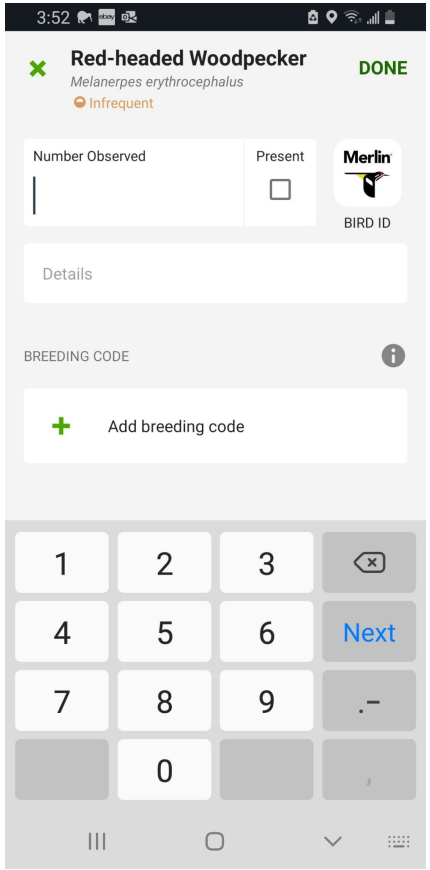


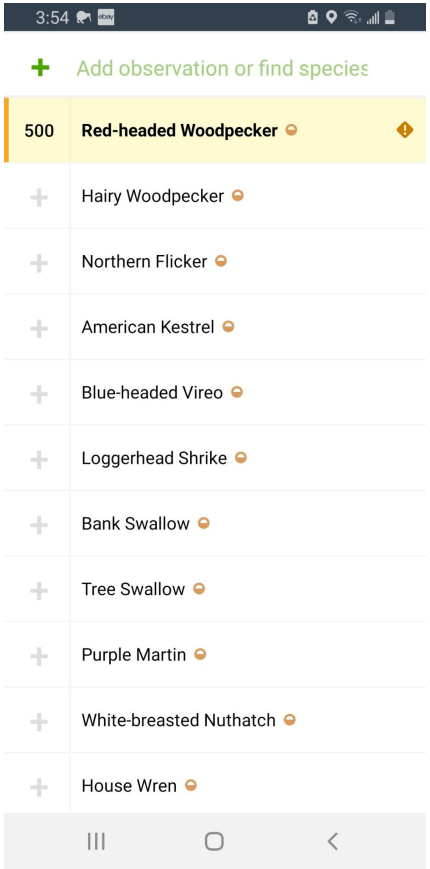
Time + Date

Spatial Extent

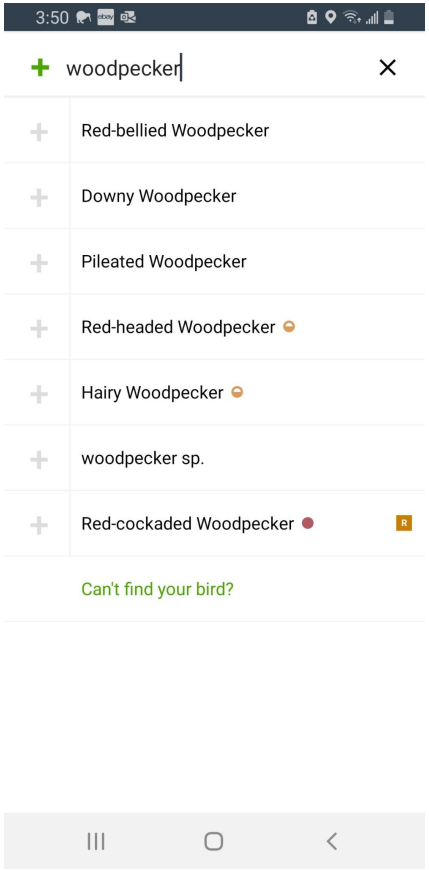
Species information + Associated Media

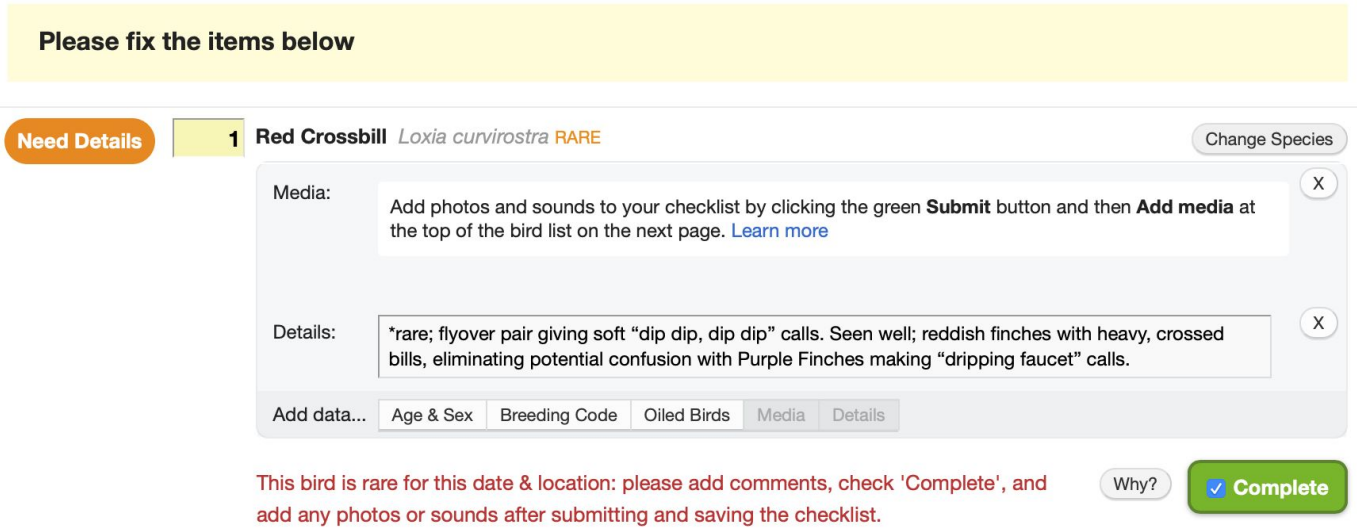
eBird Data Validation





eBird Data Validation





eBird Data Validation

Who decides?

Network of volunteer data reviewers!

2,700 reviewers active in 2023

Reviewers are assigned to cover specific localities

