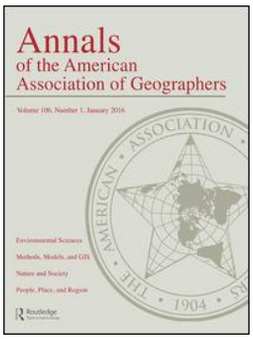

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Are There Food Deserts in Rainforest Cities?

Gemma Davies,* Gina Frausin,* and Luke Parry†

*Lancaster Environment Centre, Lancaster University
†Lancaster Environment Centre, Lancaster University, and Universidade Federal do Pará

Food deserts have been widely studied in Western contexts but rarely in transitioning economies and never within a rainforest. The Brazilian Amazon is a rapidly urbanizing region with high levels of poverty and food insecurity, providing an ideal context in which to explore this current research gap. Within this setting, five urban centers ranging from small town to metropole are examined to explore any potential variations between urban centers of different sizes and settings. A large survey was conducted with interviews in 554 food shops, assessing shop characteristics, food availability, price, and alternative household food acquisition strategies. Methods were developed to explore food deserts, accounting for food acquisition across multiple shops within a neighborhood. Insufficient access to healthy food was estimated to be widespread (42 percent of households), with access worse in smaller towns. Unlike many previous studies, local access to healthy food was not linked to neighborhood poverty and prices were generally lower in poorer areas. High levels of nonretail sourcing of food (e.g., fruit trees, fishing) in this region might lead to an overestimation of the food access problem if only retail food provision were considered. We conclude that food deserts are widespread in the rainforest cities studied, yet we highlight the importance of understanding local retail and nonretail food contexts. Finally, we question the extent to which the traditional food desert concept can be directly applied in the context of transitioning economies. *Key Words: Amazon, food deserts, food security, poverty, urbanization.*

粮食荒漠在西方脉络中已受到广泛的研究，但在变迁经济体中的研究却为数不多，在雨林中则从未有过相关研究。巴西的亚马逊是快速城市化的区域，并具有高度的贫穷与粮食不安全，因而提供探讨当前研究阙如的理想脉络。在此一环境中，我们检视五个从小型城镇到大都会的城市中心，以探讨不同规模与环境的城市中心间的任何潜在变项。我们进行了访谈五百五十四家粮食商店的大规模调查，评估商店的特徵，粮食可及性，价格，以及家户粮食取得的另类策略。我们建立探讨粮食荒漠的方法，说明邻里中数个商店的粮食获取。未能充分取得健康粮食之情形估计当普遍（百分之四十二的家户），在较小型城镇中的取得管道则更加恶劣。与诸多先前研究不同的是，　取得健康粮食的在地管道并不与邻里贫穷相连结，且在较为穷困的地区中，价格一般而言较为低廉。该区域具有高度的非零售粮食来源（例如果树、渔猎），因此若仅考虑零售粮食供给的话，将可能导致过度评价粮食取得之问题。我们于结论中主张，粮食荒漠在研究的雨林城市中相当普及，但我们仍强调理解在地零售与非零售粮食脉络的重要性。最后，我们质疑传统的粮食荒漠概念能够直接应用至转型经济体脉络中的程度。 *关键词： 亚马逊，粮食荒漠，粮食安全，贫穷，城市化。*

Los desiertos alimentarios han sido ampliamente estudiados en contextos occidentales, aunque rara vez en economías en transición y nunca dentro de una selva. La Amazonia brasileña es una región en rápido proceso urbanizador con altos niveles de pobreza e inseguridad alimentaria, que provee un contexto ideal donde explorar esta brecha de la investigación actual. Dentro de este escenario, cinco centros urbanos, que van desde el pueblo pequeño hasta las metrópolis, son examinados para explorar completamente cualesquiera variaciones potenciales entre los centros urbanos de diferentes tamaños y disposiciones. Se condujo un gran estudio de campo con entrevistas en 554 tiendas de alimentos, evaluando las características de la tienda, la disponibilidad de alimentos, precio y estrategias familiares para la alternativa adquisición de alimentos. Se desarrollaron métodos para explorar los desiertos alimentarios tomando en cuenta la adquisición de alimentos a través de múltiples tiendas dentro de un vecindario. Se estimó que el acceso insuficiente a alimentos saludables era en alta medida generalizado (42 por ciento de los hogares), con la inaccesibilidad mayor en los pueblos más pequeños. A diferencia de muchos estudios anteriores, el acceso local a los alimentos saludables no tenía relación mayor con la pobreza vecinal y los precios eran generalmente más bajos en áreas más pobres. Altos niveles de fuentes alimentarias sin menudeo (e.g., frutales, pesca) en esta región podrían conducir a una sobreestimación del problema del acceso a los alimentos si solo se considerara la provisión de alimentos al detal.

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Concluimos que los desiertos alimentarios pululan en las ciudades estudiadas de la selva pluvial, aunque destacamos la importancia de entender los contextos locales del comercio local al menudeo o al por mayor. Finalmente, cuestionamos la extensión con la cual el concepto tradicional de desierto alimentario puede ser aplicado directamente en el contexto de las economías en transición. *Palabras clave: Amazonia, desiertos alimentarios, seguridad alimentaria, pobreza, urbanización.*

Food deserts have been widely studied in Western contexts, rarely within the Global South, and never in a rainforest setting. This article therefore explores food deserts in a nontraditional context, focusing on a transitioning economy undergoing rapid urbanization and its associated food transition. The study also differs from many traditional applications of the food desert concept in that, whereas supermarkets have traditionally been significant in food desert studies, this region has not yet experienced widespread penetration of large supermarket chains.

Food Security and Food Deserts

Food insecurity affects approximately 1 billion people worldwide (Godfray et al. 2010; Piperata et al. 2013) but is only partly driven by food production, with households becoming food insecure when lacking access to affordable, nutritious, and safe food (Pinstrup-Andersen 2009). Household food security can lead to malnutrition, immune system deficiencies, health problems, and developmental consequences (Caulfield et al. 2004; Dubois et al. 2006; Seligman, Laraia, and Kushel 2010; Rodríguez, Cervantes, and Ortiz 2011; Black 2012; Lee et al. 2012). The association of poverty and malnutrition with poor cognitive development and educational development in children contributes to ongoing, intergenerational cycles of poverty (Grantham-McGregor et al. 2007). Given the immediate and long-term effects associated with food insecurity and malnutrition, it is therefore imperative to identify those most at risk (Piperata et al. 2013).

Food deserts were first identified in the 1990s to describe areas with poor access to the affordable food necessary for a healthy diet (Beaulac, Kristjansson, and Cummins 2009; LeClair and Aksan 2014). Hence, food deserts represent both physical and economic barriers to accessing healthy food (Reisig and Hobbiss 2000) and relate closely to food insecurity. In the United Kingdom and United States, food deserts first emerged as large supermarkets began to dominate food provision, leading to the closure of smaller food shops and disadvantaging carless households who became less able to access affordable food (Cummins and Macintyre 2002; White and Hamm 2014). Later the subsequent withdrawal of supermarkets from some deprived areas further exacerbated the presence of food deserts (Raja, Ma, and Yadav 2008; Russell and Heidkamp 2011). By contrast, this study examines food deserts within a transitioning economy where supermarkets are yet to widely penetrate retail food provision. As incomes increase, it might be expected that the level of service provided by food retail will also grow. There are significant differences between studies regarding how food deserts are defined, with some authors qualifying them as specifically urban (Cummins and Macintyre 2002) and others arguing that they must be located within areas with high deprivation or poverty (Jiao et al. 2012; Battersby and Crush 2014). Numerous studies identify access to supermarkets as a key determinant of food deserts (Jiao et al. 2012; LeClair and Aksan 2014; Pine and Bennett 2014), yet this approach potentially underestimates the value of smaller stores in the provision of healthy food, especially where larger stores are absent (Ver Ploeg et al. 2009; Martin et al. 2014).

