PEOPLE *in* NATURE

WORKING PAPER #3

CONSERVATION STATUS OF BIODIVERSITY IMPORTANT FOR BRIBRI FOOD AND NUTRITIONAL SECURITY

UNDERSTANDING THE POTENTIAL OF SECONDARY DATA FOR SITE LEVEL ANALYSIS

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EXECUTIVE SUMMARY

People in Nature (PiN) has been established as a new IUCN knowledge basket initiative that will bring together primary and secondary data guided by approaches, methodologies, tools and standards to document and understand interrelationships between humans and nature.[1] In early discussions about this interrelationship it was suggested that PiN should focus on provisioning and cultural ecosystem services and consider linkages to existing IUCN knowledge products. It was also recommended that PiN focus on applicability within specific policy domains, such as food and nutritional security, and in particular, highlight contributions of biodiversity for nature based solutions within these domains. During the scoping phase it was noted that the Species Survival Commission, working with the Freshwater Biodiversity Unit of the Species Programme, had undertaken regional reviews that linked biodiversity at the species level to use by humans.[2] In workshops that followed, the idea of linking existing datasets emerged to be able to identify species that make specific contributions to food and nutritional security and their conservation status. These ideas have been elaborated within the PiN mixed methodology as part of the situational analysis in which secondary data would be reviewed for specific project sites (Idrobo et al. *in prep*).

In this discussion paper, we undertook an analysis guided by three questions relevant to food and nutritional security for the project site of Sixaola on the Costa Rica – Panama border:

1. What are the locally harvested species utilized for food by the Indigenous Bribri people of Sixaola, Costa Rica and what is their conservation status?
2. What contribution does biodiversity utilized as food make to the maternal and child health of Bribri people?
3. What is the conservation status of those species high in nutrients that contribute to maternal and child health?

Our approach was influenced in part by Nabhan et al. (2010) who collated and analysed a dataset of North American species, subspecies, stocks or ecotypes of traditional foods to determine their conservation status and whether they were still utilized. Conservation status is a term in use by the IUCN Red List of Threatened SpeciesTM (Red List), but also by other conservation data providers (e.g. natureserve.org) to indicate a level of risk (e.g. Vulnerable, Endangered, Threatened) to the survival of a species at a local, regional or global scale. In our approach, we identified the Species Information Service (SIS), managed by the IUCN Species Programme as a potential dataset that could be utilized to provide information on the conservation status of species utilized by Bribri people. The SIS is the database backbone of the IUCN Red List. In order to compile a list of species utilized for foods in Sixaola, we drew upon another secondary source of data from an IUCN CEESP member (Sylvester, unpublished) who had undertaken recent work with indigenous Bribri people regarding forest foods and who was familiar with other existing secondary data related to species utilized by Bribri people for food. We then linked these two secondary datasets to provide an overview of the conservation status of Bribri foods for the Sixaola situation analysis.

In a second phase of analysis, we worked with food scientists (T. Beta and V. Ndolo) to link this list of Bribri foods with data from food composition databases that provide nutrient composition information, to differing degrees, for these species. The available food composition data for Bribri foods was analysed with a focus on the micronutrients known to be important for maternal and child health and compared to what might be seen as substitutes for these food sources. The latter represents an important comparison as many assessments of the "value" of biodiversity to people are calculated in monetary terms. As such, local biodiversity is often viewed as substitutable by alternatives that can be found in markets. We show, however, how a quantitative value can also be assigned to species locally used for food, taking into consideration the micronutrient contribution of a food for a specific function, such as maternal and child health. When evaluated through this lens, species are not as easily substituted by suggested replacements. This is especially valid if we were to further consider the multiple uses of a particular species locally in other critical areas for poverty reduction, such as material for shelter, household income and medicine.

This analysis considers what we can learn about risks to local foods important for child and maternal health at the Sixaola site from linking secondary datasets on conservation status and food composition. In addition, some key findings emerge out of this analysis on existence and use of secondary data that will need to be considered in order to advance the mixed methodology approach of PiN.

1. **SIS and scale –** Data on species stored in the SIS is compiled through the Red List assessment process which is undertaken at the global scale. As such, SIS data on species conservation status may act as a warning signal for a site level analysis that would require further information to be useful at a local level. A species used as food could be endangered or threatened globally but abundant at a PiN assessment site or

1 http://www.iucn.org/about/union/commissions/ceesp/knowledge_baskets/hdn/ The initiative was originally launched under the name, Human Dependence on Nature (HDN).

2 See Carr et al. (2013) (permalink: https://portals.iucn.org/library/efiles/documents/SSC-OP-048.pdf) and Juffe-Bignoli and Darwall (2012) for examples of this work.

vice versa. Location-specific reports are occasionally available within the SIS that may add further information. In some jurisdictions, national listings, which are not considered for the global Red List may also provide further resolution for a situation analysis. In spite of these challenges, at species and subspecies levels there is potential to use SIS as a database for both storing information on use collected through analysis of secondary data at a site, and as barometer of conservation status.

2. **Secondary Datasets Review –** It will be necessary to undertake a systematic review of potential secondary datasets for different direct use domains for species, including food and nutrition security. In this analysis, we utilized the USDA and Costa Rican Nutrient Composition Tables, but there are efforts globally regarding compilation, maintenance and standards for nutrient composition data, such as FAO INFOODS.[3] There is a history of superficial consideration of use and value of biodiversity in the conservation literature. However, there is existing data within the food and nutrition security domain that could be used to better calibrate value. This is not without its challenges and IUCN will need to partner with organizations such as USDA and FAO that actively maintain these datasets. As noted in this scoping exercise, one of the challenges of linking conservation status with nutrient contribution is that one is based upon species while the other upon foods. The two types of datasets cannot therefore be seamlessly linked. In a discussion with a USDA representative this was noted as a possible issue being addressed in new work regarding nutrient composition table standards and opens up a possibility for collaboration with the nutrition scientific community. Creating digital linkages between conservation status and food composition data would make it possible to run automated queries on food composition based on a local species list. Finally, while foods from common commercial crops are highly represented in food composition datasets, non-domesticated species, "underutilized" crop species and traditional landraces tend to be poorly represented, which causes difficulties when assessing traditional foods and food systems.

3. **Other Public Data –** Not all data on use and food composition has been contributed to existing datasets, yet there is much existing data on both within publicly available, published literature. In our case, we were fortunate that recent research by an IUCN CEESP member had been undertaken on the foods utilized by Bribri who was able to locate relevant secondary data. This highlights two possible avenues for PiN to explore to bring together existing secondary data relevant to PiN. First, there is increasing interest in creating the means to "mine" data from documents that are not linked within existing datasets. Second, it is desirable to create a crowdsourcing solution such that existing public domain or open data could be solicited from researchers and their scientific communities. Researches in human ecology, ethnosciences and nutrition have undertaken site levels studies related to use and nutritional contribution of species. A crowdsourcing platform would provide a means for researchers to contribute data to fill specific information gaps. This data could in turn be managed by the appropriate data custodian, e.g. by the SIS, in existing food composition tables, or potentially in locally or nationally maintained datasets and their mirrors. This would allow PiN to iteratively contribute to the completeness of secondary datasets.

4. **Wild Species and Traditional Landraces –** It was pointed out by our food science colleague, that looking at wild species only provides a partial understanding of the contribution of biodiversity to local food systems. Particular landraces not only provide critical nutrients either generally lacking or during specific seasons, but also provide critical calories needed for maternal and child health. Recent research suggests that many local landraces are higher in critical micronutrients not found in commercial varieties that have often replaced them in local food systems. She suggested that PiN should consider both the conservation status of wild species and traditional landraces, as well as impacts of their loss on food and nutritional security both in terms of non-communicable diseases (e.g., diabetes, hypertension, heart disease) and micronutrients specific to maternal and child health.