Example: Richland County records are reviewed by Dr. John Grego!

eBird Review Tools | Review | Quick Review | Search | Filters | Tools | Hotspots | John Garrett (johngarrett) | Sign Out

Review Observations

Filter List...

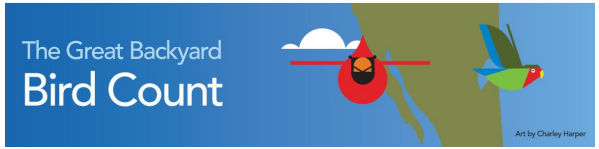
84 found (showing 1 - 25) Show 25 per page 1 | 2 | 3 | 4

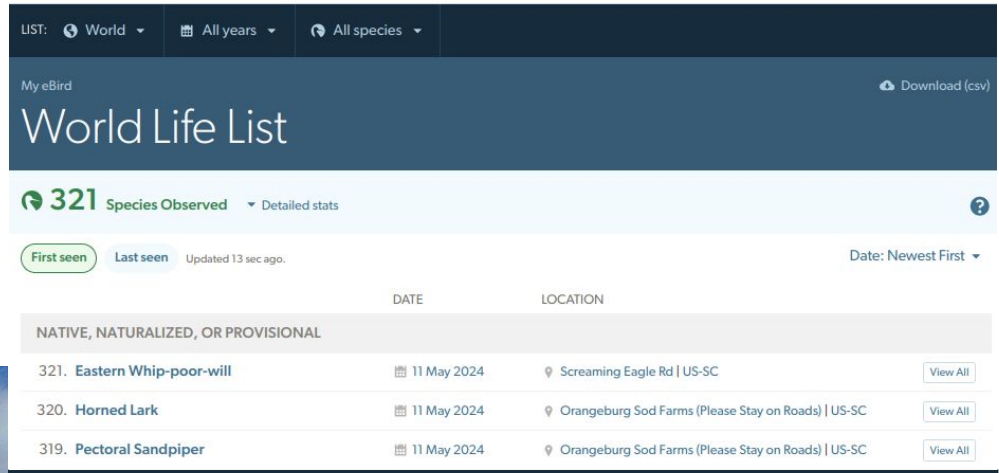
Select and change... Review decision: Reason: Notes: Change

