

Article

Sustainable Use of the Littoral by Traditional People of Barbados and Bahamas

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Abstract: This paper is about the traditional people of Barbados and The Bahamas, in the Caribbean and their sustainable adaptations to the littoral, which included both marine and terrestrial components. Traditional people are defined as having lived in a sustainable way in an environment for five generations, the littoral is described here as an ecological zone at the sea's edge, which is composed of hundreds of medicine and food plants and animals, and resilient adaptations are understood with the environmental multiplicity model. The analysis is based on more than a thousand site intercept interviews conducted by the authors and their research teams. These data argue that culturally based patterns of sustainable food use and environmental preservation can be understood from generations of successful adaptations of traditional people.

Keywords: traditional people; coastal littoral; Barbados; Bahamas; environmental co-adaption; Caribbean

1. Introduction

This essay contributes to discussions occurring worldwide that have crystalized in the United Nations Agenda for 2030, which calls for protecting the planet by promoting sustainability in food production and consumption by informing both policy and practice. This lofty goal is being acted on in many places, at many scales, and with various intervention strategies. While some have argued for new patterns of sustainable adaptation to be uniquely developed with specific reference to a place, a people, and an environment, the present analysis argues that a better starting point is to draw upon the sustainable environmental adaptations of traditional people. Instead of creating sustainability patterns out of whole cloth, the time-tested cultural adaptations of traditional people should be drawn upon first.

This analysis assumes that it is essential to understand the diachronic foundations for the development of sustainable lifeways and food consumption before considering how to share these insights with other people. Two case studies serve this purpose. They involve the traditional coastal people of Barbados, West Indies (Figure 1), and The Bahamas, Caribbean (Figure 2) who have lived in their environment for hundreds of years during which time they have come to understand and adapt to their littoral, which includes both terrestrial and marine resources occurring at the sea's edge (Figure 3). Traditional people are defined for this essay as having lived in a sustainable way in their environment for five generations. The littoral is described as composed of hundreds of medicine and food plants and animals. Resilient adaptations are understood within the environmental multiplicity model. The analysis, therefore, is focused on traditional coastal people who have resided in their communities for more than 150 years. These are people who have learned about their environment to a level that can be termed traditional ecological knowledge (TEK) and so they can be called traditional.

The people are associated with littorals that have never been fully disrupted by development but are not considered pristine. The environmental multiplicity model is argued as a useful intellectual frame for understanding adaptations where the people, their ways of life, and the environmental resources they utilized have mutually changed in sustainable ways. We also argue that the environmental multiplicity model, which has both social/economic and natural resource components, can be used to extrapolate elsewhere and up-scale study findings.

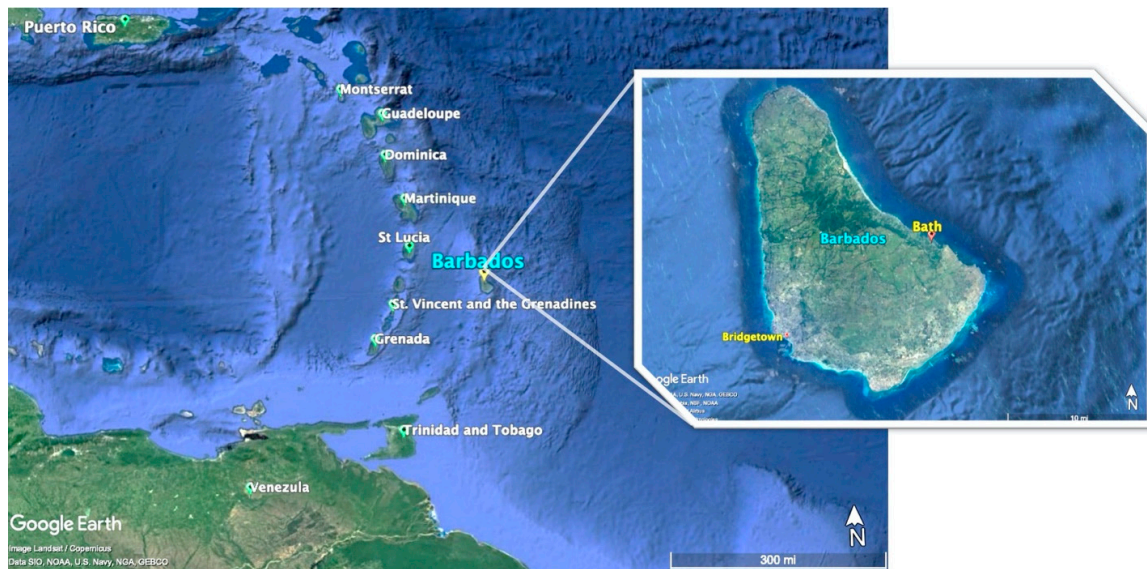


Figure 1. Barbados.



Figure 2. The Bahamas.

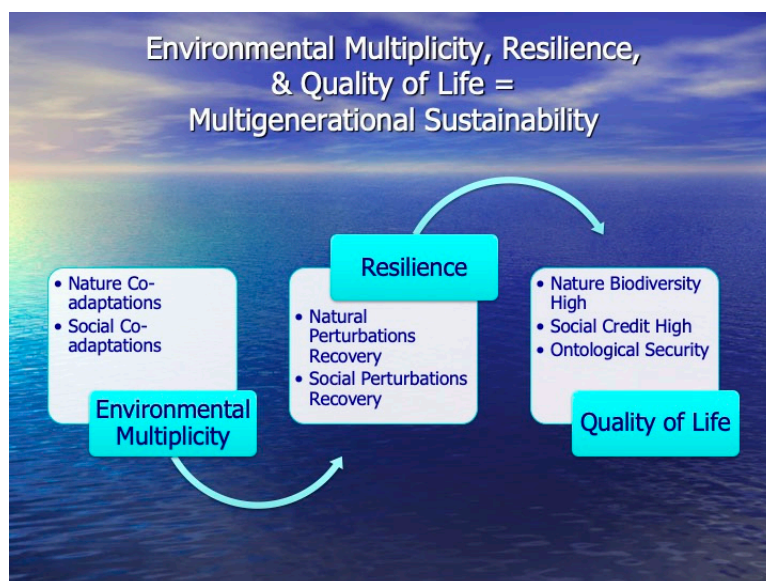


Figure 3. Environmental multiplicity.

Research that is potentially used to develop policy and influence public decisions must be understood in terms of clear limits if they are to be extrapolated to other societies and environmental situations as well as up-scaled to different societies and places. Sustainable food use and production policies can be set at the community and national levels. The authors believe that the findings are useful for understanding other coastal people who share similar histories, locations, adaptations, and live elsewhere in the Caribbean. This conclusion is based on having conducted similar studies in the Dominican Republic [1,2], Antigua [3], St. Thomas [4], and St. Croix [5].

The analysis argues that documenting and protecting the complex adaptations of coastal people is essential in order to protect them from disruption. Furthermore, we argue that some findings can be cautiously up-scaled to dissimilar social and environmental situations by using basic sustainability principles identified in the studies. In this analysis we select urban farming as an example of where new communities can be established based on a shared commitment to stable food production.

The primary power (agency) of the slave and post enslaved peoples was that their littoral use areas and nearby gardens were unwanted by more powerful people and corporations. Initially they then had only themselves as a threat to the littoral and so self-management with conservation norms developed and persisted for hundreds of years. In more recent times threats from interior non-coastal peoples and corporations have posed a threat to the littoral. We suggest that their nations declare them heritage communities in recognition of their sustainability practices and in so doing afford them higher levels of protection. All-inclusive hotels who excavate the mangroves to make boat docks and golf courses are the main threat to The Bahamas and elsewhere in the Caribbean.

