Biome product requirements document

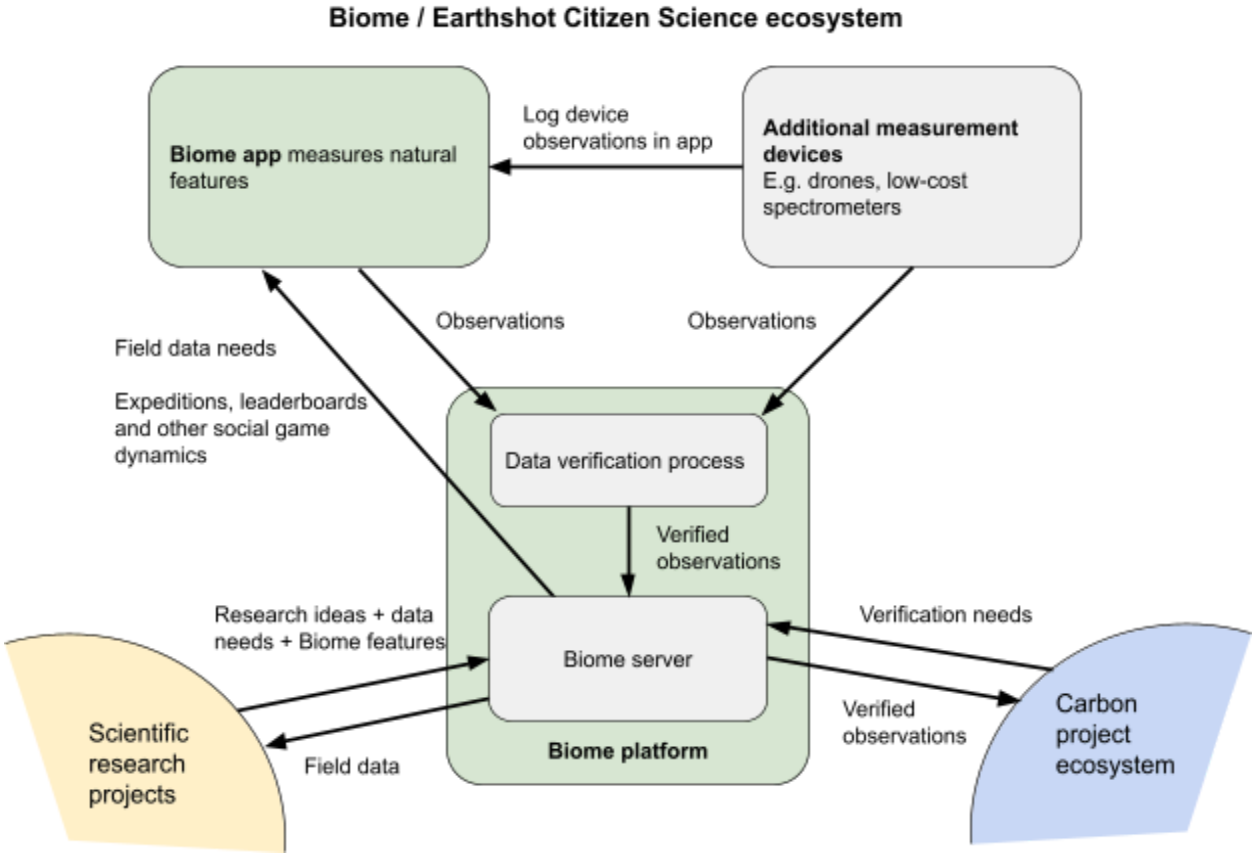
Biome is a mobile app that makes nature observations fun and valuable. Citizen scientists around the world can use Biome to gather valuable field data in order to help researchers advance ecological science. People can also use the app to collect field data that is used to verify carbon and other nature restoration projects.

