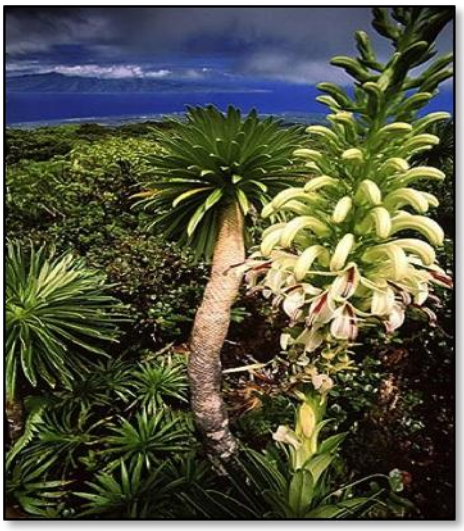
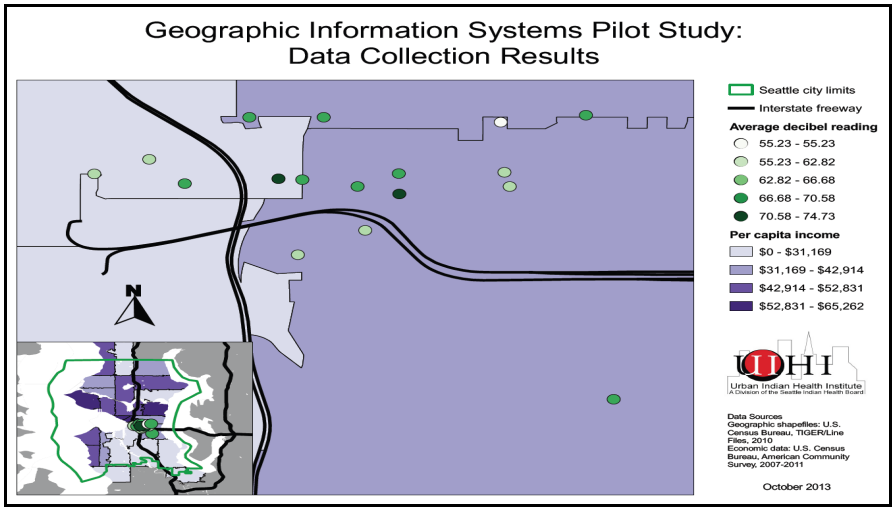
Low Cost and Free Public Health Mapping Tools

Final Report

Kurt Menke[1] and John Scott[2]

December 2013





[1] Kurt Menke is founder and president of Bird's Eye View, Albuquerque, New Mexico

[2] John Scott is founder and president of the Center for Public Service Communications, Claiborne, Maryland

Funds for the project described in this report were made possible through a contract between the National Library of Medicine (an agency of the U.S. Department of Health and Human Services) and CPSC (HHSN276201200013I).

Background
During the fall of 2012 the Center for Public Communication contracted with Bird's Eye View (BEV) to assess currently available tools for collecting and visualizing public health trends via maps and data. Focus was given to tools that allow a simple workflow from field data collection to storage, and display of collected data. The target audience was community health groups with mapping needs but without the resources to have an Esri ArcGIS license and a full time GIS specialist on staff.

The tool survey included: a) apps for Apple iPad/iPhones and Android devices, b) websites serving out useful public domain health related data, c) open source desktop tools for analyzing data and integrating field data with existing organizational data, and d) cloud solutions allowing user data to be uploaded and mapped. BEV wrote a final report with a final recommendation for a complete workflow from field data collection through web presentation.

Project Overview
During the spring and summer of 2013 the final recommendation was implemented successfully in three test locales: 1) Urban Indian Health Institute, Seattle, Washington, 2) Papa Ola Lokahi / The Native Hawaiian and Indigenous Health Office of Public Health Studies, University of Hawai'i Manoa, and 3) The Nature Conservancy of Hawai'i.

Each site was contacted to guide them in developing project ideas during the winter of 2012/13. During this time the project and tools were introduced, and each site asked to identify a suitable project. BEV developed custom training materials for each site. This was due to the fact that each site was assigned a different mobile data collection app. This would give us feedback on the three leading mobile data collection apps. Training sessions followed at each site in April 2013. The training focused on introducing each site to entire workflow recommended for their project from field data collection through data sharing and visualization. Follow up support was the provided throughout the summer and fall of 2013.

