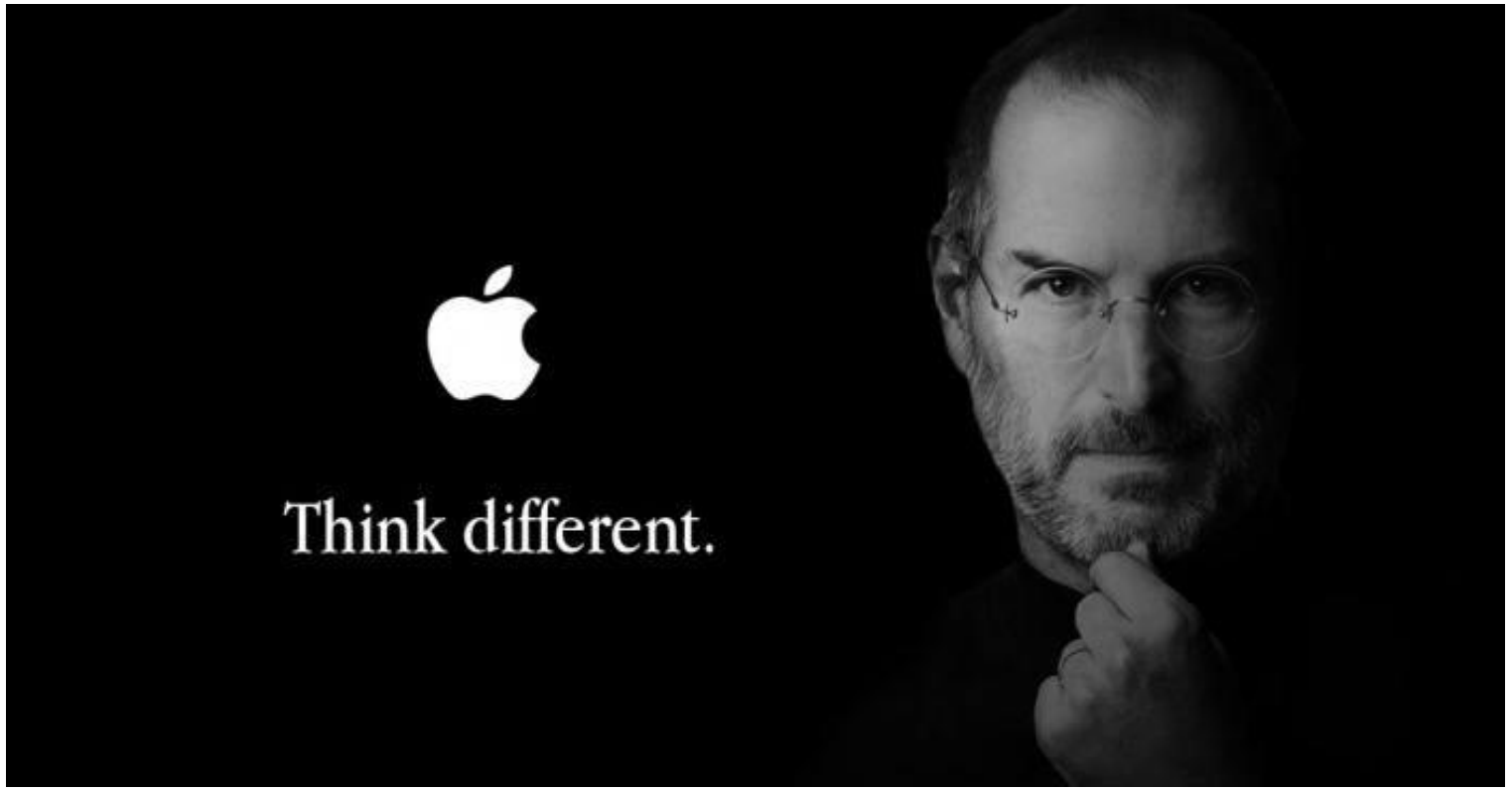
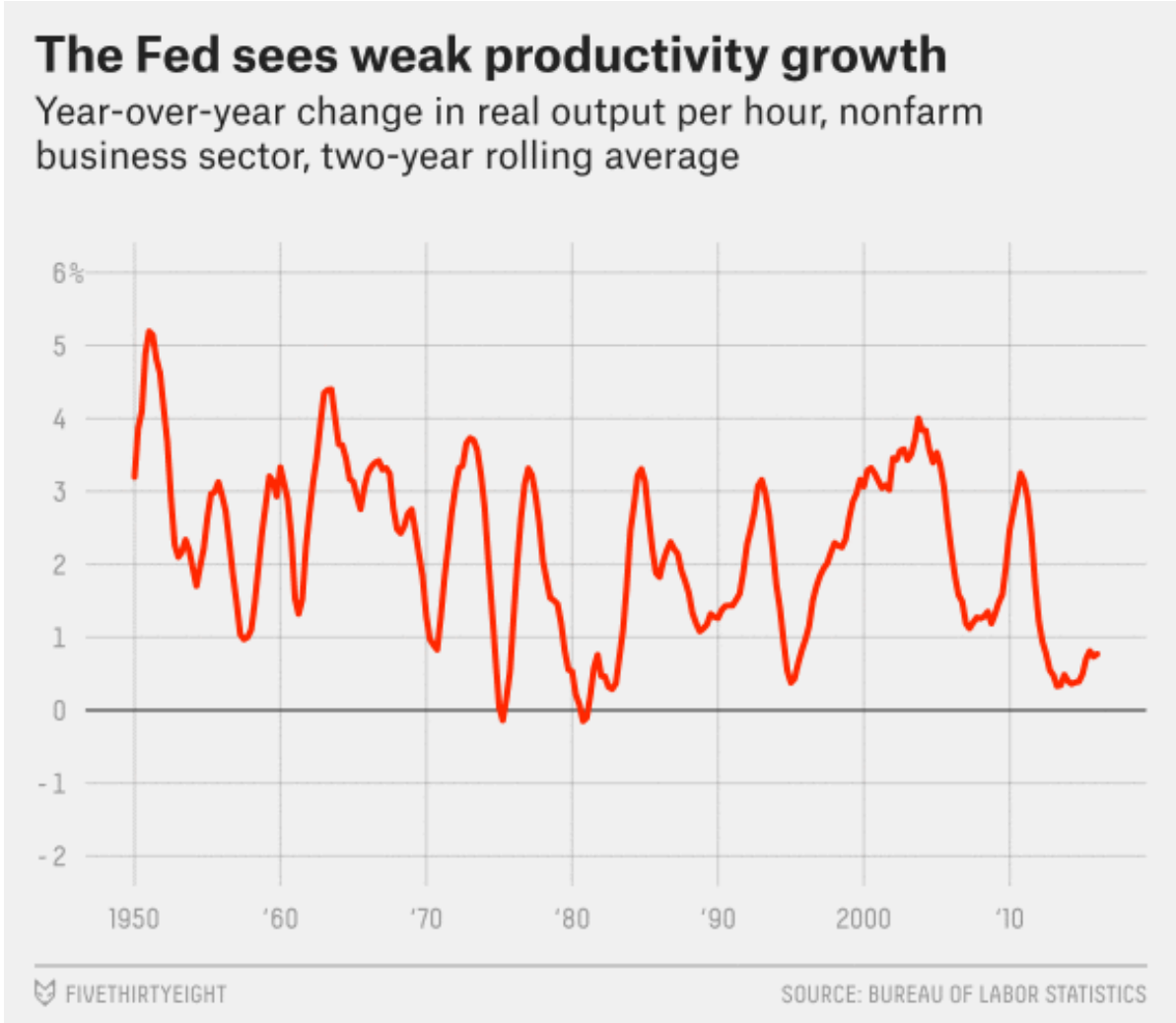
Real time massive online citizen science biodiversity programs: lessons from butterflies

