Social and Ecological Underpinnings of Human Wildlife Conflict on Dominica

Leo Ricardo Douglas

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ABSTRACT

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Conflict between psittacines (birds within the parrot family) and agriculture is a growing, unstudied threat to psittacine conservation throughout the Caribbean. The intensification of conflict as an apparent outcome of successful conservation interventions is of particular concern on the island of Dominica. Here, conflict between the island's globally threatened parrots and citrus farmers is a potential roadblock to advancing the gains of threatened species recovery programs. This dissertation provides empirical data on the extent and severity of the losses experienced by farmers due to parrots, and the degree to which the resulting conflict has provoked a parrot conservation backlash. This dissertation analyzes the causes of citrus fruit loss including the role of parrot frugivory in these losses and the predictors of parrot frugivory at multiple scales. It also highlights parrot frugivory as a source of a poorly understood commensal relationship with small passerine birds and suggests that the role of psittacines as top-down modifiers of canopy community dynamics is underappreciated. Using social science research methods I illustrate the importance of investigating the meanings and value-oriented attitudes that stakeholders hold towards parrots. I show that it is possible for popular conservation tools such as the flagship concept to inadvertently marginalize other closely related species within a local culture, and that this may be particularly important when human-wildlife conflicts are present. Finally the

dissertation illustrates that, overall, crop loss attributed to parrots on Dominica has become a surrogate issue and focal point within a much larger public dispute about the state of agriculture and the security of farmers on Dominica. The findings therefore illustrate the inherent complexity of conflicts involving wild animals and underscore that efforts to understand and mitigate such conflicts in a traditional reductionist manner as purely wildlife-crop loss issues may be misguided. I therefore advocate that multidisciplinary systems perspectives are essential for both the study and management of this and similar conflicts.

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Acknowledgements

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Dedication

I dedicate this dissertation to my master's adviser and mentor Dr. Peter Vogel. Thank you for your enthusiastic support and for making ecology both exciting and accessible. May your soul rest in peace!

Psittacine-agriculture conflict in the Caribbean: scope, patterns, and implications.

Abstract

Psittacines remain one of the most threatened groups of birds globally, and Caribbean psittacines are no exception. A developing concern in psittacine conservation is psittacine-agriculture conflict. Here I present the results of a survey of Caribbean parrot-conservation experts and a review of news media coverage of stakeholder-stakeholder disputes about such conflicts. The findings indicate that psittacine-agriculture conflict is an important, yet poorly studied conservation challenge region-wide. I show that psittacine-agriculture conflicts throughout the Neotropics are poorly reported in the academic literature. The findings also suggest that psittacine ecology, farming systems, and the history of psittacine conservation by way of the use of parrots as culturally ionic flagship species are important to understand where conflict exists. The review suggests that parrot conservation professionals should be more aware of the possible implications of parrot conservation successes, as well as vigilant against the hunting, capture, and trade of psittacines in presence of either real or perceived crop losses attributed to psittacines.

Keywords: Parrots, parakeets, human-wildlife conflict, frugivory, flagship species, crop loss, trade.

Introduction

With approximately 26% of the world's parrots threatened with extinction, compared to the 12% of the birds of the world as a whole, psittacines are one of the most threatened families of birds globally (Collar 2000, Forshaw 2006). The islands of the Caribbean have been a focal point of psittacine extinctions and they remain an important area of concern for their conservation. Historically, an estimated 34 species of psittacines were present on the archipelago. Of these, 19 species or 56% have gone extinct within the last 500 years, and of those 15 species that survive, 10 are listed as threatened and one as near-threatened by the IUCN Red Data List (Hilton-Taylor 2000, Wege 2008, Wiley et al. 2004). While these threat levels remain alarming, they are a notable improvement on the threatened status of many Caribbean psittacines when compared with just 20-30 years ago. Conflict resulting from the perception of native psittacine birds (parrots and parakeets) as crop pests is, however, of growing concern within the Caribbean (Wiley et al. 2004). Several of the region's senior parrot conservation biologists describe the re-emergence and intensification of such conflicts as a serious potential roadblock to advancing the successes made in parrot conservation within the region (Wiley et al 2004). These authors emphasize that because parrots have been key State and regional conservation flagship species, important not only for parrot recovery interventions, but also for national park and protected area establishment, the spread of these conflicts could undermine biodiversity conservation overall. Regional practitioners have therefore stressed the critical need for quantitative study of psittacine-agriculture conflict to determine their prevalence, importance, root causes, and conservation implications (Bucher 1992, Wiley et al. 2004).

Here I present data on expert opinions gathered from individuals involved in Caribbean parrot conservation to discuss the status of psittacine-agriculture conflict. While there are limitations on the accuracy and applicability of expert knowledge, the experiences and knowledge of experts are useful and necessary when empirical data is absent, and when systematic studies do not exist (Yamada et al. 2003, Vie et al. 2009). I supplement the interview data with archival material obtained from the news media. Additionally, I examine published research about psittacines as sources of agricultural losses to discuss the patterns observed and the extent of academic interest the issue has received. Finally, I draw on the results of a two-year study of psittacine-agriculture conflict conducted in the Commonwealth of Dominica in the eastern Caribbean (Chapter 2 - Douglas 2011) and preliminary telephone interviews with managers of commercial citrus producers on the island of Jamaica.

Methods

Study Region & Terminology

The insular Caribbean is subdivided into six groups, the Greater and Lesser Antilles, the Bahamas, Virgin Islands, Cayman Islands, and the South American coastal islands. With the exception of the latter, all these islands form the Caribbean sub-region, one of four sub-regions of the Neotropical eco-zone. The island group along the northern edge of South America, which includes the ABC islands (Aruba, Bonaire, and Curacao) of the Netherland Antilles and Trinidad and Tobago, while part of the insular Caribbean, is biogeographically part of South America and therefore within a separate Neotropical sub-region, the Amazonian. The Venezuelan controlled islands (Margarita and La Blanquilla) are not included. In this article I use the term parrot for species within the genus *Amazona*, and parakeet for *Aratinga* spp. I use the term psittacine to refer to species of both groups and also to any other bird within the parrot family when discussing birds outside of the insular Caribbean region. In total, the islands contain 19 native extant species of parrots and parakeets. The Neotropic sub-region contains 12 parrots and three parakeets (Wiley et al. 2004). The South American islands of the Amazonian sub-region contain an additional three native parrot species and one parakeet. This number includes the two native parrots of Trinidad and Tobago. This twin-island state also has species of macaws and parrotlets that are not discussed in this publication as their status as sources of conflict has not been reported to date.