I. Problem statement

Ecological science requires field data that is often not readily available or simply doesn't exist. This data can be locked up in corporate databases, or have very sparse geographic or temporal coverage. Examples include tree stands, soil samples, water features. This lack of available field data impedes the development of accurate models that can be applied to a range of geographic regions, species of vegetation, future forecasting ranges, and so on. Similarly, carbon verification today is a very expensive process by which experts are flown to remote sites in order to make observations on natural features relevant to the project. This process costs hundreds of thousands of dollars, putting carbon markets beyond the reach of small landowners and limiting the supply of carbon projects in the world.

II. Key product concepts

Here is a summary of the Biome citizen science platform and app. This includes features such as a crowdsourced data verification process and integration with additional measurement devices that are not in scope for the first MVP release.



Here are some key principles that underlie the Biome product concept.

1) Take full advantage of the smartphone as a scientific device

Modern smartphones are equipped with a range of very useful sensors that can be used to collect valuable scientific data. We want to use these to the fullest extent possible:

- Camera - photos and videos of natural features that can be used for identification, measurement of flora, fauna, other natural features
- Accelerometer - can be used to measure natural features
- Microphone - fauna identification, possibly provides insights into natural features that also make sound such as trees, streams
- Lidar - dimensions and volume of features such as trees
- GPS, Compass - location of recorded data

2) Fun and appreciation of nature and science are the point

We want to create the scientific, rural equivalent of Pokemon Go - making it fun to get together and move outdoors with friends. We will use game dynamics where appropriate to boost engagement, enjoyment, and the quality and quantity of data produced by our users.
We also want to provide an opportunity to not just measure but also appreciate nature. So we could for instance include whimsical observations such as unique water features, or particularly beautiful trees.

3) An adaptable, expanding platform for nature observations

We can't predict all the natural field data that researchers or carbon projects will need, or all the methods in which that data can best be gathered on a smartphone. Nor do we want to be the bottleneck for building the app features necessary to gather that additional data. So we will make Biome an extensible platform where other groups can develop new types of data to be gathered and jobs to be done. This could go beyond the direct gathering of data to include other tasks such as labeling data that's already been gathered, reviewing the submissions of others for accuracy, and perhaps even incorporating models for classifying observations, e.g. for species identification. This will have the added benefit of increasing the reach of Biome to include citizen scientists who aren't near areas that researchers or nature projects need field data for - or who are unable or unwilling to easily explore such areas.

4) Eco-themed currency to incentivize use

We want to apply a combination of social and monetary incentives for people to use Biome. One way of doing this is to use a form of digital currency that users earn when they submit valuable data using the tool. These rewards can be displayed on profiles, leaderboards and challenges can be organized around earning them, and other competitive or cooperative dynamics to encourage engagement. Earthshot will set aside funds to be assigned at some later date in order to add monetary incentive, either in the form of coins such as those on the Regen Ledger, or create our own simple virtual currency backed by cash we allocate for this purpose.

5) Commitment to openness

All data collected will be published publicly. For example observations related to nature restoration projects will be memorialized on the Regen Ledger blockchain.
The app is open source and we actively seek volunteers within the Earthshot community to contribute to the project.

III. Success criteria

While conventional engagement measures such as number of installs, number of active users, net promoter score are all important for any consumer facing app, they are not sufficient. Following are important metrics specific to Biome:

- # observations captured and verified - these could be broken out by type
- # research papers Biome data is used in

- # carbon projects Biome data is used in
- Aggregate CO2 drawdown from carbon projects Biome data is used in

IV. MVP

The initial version of Biome will focus on tree stand measurement. This is an important observation for both primary Biome use cases: science (e.g. biomass prediction, biodiversity estimation), and carbon projects (aboveground carbon sequestration estimation).
The app will allow users to sign up, select an expedition to take part in, and make tree measurement observations while keeping tabs on other users' activity via leaderboards and activity feeds.

i. Features

- Signup / signin
- Core loop:
    1. Player sees a set of expeditions on a map and what they involve, which will initially be locating and measuring trees of specified species.
    2. Player selects an expedition, travels to the location and starts making observations - tree species, height, dbh, any notes. The app checks to make sure the player is located in the area of the expedition before giving them credit for helping with the expedition
    3. Player can see overall progress toward expedition's goal as other players also submit tree observations, and a leaderboard showing the most active players
    4. Expedition is closed once predetermined goals are met and a final leaderboard is shown to all players
    5. Additional expeditions are created as needed
    6. Players can see a global leaderboard showing most active players across multiple expeditions

  This will give us a very basic game that we can test in multiple locations and for both short and long-term playability.