People's food choices are strongly influenced by availability within their immediate neighborhood (Walker, Keane, and Burke 2010). Consequently, in areas where unhealthy food options are the most prevalent and affordable, household diets tend to worsen (Hendrickson, Smith, and Eikenberry 2006; Gartin 2012; Alviola et al. 2013). Insufficient access to affordable, healthy food in food deserts has potentially serious consequences for both health and development (Moore and Diez Roux 2006; Beaulac, Kristjansson, and Cummins 2009; Larson, Story, and Nelson 2009; Walker, Keane, and Burke 2010; Cummins 2014). Greater understanding of the spatial nature of food deserts will help develop policies to improve equitable access to healthy food, thus alleviating some health inequalities (Larson, Story, and Nelson 2009; Alviola et al. 2013).

Food Deserts in the Transitioning Economies

Due to widespread poverty and food insecurity, examining food deserts in transitioning economies is more

pertinent than in Western areas where it has usually been applied. To date, very few studies have attempted to investigate food deserts in the Global South (Gartin 2012; Duran et al. 2013; Battersby and Crush 2014) despite being inhabited by the vast majority of the world's urban poor (Mitlin and Satterthwaite 2012). It remains both unclear to what extent urban food deserts are present in transitioning economies of the Global South and, moreover, whether traditionally defining food deserts in terms of retail access is compatible with different food cultures, livelihoods, food acquisition strategies, and environments.

Food retail contexts vary throughout the Global South and are often very different to Western contexts. Although supermarkets have been portrayed as a cause of (Guy, Clarke, and Eyre 2004) and solution to (Morland, Wing, and Diez Roux 2002; Walker, Keane, and Burke 2010) food deserts, the penetration of supermarkets in the Global South is highly variable (Gartin 2012; Duran et al. 2013; Battersby and Crush 2014). Where supermarkets are present, those in lower income areas often stock a less healthy range of products, thus failing to improve healthy food access (Duran et al. 2013; Battersby and Crush 2014).

Sufficient income to access food is a greater challenge to food security than food availability (Crush, Frayne, and Pendleton 2012). High levels of poverty and inequality exist across the cities of the Global South, making households vulnerable to food insecurity and food deserts (Acquah, Kapunda, and Legwegoh 2014; Frozi et al. 2015). Small and medium-sized urban centers in the Global South have higher poverty rates than larger urban centers (Ferré, Ferreira, and Lanjouw 2010). This article, therefore, includes an urban metropolis alongside smaller urban centers, enabling a holistic overview. Throughout the Global South a variety of food sourcing strategies are employed that could help alleviate the impact of living in food deserts. It is important that these are considered in the context of food deserts. In southern African cities, alternative food sourcing strategies are critical for food security (Crush, Frayne, and Pendleton 2012), with alternative food sources such as urban agriculture and informal rural–urban food transfers supplementing retail food provision (Frayne, McCordic, and Shilomboleni 2014; Pendleton, Crush, and Nickanor 2014). Credit provided by smaller stores is a further possible coping strategy employed (Gartin 2012).

The study examines variation in food deserts within a transitioning economy, examining variation between urban centers of different sizes from large metropole to small town, while also considering the importance of alternative food sourcing strategies. The relationship between accessibility and affordability of healthy food is explored across these urban centers, in relation to both income poverty and shop type. The specific research questions asked are as follows:

1. How widespread are food deserts in a rainforest metropolis and smaller urban centers?
2. Are food deserts more common in poorer neighborhoods?
3. Is the location of food deserts related to the distribution of different shop types or due to locally determined differences in food prices?
4. To what extent do urban households acquire food through methods other than shop purchases (e.g., through planting and harvesting)?

Asking these questions is important to understand the extent to which food deserts affect households within urban centers of the rainforest and which factors (e.g., food provision or low income) are related to households living in a food desert. Understanding these factors might ultimately help policymakers better target decisions to improve the food security of the most vulnerable.

Brazilian Amazon

Despite Brazil's progress in alleviating poverty, household food insecurity, income inequality, and malnutrition, rates of each remain high, especially in the Amazon. Coupled with rapid urbanization and a shift toward increased reliance on purchased food, these factors make the Brazilian Amazon an important context in which to critically apply the food desert concept. Within the northern region of Brazil where the Amazon rainforest is located, 41 percent of households are estimated to experience food insecurity (Instituto Brasileiro de Geografia e Estatística [IBGE]). Of the households, 11 percent live in extreme poverty, with a further 22 percent in the north living in absolute poverty (IBGE 2013). Brazil's income inequality ranks among the highest worldwide (Rasella, Aquino, and Barreto 2013), with a Gini coefficient of 0.54 (IBGE 2013), with malnutrition greatest in areas where income inequality is highest (Larrea and Kawachi 2005; Pathak and Singh 2011).

Attempts to alleviate low food security and poverty for some of the poorest households have been made though the government strategy *Fome Zero* (Zero Hunger), which commenced in 2003. A key element of this strategy has been the introduction of a

conditional cash transfer system, *Bolsa Família* (Wetzel 2013; World Bank 2016). Despite this assistance, families qualifying for and receiving the *Bolsa Família* are still found to be four times more likely to suffer severe food insecurity (Segall-Corrêa et al. 2009). A case study recording dietary change between 2002 and 2009 highlights a food transition contributed to by the *Bolsa Família*. It indicates that the *Bolsa Família* has encouraged purchasing of a greater proportion of food, resulting in a change of diet consisting of increased protein intake, but an overall decline in calories consumed (Piperata et al. 2011). During this period the principal food energy sources shifted from local foods (manioc flour, açaí [a local fruit], fish, and other fruits) to purchased foods (beans, rice, and crackers) while maintaining consumption of açaí (Piperata et al. 2011).

The Brazilian Amazon is a transitioning economy, accompanied by associated rapid urban expansion. The population of Manaus, for example, doubled in size between 1991 and 2015 (IBGE 2016). Although it is unclear what food access in Amazonia was like in the past, this study provides a baseline against which future changes can be measured. Within the Brazilian Amazon, large supermarkets have only begun to penetrate within large cities, such as Manaus, where urbanization and economic transition are more advanced. The majority of foodstuffs are still distributed through a network of small shops run as livelihoods for poorer families. Methods for identifying food deserts therefore need to be adjusted to reflect the local food context. Small local food shops potentially offer some advantages over supermarkets, including more convenient locations, selling in small quantities, and offering credit (White and Hamm 2014). Evidence suggests that nonretail food acquisition is also important for food security in Amazonia. Plots of land for urban gardens or rural agriculture are important for subsistence and exchange of food between rural and urban areas (WinklerPrins and de Souza 2005). Most include fruit trees, although fewer include culinary plants due to a lack of culinary interest in vegetables. In Santarém, for example, 43 percent of households kept some animals, mainly chickens and ducks, providing eggs and some meat (Winklerprins 2002). Fishing is a further important strategy for food sourcing. Nardoto et al. (2011) found that in Iranduba, 38 percent of those interviewed had a preference for fish, rather than commonly sold frozen chicken, because people could catch the fish themselves. Research in other riverine urban centers confirms the importance of fishing and hunting as food acquisition strategies for urban households. Here bush meat was consumed monthly by 44 percent of the households surveyed. Although consumption of bush meat and many types of freshwater fish causes concerns for species conservation (Parry, Barlow, and Pereira 2014), it could be significant in reducing household food insecurity. To cope with household food shortages, 43 percent of respondents to the national Pesquisa Nacional de Demografia e Saúde survey in 2013 claimed to have bought food on credit, with a further 28 percent borrowing food from family and friends (IBGE 2014).

This article focuses on urban centers within the Brazilian Amazon, specifically within the state of Amazonas. The state has rapidly urbanized and by 2010, 51 percent of the state's population lived within the urban metropolis of Manaus, 28 percent in smaller urban centers, and 21 percent in rural areas. Urban poverty in Amazonas is high, with 34 percent of households in Manaus and 59 percent of households in smaller urban centers living in absolute poverty (IBGE 2010).