Kathleen Prudic (University of Arizona), Kent McFarland (Vermont Center for Ecostudies), Rebecca Hutchinson (Oregon State University), Jeffrey Oliver (University of Arizona), Jeremy Kerr (University of Ottawa), Maxim Larrivée (Montreal Space for Life) and Elizabeth C. Long (Mohonk Preserve)

Computers change our world

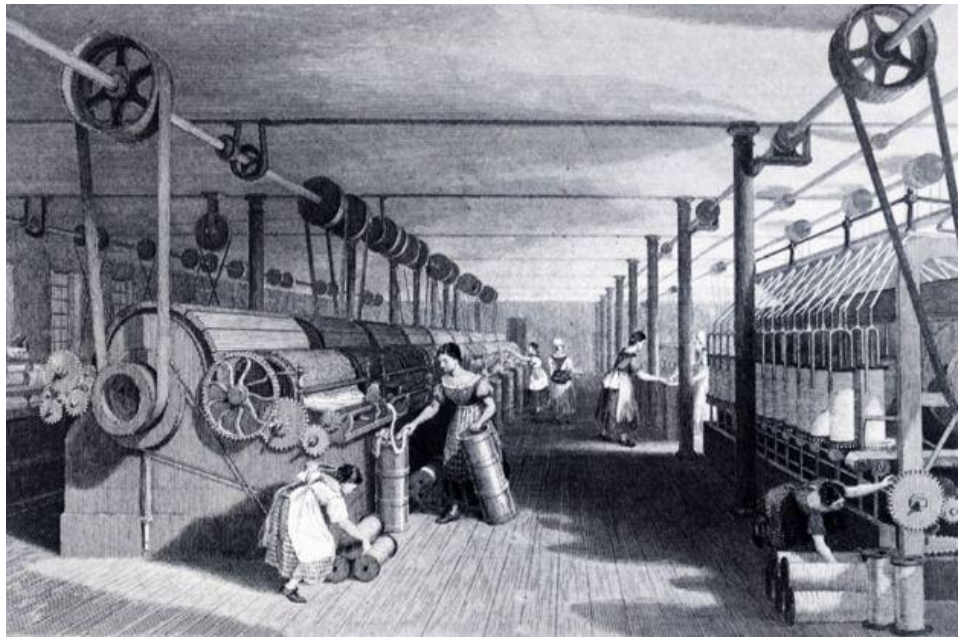


Computers have not increased productivity



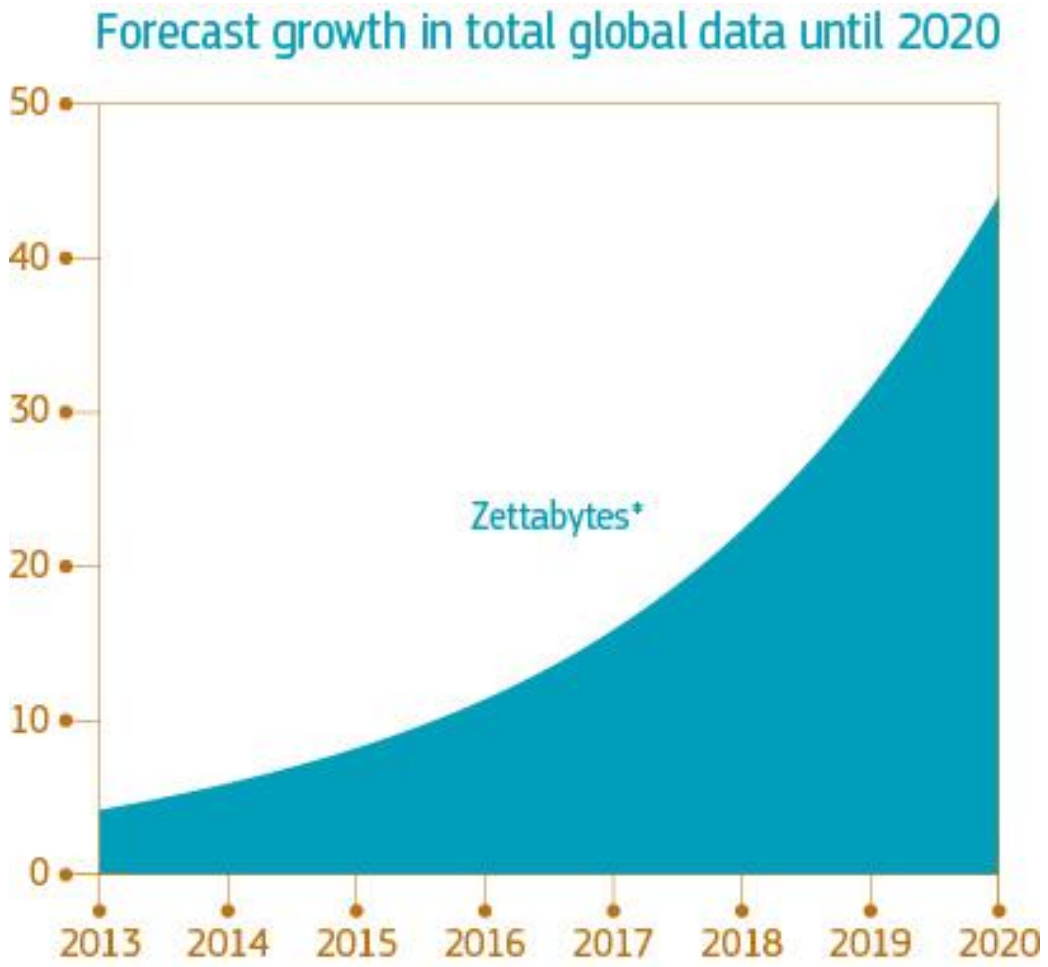
https://www.marketplace.org/2016/05/02/world/explaining-america-s-productivity-downturn