Survey Method and Participants

I gathered information on crop losses and social conflict surrounding psittacine frugivory of cultivated fruits using four methods:

1. **Online Questionnaire**

Between June and July 2009 I circulated a link to an online semi-structured questionnaire to 29 Caribbean psittacine conservation experts (see Appendix 1). I identified these experts following the multi-authorship and acknowledgements of the publication Wiley et al. (2004), and in consultation with the Parrot Working Group of the Society for the Conservation and Study of Caribbean Birds (SCSCB). Twenty of these experts completed the survey. For survey questions that solicited unstructured responses, I coded and categorized these replies and present them in a structured fashion, and where this was not practical I discuss them individually.

2. News Media Discourse Analysis

The news media is an important forum for social debate in contemporary western society. In general there is a positive relationship between the occurrence of a topic in the media and its level of importance (or interest) in a local society. One question the online questionnaire sought to determine was whether and how much the local news media had reported crop losses attributed to psittacines. For all those countries that indicated that the local media covered stories about psittacine-related crop losses in the last five years, I sought and obtained print and audio copies of any available media items from the respective media houses. I gathered these materials through personal contact with the editors/producers and through online searches of the web-archives of these media houses. I then examined the text of these news items to determine how and in what context local stakeholders discussed crop losses attributed to psittacine birds.

3. Parrot Working Group – Focus Group

Immediately following the online survey period, members of the Caribbean psittacine conservation community met for the biennial Parrot Working Group meeting at the 17th regional conference of the SCSCB, July 14-18, 2009 on the island of Antigua. During this meeting, participants presented, discussed, and recorded their top three psittacine conservation priorities for each respective island-state. These priorities were reproduced in the minutes of the working group. Note that participants were not informed about the current study prior to this session and their priorities were provided purely based on expected future parrot conservation funding opportunities facilitated by the SCSCB. The data from this focus group were particularly valuable, because not only did it permit the participants to identify and discuss their opinions, it also provided an opportunity for these experts to debate apparent trends and possible causal relationships that appeared to explain the patterns of psittacine-agriculture conflict across the region. Furthermore, because psittacine-related research is distributed unevenly across the region, it provided an opportunity for experts to compare their opinions and experiences about the importance of the issue. I also conducted unstructured individual-level interviews with many of the respondents to provide clarification on various statements that emerged from both the semi-structured survey and focus group meeting during the conference period.

4. Telephone Interviews

During June 2011 I identified and contacted senior managers of three large citrus producing estates on the island of Jamaica to discuss their experiences with crop losses attributed to psittacines.

Literature Review

To examine previous research on psittacine-agriculture conflict, I reviewed documents accessible through ISI Web of Knowledge, an online consortium of 7 databases consisting of scholarly journal entries. ISI Web of Knowledge incorporates the regularly utilized databases for the conservation sciences, social sciences, and ecology including Web of Science, Biological Abstracts, Zoological Records, and the Social Science Citation Index, among others. The objective of my research was a 40-year review of the subject (1970 – 2010). Only English-language documents were selected for the review (see Appendix 2 for further details of the method used).

I identified 60 papers related to psittacine-agriculture conflict. For the analysis I used a quantitative thematic content analysis method. I read the full text of each publication to quantify whether the document reported on: (1) empirical quantitative assessments of crop losses; (2) empirical assessments of stakeholder's knowledge, attitudes, and/or practices surrounding real or perceived losses attributed to psittacines; and (3) the types of crops affected. I also determined whether the publication was framed as part of the human-wildlife conflict discourse and ascertained the overall focus of the publication, whether ecological, crop-damage management/mitigation, or conservation and education. I then quantified what regions of the world these publications reported on, and whether or not they were part of the scholarly, peer-reviewed literature.

Results

Respondents & Parrot Working Group Members

Twenty psittacine conservation experts representing 12 independent Caribbean island states, including all the island nations with extant psittacine populations, participated in the online survey, a response rate of 69%. Half (50%) of these individuals hold professional positions within either a government ministry or division (such as a Forestry and Wildlife Department/Division), or within a quasi-government organization with responsibilities for biodiversity conservation. The remaining individuals were primarily university-based academics, or researchers based in conservation non-governmental organizations. At the Antigua conference focus group meeting there were 19 participants representing 11 independent island-states that formed the Parrot Working Group of the SCSCB for that meeting. Haiti was the only island with an extant psittacine that was not represented during the Working Group.

Importance of Crop Losses & Indications of Social Conflict

From the questionnaires 17 (or 85%) of the 20 respondents representing 10 of 12 Caribbean nations with extant psittacine populations agreed that psittacines cause some type of crop loss or damage in their respective countries (**Figure 1: box 1**). Additionally, one indicated ‘not sure’, because while agreeing that psittacines did take cultivated fruit they indicated that in the absence of quantitative study to confirm these as real agricultural losses it was difficult to comment. Only in Puerto Rico and mainland Cuba did respondents indicate that psittacines were not known to be responsible for agricultural crop loss. Cuba’s second largest island, the Isle of Youth, however, reportedly experiences psittacine-caused crop damage. Not only were both Puerto Rico and mainland Cuba thought to be currently conflict free, respondents from these island states indicated that to the best of their knowledge, such crop-losses had not occurred within the last 50 years.