Method

The five urban centers studied include the metropolis of Manaus (population = 1.8 million people) and four smaller cities in the surrounding area. They are all road-connected and were: Manacapuru (60,000 people, 96 km from Manaus), Iranduba (15,000 people, 39 km), Presidente Figueiredo (11,000 people, 122 km), and Novo Airão (9,500 people, 196 km; IBGE 2010).

Data Acquisition

During March and April 2015, 554 shops were surveyed ranging from large supermarkets to small shops and vendors of individual food products. These included all food shops found within the urban centers of Novo Airão, Iranduba, and Presidente Figueiredo and a sample of four neighborhoods in each of the larger urban centers of Manacapuru and Manaus. Sample neighborhoods were selected to represent neighborhoods along a gradient from high to low deprivation within the urban center. The selected neighborhoods were typically composed of three or four census sectors (each populated by several hundred households). The total population living within the areas surveyed in each of Manaus and Manacapuru was just over 15,000, comparable to the population size of the largest of the small urban centers within the study.

Four types of data were collected at each shop: location and shop characteristics, availability of a selection of different foodstuffs, price of available food stuffs, and shop

owners' perceptions of customers' alternative food sourcing strategies. The food products surveyed were selected as being commonly consumed within the study area, with knowledge of consumption based on field observation and consultation with a local expert. Nutritional information (e.g., saturated fat and salt content) was obtained from the *Tabela Brasileira de composição de alimentos* (Núcleo de Estudos e Pesquisas em Alimentação [NEPA] 2011) and used to exclude unhealthy food products (e.g., low in nutrients and high in sodium and saturated fat). Although all fruit and vegetable availability was recorded, only a limited selection of staple foods and sources of animal protein was selected for the survey to limit the length of the questionnaire and encourage engagement by all shop owners.

Road and path data were derived from Open Street Map (OSM) data, downloaded from http://download.geofabrik.de/. Additional roads or paths evident either on the ArcGIS Imagery base map or identified in Google Earth were also added to the data set. Google Street View was used to help identify segments of road or path that appeared to be residential. Although care was taken to ensure that the road and path locations and residential classification were complete, it is acknowledged that this cannot be guaranteed.

Spatial Analysis

Methods and thresholds used to identify food deserts vary considerably. For example, the U.S. Department of Agriculture (USDA 2015) identified food deserts as census tracts where at least a third of the population live more than a mile from the nearest supermarket or large grocery store and with a poverty rate of at least 20 percent. Alternatively, Jiao et al. (2012) considered a ten-minute drive, bus, cycle, or walk time from supermarkets. LeClair and Aksan (2014) adopted thresholds of half a mile from a supermarket or a five-minute walk from smaller food shops; and Raja, Ma, and Yadav (2008) consider five-minute travel times to food shops. All of these approaches, however, are only able to approximate the true neighborhood area an individual or household traverses (Kwan 2012). Numerous studies have relied on store type to estimate food availability; however, the same store type might sell different products (Franco et al. 2008). To measure access to affordable, nutritious food, the availability and price of products is required for all food shops within a neighborhood (Ver Ploeg et al. 2009).

In this study, walking was assumed as the main mode of transport used when obtaining food, with poor families having little access to transport. Private vehicle access is low (typically one per three households; IBGE 2016) and public transport limited to major routes and often unreliable (field observation). The maximum walking distance to a shop was considered to be 250 m, based on a travel time threshold of five minutes (LeClair and Aksan 2014) and typical walking speed of 3 km/h^{-1} in the tropics (field observation). This reflects observations during fieldwork that the majority of food shopping happened on a daily basis and was often undertaken by children. As with Raja, Ma, and Yadav (2008), this distance threshold is not intended to be an absolute measure of how far people are willing to travel, or by what means, but rather a representative measure by which households can be compared.

Spatial analysis was undertaken using a geographic information system (GIS), with the software ArcGIS 10.2.2. Insufficient access to healthy food (i.e., spatially within a food desert) was defined as household locations without access within 250 m from home to all of the staple foods (manioc flour, beans, and bread), at least five different types of fruit or vegetable, and a variety of affordable healthy sources of animal protein (at least three of the surveyed products: tinned beef, meat on the bone, chicken and eggs). To ensure distance calculations accounted for where people could walk, a 15-m buffer around the roads and paths was applied as an analysis mask. Cost distance surfaces were created and reclassified for each food product to show all areas where that product could be purchased within 250 m. A further analysis mask was subsequently applied constraining analysis only to areas where residential households were present. For each food group (staples, animal protein, fruit and vegetables) the number of products available at a given location was then added together. Each group was then reclassified to identify whether the minimum defined threshold was met. Areas with insufficient access to healthy food were then identified by combining the groups together. To estimate the number of households without access to healthy food, the proportion of the residential area within each census sector defined with insufficient access to healthy food was calculated and multiplied by the number of households within the census sector. Census sectors contain roughly even numbers of households (an average of 184 households per urban census sector in Amazonas state).

Shop Types

The survey included questions about the presence or absence of different services including whether they

accepted credit cards, employed nonfamily members, had shopping trolleys, had electricity, provided direct access to the products, had a computerized till, and had more than one till. Exploratory principal components analysis was used to assess the relationships among different shop surveys, linkages between service provision, and estimated shop width (as a proxy of shop size). Results showed that there was a tendency for cooccurrence of specific services in groupings of similar shops. These results were used to develop a typology of shops, ensuring that there were sufficient sample sizes (e.g., at least a few dozen) in each category to enable them to be used as fixed factors in statistical models. Although width was loosely correlated with service provision, there was sufficient variation in service among similar-sized shops to warrant a typology based on services. Consequently, four categories of shop were defined, and these categories were used as predictor variables in statistical models. Type 1 shops are those with none of the services listed; these are small family-run shops with products generally served to customers through a window. Type 2 are those with only one of the services listed. Type 3 shops have between two and four of the services. Type 4 shops have five or more of these services. Self-determined shop type

