Global Urban Forest
Soil Health • Tree Health

The Revolution of Open Source Science – Part # 3 - The Game Changer... PhotosynQ

A three-part series introducing the biggest game changing delopment in the global Urban Forest industry

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PhotosynQ developed at Michigan State University in the Kramer Laboratory is by far the next global game changer in environmental science. A device and platform that allows for intensive data collection to unlock nature's secrets and develop a greater understanding of how the natural world functions in its innumerable complexities are discussed in this final introduction instalment.

PhotosynQ is a collaborative online plant research platform, which enables you to create, share and collaborate worldwide to analyze detailed sophisticated environmental scientific information.

This peer to peer platform allows for global interindustry collaboration to extend our understanding of natural systems at unprecedented speed.

An open source scientific endeavor that will enable current generations to collect baseline references for future generations to develop technologies we can't currently imagine and engage management practices of the natural world that embrace holistic principals based on scientific understanding. Open science will enable more people to participate, which in return will enable projects which cannot normally be accomplished with the current scientific approaches will ultimately lead to better science and education.

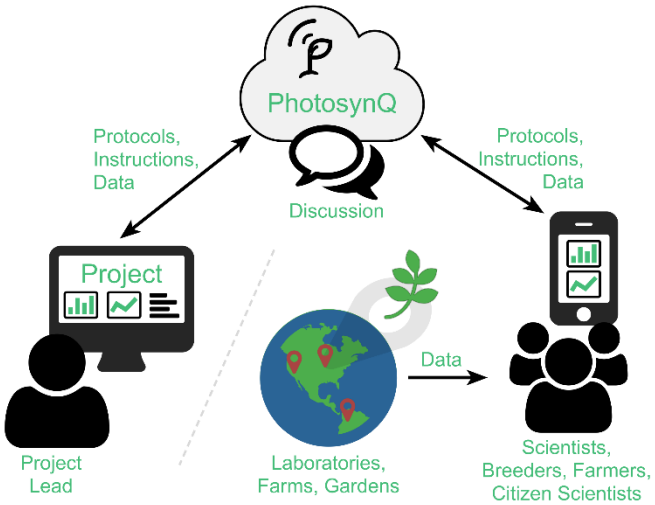
Photosynq is a tool for any environmental industry you can think of. If you want to understand anything that conducts photosynthesis and interacts with the planet directly, PhotosynQ can help you conduct the research and measure the complex parameters required to truly understand what is happening. There are no licenses or hidden costs, the platform is free to use with equipment compatible to open source, and is by industry standards extremely cost-effective compared with any other device on the market that pales in comparison to PhotosynQ.

One of the current tools used on the PhotosynQ platform is the MultispeQ v1.0

The MultispeQ (hand-held sensor device) combines the functionality of a handheld fluorometer, a chlorophyll meter, a bench-top spectrometer into a modifiable scientific tool that brings laboratory quality measurements to field applications. The MultispeQ instruments link to an Android device via Bluetooth then uploads the data to the PhotosynQ cloud-based platform instantly.

The MultispeQ V 1.0 measures an impressive range of factors such as ambient temperature, leaf temperature differential, pressure, humidity, co2 respiration, stomatal conductance and geotagging and time stamp features. The additional impressive component of the MultispeQ and PhotosynQ platform is the device and platform allow for unlimited additional measures to be collected, such as soil health and function and site-specific observations.

The MultispeQ simply measures photosynthetic phenotypes in real environmental conditions with the press of a button, and within a few seconds uploads to the PhotosynQ (platform).



PhotosynQ is an example of the shift in how science is conducted. The inherent nature of open source will change science forever. The era of ivory tower science is over, the time of global collaboration in how science is done, viewed and understood is here and all humanity can engage and contribute.

An Arboriculture perspective.

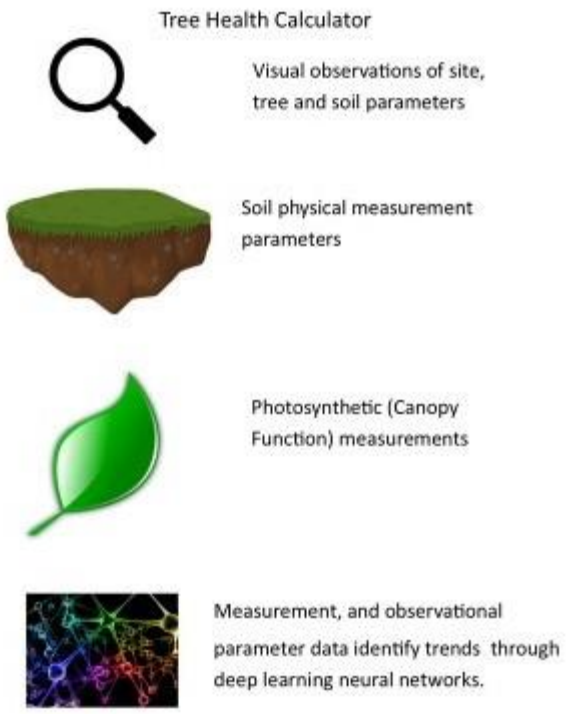
In 2015, Matthew Daniel of Global Urban Forest Pty Ltd was invited by the PhotosynQ team to Beta test the platform and join the Experts Program. An initial small group from a diverse field of industries, from agricultural research science in Malawi (East Africa), science educators in Ukraine to, Great Barrier Reef marine science researchers in Australia were all supplied with a 3D printed MultispeQ prototype to conduct research in their chosen fields, and support the development of the MultispeQ version 1.0.