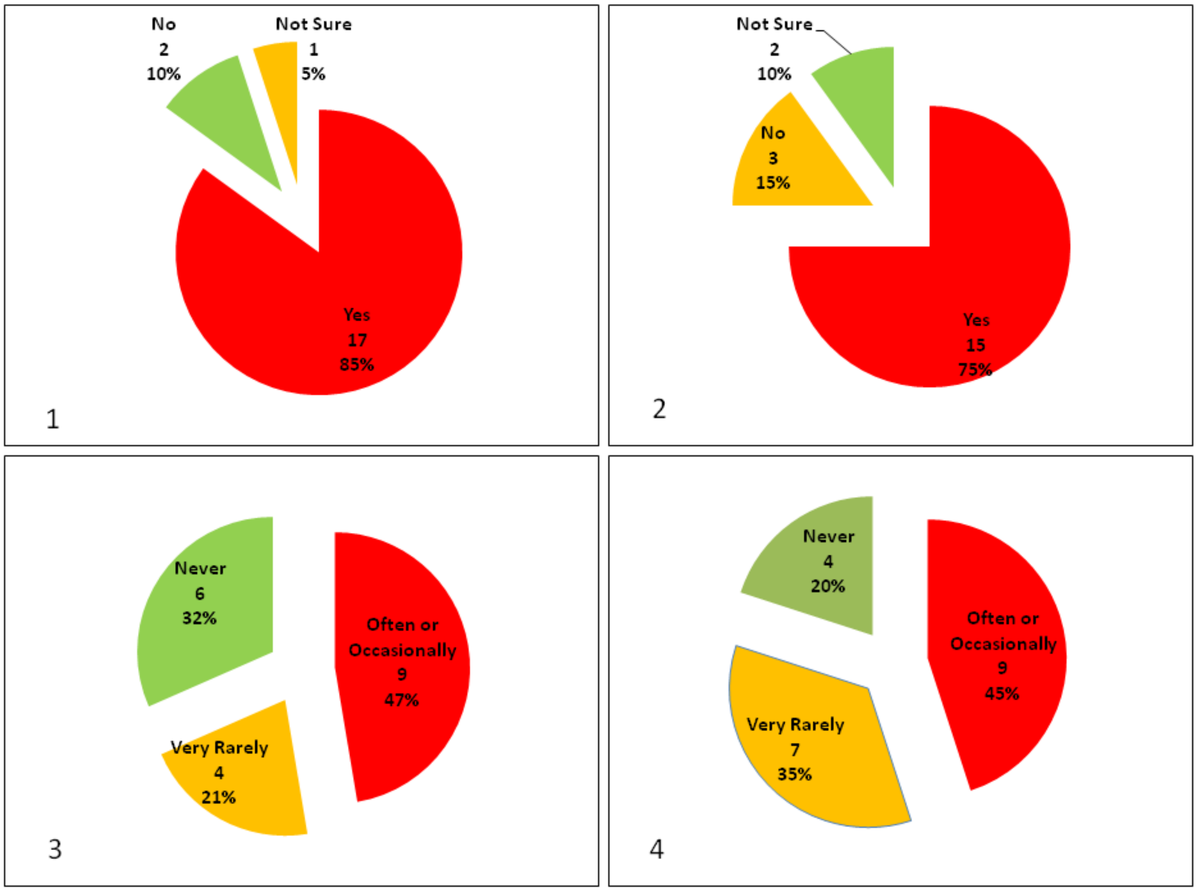

Figure 1. Responses of 20 Caribbean psittacine conservation experts to the question: Do you agree that in this country currently: (1) some type of psittacine causes some sort of crop loss/damage?; (2), it is a common belief among some farmers that some type of psittacine causes some sort of crop loss/damage?; (3) In your professional experience, how often do you hear of farmers complaining to the relevant government agencies in charge of biodiversity conservation and/or agriculture about crop loss due to psittacines? (NB: No data for Haiti); (4) How often do you hear of reports of the killing or injury of psittacines because of the crop loss/damage (real or presumed) they produce?

Fifteen (or 75%) of the respondents indicated that it is a common belief among some farmers that some type of psittacine causes some sort of crop loss or damage in their countries. Only Puerto Rico and mainland Cuba reported an absence of such a belief. Two respondents indicated that they were unsure of the “commonality” of the belief among farmers on Haiti, and on the Bahamas Islands where psittacines occur (**Figure 1: box 2**).

Respondents on Tobago and the Cayman Islands heard of complaints relatively often. Respondents from Bonaire, Dominica, and St. Lucia were aware of occasional complaints. On Jamaica and St. Vincent such reports were rare. Reports from the Bahamas Islands and Cuba were very rare, to never. There were no data for Haiti for this question, and on the Dominican Republic the respondent was not aware of any explicit complaints from farmers to the responsible government agencies (**Figure 1: box 3**).

Respondents on the Cayman Islands and Haiti hear of reports about the killing or injury of psittacines occasionally to often. Reports from Tobago and the Dominican Republic occurred occasionally. Reports from Jamaica and Dominica occurred occasionally to rarely. Reports from St. Lucia, Cuba, Bonaire, and the Bahamas occurred very rarely to never at all, while there were never reports of psittacines killed or injured due to conflict with agriculture from Puerto Rico (**Figure 1: box 4**).

Affected Crops and presumed determinants of crop loss/damage

Questionnaire respondents reported that 24 crops grown either commercially or in household/backyard gardens were eaten by psittacines in the Caribbean. The 14 most reported of these, in descending order of commonality, were (shown in brackets is the number of countries reporting this form of crop loss): Mangoes *Mangifera indica* (11), Oranges/Tangerines *Citrus spp.* (8), Grapefruits *Citrus sp.* (7), Guava *Psidium sp.* (6), Papayas *Carica papaya* (4), Kinneps *Melicoccus bijugatus* (4), Golden Apple *Spondias dulcis* (4), Passion-fruit *Passiflora edulis* (3), Corn *Zea mays* (3), Bananas/Plantains *Musa sp.* (3), Cacao *Theobroma cacao* (3), Avocado Pears *Persea americana* (3), Tropical Almond *Terminalia catappa* (3), and Pigeon Peas *Cajanus cajan* (3). In a few of these cases respondents noted that the psittacine involved did not necessarily consume the food item but was nevertheless identified as a source of crop loss by, for example, picking fruits which were then dropped to the ground either partially or completely uneaten. Respondents suggested that the most probable determinant for the existence of psittacine-induced crop losses was farming within or adjacent to psittacine habitat (15 of 20 respondents). Other key determinants proposed were deforestation and habitat loss, stochastic events such as hurricanes, or severe drought, and the preference of psittacines for cultivated crops (Figure 2).