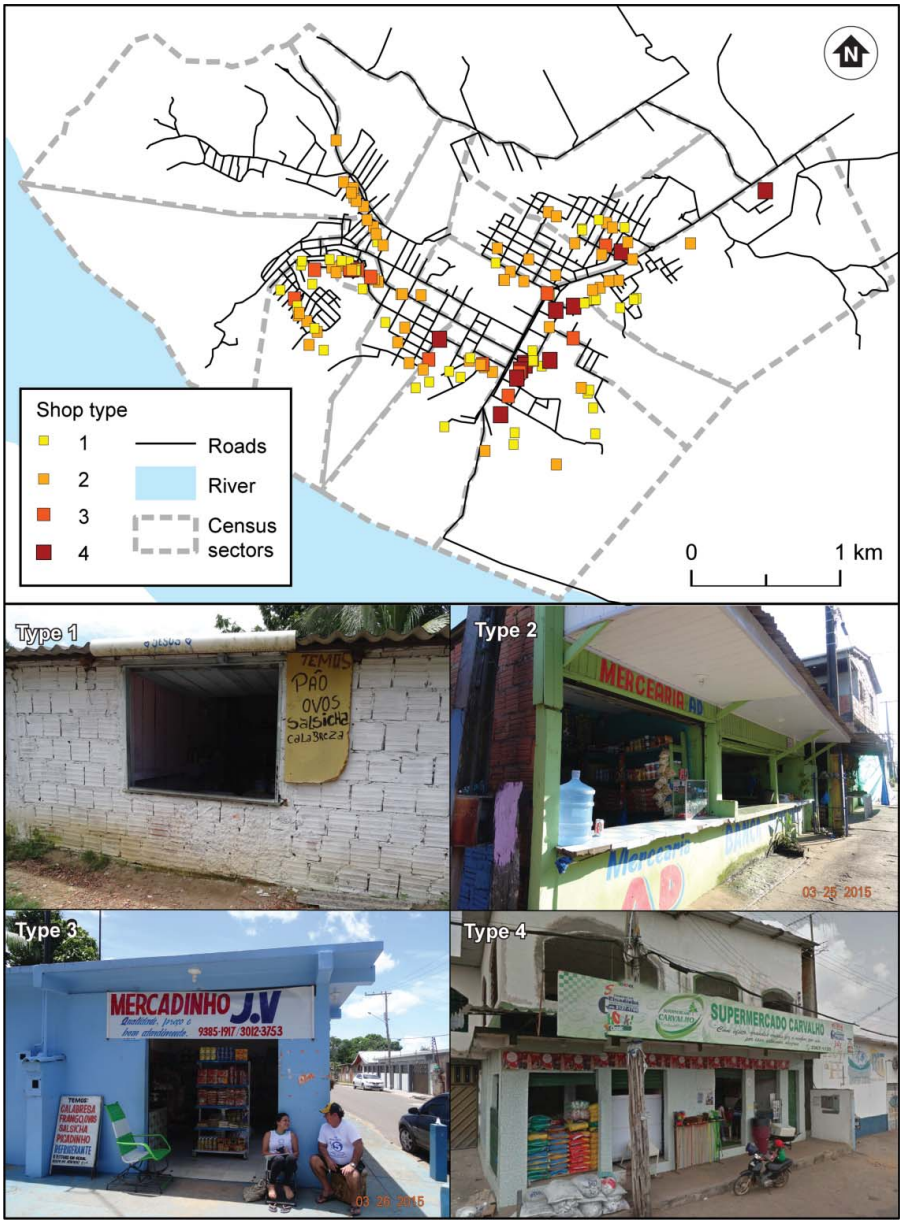

Figure 1. Distribution of shop types within Iranduba. Photographs illustrate each of the shop types. Shop types are defined in terms of number of services and facilities available, ranging from very basic (Type 1) to more sophisticated (Type 4). (Color figure available online.)

was recorded during interviews, using local names such as *mercado*, *mercearia*, and *taberna* (de Oliveira Moraes and Schor 2010). There were significant inconsistencies in these labels and thus a new typology was adopted. Figure 1 illustrates the distribution of shop types for an example urban center, Iranduba.

Healthy Food Basket

To enable analysis of price differences, a basket of healthy food items (Table 1) was defined. A subset of products was selected from the healthy food products surveyed, including those items for which standardized prices were available. It was necessary to exclude some of the surveyed food products at this stage (e.g., bread and bananas) as it was not possible to accurately standardize their prices to comparable units. Basket quantities represent expenditure on these food items during one week for an average-sized household (four people), using data from the IBGE 2008–2009 consumer expenditure survey (*Pesquisa de Orçamentos Familiares*, IBGE 2010) as a guide to estimate quantities of each food product purchased. Although the basket contains a mixture of staples, protein sources, and fruit and vegetables, it does not attempt to demonstrate total food range, quantity, or expenditure required for a healthy diet.

Statistical Analysis

All statistical analyses were conducted in the R platform version 3.2.3 and using the additional packages FactoMineR and rpart (for exploratory principal components analysis and development of the shop classification). For the shop-scale availability models (0/1), general linear models (GLMs) with a binomial error distribution (a logistic model) were used. The model predicting the number of fruits available, however, used a Gaussian error structure (following a normal distribution). Predictor variables included shop type, percentage of households living in absolute poverty ($\leq$0.5 minimum salaries per capita per month; see Parry, Barlow, and Pereira 2014), and municipality as a fixed effect, which assessed significant differences relative to the town of Iranduba, the control. For the price models (predicting foodstuff-specific and basket prices), GLMs with Gaussian error structures were used, as assumptions of normality were met. Price models also included shop type, income poverty, and municipality as predictor variables.

Table 1. Quantities, availability, and price of foods included in the food basket

Food type	Quantity included	Number of shops available	Average price (R$)	*SD* price (R$)
Manioc flour	1.5 kg	495	5.65	2.17
Beans	1.5 kg	323	6.54	1.25
Chicken	1.5 kg	338	8.56	0.79
Tinned beef	107 g	460	1.81	0.43
Eggs	1 egg	492	0.36	0.05
Onions	220 g	377	1.25	0.41
Tomatoes	180 g	251	1.12	0.20

Results

How Widespread Are Food Deserts in a Rainforest Metropolis and Smaller Urban Centers?

In this article, insufficient access to healthy food is defined in terms of spatial availability of food products within 250 m of a household (see methods). This equates to a spatial definition of a food desert before consideration of price, income, or any alternative food sources. Table 2 shows that a total of 41 percent of the households in our survey area were found to live in locations with insufficient access to a healthy range of food. In two of the smaller cities, Iranduba and Presidente Figueiredo, 50 to 60 percent of households had insufficient access to healthy food, whereas 38 percent had insufficient access in Novo Airão and less than a third in the larger city of Manacapuru and the metropolis of Manaus (28 percent and 32 percent, respectively). Across all urban centers, the major constraint in accessing healthy food was insufficient access to a range of fruit and vegetables. Overall, 38 percent of households lacked access to five or more different fruits or vegetables. Although the staple carbohydrate, manioc flour, was widely available, availability of bread and dried beans was more limited and overall a fifth of household (ranging from 14–32 percent across cities) lacked access to staple foods. In contrast, access to sufficient sources of animal protein was generally good (7–17 percent of households lacking access).

Are Food Deserts More Common in Poorer Neighborhoods?

A high proportion (42 percent) of households in the area surveyed live in absolute income poverty

Table 2. Estimated households without access to specified food groups

	Survey				Percentage of households lacking sufficient			
Urban center	Type	Census sectors	Shops	Households	Fruits and vegetables	Animal protein	Staples	Healthy food
Iranduba	Full	17	132	3,689	49	16	23	50
Novo Airão	Full	13	93	2,081	35	9	22	38
Presidente Figueiredo	Full	23	79	2,918	50	7	32	60
Manacapuru	Sample	15	178	3,236	27	13	14	28
Manaus	Sample	16	72	3,521	30	7	14	32
Total		84	554	15,642	38	11	20	41

(IBGE 2010). There is a highly variable relationship, however, between income poverty and the access to sufficient healthy food (Figure 2). Although cooccurrence of high levels of poverty (≥67 percent of households) and insufficient access to healthy food was rare (two sectors on the outskirts of Iranduba), there were many census sectors in which there was very poor access to healthy food (≥67 percent of households) and intermediate levels (33–66 percent of households) of poverty. There were two cases (outskirts of Manacapuru) where high levels of poverty cooccurred with moderate access to healthy food and many examples where intermediate poverty occurred with intermediate access to healthy food. Few census sectors (mostly in Manaus) experienced both low levels of poverty and a low percentage of households with insufficient access to healthy food. Half of all census sectors studied had a low percentage of households with insufficient access to healthy food (1–33 percent), with a moderate number of households living in absolute poverty (33–67 percent).

Is the Location of Food Deserts Related to the Distribution of Different Shop Types or Due to Locally Determined Differences in Food Prices?

Despite an inconsistent relationship between poverty and food access, the number and composition of shops varied strongly according to poverty (Figure 3). In the least poor areas, there is relatively little difference between types in the number of shops per hundred households. In areas with 33 to 67 percent of households living in poverty, the number of Type 1 and 2 shops per 100 people more than doubles, accompanied by smaller increases in Type 3 and 4 shops. In areas with the highest levels of poverty, the number of Type 1 and 2 shops increases again, yet here the presence of Type 3 and 4 shops almost disappears, with 98 percent small family-run shops of Type 1 or 2. The overall number of stores averages five per hundred households where poverty is greater than 67 percent, compared to only one and a half per hundred households where poverty is less than 33 percent.

