Esri News for Agriculture

Spring 2013

Clearwater Seafoods Achieves Sustainable Operations through GIS

Courtesy of Esri Canada Limited

Clearwater Seafoods Limited is a global leader in the seafood industry and the largest harvester of wild shellfish in the Atlantic Ocean off Canada. The award-winning company has built its business around a core commitment to long-term sustainability and responsible fishing. Always looking to improve operations, Clearwater invests significantly in technologies that enable top-quality seafood to be delivered from ocean to plate.

A recent investment in GIS has resulted in significant cost savings, minimized impact on ocean ecosystems, and promoted a sustainable approach to fishing.

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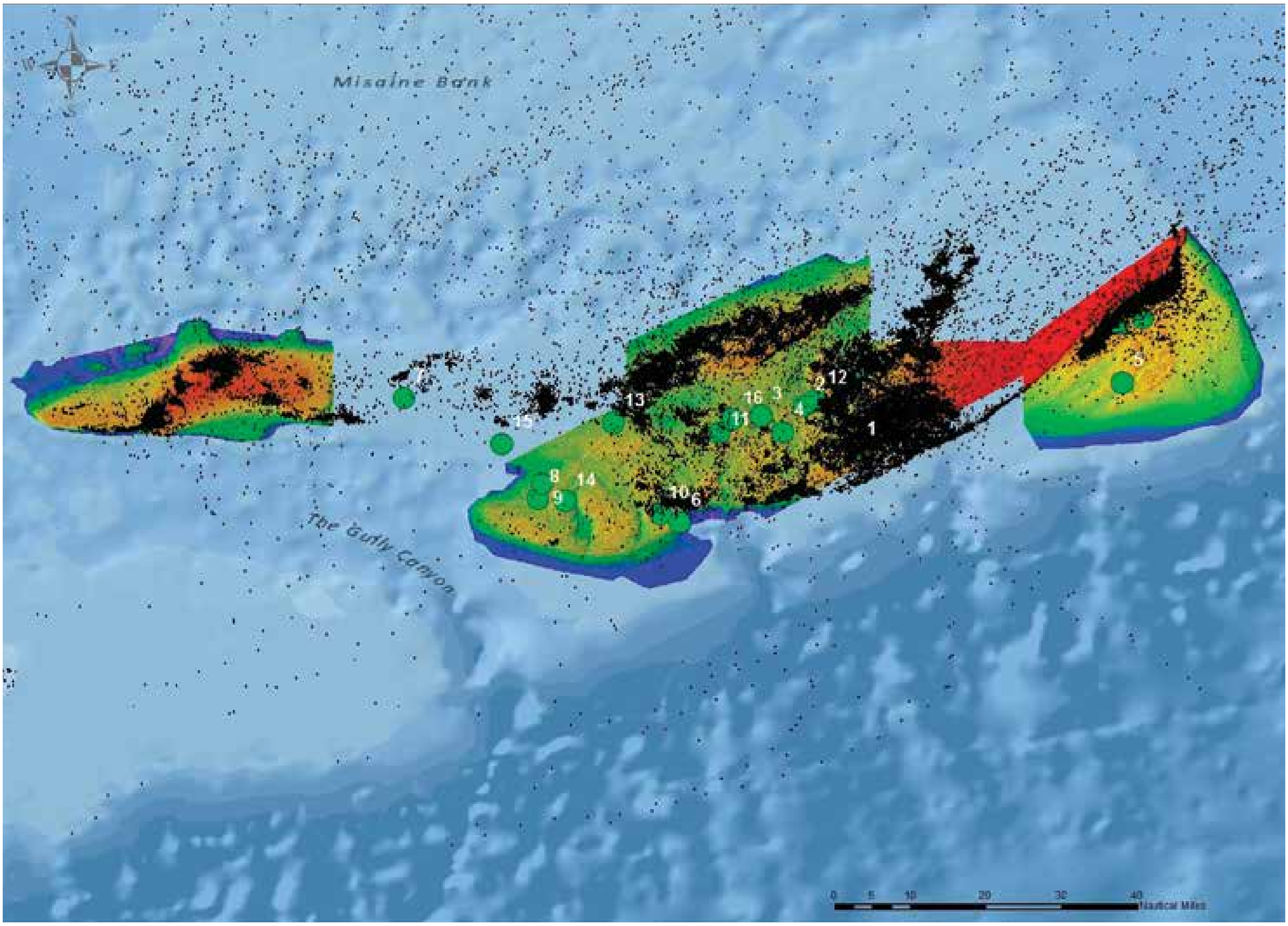