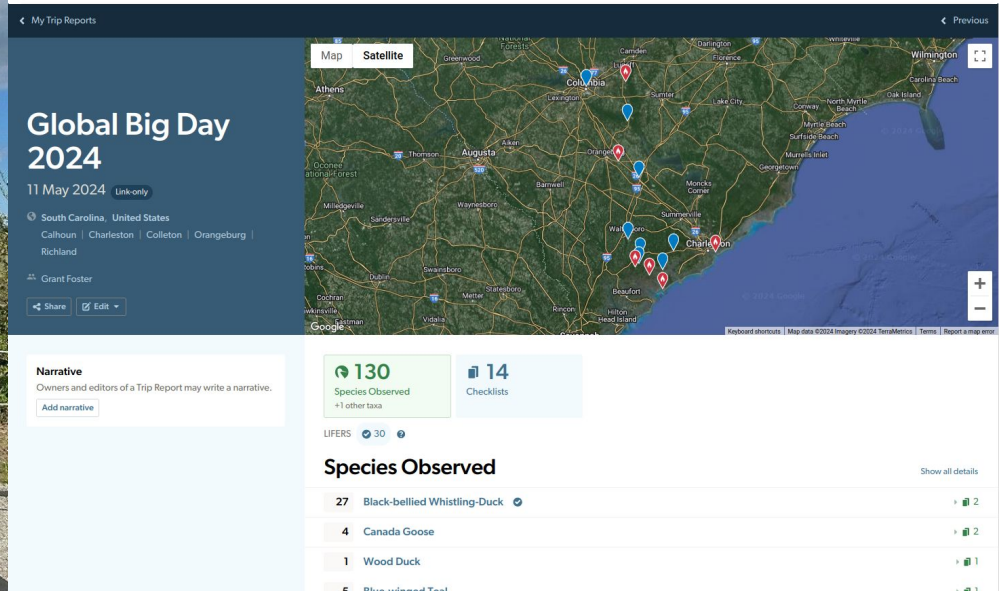
Submission	Species - Tax|Cat	Note	Count	Date	User	Location	County	St/Prov	Review decision	Status		
S86557517	Scaled Antpitta *Grallaria guatimalensis*		1	Apr 26, 2021	Sergio Pedrero Villanueva	Rancho Vista Hermosa, San Cristóbal de las Casas, Chiapas, MX (16.73, -92.672)	San Cristóbal de las Casas	CHP (MX)	Unconfirmed	Rereview	Filter	History
S86439458	Scaled Antpitta *Grallaria guatimalensis*		1	Apr 26, 2021	Daniel Garza Tobón	Rancho Vista Hermosa, San Cristóbal de las Casas, Chiapas, MX (16.73, -92.672)	San Cristóbal de las Casas	CHP (MX)	Unconfirmed	Rereview	Filter	History
S86557517	Gray-cheeked Thrush *Catharus minimus*		1	Apr 26, 2021	Sergio Pedrero Villanueva	Rancho Vista Hermosa, San Cristóbal de las Casas, Chiapas, MX (16.73, -92.672)	San Cristóbal de las Casas	CHP (MX)	Unconfirmed	Rereview	Filter	History
S86439458	Gray-cheeked Thrush *Catharus minimus*		1	Apr 26, 2021	Daniel Garza Tobón	Rancho Vista Hermosa, San Cristóbal de las Casas, Chiapas, MX (16.73, -92.672)	San Cristóbal de las Casas	CHP (MX)	Unconfirmed	Rereview	Filter	History
S86436951	Blue-winged Teal *Spatula discors*		20	Apr 25, 2021	Daniel Garza Tobón	Humedales de Montaña La Kisst, Laguna de Chapultepec y Sedem	San Cristóbal de las Casas	CHP (MX)	Unconfirmed	Unreviewed	Filter	History
S86304473	Green-backed Sparrow *Arremonops chloronotus*		3	Apr 24, 2021	Daniel Garza Tobón	Parque Educativo Laguna Bélgica	Ocozocoautla de Espinosa	CHP (MX)	Unconfirmed	Rereview	Filter	History
S86201016	Happy Wren *Pheugopedius felix*		2	Apr 23, 2021	MIGUEL GARCIA CRUZ	Area de Protección de Flora y Fauna Nahá	Ocosingo	CHP (MX)	Unconfirmed	Rereview	Filter	History
S85910876	Mealy Parrot *Amazona farinosa*		1500	Apr 19, 2021	Iris Melgar Martinez	Centro Ecoturístico Tres Lagunas	Ocosingo	CHP (MX)	Unconfirmed	Rereview	Filter	History
S85910876	Eye-ringed Flatbill *Rhynchocyclus brevirostris*		15	Apr 19, 2021	Iris Melgar Martinez	Centro Ecoturístico Tres Lagunas	Ocosingo	CHP (MX)	Unconfirmed	Rereview	Filter	History
S85561130	Bar-winged Oriole *Icterus maculialatus*		2	Apr 14, 2021	MIGUEL GARCIA CRUZ	Area de Protección de Flora y Fauna Nahá	Ocosingo	CHP (MX)	Unconfirmed	Rereview	Filter	History
S85237147	Sora *Porzana carolina*		2	Apr 10, 2021	Luz Rodriguez Parga	Humedales de Montaña La Kisst, Laguna de Chapultepec y Sedem	San Cristóbal de las Casas	CHP (MX)	Unconfirmed	Rereview	Filter	History
S85438309	Rufous-tailed Hummingbird *Amazilia tzacatl*		1	Apr 10, 2021	José santos zuniga sanchez	Cascadas El Chiflón	Tzimol	CHP (MX)	Unconfirmed	Rereview	Filter	History
S85247550	Sora *Porzana carolina*		1	Apr 10, 2021	Karina Andrea Vázquez Morales	423 Boulevard Juan Sabines, San Cristóbal de las Casas, Chiapas, MX (16.732, -92.645)	San Cristóbal de las Casas	CHP (MX)	Unconfirmed	Unreviewed	Filter	History
S85278480	Sora *Porzana carolina*		2	Apr 10, 2021	Atzin Campos	Calle Hermanos Domínguez, San Cristóbal de las Casas MX-CHIS 16.73441, -92.63984	San Cristóbal de las Casas	CHP (MX)	Unconfirmed	Rereview	Filter	History
S85775204	Sora *Porzana carolina*		2	Apr 10, 2021	Luz Rodriguez Parga	Calle Hermanos Domínguez, San Cristóbal de las Casas MX-CHIS 16.73441, -92.63984	San Cristóbal de las Casas	CHP (MX)	Unconfirmed	Rereview	Filter	History
S85283429	Sora *Porzana carolina*		2	Apr 10, 2021	Jessica Thompson	Calle Hermanos Domínguez, San Cristóbal de las Casas MX-CHIS 16.73441, -92.63984	San Cristóbal de las Casas	CHP (MX)	Unconfirmed	Unreviewed	Filter	History
S85900966	Sora *Porzana carolina*		2	Apr 10, 2021	DIEGO MANZANO MENDEZ	Calle Hermanos Domínguez, San Cristóbal de las Casas MX-CHIS 16.73441, -92.63984	San Cristóbal de las Casas	CHP (MX)	Unconfirmed	Rereview	Filter	History