Urban gardeners in the US and Cuba have a similar agency problem even after they become a community of farmers. They must establish shared conservation norms to coordinate production and to prevent their products from being taken by other community members; which is less of a problem because they share in the bounty of the gardens. The threats by outsiders who must somehow be policed by the broader community. Successful urban gardeners will be threatened by the potential sales of their farms to larger scale non-locally controlled commercial business.

2. Conceptual Background

Two concepts frame this analysis: environmental multiplicity and the littoral. Both are described as critical components of societies produced by and for slave-based and post-colonial industrial agricultural plantations in the Caribbean. The colonial societies of the Caribbean were designed to provide their European owners (which in this analysis is England) with profits through the production

of tropical cash crops. Most of these plants were imported from the East Indies and established on new lands in what would be called the West Indies. The people who farmed, processed, and shipped these cash crops did so as unfree laborers [6] and continued as underpaid laborers after the end of English colonial slavery in 1833 well into modern times [7]. The cash crop exporting societies that made Europe wealthy did not share this abundance with the workers who often had to engage in subsistence activities just to survive. Thus, the sustainable cultural adaptations to this suppressive economic situation and to the littoral resources that were not disrupted or destroyed by industrial production are key for understanding these coastal Caribbean peoples and their small island ecology today.

2.1. Environmental Multiplicity

This analysis builds on the environmental learning model suggested argued by Berkes and Turner [8], which maintains that learning and adaptation is based on an accumulation of ecological knowledge and how to protect people from the influence of social and natural perturbations. Learning and adaptation can become the foundation for self-organizing and developing conservation-orientated practices [8]. Common property, and in this case common destiny as a community, can be key ingredients in the elaboration of resource management practices at the local level.

People begin to learn about nature as soon as they arrive in a new environment that has unique (to them) fauna and flora and ecosystem functions [9]. Such knowledge is often termed local knowledge, and it may be useful in terms of proper environmental behavior within a generation [10]. To move from simple observations to deeper ecological understandings of food webs and trophic levels takes many generations. This case supports the co-adaptation model of learning, which argues that within five generations or about 150 years in a new environment a community can acquire extensive and complex ecological understandings and become what is termed traditional begin to build a resilient way of life [9]. As local knowledge is tested, becomes shared and integrated into the culture it can lead to adaptive behaviors including conservation and resilience [11].

Connell's research [12] documented that natural disturbances occurring at an intermediate scale can cause positive changes biodiversity and biocomplexity. Traditional people use their knowledge of ecosystems and make intermediate changes that have positive benefits by clearing spaces in forests [13], moving seeds to new habitats [14], digging tubers [15], changing behavior of herding animals [16], pruning wild nut trees [17], and designing agricultural fields to stimulate animals and plant populations as well as provide sustainable farming [18]. Especially important for this analysis is Turner's study of seaweed collection among the native peoples of Northwestern America where harvesting of intertidal zones improved littoral habitats for both plants and animals [19]. Gifting and trading the foods cemented social relationships, developed economic sufficiency, and built the reliance of families and communities [19].

When a people learn about the fauna and flora of their ecosystem, they can adjust their adaptive strategies to protect themselves from natural and social perturbations. When they do this and live in a sustainable way, they can be said to have developed a resilient way of life [20,21].

In The Bahamas and Barbados the African-ancestry people have made a resilient way of life by building a series of social and ecological redundancies, which we have termed environmental multiplicity (Figure 3).

This concept builds on Lambros Comitas's [22] theory of occupational multiplicity, which is widely recognized as a foundation of social adaptation and resilience in the Caribbean. He documented that Jamaicans acquire skills, invest in resources, and hold many jobs at one time. Even though it makes more economic sense to invest all of their work time in the highest paying job, they spread their efforts across a range of jobs because these come and go due with economic booms and busts. Environmental redundancies occur when people have multiple places to fish and gather the same fauna or flora. They also have agricultural fields that are left fallow for five or more years, restoring nutrients in the soil and serving as a buffer to environmental damage. These redundant and rotation use patterns restores the soil and reduces fishing and gathering pressures. These use patterns only cause

intermediate environmental disruptions. In this analysis we combined natural and social redundancies into the environmental multiplicity model so that it describes these adaptations as both parallel and functionally interrelated.

2.2. Littoral

Edges are special places for human ecology [13,23] because critical natural and human life cycle events occur there. In the Caribbean the edge of the sea is especially important for fish nurseries, mangrove wetland nutrient exchanges, and people [24]. This is a place where freshwater touches saltwater, birds' nest, and amphibians thrive. Here too people begin and end their lives.

Unlike other important areas in the terrestrial and marine environment, the human dimensions of the Caribbean littoral tend to be underrepresented or misunderstood in ecological studies and in the social impact assessment research. Research data from former slave communities in Barbados and The Bahamas illustrate that over hundreds of years the people learned about their littoral environment and adaptation to it through sustainable uses. This explains why the littoral has become culturally central to the people of these communities and why they established a sense of customary ownership and responsibility for protecting it and treating it as "family land" [25,26].

The term littoral is used in many different ways. Some scholars restrict it to the wet portion of the coast between high and low tides [27], whereas others view it as a general term of reference for socially and biologically integrated portions of the seacoasts. These ideas are combined to operationally define littoral to mean that a portion of the sea immediately adjacent to the land but no deeper than the waist of an adult at low tide. It includes places on land that are socially and biologically connected with the sea.

The littoral extends onto the land through food webs that critically depend on both salt and freshwater habitats. Thus, it extends up estuaries into mangrove wetlands, and as far as amphibious animals like crabs travel inland. Minimally the littoral involves the following kinds of places: shallow coral reefs, sea grass beds, exposed beach rock, foreshore, backshore, sand dunes, sea cliffs, mud flats, estuaries, mangrove swamps, brackish ponds (anachialine), freshwater deltas, springs, and streams.

These case studies involve a number of kinds of littorals, which are presented at various points in the essay. Figure 4 is a leeward side shallow marine sand bank littoral with slow tides. Figure 5 is a tall resistant cay with steep banks and shallow sea and fast tides. Elsewhere is a photo of a windward rain-driven littoral pressured by persistent northeast trade winds with fast tides. Also later in the article is a mostly enclosed mangrove littoral with a mud bottom and slow tides. Each of these littorals represents a different econiche. The biodiversity and biocomplexity of these types of littorals have been documented through our marine and land mapping studies [11,28,29].

It is essential to understand the biocomplexity and biodiversity of the littoral because only this explains how these coastal peoples survived periods of industrial agriculture and why they are so strongly attached to these areas today [24]. Tables A1–A3 (Appendix A) highlights some of the culturally important species by their cultural uses and names. These use species were selected from among hundreds of species identified in research interviews and published reports, in order to illustrate the many sources of traditional food, medicine, and construction.

Socially and culturally the littoral extends into the contemporary activities, history, and culture of traditional communities. So, the littoral also exists where it participates in the lives of coastal people. The littoral is more than a physical place; it is a part of the social fabric of coastal people. It is a place of teaching and learning. It is a place where knowledge is passed from generation to generation and where it is commonplace for an elder to pass cultural knowledge regarding appropriate fishing techniques and strategies to younger people. It is where lessons are taught regarding different species and ways to monitor environmental changes, be they monthly, annual, or an aspect of climate change. Here the younger generations are taught lessons regarding types of plants that can be collected and used for both food and medicinal purposes. This type of knowledge sharing has gone on for generations and according to oral history began with the forced arrival of their ancestors. Some knowledge was

brought from Africa and other types were learned over time. Environmental learning occurred from their need to sustain family and group health.