Increasing productivity requires innovation



It took manufacturing over 50 years to figure out how to use electricity to boost US worker productivity
http://www.bbc.com/news/business-40673694

90% of the world's data was collected in the past year (Age of Big Data)



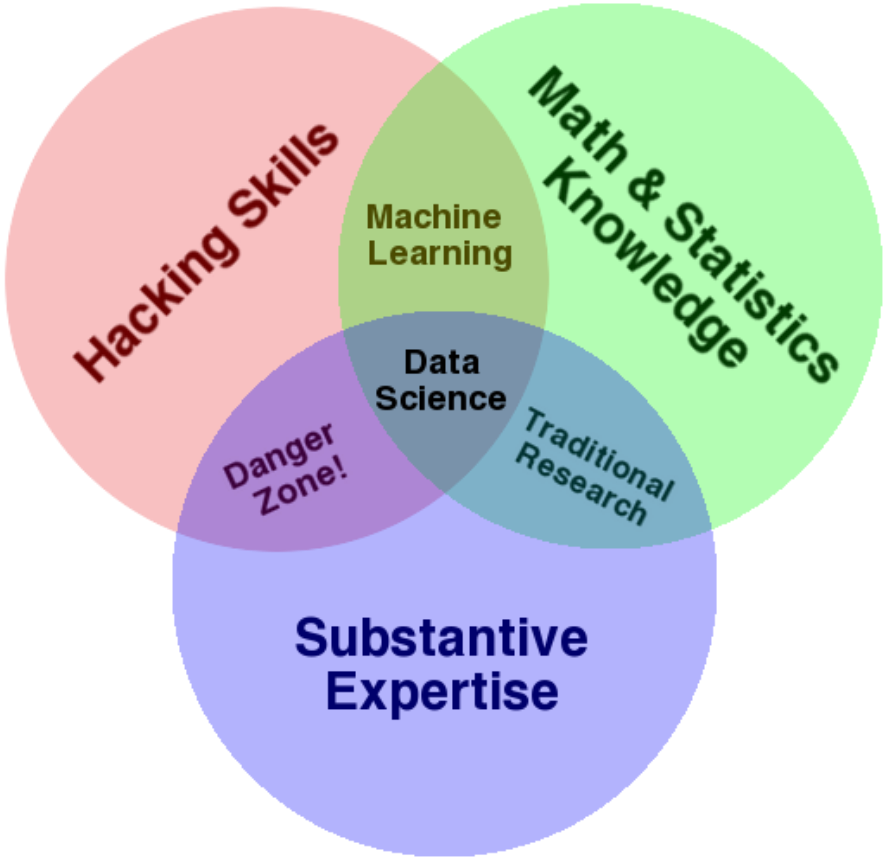
Source: IDC, 2014

* One zettabyte is equal to a billion terabytes, about 12.5 billion 80 gigabyte hard drives