Image Left – Matthew R Daniel with the 3D printed MultispeQ BETA device that exceeded the PhotosynQ team's expectations.

Matthew's focus was the Arboriculture and Urban Forest industry and developed the Tree Health Calculator 1.0 project to understand and make a link between tree and soil health and function.

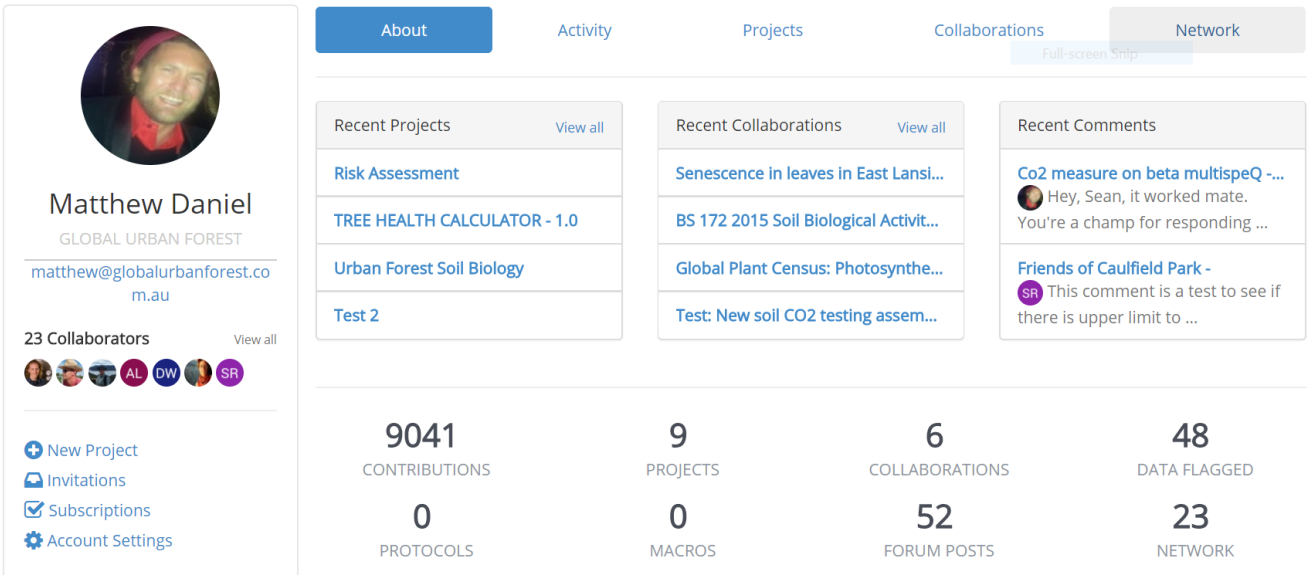
Due to the Photosynq platform being flexible and modifiable, specific custom designed additional data can be included in the user's experimental design. This meant Matthew could combine his years of soil health measurables into the overall data collection exercise and share this approach with the Arboriculture industry to promote the Urban Forestry to become more science-based and collaborative.

Not only additional measures can be included in each experimental design but human observational data can also be applied. This means the current Arboriculture industry standard of a Visual Tree Assessment (VSA) can be included and improved on.



TREE HEALTH CALCULATOR 1.0

The Tree Health Calculator combines photosynthetic and physical soil measures with site-specific observational data. The information collected can be interrogated and analyzed immediately using the PhotosynQ online platform dashboard graph and can run complex statistics. The data can be extracted and applied to external analysis such as Multivariant, Random Forest, Deep Learning Neural Networks and even Artificial Intelligence (AI).