eBird Features for Users

TheCornellLab Audubon BIRDS CANADA OISEAUX CANADA







eBird Limitations

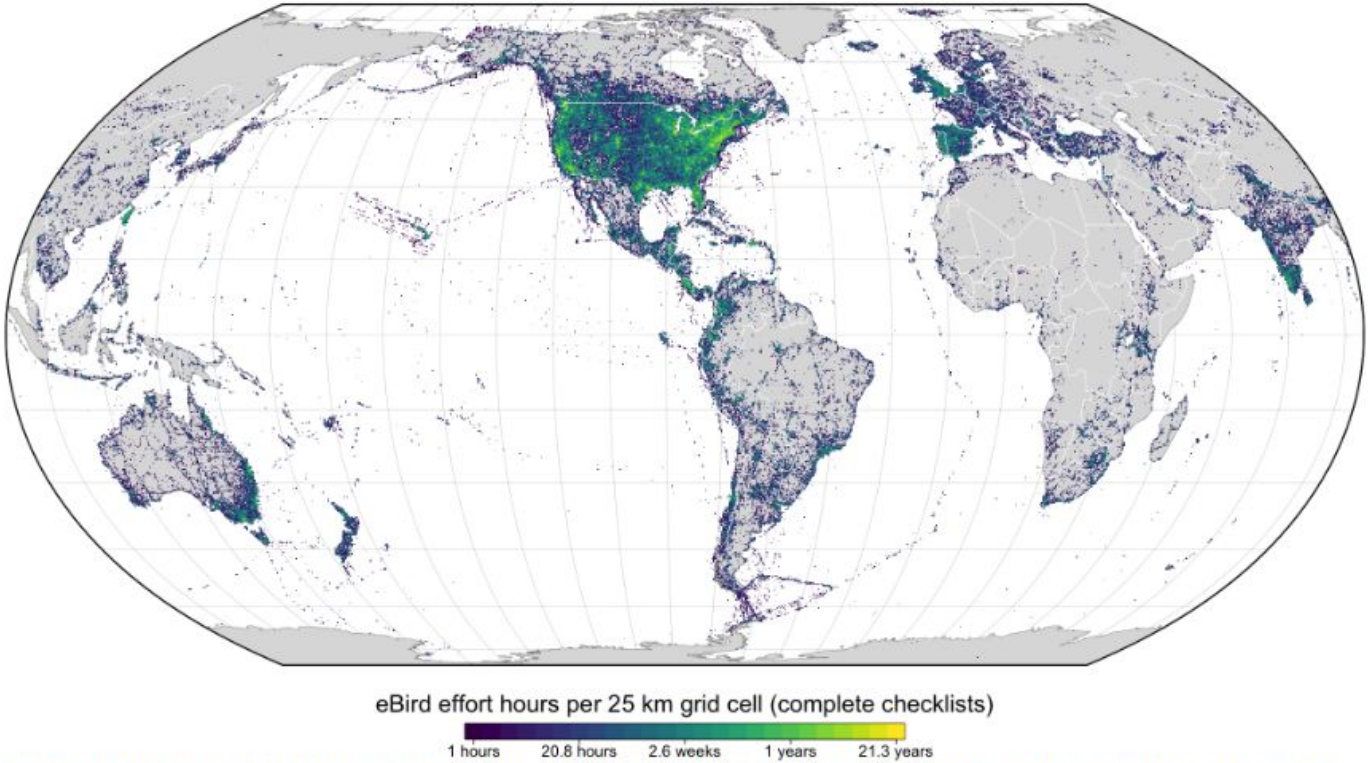


Figure 1. Cumulative duration of eBird complete checklists aggregated within 25 x 25 km grid cells. These aggregations are from eBird data submitted up to the end of Dec 2018.