Availability of food items was generally greater in higher service level shops, although there were exceptions (Table 3). The highest service shops (Type 4) were significantly more likely to stock each of the food items than Type 1 shops. Type 3 shops were significantly more likely than Type 1 stores to stock most of the food items, although, interestingly, availability of manioc flour, bread, and eggs was not significantly different. Type 2 shops were significantly more likely than Type 1 shops to stock all foodstuffs apart from meat. When controlling for shop type, shops in poorer areas were significantly more likely to sell manioc flour, chicken, tinned meat, eggs, and beans and significantly less likely to sell bananas or other fruits. There were significant differences in the availability of foodstuffs across urban centers and the availability of six of the foodstuffs was significantly better in comparable shops of Manaus than in Iranduba, the control. In Manacapuru, three items had greater availability than in Iranduba, whereas one item (frozen chicken) was less available. There were only weakly significant differences in availability between Iranduba and Novo Airão.

Although there was no significant difference in basket price between shop Types 1, 2, and 3, prices were generally cheaper in larger, more sophisticated stores relative to smaller, simpler stores (Table 3). The price of a healthy food basket was significantly cheaper (R$2.13 less) in Type 4 shops than in the most basic ones (Type 1; Table 3; Figure 4A). The reason for this price differential is unknown, although it might relate to economies of scale in shop purchasing power. The price of a healthy food basket was significantly cheaper in poorer areas

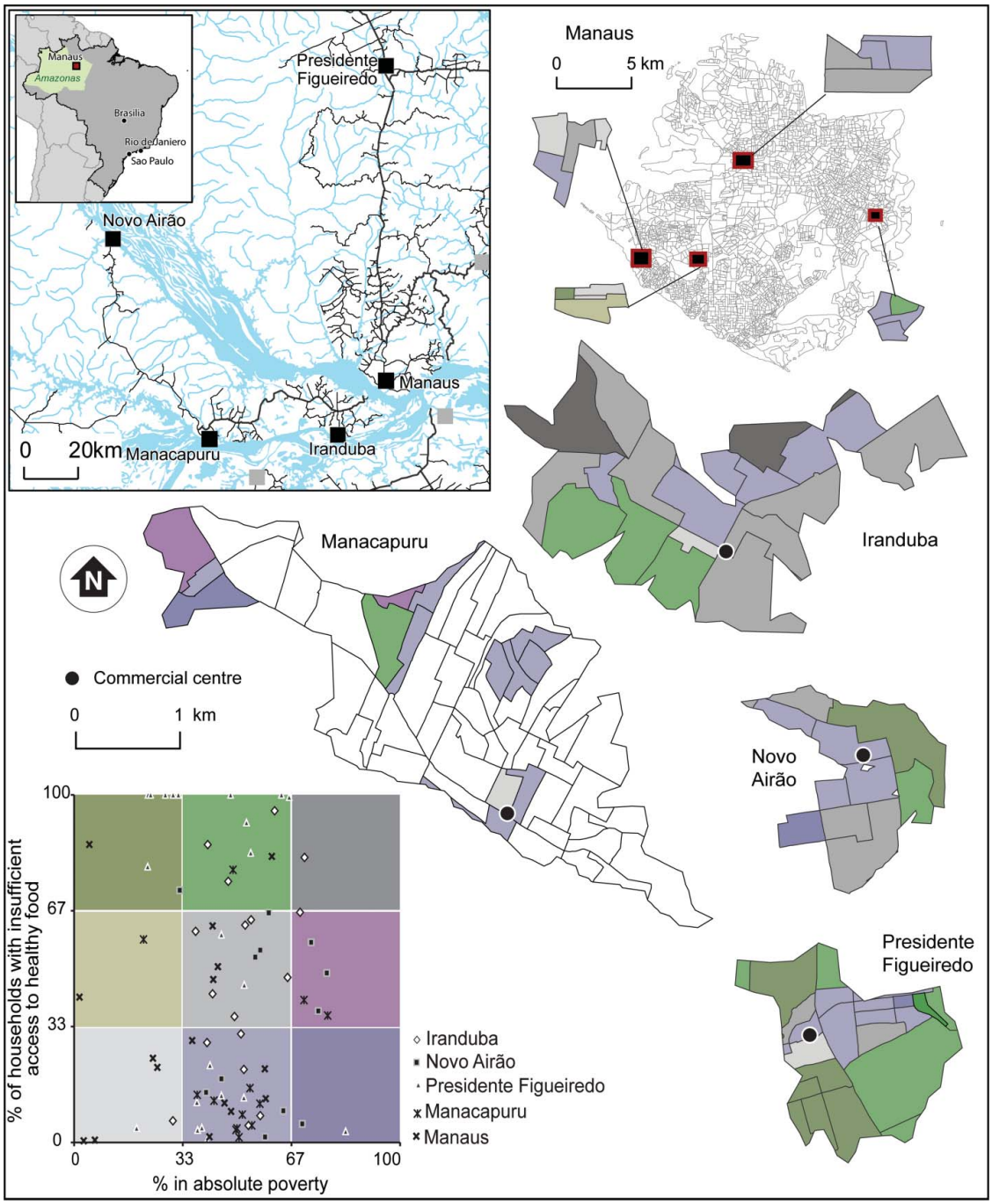

Figure 2. Relationship between absolute poverty and prevalence of households with insufficient access to healthy food, per census sector in the studied urban centers. (Color figure available online.)

when controlling for shop type, at around R$0.40 less for each 10 percent increase in absolute poverty (Table 3; Figure 4B). Despite lower prices, however, relative affordability of this food basket is much lower in low-income neighborhoods. For example, the basket of R$33 in the most affluent sector surveyed would cost only 4.2 percent of average weekly income in that sector, compared to a lower basket price of R$26, requiring 80 percent of average income in the poorest sector (Figure 5). Compared to prices in Iranduba, a food basket was significantly more expensive in Manacapuru (R$5 more) and Novo Airão and Presidente Figueiredo (R$3 more in each). There were also significant variations in the price of specific foodstuffs, according to shop type, poverty, and urban center. Beans

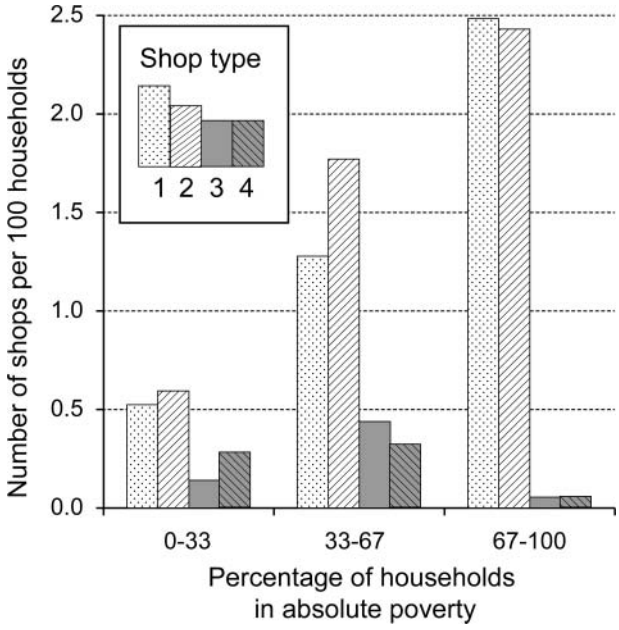

Figure 3. Access to shop types in studied census sectors of Manaus, Manacapuru, Novo Airão, Iranduba, and Presidente Figueiredo. Types defined in terms of number of services and facilities available, ranging from very basic (Type 1) to more sophisticated (Type 4).

and frozen chicken were significantly cheaper in Type 4 shops compared to Type 1, whereas greens (cheiro verde) were more expensive. Type 1 shops were significantly more expensive than all other shop types for tinned meat, eggs, and onions. The price of manioc flour, meat on the bone, and tomatoes did not vary significantly among shop types. The price of toasted manioc flour was much cheaper in Iranduba compared to Manacapuru (costing R$2.51 more per litre), Manaus (R$1.08 more), Novo Airão (R$2.12 more), and Presidente Figueiredo (R$1.55 more). Manioc flour, eggs, and greens were significantly cheaper in poorer areas. For instance, manioc flour was R$0.20 cheaper.

