CEPF SMALL GRANT FINAL PROJECT COMPLETION REPORT

Organization Legal Name:	Caribbean Wildlife Alliance
Project Title:	Floristic Survey of Hellshire Hills, Manatee Bay, and Goat Islands, Jamaica: A Contribution to Improved Protection and Management of the Jamaican Iguana
Date of Report:	19 Apr 2013
Report Author and Contact Information	Michael Fouraker, mfouraker@fortworthzoo.org; 817-759-7590 (PI: Amanda K. Neill, aneill@brit.org)

CEPF Region: Caribbean Islands (Jamaica)

Strategic Direction: CEPF Strategic Direction 1: Improve protection and management of 45 priority key biodiversity areas.

Grant Amount: $20,000

Project Dates: February 2012-March 2013

Implementation Partners for this Project (please explain the level of involvement for each partner):
Botanical Research Institute of Texas (BRIT): Amanda Neill, Director of the BRIT Herbarium: Primary Investigator, lead botanist, and project manager; Tiana F. Rehman, BRIT Herbarium Collections Manager: botanical assistant (2 expeditions); Rebecca Swadek, BRIT Herbarium Assistant: botanical assistant (1 expedition)
University of the West Indies Mona (UWI): Patrick Lewis, UWI Herbarium Collections Manager: Jamaican botanical assistant (4 expeditions); Dr. Byron Wilson and members of the Jamaican Iguana Recovery Group: field assistants and logistics (4 expeditions); Andreas Oberli, UWI Research Associate: botanical assistant (2 expeditions);
Urban Development Corporation (UDC): Damion Whyte, Environmental Officer: botanical assistant (4 expeditions); other UDC field officers and game wardens: field assistants (3 expeditions)
Caribbean Costal Area Management Foundation (C-CAM): Brandon Hay: observational capacity building (2 expeditions), Ann Sutton: observational capacity building (1 expedition), two field officers: observational capacity building (1 expedition)

Conservation Impacts

Please explain/describe how your project has contributed to the implementation of the CEPF ecosystem profile.

This project contributed to CEPF Strategic Direction 1, the implementation of improved protection and management of a priority key biodiversity area, the Portland Bight Protected Area (PBPA), Jamaica, by producing an updated and vouchered plant species list for the Hellshire Hills, including Manatee Bay, and the Goat Islands.

Hellshire supports one of the few undisturbed evergreen coastal forest habitats left in the Caribbean, the largest intact dry limestone forest in Central America and the West Indies, and has been identified as one of the wholly irreplaceable areas and highest-priority key biodiversity areas in the Caribbean by CEPF. The only survey ever made of the flora of this area was reported as part of a rapid biodiversity analysis performed in July-September 1970 (Woodley 1971). That survey reported 271 species of plants in Hellshire.

A complete flora of this highest-priority key biodiversity area provides the necessary baseline data for creation of management plans within the Portland Bight Protected Area in Jamaica, contributes to the conservation of the critically endangered Jamaican Iguana, and also relates to CEPF Strategic Direction 3 by building capacity in Jamaica for broader ecosystem studies and environmental impact assessments.

This survey of the plants of Hellshire is one component of a larger, collaborative project led by the University of the West Indies (UWI), the International Iguana Foundation, the Fort Worth Zoo, the Hope Zoo, and the Caribbean Wildlife Alliance, with major conservation impacts for a significant and unique ecosystem harboring the last surviving populations of rare and endangered species, including the Jamaican Iguana.

Please summarize the overall results/impact of your project against the expected results detailed in the approved proposal.

The specific objective of the proposed project was to collect images and species-verified voucher specimens for every plant species occurring in the Hellshire Hills, Manatee Bay, and Goat Islands, including seed collections for fleshy-fruited plants likely to be eaten by the Jamaican Iguana, in order to provide baseline data and increase regional conservation capacity. The three primary goals and deliverables originally proposed are listed below, followed by the actual final outcomes and deliverables.