Sampling biases

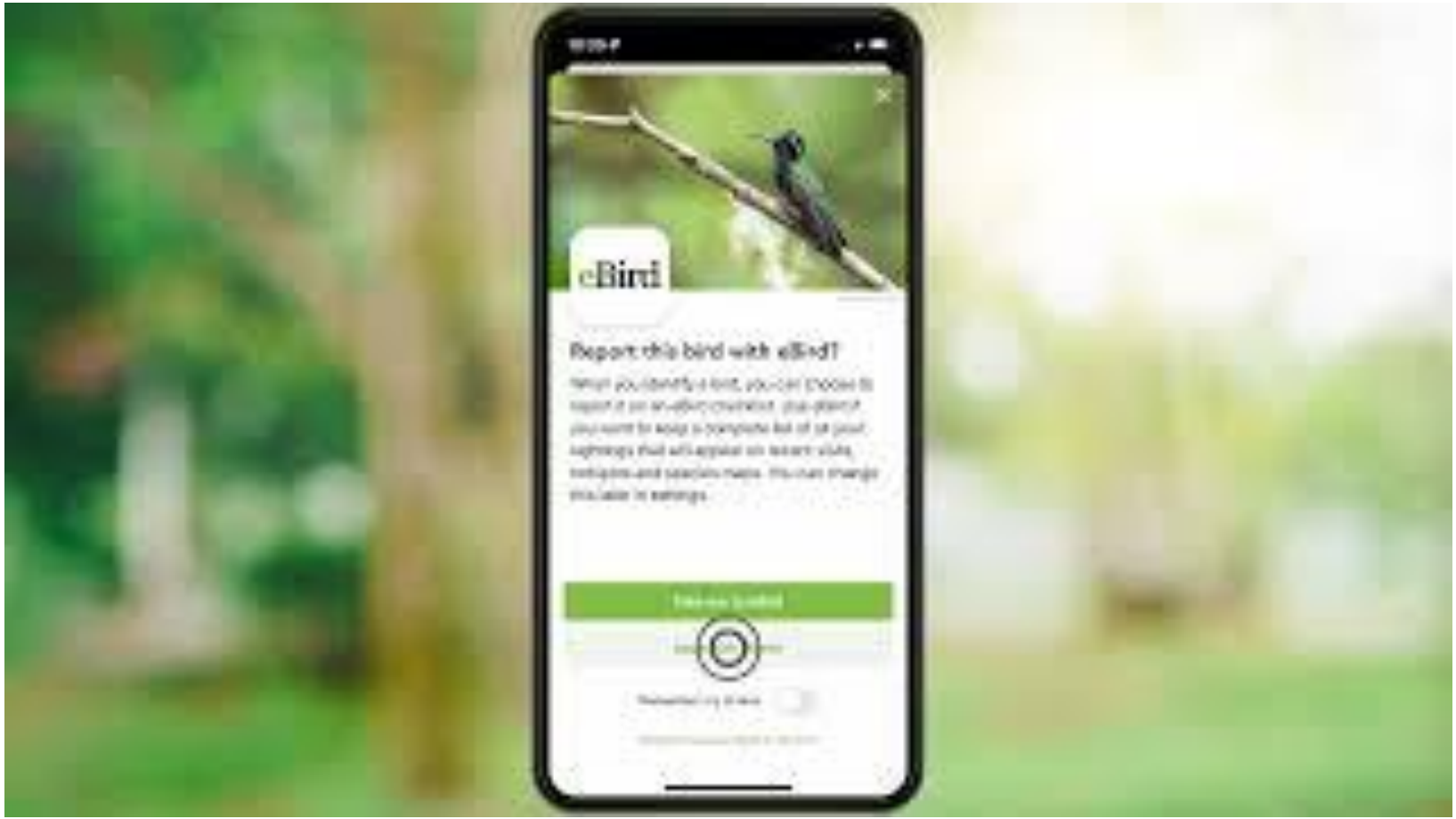
Reliant on volunteer network of local experts

Requires ID skills

AI tools may increase data quantity, but may reduce quality (without careful implementation)

From Johnston et al., 2019

Merlin: AI-Powered Avian Audio ID



How are these data being used?