To What Extent Do Urban Households Acquire Food through Methods Other Than Shop Purchases?

Although the full contribution of alternative food sourcing strategies to household food security is not clear, results do confirm many alternative strategies are used (Table 4), the most important of which are having fruit trees at home and fishing. Fruit trees were found to be important in all urban centers, with 56 percent of shop owners estimating at least half of their customers had fruit trees at home. In addition, 51 percent of shop owners estimated at least half of their customers fished. This number was greatest in small urban centers situated on a river (Novo Airão and Iranduba), compared to just 11 percent in Manaus. Among shop owners, 22 percent thought that at least half their customers kept chickens and 12 percent thought that at least half went hunting. Growing vegetables at home was the least common strategy but, importantly, 41 percent of shop owners estimated that at least half of households grew food in rural plots.

Field observations identified that many poorer households bought food in small quantities on a regular basis. Many shops help facilitate this. For example, processed sausages, a popular although unhealthy component of many household diets, are sold in packs of ten to sixteen sausages, yet many shop owners split these into smaller quantities for sale. Other products (e.g., onions) were halved.

Discussion

In this article, food desert coverage and the extent to which this concept is relevant to a transitioning economy was explored in rainforest cities. The study context in the Brazilian Amazon provided an ideal opportunity to assess the presence of food deserts in a region where large supermarket chains are yet to dominate. By sampling a large number of shops across five urban centers of different sizes, comparison across scales and between urban centers was possible rather than just within centers. Exploring both availability and price of a range of foodstuffs across all shop types enabled a full picture of retail food availability to be considered. Importantly, the method employed is able to identify poor access to specific food groups or individual products. The key findings in relation to the research questions posed in this article were as follows:

1. Food deserts (defined as areas with insufficient retail access to healthy food) were widespread within the urban centers studied, largely due to a lack of fruit and vegetables sold.
2. Food deserts were no more likely to occur in poorer areas than in less poor areas.
3. Food retail was dominated by a network of small shops with few facilities, with higher shop densities in the poorest neighborhoods. Food prices were generally lowest in poorer areas.

Table 3. Models of food availability (on sale or not) and food prices (R$) in 554 food outlets in Manaus, Manacapuru, Novo Airão, Iranduba, and Presidente Figueiredo

Models of food availability										
Item	*df*	R^2	Shop Type 2	Shop Type 3	Shop Type 4	Poverty	Manacapuru	Manaus	Novo Airão	Presidente Figueiredo
Manioc flour	575, 583	0.08	0.59	0.8 *ns*	2.66*	0.04**	0.35 *ns*	2.04***	−0.01 *ns*	1.14*
Beans	575, 583	0.10	0.87***	1.5***	3.17***	0.02	0.16 *ns*	0.42 *ns*	0.01 *ns*	0.71*
Bread	575, 585	0.04	0.64**	0.28 *ns*	1.32***	0 *ns*	0.83***	0.36 *ns*	0.53	−0.23 *ns*
Chicken	575, 583	0.16	1.25***	2.31***	3.8***	0.02*	−0.62*	−0.22 *ns*	−0.36 *ns*	0.12 *ns*
Meat	575, 583	0.24	−0.08 *ns*	1.08	2.67***	−0.01 *ns*	−0.62 *ns*	0.53 *ns*	0.17 *ns*	0.36 *ns*
Tinned meat	575, 583	0.09	0.45	1.09*	3.26**	0.03**	0.49 *ns*	1.13**	−0.56	1.23**
Eggs	575, 583	0.09	0.61	0.81 *ns*	1.54*	0.04**	1.12**	2.04***	−0.15 *ns*	1.13*
Onions	575, 583	0.10	1.03***	1.27***	2.46***	0 *ns*	−0.03 *ns*	−0.31 *ns*	0.28 *ns*	0.4 *ns*
Tomato	575, 583	0.12	1.17***	1.46***	2.76***	0 *ns*	0.01 *ns*	0.06 *ns*	0.11 *ns*	0.62
Pepper	575, 583	0.09	1.06***	1.28***	2.1***	0 *ns*	0.27 *ns*	0.7*	−0.08 *ns*	0.43 *ns*
Greens	575, 583	0.11	1.13***	1.2***	1.65***	0 *ns*	0.32 *ns*	1.38***	0.15 *ns*	1.24***
Banana	575, 583	0.09	0.72**	0.71	1.37***	−0.03***	0.36 *ns*	0.32 *ns*	0.63	−0.7
Fruits (n)	575, 583	0.17	0.68***	0.79***	1.29***	−0.01**	0.16*	0.25**	0.16	0.1 *ns*
Models of food prices										
Item	*df*	R^2	Shop Type 2	Shop Type 3	Shop Type 4	Poverty	Manacapuru	Manaus	Novo Airão	Presidente Figueiredo
Manioc flour	514, 522	0.40	−0.15 *ns*	−0.24 *ns*	0.07 *ns*	−0.02***	2.51***	1.08***	2.12***	1.55***
Beans	338, 346	0.04	−0.06 *ns*	−0.15 *ns*	−0.37*	−0.01 *ns*	0.24	−0.13 *ns*	0.10 *ns*	0.20 *ns*
Chicken	349, 357	0.21	−0.09 *ns*	−0.06 *ns*	−0.49***	0 *ns*	−0.06 *ns*	−0.36***	0.03 *ns*	0.26**
Meat	48, 56	0.22	−1.10 *ns*	−1.81 *ns*	0.86 *ns*	−0.03 *ns*	0.55 *ns*	−0.68 *ns*	0.90 *ns*	−0.15 *ns*
Tinned meat	464, 472	0.15	−0.24***	−0.40***	−0.70***	0 *ns*	0.09 *ns*	−0.03 *ns*	−0.22*	0.13 *ns*
Eggs	510, 518	0.17	−0.03	−0.07**	−0.07**	0*	0.07***	0.15***	0 *ns*	0.08**
Onions	322, 330	0.06	−0.45**	−0.45*	−0.59**	0 *ns*	0.24 *ns*	0.45*	−0.07 *ns*	0.31
Tomatoes	268, 276	0.02	−0.14 *ns*	0.09 *ns*	−0.07 *ns*	0 *ns*	0.25 *ns*	0.36 *ns*	0.31 *ns*	0.29 *ns*
Greens	148, 156	0.42	0.10 *ns*	0.09 *ns*	0.30**	−0.01***	0.02 *ns*	0.27*	0.57***	0.17
Basket price	177, 185	0.28	−0.62 *ns*	−1.09 *ns*	−2.13**	−0.04*	4.56***	0.87 *ns*	2.96***	2.76***

Note: *ns* = $p > 0.05$ (i.e., not significant); * = $p \leq 0.05$; ** = $p \leq 0.01$; *** = $p \leq 0.001$.

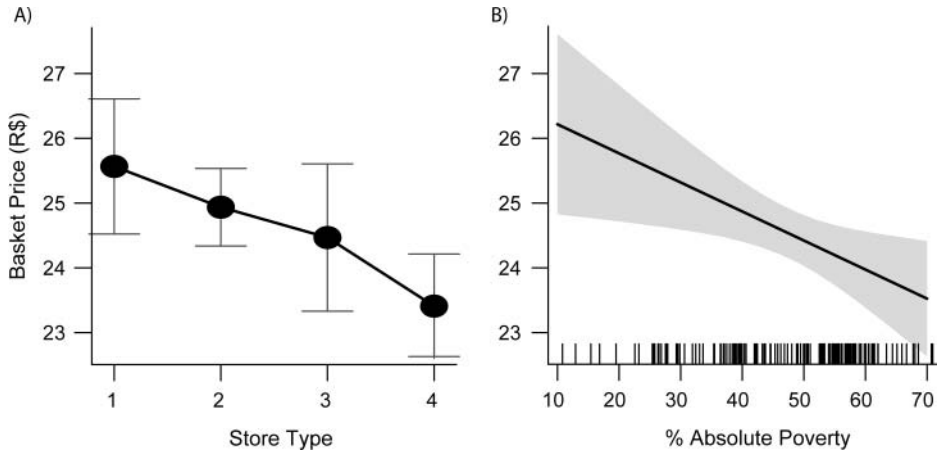

Figure 4. Relationship between (A) basket price and store type and (B) basket price in individual shops and the percentage of households within 250 m living in absolute poverty.