1) **To identify all plant species in the area for a more complete understanding of Jamaican biodiversity and to inform overall conservation efforts, including identification and removal of invasive alien species, and targeted assessment of endangered and endemic species.**

This project has accomplished the most thorough survey of the plants of Hellshire ever undertaken, and has resulted in modern, vouchered records for 379 species of plants in the area. Of these, 236 species had already been reported by Woodley (1971). In other words, this project collected **143 species not previously published as occurring in Hellshire**, a much larger number than was anticipated. These include many new records of invasive weeds (generally from coastal habitats), but also include native, non-weedy species that simply had escaped notice by earlier botanists, as well as endemic and IUCN red-listed endangered species not previously recorded for Hellshire, including *Swietenia mahagoni* (West Indian Mahogany) and *Bursera hollickii*. The list of species collected is attached to this report (Appendix 1).

By adding the 271 plant species recorded by Woodley to the 143 species this project collected that had not previously been recorded from Hellshire, one obtains a total of 414 plant species. **In other words, this project has resulted in a 52% increase in the known flora of the Hellshire Hills and Goat Islands.**

2) **To create vouchers of all plant species (herbarium specimens to be deposited at the UWI and IJ herbaria, and BRIT, and also made available online) to be used as reference material by other scientists working in the area.**

Over four expeditions, this project made **464 plant collections from Hellshire**, each in triplicate, and these sets were distributed to three herbaria: BRIT Herbarium in Texas, IJ Herbarium at the Institute of Jamaica's Natural History Museum, and UCWI Herbarium at the University of the West Indies, Mona. These permanent vouchers will be available for study at each institution, and a list of these vouchers is attached to this report (Appendix 2).

Complete data for each of the collection records is also available online in BRIT's Digital Herbarium (http://atrium.brit.org), browsing by "Project" and then selecting "Flora of the Hellshire Hills, Jamaica," or by using this direct link: http://atrium.brit.org/images_list.php?type=project&id=143, which has already been shared with

all partners and stakeholders. From this entry point, one can access collection data, maps, and over 5600 images, for individual records, or for the entire dataset. One can also create checklists at the species, genus, and family level. All images and data are downloadable, and available for re-use on other sites such as the Jamaica Clearing-House Mechanism, the Jamaica Virtual Herbarium Project, and the Inter-American Biodiversity Information Network.

3) **To create a local repository of vouchers of seeds from fleshy fruits (linked to identified herbarium specimens) to be compared with material found in Jamaican Iguana droppings.**

When plants were encountered in the course of the Hellshire expeditions with fleshy, mature fruits (or seeds with an exposed, fleshy aril serving the same purpose) that were likely to appeal to a Jamaican Iguana, triplicate herbarium vouchers were created and also additional fruits from the same plant were collected, cleaned, and imaged. **79 plant species with fleshy fruits were collected and are now represented by cleaned seed images** (also in BRIT's Digital Herbarium; see link above, and indicated in the species checklist provided in Appendix 1) and these seeds remain with the vouchers, inside "fragment packs" attached to the herbarium sheet, so they can be accessed for study in the future. The seed images were used to create a field guide that has been delivered to the Jamaican Iguana Recovery Group so that iguana scat samples can now be analyzed and the seeds successfully identified to species. A copy of the seed field guide is attached to this report (Appendix 3). The vouchered plant specimens and the rest of the plant images will also be valuable for any future observation studies of preferred vegetation consumption by the iguanas. The resources created by this project will greatly inform our knowledge of the natural history of the Jamaican Iguana and will contribute to its conservation.

Please provide the following information where relevant:

Hectares Protected: N/A

Species Conserved: At least 414 plant species are now known to occur in Hellshire as a result of this project. These are now known to include endemic and IUCN red-listed endangered species not previously recorded for Hellshire, including *Swietenia mahagoni* (West Indian Mahogany) and *Bursera hollickii*. The current plant species checklist for the area developed by this project is contributing to the C-CAM conservation management plan for the PBPA and provides vouchered baseline data critical to the assessment and conservation of the biodiversity of the Hellshire Hills. The list of species collected is attached to this report (Appendix 1).

Corridors Created: N/A

Describe the success or challenges of the project toward achieving its short-term and long-term impact objectives.

We believe this project has successfully met its short-term objectives, as defined in the proposal and described in the "overall result/impacts" section above. In general, we consider this project a great success in that it has increased by 52% the number of plant species known from the area, imaged and vouchered 379 plant species for three herbaria, and generated resources for seed identification in iguana scat from 79 species.