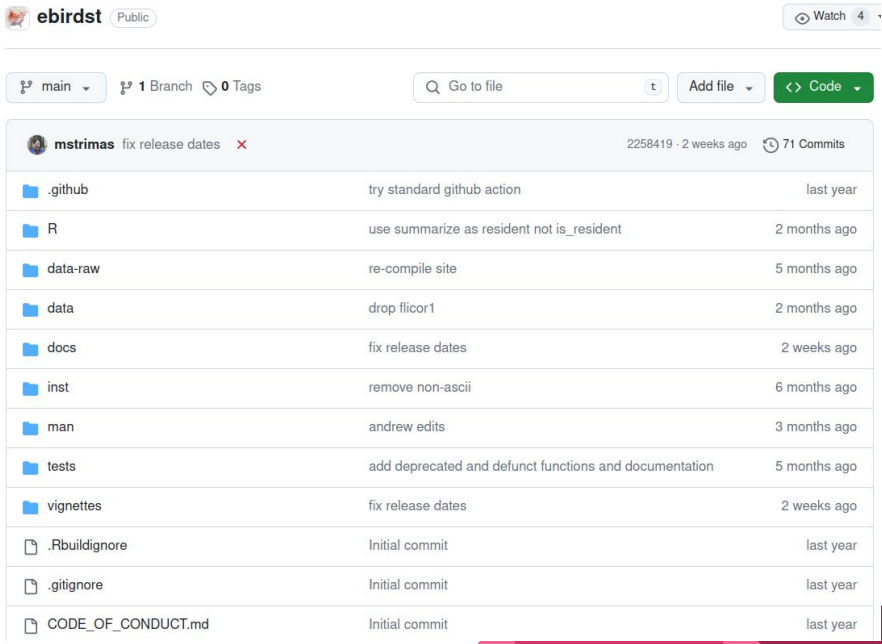
eBird Data has been cited in over 930 peer-reviewed publications

10,000+ peer reviewed papers have been published using GBIF

iNaturalist and eBird are both major data contributors

Both can be downloaded directly

Cornell Lab publishes Status and Trends data products. Accessible through download or API call, including through the r package `ebirdst` available on CRAN

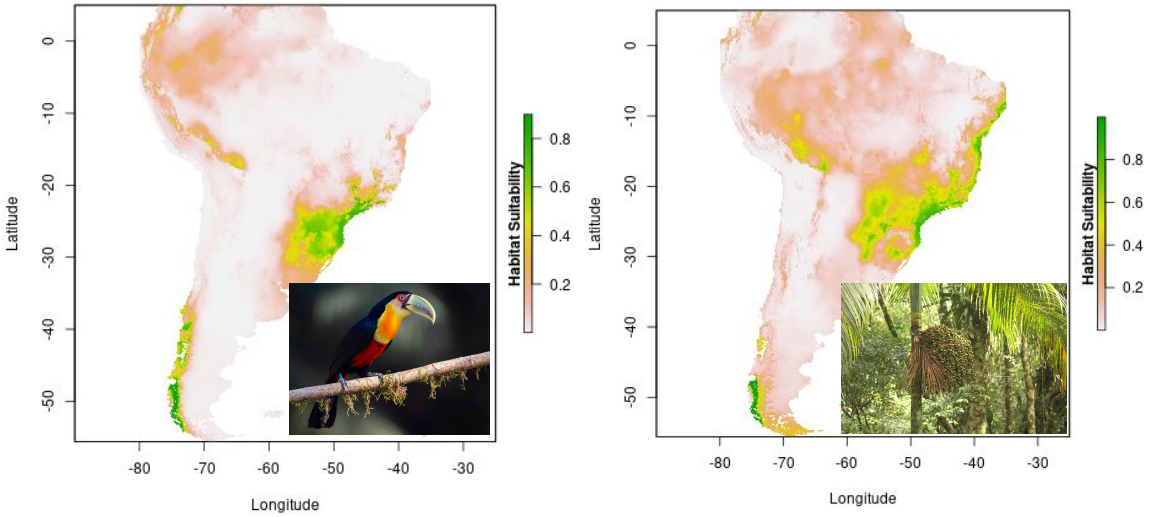


What types of questions are these data useful for?

Both to an extent “use agnostic” models (Wiersma, 2023)

Volume of data is enormous!