4. Alternative food sourcing strategies such as fruit trees and fishing appear to have significant roles in food provision. This might challenge the applicability of conventional food desert definitions within transitioning economies, but further research is required. Our main findings are now be considered further along with their policy implications.

Presence of Food Deserts

Despite observing high shop density, local access to a sufficient range of healthy food products, regardless of affordability, was found to be insufficient in many areas. The defined thresholds for both distance and food products included in the method are only illustrative and cannot encapsulate all nutritional needs or household purchasing or coping strategies. Nevertheless, these results indicate that there is significant scope to improve access to some food products and, in particular, fruit and vegetables. A lack of access to fruit and vegetables is of particular concern, as Brazil's consumption only reaches half of the World Health Organization–recommended levels (Cobayashi et al. 2014). Evidence both from shopkeeper responses within this study and elsewhere (WinklerPrins 2002) suggests, however, that fruit is often sourced from fruit trees at home and might to some extent supplement a lack of retail provision. There is less evidence of alternative provision of vegetables. Understanding which food products cause food deserts to be defined can both help direct further research and help guide policy.

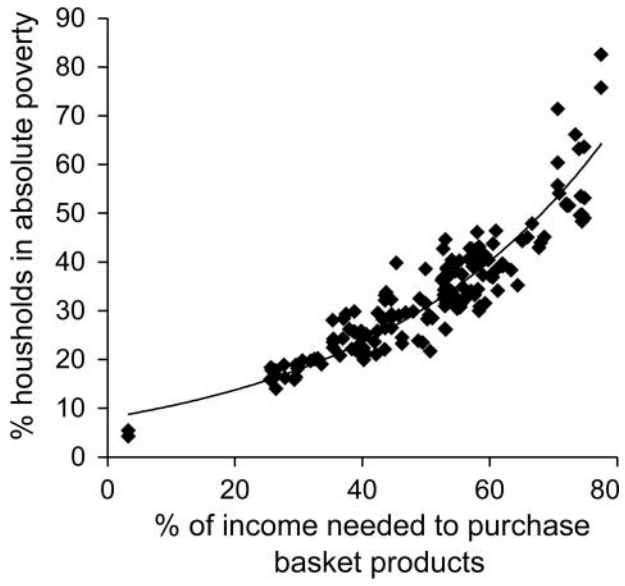

Figure 5. Relationship between the percentage of weekly household income required to purchase the sample basket and the percentage of households living in absolute poverty. (Calculated for 165 shops where all basket products were available. Demographic data calculated as the average for the area of 250 m around the shop.)

In contrast to most previous studies (Duran et al. 2013), neighborhood poverty in urban Amazonia was

Table 4. Alternative food sourcing strategies, reported as percentage of shop owners surveyed who thought that at least half of their customers used this strategy

Strategy	Iranduba	Novo Airão	Presidente Figueiredo	Manacapuru	Manaus	%
Fruit trees at home	66	58	56	47	57	56
Fishing	82	69	9	54	11	51
Rural plots	38	66	66	32	10	41
Chickens	35	35	14	13	10	22
Hunting	14	35	3	4	6	12
Vegetables at home	14	10	5	4	3	8

found to be unrelated to access to healthy food. Reasons for this might include the very high density of small family-run shops, especially in the poorest areas. Although the range of foodstuffs available within any individual one of these shops is lower than in more sophisticated stores, the high density of these shops means that the availability of products within a local neighborhood is not necessarily compromised. Yet, shops in poorer areas were less likely to sell fruit and vegetables. This might relate to lack of demand, either due to prioritization of spending on other items or due to use of alternative sourcing of fruit from local trees by poorer households (European Food Information Council [EUFIC] 2012). Although neighborhood availability of food might be the same, food access might be better for those with higher income as their access to resources, including transport, will be greater, enabling them potentially greater options for sourcing food from a wider geographic area (Shannon 2016).

Small family-run food shops (Types 1 and 2) dominated food retail in the Amazonian urban centers studied, especially in poorer neighborhoods. Of the more sophisticated shops (Type 4; for example, with trolleys, accepting credit cards), few were in the poorest neighborhoods and instead tended to be located more strategically near commercial centers. Meanwhile, many of the poorest neighborhoods are located on the urban fringes. In poor areas, although there are less of the more sophisticated shops, there were many more shops overall. These predominantly small, family-run shops with few services might be in high demand with households depending on shopping very locally. These small shops also provide the additional advantage of providing a livelihood for an estimated one in fifty households. Unlike the context for most other food desert studies to date (Jiao et al. 2012; Frndak 2014; USDA 2015; Barnes et al. 2016), large supermarket chains are yet to dominate the food market in this transitioning economy and thus have not had the impact seen elsewhere of outcompeting local neighborhood shops (Cummins and McIntyre 2002; Gartin 2012). Our results show, however, that in areas with lower income poverty, the overall density of shops is lower, whereas the facilities offered by stores are higher. This implies that as an economy continues to transition, there is a shift toward fewer but larger food shops. The introduction of supermarkets within the United Kingdom and United States was linked with the emergence of food deserts (Cummins and Macintyre 2002; White and Hamm 2014); thus, care must be taken to ensure that as the economy transitions, the food access of less mobile households does not worsen.

Interestingly, food prices were generally found to be cheaper in poorer areas. This result is opposite to the findings of most previous studies, where the prevalence of higher priced, small convenience shops and lack of cheaper supermarkets in poor areas causes prices to be higher (Beaulac, Kristjansson, and Cummins 2009). This novel finding might be due to the very different retail food provision available within the study region. It also suggests that the market adjusts well to relative purchasing power and that poor food access is not always about market failure. Although food might overall be slightly cheaper in the poorest neighborhoods, this does not mean that it is more affordable when income differences are taken into consideration. The proportion of income required for purchasing the basket food items increases exponentially in relation to the rise in percentage of households living in absolute poverty. The average proportion of monthly household income required to purchase the basket items is greater than 80 percent in the poorest urban areas, and this basket only represents part of a household's required food intake (NEPA 2011). This implies that for some households the cost of purchasing sufficient healthy food might exceed their income, even before accounting for other essential living costs. Incomes have failed to rise in line with very high inflation (11 percent in 2015; Banco Central do Brasil 2016), meaning that affordability is currently getting worse.

Alternative Strategies

Alternative food sourcing strategies were employed by many households, consistent with other studies elsewhere in the Amazon (Parry, Barlow, and Pereira 2014). The high proportion of fruit trees at home and low numbers growing vegetables at home concur with the findings of WinklerPrins (2002). Even within the metropolis of Manaus, fruit trees at home appear to be a significant alternative food source and could be important in mitigating some of the negative food desert impacts arising from lack of retail availability. Land outside of the city and its related urban–rural transfers (WinklerPrins 2002) was also found to be important in most urban centers, although less so in Manaus, presumably due to the size of the city; yet even here in the metropolis, 10 percent of shop owners still thought that over half of their customers had land outside of the city. Although fish is rarely present within retail food provision, it appears to remain a significant alternative source

of food in many urban centers across the study region. In Iranduba the proportion of households thought to fish is particularly high. Despite a nutritional transition from fish to frozen chicken (Nardoto et al. 2011), fishing was important in other smaller riverine centers (Iranduba Novo Airão and Manacapuru) but less important in Manaus and in the urban center away from a river (Presidente Figueiredo).