5. **Scientific and Indigenous Knowledge –** One of the requirements of the CEESP knowledge baskets is that they generate credible knowledge. In drawing upon public secondary data on conservation status, use and biodiversity values, such as nutritional composition, it will be possible to ensure scientific credibility of sources. In some cases, this will include published data collected in partnership with Indigenous Peoples. In either case, an analysis based solely on public secondary data would not be sufficient in order to credibly trigger policy outcomes. Interpretations drawn from secondary datasets must be verified with Indigenous People and Local Communities that may hold quite distinct perceptions on conservation status or the value of biodiversity.

3 http://www.fao.org/infoods/infoods/en/

INTRODUCTION

It has been shown that wild and semi-wild plant and animal life is a critical source of energy, macro- and micronutrients for over a billion people, where deficiencies in vitamins and minerals constitute a threat to health (CBD Secretariat and WHO 2015, IUCN 2013). Staple diets in rural areas characterized by high poverty levels often feature a few major food sources that are rich in energy, yet low in micronutrients (Salomeyesudas et al. 2013). For instance, micronutrient deficiencies associated with low food diversity is linked with stunting of children under five, with approximately 165 million children affected in developing countries (UNICEF 2013). Access to nutritious foods introduces a distinction between food and nutrition security (FAO 2013). Risk of micronutrient deficiencies exists when and where small numbers of cultivated species and varieties are used, paradoxically even where biodiversity is high (Barucha and Pretty 2010, Boedecker et al. 2014). In such scenarios, the re-assessment of the potential of biodiversity in diets can present effective pathways to address micronutrient deficiencies sustainably (Burlingame et al. 2006; Grivetti and Ogle 2000; Johns and Eyzaguirre 2006). The contribution of biodiversity to nutrition has special significance for addressing issues in maternal and child health for whom particular micronutrients requirements are critical (Arimond et al. 2010).

Common nutrition problems of the present were frequently prevented in the past through dietary diversity characteristic of traditional food systems. Indigenous Peoples and Local Communities (rural and remote communities) often continue to rely on local food provisioning strategies for a significant proportion of daily dietary intake. Some studies have demonstrated the vast variety of foods – the "hidden harvest" – available to people living in biodiverse areas, consisting of high numbers of wild edible species and cultivated farmer's varieties (Penafiel et al. 2011; Scoones et al. 1992; Smith 2010). Numerous studies have been conducted showing variation in composition of wild and cultivated species emanating from genetic and environmental effects. While there are over 7000 plant species cultivated, only 30 species provide approximately 90% of the world's dietary energy supply (Hammer et al 2003). The latter is concerning as recent research has confirmed the micronutrient superiority of some lesser-known cultivars and wild varieties over those cultivars that are extensively utilized (Burlingame et al 2009). The differences in micronutrient content may result in micronutrient deficiency and micronutrient adequacy depending on which cultivars and wild harvested species are readily accessible in a particular region or community.

Local and traditional foods contribute to meeting micronutrient recommendations, with some rural and remote communities relying on 200 or more different species, suggesting that micronutrient deficiencies can be addressed through food biodiversity-based approaches (Kuhnlein et al. 2009; Penafiel et al. 2011). Biodiverse diets additionally offer a dimension of food and nutrition security in that they may provision critical energy and micronutrients at times of the year when other nutritious foods are not readily available, or as means to cope with shocks, natural disasters or loss of a family breadwinner (CBD Secretariat and WHO 2015, Turner and Davis 1993). Thus, there is increasing interest from international policy circles in the biodiversity-nutrition-health nexus, focusing on food systems, rather than compartmentalizing nutrient deficiencies through narrow interventions such as micronutrient supplement pills (Power 2008; WHO and CBD 2015).

As evidence of the importance of creating nutrition-biodiversity linkages, the Cross-Cutting Initiative on Biodiversity for Food and Nutrition provides a precedent for renewed efforts to link across areas of research predominantly characterized by distinct scientific, knowledge-sharing communities.

Biodiversity managed sustainably supports sustainable food systems, and environmental degradation can result in lowered biodiversity and potential exposure to higher risk for dietary diversity (Allen et al. 2014; Turner et al. 2013). In 2013, IUCN identified the lack of integration of ecosystem factors as being one of the key gaps in food security policy-making:

> Ecosystem factors are still missing from much of the thinking behind food security policy-making. This is resulting in ill-informed, ineffective policies and contributing to ecosystem mismanagement and degradation, which in turn undermines the food security objectives of these policies (IUCN, 2013:7).

This is of particular importance in times of environmental and climatic change, when human reliance on certain natural resources may be at risk unless there is targeted action guided by informed policies (Boedecker et al. 2014).

Nonetheless, empirical efforts to identify linkages between biodiversity, ecosystems and human health continue to be overlooked in global conservation policy (Allen et al. 2014) and knowledge about biodiverse diets has yet to be systematically integrated into planning, assessment and policies concerning food systems (CBD Secretariat and WHO 2015). The ability to efficiently linking openly available data across biodiversity and nutrition domains of knowledge would address a gap in terms of the role of biodiversity in food and nutritional security.

4 http://www.cbd.int/decision/cop/?id=11037

IUCN (2013) began to consider threats to biodiversity, including species and ecosystems, which support healthy food traditions with a stated commitment to food and nutritional security as a policy domain. IUCN launched the People in Nature (PiN) initiative in 2012 at the World Conservation Congress. The purpose of this discussion paper is to investigate the potential for the proposed PiN mixed-methodology to empirically demonstrate linkages between biodiversity and food and nutritional security using publicly available secondary data.

The PiN mixed-methodology is composed of three phases, the first of which is an interdisciplinary situation analysis (SA), involving collection and preliminary analysis of secondary data on biodiversity used by people within a bounded landscape assessment site (Idrobo et al. *in prep*). For this phase, data on species used directly for provisioning is available in literature and in publicly available datasets. The IUCN Species Information Service (SIS) is a database open to non-commercial use by the public. This database forms the backbone of the IUCN Red List of Threatened Species.[5] In scoping workshops, it was proposed that the SIS may be used both as a source of data on species use and conservation status, and as a repository for management of new data created through PiN landscape assessments at sites. In order to provide more scientific rigour regarding specific contributions of species to food and nutritional security, it was also proposed that linkages could be made between SIS data and food composition data. The case study presented in this paper puts these proposals to the test by collating and analysing existing knowledge to link conservation status of biodiversity to food and nutritional security of rural and remote communities.

Mother and daughter explaining cacao grafting technique in Yorkin. Credit Nathan Deutsch

5 http://www.iucnredlist.org/

THE SITUATION ANALYSIS – LINKING PiN, SIS AND FOOD COMPOSITION DATASETS

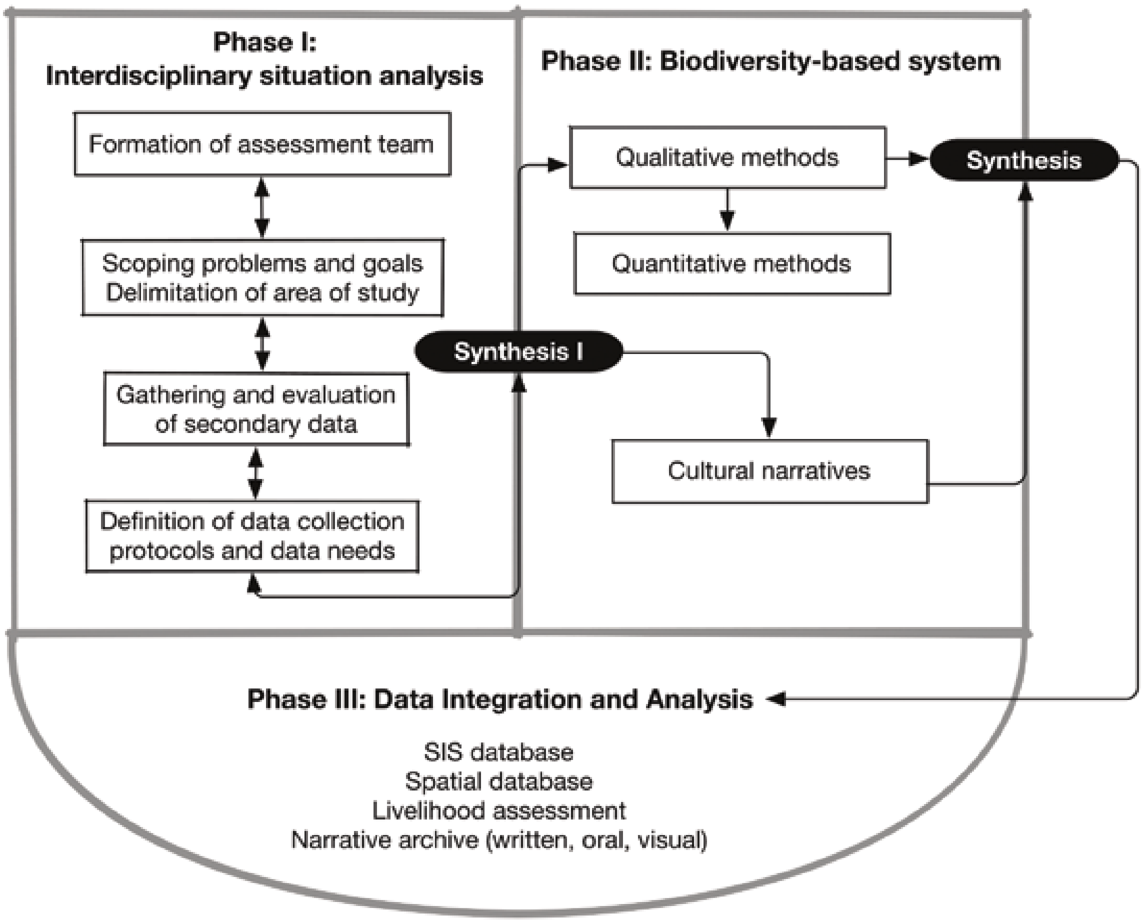
The PiN mixed methodology represents a systematic approach to gathering and using secondary data on the direct use (provisioning) and symbolic importance of biodiversity for rural and remote communities. Each local implementation of the PiN methodological approach is referred to as a landscape assessment, comprising a case study area, a community or group of communities constituting a local/Indigenous territory, and an interdisciplinary assessment team (Idrobo et al. in prep.). The initial phase of the PiN landscape assessment methodology involves collection and preliminary analysis of secondary data pertaining to social, economic, political and ecological aspects of the case study area. This phase has been termed the interdisciplinary situation analysis (see figure 1), and is the phase to which this working paper aims to contribute.

PiN aims to engage policy makers on a range of policy domains, and guides assessment teams as they drill down into particular datasets and secondary data sources during the situation analysis. This discussion paper takes food and nutritional security as an example of such a policy domain. During the situation analysis (phase I in figure 1), an assessment team would analyse and identify gaps in existing data to guide primary data collection (phase II in figure 1).

As PiN focuses on the interrelationships between humans and nature, we have chosen to utilise a conceptual framework built around the dependent variable, use, and a set of independent variables that describe the ways by which use is shaped over time in specific locations (Davidson-Hunt et al. *in prep*.). In our current conceptualization we consider use to be shaped by access (e.g., normative frameworks, physical and institutional barriers), availability (of biodiversity at a point in time), stability (of biodiversity over time), technology (e.g., related to harvesting or processing) and perception (e.g., recognition of species as useful or culturally valuable). Use provides a measure of richness, representing the total number of species that could be used (potential use), have been used (historic use) or are in current use (actual use). This variable can also be considered separately in relation to different domains of use, such as food and nutrition, medicine, energy, materials, trade and ceremony. This framework allows us to consider how use is shaped across time or at different sites. It also allows us to consider biodiversity across scales from genes to species to landscapes.

In this conceptualisation, use is not a given outcome but is emergent out of the interrelationship between humans and nature. While this is covered more fully in a PiN discussion paper in preparation (Davidson-Hunt et al. *in prep*.), suffice it

Figure 1: The PiN landscape assessment approach



to say that for the purposes of this working paper, the linking of SIS data to nutritional data provides possibilities to understand how use of a species can be shaped by its availability, the stability of its population and the value of a species in terms of nutrition. Independently, the SIS contains data that can inform a SA about the conservation status (availability)[6] of species used for food and potentially about threats to the stability of the populations utilized, along with other non-food uses. Likewise, nutrition datasets can reveal why species may be important for food and nutritional security. By linking the two datasets, useful information can emerge in relation to populations that people may see as important for restoration efforts, or around which contentious governance issues may emerge regarding access or appropriate measures to ensure that populations recover and persist into the future.

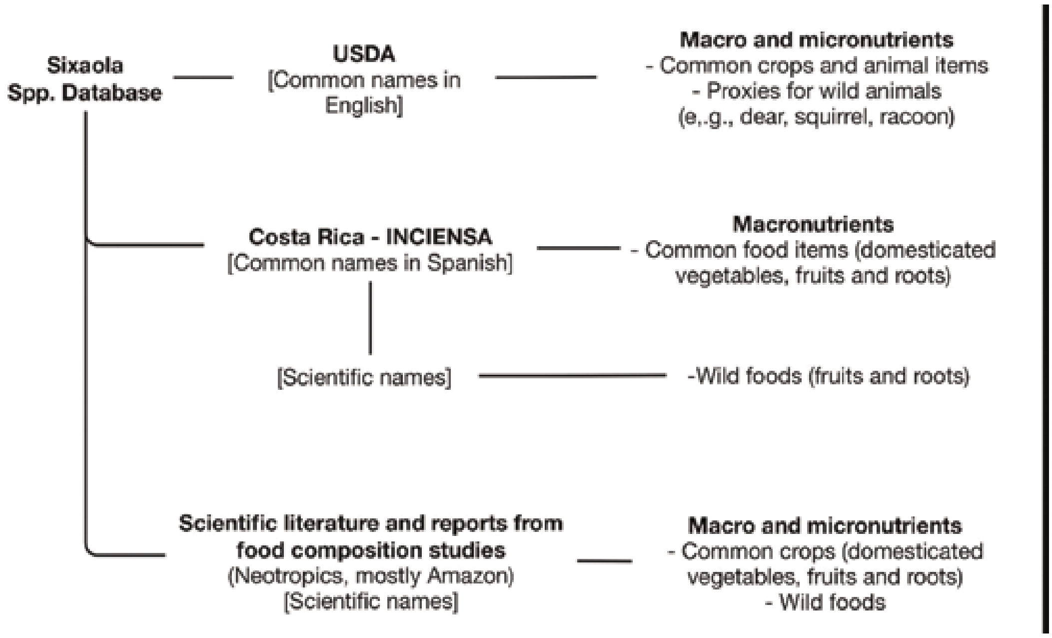
While much data has been collected globally regarding locally available foods, studies are often repeated at the same sites for the same people without giving consideration to use of existing data. This becomes problematic when it comes to asking communities about species use. To avoid repetition and fatigue, the PiN SA prioritises analysis of existing, publicly available data. Some of this data is held within the SIS but much is to be found dispersed among other datasets and documents. One of the possibilities explored by PiN is the potential for Members and Commissions of IUCN to contribute their data to specific PiN landscape assessments. When the appropriate PiN digital infrastructure has been created, this data can be made more publicly accessible for future projects. Furthermore, by linking to researchers and agencies working on nutritional properties of foods, it would be possible not only to utilize existing nutritional datasets, but to engage researchers in diverse scientific communities to provide public data not yet found in those dataset for specific foods and species.

6 The term availability has been flagged as potentially confusing, as it may be understood not to relate to biological aspects, but to social aspects, including access, capacity, etc. This is a broader question that has thus far received some discussion in Davidson-Hunt et al. (in prep.), involving choice of terminology that will be eventually adopted for a PiN conceptual framework.

In the case present, we drew upon a recent project that identified species (exclusively terrestrial, in this case) utilized for food by Bribri People, and for which the researcher had compiled information on species use for the area from existing literature (Sylvester, unpublished dataset). This species list represents a dataset for a particular geographical area and cultural group. The task of linking species names in this list to datasets on food composition and species conservation status can reveal gaps in available data that researchers in the conservation and nutrition communities may be capable of addressing.

Our list of species used by Bribri served to perform queries using the SIS and several datasets related to food composition. We conducted a systematic review of data available about the nutritional value of each species in nutrient datasets and relevant literature (Figure 2). The United States Department of Agriculture (USDA[7]) food composition tables provided information about macro- and micronutrients of common foods that included vegetable crops and domesticated animals. Surrogate species were chosen for wild animals present in Sixaola when nutrition data for the species was not available. The Costa Rica Institute of Research and Education in Nutrition and Health (INCIENSA[8] from its acronym in Spanish) food composition tables provided information about macronutrients of common crops, such as vegetables, fruits and tubers, as well as some wild foods including fruits and roots. Additionally, we consulted the international food composition tables on the Canadian Nutrient File website.[9] This search provided information complementary to that found in the two other databases. Finally, we reviewed datasets found in the scientific literature and reports from food composition studies conducted in the neotropics, primarily in the Amazon area (Aguiar 1996; Asprilla-Perea 2012). This review provided information about common crops and wild foods such as fruits and game animals.

Figure 2: Review process for examining nutritional profiles of Sixaola species



7 http://ndb.nal.usda.gov

8 http://www.inciensa.sa.cr/actualidad/Tabla%20Composicion%20Alimentos.aspx

9 http://webprod3.hc-sc.gc.ca/cnf-fce/index-eng.jsp

Table 1 presents a summary of the data available in the main two food composition databases consulted. While the USDA database reported a range of micronutrient data, the INCIENSA database only contained data on macronutrients.

Our interest in information stored in the SIS database primarily concerns our ability to understand the threats to species used as a food at the site of a PiN landscape assessment study and to understand their conservation status. The SIS is used to store data on use of species along with information on threats and their global conservation status. We took interest in several SIS database modules that are used to store particular kinds of data in relation to species, namely: *Use and Trade, Threats, Habitats and Ecology and Occurrence. The Use and Trade and the Threats* modules were both used in the present analysis because of our interest in understanding threats to availability and stability of the populations. *The Habitats and Ecology and Occurrence* were not analysed, but may provide information on presence of a species in a PiN assessment area and within particular habitats or ecosystems. These SIS modules will be considered in future analyses.

Red List assessments of species are performed at the global scale. As SIS data relate to a species' entire range, it may be difficult to find application of threats data in local PiN landscape assessments. Species may be abundant and stable within the PiN landscape assessment area of interest, but globally may be declining and threatened. The opposite may also be true with species being locally threatened but globally abundant. Threatened species are, nonetheless, more likely to be restricted in range and therefore their threat data, as well as other information in the SIS database, could be more applicable locally and regionally.

SIS data can highlight and inform further investigation into use of and threats to particular species at the site of the PiN landscape assessment, but will not replace the PiN methodological workflow for field sites. In this study, the SIS was searched using a list of species known to be used as food in Sixaola to identify their conservation status along with threats to species.[10] Threats to the habitats and ecosystems that populations of the species depend upon for their continued persistence within a landscape may sometimes be inferred from threats data, even though threats pertaining to specific geographical areas are stored in the SIS database. However, as many species have restricted ranges, it would often be reasonable to assume that threats occur across the geographic area of interest.[11] For example, if species are listed as being threatened by shifting agriculture in the SIS, we could make an assumption that this land use activity may locally affect species persistence.

We cross-referenced our species list with the SIS database using corrected names at the species level if possible. Out of a total of 98 species and cultivars identified, 76 had species level names and were searched in the SIS. Out of these species, 52 species and one subspecies had assessment data published on the Red List. This species list was used to extract data on threats, and use and trade from the SIS database. Of these species, 25 species records contained information on threats according to the SIS threat codes.

10 The reason for this is to identify not only those species identified as threatened by harvesting, but of any threats to availability of species used locally as a source of nutritious food. If a species is found to be listed as threatened in global or regional Red Lists, this would raise issues for further analysis during PiN landscape assessments.

11 In addition, the SIS may be used to store individual "harvest" records attached to species at multiple geographical locations. In this mode, the SIS has a potential use in terms of identifying uses and threats pertaining to specific geographical areas. Harvest records were not found in the SIS for Sixaola for the purposes of this study.

Table 1: Data available in food composition databases consulted

Nutrient profile	Unit of measurement per 100g	Nutrient profile		Unit of measurement per 100g
USDA		INCIENSA (Spanish)	INCIENSA (English)	
Macronutrients				
Water	g	Humedad	Water	G
Energy	kcal	Energy	Energy	kcal
Protein	g	Proteína	Protein	G
Total lipid (fat)	g	Grasa	Total Lipids	G
Carbohydrate, by difference	g	Carbohidratos	Carbohydrates	G
Fiber, total dietary	g	Totales digeribles fibra dietética	Total digestible dietary fibre	g
		Total	Total	
		Insoluble	Insoluble	
		Soluble	Soluble	
Sugars, total				
Ash	g	Ceniza	Ash (total minerals)	g
Micronutrients				
Calcium, Ca	mg			
Iron, Fe	mg			
Magnesium, Mg	mg			
Phosphorus, P	mg			
Potassium, K	mg			
Sodium, Na	mg			
Zinc, Zn	mg			
Vitamins				
Vitamin C, total ascorbic acid	mg			
Thiamin	mg			
Riboflavin	mg			
Niacin	mg			
Vitamin B-6				
Folate, DFE				
Vitamin B-12	µg			

Table 1 (cont'd): Data available in food composition databases consulted

Nutrient profile	Unit of measurement per 100g	Nutrient profile	Unit of measurement per 100g
Vitamin A, RAE	µg		
Vitamin A, IU	IU		
Vitamin E (alpha-tocopherol)			
Vitamin D (D2 + D3)	µg		
Vitamin D	IU		
Vitamin K (phylloquinone)	µg		
		Lipids	
Fatty acids, total saturated	g		
Fatty acids, total monounsaturated	g		
Fatty acids, total polyunsaturated	g		
Caffeine	Mg		
		Other	
Cholesterol	Mg		

FOOD COMPOSITION OF SPECIES CONSUMED IN SIXAOLA

In general, micro- and macronutrient information was available for common crops, including fruits, cereals, legumes and tubers, as well as domesticated animals. With few exceptions, nutrient profiles for non-cultivated plants and wild animals were difficult to find. The nomenclature employed in the databases limited access to nutritional profiles, as USDA and INCIENSA used only use English and Spanish common names to identify common crops and domesticated species.

Table 2 presents a summary for the cultivated edible plants, indicating their common name in English and Spanish as well as the dataset in which we found their nutritional profiles. We grouped species according to functional categories, including tubers (2 species), fruits (30), stimulants (4), cereal grains (2), legumes (3) and spices (2). Out of a total of 43 species analysed, we found food composition data (including proxies) for 28.

Table 3 presents wild plants that are harvested and consumed in Sixaola. Out of the thirteen species on our list, we found information available for five in the USDA database. Table 4 presents the wild mammal species. Out of a total of 21 species, we found micronutrient data available for six species and compared them to similar species in the USDA database and related literature. We could not find nutritional profiles for the three species of reptiles and fourteen species of wild birds reported to be hunted in Sixaola.

Table 2: Cultivated edible plants (highlighted species were analysed in this study)

Scientific name (family)	Common name English (Spanish)	Database/ Source
	Tubers	
Xanthosoma sp. (Araceae)	(nampi)	USDA/INCIENSA
Manihot esculenta (Euphorbiaceae)	Manioc (yuca)	USDA/INCIENSA
	Fruits	
Bactris gasipaes (Arecaceae)	Peach palm (pejibaje)	INCIENSA
Cocos nucifera (Arecaceae)	Coconut (coco)	USDA
Spondias purpurea (Anacardiaceae)	Jocote (jocote)	INCIENSA
Annona muricata (Annonaceae)	Soursop	USDA
Rollinia mucosa (Annonaceae)	Wild sugar apple (biriba)	USDA
Carica papaya (Caricaceae)	Papaya (papaya)	USDA/INCIENSA
Cucurbita pepo (Cucurbitaceae)	Squash (chayote, ayote)	USDA/INCIENSA
Inga edulis (Fabaceae)	Ice cream bean (guaba)	Aguiar (1996)
Persea americana (Lauraceae)	Avocado (aguacate)	USDA
Couroupita sp. (Lecythidaceae)		
Quararibea cordata (Malvaceae)	South American sapote (sapote)	
Artocarpus altilis (Moraceae)	Breadfruit (fruta pan)	USDA
Musa acuminata (Musaceae)	Gros Michel	
Musa acuminata (Musaceae)	Cavendish/lacatan	
Musa acuminata (Musaceae)	(pilipita)	
Musa acuminata (Musaceae)	(cuadrado)	INCIENSA
Musa acuminata (Musaceae)	(primitivo)	
Musa acuminata (Musaceae)	Cavendish/congo	
Musa acuminata (Musaceae)	(chopo)	
Musa sp. (Musaceae)	Plantain (platano)	USDA/INCIENSA
Musa sp. (Musaceae)	(platano propio)	
Eugenia stipitata (Myrtaceae)	Strawberry guava (Arazá)	USDA
Syzygium malaccense (Myrtaceae)	Malay apple (manzana de agua)	USDA/INCIENSA
Averrhoa carambola (Oxalidaceae)	Star fruit (carambola)	USDA
Saccharum sp. (Poaceae)	Sugarcane (caña de azúcar)	
Citrus reticulata (Rutaceae)	Mandarin orange (mandarina)	INCIENSA
Citrus limmeta (Rutaceae)	Sweet lemon (limón dulce)	INCIENSA
Citrus sp. (Rutaceae)	Lime (limón criollo)	
Citrus sp. (Rutaceae)	Orange	USDA
Nephelium lappaceum (Sapindaceae)	Rambutan (mamon chino)	USDA
Pouteria sapota (Sapotaceae)	Mamey sapote (zapote)	USDA

Table 2 (cont'd): Cultivated edible plants (highlighted species were analysed in this study)

	Stimulants	
Theobroma cacao (Malvaceae)	Cocoa (cacao)	USDA
Theobroma bicolor (Malvaceae)	Cocoa variety (pataste)	USDA
Coffea arabica (Rubiaceae)	Coffee	USDA
Coffea sp. (Rubiaceae)	Elders coffee (café de los ancestros)	
	Cereal grains	
Oryza sativa (Poaceae)	Rice	USDA/INCIENSA
Zea mays (multiple varieties; Poaceae)	Corn	USDA/INCIENSA
	Legumes	
Phaseolus vulgaris (Fabaceae)	Black bean (frijol negro)	USDA
Cajanus cajan (Fabaceae)	Pigeon pea (gandul)	USDA
Phaseolus sp. (Fabaceae)	Other Beans	USDA
	Spices	
Capsicum sp. (Solanaceae)	Chilli pepper (chile picante)	USDA
Capsicum sp. (Solanaceae)	Sweet pepper (chile dulce)	USDA

Table 3: Wild plants harvested and consumed in Sixaola

Scientific name (family)	Common name English (Spanish)	Database
Cyathea sp. (Cyatheaceae)	Fiddlehead ferns (quelites)	USDA
Dioscorea sp. (Dioscoreaceae)		
Chameadorea tepejilote (Arecaceae)	Pacaya palm (pacaya)	USDA
Iriartea deltoidea (Arecaceae)	(jira)	
Cryosophila warscewiczii (Arecaceae)		
Socratea exorrhiza (Arecaceae)	(Chonta)	
Carludovica sp. (Cyclanthaceae)	(Estococa)	
Heliconia sp. (Heliconeaceae)		
Renealmia alpinia (Zingiberaceae)	Garden ginger (jenjibre de jardin)	USDA
Jacaratia dolichaula (Caricaceae)	(Papayilla, papaya de venado)	USDA
Urera baccifera (Urticaceae)	(pringamoza)	
Phytolacca rivinoides (Phytolaccaceae)	Pokeweed or pokeberry (calalu)	USDA
Herrania purpurea (Sterculiaceae)	(cacao de montaña)	

Table 4: Wild mammals hunted and consumed in Sixaola

Species	English Name	Database/ Source	Comments
Dasypus novemcinctus	Nine-banded armadillo		
Nasua narica	White-nosed coati	USDA	Compared to raccoon (*Procyon lotor*)
Tayassu tajacu	Collard peccary	Aguiar (1996)	
Tayassu pecari	White-lipped peccary	Aguiar (1996)	Compared to collared peccary
Agouti paca	Paca	Aguiar (1996)	
Dasyprocta punctate	Agouti	Aguiar (1996)	
Choloepus hoffmanni	Hoffmann's two-toed sloth		
Bradypus variegates	Brown-throated three-toed sloth		
Mazama americana	Red brocket	Aguiar (1996)	
Odocoileus virginianus	White tail deer	USDA	
Allouatta palliata	Mantled howler monkey		
Herpailurus yagouaroundi	Jaguarundi		
Leopardus pardalis	Ocelot		
Potos flavus	Kinkajou	USDA	Compared to raccoon
Tamandua mexicana	Northern tamanudua		
Sciurus variegatoides	Variegated squirrel	USDA	Comparted to American red squirrel (*Tamiasciurus hudsonicus*)
Sciurus sp.			
Proechimys semispinosus	Tome's spiny rat	Asprilla-Perea, et al. (2012)	
Hoplomys gymnurus	Armored rat		
Tapirus bairdii	Baird's tapir	Aguiar (1996)	Compared to South American tapir (*T. terrestris*)
Sylvilagus brasiliensis	Forest rabbit	USDA	Compare to Eastern cottontail (*S. floridianus*)

CONTRIBUTIONS OF SPECIES TO MATERNAL AND CHILD HEALTH

In order to provide an example of linking conservation status to a specific component of food and nutritional security we also considered the critical micronutrients for maternal and child health. These micronutrients include vitamins A, B12, D and folic acid as well as minerals such as Calcium, Zinc, Iron, Iodine and Selenium (Black et al. 2008; Torheim et al. 2010). According to the National Institutes of Health (NIH)[12], women require higher consumption of these micronutrients during pregnancy and lactation (Table 5). With these parameters in mind, we analysed the potential contributions of key species to the local diet of people in Sixaola. We did this by comparing cultivated and wild species against species commonly consumed and commercially available.

Table 5: Recommended amount for daily consumption

Mineral	Pregnant teenager (14 to 18 years old)	Breastfeeding teenager (14 to 18 years old)	Adult pregnant woman (19 -50 years old)	Breastfeeding woman (19 - 50 years old)
Calcium	1,300		1,000	
Iron	27	10	27	9
Zinc	12	13	11	12

Table 6 compares the mineral composition of plantain, papaya, breadfruit and mamey sapote. Boiled and raw seeds of breadfruit have the highest concentration of calcium, followed by raw papaya and sapote. Raw seeds of breadfruit had the highest concentration of iron, followed by raw sapote. Raw and boiled seeds of breadfruit were also found to have the highest concentration of zinc.

Table 6: Mineral composition of selected fruits (in milligrams/100g)

Scientific name	*Musa* sp.		*Carica papaya*	*Artocarpus altilis*			*Pouteria sapota*
Common name (English	Plantain		Papaya	Breadfruit			Mamay sapote
Descriptor	Raw	Cooked	Raw	Whole, raw	Seeds, raw	Seeds, boiled	Raw
Calcium, Ca	3	2	20	17	36	61	18
Iron, Fe	0.6	0.58	0.25	0.54	3.67	0.6	0.78
Magnesium, Mg	37	32	21	25	54	50	11
Phosphorus, P	34	28	10	30	175	124	26
Potassium, K	499	465	182	490	941	875	454
Sodium, Na	4	5	8	2	25	23	7
Zinc, Zn	0.14	0.13	0.08	0.12	0.9	0.83	0.19

Table 7 compares the mineral composition of asparagus as an example of potential substitution for wild and semi-cultivated local species, fern fiddleheads, pacaya palm and pokeberry shoots. Pokeberry shoots were found to have the highest concentration of calcium, followed by canned pacaya palm hearts and inflorescences and fern fiddleheads. Canned pacaya palm hearts and inflorescence had the highest concentration of iron, followed by asparagus. Raw and canned pacaya palm hearts and inflorescences had the highest concentration of zinc. In the case of canned pacaya palm, a 100g serving provides one third of the recommended daily intake (RDI) for breastfeeding teenage and adult women. Additionally, raw pacaya palm provides over a third of the RDI for the same population segment.

12 http://ods.od.nih.gov/factsheets/list-all/

Table 7: Mineral composition of selected wild vegetables compared to cultivated asparagus (milligrams/100g)

Scientific name	*Asparagus officinalis* (Asparagaceae)	*Cyathea* sp. (Cyatheaceae)	*Chameadorea tepejilote* (Arecaceae)		*Phytolacca rivinoides* (Phytolaccaceae)	
Common name (English)	Asparagus (cultivated and available in local markets)	Fiddlehead fern	Pacaya palm		Pokeweed or pokeberry	
Part consumed	Stem	Stem	Palm heart, immature inflorescence		Leaves	
Descriptor	Raw	Raw	Raw	Canned	Raw	Cooked, boiled, without salt
Calcium, Ca	24	32	18	58	53	53
Iron, Fe	2.14	1.31	1.69	3.13	1.7	1.2
Magnesium, Mg	14	34	10	38	18	14
Phosphorus, P	52	101	140	65	44	33
Potassium, K	202	370	1806	177	242	184
Sodium, Na	2	1	14	426	23	18
Zinc, Zn	0.54	0.83	3.73	1.15	0.24	0.19

Table 8 presents a comparison between domesticated chicken and two wild bird species. Ground doves were estimated to have the highest concentrations reported for calcium, iron and zinc. A 100g serving of ground dove can provide two thirds of the RDI for iron as well as one third of the recommended amount of zinc for an adult breastfeeding woman. These values are 6.6 and 2.5 times the amounts than can be obtained from an equal serving of chicken.

Table 8: Comparison of minerals between domesticated chicken and wild birds (milligrams/100g)

Common name in English	Chicken	Quail	Ground dove
Scientific name	*Gallus gallus*	*Odontophorus erythrops*	*Columbina* spp.
Calcium, Ca	12	13	17
Iron, Fe	0.89	4.51	5.91
Magnesium, Mg	25	25	26
Phosphorus, P	173	307	332
Potassium, K	229	237	256
Sodium, Na	77	51	57
Zinc, Zn	1.54	2.7	3.83

Table 9 compares the nutrient composition of spiny rat to a selected group of domesticated mammals. A 100g serving of this species provides not only 86.7% of the recommended daily intake for an adult breastfeeding woman, but also contributes 2.8, 3.12 and 11.30 times what lean beef, pork and chicken contribute respectively. Likewise, the same serving of spiny rats contributes 48.29% of the daily recommended intake for an adult pregnant woman, which is equivalent to 1.76, 2.30 and 5.7 times what lean beef, pork and chicken contribute respectively.

Table 9: Comparison of nutrient composition among spiny rat and selected domesticated mammals

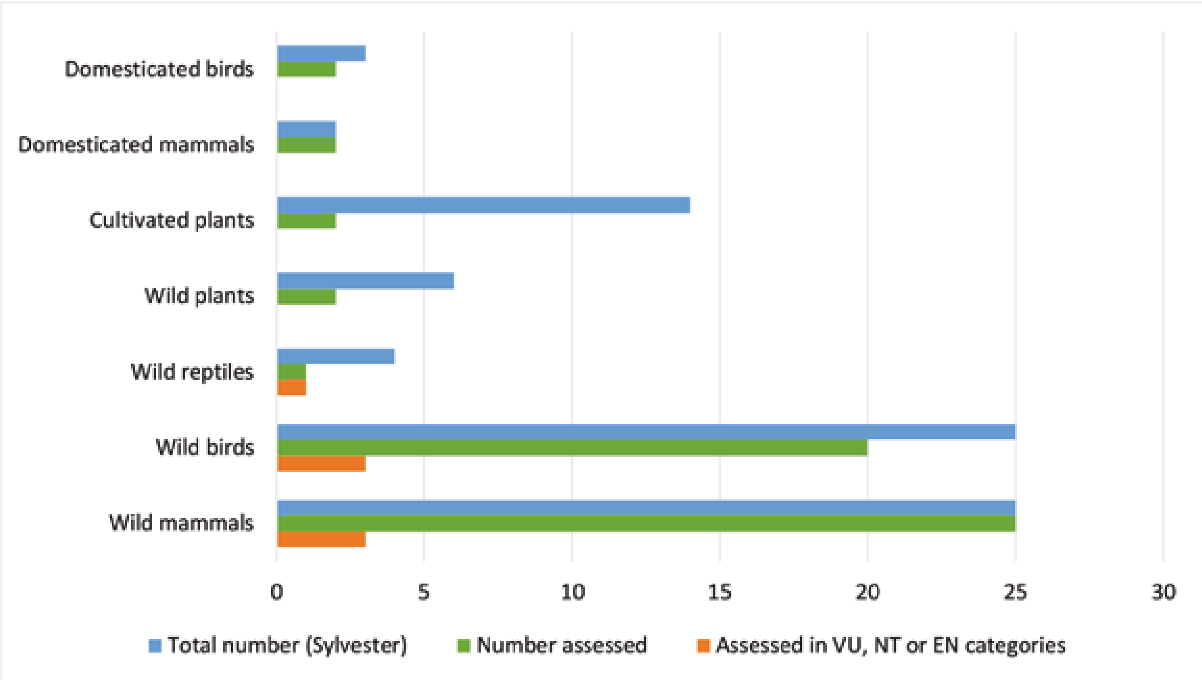
Common name English (Spanish)	Unit per 100g	Tome's spiny rat	Lean beef	Pork	Chicken
Scientific name		*Proechimys semispinosus*	*Bos taurus*	*Sus scrufa*	*Gallus domesticus*
Water	g	78	71	64	70.5
Energy	kcal	3.34	144	198	170
Protein	g	20	21.5	20.1	18.4
Total lipid (fat)	g	0.4	6.5	11.9	10
Total minerals/Ash	g	0.97	1	1.1	1
Calcium, Ca	mg	190	6	8	200
Iron, Fe	mg	7.8	2.7	2.5	0.69
Magnesium, Mg	mg	110	20.7	23	19.19
Phosphorus, P	mg	820	215	210	200
Potassium, K	mg	1500	nd	350	189
Sodium, Na	mg	112.1	54.9	72	51.55
Zinc, Zn	mg	5.3	3.28	2.3	0.92
Copper, Cu		5	0.13	nd	0.15

Grinding cacao in Yorkin. Credit Julián Idrobo

CONSERVATION STATUS OF SPECIES WITH IMPORTANT ROLES IN NUTRITION

This section brings together the two datasets, considering conservation status of species and making links to the nutritional contribution of these species to Bribri diets. Threats to species are categorised hierarchically in the SIS database. Threats information is often available for a species regardless of its reported conservation status. Thus, it may be possible to use the SIS to understand risks posed to a species by local land uses or land use change. Figure 3 shows the conservation status of species in our dataset (Threatened and Near Threatened species), while table 10 explores threats by category as recorded in the SIS. A discrepancy is immediately apparent between proportion of assessed animals and plants. Nutritionally critical wild plants were poorly represented in the SIS database.[13]

Figure 3: IUCN Red List species assessments for species used for food in Sixaola (n=54). Domesticated birds and mammals assessed as wild.



The information available from the SIS indicates that the most important threats to species in our list were tied to intentional use and agriculture – more than half of which has been attributed to small-holder and slash and burn agriculture. Meanwhile, a cursory assessment of problems faced by local communities in the Sixaola region points to other pressing concerns such as climate change as being of salient importance for availability and stability of biological resources for local communities (meeting notes, *March Limon meeting*). In this case, the utility of the threats analysis was found to be limited for use in the local landscape assessment.

Of the species identified in the previous section for their contributions of minerals important for maternal health, little information was available in the SIS in terms of conservation status and threats because few species have yet been assessed for the Red List or no threats were recorded in the SIS (see table 11). This was largely because the majority of species analysed were agricultural species and as such are of low priority or will not be assessed in the future. In addition, few of the non-cultivated plants used in Sixaola were found in the SIS. However, this situation has been recognized by IUCN, and steps are being taken to improve data coverage for these taxa. For example, the IUCN Plants for People (P4P) project explicitly aims to improve IUCN Red List coverage of wild plant species with local uses in food and medicinal systems.[14]

13 It may be worth noting the current taxonomic coverage of the Red List, and whether/how PiN aims to achieve or target better taxonomic and geographic coverage of species that are known to be useful (e.g. particularly high in micronutrients). This is discussion point that merits future attention.

14 https://www.iucn.org/about/work/programmes/species/our_work/plants/plants_projects_initiatives/plants_for_people_/

Relatively few wild species used by Bribri people were found to be in the Threatened or Near Threatened conservation status categories. Table 12 lists all Vulnerable, Threatened and Endangered species in our list along with threat descriptions. Although no information on micronutrient composition was found in databases or in the literature for these species, information on use of these species for food was found with reference to Central America. For instance, in a study of bird species hunted for food in western Panama, curassow (*Crax rubra*), status=VU, was found to be the most important bird species hunted, closely followed by great tinamou (*Tinamus major*) status=NT (Smith 2010).

Table 10: Threats to species analysed (n=25)

Threat category	Number of species listed as LC or DD	Number of Threatened and Near Threatened species	Total
Agriculture and aquaculture	12	5	17
Of which smallholder grazing, ranching of farming or shifting agriculture	8	2	10
Biological resource use	17	6	23
Of which intentional use, persecution, control of species	16	1 (subsistence use) + 5 (species is target)	22
Energy production and mining	1	1	2
Human intrusion and disturbance	1 (recreation)	0	1
Natural systems modification	5	1	6
Pollution	2	0	2
Residential and commercial development	6	3	9
Transportation and services corridors	6	1	7
Invasive species	5	0	5
Climate change and severe weather	1 (only *Odocoileus virginianus* listed as threatened by drought)	0	1

Meeting with Women's Association (Stibrawpa) in Yorkin. Credit: Julián Idrobo

Table 11: SIS information on species considered in this study

Species	common name	RL assessment	Calcium	Iron	Zinc	SIS use	SIS use value
Carica papaya (Caricaceae)	Papaya	not yet assessed	20	0.25	0.08		
Artocarpus altilis (Moraceae)	Breadfruit (fruta pan)	not yet assessed	17-61	0.54-3.67	0.12-0.9		
Musa sp.	Banana/plantain	not yet assessed	3-10	0.58-60	0.13-0.14		
Pouteria sapota (Sapotaceae)	Mamey sapote (zapote)	not in SIS	18	0.78	0.19		
Chameadorea tepejilote (Arecaceae)	Pacaya palm (pacaya)	not in SIS	18-58	1.69-3.13	1.15-3.73		
Cyathea sp. (Cyatheaceae)	Fiddlehead ferns (quelites)	no species level name	32	1.31	0.83		
Phytolacca rivinoides (Phytolaccaceae)	Pokeweed or pokeberry (calalu)	Not in SIS	53	1.2-1.7	0.19-0.24		
Gallus gallus	Chicken	Won't be assessed	12	0.89	1.54		
Odontophorus erythrops	Quail	LC	13	4.51	2.7	Food-human	subsistence, national
Columbina spp.	Ground dove	no species level name	17	5.91	3.83		
Proechimys semispinosus	Tome's spiny rat	LC	190	7.8	5.3		

Table 12: Threats, use and trade for threatened, vulnerable and endangered species (VU=vulnerable, NT=near threatened, EN=endangered)

Species	Red List assessment	Global-level threat description (incomplete)	End use	End use scale
Alouatta palliata ssp. aequatorialis Mantled howler monkey	VU	Development, agriculture, intentional use	Food – human, pets/display animals	Subsistence
Chelydra rossignonii Central American snapping turtle	VU	Development, subsistence/ small scale harvest	No record	No record
Crax rubra Great curassow	VU	Increase in fire, agro-industry farming, intentional use	Food – human, pets/display animals	Subsistence, national, international
Ramphastos ambiguus Chestnut-mandibled toucan	NT	Agro-industry grazing, ranching and farming, Intentional use	Food – human, pets/display animals	Subsistence, national
Tapirus bairdii Baird's tapir	EN	Development, logging, agriculture, intentional use	Food – human, sport hunting/specimen collecting	Subsistence, national
Tayassu pecari White-lipped peccary	VU	Development, agriculture, intentional use	Food – human, wearing apparel, accessories	Subsistence, national, international
Tinamus major Great tinamou	NT	Agro-industry grazing, ranching and farming, Intentional use	Food – human, pets/display animals	Subsistence, national

DISCUSSION POINTS

Valuing non-cultivated species for food and nutritional security

Our analysis used available food composition data for Bribri foods and focussed on nutrients known to be important for maternal and child health. By drawing quantitative comparisons to what might be seen as substitutes for these food sources (e.g. commonly found domesticated plants and animals), we were able to make statements regarding the value of traditional foods in meeting critical nutritional needs. It is clear from our analysis that for species utilized by Bribri people for which secondary data could be found, nutritional contribution to maternal and child health is higher than what might be easily substituted by alternatives.

Many studies that attempt to place a quantitative value on biodiversity calculate value in monetary terms. As such, assessment methodologies often point to the substitutability of local elements of biodiversity. As we have argued, however, quantitative value can also be assigned to species used for food in terms of their specific nutritional contributions. When evaluated through this lens, species are not as easily substituted by suggested replacements, especially if we were to consider the cumulative local importance of particular species that may contribute in other critical areas for poverty reduction, such as material for shelter, household income and medicine.

Biodiversity-nutrition linkages & the PiN methodological approach

To our knowledge, no systematic analysis has yet been undertaken linking data on nutritional quality of traditional foods with data on their conservation status and threats to survival. The review of databases and available literature allowed us to identify nutritional information already available as well existing gaps and limitations in the data record. Others have conducted more intensive studies, often with the purpose of obtaining better primary data through case studies on use of wild or semi-wild species as sources of food, and to obtain information on their contribution to human nutrition. Much of this information remains scattered in journal publications. Some approaches have aimed to compile and compare illustrative case studies on the contribution of biodiversity to local diets, and to recovery of dietary diversity through revalorization or restoration of local foods and food systems (e.g. Kuhnlein et al. 2009; Nabhan et al. 2010).

What PiN stands to offer is a systematic approach to integration of primary data from local landscape assessments with global secondary data to address policy regarding biodiversity and nutrition with better data. The aim of this analysis is to provide a preliminary assessment of the potential to use secondary data to address fundamental biodiversity conservation and development gaps identified in policy. It is not our view that this approach represents a complete assessment of risks to a local food system, as this would require a range of methodological approaches to understand Bribri perspectives on conservation status of species used as foods as well as other culturally significant foods. PiN can build on approaches, such as those employed by Kuhnlein et al. (2009) and Nabhan et al. (2010). However, the PiN secondary data workflow differs in that it offers a more systematic approach to (1) assessing conservation status (availability / stability) of species and populations of species used as foods; (2) understanding the potential of wild species and traditional landraces to meet peoples' needs from the perspective of food and nutritional security; and (3) creating database resources and digital tools to link conservation status with nutritional contributions of species and landraces that can be made publicly available for future assessments.

Missing data and data quality concerns

One of the challenges with the food composition databases utilized was the absence of micronutrient data for the majority of wild species. More information is needed for a more comprehensive understanding of the dietary contributions of biodiversity to Indigenous people and local communities. Some efforts to make more complete data available on wild species used as food and traditional food landraces are underway and offer the potential for partnership formation. For example, the FAO International Network of Food Data Systems (INFOODS) maintains a Food Composition Database for Biodiversity, and provides useful indicators for progress on nutritional composition of non-cultivated and underutilized species.[15] A scientific community focused on neglected and underutilized agricultural species is progressively assembling a list of species that deserve greater attention for more sustainable diets and dietary diversity.[16] In this case, however, while lists of species utilized as foods by specific communities, or in nearby locations were not overly difficult to locate, for example in the ethnobiology literature, data on the contribution of these species to food and nutritional security were not readily available in existing datasets.

With regard to the conservation status of species used as food, it was a challenge to reconcile the scale of the available global assessment data with the site level unless species concerned are endemic or have restricted ranges. Species range may be possible to assess using the occur-

15 See http://www.fao.org/infoods/infoods/tables-and-databases/faoinfoods-databases/en/ (accessed 15/07/2015)

16 See http://www.nuscommunity.org/ (accessed 15/07/2015)

rence module of the SIS, which in some cases includes spatial data. The SIS stores data on threats and conservation, regardless of assessed conservation status. Even if assessed as LC, data on threats may be revealing in terms of local-level land uses. For instance, land use conversion of a particular type may be listed as a threat to availability of a particular species in the SIS. Our species list also revealed lacunae in assessment data for certain groups of species. For example, while wild mammals harvested by Bribri people were fully assessed in the SIS, all other groups (e.g. food plants) were poorly represented (see figure 3).

As use of traditional landraces and different agricultural varieties or cultivars of a species were not the focus of the work by Sylvester (unpublished) except in the case of *Musa* sp., we did not assess threats to crop diversity and associated nutritional contributions in this case study. Linking assessment of threats to nutritional information on agricultural varieties will likely be a complex task. Micronutrient composition varies tremendously across species, but perhaps more critically in terms of implications for local nutritional adequacy, across varieties and indigenous landraces. Variation in nutrient composition among varieties of the same species may be greater than the differences between species; this is the case, for example, in *Musa acuminata* (Burlingame et al. 2009; CBD Secretariat and WHO 2015; Wall 2006). Given the importance of macronutrient-rich foods for maternal and child health, and the complexity of local and indigenous food systems, PiN cannot ignore the conservation status of traditional landraces and their contribution to food and nutritional security.

Existing knowledge and programmes within IUCN may provide stepping stones to resolution of some of the data gaps discussed above. As such, PiN may provide systematic guidance, or harmonise a set of indicators on data gaps that will make such assessments more useful for specific policy areas, and to address specific human needs by creating better linkages between PiN assessment data and other global data. Certainly, in undertaking more systematic analysis of the conservation status of nutritionally important species, PiN may need to develop an approach to data pertaining to threats to agricultural varieties. These are currently not assessed in SIS, nor directly by other IUCN knowledge products.[17]

Finally, there are some limitations to the type of information stored in the SIS, which make it less well suited to particular needs of the PiN situation analysis. Local uses of species that overlap with threat codes (e.g. intentional harvesting or slash and burn agriculture), may not contribute to a species' overall assessment, and thus uses, trade and threats should not necessarily be considered to be correlated unless, perhaps, a species range is highly geographically restricted (i.e. endemic species). Threats data in the SIS are documented at the global level (i.e. across the entire species range). In the absence of more detailed national and/or regional information, the global data in the SIS necessarily constitutes the most useful secondary source of information on threats to species. It is, however, possible to store individual local "harvest records" in the SIS. These records contain geographically and temporally specific information about species status and threats, and are used to form the basis for global assessments of species. This harvest records hold promise in terms of yielding useful local information on the availability and stability of populations. PiN can potentially both use and contribute data to local harvest records for particular landscape assessment sites.

SIS species assessments rely on the knowledge of expert members of the Species Survival Commission to assemble data on species conservation status. However, data in the SIS Use and Trade module does not currently draw on comprehensive ethnobiological knowledge and secondary data. As an example, only one plant on our list, *Iriartea deltoidea* (Jira), was associated with use for shelter (but not as having value as food). These, significant gaps in use information reduce the utility of the SIS as a secondary dataset on the importance of local species to people. Incomplete species use information, however, does not appear to be a long-term limitation and preliminary discussions with Species Programme staff and SIS maintainers has opened space for PiN to source and make available global use data from secondary sources using the Use and Trade module in order to iteratively improve data held in the SIS over time.

This review has pointed to the potential for linking conservation status with the use of biodiversity in order to inform decision-making in critical policy domains. It has also pointed out challenges to linking existing datasets and limitations in the secondary data record. These challenges are not insurmountable but point to the need for IUCN to consider specific partnerships to move this initiative forward. In order to perform our analysis, we used readily accessible, publicly available data in unpublished formats, scientific literature and public databases. Further development of networks and communities of practice – such as among Commission members – and digital tools linking diverse datasets and for crowdsourcing additional data could increase both the availability and accessibility of secondary data. The potential to automate phases of the situation analysis in the future by linking different global datasets could add value to the set of PiN tools and protocols for organizations that see value in having sound data in relation to these areas.

17 Assessments of pollinators and crop wild relatives (CRWs) may provide an important entry point for assessment of threats to agricultural species, establishing a clearer role for IUCN volunteer-generated and aggregated data to support traditional food systems and landscapes more broadly.

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IUCN is a membership Union composed of both government and civil society organisations. It harnesses the experience, resources and reach of its 1,300 Member organisations and the input of some 15,000 experts. IUCN is the global authority on the status of the natural world and the measures needed to safeguard it.

CEESP, the IUCN Commission on Environmental, Economic and Social Policy, is an inter-disciplinary network of professionals whose mission is to act as a source of advice on the environmental, economic, social and cultural factors that affect natural resources and biological diversity and to provide guidance and support towards effective policies and practices in environmental conservation and sustainable development.

The People in Nature (PiN) Knowledge Basket is an initiative established by the IUCN programme of work and whose development is led by a steering group composed of representatives from CEESP, IUCN secretariat and IUCN members. As described in the 2017-2020 CEESP mandate, PiN will promote learning to improve our understanding of how nature contributes to local livelihoods and well-being. It will focus on material use while recognising that use is embedded within worldviews that include deep-seated cultural norms, values, and understandings. It will also consider symbolic interrelationships with nature expressed through cultural narratives, language, and traditions, including diverse understandings of sacred and divine aspects of nature and our relationship with natural resources. This work will contribute to valuing and conserving nature through understanding the value of nature to human societies.