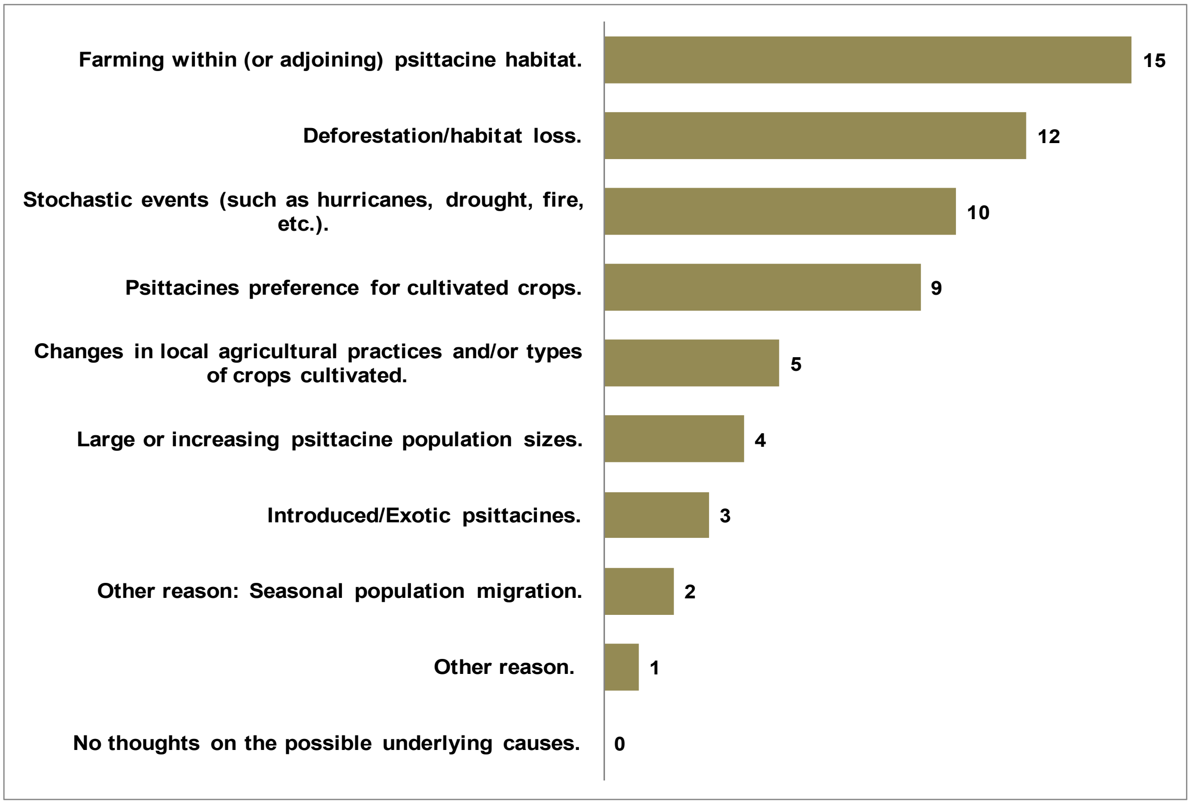

Figure 2. Responses of 20 Caribbean psittacine conservation experts about their perceptions of the underlying causes of crop loss attributed to psittacines. At the end of each bar is the number of respondents indicating this cause.

Conservation & Economic Importance

While the experts surveyed noted a lack of basic quantitative data on the quantity and geographic distribution of crop losses, and frequently noted their unfamiliarity with the specifics of the costs related to the crops affected, respondents generally did not perceive the financial losses sustained by (even some) farmers as serious (Figure 3). Only on Tobago, Hispaniola (both Haiti & the Dominican Republic), and Dominica did practitioners consider the financial impacts of psittacine-induced crop losses to be potentially serious. In general, respondents indicated that affected farmers, who attributed both real and perceived crop losses to psittacines, were most likely a small minority of the local farming community and that even for them losses were perceived to be insignificant. Regionally however, respondents largely perceived psittacine-agriculture conflict as an important conservation concern (Figure 4). Only in the islands of Puerto Rico, mainland Cuba, and the Bahamas Islands did respondents not indicate some level of agreement on the importance of the issue for their countries. The islands with the highest levels of agreement on the national conservation importance of psittacine-agriculture conflict were the Cayman Islands, Trinidad and Tobago, St. Lucia, Dominica, the Dominican Republic, and Bonaire. A particularly central factor for the high degree of importance that these practitioners attached to the issue on these islands was the apparent relationship between psittacine-related crop losses and the injury, capture, and hunting of psittacines and the destruction of nesting trees. For example on the islands of Hispaniola and the Cayman Islands the injury, capture, and killing of endemic psittacines was noted as of particular concern. It is reported that each month an estimated 20-25 individuals are brought to the national rescue center (Parque Zoologico Nacional – ZOODOM) because of poaching/hunting, in part within agricultural lands (Jorge Brocca, survey results). On Trinidad and Tobago, however, while psittacine-related crop losses are high, hunting was less of an issue because here the psittacine species predominantly involved in crop loss, the Orange-winged Parrot (*A. amazonica)*, is hunted legally as a crop pest (Bonadie & Bacon 2000).

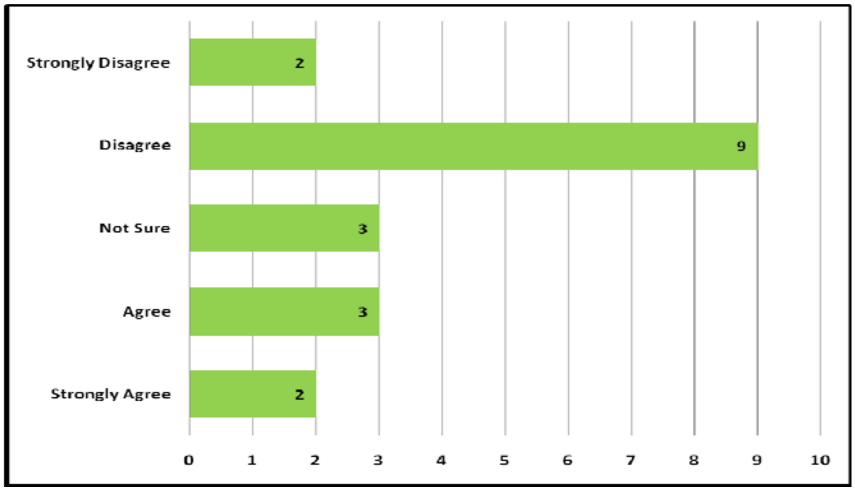

Figure 3: Responses of 20 psittacine conservation experts to the question: Do you agree that these crop losses produce serious financial impacts for some local farmers in some areas?