Ex. Incredibly useful for training Species Distribution Models



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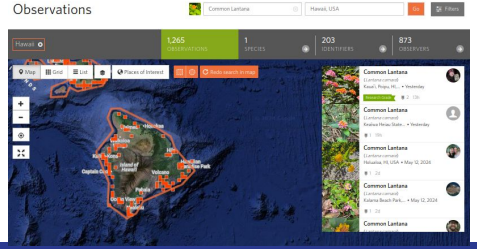
Ex. Tracking range shifts/spread of invasive species



Diversity and Distributions
A Journal of Conservation Biogeography
Open Access

RESEARCH ARTICLE | Open Access

Citizen science can complement professional invasive plant surveys and improve estimates of suitable habitat

Monica Dimson | Lucas Berio Fortini, Morgan W. Tingley, Thomas W. Gillespie

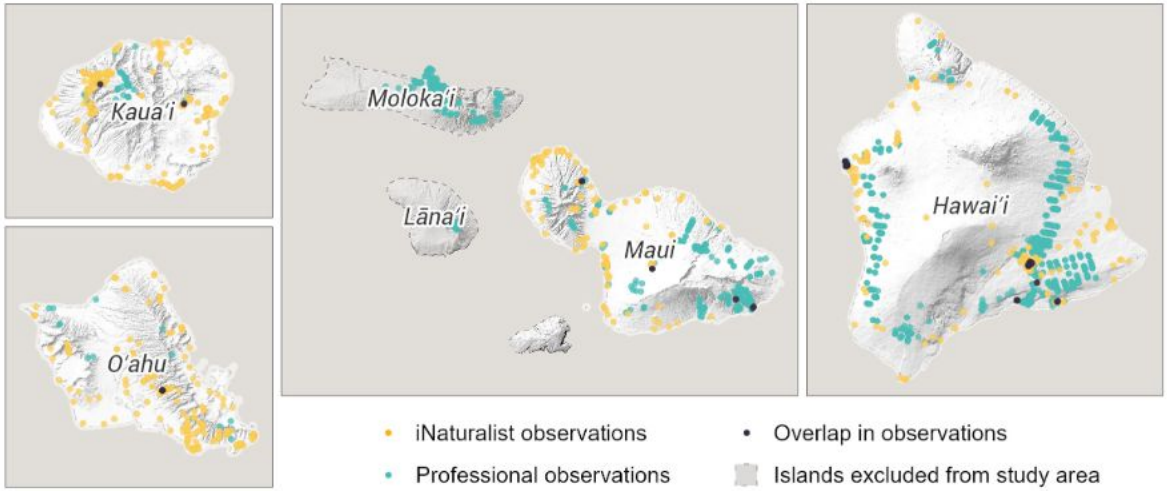


FIGURE 1 Distribution of iNaturalist and professional agency observations for *Hedychium gardnerianum*, *Lantana camara*, *Leucaena leucocephala* and *Psidium cattleianum* (map projection: Universal Transverse Mercator Zone 4N; Kaua'i, O'ahu, and Maui scale 1:1900000; Hawai'i scale 1:2900000).

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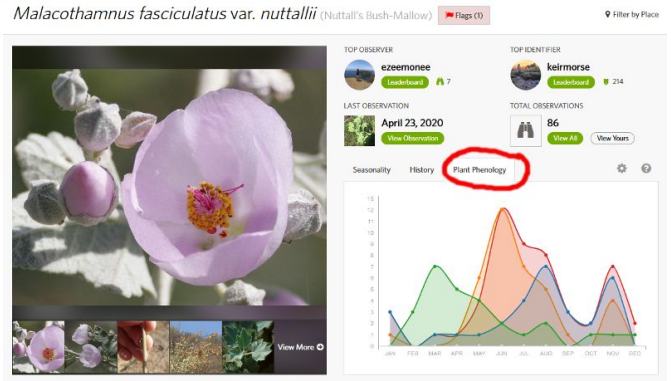
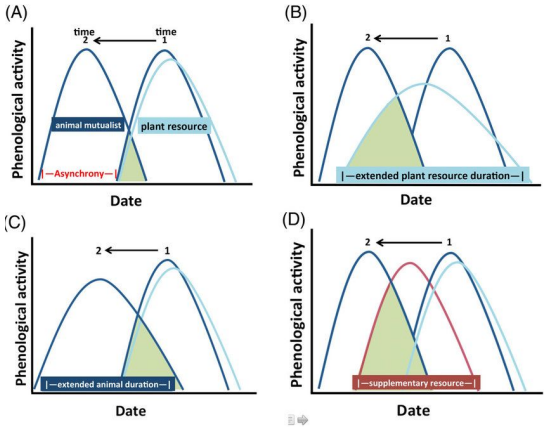
Capture phenological & geographical shifts