↑ Footprint of Clam Harvest Distribution with Survey Positions

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Based in Nova Scotia, Clearwater harvests, processes, markets, and sells premium shellfish and seafood to a variety of markets worldwide. The company must balance a high level of production with a commitment to responsible fisheries management—a practice that draws on science to ensure sustainable exploitation. As a largely geographic undertaking, sustainable fisheries management requires the ability to intersect and analyze many layers of data including species abundance and composition, feeding and reproduction, historical fishing efforts, and oceanographic/ecosystem conditions.

Forecasting where and what type of harvest will be available is also a key component of responsible fishing. This can be achieved through assessment models that predict the location, stage of growth, and populations of various biomasses. Access to this information improves fishing success rates and also helps protect the ocean's diverse ecosystems by minimizing impact on nontarget species.

"GIS serves as the ideal platform to analyze, model, and forecast outcomes so that we can significantly reduce the cost of harvesting," says Jim Mosher, director of harvest/science management, Clearwater Seafoods Limited. "More importantly, it enables us to plan our activities in a much broader context so that we can fulfill our core commitment to long-term sustainability."

In addition to resource analysis, fisheries must strategically route ships to ensure sustainability and reduce fuel emissions. With a large and diverse fleet of oceangoing vessels along with rising fuel costs, Clearwater decided to invest in technology that could serve as a platform to intersect and analyze diverse data.

Clearwater selected Esri's ArcGIS for Desktop and the Spatial Analyst extension to study fish resources and population dynamics. This technology enables the company to overlay spatial and temporal fishing data, including bathymetry (the study of underwater depth and ocean floors), sediment types, survey data, harvest areas, and benthic habitat, to quickly identify potential growth areas. Staff can also factor in weather influences, species biology, lunar cycles, and other relevant data to determine the most effective methods of harvesting resources.