  The core essential loop that we can start out with would be simply a single expedition and steps 2 & 3.
- View / edit profile showing observation history and acorns
- Delete or remeasure an observation
- View recent submissions by other users
- View aggregate submissions by the whole Biome community

ii. Data gathered

Initially the app will focus on measuring trees:

- Location (recorded for all observations)
- Diameter at breast height, overall height

- Tree species

Optional:

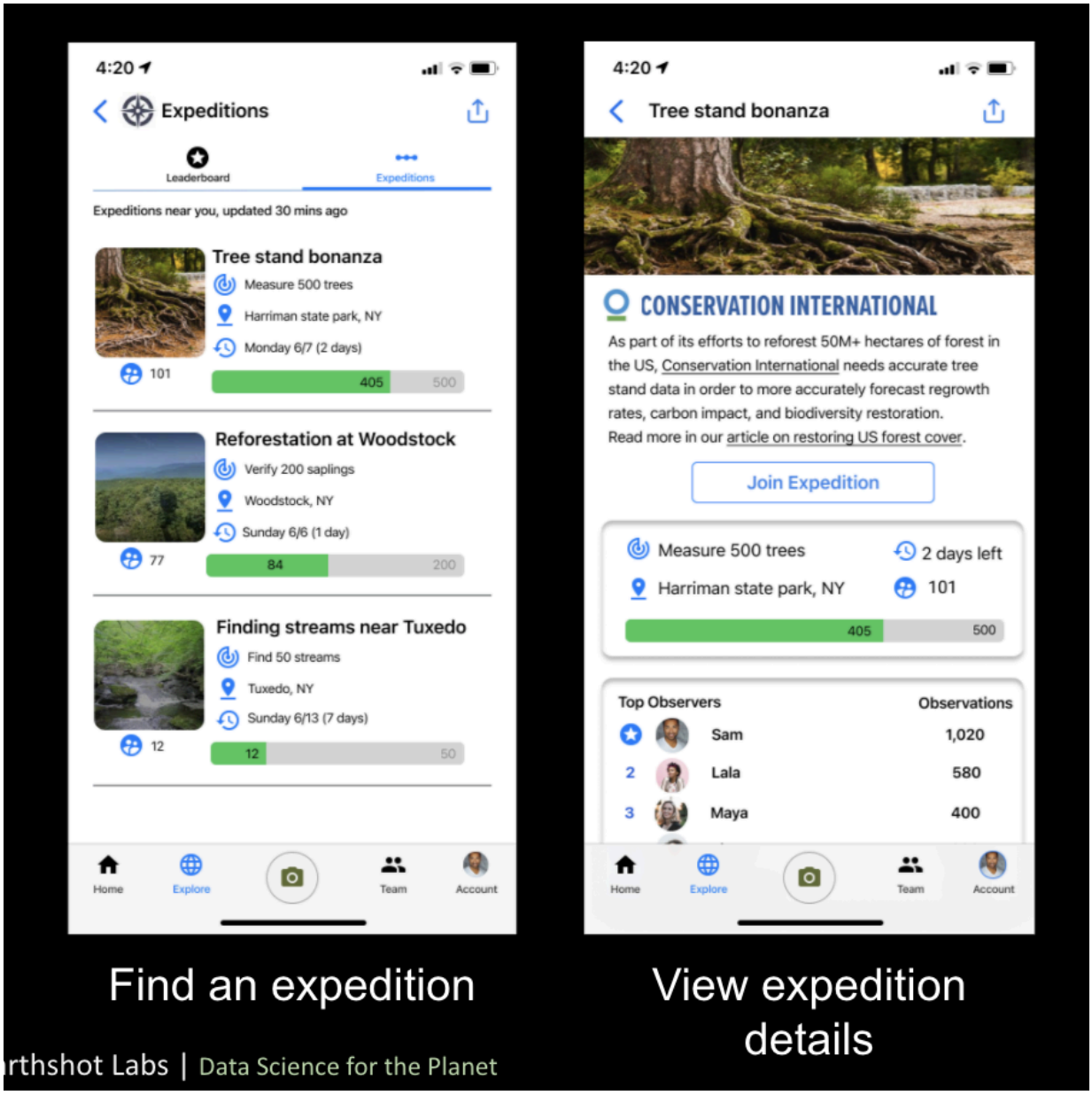
- Crown base height & width
- Estimated volume (via AR, possibly LiDAR)