Urban Indian Health Institute - Noise *Pollution and Health in the Urban Environment: A Geographic Information Systems Pilot Study Engaging Urban Indian Health Organization Staff*

Noise pollution is an environmental health concern that has been linked to a variety of health conditions in both occupational and community studies. Excess noise levels are a well-recognized cause of hearing loss. Additionally, noise pollution has been linked to cognitive deficits; sleep disturbance, hypertension, heart disease, and diabetes. The health impacts of excess noise in the environment may be especially deleterious for children. While the mechanism linking noise to health is not fully understood, the association may, in part, be explained by stress responses. Noise is not uniformly distributed in urban settings. Excess noise pollution commonly occurs in predictable

settings (e.g., near traffic, industry or transportation systems) and disproportionately impacts individuals living in these areas. UIHI hypothesized that high levels of noise pollution in residential areas inhabited by urban American Indians and Alaska Natives (AI/ANs) contribute to the health disparities experienced by this population.

The goals of this project were: 1) to evaluate the community's collection and processing of spatial data to merge with health or other contextual data for analysis, and 2) to offer recommendations on the feasibility of the workflow and next steps for scalability to the larger Urban Indian Health Organization (UIHO) network. The project aimed to collect data on noise pollution in urban Native American/Alaska Native (AI/AN) neighborhoods in Seattle.

Materials Used:

- Hardware: iPad mini, desktop PC
- iPad apps: Decibel 10th by SkyPaw Co Ltd.; GIS Pro by Garafa, LLC
- Desktop software: Quantum GIS 1.8.0 Lisboa (QGIS); Microsoft Excel 2013; StataIC 10; iTunes
- Online services: GIS Cloud hosted on www.giscloud.com
- Data sources: U.S. Census Bureau, American Community Survey (ACS), 2007-2011; U.S. Census Bureau, TIGER/Line Shapefiles, 2010

There were five stages in this project: preparation, recruitment of field workers, training, data collection and analysis. The train-the-trainers method was used. BEV conducted training for the UIHI staff member that would then train field workers in data collection. UIHI developed its own in-house training manual based off of the material provided by BEV.

When the training preparations were complete, UIHI began recruitment. They trained seven data collectors to: 1) collect noise data, 2) take a site photo, 3) collect the GPS location, and 4) export the data from the iPad Mini for use on the desktop. UIHI also developed an exit survey so that feedback could be solicited from field workers.

Field Data Collection

The field app used was GIS Pro. This was the only app used in the pilot study that was not free. It costs $199. However, UIHI managed to get a free copy as a non-profit. It is the most robust GIS app tested. In general data collection went very well and participants came back seemingly satisfied and not overwhelmed or frustrated by the process. The decibel data were collected correctly (i.e., recorded for the correct amount of time, screen shot taken, email completed and sent) and the site locations were correctly mapped and described. In exit surveys, participants expressed that they enjoyed the work-related outdoor time, traveling to sites, and seeing the noise levels for some of the places they visit frequently. When told that they were to select their final data collection site, many expressed heightened interest and could immediately think of where they wanted to collect that data point.

Desktop GIS with Quantum GIS
Quantum GIS (QGIS) as a program worked well for this purpose. They felt it is more user-friendly and quicker to learn than ArcMap yet it has advanced data analysis and presentation capabilities. It interfaced easily with the data from the iPad.

Data Presentation with GIS Cloud
UIHI found GIS Cloud generally easy to use. The interface is simple, lacking flashy tools that can sometimes make for confusion in full mapping programs. It was seamless to add the basemap and other data layers into a clean presentation layout. The process of sharing the map was also straightforward.

Analysis
In the analysis stage, decibel data were exported from the iPad. The readings for the last 60 seconds were averaged in Excel to calculate the average decibel level at the site. This information was inputted into the site's attribute table in GIS Pro on the iPad. When this process was complete for all data points, the data were exported from the iPad as shapefiles with images, via a file transfer on iTunes. Data were analyzed using QGIS desktop software. GIS data were merged with ACS economic data. In QGIS, the relationship between economic data and noise data was shown geographically. Site data points were displayed with graduated symbology to show different decibel levels. Zip code shapefiles were joined with ACS data for graduated symbology display as well. A CSV file with summary GIS data and ACS economic variables was imported into Stata statistical software for analysis.