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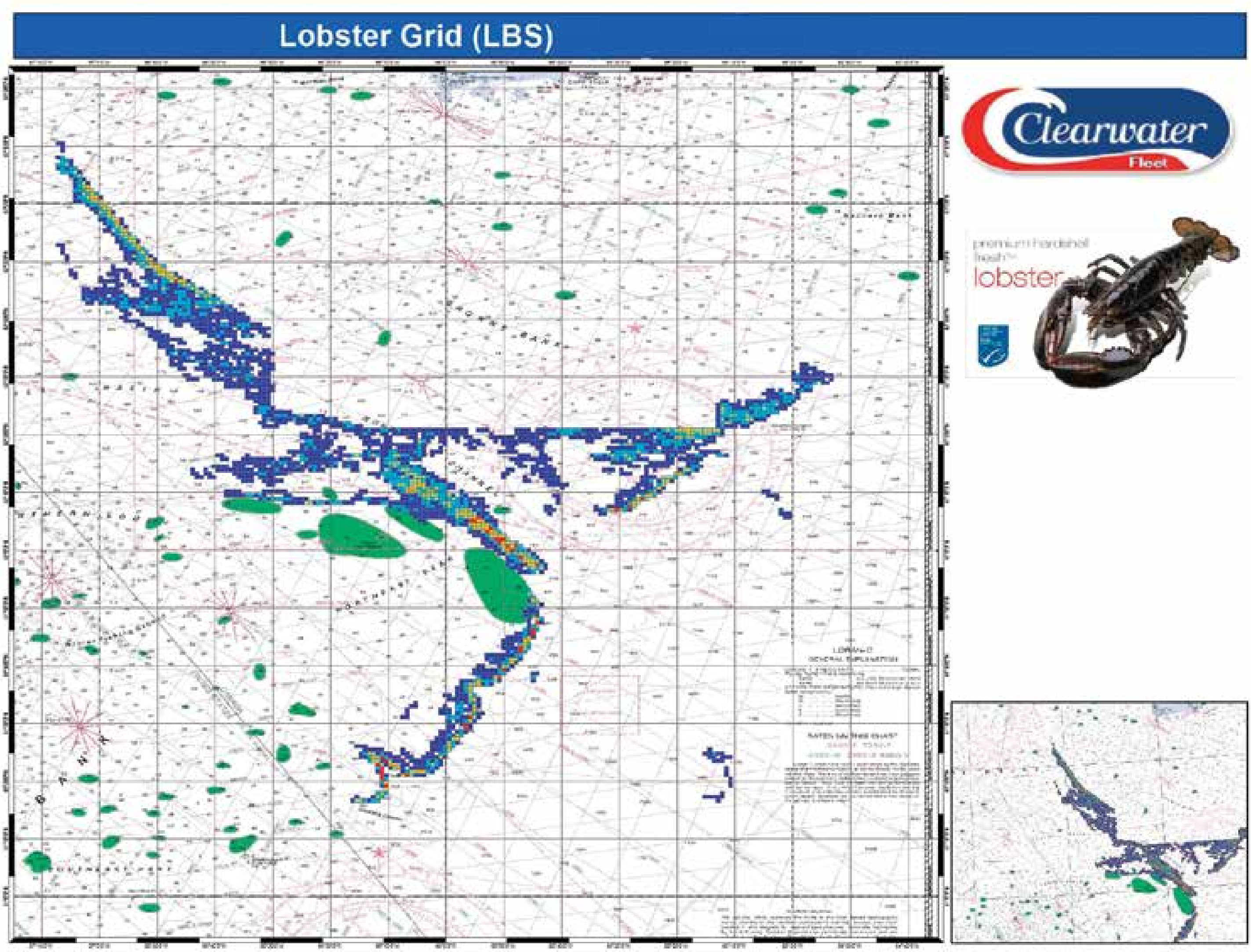


↑ Historic data depicts the spatial distribution of lobster catch per trap along the southern coast of Nova Scotia.

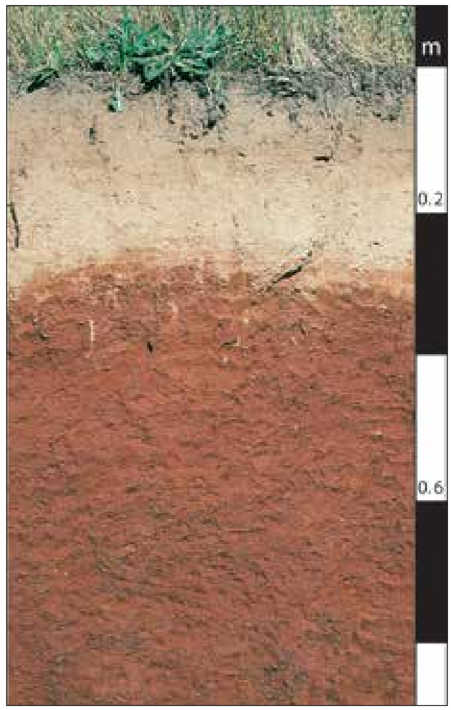
ACLEP Digs Deep to Create National Soil Database

Courtesy of Esri Australia Pty. Ltd.