We believe this project will also successfully meet its long-term impact objectives, in that the data generated will make possible the various ecological assessments and conservation management decisions predicted in the proposal, although the delivery of these impacts depends on the activities of other agencies and stakeholder groups. The results of this project allow the first assessment of endangered and endemic plants in Hellshire in over 40 years. This survey has direct impacts on conservation of an endangered and charismatic animal by assisting the Jamaican Iguana Recovery Group in the planned Goat Islands restoration project by delivery of

reference material for the identification of important iguana food plants, and enabling a focus on those food plants that have been extirpated from the Goat Islands as species of priority for revegetation activities, if necessary. The species checklist, online images, and maps generated by this project now make possible the other kinds of ecological surveys required by C-CAM for long-term management and metrics of ecosystem health.

Were there any unexpected impacts (positive or negative)?

Unexpected positive impacts of this project are primarily in the larger-than-expected amounts of data (in terms of numbers of collections, numbers of species, and numbers of images, including images of the seeds of fleshy fruits) gathered by a small group of botanists over four expeditions in only one year. The broader impacts of these results are yet to come, but are already helping to generate interest and publicity for the conservation of the biodiversity of Hellshire. This project will continue to have impacts in fostering collaboration among C-CAM, UWI and IJ biologists and ecologists, the Urban Development Corporation, and collaborators at the Hope Zoo and the Fort Worth Zoo in their active conservation efforts in the region.

This project's actual and online publications and access to images and data for the plants of the area will also continue to have broader impacts, as these materials will be used by Jamaican educators to encourage appreciation and higher valuation of local biodiversity, leading to a more conservation-minded general populace. These same materials will be valued by future ecotourists and will enrich their experience and appreciation of the area.

Lessons Learned

Describe any lessons learned during the design and implementation of the project, as well as any related to organizational development and capacity building. Consider lessons that would inform projects designed or implemented by your organization or others, as well as lessons that might be considered by the global conservation community.

Attempting to produce a complete floristic survey of a large, roadless, dry and dangerously rocky area is logistically complex, for a number of reasons.

The inclusion of several people on an expedition team is safer, provides more eyes to look for plants and more experience to identify them, and is necessary for efficient division of labor; a large team allows more plant species to be located, identified, and collected. However, large teams create logistical difficulties as well, in that the need to carry more food and water overland is burdensome, transport to and from drop-off sites becomes more complex, and the coincidence that everyone is available to undertake an expedition at the same time, for a long enough time, becomes a rare occurrence. These factors prevented expeditions as lengthy as originally proposed, and reduced the number of sites the botany team was able to access, although we did manage broad coverage of the area (see Appendix 4 for a map showing all the collection localities).

A second complication is encountered from the plants one is attempting to survey. Of course, every species has a distinct and restricted period of flowering and fruiting each year or season, and the most useful botanical specimens are produced by collecting flowering and/or fruiting material. Without the ability to survey every part of Hellshire in every month of the year, there were, inevitably, species only encountered in a sterile state, or in a flowering state, when a fruiting state would have been more desirable, given that one of the project goals was the vouchering and imaging of seeds of fleshy fruits likely to be consumed by the Jamaican Iguana. While this project collected 79 species with fleshy fruits present (and subsequent seed vouchers and images), we estimate an additional 52 species were collected that are known to have fleshy fruits, but were not ever seen in the fruiting stage by our team (see Appendix 1).

In summary, we consider this project a great success in that it has increased by 52% the number of plant species known from the area, imaged and vouchered 379 plant species for three herbaria, and generated resources for seed identification in iguana scat from 79 species. But the primary lesson learned is that it would be more convenient for the people— and the plants— if more frequent, shorter expeditions were made. This would undoubtedly allow more plant species to be found in a fertile state, would be less burdensome logistically, and would likely allow a larger and more diverse group of participants to be spread out over multiple trips to a larger number of sites.

Project Design Process: (aspects of the project design that contributed to its success/shortcomings)

The project was well designed, within the limited awareness of logistical issues that would be faced conducting large, intensive botanical expeditions in Hellshire. The process of a floristic survey is fairly standard in any region of the world, as is the process of collecting, imaging, and vouchering species records. And the targets of the project were not only met but exceeded our design's anticipated results. As noted above, more frequent, shorter trips would have been more ideal for more complete area and seasonal coverage, as well as logistical ease, but predicted costs for more trips would have exceeded the CEPF small grant budget limit. The process of identifying species and arranging for export, particularly of the CITES and endemic species requiring special permits from NEPA, took longer than anticipated.