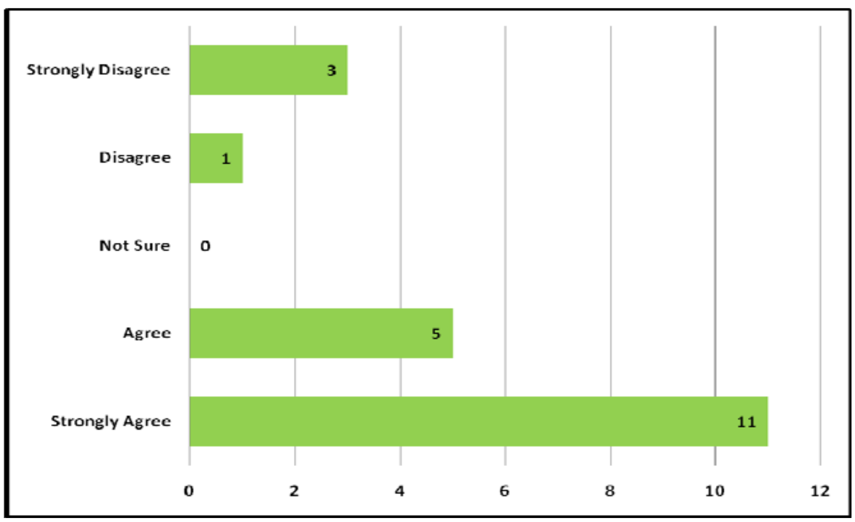

Figure 4: Responses of 20 psittacine conservation experts to the question: Do you agree that human conflict with psittacines is an important conservation concern in your country or territory?

Representation of Psittacine-related Crop Loss in the Media

The local media covered stories on psittacine-agriculture conflict on three island-states, namely the Cayman Islands, Dominica, and Trinidad and Tobago within the last five years. In all of these countries the subject received multiple media features that included news reports, letters to the editor, press releases, and radio talk-show programs (Irish 2009, Joseph 2010, Knight 2008, The Sun Newspaper 2008a, The Sun Newspaper 2008b, CNN 2009, Bodden 2008, Knipp 2009, Herrera 2010, Myers 2006, TCC 2009, Tobago News 2005, Trim 2010). Relative to Dominica and the Cayman Islands the media coverage from Trinidad and Tobago, which focused on the Orange-winged Parrot *(Amazona amazonica*), was minimal. I identified and reviewed five media items from the Cayman Islands including online blog postings associated with the articles, five from Dominica, and two from Trinidad and Tobago. For all media items from both Dominica and the Cayman Islands parrot-related crop losses were the major focus of the media item. For Trinidad and Tobago, however, while parrot-related crop losses were mentioned this was not a major focus of the news items.

On both Dominica and the Cayman Islands different stakeholder groups actively used the media to define parrot induced crop losses and frame the issue for the public.
In both countries parrot-related crop losses were politicized and stakeholders framed the debate within the context of the species as the State symbol of their nation. Non-farmer stakeholders indicated that retaliatory killing of parrots was the destruction of an iconic national treasure and a reflection on the patriotism (or lack thereof) of such offenders. Fruit farmers in both countries alternatively indicated that parrots were overabundant pest species that were unjustifiably protected by State law and noted the irony that it was the nation's symbol independence and identity that had become the source of their anguish. These farmers primarily framed the issue around the overall

economic hardship they experienced which they indicated was now compounded by parrot frugivory of their fruits while elected State officials ignored their pleas.

In one article from the Cayman Islands (CNN 2009) a farmer states:

"The National Trust, and the Department of Environment, are saying that this bird is endangered. But this is just not true. I often see flocks of 50 parrots fly overhead, and now they come all year long. And, each year, I see more and more. People are lying about this, because, for them, it is a political issue. They are worried only about CITES [the Convention on International Trade in Endangered Species of Wild Fauna and Flora]. But for me, and all other farmers, it is our livelihood that is at stake."

In the same article another farmer says:

"I can tell you this, if a poll today asked if we should name the Cayman parrot the 'National Bird' or a 'National Nuisance", 99 percent of the people who did not live in an apartment would call it a nuisance. Because, aside from its beauty, that's exactly what it is." The interviewing reporter notes that the farmer adds that "*a very senior government official has had his own avocado garden ravished by the locust-like parrots, but will not touch on the topic, publicly, because it is too political."*

Additionally, in both countries farmers clearly indicated their need for compensation for crop losses if parrots were to be allowed to survive and coexist with agriculture. A notable component of the media coverage from Dominica between 2008/09 was a legal case brought against the State by one farmer to obtain compensation for crop losses. This case was subsequently dismissed by Dominica's high court on the basis of being without constitutional merit (The Sun Newspaper 2008b). On the Cayman Islands non-farmer stakeholders primarily framed the debate around the continued illegal shooting of parrots by farmers of commercial mango crops indicating that the political power and influence of these commercial farmers prevented the enforcement of existing laws against the taking of parrots. News reports from Trinidad and Tobago were far less emotive. Here media coverage focused on parrots as one of a set of factors that were perceived as producing losses in the agricultural sector, primarily for cacao (*Theobroma sp.*) farmers.