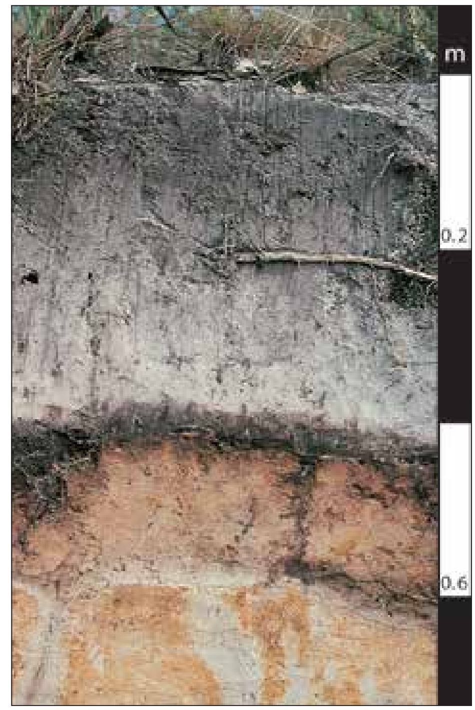
Australia's 7.69 million square kilometers of land are arguably its most valuable natural asset, particularly when it comes to the nation's food security. But this vast landscape's geographic diversity means that developing and maintaining detailed, accurate soil information—crucial to the effective management of the agribusiness sector—is no easy feat.

Traditionally, soil records have only been available in hard copy, and since soil data was managed differently by the states and territories, the records were sometimes difficult to locate. To ensure the nation's soil data could be properly maintained and accessed, the Australian Collaborative Land Evaluation Program (ACLEP) identified the need for a nationally consistent and publicly available land and soil information system.

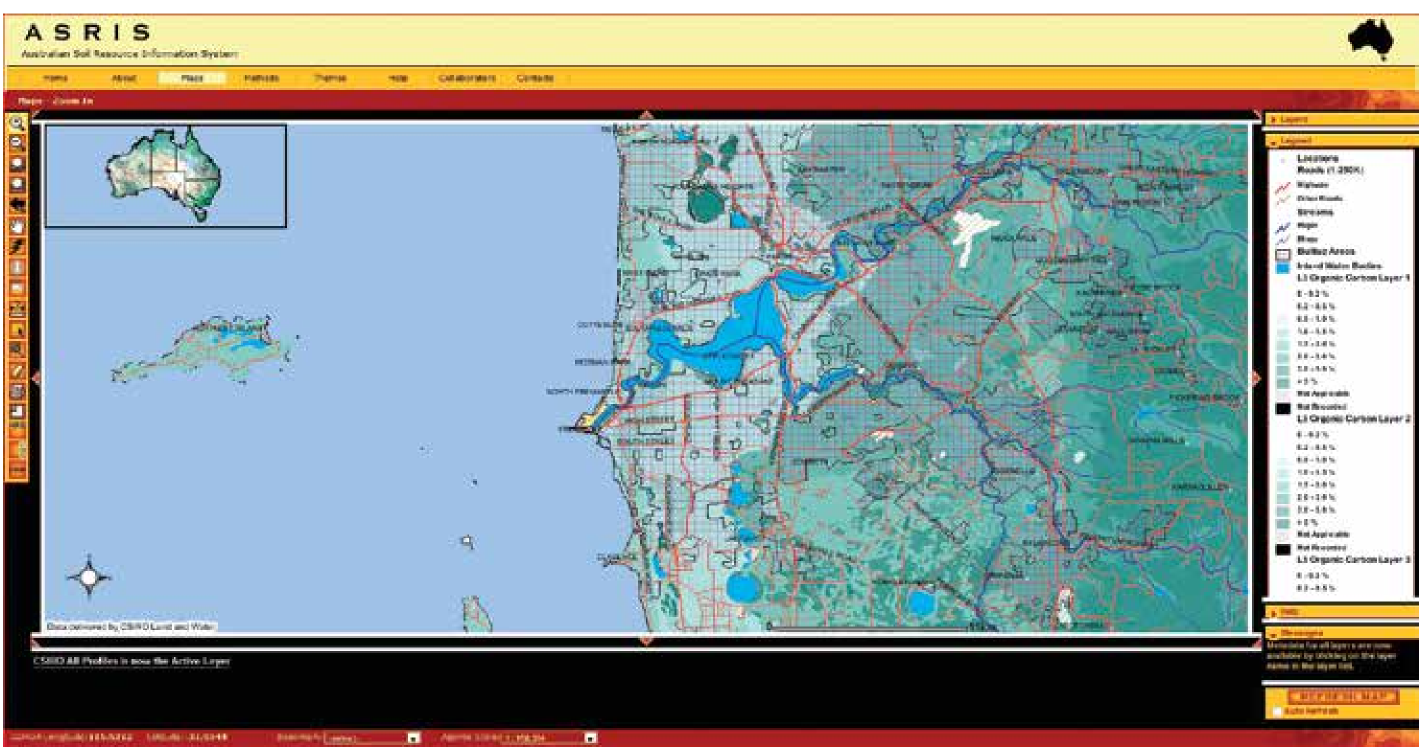
ACLEP partnered with Esri's distributor in Australia, Esri Australia Pty. Ltd., to overhaul existing disparate information systems and develop an online portal for national soil data management and delivery. Using