The extent to which different alternative sourcing strategies are employed was found to vary among urban centers. Sometimes the reasons for this variation are obvious, such as ease of access to a river affecting likelihood of fishing. Yet, in other cases (e.g., keeping chickens) further investigation is needed to discover and understand strategies specific to a given community. Overall, it is clear that alternative food sourcing strategies play a potentially significant role in supporting household food security and alleviating potential impacts of living in a food desert (as defined in terms of retail food access; Frayne, McCordic, and Shilomboleni 2014). This might be especially significant in the case of alternative provision of fruit, which is insufficiently available through retail provision in many areas (WinklerPrins 2002). The availability and consumption of nonretail sources of fruit warrant further investigation to more fully understand the extent to which this might help alleviate the impact of food deserts. When taking the impact of alternative food sourcing strategies into account, it is likely that defining food deserts based only on retail food provision will overstate the food access problem within a rainforest setting, although the impact will vary among urban centers. Elsewhere in the Global South alternative food sourcing strategies might also influence the true impact of conventionally defined food deserts on food security. The relative prevalence of these strategies is likely to be place specific, however, and thus understanding local context is very important. Interestingly, the results challenge the application and relevance of conventional food desert definitions to non-Western contexts given the high prevalence of alternative food sourcing strategies in the urban centers we studied. Incorporating alternative food sourcing into the spatial assessment of food deserts was beyond the scope of this study given the data available, but it does highlight an important area for future research.

Limitations

Further research is needed to ascertain whether nutrition and health are indeed worse within those areas identified as food deserts. Socioeconomic and spatial inequalities in nutrition and food security also need to be considered (Beaulac, Kristjansson, and Cummins 2009). The food desert concept involves making simplified assumptions about households within a given area, yet there might be significant variation in food sourcing behaviors, and households will employ different strategies for sourcing food depending on their capabilities (White and Hamm 2014). It should be recognized that not all food sourcing will take place on foot and near home and that food sourcing might vary considerably between households, according to transport availability and mobility patterns. Some households might, for example, purchase food in other localities such as near their workplace rather than in their immediate neighborhood. Mobility is much higher in some locations than others (Shannon 2016) and might also vary significantly between individuals within the same neighborhood affecting the true geographic extent within which they shop for food (Chen and Kwan 2015). The thresholds (both distance and selection of products) used will also significantly affect the spatial distribution of food deserts. For this reason they should be used for understanding inter- and intraurban variation and should not be interpreted as a definitive number of households living within a food desert.

Policy Implications

Drawing on the findings of this research, a number of policy interventions that might reduce the prevalence or food security impact of food deserts on urban households in Amazonia and other transitioning economies are highlighted. Although the food basket prices were cheaper within income-poor neighborhoods, relative to income, sufficient healthy food remained cost prohibitive for the most deprived households. Low household income presents one of the biggest challenges to the ability of households to access sufficient healthy food for a nutritious diet. In Brazil, continued efforts by the federal government to raise the incomes of the poorest members of society, through cash transfers and improved educational and employment opportunities, will therefore remain key to alleviating food deserts. Research shows that conditional cash transfer schemes such as the Family Grant (*Bolsa Família*), have positive impacts on food security, although they might also encourage consumption of higher density calories and greater obesity (Wezel and Bender 2003; Cotta and Machado 2013).

It was observed that most households shop close to home, especially for those living in poor neighborhoods located on the urban fringes where public transport is largely absent. Within the urban centers studied, public buses are unreliable and travel only along major routes, partly due to poor quality roads in deprived neighborhoods. Small privately owned minivans served as buses on some routes in Manaus and motorbike taxis existed in all study cities, yet both options remain cost prohibitive for the poorest members of society. Improvements to the level of service and affordability of public transport for poorer households might improve their mobility and subsequently, food access (Reisig and Hobbiss 2000). Hence, investments to improve infrastructure (especially roads) in poorer neighborhoods should aid mobility and attract investment in terms of food retail. Care also needs to be taken to ensure that the expansion of large housing schemes for low-income families such as "Minha Casa, Minha Vida" (My Home, My Life; CAIXA 2016) occurs in parallel with the development of local shops and services able to provide sufficient access to healthy food.

The availability of fruit and vegetables in shops was generally low in this study context. Low levels of agriculture within Amazonas state and poor transport connections both within the state and to elsewhere in Brazil (Fenley, Machado, and Fernandes 2007) are likely to limit supply, keeping prices relatively high. Investment nationally to improve transport links both within Amazonas state and to the rest of Brazil might help increase access to affordable food. New road links would be ill advised because they invariably lead to uncontrolled deforestation and thus would exacerbate global climate change (Fenley, Machado, and Fernandes 2007). At the municipal scale, policies supporting periurban agriculture might also help to increase supply of fruit and vegetables.

The results also showed that in urban Amazonia, alternative food sourcing—especially fruit trees, fishing, and home gardens or periurban farm plots—might be significant contributors to local health and nutrition. Indeed, one of the principal reasons people maintain periurban food plots is to minimize risk of food insecurity (Lerner and Eakin 2011). Therefore, as urban areas continue to grow it is important for local planning policy not to overlook the potentially important role of these alternative strategies for food security. Local urban planning should therefore seek to maintain access for urban populations to alternative food sources such as urban fruit trees and periurban food plots. In addition to improving the supply of foods such as fruit and vegetables, educational interventions to increase demand for vegetables might be beneficial. WinklerPrins (2002) observed low preference for vegetables within Amazonian towns and our observations during fieldwork appear to confirm this. This lack of preference might influence demand and thus current lack of availability. Similar barriers to fruit and vegetable consumption have been found in Europe, where fruit and vegetable consumption is affected by income and affordability, level of education and knowledge of nutritional importance, local availability, and taste preferences (EUFIC 2012).

Conclusion

In providing the first examination of food deserts in a rainforest context, this article has demonstrated that food deserts appear to be widespread in urban centers, regardless of their size. It is clear that some elements of a healthy diet, especially fruit and vegetables, are lacking in local retail provision. It is also evident that although food deserts are no more likely in poorer areas and prices are in fact generally cheapest in the poorest areas, the proportion of average household income required to purchase a healthy basket of food is unaffordable for many of the poorest households. The full extent of nonretail food provision and its influence in alleviating the impacts of food deserts warrant further investigation. The availability of fruit from trees at home or within the local neighborhood, along with continued urban–rural linkages in the form of land outside the urban extent, could play a significant role in reducing the effect of food deserts where availability of fruit and vegetables is a significant problem. Other alternative food sources such as fishing might also help to reduce challenges relating to affordability of food. As the Amazonian economy continues to transition, the future importance of alternative food sources remains to be seen. The role of alternative food sourcing strategies, especially in smaller urban centers, leads us to question the applicability of conventional food desert research—the origins of which lie in Western contexts with mature economies and high supermarket penetration—to transitioning economies. Key policy implications have been highlighted, including the need for continued programs designed to improve incomes for the poorest households and infrastructure investment to improve affordable supply of healthy foods.

The method presented here could usefully be applied in other contexts where supermarkets are not yet significant to local food retail. More research is, however, still needed to improve understanding of food deserts within transitioning economies and across the Global South, where the majority of those most vulnerable to food insecurity reside. Importantly, local food contexts (both retail and nonretail) need to be understood and explored together to effectively expand the concept of food deserts.

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GEMMA DAVIES is the GIS Officer in Lancaster Environment Centre at Lancaster University, Lancaster LA1 4YQ, UK. E-mail: gemma.davies@lancaster.ac.uk. Her research interests include many areas of applied GIS, including food security, journey-time exposure to air pollution, and mobility.

GINA FRAUSIN is a researcher in Lancaster Environment Centre at Lancaster University, Lancaster LA1 4YQ, UK. E-mail: ginafrausin@gmail.com. Her research interests include the knowledge of plants and their uses by indigenous populations in the Amazon.

LUKE PARRY is a Lecturer in the Lancaster Environment Centre at Lancaster University LA1 4YQ, UK. E-mail: luke.parry@lancaster.ac.uk. His research interests include urbanization and linkages with environmental change and food security with a geographic focus on Amazonia.