Existing Research

Formal investigations of psittacine-agriculture conflicts in the Caribbean have been preliminary to date at best. Sixteen of 20 respondents noted that they were not aware of any studies of psittacine-agriculture crop losses within their countries. With respect to prior research, there have been three short-term investigations to date. Wiley (1993) conducted a 7-day trip to Dominica to examine reports of citrus fruit loss, meet with stakeholders, and recommend research needs and possible mitigation measures; Berthol (1993) conducted questionnaires to investigate fruit damage produced by a variety of bird species on Tobago; and Voous (1983) reported frugivory within gardens and fields on Bonaire and Margarita Island. At the time of writing of this publication there were currently three projects related to psittacine-agriculture conflict in the region: (1) A. Ramsey – Trinidad and Tobago; (2) D. Parks – Bonaire (Parks 2010); and (3) L. Douglas – Dominica (Chapter 2 - Douglas 2011). On Dominica the most heavily affected farmers experience parrot-related fruit losses of up to 45% of their commercial citrus fruit production each season (Chapter 2 - Douglas 2011). On Bonaire parrot frugivory affected over 50% of total fruits produced in some backyard (subsistence) gardens (Parks 2010). Preliminary inquiries conducted with the managers of commercial citrus orchards on Jamaica indicated that where commercial citrus occurs in the range of native parrots, frugivory was perceived to be not uncommon by farm managers, and shooting was the primary management approach applied when crops of commercial importance were affected (interviews June 2011 – Worthy Park Estate, Clarendon, & Good Hope, Trelawney).

Focus Group

The results of the focus group showed strong agreement with the survey findings. Participants indicated that psittacine-agriculture conflict was among the top three most important psittacine conservation priorities for six of the twelve islands with extant psittacines. These islands were the Cayman Islands, the Isle of Youth (Cuba), Dominica, St. Lucia, Tobago, and Bonaire. St. Vincent and the Dominican Republic also expressed concern about psittacine-agriculture conflict, but this was not a top-3 priority for these island-states at present. Note: only the *Amazona* parrots were discussed during this meeting (Table 1).

Table 1: List of Caribbean island that identified human-parrot conflict among their country's three most important psittacine conservation priorities during the Parrot Working Group session of the 17 biennial meeting of the SCSCB, Antigua, July 15, 2009. (*Abstracted from the minutes of the Parrot Working Group - with modifications to include species conservation status and exclude the psittacine conservation priorities not relevant to the current topic*). * Island endemic species or sub-species. Conservation Status: IUCN Red List (Hilton-Taylor 2000): CR = Critically Endangered, EN = Endangered, VU = Vulnerable, LR = Lower Risk, NT =Near Threatened.

Island	Human-parrot conflict	Species	Conservation Status (from Wiley et al. 2004; Hylton-Taylor 2000)
Cayman	√	A. leucocephala caymanensis* & A. leucocephala hesterna*	LR/NT - Stable
Cuba (mainland)		A. leucocephala leucocephala*	LR/NT - Declining
Cuba (Isle of Youth)	√	A. leucocephala palmarum*	LR/NT - Declining
Bahamas		A. leucocephala bahamensis*	LR/NT common on Great Inagua, threatened on Abaco, extirpated on other islands.
Jamaica		A. agilis* & collaria*	VU – declining
Hispaniola		A. ventralis*	VU - Widespread, locally common but declining rapidly.
Puerto Rico		A. vittata*	CR - Tiny population
Dominica	√	A. imperialis* & arausiaca*	VU - Increasing
St. Lucia	√	A. versicolor*	VU - Increasing
St. Vincent		A. guildingii*	VU - Increasing
Trinidad		A. amazonica	LR
Tobago	√	A. amazonica	LR
Bonaire	√	A. barbadensis	VU - Increasing

Thematic Content Analysis

Of the 60 citations identified from the ISI Web of Knowledge search, only 45 were available either through the libraries of Columbia University or the interlibrary loan system. The remaining 15 were primarily publications that appeared in gazettes, magazines, and organizational bulletins. Of the 45 publications available, 42% or 19 focused either primarily or exclusively on psittacine birds. 48% of the 45 reported on some level of field assessments of crop losses, and 46% of the 45 focused on issues of management and/or mitigation of psittacine-induced losses. Eleven of the identified papers were from the Neotropical region. Of these only three papers included some form of quantitative assessments of crop losses (Higgins 1979; Matuzak et al. 2008; Trivedi et al. 2004). Two of these were on forest trees utilized as food by humans, namely Breadnut (*Brosimum utile*: Moraceae - Higgins 1979) and Brazil nuts (*Bertholletia excels* - Trivedi et al. 2004). One of these two papers (Higgins 1979) was based on observations of a single tree crown over two days. The only study that included frugivory of cultivated crops used the number of feeding observations and feeding bouts to examine the feeding ecology of several species across a range of vegetation types within human-dominated areas with no quantification of actual losses. Only one study (published as a popular magazine article) quantified stakeholder perceptions and attitudes (Rita Perez et al. 2005).

Discussion

Psittacine-agriculture conflict poorly studied in the Neotropics

Despite the diversity of psittacines within the Neotropics and this region's large total land area covered by a continuum of subsistence to large-scale agriculture, studies about psittacine-agriculture interactions are poorly represented in the academic literature. The literature review identified 19 publications in which psittacine-agriculture interactions was a major focus over 40 years. Of these, 15 were published within the academic literature. These studies were overwhelmingly located in Australia, Africa, and within the Indian subcontinent. Most strikingly, in the 20 years since the release of the influential publication *New World Parrots in Crisis: Solutions for Conservation Biology* (Bucher 1992) that highlighted the importance of Neotropical psittacines as agricultural pests, only two articles have documented quantitative study of psittacine-related crop losses in this region (Trivedi et al. 2004, Matuzak et al. 2008). Furthermore, only one of these (Trivedi et al. 2004 – Brazil Nut) had psittacine-agriculture conflict as a major focus even though several studies have mentioned the phenomena. This is despite the concerns of some leading experts who note that conflict: (1) continues to grow (Bucher 1992, Wiley et al. 2004); (2) has produced lax conservation planning in some countries with potentially serious implications for long-term conservation (Forshaw 2006); and (3) includes critically endangered species such as the Lear's Macaw (*Anodorhynchus leari*) (IBAMA 2006).