↑ Soil Sample: Red Kurosol



↑ Soil Sample: Semiaquic Podosol



↑ Australian Soil Resource Information System (detail) cutting-edge ArcGIS technology to literally map the geographic elements contained within the data, ACLEP developed the Australian Soil Resource Information System (ASRIS), a publicly accessible interactive mapping website.

ASRIS is underpinned by Australia's first comprehensive, nationally consistent soil database, which integrates land and soil data from all state and territory databases. Soil is a vital part of the equation in any development or agricultural project, as it determines to a large extent how the land may be used. For example, agricultural industries can use ASRIS to make informed management decisions by considering soil-related issues such as water holding capacity, erodibility, or salinity. Developers can also use ASRIS to identify soil types prior to building commencement, potentially avoiding costly problems associated with excavation, swelling clays, and unstable land.

David Jacquier, land and water project manager for the Commonwealth Scientific and Industrial Research Organisation (CSIRO), says that GIS technology provides the public and agribusiness stakeholders with instant access to essential land and soil information.

"By making all the country's soil data available through one mapping interface, ASRIS presents complex information in an accessible format that transcends a user's education, language, and technical experience," says Jacquier. "Users select the area they're interested in learning about, and with a click of their mouse, they can see soil data and information that previously might have taken hours or days to locate."

ASRIS mapping tools benefit a multitude of industries and individuals, including government departments, agricultural groups, researchers, developers, and the broader community. "Streamlining the way these stakeholders access soil data is an enormous step toward our goal of better matching land use with land suitability," says Jacquier.

ASRIS contains seven levels of soil and land data—which can be switched on and off depending on the detail of information required—and provides general descriptions of soil types and landforms as well as more detailed information on properties such as soil depth, texture, and acidity. By streamlining access to soil information, ASRIS enhances regional growth and sustainability by improving the understanding of soils and ensuring suitability for development.

"Soil data is vital to our environmental sustainability, and with GIS technology, this information is now more readily available in a useful, consistent format," concludes Jacquier.

International Researcher to Help Guide Esri's Agriculture Initiatives

Agriculture researcher Susana Crespo has joined Esri's natural resources team as its new agriculture specialist. Crespo was a research analyst for HarvestChoice, part of the International Food Policy Research Institute (IFPRI) before moving to Esri. She received her master's degree in international development and social change from Clark University in Worcester, Massachusetts.

"Susana is a welcome addition to our team," says Geoff Wade, natural resources manager. "She brings a wealth of experience and passion in applying Esri solutions to critical challenges in the agriculture industry."

At HarvestChoice, Crespo designed solutions for managing global agriculture spatial datasets, which supported IFPRI's efforts to collaborate and share spatial data across centers to minimize duplication and maximize access to that information.

"I believe that a more fluid flow of information leads to increased food security, more adaptive climate mitigation strategies, and better use of scarce financial and natural resources worldwide," says Crespo. "It is my purpose to support these endeavors through the smart adoption and application of spatial technology, and being part of Esri's natural resources team will help me advance these goals while supporting the team's mission."