Project Implementation: (aspects of the project execution that contributed to its success/shortcomings)

The project was well implemented, within budgetary limitations. The plant-collecting activities went perfectly and were very successful in that approximately 143 new species records for the region were vouchered, along with 236 species already known to occur in Hellshire. All collections have a voucher set located at BRIT, UCWI, and IJ herbaria. If another expedition had been possible within the project-year, no doubt the remaining approximately 35 species recorded by Woodley but not collected by this team would have been located and vouchered as well, perhaps along with additional new species records. This project collected 79 species with fleshy fruits present (and subsequent seed vouchers and images from these), and their digital records were used to create a field guide that has been delivered to the Jamaican Iguana Recovery Group as well as to C-CAM and other project partners (and is attached as Appendix 3). The digitization of collection records at BRIT took slightly longer than expected but was completed within the project timeline. As mentioned above, the process of identifying species and arranging for export, particularly of the CITES and endemic species requiring special permits from NEPA, took longer than anticipated. NEPA recently issued the final export permits for the CITES collected by this project and they are now being prepared for shipment, along with the other specimens from the fourth expedition.

Other lessons learned relevant to conservation community:

The collection and analysis of baseline data, especially when one must cover a lot of ground and identify a lot of species that are not well known or documented, is no rapid matter. Correctly identifying certain species may require museum (herbarium) study, microscope time, library time to locate appropriate references, and often the sharing of images or physical specimens with taxon experts at other institutions around the world. This project found 143 plant species not previously known from Hellshire. Included in this number are some species that are not yet "keyed-out" or completely identified, because that often requires more time, after fieldwork is completed. In these cases these taxa were not recognized (to the level of species) by Jamaican botanists. It may turn out that some of these species were not previously known from Jamaica. It may turn out that some of these are actually species new to science (though that is a slim chance, it is possible).

Though some of the species determinations made by BRIT and UWI botanists are preliminary and some species are not completely identified, the numbers reported in this document are real numbers, e.g., this project collected four species of *Chloris* (Poaceae) in Hellshire represented by four collections (see Appendix 1). One of these has been tentatively "keyed-out" to *Chloris barbata*, a species not recorded by Woodley. Three other collections represent three other distinctly different species, one of which is probably *Chloris petraea*, which is the only *Chloris* species recorded by Woodley. So, four species are reported in the genus *Chloris*, at least three of which are new for the Hellshire list. Species keying and more final determinations for the collections from this project will continue after the grant period and should be completed by the end of summer, 2013.

The project data have been provided to C-CAM as a contribution to their management planning for the region, in multiple formats. They have also been instructed on the steps to download project data and images for re-use in their reports. But further work is required, and perhaps more discussion at the outset of such projects, on which kinds of data and what formats would be most useful for communication with those writing management plans. Aside from the slow and difficult generation of an accurate species list, the additional desire of the conservation community for a "report" on the findings and some recommendations on what they mean requires another level of analysis once the species list is complete. Ideally, the newly-generated data should be compared with and combined with extant historical baseline data, such as records of other collections of Hellshire's plants residing in the two herbaria in Jamaica, and the conservation implications for certain species of interest should be discussed with the broader botanical community in Jamaica before recommendations can be made. This process is actually now underway, in a large collaboration involving BRIT, UWI, and the Institute of Jamaica, but the resulting article will likely not be published until 2014.

ADDITIONAL FUNDING

Provide details of any additional donors who supported this project and any funding secured for the project as a result of the CEPF grant or success of the project.

Donor	Type of Funding*	Amount	Notes
Urban Development Corporation (UDC)	A (in-kind)	Unknown, but resulted in reduced direct costs and increased project success	At no cost to the grant, UDC provided staff support for every expedition, as well as vehicle use for expeditions 2-4, and lodging for expedition 2.
Botanical Research Institute of Texas	A (matching)	$33,042	BRIT staff salary and fringe for time spent on project (Neill and Rehman)
Caribbean Wildlife Alliance	A (matching)	$3000	15% administrative overhead

***Additional funding should be reported using the following categories:**

A *Project co-financing (Other donors contribute to the direct costs of this CEPF project)*

B *Grantee and Partner leveraging (Other donors contribute to your organization or a partner organization as a direct result of successes with this CEPF project.)*

C *Regional/Portfolio leveraging (Other donors make large investments in a region because of CEPF investment or successes related to this project.)*

Sustainability/Replicability

Summarize the success or challenge in achieving planned sustainability or replicability of project components or results.