It is suggested that, overall, research on crop losses attributed to avian species perceived as crop pests is lacking because of the difficulty in obtaining reliable data from which robust conclusions may be drawn (Bomford & Sinclair 2002, Tracy et al. 2007, Saxton 2006). The relative paucity of research may also be a product of the overall history of avian crop loss research. Some authors note that research involving bird-related crop losses has generally been spearheaded by State-led agricultural departments and related organizations, whose traditional focus has been the control and management of agricultural pests and diseases (De Grazio 1989). For this reason existing research might be poorly reported in scholarly and academic literature. The literature review similarly indicates that even in countries such as Argentina and Uruguay, where multiple government and UN/FAO sponsored studies have been conducted, investigations focused on short-term control measures without scholarly research on the ecology of the species perceived as pests within these agro-ecosystems (Bruggers et al. 1998). Most studies from the Neotropical region have been published in non-English institutional documents, bulletins, or technical reports (e.g. dos Santos Neto et al. 2007, see also the list of references in Bruggers et al. 1998). Additionally, the results of consultancy studies have not been shared with the wider conservation community. Forshaw (2006) further notes that for biologists, “when looking at conflicts between parrots and agriculture, attention is often focused unduly on Australia.” Studies of the biological underpinnings and the development and effect of stakeholder conflict about psittacine-agriculture interactions, therefore, appear neglected. Not surprisingly, in the absence of a body of empirical studies, most prominent publications evaluating the threats to Neotropical psittacines have only rarely cited psittacine-agriculture conflict along with the other commonly reported threats that these native psittacines face such as the effect of invasive species, disease, hybridization, genetic isolation, climate perturbation, habitat degradation and loss, hunting, and trade.

Psittacine-Agriculture Conflict in the Caribbean

The results of this investigation strongly indicate that crop losses are of conservation concern across the Caribbean on the vast majority of the island-states with extant psittacine populations, with two notable exceptions, Puerto Rico and Cuba, and a possible third, the Bahamas Islands. Reports from the early 1990s from the Cayman Islands, Dominica, and Tobago, indicate that even 15-20 years ago the phenomenon was present, and of major concern among stakeholders on at least these islands (Bruggers & Harris 1990-1991, Wiley 1993, Christian et al. 1994, Berthol 1993). Recent quantitative assessments on both Dominica and Bonaire indicate that crop losses due to *Amazona* parrot frugivory can be serious for some farmers (Chapter 2 -Douglas 2011, Parks 2010). Additionally the last known psittacine population extinction within the Caribbean is attributed to conflict with agriculture. The population of *A. b. barbadensis* on Aruba was extirpated around 1947 reportedly because of its destruction of millet fields (Voous 1983).

While there are no quantitative data from the majority of the islands, based on the review of expert knowledge and the available literature from the Caribbean region, including news media reports, there is possibly a pattern in psittacine-agriculture conflict in the region. The Greater Antilles (mainland Cuba, Hispaniola, Jamaica, and Puerto Rico) and The Bahamas reported the fewest crop losses attributed to psittacines. Conversely, within the smaller islands of the region, crop losses attributed to psittacines are considered more severe and it is in these islands that local authorities overwhelmingly identify conflict as among their top conservation priorities. It is also among this group that there are more credible indications of stakeholder-stakeholder disputes about psittacine-induced crop losses as reflected in media coverage. I call this latter group of islands Psittacine-Agriculture Conflict Centers (PACCs) (Table 3). Besides their small geographic sizes, Caribbean PACC countries in general appear to share some other important characteristics. These islands disproportionately have parrots as their national bird and State symbol. Notable exceptions are Bonaire and the twin island state Trinidad and Tobago, where the Rufous-vented Chachalaca (*Ortalis ruficauda*), another species perceived as an avian crop pest, is the national bird. Additionally, they disproportionately occur where parrots were used as conservation flagships (Butler 1992, Wiley et al. 2004, see also Table 3 for further details). These patterns suggest a line of inquiry as to whether psittacine-agriculture conflict can at least be partially understood within the Caribbean as a relationship between parrot ecology, cultural symbolism of psittacines, and possibly also island agro-economic systems.

Table 2: Caribbean island-states in which a psittacine is the state symbol and which have participated in national parrot education campaigns.
√ √ √ = strong, most credible indication that this is a PACC country; √√ = moderate indication that this is a PACC country; √ = weak indication that this is a PACC country.

Country	Suggested PACC	National Bird	National Parrot Education Campaign
Cayman Island	√√√	Grand Cayman Parrot	Yes
St. Lucia	√	Saint Lucia Parrot	Yes
St. Vincent	√	St. Vincent Parrot	Yes
Dominica	√√√	Imperial Parrot	Yes
Bahamas		The Flamingo	Yes
Jamaica		Streamer-Tail Hummingbird	No
Trinidad		Scarlet Ibis	No
Tobago	√√√	The Cocrico	No
Cuba (Mainland)		Cuban Trogon	No
Cuba (Isle of Youth)	√	Cuban Trogon	No
Puerto Rico		Bananaquit	Yes
Haiti		Hispaniolan trogon	No
Dominican Republic	√	Palm Chat	No
Bonaire	√√	The Flamingo	Yes

Parrot Ecology, Island ecosystems, and Agriculture

Parrot ecology, the features of island ecosystems, and agricultural production all appear to interact to influence conflict between psittacines and crops. Neotropical psittacines are important canopy frugivores and pre-dispersal seed predators (Francisco et al. 2008, Haugaasen 2008). Farm lands can be very attractive for birds because they frequently provide a concentrated, highly palatable, and reliable source of food (Dhindsa

& Saini 1994, Matuzak et al. 2008). In the Caribbean overall the most commonly reported crops eaten by psittacines are mangoes (*Mangifera indica*) and oranges (*Citrus sp.*). The literature review indicates that psittacine frugivory of citrus was also of concern in Australia, Brazil, Pakistan, Nicaragua, and Argentina (Bomford and Sinclair 2002, Fernandez-Juricic 1999, Marsden 2000, Matuzak et al 2008, Navarro 1991, Tracy 2007, Shafi et al. 1986, Wermundsen 1997). These accounts appear to indicate that psittacine frugivory of citrus fruits is not only common within Caribbean PACCs, but also a relatively common form of agricultural crop loss in many regions experiencing psittacine-agriculture conflict (see also Berthol 1993 & Wiley 1993).