E-mail Susana Crespo at screspo@esri.com or follow her on Twitter: @AgMapper.

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ArcGIS Spatial Analyst is used to facilitate interpolation techniques. Leveraging this tool, complex surfaces can be analyzed to reveal patterns that may not be readily apparent in raw data. The density, magnitude, and concentration of underwater harvest species can be measured at strategically dispersed sample locations and then extrapolated to accurately predict values in other locations. This makes it significantly easier to uncover high concentrations of harvest species and take a more targeted approach to operations.

Through access to a geodatabase of historical data, the company can identify trends based on what was accomplished in previous years and plan fishing activities to maximize output. Historical data can also be analyzed to ensure that harvest species are not overfished, a critical objective of responsible fishing practices.

A more strategic approach to vessel routing has enabled Clearwater to significantly reduce harvesting costs and take steps toward effectively reducing its carbon footprint. By equipping its fleet with sophisticated habitat imaging and vessel monitoring systems, the company has also been able to ensure that only targeted areas are fished.

Access to a GIS-based database further supports targeted activities by enabling analysts to review historic data. Overlaying this historical information with survey data makes it easy to readily identify areas that have already been harvested, supporting the spatial management of resources. They can also leverage patterns in the data to model and predict where there is most likely to be an abundance of harvest species.

As an environmental leader, Clearwater recognizes the importance of long-term sustainability and works toward ensuring that all harvesting activities promote a healthy ocean environment. GIS provides the company with a cost-effective tool to intersect diverse datasets so that Clearwater can better understand targeted resources and their connections to the broader ecosystem. As a result, the company is able to take an informed approach to harvesting that limits the impact of fishing activities and promotes sustainability both at sea and on land.

Will Breadfruit Solve the World Hunger Crisis?

New Developments in an Innovative Food Crop

By Matthew P. Lucas and Diane Ragone, National Tropical Botanical Garden

↑ Breadfruit is extremely productive, producing an average of 150–200 and up to as many as 600 nutritious fruits per season.

A map can be a powerful visual tool, but can a map help solve world hunger, rejuvenate agricultural soil, and prevent mosquito-borne infections? Can a map help slow global warming and spur sustainable economic development in tropical regions around the world? Perhaps a map alone can't do these things, but a map can help display the real potential of a very special tree, the breadfruit.

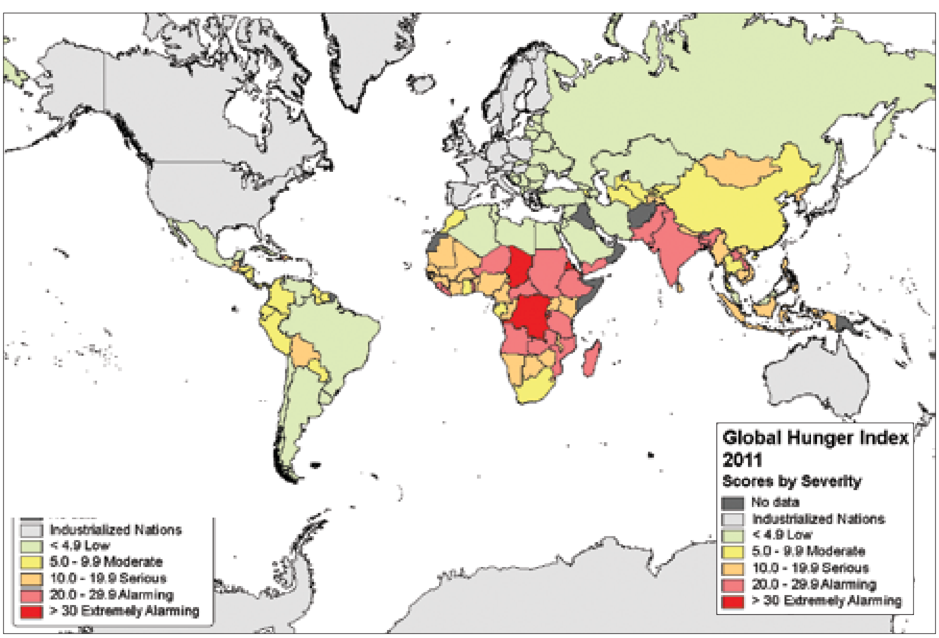
Breadfruit (*Artocarpus altilis*) is a tropical tree originally from Papua New Guinea with a rich and storied history. This starchy staple crop has been grown in the Pacific for close to 3,000 years and was introduced to other tropical regions more than 200 years ago. The trees are easy to grow and thrive under a wide range of ecological conditions, producing abundant, nutritious food for decades without the labor, fertilizer, and chemicals used to grow field crops.