iii. Expeditions

Expeditions are finite in length, e.g. today; this week; this weekend
Expeditions have a specific goal for the community to collectively achieve, e.g. record 300 bird songs; photograph 200 fish
Expeditions have different types:

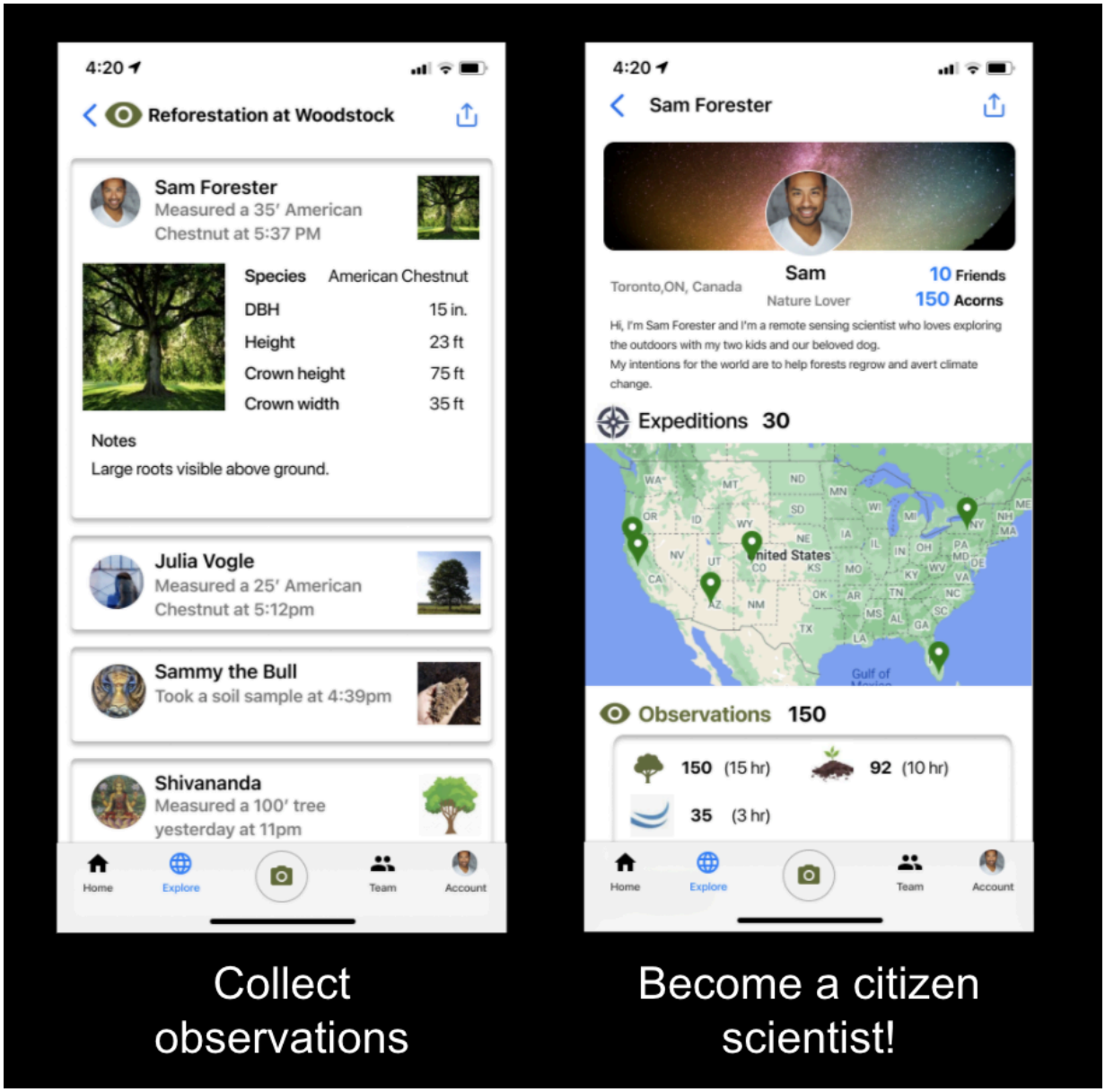
- General purpose - can be performed anywhere, have less or maybe even minimal scientific value but serve to be inclusive, fun, help people appreciate nature
- Science-driven - location is targeted by researchers' needs and measurements might be very specific