Science is about scaling up

Data Science is emerging to tackle big scientific questions with this data

Programming



Statistics

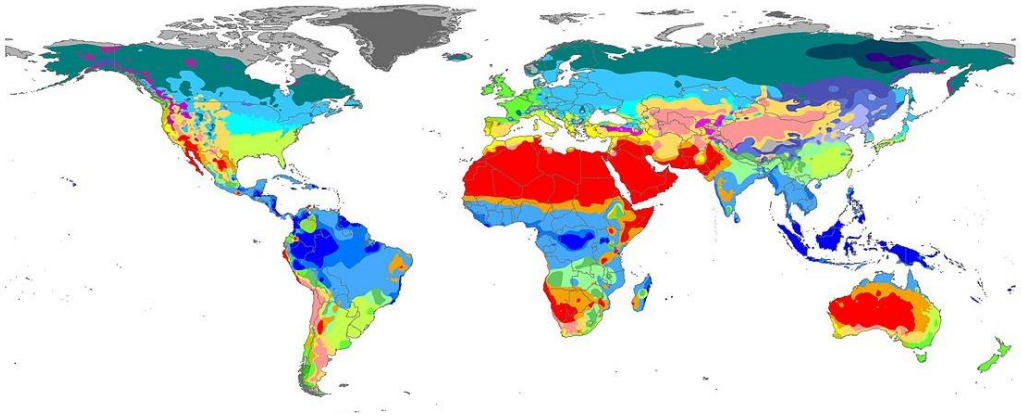
Domain Knowledge

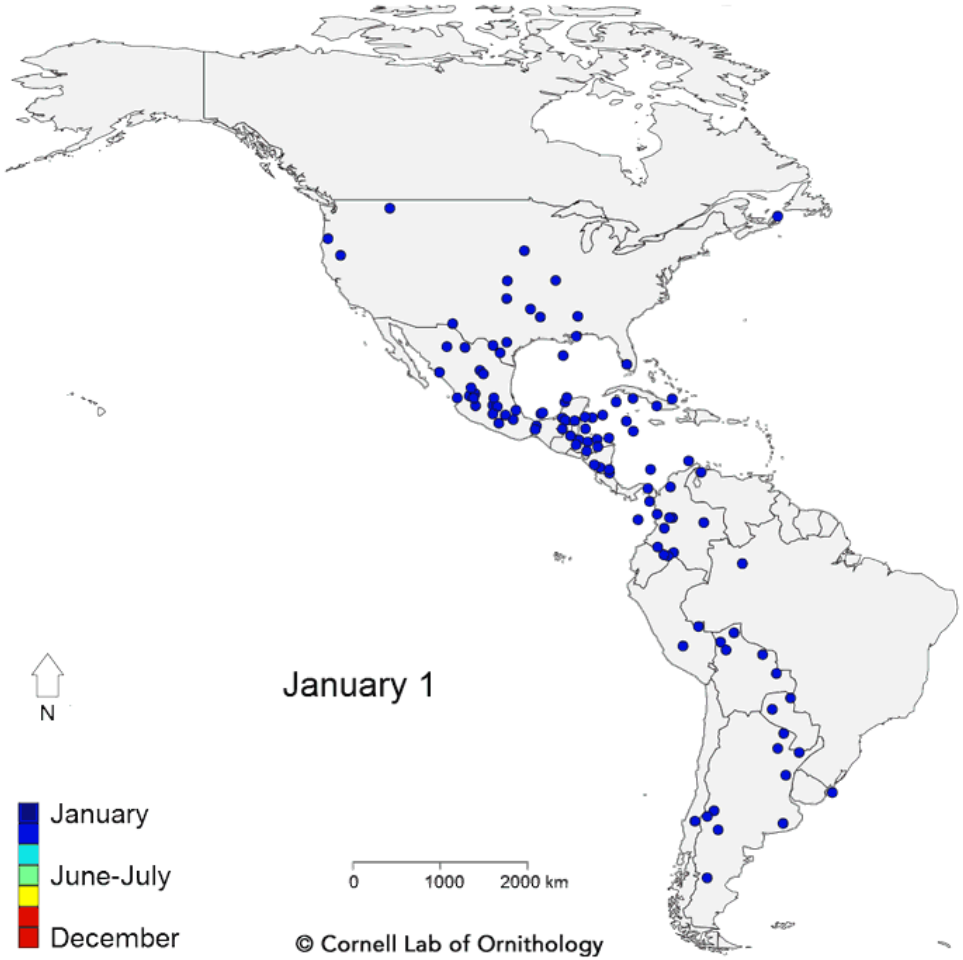
Big Data is changing biodiversity research quickly

Environmental Sensors

Citizen Science

Both provide huge quantities of data to scale on the cheap

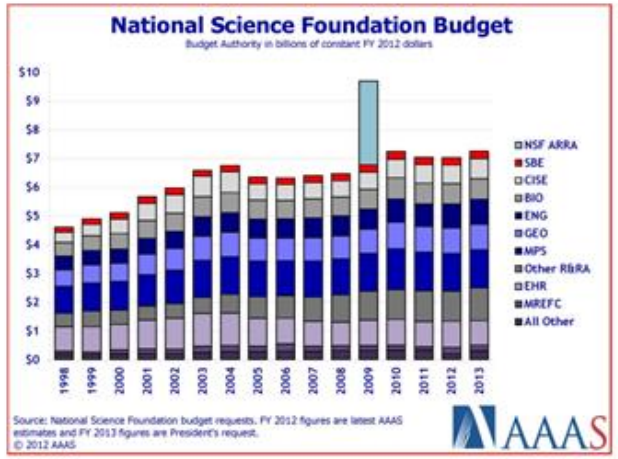


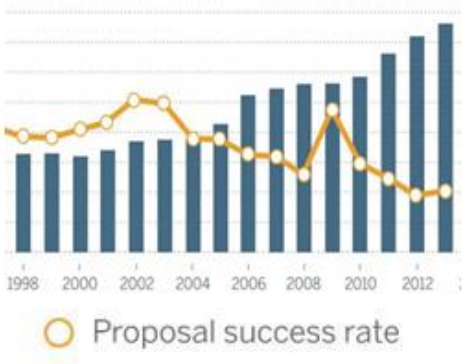


https://www.allaboutbirds.org/mesmerizing-migration-watch-118-bird-species-migrate-across-a-map-of-the-western-hemisphere/

And wow, we need it

Research funding is decreasing





The need for biodiversity data is growing

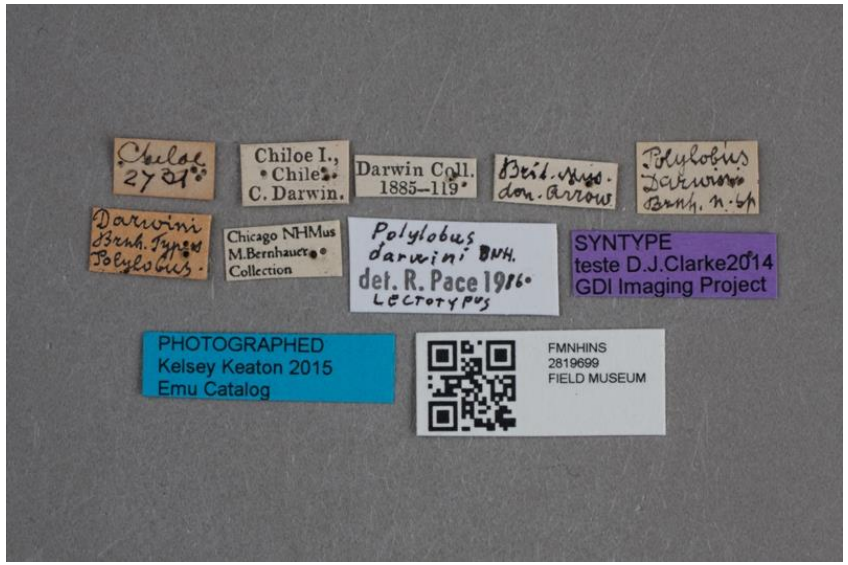
Historically, biodiversity data has been collected two ways by two different groups