These multipurpose trees improve soil conditions and protect watersheds while providing food, timber, and animal feed. All parts of the tree are used—even the male flowers, which are dried and burned to repel mosquitoes. Because of its multiple uses and long, productive, low-maintenance life, breadfruit was spread throughout the tropical Pacific by intrepid voyagers. Hawaii is one of the many island chains where breadfruit, or *ulu* in Hawaiian, was cultivated as a major staple. It is fitting that now Hawaii is home to the headquarters of an organization devoted to promoting the conservation and use of breadfruit for food and reforestation around the world.

The Breadfruit Institute, within the nonprofit National Tropical Botanical Garden (NTBG), is a major center for the tree's conservation and research of more than 120 varieties from throughout the Pacific, making it the world's largest repository of breadfruit. As a result of this work, the institute has received requests from numerous countries seeking quality breadfruit varieties for tree-planting projects. To address this need, the Breadfruit Institute has developed innovative propagation methods, making it possible to produce and ship thousands, or even millions, of breadfruit plants anywhere in the world.

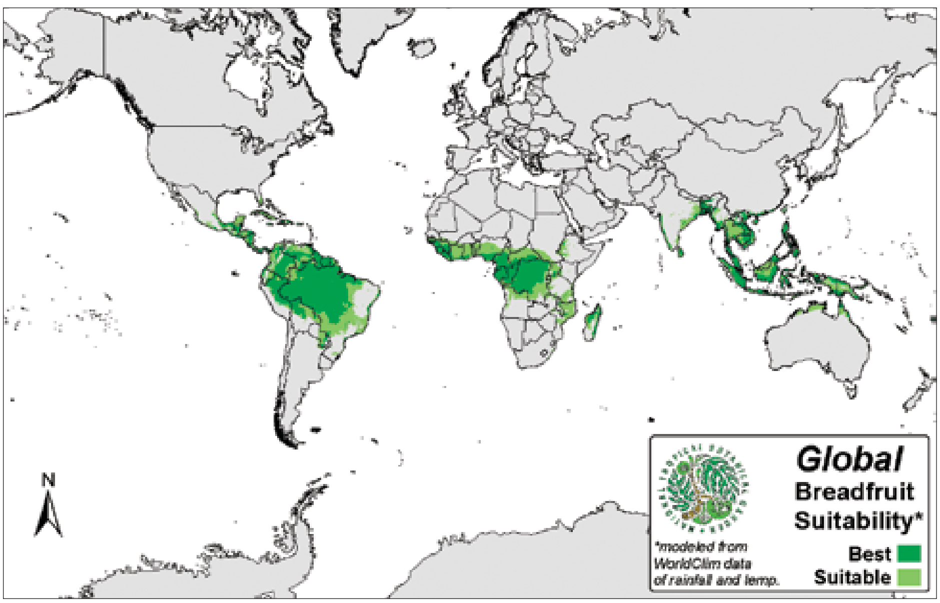
These breadfruit tree-planting projects can help alleviate hunger and support sustainable agriculture, agroforestry, and income generation. Most of the world's one billion hungry people live in the tropics—the same region where breadfruit can be grown. However, as Dr. Diane Ragone, author and director of the Breadfruit Institute, has learned, stating these facts and illustrating them are two very different things. A strong realization is made when a person sees the data from the United Nations Food and Agriculture Organization global map on world hunger coupled with a map showing areas suitable for growing breadfruit.