Figure 4. A leeward sand bank littoral.



Figure 5. Littoral on small key with sea grass beds at edge.

Today these activities in the littoral provide subsistence and small-scale commercial (informal economy) opportunities for young men and women who engage the littoral, gather, and collect to offset unemployment and as a means of contributing to the household income and welfare. Young adults between 16 and 25 tend to experience high levels of unemployment. Their ability to go to the littoral allows them to harvest fish and other marine products for sale or trade. It is not uncommon to see young adults on their way to the beach stopping by various homes to see if individuals want a certain species. Upon return that species is sold or given to the individual. This allows for either cash payment or the ability to call on a future favor. Dinner stews often include marine species and plants gathered on the way home.

3. Methods

This paper presents an analysis of traditional communities situated along the coasts of the Exumas islands in the central Bahamas and the island of Barbados. Data from the two studies were collected with different funding sources and each study had its own specific purpose. The studies are comparable because each included the systematic gathering of data regarding use of littoral by community members. In both studies the members of the communities had been dependent for food, medicine, and construction for more than 150 years on the animals and plants from the littoral. Residing in place for this period and sustainably using the littoral argues that the people should be defined as traditional, which is an analytically important stage of adaptation. In fact, the communities in the Exumas, Bahamas were established 235 years ago (post-1785) and the Bath plantation was established more than 227 years ago (post-1793) [30].

Social science researchers use mixed methods [31,32] and triangulation [33]. Mixed methods involve collecting qualitative and quantitative data, and where there is convergence, confidence in the findings grows considerably [34]. Participant observation was an important component of each case study. The Exuma study used seven instruments (a) sea attachment, (b) quality of life, (c) grubbing, (d) tourism, (e) ethnobotany, (f) land mapping, and (g) sea mapping. The Barbados study used two instruments one focused on occupational multiplicity and other on household finance and micro-credit. Both studies used oral histories, which were both structured and open, ended and were comprehensive given the dozens of hours each required. Most data collection instruments were diachronic in order to contextualize contemporary life ways in short (30 years) to long (200 years) adaptation time frames. All formal interviews were systematic in that they were administered using a structured data collection instrument, thus permitting direct comparisons from instrument to instrument and person to person.

Informal interviews are an important tool for collecting data when formal interviews are not possible because of either time or interest of the interviewee [32]. They are often the best way of listening to people about subjects not currently contained within the formal interview instruments. Informal interviews permit topics to emerge that may become critical to the study, perhaps eventually requiring their own formal instrument. In-depth understanding of some topics like ethnobotany required dozens of hours of informal interviews. All informal interviews were recorded in bound field notebooks and logged into a data base.

It is important to recognize, however, that confidence in these findings derives from an overall triangulation of comparable findings from any of the instruments and oral histories. The triangulation of data thus involves comparing responses generated with divergent instruments. When two or more instruments provide the same answer to a research question then the confidence in the accuracy of the answer is increased. Confidence in the accuracy of responses also increases to the extent that most interviewees provide the same answers.

3.1. Barbados

The Barbados interviews were conducted during a 3-year study of rotating savings and credit associations known in the Caribbean as meeting turn, sou sou, asu, box hand, and partner [35]. During five field sessions a single researcher [36] conducted 500 formal and informal interviews in Barbados; of these 120 were with the people of the Bath plantation area on the northeastern coast. Data were collected on microeconomic systems, which are a creole (or informal) economic system [7] and community lifeways. Responses regarding direct production from the sea provided data on patterns of littoral use.

The research is built on the findings from earlier studies, especially questions generated by previous interviews. The research methodology included: literature review; participant observation; formal interviews with instruments; and informal interviews using a memorized interview schedule.

The Barbadian analysis assumes that broader patterns of Caribbean life, especially ones occurring over the life cycles of individuals and traditional patterns established over many generations can be understood through systematic interviews as well as through a few typical stories (oral history) from a

single settlement. The 500 plus interviews established the cultural centrality of the littoral in the lives of people in coastal Barbados. The Barbados analysis situates these findings through the diachronic story of the Bath settlement and one fisherman.

3.2. *The Bahamas*

The Bahamas research focused on how proposed marine protected areas (MPAs) could impact six local communities in the Exumas. Community perceptions of potential MPA impacts were assessed as predictors of local responses to the MPAs. Beginning with an open-ended ethnographic approach, the study sought to elicit variables rather than test them.

The Bahamas case involved 572 interviews conducted with 193 people from six coastal communities in the Exumas islands and cays. Various data collection instruments were used, often with the same people. There were 352 formal and 221 informal interviews. An overall sample size of 34% of the census recorded population was achieved for each community.

The research is (a) inductive, (b) iterative, (c) mixed methodologically, (d) collaborative, and (e) consultative. Eight field sessions occurring over a six-year period permitted an iterative cycle of collecting data, analyzing findings, and returning with both new and revised data collection instruments.

The sea attachment, land mapping, and sea mapping instruments were central to this analysis. It is important to recognize that confidence in these findings derive from an overall triangulation of comparable findings from any of the seven instruments and oral histories. A fourteen-page sea attachment instrument was developed to explore the widest range of marine uses and cultural meanings. It has 208 questions distributed across seven knowledge and use domains such as: material arts, sea biology, underwater landscapes, land biology, expressive arts, identity symbols, and settlement stories. Land mapping and sea mapping interviews were used to define resource use patterns across space and through time from slavery until the time of research.

The oral history accounts, some of which involved hundreds of hours of interview time, describe environmental learning and the subsequent behaviors of ancestors during slavery and just beyond. These are up to 235-year-old heritage memories (post-1785). It is important to remember that many of the people today and their ancestors have continuously lived in or near their initial slave village, have taken and kept the last name of the original planters, and for most of this time have relied upon the same marine and terrestrial ecosystems that their ancestors faced. Continuity of people and place is illustrated by the fact that many people remember when the first commercial pharmaceuticals became available in the Exumas in the 1950s. So, bush teas and medicines were relied upon throughout this period and are used extensively today. Memory timelines, given these criteria, are well within the accepted standards of accuracy [37]. Elsewhere, Stoffle and Zedeño [38] document accurate oral history accounts going back thousands of years. From an ethnological perspective the slave-period interpretations also are robust because many people interviewed in the Exumas similarly describe the environmental learning and adaptations of their ancestors.

4. Cases

These cases have the common theme of the diachronic development of sustainable life ways in former enslaved communities who have maintained a core traditional population. Both cases are primarily about of African-ancestry people, but each involves traditional European-ancestry neighbors who for hundreds of years have worked alongside them on the plantations. Neither Barbados nor the Bahamas colonial society provided a social/economic safety net for its rural poor; thus, individual security was established by the people themselves as members of small-scale communities located near the edge of the sea.

Both cases are focused on a marine littoral activity, but it is important to understand that complex sustainable use patterns exist for terrestrial fauna and flora. Oral history studies of plant specialists, for example, have documented 264 species of traditional use plants for the Exumas [39] and almost as many for Barbados [40–42].

4.1. Case One: Barbados

The east coast of Barbados can be characterized by its rugged coastline where prevailing easterly wind and wave action carved out a variety of locations in which flora and fauna thrive. One impressive area is the former Bath plantation where in the nearby shallow sea is a predominant feature known as the Great Rocks. The Great Rocks serves as a defining marker between deeper ocean and land interaction (Figures 1 and 6). The area outside of the Great Rocks tapers off to mixed patches of shallow and deep-water coral reefs that create an environment where fish and underwater plant life flourish. The Great Rocks littoral supports land and marine based plants and animals.



Figure 6. The Bath area and littoral zone.