Museum Collections - presence only data

Sussex Butterfly Atlas

Checklist Surveys - presence/absence data

Some QA/QC challenges as data is aggregated



Inconsistent metadata

Mostly non-digitized

Collection bias

Past may not predict present and future

All mass extinctions have been correlated with increases in atmospheric CO2

New web platforms are collecting biodiversity data at unprecedented scale

iNaturalist (https://www.inaturalist.org)

Presence-only data like museums

eButterfly (http://www.e-butterfly.org)

Presence-absence data like surveys

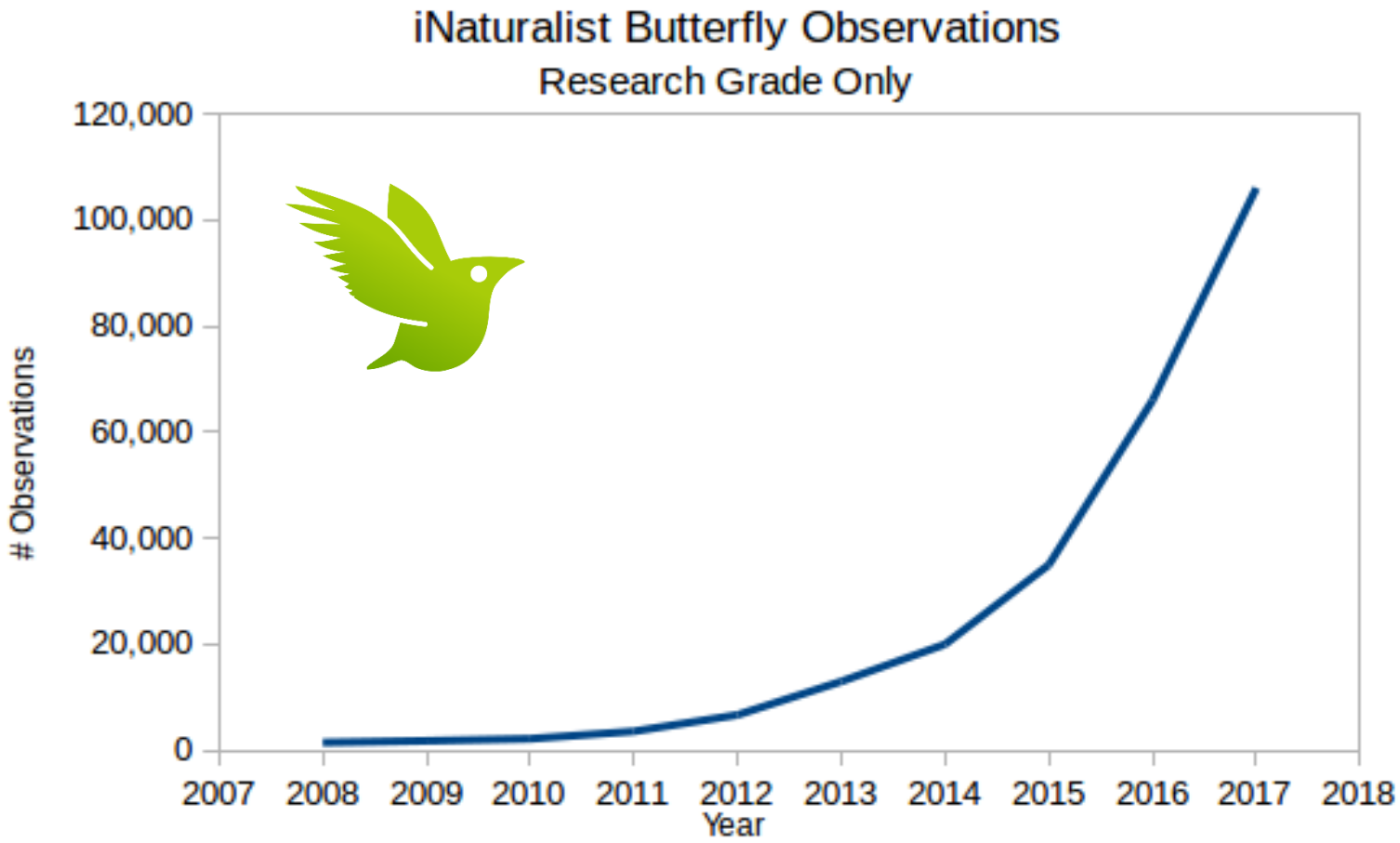
Collaborate with citizen volunteers

72 million US residents watch wildlife for fun

10 million US residents watch butterflies a minimum of 85 hours a year each

~ $1,700,000,000 in butterfly volunteer hours a year

Citizen Science data is getting big, and fast!



What do we do with this data?

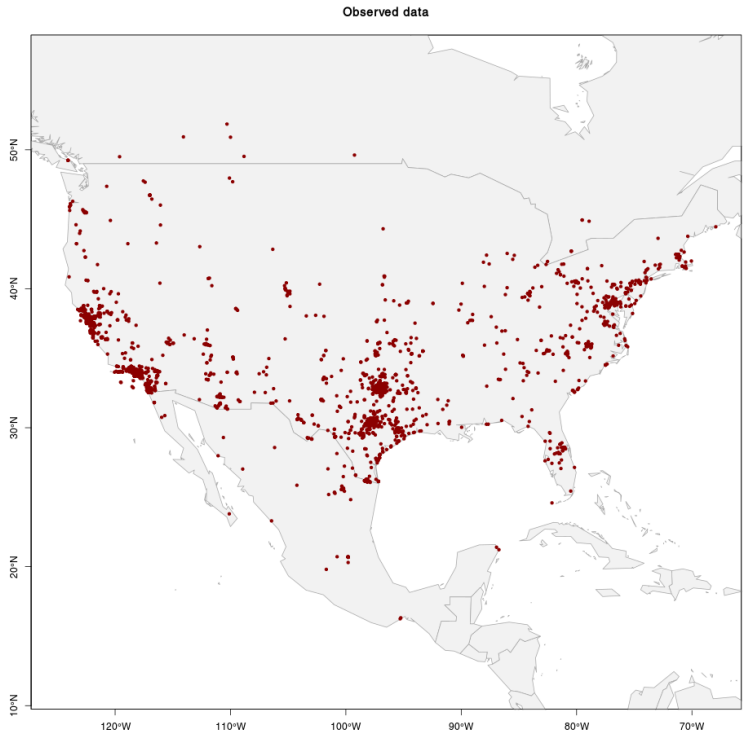
iNaturalist (https://www.inaturalist.org)