Olliff Yang et al., 2020

USA npn National Phenology Network

budburst

A project of the Chicago Botanic Garden

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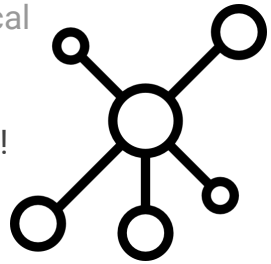
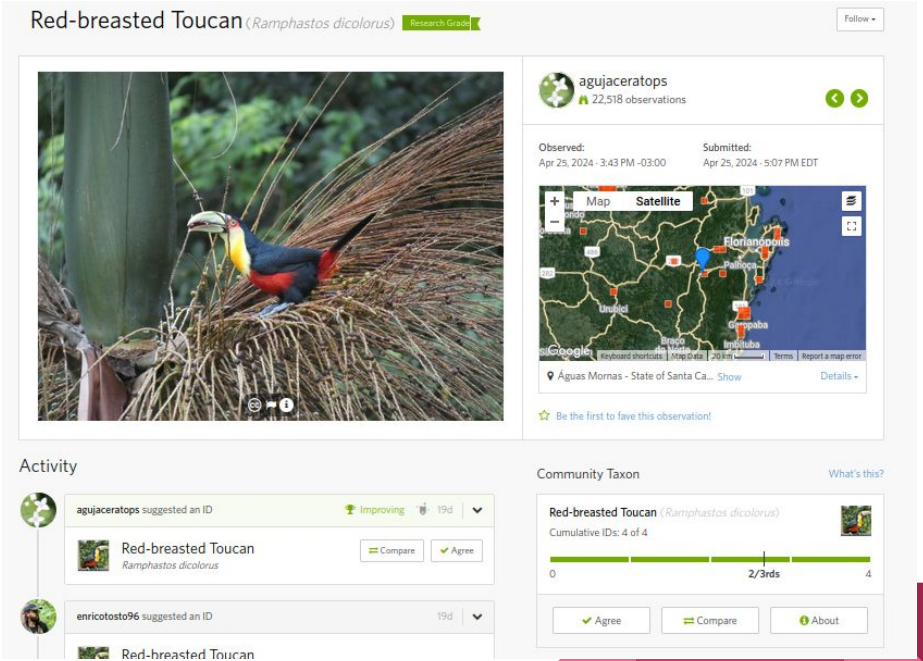
Other potential uses/data scraping!





Citizen Science is a Tool for Outreach & Empowerment

Increase Public Engagement

Empower local communities

Support Conservation

SOUTH CAROLINA CONSERVATION COALITION

Limitations

Data make abundance estimation difficult

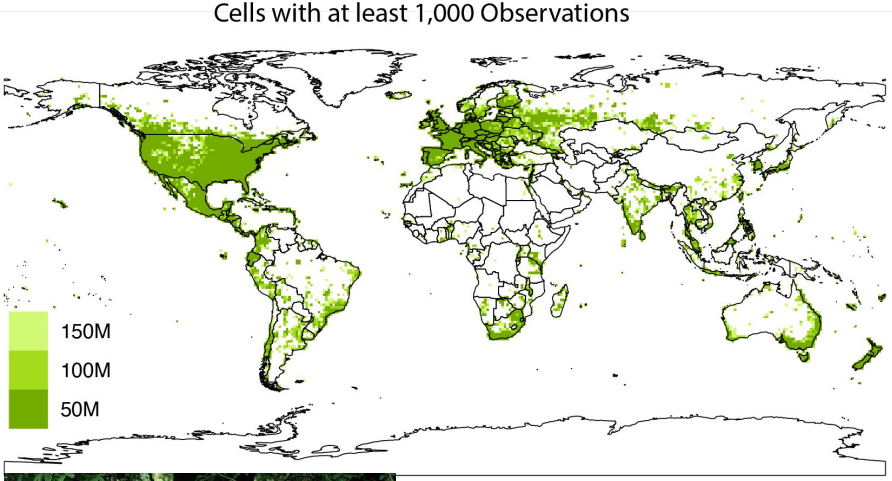
Things like ebird's quantification of effort help, but still need to account for biases & detection probability

Spatial/taxonomic biases mean we have to interpolate a lot in some places/times

Diversity is often low in citizen science spaces

Allf et al. (2022) found that members of US citizen science projects were 8x more likely to be white and 5x more likely to hold advanced degrees than the general populace

Need to create inclusive spaces and encourage community-level participation



NABA

GREAT World Wide STAR COUNT
starcount.org

iNaturalist

CoCoRaHS
The Community Collaborative Rain, Hail and Snow Network

Merlin Bird ID

EYES OF THE REEF

nature's notebook
A project of the USA-NPN

ADOPT a STREAM

eBird

CSO

budburst
A project of the Chicago Botanic Garden

Citations

Thigpen, CL and Funk, C. 2020. *Younger, more educated U.S. adults are more likely to take part in citizen science research*. Washington, DC: Pew Research Center

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Allf, B. C., Cooper, C. B., Larson, L. R., Dunn, R. R., Futch, S. E., Sharova, M., & Cavalier, D. (2022). Citizen science as an ecosystem of engagement: Implications for learning and broadening participation. *BioScience*, *72*(7), 651-663