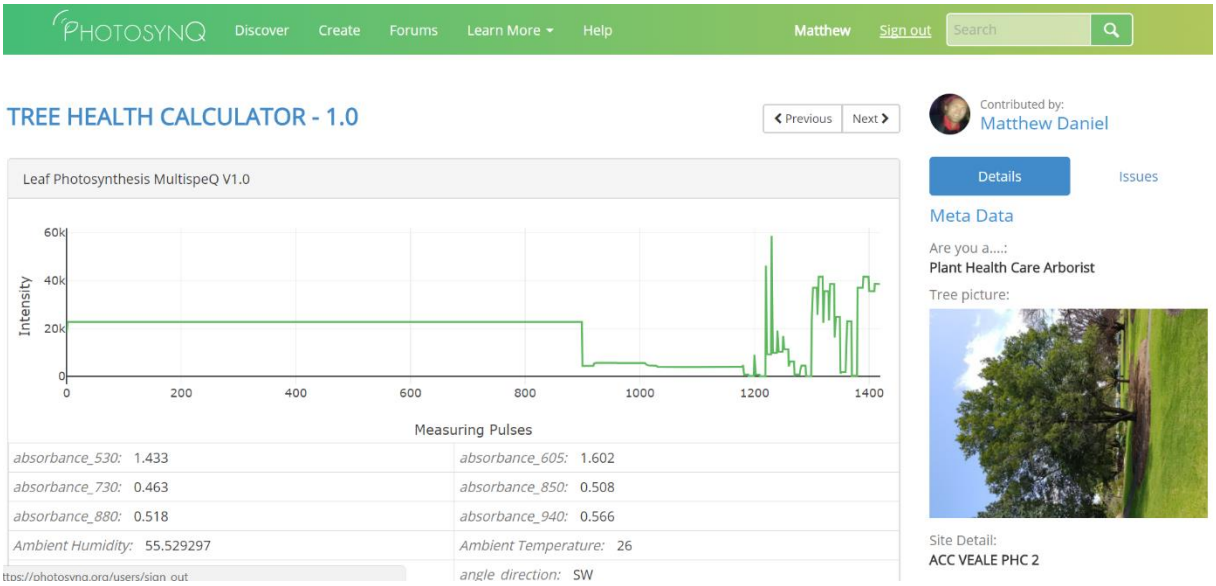
The above PhotosynQ user dashboard profile page displaying measurement contributions, projects, collaborations, discussions and much more.

The impressive practical applications of the Photosynq technology and current projects the Tree Health Calculator 1.0 has been applied to in Urban Forestry are:

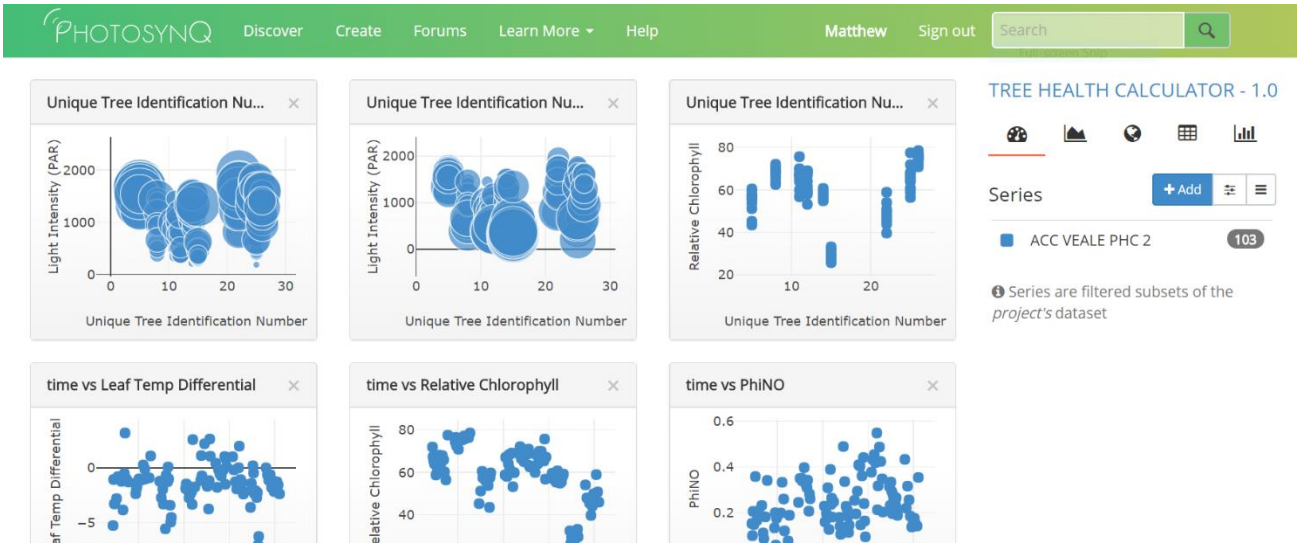
- Trees undergoing soil remediation and measuring the response to improved growing conditions
- Trees on development sites to capture the impact to tree health and function from incursion to the Tree Protection Zone (TPZ)
- Monitoring the establishment of new tree plantings in Urban Forest projects
- Working with the landscape architecture industry in determining the success of retaining established trees on development sites
- Monitoring significant tree populations through quantifiable measurables
- Quantifying the effects of pest and disease on canopy function and long-term tree health
- Prediagnosis of abiotic and biotic stressors in urban tree populations
- Developing a functional value of species-specific microclimate production, to develop a more appropriate species pallet for Urban Heat Island Effect (UHIE) policy