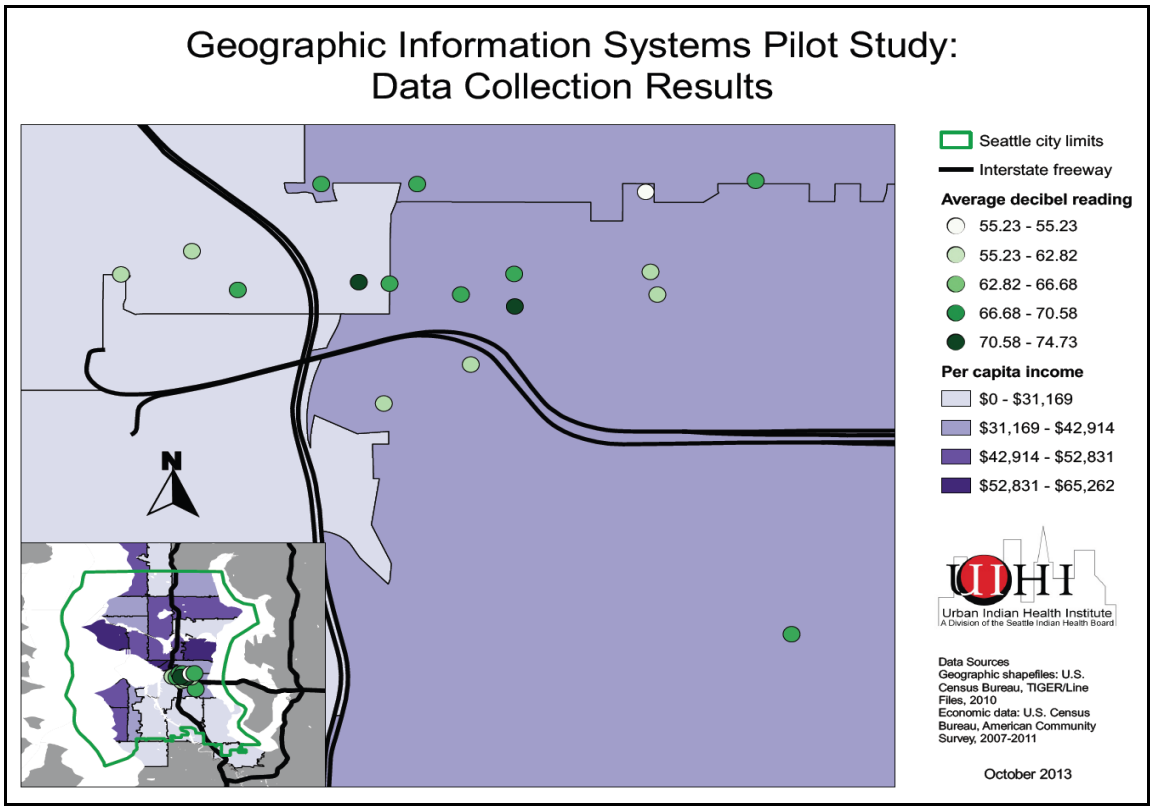


Figure 1. UIHI QGIS Map

Results

Participants collected 17 total geospatial data points spanning three zip codes. Collected data included temporal data, a site description, the weather, a site photo, a screen shot of the Decibel 10th app and the site's calculated average decibel reading over one minute of recording.

Given the proximity of the data collection sites to each other and the pilot nature of this work, they did not conduct extensive analysis of data. They did look at some of the data, however, to demonstrate that the data could be easily pulled into analytic software. The average decibel reading for all sites was 65 decibels (mean 65.7; median 65.2). This level corresponds roughly to someone practicing the piano. The site average minimum of 60 decibels and maximum reading of 75 decibels corresponded with quiet conversation and noise from an alarm clock, respectively. In general, there was little variation in average noise levels by site, though there was some correlation between high-traffic sites and higher decibel readings.

While their data site locations were too homogenous for comparison and interpretation, They did feel that more varied data collection is feasible and has the potential to highlight decibel rating differences by socioeconomic factors and selected health indicators.

Final Impressions

The most difficult aspect was overcoming the bureaucratic hurdles associated with volunteer recruitment. It took two months to receive permission to advertise for volunteers and another month to obtain permission to allow data collection to occur on weekends.

Having a staff member serve as the central data manager and trainer is effective. The software tools work very well and the train the trainer model was effective. The original UIHI trainer left the organization shortly after the BEV training. There was overlap between her and her replacement and she successfully trained her replacement who went on to train the volunteers.