V. User experience



Find an expedition

View expedition details



VI. Post-MVP features

- Soil observations:
  - Color - possibly using a specialized color detection device like the Nix Pro: Soil color sensor data collection using a GPS-enabled smartphone application
    Measurement of Soil Color: A Comparison Between Smartphone Camera and the Munsell Color Charts
  - Measure available N and extractable P using the Quantofix NO3− and PO43− test strips combined with reflectometer analysis as described here: https://www.nature.com/articles/s41598-019-52702-8

    - Soil ribbon test: add water to soil and form a ball, then a ribbon. Complex: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/164615/determining_soil_texture_using_-ribboning_technique.pdf Simple: https://www.cedarfalls.com/DocumentCenter/View/9851/Topsoil-Soil-Ribbon-Test

  We have to be careful about telling people to dig up soil, it will only work if we enforce it being done in moderation

- Other forms of nature measurements:
    - Terrain - not sure if this is possible using lidar, computer vision or altimeter?
    - Location of swales, check dams, other interventions
    - Understory and lichen/moss. Tevin has done some coding to approximate lichen coverage and canopy coverage based on pixel density and color matching
    - Biodiversity - bird songs, more plant species the app can visually classify the species of, photos of animals with or without species classification
    - Bark - super useful for tree classification
- Chronologs - daily (or more frequent) photos of the same landscape to pick up transient and detailed temporal changes. See https://chronolog.io
- an index of the species you've captured,
- a listing of the known species in the area,
- a list of what other users have seen a specific tree (or at least how many other users have seen a tree for privacy reasons),
- Notifications if you walked by a tree that was identified and measured, but that you don't have,
- Expeditions where a land owner can set up a land survey for their land and recruit volunteers,
- Rules that prevent users from measuring off trail trees (in parks and forest/ preserved lands) when not on a sanctioned expedition (to respect wilderness).
- Virtual acorn currency to reward people for doing things, create a form of social currency in the player community
- Varying the bounty for particular types of trees and other natural features we need to collect data on (location will probably also factor into this as we want to know how the same species grows differently in different conditions). So we have a kind of data driven nature treasure hunt gameplay dynamic
- Direct people to these features by showing a geographic heat map highlighting which areas are likely to have high value trees.
- Show the user how their data was used - e.g. show the species of bird that was predicted from imagery or audio samples. Show the model that was enhanced or built using the data collected, e.g. 30 year biomass forecasting for a particular biome or geographic area. This would result in additional acorns and could be shown on the user's profile as having helped advance scientific research. Bonus acorns if the research was published, mentioned, used by other organizations, etc.

Researcher initiated observation experiments - let researchers come up with hypotheses, e.g. we can estimate stream depth by analyzing its recorded sound and appearance. This would

then reward citizen scientists for submitting such observations until the necessary data is collected for the experiment. And let them know if the hypothesis ended up being correct, what the model predicted using their data, etc.

VII. Comparable products

iNaturalist
Zooniverse
Arboreal Tree / Forest - uses LiDAR to estimate volume