- Understanding trees that have been poisoned. PhotosynQ can be applied in developing better decision-making on how and when to intervene or make the determination the tree has ceased function
- Species-specific Poor, Fair and Good - Visual Tree Assessment (VSA) based on photosynthetic function, improving a global Arboriculture standard
- Understanding the long-term effects on tree health and sustainability of artificial lighting in cities
- Measuring soil Co2 respiration of compacted soils, turf park trees, remediated soils and different standards of composts and mulches
- Monitoring and benchmarking soil carbon levels

What does the data look like?



Each individual measurement contains 84 photosynthetic measurements and 36 metadata including GPS location, images, soil measurables and visual observations. Not all the data can fit in a single screenshot. This particular single measurement (above) takes up a total of six screenshots.



To browse and interrogate data a dashboard (above) is available to load a large number of graphs from the extensive range of measurements collected. This allows the user to quickly determine outliers and investigate trends.

The development of PhotosynQ & MultispeQ has revolutionized the way we diagnose trees and will continue to build our understanding of tree/plant/soil science.

The combination of platforms builds on the aged Visual Tree Assessment (VTA) approach commonly used in the Arboricultural industry. The platform helps to distinguish the photosynthetic capacity of the subject tree/plant in real environmental conditions with consideration of biotic and abiotic stresses and soil science.

Some of the elements considered vital and presently collected using the MultispeQ are as follows but not limited to:

- The efficiency of photosynthesis or quantum yields of photosystem 2 (Phi2)
- Energy loss (Phi NO)
- Non-photochemical quenching (Phi NPQ)
- Relative chlorophyll content (SPAD)
- Photosynthetically Active Radiation or light intensity(PAR)
- ATP production or proton motive force (PMF)
- Leaf Temperature Differential (LTD)
- Relative Humidity and Stomatal Conductance

The combination of MultispeQ and PhotosynQ has enabled early identification of diseases, chlorophyll fluctuation, photosynthetic capacity, soil carbon configuration and microbiology connection and much more to help piece the complexities with the management of trees within an Urban Forest. This evolution has forged the development of the Tree Health Calculator 1.0 by Matthew R Daniel.

With the first 6 MultispeQ devices (left) shipped out from the USA, Global Urban Forest is delivering Community Engagement Citizen

Science workshops for municipalities throughout Australia, working with other associated industries and education/research institutions to provide training and develop collaborations within the Urban Forest industry.

Baseline tree/plant and soil measurements are vital, the scientific applications using MultispeQ and the PhotosynQ platform allows users to draw comparisons with canopy morphology traits and other areas of critical interest.

The PhotosynQ platform allows multivariate analysis, and in future, data to apply to Deep Learning Neural Networks and Artificial Intelligence (AI) that will provide real-time feedback to health and function of individual trees and the Urban Forest as a whole.

Over time MultispeQ and PhotosynQ will authenticate the real environmental conditions influencing tree health attributes.

The progression of the Tree Health Calculator 1.0 will create a complete understanding of abiotic and biotic influences, photosynthetic phenotypes and complex linkages to a tree's growing environment above and below the ground.

Furthermore, the Tree Health Calculator will remove speculation and help determine the appropriate Plant Health Care (PHC) program while validating areas of research, and making the link between tree and soil health.

Prior to the development of PhotosynQ & MultispeQ it was virtually impossible to exactly reproduce the environmental conditions that affect tree growth. It is commonly known that the delicate balance inside plant tissues can be adversely affected by only a few seconds of exposure to harsh weather conditions, changing photosynthetic function, alternating moisture levels or varying soil pH, insect infestation and fungal pathogens. Therefore, the evolution of the PhotosynQ online platform and the MutispeQ hand-held device will transform plant research by facilitating seamless exchange of scientific data and knowledge among researchers worldwide.

We believe PhotosynQ can profoundly affect the traditional way we view scientific research and collaboration. It has the capacity to revolutionize the Arboriculture industry and projected ways we manage the Urban Forest within a short period of time.

A new era of global Urban Forest collaboration will propel the industry into a collective knowledge base and provide future generations with baseline data that will improve management, funding and sustainability of forests within cities.

Tree Health Calculator 1.0

Tree Health Calculator 1.0 Results

PhotosynQ Focus - Blog

tree health calculator BETA

tree health calculator BETA - Results

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