It was originally this type of powerful visual aid Ragone wanted when she began working with NTBG's GIS coordinator and coauthor Matthew Lucas. To create such a map, Lucas began by constructing a model within ArcGIS using WorldClim 30-second resolution global raster datasets of interpolated climate



↑ This map is based on the 2011 Global Hunger Index score displayed per country.

↑ Different varieties of breadfruit are conserved in the world's largest collection of breadfruit at the Breadfruit Institute in Hawaii. (Photo credit: © Jim Wiseman, courtesy of the Breadfruit Institute)



↑ Map showing zones of "best" and "suitable" growing conditions for breadfruit.

conditions compiled from the past 50 years (Hijmans et al. 2005). With the GIS, monthly rainfall and temperature data was condensed into total annual rainfall, mean annual temperature, and minimum and maximum annual temperature. Then, the annual climate data was reclassified.

"Suitable" and "best" ranges of rainfall and temperature were identified after referring to the breadfruit profile written by Ragone for *Traditional Trees of Pacific Islands* (Elevitch 2006). The best ranges in mean temperature and rainfall were given a value of 2, whereas suitable conditions were given a value of 1; conditions that were deemed too low or high were given a value of -10. ArcGIS was used to combine all the reclassified climate datasets. The final output resulted in a global dataset that now displayed areas deemed unsuitable for growing breadfruit as < 0, areas assumed suitable with a value of < 4 and > 0, and best areas with a value of 4. This data was displayed in combination with 2011 Global Hunger Index scores entered into a vector dataset of countries. The resultant map helps the viewer see the real potential breadfruit development has for tropical regions.

With this new visual aid completed, Ragone and Josh Schneider, cofounder of Cultivaris/Global Breadfruit, a horticultural partner that propagates breadfruit trees for global distribution, attended the World Food Prize symposium in October 2011. The breadfruit suitability map was shared with Calestous Juma, professor of the practice of international development and director of the Science, Technology, and Globalization Project at the Belfer Center for Science and International Affairs at the Harvard Kennedy School. Juma has extensive experience and contacts in Africa.

The map was also shared with the former president of Nigeria, Olusegun Obasanjo. It was at Obasanjo's invitation that Schneider visited Nigeria and met with government officials and researchers to discuss breadfruit planting projects. Due to the relatively fine scale (1 km) of the original datasets, a more detailed map of Nigeria showing areas suitable for growing breadfruit, along with roads and cities, was an invaluable tool during discussions.

The World Food Prize meeting also inspired the creation of similar country-specific maps that have been shared with organizations and individuals working in Haiti, Ghana, Jamaica, Central America, and China. The maps provide government officials, foundations, and potential donors with clear information about the potential of breadfruit in specific areas. The maps have spurred the question, What countries are best suited for growing breadfruit? ArcGIS was used to combine the breadfruit suitability data with a vector layer of country borders. This not only resulted in a list of countries that could grow breadfruit but also made it easy to identify and rank the amount of area each country has that is suitable and best for growing breadfruit.

It became clear that this map, the data within it, and the ArcGIS methodology used to construct it provided not only a powerful visual aid but also a useful research tool. Armed with such maps and the information they convey, Lucas and Ragone are continuing to pair what has been learned about breadfruit cultivation with ArcGIS to help understand and display future breadfruit potential. They are currently working on a climate change analysis that uses datasets of various future climate models and scenarios in an attempt to quantify areas that have the highest likelihood of sustainable breadfruit development. They are also working on publishing an online map displaying global breadfruit growing potential. Finally, it is the hope of the Breadfruit Institute and NTBG that future breadfruit development will be expanded and that ArcGIS will help guide potential breadfruit-growing countries in planning and implementing planting projects of this very special tree.

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