QGIS was found to be comprehensive and includes nearly all of the features of paid programs such as ArcMap. With respect to the Decibel 10th iPad app, which uses iPad microphone technology, we did not test it for accuracy and so cannot be certain of the quality of those data. Future studies that need high quality decibel data should explore apps and hardware more fully before selecting one.

From the perspective of a project staff member, the smoothest parts of the workflow were training and working with the data in QGIS. The most challenging aspects were recruiting and scheduling participants. For participants, the best parts of the workflow were the training and fieldwork activity. We would endorse this workflow for future projects with some minor modifications to accommodate the fact that more than one training/orientation of the iPad apps was necessary for many volunteers. We believe the following changes might improve the workflow in future: 1) a more hands-on training with participants following along with the demonstration in addition to completing a trial data collection; 2) completing the data collection at a date closer to the training; or 3)

keeping the same training structure but doing an additional run through of the workflow process the day of data collection.

UIHI is considering using the workflow for five projects:
1. Mapping of Medicaid enrollment sites to compare with distribution of target enrollment population

2. Expanding on previous food source mapping project completed by the UIHI to include more neighborhoods and public physical activity spaces

3. Mapping community health centers and their services in proximity to the urban AI/AN population

4. Expand noise mapping to a wider region with more scientific data collection methodology (revise and expand this pilot project)

5. Mapping bike and walking trails locations for comparison with the distribution of obesity.

Papa Ola Lokahi - *The Network, Access and Education Project (NAE)*

The Network, Access and Education Project (NAE) is a Native Hawaiian effort to provide mapping and service resources for Native Hawaiians, case managers, outreach workers, service providers and others. The NAE project involves identifying existing resources (service organizations, facilities, supplies, etc.) that are available to assist Native Hawaiians in improving their health and wellness. By identifying, mapping, describing, and cataloguing these resources, case managers who serve the Native Hawaiian community can better serve their clients. The final result will be a current queryable map of resources.

The Network, Access and Education Project (NAE) carries with it another meaning in the name. In the Hawaiian language, the *nae* is a fishing net with small meshes or net structure to which feathers were attached for feather capes. The NAE project, like the Hawaiian fishing net, will serve to collect all resources available for Native Hawaiians and serve to nourish their wellbeing.

Materials Used:

- Hardware: iPhone and desktop PC
- iPad apps: EPI Collect (http://www.epicollect.net/)
- Desktop software: Quantum GIS 1.8.0 Lisboa (QGIS)
- Online services: GIS Cloud hosted on www.giscloud.com

Field Data Collection

POL used EPI Collect as a data collection app with an iPhone. This app is free of charge and allows a custom data collection form to be loaded onto the mobile device. POL felt the app was easy to use and the free-ware aspect was attractive when thinking about expanding data collection efforts with multiple devices. The fact that it allows for

data standardization among many data collectors using the same form was also greatly appreciated. The form POL established included the following elements:

Data Elements To Collect
Name of Organization
Type of Service
Description
Service Cost (y/n)
Accepting Medicaid/Medicare (y/n)
Location (GPS)
Qualifiers to Receive Services
Hours of Operation
Photo of Facility
Bus lines to location
Contact Number
Website
Contact Person
Other Important Information
Date Information Recorded

Table 1. POL data collection form

Desktop GIS with Quantum GIS
Quantum GIS (QGIS) as a program worked well for this purpose. It was very straightforward to bring the data collected via EPI Collect into QGIS. Other datasets were downloaded from the State of Hawaii GIS page and combined with the field collection.

Data Presentation with GIS Cloud
Currently POL is just beginning to import their field data into GIS Cloud.

Lessons Learned
There were some bureaucratic hurdles between Papa Ola Lokahi and the University of Hawai'i Manoa. However, since their internal issues have been resolved, the project has been going very smoothly from a technology standpoint. Based on this experience it is important that partner organizations be dedicated to the project to ensure success and that they have the time to spend learning the tools and collecting data.

Related Projects
Dr. Maile Taualii had several students attend the April training. Several of those students leveraged the new tools in their own studies over the summer independently of our project. This is further evidence that the technology is ready to be implemented. Below are brief descriptions of the other projects completed.