~200,000 North American butterfly records

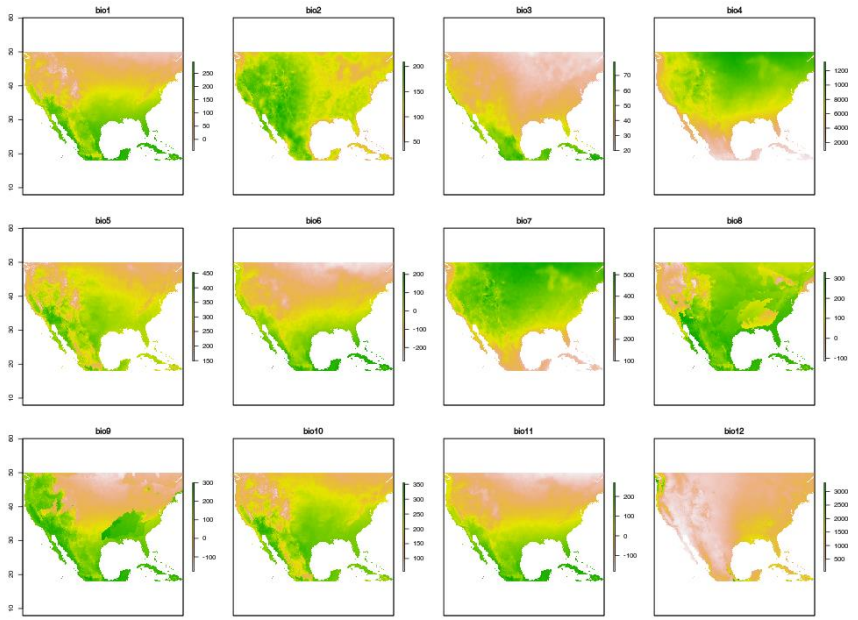
eButterfly (http://www.e-butterfly.org)

~300,000 North American butterfly records

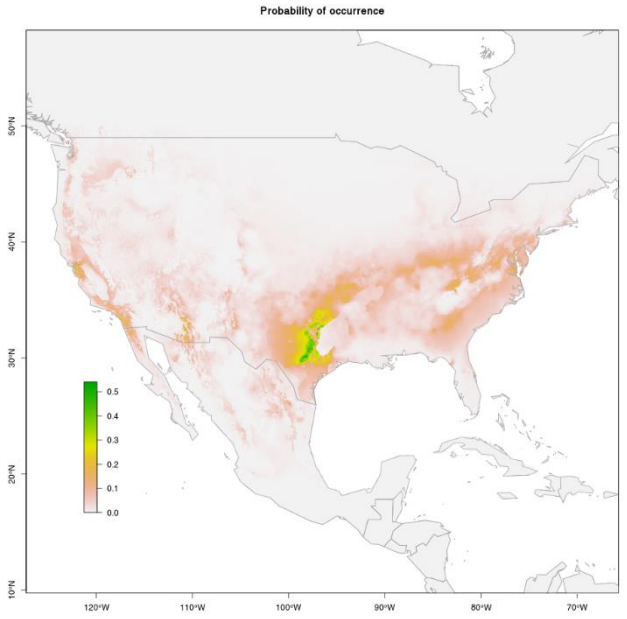
Where do species live?



Observational Map



Monthly Species Distribution Maps



Annual Species Distribution Map

Where are the biodiversity hotspots?

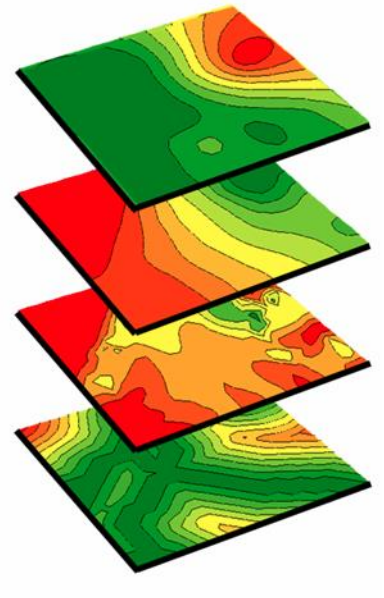
Biodiversity hotspots can be estimated by combining SDMs