The largest achievement in sustainability by this project is in the delivery of an updated, vouchered plant species list for the Hellshire Hills and Goat Islands, as well as the creation and deposit of triplicate herbarium specimens (at BRIT, IoJ, and UWI) and over 5600 online images (at http://atrium.brit.org/images_list.php?type=project&id=143). All of these resources vastly improve access to baseline floristic data and tools for identification of unknown plants. The subset of 79 fleshy-fruited plant species which have had seed images recorded is a direct contribution to research activities that will improve conservation of the Jamaican Iguana.

The conservation management program for the Portland Bight Protected Area being carried out by C-CAM is just one example of the long-term applicability of this project's data, including the species checklist, with potential for use by any element of C-CAM's sub-area management plans, including any kind of ecological studies to be carried out on organisms that rely on plants, as well as quantitative vegetation analyses. In this way, floristic baseline data directly contributes to concrete conservation results. By sharing techniques of botanical field work, this project also contributed to capacity building for agencies in the region. C-CAM ecologist Brandon Hay accompanied the botany team on the first expedition and brought two field officers who assisted with field equipment over two days of arduous field work. Hay and C-CAM ecologist Ann Sutton accompanied the field team on the final expedition during two days of plant collecting.

Several project activities involving interaction with the various agencies responsible for oversight of the PBPA have successfully contributed to sustainability in that they have increased awareness of, and value perception of, the flora of Hellshire, not only as a food source for Jamaican Iguanas but also as a refuge for numerous rare and endemic plant species, some of which were recorded for the first time in Hellshire as a result of this project. Over the course of the project, the PI met with various agencies and stakeholders in the region and has also provided them updates after each expedition.

The Forestry Department and NEPA were both very interested in the larger-than-expected species numbers being found in Hellshire, including rare and endemic species. The final species list and a copy of this report is being provided to these agencies, which helps to support them by providing more baseline data that will justify their future decisions regarding natural resource management and protection within the PBPA, and beyond its borders.

The Urban Development Corporation, in particular, has shown a great interest in this project and has provided personnel and logistical support for every expedition at no cost to the project. In February 2013 they interviewed the PI about the importance of Hellshire's plants and their conservation, and filmed her and her botanical crew collecting in Hellshire; these will form one segment of a new public education video on Hellshire, now in production. The final species list is also being provided to the UDC.

The voucher specimens created by this project will last hundreds of years when cared for (BRIT's oldest specimen was collected in 1791). It is expected that the online data and images will have at least as long a lifespan. By making these digitized specimens available to the Jamaica Clearing-House Mechanism, the Jamaica Virtual Herbarium Project, and the Inter-American Biodiversity Information Network, and partners such as C-CAM, UWI, and the Institute of Jamaica, along with the floristic synthesis made possible by this project, this project will help all these partners to build local capacity for science, education, and conservation work.

The techniques of floristic surveys are standardized and species lists can be compared easily between regions to obtain an understanding of plant diversity. Future surveys of the same area can be quantitatively compared with this project's results to discover positive or negative changes in ecosystem health, movement of invasive species, and endangered species survival. While the creation of botanical specimens and the documentation of the flora of an area is generally an easily replicable activity, modern improvements to collecting protocols make the outputs much more valuable and useful. Innovations standardized for this floristic project, and demonstrated to all participants and observers (so that these practices could be carried on by them in the future) include: recording of GPS points for every collection, creation of multiple digital images of every aspect of the living plant, and creation of digital images of cleaned seeds of each collection with fleshy fruit. It is hoped these practices will be replicated by other botanists and ecologists working in Jamaica.

Summarize any unplanned sustainability or replicability achieved.