1. Surveying over 6,000 people in a relocation settlement village in the Philippines, focusing on access to water, food electricity and employment (Chad Noble - http://chadnobletabiolo.blogspot.com).
2. Developing an educational tool to describe the relationship to place and traditional food sources.
3. Collecting information on utilization of smoking areas in a large college campus pre and post the introduction to a campus wide band on tobacco smoking.

The Nature Conservancy of Hawai'i - *Identifying Locations of Native Medicinal Plants*

The goal of this project was to create a database of observations of the phenology of plants of use in Hawaiian ethnopharmicology and ethnobotany. This will provide information on when various plants are flowering, fruiting, in flush, etc., and where are those plants located? This database can provide practitioners with both an almanac approach to gathering needed botanicals, as well as compile a geospatially explicit compilation of the presence of significant plants across the islands.

Materials and Methods
The following materials were used:

- Hardware: Android phone, desktop PC
- Android apps: Open Data Kit (http://opendatakit.org/use/collect/)
- Desktop software: Quantum GIS 1.8.0 Lisboa (QGIS)
- Online services and GIS Cloud hosted on www.giscloud.com.

Field Data Collection
TNC was the test site for the Android platform. The app used was ODK Collect. This is a very powerful tool available only for the Android operating system. Similarly to EPI Collect the user can create a data collection form. One convenient aspect of ODK Collect is that the form is designed in Microsoft Excel. Building the form in a familiar environment makes its design very intuitive. FormHub is a companion website where a free account can be established. From there one simply uploads the Excel spreadsheet and syncs the app to begin data collection. FormHub later allows for the data to be exported including geospatial data, attributes and photos. This combination was BEV's preferred platform for data collection of all tested. TNC reported that data collection was a great success. The tool was thought to be scalable and robust and the free and open source aspect was attractive.

Status

TNC is just beginning to work with QGIS and GIS Cloud. This is largely due to a delayed introduction to the project and other commitments competing for time. UIHI and POL were contacted early in 2013 and trained in April. TNC wasn't contacted until July and training was done remotely via phone and email.