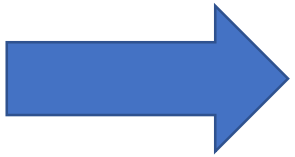
Species 1

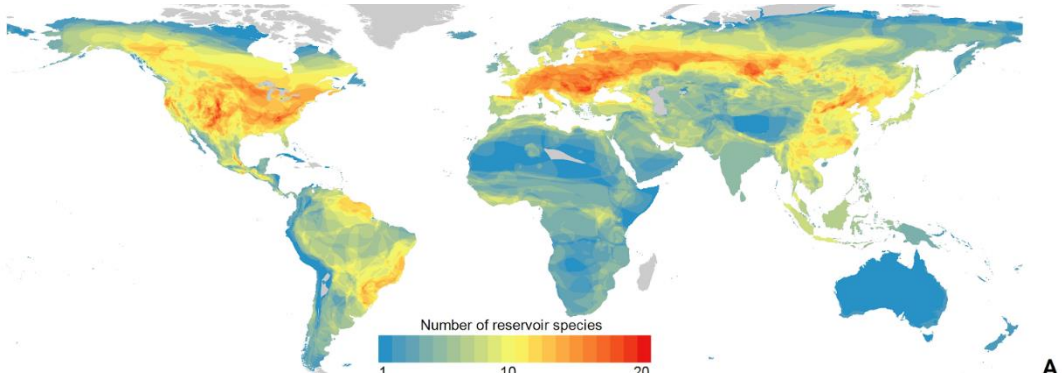
Species 2

Species 3

Species 4







QA/QC problems that impact our analyses at scale

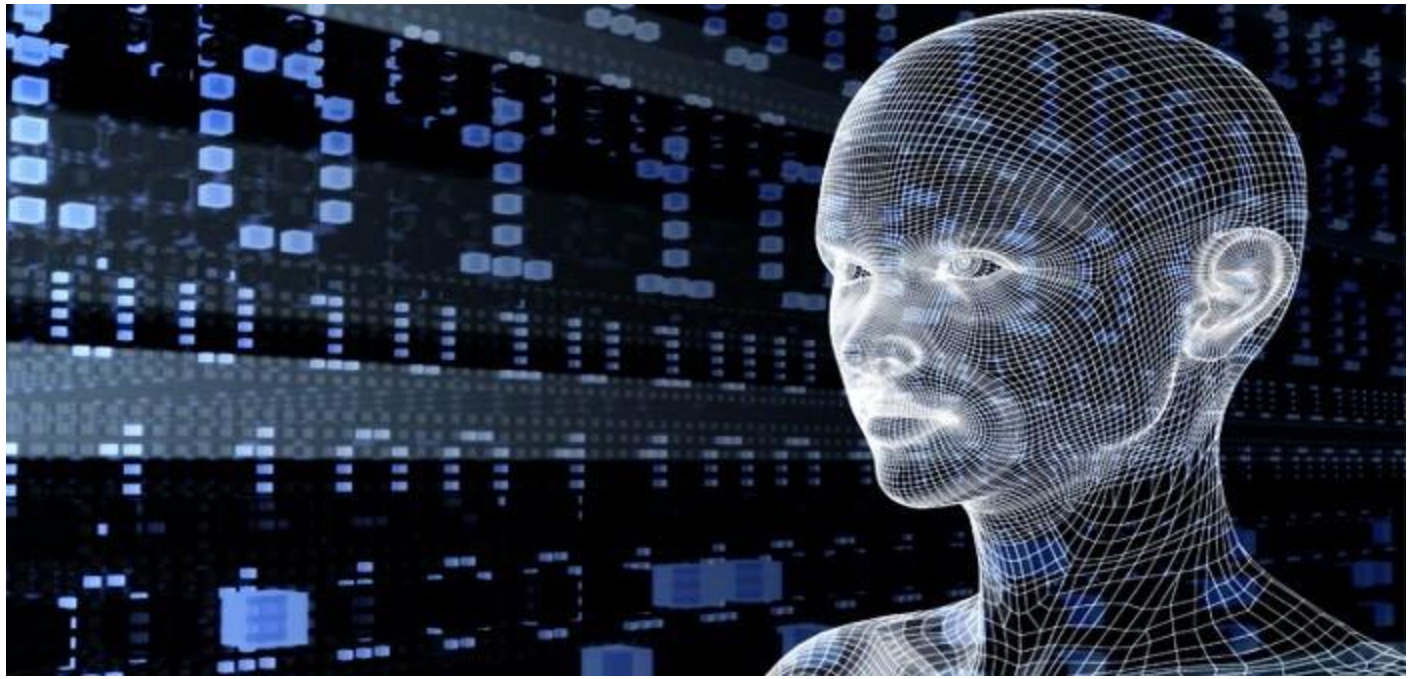
Many Contributors

Participants vary in their ability to identify organisms

Participants vary in their desire to travel

Participants vary in what organisms they like to engage with

Using a Human-AI combination



The core butterfly analytics team!

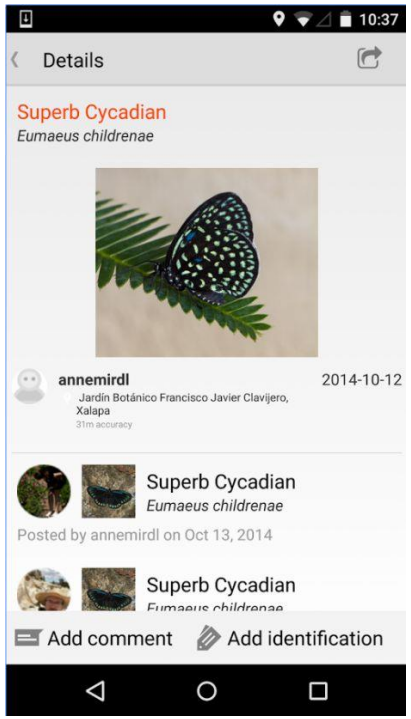
Rebecca Hutchinson
Oregon State University