An extensive littoral zone extending from the Great Rocks north to Martins Bay and south to Conset Bay (Figure 7) has been and continues to be a socially, culturally, and economically important part of the lives of two distinct ethnic groups of people; Irish indentured servants brought over in the latter 1600s and subsequently African enslaved people in the late 1600s. Both of these groups continue to inhabit the area and have done so ever since the first plantations were established in this part of Barbados. The littoral provided food and medicine in addition to creating social and economic security and stability. The collection of plants and animals in this area was an important strategy for offsetting the cruel and harsh conditions of slavery and allowed the people to sustain themselves, when provisions from the plantation were grossly inadequate.



Figure 7. The Bath littoral with sea swells made by northeast winds.

The north east coastal littoral was used from the earliest times of English settlement (1627) but it seems that fishing was primarily the responsibility of 40 Arawak families many recently from Dutch Guiana. Richard Ligon [43], who lived in Barbados from 1647 to 1650 provided a map of the Indian area located just inland near Bath on the north east coast. He observed:

“that Indian women were primarily, if not solely, employed in household tasks. On the other hand, the men...were use for footmen, and killing of fish, which they are good at. With their own bows and arrows they will go out, and in a day’s time kill as much fish as will serve a family of a dozen persons two or three days, if you can keep the fish so long”. [41,43]

This observation is an intriguing insight into the pristine condition of the littoral. It is not clear how long Indian men were employed in the fishing industry with their six-foot bows and long arrows, but it is unlikely that African-ancestry people were permitted to make and use of such weapons.

Ligon [43] recorded on an inland plantation that African-ancestry males were allowed two mackerel a week and each woman one. African ancestry people were not observed fishing except under the direction of a coastal plantation owner who had a seine net. This may have occurred because they were restricted to industrial plantation labor and thus their visits to the littoral were at odd hours and on Sunday and conducted with little equipment. Some later evidence of this comes from the analysis of the nearby Codrington Plantation (pre-1710 to 1782) where about 300 people were enslaved [44]. The Codrington plantation records of 1776 list the occupations of 51 skilled men, and 21 women and 9 boys who were not on the field gangs, but the occupation of a fisher is not listed [44]. This is especially interesting because Codrington plantation became a major English Religious College occupied by students and ministers of the Anglican Church all of whom consumed fish on a regular basis. Perhaps the lack of the fisher job was unique to Codrington because 12 years later in 1788 the island’s governor, reported that the number of fishermen may be about 500 out of an enslave population of about 62,000 [41].

Crab fishing during slavery may be a better analog for patterns of littoral use than fishing. They are caught at night by fishers using torches that both provided light for movement and to attract the crabs [41]. Similar patterns occurred in the shallow water for collecting lobsters. Torches combined with nets were used to catch flying fish along the shore. McKinnen in 1802 recorded that in Barbados the local people are very successful at taking flying fish. At night they spread their nets before a light and disturb the water at a small distance. The fish rise and eagerly fly toward the light and are intercepted by the nets [45]. This pattern of using torches and nets to catch flying fish was observed again by another visitor in 1818 [46]. Use of torches to collect in the littoral is in keeping with the need for enslaved people to be out of sight when they are away from the plantation.

There are many key features and resources of the littoral utilized by the enslaved people and their descendants in the area today. The collecting of marine resources was an important strategy for providing much needed protein in a diet that was inadequate at best when based on provisions provided by the plantation owner or overseer. These littoral collection strategies are much the same as they were in the past using hands to grab or hook, small/light fishing poles or lines, and self-made nets (cast nets) as seen in Figure 8.

The Bath case is centered on the life of one outstanding, but in many respects, a typical fisher. His is the story of the people of Bath and many other coastal communities in Barbados. Fred Watson is a 94-year-old fisherman (in 2020) who was born in a little house across from the beach in Bath. He has lived his whole life in and around this area, fishing as a means of providing food and money for his family. As a youth Fred was trained to fish and collect marine and terrestrial resources such as seacat (*Octopus brareus*), conch (*Strombus gigas*), spiny lobster (*Panulirus argus*), Red Sea crabs (*Careilius corallinus*), whelks (*Buccinum undatum*), and curbs (*Polyplacophora* ssp.) from the sea, and seaweeds, sea grapes (*Coccoloba uvifera*) and white swampee crabs (*Cardisoma guanhumu*) from the land. These lessons were a common part of the informal environmental education of young boys as older relatives and community members often felt obligated to pass on what they knew to the

younger generation. As he grew older, he attended school and upon completion of his formal education was made a primary school teacher. During that time Fred continued to live and support his family, especially his 15 family members. The problem was that even with Fred's salary there still was not enough food to feed everyone.



Figure 8. Irish fishermen with littoral fishing equipment in Barbados near Bath [47].

Fred stated, at the age of 13:

“I had to give up being a teacher even though I enjoyed it. Even though I had a steady paycheck I couldn't always make enough money to make sure that everyone was fed. I would still fish at that time but because of my commitment to the school I wasn't able to do it as often as I needed to. So, I gave up being a teacher and went to the sea full time. I would fish all day and all night, sometimes inside Great Rocks and sometimes outside. Even though I made a lot less money, I was able to make sure that everyone ate. My brothers and sisters never went hungry because the sea always provides.”

Fred comes from a fishing family and his fisheries knowledge and success in training fishermen from the area comes from his over 85 plus years of fishing plus the generations of knowledge acquired from those that came before him. His knowledge of the sea has garnered a great deal of local as well as national respect and attention. In 2016, the Prime Minister awarded Fred the Honor of Oldest Active Fisherman in Barbados building on his previous award from 2002 for his lifelong service in fishing and recognizing him as the Best Fisherman in Barbados [48]. This service includes not only providing food for the people of Barbados but also includes his role in assisting researchers and policy makers in creating laws that benefit the creation of sustainable fishing practices. The young boys and young men still turn to him for advice and even at 94 he spends his days mending nets and holding “classes” for those that need assistance.

The littoral is full of marine and terrestrial resources that can be sustainably used for consumption and sale. Many plants are needed for making medicinal tonics. “Bush teas” are made from various combinations of plants and used for a variety of ailments, from sickness related to colds and flu to detoxifying internal organs. People bathe in the saltwater to cleanse the body from wounds as well as consume saltwater to cleanse congestion from head and lung ailments. These folk cures are passed down from generation to generation and are often selected over the use of “western” chemical medicines.

Fred is a person who acquired generations of knowledge about the littoral zone from elder family and friends and he continues to be an important conduit of this information. He is quick to fulfill his role as teacher for those who wish to carry on the responsibility to share and build upon the lessons of the past. While he is no longer able to fish in the same ways as he did in the past, he still is a regular fixture at Bath where young men come to improve upon their fishing knowledge and practices. He is revered as the “best fisherman in all of Barbados” and has made sure that the youth are educated as to the best practices for sustainable use.

In 1999 he demonstrated how to use a cast net in the littoral can provide enough for a single person to provide adequate amounts of food to multiple feed families. In this instance he went out across the shallows targeting small fish known as fray (a small fish) and sardines. With two net throws and over 30 min he was able to fill a bucket of these small fish providing enough food for two days of meals for both his family and that of his helper (Figure 9).



Figure 9. Fred Watson on the right with a younger fisherman.

When asked why he did not continue to throw and catch more fish his response demonstrated a conservation strategy. Fred stated, “Why would I continue to throw the net when I have all that I need for now (Figure 10). Sure, I could catch much more but why would I hurt the fish. I do not need more than I have and by taking more than I need all I do is hurt them (the fish). Now I know that they will be there for me for the future.”.