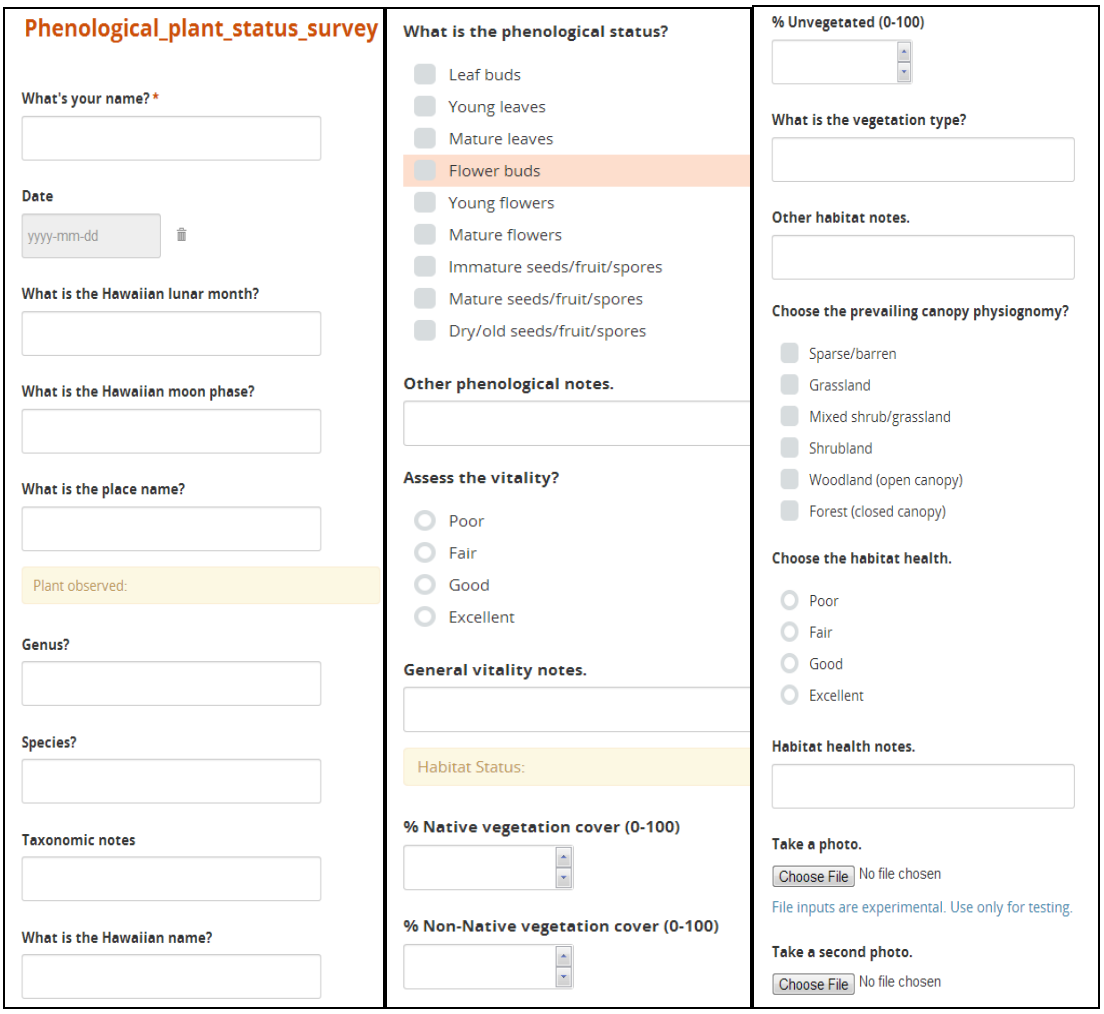


Figure 2. TNC Data Collection Form

Discussion

The project was very successful. The software and the hardware were found to be intuitive and effective. The tools enhanced the mapping capability at each testing location. Each location is now thinking of using this tool in other projects. Mobile GIS/GPS technology is ready to be implemented and is rapidly improving. The open source GIS world now has mature products and there are numerous cloud GIS sites sprouting up for serving out data easily. None of the difficulties had to do with the technology itself. They had to do with the overarching bureaucracy and would likely be encountered in any project.

Community Health Mapping\Recommendations for Future Work

Project Description

Following on the success of the 2013 pilot study, "Low Cost and Free Public Health Mapping Tools", Bird's Eye View (BEV) will partner with the Center for Public Service Communications on three activities. The first will be to provide ongoing low-level support for partner groups implementing the suite of mapping tools. The second will be to co-author a peer reviewed article on the workflow and present the paper at one or more conferences. The third will be to create and maintain a web resource on low coast and free public health mapping tools.

Ongoing Support

BEV will provide limited support to partner groups. BEV will be available via phone and email to assist groups implementing the workflow. Support may include troubleshooting hardware, software and data issues but will be limited to phone and email. BEV will also be available to make recommendations on project design and scope. This task will ensure the ongoing successful use of the workflow with interested community health care organizations.

Article

BEV will co-author a peer reviewed article discussing the experience and outcomes of implementing the low cost workflow developed in 2013. This will be co-authored with John Scott (CPSC) and Gale Dutcher (NLM). The specific journal to submit to will be decided upon at a later date. BEV will present this paper at one or more conferences such as the 2014 Free and Open Software for Geospatial conference in Portland, Oregon. This paper and associated presentations will serve to share the success of the pilot study to new audiences.

Web Resource

BEV will develop and maintain a web resource for community health mappers. Mobile mapping technology is evolving rapidly. This resource will allow interested partner groups, or others interested in community health mapping, to stay abreast of the most recent advances. This site will initially include the training materials developed in 2013. However, the main focus of the site will be a blog. The blog will be updated regularly and will be aimed at health care practitioners. As such the blog will be written at a layperson level of technical detail. The blog will serve to keep the workflow current, and will focus on success stories and new advances in community health mapping tools. Success stories will include projects completed by partner groups, or other similar applications of mobile mapping. BEV may facilitate and solicit guest bloggers such as the Urban Indian Health Institute. Some blog entries will be reviews of new applications or new capabilities, which add functionality to the workflow. Twitter and Facebook accounts will also be established and maintained to help spread the word about updates on the web resource and community health mapping via social media.

Timeline and deliverables

Deliverable Date	Task	Deliverable
January 31, 2014	Web resource	Website established
February 28, 2014 and ongoing	Web resource	First blog entry. Additional entries to be continually added throughout 2014
March 1, 2014	Peer-reviewed article draft completed	Article draft
April 1, 2014	Submit to selected journals	Article submitted
Fall 2014	Article accepted by a journal	Article accepted
Ongoing	Technical support	Support