Jeff Oliver
University of Arizona

Ben Hickson
University of Arizona

Ryan Farrell
Brigham Young University

Visual recognition of butterfly photos helps ID

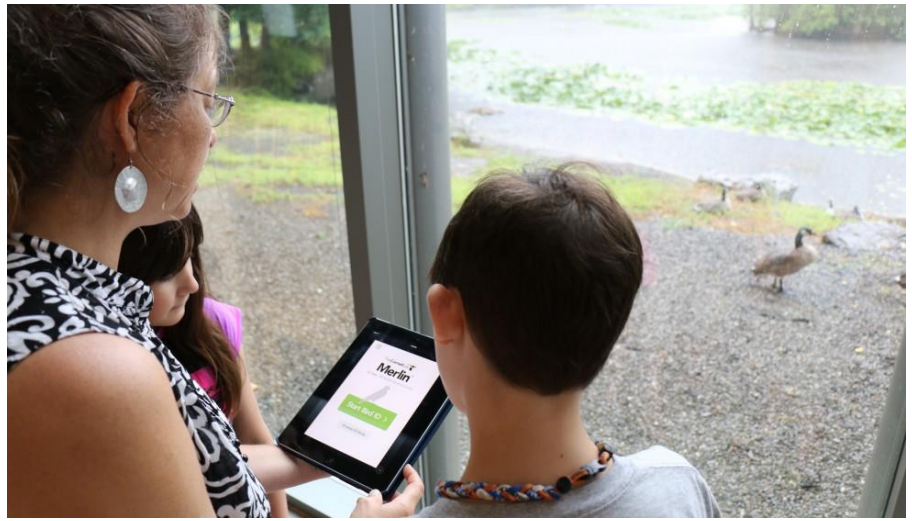


iNaturalist AI suggests IDs

eButterfly uses host data to inform butterfly ID

ID bias is based on expertise

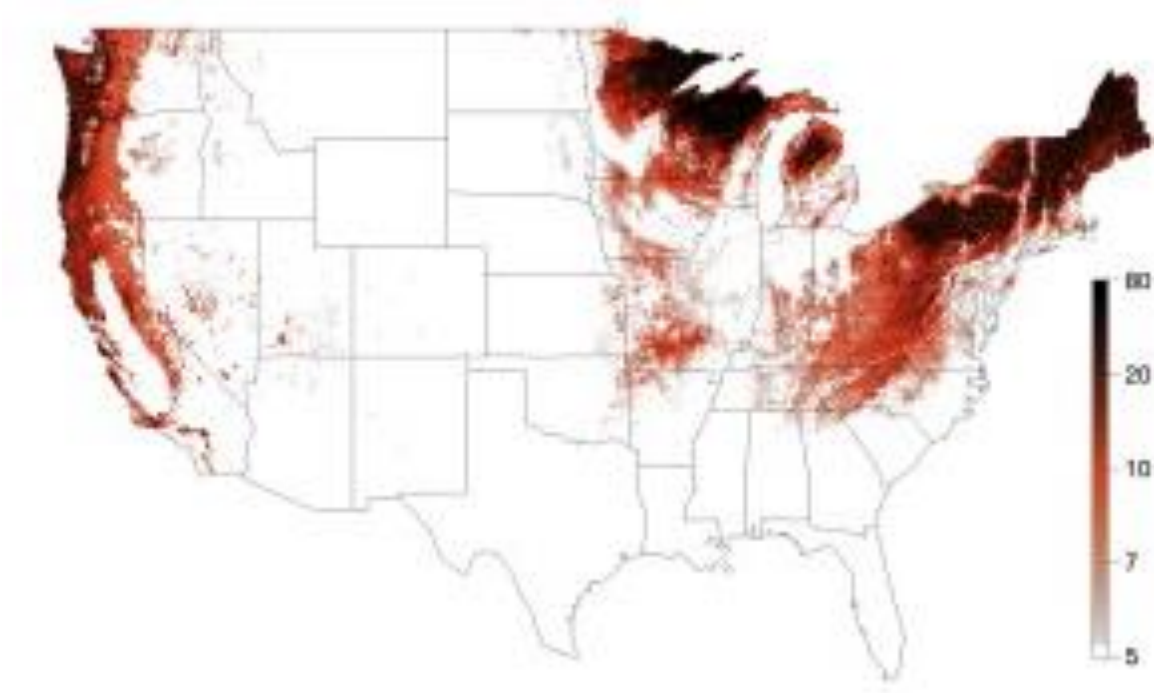
Experts are more likely to mis-ID a common species for a rarer one



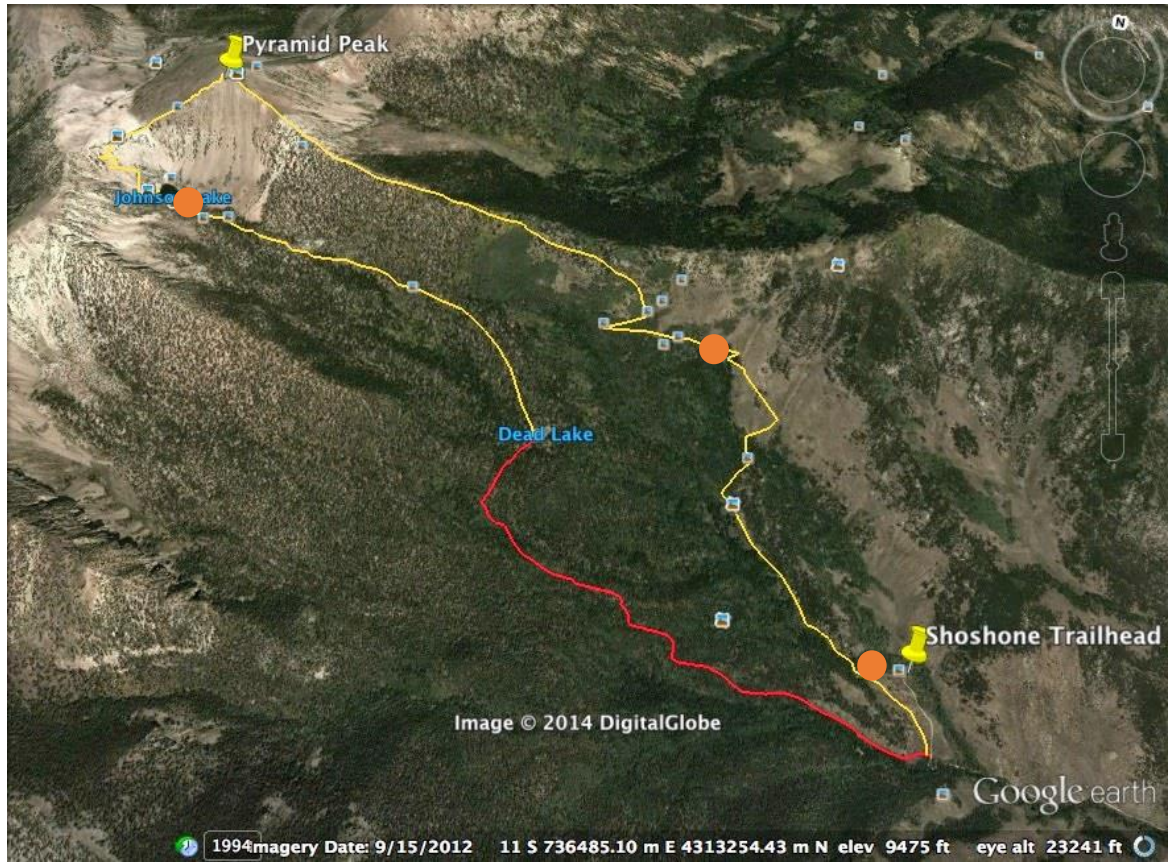
Beginners are more likely to mis-ID a rare species for a common one

Most observations are close to home

Use models to identify under sampled locations



Use predictive models to generate potential coordinates for butterfly habitats in those areas



Then partner with other groups to sample those locations

http://www.adventurescientists.org/pollinators.html

Photographs are biased toward larger butterflies

Adding other collection methods such as Malaise traps can help document the small b’flies (BIOSCAN Long et al)

More data is coming

Build processes and tools to increase understanding and conservation of biodiversity in fine scale across continents

Precision conservation!

Many thanks to …