This strategy of creating a balance between conserving the fish while supplying food for the family ensures that resources will be there for future use. This knowledge stems from generations of day-to-day involvement with the resources and is a lesson that when passed to future generations of fishermen will ensure that the practice is sustainable for both humans and the fish. This is a practice that many coastal people throughout the world have employed because of their recognition of humans’ potential impact on the health of the environment.



Figure 10. Fred Watson casting the net.

4.2. Case Two: The Bahamas

The Bahamas case analysis is about how African ancestry people living on the isolated Exumas islands and cays (Figure 10) located in the central Bahamas have learned about and adapted to their environment. The case contains a range of dates for the beginning of environmental learning after individual plantations failed post 1785 and the eventual collapse of most slave plantations in the late 1790s. Two types of TEK, a form of hand fishing and extensive knowledge of ethnobotany, illustrate the complexity of these in-situ knowledge domains. The case documents how TEK has gone beyond understanding species to awareness of trophic levels interactions, ecosystem functions, and eventually to ways to conserve this delicate coastal environment. Their in-situ TEK, co-adaptation, and conservation have produced a lifeway based on environmental multiplicity that is has been resilient for over about 235 years.

4.2.1. History of Bahamian Case

The arrival of the Spanish in the Bahamas in 1492 initiated a period of rapid depopulation and the eventual extinction of the original inhabitants of the Bahamas, the Lucayan people. Most evidence suggests that Bahamian islands and cays subsequently lay unused by humans. The ecology as it had existed under thousands of years of Lucayan farming changed when they became extinct and the Spanish failed to occupy the Bahamas. With no managers, nature went wild so to speak. A new Bahamian state of nature emerged over the next 156 years, until being interrupted in 1648 when English Puritans settled Eleuthera Island in Northern Bahamas.

The Exumas, being more isolated and removed from the centers of the Bahamian colonial economy, remained unoccupied for 293 years, when in 1784 the two large Exuma islands were surveyed and conditionally given as plantations to Loyalist (refugees from the 1776 to 1783 American Revolution). A plat map made in 1792 documents the presence of 115 land grants each of which is a small plantation [49]. Only a few platted areas lacked an indicated owner, most of who resided with their enslaved workers. The Loyalists were required, as a condition of receiving Crown lands, to clear the land and make it into productive cash crop farms. Failure to accomplish this within ten years would result in forfeiture of the land back to the Crown.

Living in a new ecosystem that had been fallow for about 293 years and required by the Crown to rapidly produce a commercial plantation, the Loyalists stripped this long fallow ecosystem. They sold off all commercial timber, moved to define boundaries with coral rock walls, and planted cash crops such as cotton on all suitable land. Tropical rains and hurricanes soon revealed the danger of opening all lands to farming. Keegan and Mitchel [50] estimate that the topsoil of most plantations washed away within three years, exposing the hard-calcariferous bed rock. The chenille bug destroyed much of the cotton grown in the Bahamas in the late 1790s [51]. So, most Exumian slave plantations quickly failed, although a few remained for another 100 years as salt producers. With crop failures, the Loyalists left the Exumas, but their African ancestry slave populations remained in a limbo status

because of English laws, which made moving slaves illegal, although slavery continued to be legal and they continued to be considered enslaved people. As an Exumian plantation failed and was abandoned by the Loyalist owner, the workers were left to fend for themselves, which they did by organizing themselves as a community and taking control of the plantation lands. In order to define their common occupation rights (which later would become recognized as usufruct rights or generation lands) the people called their community after the name of the former plantation owner and each person took his name as their last name. This was the beginning of environmental learning and the foundation of contemporary African ancestry communities in the Exumas. Today, the descendants of the former slaves are largely clustered in twenty-six settlements located on or near the post-1784 plantations [51].

Little applicable ecosystem knowledge was brought by the Loyalists or the African ancestry people because neither had lived in environments identical to the Exumas. These peoples neither had access to Native American TEK from the American colonies nor in the Exumas. African ancestry people were both Creole (born in the New World) and arrived directly from Africa. The former came from the revolting mainland colonies, especially South Carolina and Georgia, many of the latter came from the interior of the Senegambia region of West Africa [52].

The English government stipulation that the Loyalists must produce cash crops within ten years, caused the small plantation owners to pressure enslaved people to invest maximum time clearing the land, growing mono crops, and processing for the market. Free time for slaves was not abundant even though Bahamian law required that the slaves have plantation land for their own gardens [53]. The enslaved people were often underfed because most food was grown in another English colony [54]. So, they used small gardens and gathering in the littoral just to survive. Free time during slavery was constrained by limits on permissible distance traveled and time absent. Oral history accounts document that each evening one local planter took his enslaved people by small boat to an isolated cay surrounded by swift tides where they were left to fend for themselves until work the next day.

Most Loyalist plantations were abandoned by the end of the ten year economic viability period, others failed by the early 19th century, and all slaves were freed in The Bahamas in 1834, which defines a point after which all African ancestry people had full access to their own labor, lands, and ocean [51,52]. Like Barbados, by this time most of the land was completely cleared. After the plantations failed there were few natural plants; however, ecologists believe that something resembling the natural ecology did reoccur within a generation due to small island biogeography [55]. Fauna and flora traveled from dozens of undisturbed cays and reestablished a new but not pristine ecology.

The formerly enslaved people began immediately after the failure of their plantation to use the littoral [24]. This area was accessible by foot or by floating on small rafts to the neighboring cays just offshore. Foods for daily consumption, construction materials, and medicines came from the littoral because it was salty and thus never cleared for plantation cash crops. Here people could access a wide variety of protein, while patches of natural vegetation and home gardens were being expanded.

Subsistence farming for African ancestry people occurred on limestone bedrock because the thin soils had been eroded away by unsustainable plantation agriculture; so people developed a system of pot culture in which farming holes were annually expanded by burning small fires in them and supplementing the soil with seaweeds and earth from elsewhere like bat caves. When hurricanes overturned a larger tree, the soil contained within its root ball was eagerly sought after and used in the pot-hole fields. This pattern was observed during this study. Developing this practice, African ancestry people (re)established a form of Native American swidden farming, which seems uniquely adapted to Exumian ecology.

4.2.2. Grubbing: Unique Ecology of Case

During the plantation period, enslaved people stood on the shore and watched ocean currents, learned about the movement of water in the mangroves, and observed how weather patterns such as mid-day storms and hurricanes affected the sea. People used free time to study fish behaviors and to collect marine products. Once on their own they turned to the littoral.

This analysis is based on thirty-four grubbing-specific interviews and half of a dozen family oral histories. Grubbing only occurs in mangroves where the sea is relatively calm and shallow; and when it is effective to use hands and team work to catch fish during low to medium tides. In order to grub, a person must have full knowledge of the littoral and fellow fishers including (1) tides—grubbing occurs during low to medium tides because then it is easy to walk to grubbing locations, which can be up to a mile off shore, and not all grubbers can swim, (2) fish behaviors and types—especially important are life cycles, (3) weather—rapidly changing weather conditions place people at risk, (4) plants—these were used to catch fish and to protect grubbing groups from attack, (5) predators—mangroves are a dangerous place to walk because of sharks, moray eels, and barracudas, (6) mangroves services—a system of regulations was imposed to assure that the key ecological roles were protected, and (7) social relations—normally grubbing involved groups who functioned successfully when there was a shared division of labor, clear communication, mutual commitment, and redundant skills.

4.2.3. Exposed Mangroves and the Grubbing Circle

This description of the grubbing circle comes from Forbes Hill where it normally involved a large group of women, usually one from most households and sometimes her oldest child. The group would venture a mile and a half offshore to the end of a large mangrove covered peninsula (Figure 11). A deep salt-water creek had to be crossed to get to the grubbing area. This mangrove is largely an open system marked by shallow waters and some sheltered areas. One of the best areas is far from shore and surrounded on three sides by ocean thus is especially vulnerable to shifts in tides, adverse weather, and large predators. All areas are open to the sea and shallow where the mangrove dries out completely forming massive mud flats or the mangrove fills rapidly with water making grubbing impossible. Women recount sinking up to their waist in mud fearing the rapidly returning tides, which carry sharks and barracudas. The path taken by the women to the grubbing area is documented in Figure 11.

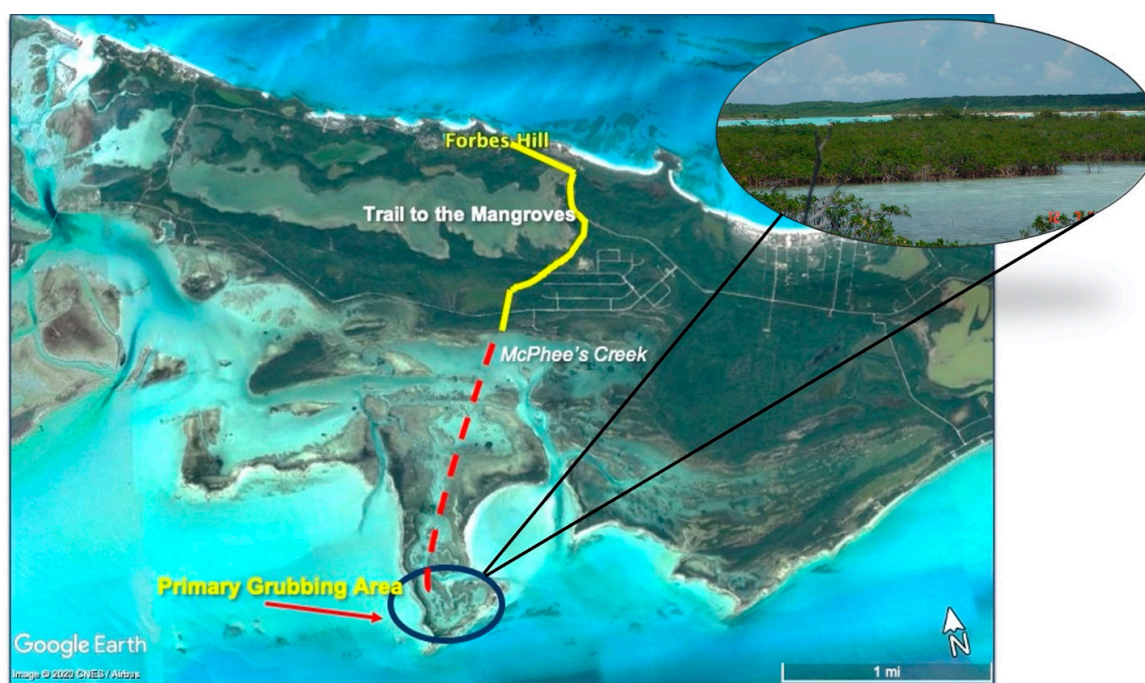


Figure 11. Grubbing area near Forbes Hill and exposed mangrove, with the ocean behind.

The dozen or more women who circle grubbed together had very specialized roles because of the risks and location far away from shore. One woman was charged with watching the whole group; to make sure every woman returned home safely even if she helped them swim across the blue holes and

the creek. Another woman was charged with watching unpredictable tides often triggered by strong winds. Those women who did not know how to swim had to be protected if the tide came in suddenly. One woman watched for and fended off dangerous animals like sharks, barracudas, and moray eels. She was fearless. Women interviewed recalled an incident when a big moray eel swam into the group and this woman forced her hand down the moray's throat and strangled it to death.

The majority of the women in the grubbing circle were tasked as fish herders, who were to muddy the mangrove waters by slowly walking in a line, slightly raising a muddy cloud causing the fish to become confused and have a difficult time breathing.

“They would make the water muddy in the mangrove because when the water get muddy, if any moray in there, they gonna come out [and go away]. They [the fish] gonna get drunk and they gonna keep pushing their head in the mud . . . they gonna keep making a noise like a grunt, so you know just where they is.”

The herders moved the fish in an ever-tightening semi-circle towards a group of fish catchers each of whom wear a wide flared skirt with the hem tucked tightly underneath their heels. As the fish are driven blindly, they seek refuge under the skirt where they are easily caught and placed in a specially constructed woven grubbing basket with a narrow opening at the top. Children who often hold the baskets are brought to learn grubbing and to not slip in the mud and have the fish swim out of the basket.

The grubbing circle women (Figure 12) developed this unique fishing method using social organization, cooperation, mangrove TEK, a wide flair skirt, and a narrow-mouthed basket. It often was the women who had the responsibility to catch fish for the whole community when the men were gone; a common situation because ships would come seeking laborers and remove all the men in the community for months. When the women returned home, they gave fish to other community members who could not go out into the mangroves to grub or chose other community tasks. Fish was often exchanged for breads or vegetables. Sometimes the fish became part of a large communal meal. The women of Forbes Hill depended on each other and the social networks they created influenced community structure and all other aspects of their life.



Figure 12. Grubbing ladies of Forbes Hill at St. Peter's Union Church.

4.2.4. Sustainability and Grubbing

Grubbing continued to be a primary form of subsistence fishing in the Exumas throughout the post-slavery period, but it declined with new technologies associated with boat building, fishing lines,

and nets. Soon people traveled beyond the mangrove system into deeper waters and expanded the fishing territory. As Exumians broadened their knowledge of the sea, people with boats learned about the best distant and deep locations to fish. Deep water fishing teams had multiple places to fish because it was beneficial to rotate fishing areas. By dispersing fishing pressure people did not over-fish the mangroves despite increases in population and more efficient technologies.

Knowing that the mangroves are a vital part of the ecosystem, a system of regulations (conservation ethics) were agreed to and imposed. These regulations involved only taking fish from the mangroves when necessary, not fishing in the mangroves every day, and never taking juvenile fish. The rules were regulated by the family and community, so the mangroves are protected for future generations. A man from Little Farmers Cay explained that in the mangroves, young fish grow before moving to the deeper waters and therefore people learned not to always fish in the mangroves. People have redundant mangrove resource use areas to prevent overexploitation. They fished in two very different mangroves—one close to the settlement and another in the leeward cays. Redundancies are important for conservation, so people have multiple use areas with similar ecology.

Even though people acquired new fishing technologies and used territories away from shore, knowledge of and respect for grubbing persists. People still grub occasionally but speak of it more as security heritage; that is, a traditional way of life that can always be turned to in times of need. It is a source of pride in the resourcefulness of the ancestors and a proven way of fishing to be relied upon during difficult periods.

5. Discussion

Stuart Pimm [56], a foremost ecologist maintains that understandings of world-wide environmental principles have slowly developed because ecology studies are designed to be narrow in time, place-space, and species. Ecologists seek to improve the quality of their findings by carefully focusing their studies; however, Pimm concluded that broader understanding of other places, species, and time frames require a different type of integrative analysis. He, thus, wrote *The World According to Pimm: A Scientist Audits the Earth* to demonstrate the importance for public policy of up-scaling local research findings to the planet level.

Here we cautiously address ways of extrapolating and up-scaling some of the findings from the Barbados and The Bahamas research. We do not assume that just because a community has been in place for hundreds of years and today has clear conservation and sustainable use practices that they have not made mistakes. In fact, if patterns of sustainable food use are to be learned by others, it is necessary to understand how these practices came into being. Some models of environmental learning suggest that people make mistakes (depletion crisis model) and learn what damage they can cause. Over time, they move away from harmful practices and replace them with sustainable uses [8].