One outreach activity related to this project has contributed to sustainability that was not anticipated at the time of the project proposal. As increasing number of plant species were collected in Hellshire that had not previously been recorded from the area, it became obvious that publication of the new species list (in a formal peer-reviewed scientific journal) would be warranted. This project's list is now being compared with and combined with unpublished historical baseline data, such as records of other collections of Hellshire's plants residing in the two herbaria in Jamaica, including those from the original 1970 Woodley survey. This process is well underway, in a large collaboration involving botanists and ecologists from BRIT, UWI, and the Institute of Jamaica, among others, including one of the original Woodley survey participants. The resulting, updated "Flora of Hellshire" article will likely be submitted for publication in late 2013.

Safeguard Policy Assessment

Provide a summary of the implementation of any required action toward the environmental and social safeguard policies within the project.

This project did not require any actions regarding World Bank safeguard policies.

Additional Comments/Recommendations

Literature Cited

Woodley, J.D. 1971. Hellshire Hills Scientific Survey. University of the West Indies / Institute of Jamaica.

Information Sharing and CEPF Policy

CEPF is committed to transparent operations and to helping civil society groups share experiences, lessons learned, and results. Final project completion reports are made available on our Web site, www.cepf.net, and publicized in our newsletter and other communications.

Please include your full contact details below:

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*****If your grant has an end date other than JUNE 30, please complete the tables on the following pages*****

Performance Tracking Report Addendum

CEPF Global Targets

(Feb 2012- Mar 2013)

Provide a numerical amount and brief description of the results achieved by your grant.
Please respond to only those questions that are relevant to your project.

Project Results	Is this question relevant?	If yes, provide your numerical response for results achieved during the annual period.	Provide your numerical response for project from inception of CEPF support to date.	Describe the principal results achieved from Feb 2012- Mar 2013. (Attach annexes if necessary)
1. Did your project strengthen management of a protected area guided by a sustainable management plan? Please indicate number of hectares improved.	Yes	Ca. 14,700 hectares	Ca. 14,700 hectares	**Hellshire Hills Sub-Area of the Portland Bight Protected Area, Jamaica** The current plant species checklist for the area developed by this project is contributing to the C-CAM conservation management plan for the PBPA.
2. How many hectares of new and/or expanded protected areas did your project help establish through a legal declaration or community agreement?	No			
3. Did your project strengthen biodiversity conservation and/or natural resources management inside a key biodiversity area identified in the CEPF ecosystem profile? If so, please indicate how many hectares.	Yes	Ca. 14,700 hectares	Ca. 14,700 hectares	**Hellshire Hills, Jamaica (a CEPF highest-priority key biodiversity area)** The current plant species checklist for the area developed by this project provides vouchered baseline data critical to the assessment and management of the biodiversity of the Hellshire Hills.
4. Did your project effectively introduce or strengthen biodiversity conservation in management practices outside protected areas? If so, please indicate how many hectares.	Yes	unknown	unknown	**Jamaica** The vouchered collection records from this project inform natural resource management decisions throughout the country because these have increased the number of known localities for endangered plant species as well as updated the known ranges of invasive species.
5. If your project promotes the sustainable use of natural resources, how many local communities accrued tangible socioeconomic benefits? Please complete Table 1below.	No			

If you answered yes to question 5, please complete the following table.

Table 1. Socioeconomic Benefits to Target Communities

Please complete this table if your project provided concrete socioeconomic benefits to local communities. List the name of each community in column one. In the subsequent columns under Community Characteristics and Nature of Socioeconomic Benefit, place an X in all relevant boxes. In the bottom row, provide the totals of the Xs for each column.

Name of Community	Community Characteristics								Nature of Socioeconomic Benefit												
									Increased Income due to:												
	Small landowners	Subsistence economy	Indigenous/ ethnic peoples	Pastoralists/nomadic peoples	Recent migrants	Urban communities	Communities falling below the poverty rate	Other	Adoption of sustainable natural resources management practices	Ecotourism revenues	Park management activities	Payment for environmental services	Increased food security due to the adoption of sustainable fishing, hunting, or agricultural practices	More secure access to water resources	Improved tenure in land or other natural resource due to titling, reduction of colonization, etc.	Reduced risk of natural disasters (fires, landslides, flooding, etc)	More secure sources of energy	Increased access to public services, such as education, health, or credit	Improved use of traditional knowledge for environmental management	More participatory decision-making due to strengthened civil society and governance.	Other
Total																					

If you marked "Other", please provide detail on the nature of the Community Characteristic and Socioeconomic Benefit: