

Changing Taste Preferences, Market Demands and Traditions in Pearl Lagoon, Nicaragua: A Community Reliant on Green Turtles for Income and Nutrition

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Abstract

Caribbean Nicaragua has its own cultural logic that helps to explain the eating habits of indigenous communities that rely on sea turtle meat for nutrition and prefer its taste to that of other available meats. Nutritional costs and benefits form a fundamental part of this reliance, yet there are ecological, economic, cultural, and other factors that may be just as if not more important than the nutritional value of turtle meat. Caribbean Nicaraguans have legally harvested green turtles (*Chelonia mydas*) for more than 400 years, and continue to rely on the species as an inexpensive and tasty source of protein and income. From 1967 to 1977, green turtles were harvested for both local and foreign consumption, including annual exports to the US and Europe from turtle packing plants in Nicaragua in excess of 10,000 turtles. Although the processing plants have been closed for over 30 years after Nicaragua became a signatory of CITES in 1977, the local demand for turtle meat in coastal communities has continued. Following themes of cultural ecology and ecological anthropology, we first discuss what is known about the traditional culture of Caribbean Nicaragua, in particular the history of its changing economy (after European contact and settlement on the coast) and subsistence lifestyle of Miskito and Creole societies on the coast. Second, we provide background information on regional ethnic identity and the human ecology of the Caribbean Nicaragua sea turtle fishery. We then present a quantitative analysis of the relationship between protein preference and various demographic characteristics, and speculate whether protein preferences have been altered in the coastal culture, providing recommendations for future research. Recent studies present disparate views on whether nesting and foraging green turtle populations are increasing or decreasing in the region: in either case the level of harvest makes the topic of protein preference an important and relevant consideration in conservation.

Keywords: Caribbean Nicaragua, Pearl Lagoon, sustainable use, green turtle (*Chelonia mydas*), cultural ecology, environmental anthropology, market integration, taste preferences, road impacts

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INTRODUCTION

For many living in developing countries, sea turtles are spectacular, serene and beautiful creatures, gliding through coral reefs in warm tropical waters, instilling a sense of awe in those granted the privilege of a close encounter. However, charismatic green turtles (*Chelonia mydas*) also represent challenging aspects of environmental conservation, cultural connections to sustainable harvests, illegal international trade

issues and economic struggles of poverty-stricken indigenous groups and traditional societies. Communities in rural areas of developing countries are progressively becoming exposed to and incorporated into the global market systems, resulting in the alteration of long-established means of harvest and changes in kinship relationships. This market incorporation by indigenous groups has also been linked to adaptation of traditional, subsistence activities (Silvius 2004).

The primary goal of this article is to explore the importance

of cultural adaptations and taste preferences as they relate to the legal, uncontrolled harvest of green turtles in a Nicaraguan fishing community.¹ The secondary goals of this article are to elucidate the links between individual demographic characteristics (e.g., socio-economic level, age and level of education) and taste preferences for turtle meat in Caribbean Nicaragua and to discuss whether these taste preferences have been altered following integration into the global market from 1969 to 1976 (during the operation of three turtle processing plants); to question if there are obvious conditions under which these indigenous societies were transformed by market trade relationships from subsistence-based to ecologically exploitative; to describe the decreasing isolation in the Pearl Lagoon Basin and anticipate potential impacts of an increase in accessibility to indigenous and ethnic coastal communities for outsiders and tourists.

This paper is organised as follows: first, we present background information on the Caribbean coast of Nicaragua (Figure 1) and our study site in the Pearl Lagoon Basin, including descriptions of the indigenous groups and ethnic communities inhabiting the region. Using key concepts from environmental anthropology and cultural ecology, we discuss the significance of green turtles for coastal indigenous societies and how the alteration of traditional uses of turtle meat has resulted in various cultural adaptations. Next, we

describe how trade relationships with Europe, increasing market demands from extractive and exploitative foreign enterprises (which were also providing much desired wage labour), and historical taste preferences for turtle meat have contributed to the current endangered status of the species, illustrating that the current problems facing green turtles have historical routes and links to outside markets. We then explicate the preliminary results of our study on the community of Pearl Lagoon, Nicaragua, focusing on present-day taste preferences and demographic factors that contribute to local preference for turtle over other available meats. We also consider the addition of a road in this previously isolated region, suggesting potential effects of the road on cultural and social structure. We conclude with a discussion of potential future research.

STUDY SITE

Our case study focuses on communities of mixed Miskito and Creole ethnicity based in the 5200 sq. km Pearl Lagoon Basin (RAAS), located approximately 40 km north of Bluefields, Nicaragua (Figure 2). Twelve communities, most of which have less than 500 inhabitants², are located around the Pearl Lagoon Basin. According to recent population estimates, the basin has a total population of 8,802 inhabitants (in 1,830



Figure 1

Map of Central America.

Nicaragua is located south of Honduras and north of Costa Rica.

The Pearl Lagoon Basin, where this research was conducted, is located on the Caribbean Coast of Nicaragua

households), 57% (5,017) of which are males and 43% (3,785) female. The majority of the population (61% of males and 84% of females) is between 0 and 30 years of age. The most densely populated communities (1000+ inhabitants each) are Pearl Lagoon (2,540), Haulover (1,897), Tasbapaunie (1,445) and Orinoco (1,010) (Beer & Vanegas 2007). The primary indigenous and ethnic groups represented in the Pearl Lagoon Basin are Miskito, Creole, Garifuna and Mestizo. Coastal people identifying themselves as ethnically Creole comprise 52% of the basin population. They are followed by 33% Miskito, 14% Garifuna and 1.5% Mestizo (Riverstone 2003; Beer & Vanegas 2007).³ The primary language, spoken by 83% of basin inhabitants, is Creole-English, though many

communities also have bilingual Creole-Miskito, Creole-Spanish, or Miskito-Spanish residents (Table 1).⁴

Although discussing the entire basin, this paper focuses on two main communities: Tasbapaunie and Pearl Lagoon. This account is mainly composed of historical information (described further in the following section) on the Miskito community of Tasbapaunie (Nietschmann 1972, 1972a, 1973, 1974, 1975 and 1979), and present-day accounts primarily from our study in Pearl Lagoon.

The lead author conducted all field research in Pearl Lagoon, 40 km southwest of Tasbapaunie and 30 km north of Bluefields, over a seven-month period (May to November) in 2008 (Figure 2). The village of Pearl Lagoon is a primarily Creole



Figure 2

Map of the Pearl Lagoon Basin and surrounding areas, Caribbean Nicaragua.

This research was conducted in the community of Pearl Lagoon, on the southern end of Pearl Lagoon (the large inland body of water)

Table 1

Ethnic identities and native languages represented in the community of Pearl Lagoon (total population estimate = 2540) according to 2006 census data. Creole-English is the primary language spoken in the community, with 95.7% of residents listing it as their native language (Beer & Vanegas 2007)

Ethnicity	Individuals N (%)	Native language	Individuals N (%)
Miskito	90 (3.7)	Miskito	80 (3.1)
Mestizo	40 (1.6)	Spanish	30 (1.2)
Garifuna	10 (0.4)	Garifuna	0 (0)
Creole	2400 (94.5)	Creole-English	2430 (95.7)

community located in the southeast region of the lagoon for which it was named (Beer & Vanegas 2007). For clarity, from this point forward we will refer to Pearl Lagoon, the body of water, as the Lagoon, Pearl Lagoon Basin as the Basin and the community of Pearl Lagoon as Pearl Lagoon.

The economy of Pearl Lagoon has traditionally been based on fisheries and agricultural products (Christie 1999; Christie *et al.* 2000). The main fisheries products (i.e., lobster, shrimp, gill fish and sea turtles) have numerous target markets located varying distances from the community; e.g., green turtle is usually sold within the community to individuals from Pearl Lagoon or the neighbouring communities (Haulover, Raitipura and Awas), whereas fish and shrimp may be sold to middlemen in Pearl Lagoon who will then sell the goods to markets in Bluefields (Hostetler 1998; Christie *et al.* 2000; personal observation). The US imports fish, shrimp and lobster from the region; in 2009, the US imported approximately 700,000 kg of shrimp from Nicaragua in the month of September (Foreign Trade Statistics 2009). Agricultural products are grown primarily for local consumption rather than for sale (Dodds 1998). Similar to other rural, disadvantaged communities in Central America, the local economy in Nicaragua is significantly supplemented by remittances (a key source of household income from family members working outside Nicaragua). Remittances from family members, working primarily in the United States and Costa Rica, provide a significant contribution to the economy of Pearl Lagoon and often act as the primary source of household income (Orozco 2003).

THE PEOPLE OF CARIBBEAN NICARAGUA

The Caribbean Coast of Nicaragua (Figure 1) is divided from the western part of the country not only by rugged mountains, tropical rainforest and extensive agricultural lands, but also by historical and cultural differences. Since the Caribbean lowlands were a British protectorate beginning in the seventeenth century, but were never part of the Spanish empire, the inhabitants of this region are more likely to speak English (or an indigenous language) than Spanish in everyday conversation (Hale & Gordon 1987). Often referred to as the Caribbean Miskito Coast, named after the indigenous Miskito Indians inhabiting the region, the Eastern half of Nicaragua is divided into two autonomous regions—Región Autónoma del Atlántico Sur (RAAS) and Región Autónoma del Atlántico Norte (RAAN). The Miskito Coast territory more accurately consists of a narrow strip of land along the Caribbean Sea extending from Cape Cameron in eastern Honduras to San Juan del Norte in southeastern Nicaragua (Beer & Vanegas 2007).

This study focuses on Pearl Lagoon, a coastal community in the RAAS of Nicaragua. Outside the primary commercial centres in the RAAS, Bluefields and Corn Island, inhabitants of the Caribbean coast live in a variety of indigenous and ethnic communities. Ethnicity in these communities is not only based on ancestry, but also on linguistic, economic and cultural characteristics (Gordon 1998; Riverstone 2003; Dennis 2004). RAAS communities are comprised of individuals in

the following indigenous and ethnic groups: Miskito Indian, Rama Indian, Sumu Indian, Garifuna (Carib), Mestizo (Spanish-indigenous), Creole (Afro-Caribbean) and Miskito/Creole mix (Hale & Gordon 1987; CACRC 1998; Riverstone 2003; Lagueux *et al.* 2005).⁵ The population of Pearl Lagoon is primarily Creole, however is neighboured by two Miskito communities: Raitipura and Awas.

HISTORY OF A TRADITIONAL SUBSISTENCE ECONOMY

Green turtles in Caribbean Nicaragua

Green turtles are large, primarily herbivorous marine reptiles that inhabit relatively warm ocean waters around the globe (Carr *et al.* 1978; Bjorndal 1997; Lagueux *et al.* 2005). Currently, the green turtle is classified as globally endangered, according to the 2008 IUCN (World Conservation Union) Red List of Threatened Species (IUCN 2008).⁶ They are listed in Annex II of the SPAW Protocol (Protocol to the Cartagena Convention Concerning Specially Protected Areas and Wildlife), listed in Appendix I of CITES (Convention of International Trade in Endangered Species), and Appendices I and II of the Convention on the Conservation of Migratory Species (UNEP-CEP 1990; CMS 2008; UNEP-WCMC 2008). Green turtles are the largest of the hard-shelled sea turtles and, like other sea turtle species, have several life history characteristics that make them susceptible to exploitation—they are air breathing and therefore have to surface frequently, they forage and mate in large groups, and they migrate in predictable seasonal patterns to accomplish these stages of their life cycles. Nesting females also have to emerge onto beaches to lay eggs, leaving track marks behind them, and making them subject to consumption, poaching, and animal predation (Parsons 1962; Carr *et al.* 1978). The largest remaining green turtle rookery in the Atlantic Basin, and one of the two largest in the world, is the population that nests in Tortuguero, Costa Rica (Lagueux 1998; Tröeng & Rankin 2005). The monitoring and conservation of this population began in 1955 and continues to this day (Tröeng & Rankin 2005). The primary foraging habitats for this rookery are the extensive sea grass (*Thalassia testudinum*) pastures located on the extensive continental shelf along Nicaragua's Caribbean coast (located north of Tortuguero), which is also the location of one of the largest legal, commercial sea turtle fisheries in the Americas (Bjorndal 1997; Campbell & Lagueux 2005).

The changing role of green turtles on the coast

Caribbean Nicaragua's green turtle fishery has been in existence for at least 400 years (Lagueux *et al.* 2005). Green turtles in the Caribbean Nicaragua have played an important role in this region by providing nourishment, maintaining social relationships and economies based on sharing and exchange, opening up the Caribbean region for trade with Europe and ultimately, providing the means for coastal indigenous groups

to acquire income and material goods (Parsons 1956).⁷

Historically, the Miskito Indians of Nicaragua and Honduras developed settlements based on the spatial and temporal distribution of green turtles along the Caribbean coast (Nietschmann 1972a, 1973). In traditional Miskito society, social relationships and an economic system based on exchange were one and the same; every action or exchange, especially of turtle meat, included both an economic aspect and a social context (Helms 1969, 1971). Prior to the introduction of cash-based market activities, green turtle meat was one of the primary items exchanged and given in this system as a crucial marker of kinship and solidarity relations (Nietschmann 1973). Sea turtle meat was a dietary staple and an integral aspect of consumption and repayment in Miskito culture. Consumption is defined as the use of goods and services in which the objects being used (or usage activity) are not only material items, but also items or activities in which humans construct their social and cultural understandings (Robbins 2002). For the purpose of this article, we are referring to consumption of sea turtles as the act of eating (using) sea turtle meat as a source of protein. The shared cultural act of eating is performed by all humans through the transformation of raw natural resources (food) into meals and cooked dishes that vary by society (Rose 2001; Apaza *et al.* 2002). Consumption of wildlife is, according to some theories, based on strong traditions and deep-seated cultural taste preferences (Apaza *et al.* 2002).

The Miskito depended on turtles for both subsistence and forms of payment or gifts in kinship relationships (Helms 1971; Nietschmann 1973, 1979; Lagueux 1998). Green turtle meat was a common form of repayment in the Miskito system of social responsibility based on exchange and reciprocity (of both goods and services). This system ensured that no family member or other member of society would go without meat for long. Community members held themselves equally responsible for the care of elders, children, ill individuals and other people unable to administer their own care (Helms 1969). Green turtles were therefore embedded in the Miskito 'ethic of subsistence,' which regulated natural resource use through debts and obligations to relatives or other community members that could be paid/re-paid in the form of turtle meat or other resources (Helms 1971; Nietschmann 1972a, 1973, 1974, 1975; Lagueux 1998).

Prior to arrival of the British in 1630 on Nicaragua's Caribbean coast, there was no need for money in the indigenous communities since there was nowhere to earn it or spend it. After the English opened their first trade company in Caribbean Nicaragua around 1634, outside contact and trade became part of Miskito society and significantly altered the traditional culture, subsistence livelihoods and natural resources (Helms 1971).⁸ Cash-based market systems began to divert turtle meat from the traditional intra-village exchange system to other individuals and outsiders, placing substantial strain on familial ties and kinship relationships (Kindblad 2001). Once trade became a way of life, resources, especially sea turtles, became a means to secure material goods at trading stations (Nietschmann 1973).

Boom-and-bust society

In the seventeenth and eighteenth centuries, Caribbean Nicaragua was sporadically trading with both French and English explorers (and pirates), resulting in alterations to local subsistence-oriented natural resource uses, including the emergence of income-driven exploitation (Roberts 1827; Helms 1969). The coast was then subject to a series of 'boom-and-bust' industries in the eighteenth and nineteenth centuries (and lasting through the twentieth century) after the British set up trade relations with the coastal Miskito (Nietschmann 1974, 1975; Christie 1999). The first commercial operations to employ a significant number of Miskito were focused on both mahogany (a type of wood) and rubber extraction, followed by the introduction of banana companies (Nietschmann 1972a). The Banana Era lasted through the 1930s, intensifying natural resource destruction, providing the coastal people with opportunities for wage labour, and replacing the traditional, selective natural resource extraction practices that had previously dominated (Parsons 1955; Robb 2005).

During what locals refer to as 'the Golden Years' or 'the Company Period' (1890–1930), members of local communities were employed in the extraction of other goods as well, including non-timber forest products (rubber), gold, cotton, sugar, and seafood—especially sea turtles (Conzemius 1932; Helms 1971; Nietschmann 1973, 1974, 1975; Dozier 1985; Hale 1994; Christie 1999). These initial relationships were mutually beneficial, allowing the Miskito access to foreign goods and arms, and creating opportunities for British traders to employ skilled local fishermen, and providing them with fearsome warriors in territorial battles against the Spanish (Nietschmann 1979). However, the relationship between the Miskito and the environment was changing drastically and the environment was beginning to suffer from the exploitative nature of these intensified extractions (Nietschmann 1973). In his article, *When the Turtle Collapses, the World Ends*, Nietschmann states that as the coast experienced these economic booms, 'resources became a commodity with a price tag, market exploitation a livelihood and foreign wages and goods a necessity' (1974: 161).

Exportation of turtle meat and calipee, a cartilaginous substance found between the upper and lower shell that is a key ingredient in turtle soup, resulted in a 228% increase in green turtle exploitation from 1969 to 1971 in Tasbapaunie alone (Nietschmann 1972). The relationship between the British and coastal Nicaraguans was 'based on sea turtles' for over 200 years, leading to changes in cultural uses and the significance of these uses of turtles (Nietschmann 1974). Due to the rapid development and industrialisation of the turtle industry in the 1960s and 1970s, sea turtles became an intensively harvested commodity in the area and forever altered the traditional relationship between the Miskito, the local environment, and sea turtles. The level of production and harvesting activities, once driven by daily food needs and kinship obligations (based on reciprocity, generosity and communal exchange), were now intensified and fuelled by a common desire for cash and

associated material goods.

For every economic boom on Nicaragua's coast, there was a subsequent 'bust' period, beginning in the late 1800s (Nietschmann 1973; Lagueux 1998). The 'boom-and-bust' characterisation that many give to this region continues today, leaving coastal inhabitants with a continued desire for income and material goods, but with sometimes unsteady access to employment and/or goods. Nietschmann described the Miskito in the 1970s as being, 'left with an ethic of poverty, but they still had the subsistence skills that maintained their culture for hundreds of years... still capable of providing reliable resources for local consumption' (1974: 161). Traditional subsistence culture no longer dominates; resources now have monetary values and manual labour requires wage compensation. Relative isolation and lack of political control over the larger economic context upon which they are dependent, contributes to the current vulnerability of these coastal societies in the global market economy. In other words, foreign-led exploitation and trade in Caribbean Nicaragua's natural resources resulted in irreversible changes to the coastal ecology and to local cultures and practices (Nietschmann 1997).

Endangered species, regulations and conservation efforts

In 1969, the United States Congress amended the Endangered Species Conservation Act (ESCA, a predecessor to the Endangered Species Act of 1973) to protect species and ecosystems nationally. This amendment to the ESCA also called for an international meeting to adopt an endangered species conservation treaty, resulting in the 1973 creation of CITES (Convention on International Trade of Endangered Species of Wild Fauna and Flora). Countries voluntarily participated in CITES, which ultimately subjected all international trade in specimens or products originating from species listed as threatened or endangered (including sea turtles) to certain restrictions and permitting systems. In 1969, the same year that the ESCA was amended, the first sea turtle processing operation opened in Bluefields, Nicaragua (another plant was built in the northern commercial centre of Puerto Cabezas the previous year). These operations resulted in the exportation of up to 10,000 green turtles annually through 1976 and the monetisation of the traditional subsistence sector (Nietschmann 1973, 1979; Lagueux *et al.* 2009).⁹ In 1977, however, Nicaragua became a signatory of CITES, as an indirect result of pressure from the United States and the 1975 initiation of sea turtle conservation programs in Tortuguero, Costa Rica. Once a signatory, Nicaraguan turtle factories were permanently closed (Nietschmann 1979). By this point, following years of green turtle exploitation and export, even the most skilled traditional turtle fishermen could no longer catch enough to feed their families.¹⁰

From 1981 to 1990, Nicaragua experienced a civil war that indirectly resulted in the coastal sea turtle harvests decreasing to approximately 2,780 turtles annually from 1985 to 1990 (Montenegro-Jiménez 1992; Campbell 2003). According to

Lagueux (1998), this reduction in the green turtle harvest levels may have provided enough time for populations to increase, allowing the increase in harvest sizes seen in the 1990s and 2000s. Between 1994 and 1999, Lagueux reports harvests ranging from 9,400 to over 11,000 green turtles annually (Lagueux 1998; Campbell 2003). From 1999 to 2007, the minimum harvest numbers were 6,450 green turtles/year (Lagueux *et al.* 2009). According to population studies by Campbell (2003), in order for the Nicaragua green turtle harvest to be sustainable, the maximum allowable annual take should be approximately 1,800 turtles/year. This predicted sustainable maximum annual take identified the 1999 to 2007 reported (minimum) harvest numbers as 72% over the maximum allowable for sustainability (Lagueux *et al.* 2009).

Efforts to protect and manage populations of threatened sea turtles have become a central issue in international marine conservation projects, with many incorporating community-based conservation initiatives. The concept of community-based conservation focuses conservation design and implementation at the local community level, rather than at a national or international scale, and is based on the assumption that rural communities and indigenous groups will opt for protecting the natural resources that they have a vested interest in, including wildlife (Chambers 1983; Western & Wright 1994). However, it has become evident in numerous case studies that indigenous groups do not always conserve their natural resources and that traditional subsistence practices are not always sustainable (Henley 1892; Colchester 1981; Johnson 1989; Alvard 1993; Dodds 1994). Whether or not indigenous practices are sustainable depends on many factors, such as: traditional values and uses of natural resources, local population of inhabitants, security of land tenure and changing use of natural resources because of outside market pressures and the desire for foreign goods (Helms 1971; Nietschmann 1974; Herlihy 1990; Hames 1991; Campbell 1998). According to Western & Wright, 'the deeper agenda, for most conservationists, is to make nature... meaningful to rural communities. As far as local communities are concerned, the agenda is to regain control over natural resources and... improve their economic well-being' (1994: 7).

The constitution of Nicaragua, which recognises Caribbean coastal communities as having traditional rights to use the country's natural resources, is the basis for all natural resource management and environmental regulations. The *Ley de Pesca y Agricultura* N° 489, adopted in 2004, provides that: 'subsistence fishing' is defined as only providing sustenance and food for the fisher and his or her family (not used for sale in any form); the capture or killing of any turtles other than subsistence use is prohibited; subsistence fishing is only allowed on the Atlantic coast of the country and fishers must comply with closed seasons and regulations; and there are penalties for those who do not follow these laws and regulations (Bräutigam & Eckert 2006).

There are various other laws and legal provisions for the protection of sea turtles in Nicaragua and MARENA (the

Ministry of Environment and Natural Resources) regulates a 'closed season' from March 1 to June 30. However, the autonomous status of the Caribbean coastal regions, as well as the time constraints and lack of enforcement make implementation of these laws challenging (Bräutigam & Eckert 2006).

Regional regulations were created to limit harvest numbers in indigenous communities in the RAAS and the RAAN, yet the quotas frequently change without explanation and are not strictly enforced in most coastal communities. In late 2008 and early 2009, harvest limits were set at 5,000 turtles/year in the RAAN and 3,100 turtles/year in the RAAS, with a 3-month closed season along the entire Caribbean coast. Regulations have also been made in the RAAS to limit the size of green turtles captured, to prevent the capture of female turtles between March and October, and to prohibit the transport of turtles between the north and the south (Lagueux *et al.* 2009). In some communities, local research and conservation efforts have been met with defensiveness and even hostility (personal observation).

Increased commoditisation

Currently, year-round unlimited legal harvests of green turtles take place along Nicaragua's Caribbean coast, with efforts only abandoned if the weather is bad, fishermen are sick or if there is a local holiday (Lagueux 1998; Lagueux *et al.* 2005). Nicaragua still has the largest remaining legal green turtle fishery in the Caribbean (Lagueux *et al.* 2009).¹¹ In Pearl Lagoon, local people claim that the turtle fishery is part of their culture and a tradition they have the right to continue practicing for the local consumption of a preferred protein and, more recently, income generation through local sales. It is also interesting to note that many changes have been made to fishing methods, including technological advances and the use of nets to catch green turtles, which has completely replaced the traditional method of harpooning (Nietschmann 1979; Lagueux 1998; Campbell 2003; personal observation).

High levels of green turtle harvest in the 1970s were the result of foreign-operated factories dependent on Miskito fishermen and Creole operations for their turtle fishing skills, but sales today are driven by local market demand for meat, and the desire for cash and material goods (obtainable by selling turtle meat). Although turtle meat is still one of the cheapest available meats, some fishermen report that harvesting and selling turtles is also the quickest and easiest legal way to make money and feed one's family. The minimum price of turtle in Puerto Cabezas (RAAN) ranges from USD 0.90 to USD 1.10 per pound of mixed meat (non-specific cuts of meat, not including the most desired organs or flippers, chosen at random and sold by the pound) (Lagueux *et al.* 2009). In addition to local sales, turtle meat is occasionally transported to Managua, Pacific towns, mine towns (Bonanza, Rosita and Siuna) and other inland markets for sale to individuals and restaurants (Bräutigam & Eckert 2006). Market pressures encroaching on Pearl Lagoon and migration to remote communities can

affect consumption levels. Conservationists worry that market pressures in Caribbean Nicaragua are affecting green turtle harvests to a degree that is most likely too high and no longer sustainable (Nash 1994; Campbell 2003; Lagueux *et al.* 2005; Lagueux *et al.* 2009). In Tortuguero, Costa Rica, however, nonparametric regression models on the green turtle rookery indicate an increase of 417% in nesting between 1971 and 2003 (Troëng & Rankin 2004). This increase may be due to events and policies in the mid to late 1900s, including—a ban on turtle fishing vessels from the Cayman Islands, Nicaragua becoming a signatory to CITES, the Nicaraguan Civil War, and laws requiring all turtle harvest in the Atlantic autonomous region be for subsistence use only (Nietschmann 1973; Lagueux 1998; Troëng & Rankin 2004). Currently, it is uncertain how population increases in the Tortuguero green turtle rookery relate to (or possibly buffer) the turtle harvest in Nicaragua, and further studies are needed to determine the overarching effects (if any) of the turtle harvest on green turtle populations in the Caribbean.

Today, in the Basin, meat is rarely, if ever, given or traded in traditional ways and the once prominent shared social responsibility regarding community food provision in Miskito communities has largely been supplanted by a culture of individualism (with the individuals only being responsible for immediate family members). The role of turtles has shifted to one of commodities that are traded for income. Today in Pearl Lagoon, fishermen may catch turtles for personal consumption but they also stay out on the cays to catch turtles to sell to a butcher in town (some fishermen butcher their own catch). If turtles are brought into town to be butchered, some meat is set aside for the butcher's family and the remaining meat is sold in the community. There is no need for advertisement of availability; word travels quickly to the people in Pearl Lagoon if a turtle is being butchered for sale in the morning and the meat sells almost as quickly as it can be prepared (personal observation). Income from the sale of turtle meat is then often used to purchase household goods and processed food items at a local shop.

Road impacts and accessibility of Pearl Lagoon

The Caribbean coast of Nicaragua represents one of the most isolated areas in Central America. This isolation is being reduced as new highways are added to Nicaragua's road system, creating new connections between the Caribbean Coast and market systems in Western Nicaragua.

Until last year, Pearl Lagoon was only accessible by water, via pangas (passenger boats) from Bluefields. Bluefields is typically accessed from Managua (the capital of Nicaragua) by either small jets or larger ships carrying both goods and passengers, via El Rama. Travel from Managua to El Rama takes 9–10 hours by bus, followed by a three-hour boat ride from El Rama to Bluefields, and another 1½ hours boat trip from Bluefields to Pearl Lagoon (not including wait times). Previously, El Rama was the port town where the paved road due east from Managua ended, making water or air accesses

the only option beyond this point (Figure 3 – Map of region prior to road construction). However, in the summer of 2007, an unpaved road linking El Rama to Pearl Lagoon was completed. Although it is not as accessible as the national highway system, this dirt and stone road has completed the connection between the east and west coasts of Nicaragua. A daily passenger bus now makes the round trip from Pearl Lagoon to El Rama, taking approximately three hours. Locals and visitors wishing to visit Bluefields from Pearl Lagoon are still only able to make the trip by pangas (small boats) (1½ hours) or ferries (8 hours).

Improved access to Pearl Lagoon via the new road has also brought increases in business and market influences, increased availability of much-desired material goods (clothing, house wares, electronics, etc.), an increased variety of food and some road-travelling tourists. The road has also contributed to increased extraction of goods and natural resources from the community and surrounding ecosystems (personal observation). For example, during our field work, vendors from Managua and various other towns between the capital and Pearl Lagoon arrived daily looking to purchase fishermen's entire catches—they can buy them cheaply in Pearl Lagoon and re-sell them at a profit in Managua. Local

businesses and poorer families will most likely experience the greatest negative impact from the initial changes associated with the new road. Also, Pearl Lagoon and the surrounding communities currently lack the infrastructure and social capital to deal with the many changes associated with the road development and increased presence of external entrepreneurs. For example, the road is bringing in new immigrants (additional competition for employment) and extracting important resources (removing fishermen's catches of cheap local protein sources). With fish sales becoming scarce in the community, turtle meat is now the cheapest preferred meat available (crab is cheaper, but has seasonal availability and is less preferred), making it more attractive to poorer segments of the population. Conversely, the road has also brought more goods (including more meat options) to local markets. For the time being, however, the prices of chicken, beef and pork remain significantly higher than that of green turtle meat, and some community members stated in casual conversation that they still prefer the taste of turtle, fish and local meats to imported meats from industrially farmed livestock (personal observation).

From a 'pro-turtle conservation' perspective, the short term

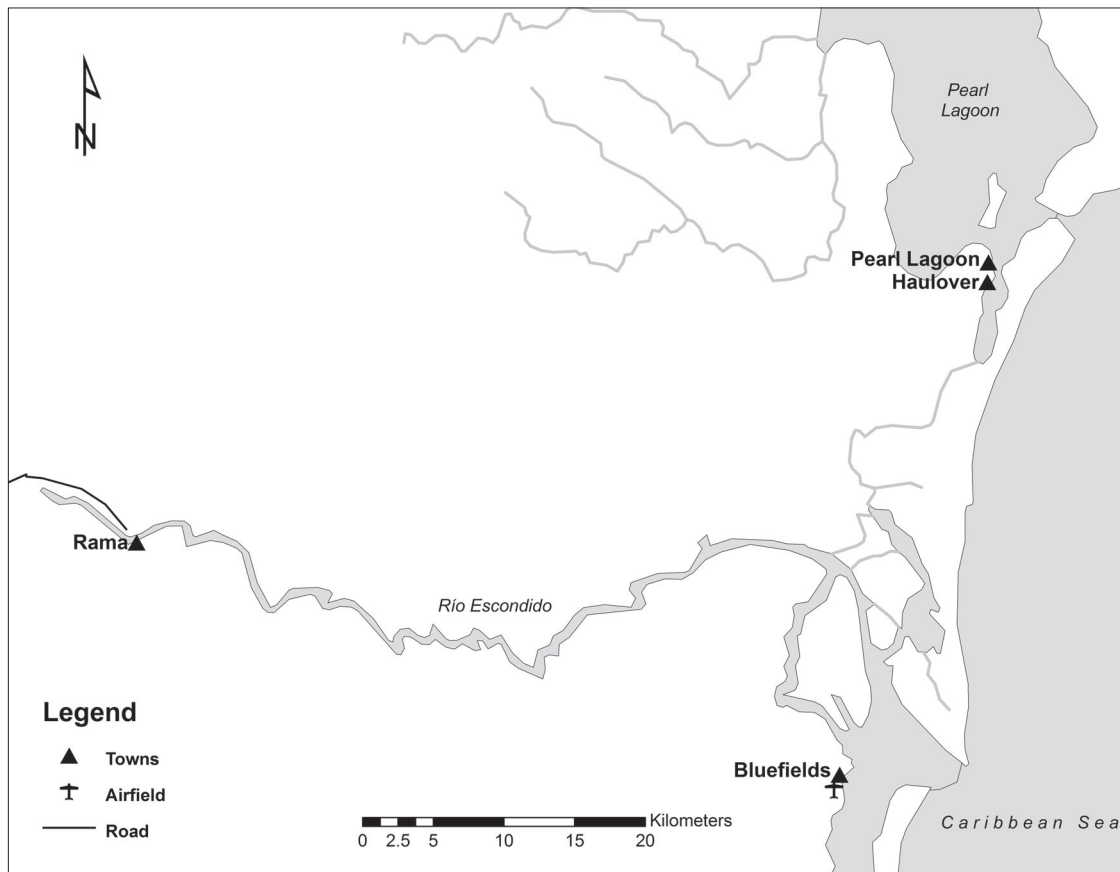


Figure 3

Map showing area between Port Rama and the community of Pearl Lagoon, which are now connected by a road used for daily transport of people and goods. Prior to the construction of this road, people and goods were only able to reach (and leave the community) Pearl Lagoon through boat transport

impact of the new road on the sale of turtle meat could be interpreted as a positive one since it has increased availability of chicken and processed meats in local stores. But the ease of access to chicken has not been accompanied by more accessible prices. Chicken (over 26 cordobas, USD 1.25) remains more expensive than fish (10 to 20 cordobas, USD 0.48 to 0.96), turtle (approximately 17 cordobas, USD 0.82), crab, and small shrimp (with heads). If locally caught fish and shrimp continue to be trucked out to Managua in large numbers, and the price of chicken does not decrease, sales of turtle meat could increase, as it is readily available locally, and will increasingly be the cheapest option as locally caught fish becomes scarcer in local markets. Yet, it is not known how long turtle meat will be available if the fishing pressures on the species increase from the current minimal harvest numbers of 6,450 green turtles/year (Lagueux *et al.* 2009). Half of Pearl Lagoon residents (50%) that participated in this study stated that they do not think green turtle availability has changed over the past 20 years, while 42% stated they were not sure.

METHODS

Ecological anthropology

Cultural ecology is a materialist subfield of anthropology that seeks to link the adaptations of human societies or populations to their environments, with a particular focus on the role that social organisation, economics and technology play in cultural reactions to the natural world (Steward 1968; Winthrop 1991). In other words, it is a strategy for understanding the 'interactions between behaviour and environment as mediated by the human organism and its cultural apparatus' (Marvin Harris 1968: 23). Cultural ecology does not assume that all societies progress through the same stages of development (Steward 1973). In general, cultural ecology seeks to explain the adaptations of human societies to their natural environment, and ecological interactions as functions of culturally mediated experiences (Seymour-Smith 1986; Winthrop 1991).

In response to cultural ecology, ecological anthropology was developed to concentrate the focus on the complex human–nature relationships using humans and the ecological population as the unit of analysis, and culture as the primary means of adaptation (Vayda & Rappaport 1968; Vayda & McCay 1975; Rappaport 1979; Kottak 1999). Human populations, socially organised by means of particular cultures, have ongoing contact with and also impact the land, water, climate, plant and animal species and other humans in their environment and these in turn have reciprocal impacts (Salzman & Attwood 1996). Ecological anthropology directs our attention to the ways in which a particular human group either intentionally or unintentionally shapes its environment and the ways in which their relationship with the environment shapes their local culture, society, economy and politics (Orlove 1980).

Nietschmann's anthropological research in the Miskito village of Tasbapaunie serves as the key historical dataset on

the cultural significance and practical uses of marine turtles by the Miskito Indians in Caribbean Nicaragua. Grounded in geography and ecological anthropology, his research in the Miskito village of Tasbapaunie began in 1969 and continued until 2000. Tasbapaunie is located in the northeast region of the Pearl Lagoon Basin, on a narrow strip of land bordered to the west by the Lagoon and to the east by the Caribbean Sea.¹² According to the 2006 government census, the population in Tasbapaunie is approximately 1,445; however, in 1969 the population consisted of less than 1,000 inhabitants (Nietschmann 1973; CACRC 1998; Beer & Vanegas 2007). Using his training in geography, anthropology and ecology, Dr. Nietschmann conducted an empirical analysis of local subsistence use of green turtles and documented how the people of Tasbapaunie were adapting to outside market influences and changes in traditional kinship relationships (Nietschmann 1973, 1975, 1979).¹³ His work resulted in several major publications that documented the environmental consequences associated with the increasing integration of this coastal indigenous community into the global market system.¹⁴

Data collection

According to Nietschmann (1973), green turtle was the most preferred type of meat in Tasbapaunie and community members explained having a 'specific type' of protein hunger for turtle meat, especially when it was not available. Ecological anthropology theorises that human cultures not only shape the environment they live in and interact with, but that their local environment also shapes their culture and society based on these human–ecological relationships. Using this concept as the basis for our research design, we set out to determine if the changing roles of green turtles in Caribbean Nicaraguan culture and society have effects on meat taste preferences in Pearl Lagoon.

The present analysis of taste preferences and frequency of meat consumption in Pearl Lagoon, Nicaragua, is based on fieldwork conducted over ten months in 2006 and 2008 (May to July 2006 and May to November 2008). Local data for this paper were primarily collected using ethnographic methods. Data collection consisted of observation, semi-structured interviews and ranking exercises with community members in Pearl Lagoon, Nicaragua. Ethnographic research is ideal for investigating how a community thinks about and uses their natural resources, and how natural resource availability and cultural uses shape settlement patterns and social relationships (Russel & Harshbarger 2003).

Organised data collection described below was supplemented by observations of everyday community activities including: variations in market prices, meat availability and consumer preferences (meats purchased most frequently when more than one option was available), butchery of sea turtles and meetings with community leaders to discuss sea turtle harvest restrictions.

Data described in this paper are drawn primarily from ranking exercises. However, as items used in those exercises

were identified during in-depth interviews, both research techniques are described below.

Semi-structured interviews

After becoming familiarised with the community, gaining the approval of local community leaders, and establishing the lead author’s role as a student researcher, we conducted semi-structured interviews (n=50) over a period of three months in 2008. The interview guide consisted mainly of open-ended questions but, when required or beneficial to the research, follow-up questions were asked. Interview questions were pre-tested with a native Creole-English speaking Sociology student at the Bluefields Indian and Creole University, to ensure terminologies used were compatible with the local dialect.

Handwerker states that, ‘Useful sample designs for the study of cultures...employ judgemental selection of key informants and critical cases; and select other cases based on their availability, either out of convenience or through a snowball procedure’ (2003: 435). Rather than conduct a random sample, we selected informants purposively to include variations (variations in lifestyle and experiences) in a specific time (2008 field season) and at a specific place (Pearl Lagoon). Purposive (judgement) sampling identifies cases that exhibit certain characteristics to acquire specific ethnographic information (Bernard 2006). In this study, informants were purposively selected for various demographic data including: gender, age, religion, level of education completed, marital status, occupation, number of children (and household size), socio-economic status (and wealth), and direct association with the turtle fishery (e.g., the sample includes turtle fishermen, butchers, fisheries enforcement officers, natural resource managers and community leaders).

Interviews lasted between 30 and 120 minutes, and were digitally recorded with permission from the informant. Questions focused on participant diets and preferences (foods and consumption frequencies), food availability, food affordability, development of the road to Rama, and availability of occupations or income-generating activities in Pearl Lagoon.¹⁵ From these interviews, we created the list of all food items available in Pearl Lagoon to use in subsequent ranking exercises.

Ranking exercises

We developed ranking exercises in order to collect interval-level data on food preferences and to test for differences among genders, age groups, religions, income groups and other characteristics. We created a deck of 20 laminated index cards naming all food items identified as available in Pearl Lagoon during interviews. Food items, described in local terms, were written in English on one side of the card and Spanish on the other side, as many community members were taught to read in Spanish. Images were not used on the cards.

All participants were asked to complete the following activities (1) rank cards by price (1 being most expensive;

10 being least expensive), (2) rank the top ten most available foods, (3) rank the ten foods eaten most often in participant’s household (1 being the item eaten most often; 10 being eaten least often), and (4) using only the meat cards, rank meats by preference (1 being the participant’s most preferred meat; 10 being the participants least preferred meat).

A total of 73 people completed the ranking exercise, which took between 30 and 90 minutes, and included seven illiterate participants. They were afforded the reading assistance of a household member (recognising that this may have affected resulting ranking).

RESULTS

Semi-structured interviews

Characteristics of interviews are given in Table 2. As Table 2 shows, very few interviewees were in the youngest age category, and the majority were between 27 and 50 years old. Food items identified as being available in the community by more than one interviewee were: chicken, beef, pork, fish, turtle, shrimp, lobster, crab, wari (wild pig), deer, duck, pelibuey (mutton), manatee, cheese, eggs, rice, beans, vegetables (including the following local starches: cassava, potatoes and dasheen) and fruits (including the following starches: plantains and banana). These items were used on the index cards for the ranking exercises. Interviewees were also asked to list meats that they consumed fairly regularly in their households; of the 50 total informants, 46 (92%; 82.6% of men and 100% of women) listed turtle as a common meat served in their household. It is unclear from the data analysis why female interviewees report eating turtle more than males in the sample population (i.e., cultural phenomenon, income-related, interviewer effect, gender roles), but this finding warrants further investigation.

Ranking exercises

Characteristics of participants in the ranking exercise are given in Table 3. While not random sample, the gender breakdown (46.6% male; 53.4% female) is comparable to the gender breakdown in the Pearl Lagoon census of 2006 (51.6% male; 48.4% female). In contrast, young people (age group 18–26) are only 15% of the group of people who ranked food

Table 2
Characteristics of semi-structured interview participants
Percentages of men and women are calculated from the total in the age group, not the total of men and women interviewed

Semi-structured interview demographics (N=50)				
		Total N (%)	Men N (%)	Women N (%)
Participants		50	23	27
Age ranges	18–26	9 (18)	4 (44.4)	5 (55.6)
	27–35	10 (20)	7 (70)	3 (30)
	36–50	20 (40)	13 (65)	7 (35)
	50 and older	11 (22)	7 (63.6)	4 (46.4)
Percentage that eat turtle		46 (92)	19 (82.6)	27 (100)

Table 3
Ranking activity participant characteristics and mean attribute values

Ranking activity demographics				
		Total	Men	Women
Participants		73	34 (46.6)	39 (53.4)
Age ranges	18–26	11 (15.1)	2 (18.2)	9 (81.8)
	27–35	15 (20.5)	7 (46.7)	8 (53.3)
	36–50	17 (23.3)	8 (47.1)	9 (52.9)
	50 and older	30 (41.1)	16 (53.3)	14 (46.7)
Mean age		44.5	46	41.3
Mean number of children		4	5	3
Mean hours worked/week		26	26.6	25.9
Mean self-reported socio-economic status (1=low, 2=middle, 3=high)		1.7	1.8	1.6
Mean days/week consume meat		5.1	4.7	5.4

items, while those under the age of 31 make up 56.4% of the population in Pearl Lagoon (according to the 2006 census). The small percentage of younger participants may be a result of sampling, which targeted household heads that met the desired characteristics (religion, occupation, income, etc.), or an artefact of emigration by young people find employment or seek education. Families who can afford to send college age students to Bluefields or Managua often do, and many young adults also leave Pearl Lagoon for work in other countries or on cruise ships.

Participants reported eating meat (on average) five days/week (range 1 to 7 days). Many participants also stated that they would like to have meat in their household every day, but that it is not affordable. Twenty-one participants (28.8%) ranked turtle as their most preferred meat overall (for various reasons including taste, cost and tradition), and 59 (80.8%) ranked turtle between 1 and 10 (out of a total of 20 available food items) when asked to rank food items according to what is eaten most frequently in their household (only 2.7% ranked turtle as the food item eaten most frequently in their household). More female respondents (94.9%) than males (64.7%) rank turtle in their top 10 foods most frequently eaten.

On average, Pearl Lagoon respondents prefer the taste of turtle meat over all other meats, followed by chicken and fish (Table 4). Analysis using Ordinary Least Squares Regression (OLS) revealed that participant age ($p=0.021$) and self-reported socio-economic status (SES) ($p=0.00001$) were both found to have statistically significant, ($p<0.05$) relationships with taste preference for turtle meat (Tables 5 and 6 respectively); preference for turtle is greatest among poorer and older participants in this sample of Pearl Lagoon residents. OLS analysis also showed a concurrent relationship of age and SES on taste preferences with statistical significance ($p<0.05$) for the sample (Table 7).

The average participant rankings of food items by price were very accurate compared to the average actual prices of food items (Table 8) during the research period (calculated

Table 4

Assigned preferential ranking of meats by participants in RAAS communities in 2006 (Lagueux et al. 2006) and in Pearl Lagoon in 2008. The lower the average ranking, the higher the taste preference. In both 2006 and 2008, turtle ranked as most preferred meat

Preferential ranking of available meats		
Average ranking assigned	2006, RAAS Communities* (N=254)	2008, Pearl Lagoon (N=73)
1	Turtle	Turtle
2	Fish	Chicken
3	Deer	Fish
4	Beef, Chicken, Wari	Shrimp
5	Agouti	Beef
6	Pork	Lobster
7	Manatee	Pork
8		Wari (wild pig)
9		Deer
10		Pelibuey (mutton)
11		Crab

*Data from 2006 represents preferences of nine RAAS communities (Awas, Haulover, Kahkabila, Pearl Lagoon, Raiti Pura, Rio Grande Bar, Sandy Bay Sirpi, Set Net Point and Tasbapauni) sampled by Wildlife Conservation Society and Universidad de las Regiones Autónomas de la Costa Caribe Nicaragüense, Bluefields (Lagueux et al. 2006). The 2006 study is not affiliated with the 2008 study and each implemented different methodologies.

using bi-weekly price information collected from four vendors/shops in Pearl Lagoon between May and November of 2008). A Spearman rank correlation indicates that there is a positive correlation between people’s perceptions of the food prices and the actual food prices ($r_s=0.96$; $n=17$; $p<0.01$). Lobster was the most expensive available meat, followed by livestock; crab, followed by turtle and fish, is the cheapest available meat.

DISCUSSION AND CONCLUSIONS

Changes in taste preference and the significance of green turtle meat

Caribbean Nicaraguan food culture has been altered by the commoditisation of green turtles, and the greater integration of coastal communities into surrounding cash-based economies (and will likely continue to adapt to various effects of globalisation). In 1972, Nietschmann noted changing taste preferences in Tasbapaunie: ‘populations of green turtles, white-lipped peccary and white tailed deer are receiving additional pressure from human populations because of their taste preference and marketable potential... Miskito hunters and fishermen are focusing on animals with a high market potential in the village’ (1972: 63). Due to their classification as globally endangered (IUCN 2008), the legal, uncontrolled harvest of green turtles taking place year-round in Nicaragua has become an area of concern for conservation biologists. Using ecological anthropology as a theoretical basis, we analysed meat taste preferences (and investigated various factors for associations with taste preference) in Pearl Lagoon, Nicaragua (RAAS). Taste preference is one aspect of local

Table 5
OLS results (N=73) for participants' preferential ranking of meats, based on age group (p=0.0208, sig=0.01)
A preference ranking of 1 is the highest/most preferred and a preference ranking of 3 is least preferred

Meat preferences in different age groups				
Preference ranking	18-26 years (11)	27-35 years (15)	36-50 years (17)	50 and older (30)
1	Chicken	Turtle	Turtle	Turtle
2	Fish	Chicken	Chicken	Chicken
3	Turtle	Beef	Fish	Fish

Table 6
Ordinary least squares regression results for participants' preferential ranking of meats (p<0.001, sig=0.01), based on self-reported socio-economic status (SES). Participants were asked to rank their household's income as higher than others in the community (high), roughly the same as other households (middle) or less than other households (low)

Meat preference and self-reported socio-economic status			
Preference ranking	Low (32)	Middle (32)	High (9)
1	Turtle	Turtle	Shrimp
2	Chicken	Fish	Chicken
3	Fish	Chicken	Lobster

Middle socio-economic status (32)				
Preference ranking	18-26 years	27-35 years	36-50 years	50 and older
1	Fish	Turtle	Turtle	Turtle
2	Lobster	Fish	Fish	Chicken
3	Chicken	Chicken & Beef	Chicken	Fish

High socio-economic status* (9)		
Preference ranking	27-35 years	50 and older
1	Shrimp	Chicken
2	Lobster	Shrimp
3	Chicken & Beef	Pork

*No participants in the age ranges of 18-26 or 26-50 reported having a socio-economic status higher than other community members (High SES).

Table 7
Ordinary least squares regression results for taste preferences of participants based on self-reported socio-economic status and age group (p<0.05, sig=0.01)

Low socio-economic status (32)				
Preference ranking	18-26 years	27-35 years	36-50 years	50 and older
1	Chicken	Turtle	Turtle	Fish
2	Turtle	Fish & Chicken	Chicken	Turtle
3	Fish	Beef	Beef	Chicken

culture that is influenced by both the environment and culture, including the ever-changing relationships between Nicaraguan coastal communities and green turtles.

Based on taste, turtle ranks as the most preferred meat overall and 92% of participants reported eating turtle meat in their households. However, when using age as the sole determining factor for taste preference, turtle is not as preferred as chicken (first preference) or fish by the younger generations, age group 18–26 (turtle ranks third). According to Rozin (1996), convenience and ease of acquisition is regularly cited as an important factor in determining both the frequency of consuming a particular food item and the preference for that food item over others. Using the convenience argument, the youth preference for chicken and fish over turtle could be an indication that turtle meat has not been acquired as easily as in the past. Also, if ease of acquisition is a strong determining factor in taste preference in the Pearl Lagoon sample, it is possible that the

younger generation (age group 18–26) prefers chicken and fish to turtle because that is what their family consumes more often. Currently, the younger generation (age group 18–26) in Pearl Lagoon is also more prone to migrate for work (according to data collected in semi-structured interviews), which may result in increased exposure to other types of meat and foods, which may contribute different taste preferences. On the other hand, the older generations have grown up with few alternatives to turtle and fish, and may have been more sedentary in their youth (during the last period of economic booms in the 1900s); consequently, older participants may have developed greater taste preference for turtle, having grown up with it as their primary meat. Since the older generation prefers the taste of sea turtle meat, they will likely continue to purchase and eat it despite potential alternatives that become available.

As a result of cultural changes, including the developments of technology and road building, the residents of Pearl Lagoon

Table 8

Informant ranking of perceived price, and actual price ranking of available food items (1=most expensive, 16 = least expensive). Price given is the average value (in USD) of prices recorded bi-weekly during the research period (May–November 2008). All items were ranked by price per pound, except eggs (per 3 eggs) and milk (per ½ gallon). Spearman rank correlation indicated a high level of positive correlation between perceived and actual costs ($r_s=0.96$; $n=17$; $p<0.01$)

Available foods ranked by price (per pound)		
Rank	Informants' perceived price ranking	Actual price ranking (Average Price in USD)
1	Lobster	Lobster (7.85)
2	Shrimp	Shrimp (2.09)
3	Wari	Wari and Deer (1.56)
4	Milk	Milk (0.76)
5	Beef	Cheese (1.46)
6	Chicken	Pork (1.45)
7	Pork	Chicken (1.41)
8	Deer	Beef (1.31)
9	Cheese	Beans (0.94)
10	Beans	Turtle (0.89)
11	Turtle	Fish (0.78)
12	Vegetables	Rice (0.61)
13	Rice	Eggs (0.48)
14	Fish and Eggs	Vegetables (0.46)
15	Fruits	Fruits (0.45)
16	Crab	Crab (0.42)

and neighbouring communities now have available in local stores, at a reasonable price, more food choices and more foods that can be consumed with minimal preparation than have ever been available along this coast. Frozen chicken brought in from Managua can now be purchased daily in local markets, for a higher price than turtle, but with greater availability and ease of access. The majority (1390 individuals or 55%) of the population in Pearl Lagoon is under the age of 31, with 35.7% (907) under the age of 21, so it will be interesting to see if taste preferences for turtle diminish, resulting in less turtle consumed over the next twenty or thirty years. However, one limitation of all age-based assumptions for Pearl Lagoon is the fact that there are fewer participants in the 18-26 age group represented in the sample population; therefore, further sampling of the younger generation is needed to accurately determine the validity of variations in preference based on age.

Based on self-reported socio-economic status (regardless of age group), it appears that turtle meat is preferred more by the poorer members in the sample, perhaps since turtle is one of the cheaper meats available. Rozin states that, when it comes to food consumption, 'price is a major practical determinant of what is effectively available, and hence intake.' (1996: 86). If this determinant holds true for the community, it is likely that should turtle and non-turtle meats become available at lower prices, people that classify themselves as poor may begin to purchase and consume the alternatives to turtle meat. Likewise, if those classifying themselves as poor experience increases in socio-economic status, they may buy more of the alternative sources of meat available. It is also possible that if turtle meat remains one of the cheapest meats in Pearl Lagoon, and alternative, non-turtle meats continue to be readily available, people at the upper echelons of society will view it as a 'poor person's meat' and thus prefer it less than other available meats

based on cultural beliefs regarding social status.

When looking at age and socio-economic status together as determining factors of taste preference in our sample population, the older and poorer participants prefer turtle meat to the available non-turtle meats. The change in taste preferences with age and economic standing is likely linked to the social evolution of Pearl Lagoon. It is widely accepted that variations in food preference within cultures has much to do with availability and price (Rozin 1979, 1996; Shepherd 1989). For example, if turtle and chicken were the same price and equally available, there would still be a fundamental distinction between preferences and liking that determined which meat Pearl Lagoon residents would purchase and eat more frequently (these distinctions include factors such as: sensory properties, cultural approval, health consequences and familiarity) (Schutz 1989). However, the best predictors of food habits and taste preferences are distinctly social: culture and ethnic group (Shepherd 1989; Schultz 1989; Rozin & Fallon 1987; Rozin 1996). Cultural norms, knowledge and beliefs, each of which are specific to the individual and influenced by socio-cultural influences in the past, are the primary determinants of food choice and taste preference (Rozin 1996). Therefore, the assumption that providing with a cheaper, 'better alternative' meat to turtle meat in Pearl Lagoon (or other Nicaraguan communities on the Atlantic coast, for that matter) as the sole 'solution' to turtle consumption is not viable in Caribbean Nicaragua.

Potential changes from road building and market integration

The integration of indigenous and subsistence economies into market-based economies often results in increased

specialisation in local food production and harvest, as well as increased access to alternative foods, thereby altering cultural norms, consumption patterns and resource use (Behrens 1992). Unlike the market access that occurred in Pearl Lagoon in the 1970s and 1980s, the current increase in market access is linked with restrictions and conservation laws with respect to green turtle harvest. If these laws (making the sale of turtle meat outside of the community illegal) were enforced, then increased market integration would not result in concurrent detrimental effect to the sea turtle population, as was the case before. Since the harvest limits and closed season are currently not strictly enforced, especially in communities with direct coastal access, integration with outside markets may result in increased take of both turtle and (legal) non-turtle protein sources. If there is an increase in emigration from Pearl Lagoon to cities (i.e., Managua) in Western Nicaragua, a new market for turtle meat may arise, both as a novelty and for migrants from the Caribbean coast who traditionally ate the meat. This increased take and potential export to other RAAS communities and Western Nicaragua (e.g., fish and shrimp) could: provide the community with more capital; increase the illegal trade of turtle meat via new road building and enhanced market access; and potentially expose residents to alternative food sources from outside of the community. On the other hand, there is a possibility that the increased importation of meat and other food items to Pearl Lagoon will result in sea turtle populations increasing and the take of green turtles returning to a subsistence level in Caribbean Nicaragua. If coastal inhabitants' taste preferences lean toward imported foods and become more cosmopolitan, one can speculate that turtle meat could become 'nostalgic novelty' meat, rather than a necessity.

The influx of people from Western Nicaragua into Pearl Lagoon to open shops and small businesses could also result in local reliance on imported goods and increased poverty (decrease in socio-economic status of local inhabitants). Residents of the Atlantic Coast have historically been self-sufficient; able to plant, harvest, hunt and gather, or produce their daily needs. If this characteristic is lost and households become dependent on imported goods, poverty levels will increase and locals will be placed at a distinct disadvantage in their own community. Similar to the link between deforestation and firewood needs in poor rural areas, increased poverty levels in Pearl Lagoon will affect local environmental quality and natural resource use. If community members are unable to afford imported goods and cannot compete with new businesses, there will likely be an increase in local demand for the cheapest source of available (preferred) protein: turtle meat. Yet, it is unknown whether the socio-cultural and environmental costs of current turtle consumption levels (loss of turtle lives) is lower than the environmental costs of exporting local resources and importing alternative meats and goods. Historical trends of economic 'booms and busts' may thus be continuing, creating new situations with historical parallels that originally placed turtles (and other wildlife) at increased risk of overexploitation.

Future studies

Historical taste preferences for sea turtle meat persist in coastal Nicaragua. The changes in cultural roles and uses of turtle meat as well as the impacts of these changes (i.e., on various dietary protein sources) are not yet well understood for Pearl Lagoon. For example, it is not known whether an increase in the price of chicken, beef or fish would result in an increase or decrease in the amount of turtle consumed. If the community considers another meat to be a substitute for turtle, then it is possible that if prices of the turtle substitute decrease, the consumption of turtle could decrease (Wilkie & Godoy 2000). Yet it is unknown if there is (or even could be) a true substitute for turtle meat and further research is needed to make this determination. According to studies on availability and price affecting food preference, it is unlikely a cultural substitute for turtle meat exists (Shepherd 1989; Rozin 1996). However, studies by Schenck *et al.* (2006) suggest that once consumers become used to an alternative meat, such as chicken, they may grow accustomed to it and choose to eat less bushmeat or, in this case, turtle. From a policy perspective, in order to provide an alternative to turtle meat in Caribbean Nicaragua, we must determine the difference between consumer stated and actual preference for both turtle and alternatives. One method to determine this would be to hold taste test sessions (with turtle and alternative meats available in coastal communities, prepared in similar manners and provided in similar settings) to empirically compare participants' stated with observed meat preferences, and to assess the role of taste in determining turtle meat consumption relative to alternatives.

Apaza *et al.* (2002) implies that exploitation of wildlife for consumption can also be reduced (or eliminated) by lowering prices of livestock products. On the other hand, reductions in livestock prices and increased consumption of the associated meat products could result in increased imported meats and/or increased local livestock production, which would then lead to a need for more pasturelands. Any attempts to lower the prices of alternative sources of meat through local production must also consider the potentially deleterious effects of increased deforestation in the region (which often accompanies local livestock and poultry production), rather than national or foreign importation. Livestock grazing can affect water balance and the natural plant cover and their waste is an environmental hazard to humans and local biodiversity. In order for livestock rearing to be a viable environmental alternative to harvesting sea turtle, we suggest investigation into non-traditional livestock production methods, such as mini-livestock (e.g., rabbit raising) or small game (Wilkie & Carpenter 1999). Even if these methods are acceptable environmentally in the region, the acceptance by local inhabitants of both the meat taste and rearing methods would need to be determined prior to their mitigation. Efforts should be made to improve the socio-economic status of individuals in the community by ensuring any alternative employment opportunities from acceptable livestock rearing

options are given to local community members (and that proper training is also provided).

Support for ensured enforcement of laws preventing the sale (or trade) of turtle meat outside of coastal, indigenous communities, is critical since the current increased access to Pearl Lagoon means there is also increased potential to increase the illegal trade of turtle meat and products. In order to assess the level of both green turtle harvest and marine resource exports in future studies, a good point of reference would be the number of fishermen now compared with five and ten years from now, along with a study of their target species.

There needs to be substantial effort spent on further study in Pearl Lagoon, as well as in the region, to examine how taste preferences change (or are altered) over time and whether or not the taste preference for turtle meat within the study are in fact declining among the younger generation in the community as suggested by the data (and if so, why).

Pearl Lagoon and the surrounding region present a compelling opportunity to examine the complex and dynamic interplay of resource use (turtle harvest), cultural preferences (choice of protein source), demography-mediated evolution of preferences (community size and age structure effects), and external forces (community accessibility, emigration and immigration). Further studies along the lines suggested would both inform the planning of regional conservation strategies and have broad general applicability, as similar scenarios are currently playing out in the rural communities of developing nations across the globe.

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Notes

1. There is some discretion regarding the correct spelling of the indigenous group (people) and language called Miskito. However, the spelling depends on what language you are writing or speaking. The English word is 'Miskito'. In Spanish, the indigenous group (people) is spelled 'misquito' and when referring to the name of the language, the word is 'Misquito'. In Miskito it is spelled 'Miskitu' and their pronunciation

is MEES-kee-too. Although some would argue that one should use the spelling that is used by the indigenous group themselves, for the purposes of this paper, written in English, we will use the spelling 'Miskito', just as we will use the spelling English rather than 'inglis'.

2. Various publications refer to the 13 (or more) communities in the Pearl Lagoon Basin, often including the village of Pueblo Nuevo, which is located upstream on the Wawashang River. In this article, regional summaries include the following 12 communities: Tasbapaunie, Marshall Point, Orinoco, San Vicente, La Fe, Brown Bank, Kakhabila, Pearl Lagoon, Raitipura, Awas, Haulover and Set Net Point.
3. There are two individuals living in Tasbapaunie that stated their ethnicity as Rama, therefore the population of the Pearl Lagoon Basin is less than 1% Rama. There were no participants in the 2006 census that self-identified as Sumu.
4. There are also individuals in the RAAS that are trilingual (Creole-English, Miskito and Spanish). This is often the case when raised in a household with parents speaking different languages and a third language is learned at school. For example, in Pearl Lagoon, the local language is Creole-English, but most schools teach inhabitants to read and write in Spanish, using Spanish textbooks. Also, coastal Miskito in the RAAS speak the Miskito language in their communities, but can also speak either Creole-English or Spanish.
5. Miskito Indian, Rama Indian and Sumu Indian are all indigenous groups, whereas Garifuna (Carib), Mestizo (Spanish-indigenous) Creole (Afro-Caribbean) and Miskito/Creole mix are ethnic groups.
6. Having an IUCN Red List status of endangered means that *Chelonia mydas* is facing a very high risk of extinction in the wild. The species' population trend is listed by IUCN as decreasing (IUCN 2008).
7. Archie Carr stated 'More than any other dietary factor, the green turtle supported the opening up of the Caribbean' (1956: 17). In the 1600s, the western Caribbean region, specifically the Cayman Islands, Jamaica, the San Andres Archipelago, Tortuguero (Costa Rica) and Caribbean Nicaragua were united through networks of resource trade between the English and Miskito Indians.
8. Mary Helms (1971: 228) also said the Miskito 'existence as an identifiable ethnic group with a distinctive way of life is a direct result of trade with the West.' Although the Miskito culture did not undergo a complete change once trade relations were in place, they did alter their existing system of exchange to incorporate trade in a cash-based market economy.
9. Once sea turtles became a valuable commodity on the coast, market intensification, exploitative fisheries, dependence on foreign goods and conflicts between kinship obligations and the desire for monetary income altered the traditional self-sufficient life of subsistence.
10. In the late 1970s, the legal harvest of green turtles by indigenous and ethnic communities on Nicaragua's Caribbean coast was still legal at a sustainable level, but turtle fishermen were no longer able to make a living by selling turtles to the companies and local households and villages felt the economic impact of this change. In response to protective legislature (i.e., the Ley de Pesca y Acuicultura N° 489, 2004 and the Decreto Ejecutivo Relativo a la Veda de Tortugas en el Océano Atlántico N° 204-DRN, 1972), factory closings and decreased population of green turtles at traditional fishing grounds, the Miskito shifted their hunting efforts to wildlife that was not protected and began opening small stores and operations to earn income. The migration rates of coastal Nicaraguans also increased from the late 1970s to the early 1980s, in response to those seeking new income-generating activities.
11. Although the Nicaraguan government has adopted legislation to limit the indigenous subsistence harvest of green turtles, there is very little enforcement of the closed season (Decreto Ejecutivo Relativo a la Veda de Tortugas en el Océano Atlántico N° 204-DRN, originally established in 1972) and turtle fishing and selling remain attractive income generating opportunities for many coastal fishermen.
12. Tasbapaunie is located approximately 40 km northeast of the community of Pearl Lagoon and approximately 80 km north of Bluefields (distance given are 'as the crow flies', as transportation along the coast is primarily

by boat through winding creeks, rivers and lagoons).

13. Nietschmann referred to his approach as ethno-ecology; related to cultural ecology and ecological anthropology. In his book, *Between Land and Water*, Nietschmann defines subsistence as acquiring food through strategies that do not interfere with or hamper the ecological integrity. Unlike market systems, systems defined as being subsistence have a primary objective of food acquisition when hunting, fishing, farming, gathering, or raising livestock. In Nietschmann's words, 'production-consumption relationships are regulated mostly by internal homeostatic mechanisms in closed subsistence systems and are increasingly regulated by external mechanisms in open or market systems' (1973: 231).
14. In his study, Nietschmann defined culture as, 'a form of adaptation of human populations... the adaptive link which unites humans with their environment and serves as a blueprint for the creation and maintenance of the human habitat' (1973: 5).
15. Interview responses and participant observation regarding conservation knowledge and perceptions of conservation are not included in this article. However, these questions were included in the semi-structured interviews to determine what locals think about conservation (if they know what it is and if so, if they believe it is necessary), if they know of conservation efforts in their community and if they support activities to protect the natural resources of Pearl Lagoon. For more information on these results, please contact the lead author.

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