One example from both cases is that of learning from mistakes using fish poisoning. In Barbados the practice of poisoning fish with the juices of the manchineel tree (*Euphorbiaceae* sp.), which may have been brought by the Carib or Arawak fishers. It became so widespread and destroyed great quantities of fish in the bays, creeks, and shoals. So, in 1724 the government passed laws against its use. The practice was not eliminated, however, so in 1766 a similar law was passed with more severe penalties [41]. It is understood that the pattern of fish poisoning was largely practiced by non-fishers who were primarily farmers living away from the sea and thus less committed to its sustainability. Fred remembers it was used in his youth about 1950 but there is no evidence of fish poisoning in the Bath area at the time of the study; fishers decided to stop the practice (personal communication Fred Watson 2020).

In the Exumas there is a traditional form of fish poisoning (stunning) called chemical grubbing that uses the bark of dogwood (*Piscidia piscipula*) and joewood (*Jacquinia keyensis*). While still practiced today both for fishing and protection it is closely governed by local customs [39]. Like in Barbados, the poison derives from a native tree bark that is so strong if used while wadding in the water the fisher also can be drugged. Women carry the bark in a bag to protect themselves from shark attacks while

rowing small boats. It is only used today by fishers who both know littoral TEK and have experience using it for chemical fishing and it is not widely taught to youth.

Certainly, it is possible to extrapolate findings to other Caribbean coastal people living in traditional post-slavery industrial plantation communities who already use appropriate technology (Schumacher 1973) for littoral fishing and plant harvesting. Based on published research very similar sustainable food use and environmental protection patterns exist elsewhere; such as in the Dominican Republic [2,5,57,58]. The key here is to carefully evaluate through sustainability assessment [59]. Potential impacts of developments would shift the land use patterns or community stability and thus reverse sustainability in food production. Especially critical are coastal littoral impacts from developments that both modify the ecology and exclude the local people, such as national tourism parks [60] and all-inclusive resorts. Traditional coastal communities need to be protected as heritage communities who have learned how to sustainably use and protect the littoral.

The study findings, however, must be up-scaled to more complex societies and their members who are living in different environments, and who must use alternative technologies and change their pattern of food production and consumption in order to meet the UN 2030 goal of increased sustainability. So, where are the findings most likely to be well received and potentially make a useful contribution? Here we consider the example of urban gardening; which has occurred in Cuba, Detroit, and New York (Appendix B). In each of these situations locally controlled urban gardening emerged after the collapse of external support systems and withdrawal of regional and world economies. In other words, like the people of Barbados and The Bahamas the residents were to one degree or another left to adapt on the own.

So what general principles need to be agreed upon to by the people surrounding the urban gardens in order to make a sustainable food producing system? The new gardens, which replace abandoned and removed buildings, must become resilient to climate change, economic, and social perturbations. One strategy is to use environmental multiplicity model whereby different soils, rain shadows, and sunlight distributions can be assessed to in order to establish different places for growing the same plants and to experiment with different plants growing in these same places. Knowledge of outcomes from these micro-experiments needs to be shared among the farmers in order to build a body of knowledge and create a sense of common purpose. New urban farmers will be confronted, like the people of the Caribbean, with shifts in weather and climate. The weather will be dryer or wetter, hotter or colder, and have storms. Learning to adapt to weather shifts and eventually climate changes will require generations. The new farmers will become a component of the urban economy and perhaps be in competition with rural farm systems. If successful the urban gardeners may face capital intrusions whereby larger more powerful business will try to purchase and consolidate the farms in an attempt to profit from past successes and reputation. At these moments urban farmers must decide if they were just surviving an economic transition or building a new way of life and community in the city. To survive long term, people in the city must develop a sense of ownership of the gardens and build a system of sustainable rules for their protection and preservation. All of these sustainable principles were developed over long periods by the traditional peoples of Barbados and The Bahamas and elsewhere in the Caribbean and potentially will be needed for urban gardeners.

The Barbados and Bahamas cases are useful for understanding the beginnings of community gardening and exchanges, but more importantly they document the need for such local gardens and exchanges to prepare for perturbations caused by climate change, economic withdrawal, and development intrusion. The Caribbean cases have components proven to be successful for hundreds of years, but new learning methods must be developed to rapidly use old lessons and stabilize past adaptations [61,62]. There is a need to constantly assess current needs and develop adaptive responses for future threats. The key is community ties, thus any threat to natural and human relationships threatens the whole system. As said earlier, common property and common destiny are key ingredients in the elaboration of sustainable resource use practices at the community level. Clearly urban gardening communities and the coastal communities of Barbados and The Bahamas share these challenges.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Land animals of the littoral.

Land Animal Name	Scientific Name	Local Name	Location	Interaction
Land crab		Swampy, Land Crab	brackish freshwater springs before ocean	food source, bait for hand line fishing
Marsh Fiddler crab	<i>Uca pugnax</i>	Stone Crab	Shoreline	Food source
Bahamaian Nighthawk	<i>Chordeiles gundlachi</i>	Nighthawk	Shores, marshes, estuaries, grassy wetland areas	Eats insects that bother people
Blue Crab	<i>Callinectes sapidus</i>	Blue crab	Shores, marshes, estuaries, grassy wetland areas	Food source
Blue Heron	<i>Adrea herodias</i>	Arsenicker	Shoreline	Food source, prey on crabs
Crescent-eyed Pewee	<i>Contopus caribaeus</i>	Pewees	Mangroves, edges of clearings	Eats insects that bother people Eat crabs that
Green Heron	<i>Butorides virescens</i>	Gaulin birds, Poor Joe	Shoreline	would come into gardens and eat crops, stories
Hermit Crab	<i>Paguristes</i> ssp.	Hermit crab, Solider crab	Reefs, shallows, sand patches	Food source
Killdeer	<i>Charadrius vociferus</i>	Killdeer	Shores, marshes, estuaries, grassy wetland areas	National symbol
Laughing Gull	<i>Larus atricilla</i>	Sea gulls	Salt marshes, lagoons	Indicates schools of fish
Least Tern	<i>Sterna antillarum</i>	Gulls	Shoreline	Fed and cared for by people

Table A1. Cont.

Land Animal Name	Scientific Name	Local Name	Location	Interaction
Mangrove crab	<i>Cardisoma guanhumii</i>	Land Crab, Cigga	Mangroves	Put nicker bean in crab hole to prevent them from destroying garden, used for crawfish bait
Osprey	<i>Pandion haliaetus</i>	Fish Hawk	Nest near the ocean	Eat eggs, story of climbing to the nest of the hawk to get eggs
Pigeon	<i>Columba leucocephala</i>	White Crown Pigeon	nests in mangroves	Food source
West Indian Rock Iguana	<i>Cyclura</i> spp.	Iguanas	Brush, lagoon areas	Tourist attraction, food source
Zenaida dove	<i>Zenaida aurita</i>	Wood dove	low lands	Food sources, hunted and eggs eaten

Table A2. Sea animals of the littoral.

Sea Animal Name	Scientific Name	Local Name	Location	Interaction
Bonefish	<i>Albula vulpes</i>	Bonefish	Shallow flats near mangroves	Tourist attraction, food source
Caribbean Reef Octopus	<i>Octopus brareus</i>	Octopus, sea cat	In shore reefs	Food source
Caribbean Spiny Lobster	<i>Panulirus argus</i>	Lobster, crawfish	Reefs, caves, holes, ledges	Food source, not caught during spawning, spawning crawfish thrown back
Chiton	<i>Polyplacophora</i> ssp.	Curb	Rocky shores	Food Source
Chub	<i>Kyphosus sectatrix</i>	chub	Sea grass beds	Food Source
Conger Eels, Garden Eel	<i>Nystactichtys halis</i>	conga eel	shallows	Food source
French Grunt	<i>Pomadasyidae</i>	Grunt	Near reefs, mangroves	Food source
Giant Brain Coral	<i>Colpophyllia natans</i>	Coral	Reefs	Made into cement for houses
Great Barracuda	<i>Sphyraena barracuda</i>	Barracuda	All, especially reefs	Food source
Green Eel, Green Moray	<i>Gymnothorax funebris</i>	green eel	In shore reefs	Food source
Hawksbill Turtle	<i>Eretmochelys imbricata</i>	Turtle	Shallow, coastal waters and estuaries	Food source, shells were sold to make jewelry
Jolthead Porgy	<i>Calamus bajonado</i>	Porgy	Reefs, sand, coastal interface	Food source
Lemon Shark	<i>Negaprion brevirostis</i>	Lemon Shark	Lagoons, estuaries and the shallows	Food source, helps fight cancer, skin used for fertilizer
Mangrove Snapper	<i>Lutjanus griseus</i>	Snapper	Near mangroves	Food source
Nassau Grouper	<i>Epinephelus striatus</i>	Grouper	Shallow to mid-range reefs	Food source, grouper is not caught during spawning

Table A2. Cont.

Sea Animal Name	Scientific Name	Local Name	Location	Interaction
Nurse shark	<i>Ginglymostoma cirratum</i>	Nurse Shark	All (shallow and deeper)	Skin used to fertilize gardens
Parrotfish	<i>Sparisoma viride</i>	queen parrotfish	Reefs, sea grass beds	Food source
Crevalle	<i>Caranx hippos</i>	jack crevalle, rainbow crevalle	located in shallows as well as offshore	Food Source
Queen Conch	<i>Strombus gigas</i>	Conch	Sand and eel grass beds	Food source
Queen Triggerfish	<i>Balistes</i> ssp.	Triggerfish	Reef tops	Food source
Reticulated Sea Star	<i>Oreaster reticulatus</i>	Starfish	Eel grass beds	Tourist attraction
Sea Sponge (1.) Yellow Tube Sponge (2.) Red Cup Sponge	(1.) <i>Aplysina fistularis</i> (2.) <i>Mycale Laxissima</i>	sponges		Cleaning, songs are made about going sponging, today spongers uses knives, so sponges grow back Food source, shells sold, shells ground and burned, ground into lime to build houses, black ones used for bate for Jacks
Sea Urchins	<i>Tripneusts ventricosus</i>	Sea eggs	Sea grass beds	

Table A3. Plants of the littoral.

Plant Name	Scientific Name	Local Name	Location	Interaction
	<i>Ambrosia hispida</i>	Bay Tansy, Baygereen	Beaches, dune sands or occasionally on rocky shelves along coast	Medicinal properties
Black mangrove	<i>Avicennia germinans</i>	Black Buttonwood	Mangrove lagoons and along tidal shore	Medicinal properties
Sea Ox-eye	<i>Borrchia arborescens</i>		Coastal sands and rock and margins of brackish water	Medicinal properties
Nicker bean	<i>Caesalpinia bonduc</i>	Nickers	Native to seacoasts	Children use the seeds as marbles and playing pieces in Wari, a traditional African game widely played in the West Indies, medicinal properties
Seven-year apple	<i>Casasia clusiifolia</i>		Coastal rocks but also in coppices	Edible wild plant
	<i>Cassytha filiformis</i>	Love vine	Parasitic on various herbaceous and woody plants	Medicinal properties

Table A3. Cont.

Plant Name	Scientific Name	Local Name	Location	Interaction
Cocoplum	<i>Chrysobalanus icaco</i>		Coastal swamps and thickets along sea beaches	Edible wild plant
Sea grape	<i>Coccoloba uvifera</i>		Coastal thickets and rock outcrops	Edible wild plant
Silver thatch	<i>Coccothrinax argentata</i>	Silver Top	In coastal flats along beaches	Plaiting and making straw crafts, thatch material for roofs
Coconut palm	<i>Cocos nucifera</i>		Thrives in the low tropics, especially in coastal sands	Food, boat building wood, aesthetic qualities, medicinal properties, plaiting and making straw crafts
Button wood	<i>Conocarpus erectus</i>		Coastal mud, savannas and edge of salines	Boat building wood, source of driftwood used for decoration in homes
Lignum vitea	<i>Guaiacum sanctum</i>		Rocky slopes and ridges, seaside ledges, palm-shrub associations, and dense coppices	National tree of Bahamas, medicinal properties, boat building wood
Pigeon berry	<i>Guapira longifolia</i>		Coppices, scrublands, and on rock flats, often along the coast and on ridges	Recognized as a main food source for wild pigeons. Used during the hunting season to find pigeons
Horse Bush	<i>Gundlachia corymbosa</i>		Clayey or rocky saline flats, marshes, dune sands, pinelands, edge of coppices	Medicinal properties
Log wood	<i>Heamatoxylum campechianum</i>		Coastal thickets, hillsides and on edge of salinas and periodically flooded places	Medicinal properties
Wild Dilly	<i>Manilkara bahamensis</i>		Coppices or scrublands, especially along coastal areas and on rock flats	Edible wild plant, medicinal properties, fruit chewed as chewing gum

Appendix B Urban Gardening

Appendix B.1 Cuba Urban Gardening

The USSR withdrawal from Cuba began about 1990 largely leaving the country on its own for the production of food. Given the crisis Cubans began to clear areas near their homes and plant food [63]. While initially individual efforts soon both the people and the government worked together to feed themselves. Some adaptations were organized into a movement termed Organoponicos, which placed individual gardens into a system using low-level concrete walls filled with organic soils and watered with a drip system. Through time gardeners self-organized and added government knowledge of

pest management, alternative forms of fertilization, and crop rotation to make a more effective and sustainable human and natural system.

Appendix B.2 Detroit, Urban Gardens

The collapse of the car industry combined with the urban riots in the 1960 placed the residents of Detroit in a near starvation situation. As hundreds of ruined buildings were removed and a million people left, soil became available where only pavement and bricks were before. People turned to farming to survive and to feed others [64]. Today 23,000 residents participate in urban gardens as even more buildings are removed to eliminate blight and open earthen spaces. Like Cuba, Detroit gardening began as a response to a crumbling economy and eventually the gardeners themselves and the city combined to organize a more efficient system.

Appendix B.3 New York City Urban Gardening

In New York City (NYC), urban agriculture has become integrated throughout the five boroughs and individual neighborhood [65]. Currently, NYC has more than 700 urban agricultural sites with the Department of Parks and Recreation and the Housing Authority running the two largest community gardening programs in the country. These departments oversee with more than 1000 gardens throughout the five boroughs, most located on public land. The NYC Department of Education and the nonprofit GrowNYC support 300 school gardens. Out of the 300 gardens, 117 grow food for a farm-to-cafeteria program in over 50 schools. The food products are used in making healthy lunches for many NYC school children [65].

Even though urban gardening and agriculture span all demographic and geographic categories of people, the city's farms and gardens are clustered in places that were hardest hit by decades of disinvestment, i.e., places abandoned. Residents in these neighborhoods faced a number social and economic challenges such as limited access to healthy food options, underperforming schools, poor health, high unemployment rates, and twice as many vacant lots on average than in the city's wealthy neighborhoods. Urban agriculture gives people a way to address some of their neighborhoods' pressing needs.

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