The characteristics of island ecosystems are also important. Caribbean PACCs are among the smaller islands. On small islands, psittacines facing limited ecological diversity and total natural habitat area may be more inclined to be habitat generalists and even more opportunistic relative to their congeners on larger islands or on a mainland (Oliveira et al. 2006, Lack 1976). Avian-related conflicts are most commonly encountered at the forest-farmland interface. At this interface, agricultural land shares most of the characteristics identified for landscapes in which crop damage caused by avian frugivores is overall most severe (Warburton & Perrin 2006, Bucher 1992). These areas bring crops susceptible to wildlife frugivory close to nesting and roosting sites and also close to forest food sources where new, abundant, and predictably available crops may be discovered and readily exploited (see also Figure 2).

The history of Caribbean agriculture is one that has brought psittacines and agriculture in close proximity. Fruit crops are of important subsistence and commercial value within the region and their importance within Caribbean agro-economics has increased within the last few decades. In many of the islands fruit crops were an important part of the post-banana/post-sugarcane agricultural diversification programs, for example on Dominica, St. Lucia, and St. Vincent among others (O.E.C.S 1987, Wiley 1998). Due to growth in the local and international market for traditional and exotic fruit, improvements in storage and transportation of perishable produce, and the demise of many of the historical staple export crops, many Caribbean nations have diversified their agricultural base away from the few traditional plantation crops such as sugarcane, green bananas, and pineapples (Koopman & Pitt 2007, Payne 2006). With these changes Caribbean agro-economies have moved from the extensive plantation or estate-style of farming of the colonial era, towards a sector dominated by small farmers who cultivate crops relatively more susceptible to bird damage. With this change cultivation is predominantly on more marginal interior lands as opposed to the larger plantation agriculture systems that was usually developed on the low-lying, more uniformly deforested coastal areas where there is less edge habitat (Weis 2007, McElroy & Albuquerque 1990). By extension Caribbean agriculture is now present in or adjacent to prime existing psittacine habitats. Where tree crops grown for their fruit or seeds are cultivated along habitat edges where psittacines occur, there is a high probability that psittacine-agriculture conflict will develop if psittacine population numbers are not seriously threatened.

Cultural symbolism of psittacines

Amazona parrots are particularly important iconic symbols of nationhood and cultural identity on islands of the eastern Caribbean with extant psittacines, as well as on the Cayman Islands (Butler 1992, Christian et al. 1994, Christian et al. 1996b). These psittacines are well known locally because in the 1980s and 90s the local governments, in collaboration with international conservation organizations, implemented major educational programs to support local psittacine conservation and established national parks and protected areas using their native parrots as focal flagship species. These programs, implemented on Dominica, St. Lucia, and St. Vincent, the Cayman Islands, The Bahamas, and Puerto Rico, were a vital part of halting and reversing the declining psittacine populations in these states (with the exception of Puerto Rico where that island's *Amazona* parrot has been listed as critically endangered since the 1960s) (Butler 1992, Christian et al. 1994, Christian et al. 1996a, Reillo & Durand 2008).

Given their relatively extensive exposure to parrot-conservation messages, national emblems, and culturally iconic symbolism associated with native psittacines, it is not surprising that the crop losses attributed to psittacines would be perceived as significant and culturally sensitive on these smaller islands. Today, debates about psittacine-induced crop losses have entered the public discourse on some islands by way of the local news media, particularly on the Cayman Islands and Dominica. Here stakeholders debate and frame the issue in ways that highlight the fact that crop losses attributed to local psittacines are not only about the quantity of real crop losses but simultaneously a broader social debate about the symbolic status of parrots as icons of nationhood and their importance, role, and place of within these cultures. In these cultural climates heated stakeholder-stakeholder disputes about both the symbolic and ecological value parrots have flourished. Farmers attempt to link crop losses symbolically to their perception that local governments prioritize nature conservation above the economic survival of local farmers (The Sun Newspaper 2008b, Knipp 2009). Furthermore disaffected farmers are willing to use force by directly killing psittacines or open aggression towards wildlife and forestry professionals. Where these farmers have political influence, permitting them to avoid the legal consequences of killing native psittacines, such as on the Cayman Islands, violent outcomes are largely tolerated (Godbeer 2010). On Dominica, however, where wildlife conservation laws are relatively strictly enforced, the capture and killing of parrots is largely hidden but is not uncommon (Douglas unpublished dissertation results). While parrot populations on the Cayman Islands and Dominica are considered relatively stable, these findings about the illegal taking of psittacines are disquieting because they suggest that if the plight of farmers worsens generally and stakeholder animosity increases, psittacines might suffer even if levels of psittacine frugivory do not increase.

Relationships between conflict, hunting, and trade

Respondents from Cuba, Hispaniola, and Jamaica in this study reported that affected agriculturalists usually do not report the occurrence of crop losses attributed to native psittacines unless specifically queried about their experiences in this regard.

Furthermore respondents indicated that some rural agriculturalists reportedly “welcome” psittacines within agricultural landscapes because of the opportunity that it afforded them to capture and/or kill these species. For example, in the Baracoa municipality of Cuba it is reported that the capture of parrots in agricultural areas was not uncommon to supply the demand for parrots kept in private houses used for tourist (room-for-rent) lodging. Similarly the owners and managers of some commercial citrus orchards on Jamaica readily admitted their personal practices of shooting native psittacines in response to their frugivory. Psittacine-agriculture conflict is therefore connected with the important issues of the illegal taking of birds and the local and international pet trade. One challenge here is the profound difficulty in obtaining quantitative data on the capture, killing, and trade of Neotropical psittacines. Psittacines are sought as game in many Caribbean countries (Miller 2009, Wege & Anadon-Irizarry 2008 – esp. page 297, Douglas unpublished dissertation data from Dominica). Importantly, this may be neither hunting for subsistence nor a direct response to crop losses. Frequently such hunting is by members of the society’s elite who have greater access to ammunition, and who are part of a culture of game hunting for leisure. Such hunting is usually justified on the grounds that the hunted species are perceived as locally overabundant, malicious, and aggressive “crop pests” (survey results from Jamaica & Dominica, Douglas unpublished data from Dominica, Miller 2009). Psittacine-agriculture conflict might therefore be particularly insidious and poorly recognized because its characteristic components are part of the traditionally reported underlying causes of psittacine endangerment, namely hunting/overharvesting, and the local and international pet trade. Improving psittacine conservation in the presence of conflict will therefore require more informed targeted approaches in conflict identification, study, and mitigation.

On some islands the taking of psittacines listed as pests is legal. The Orange-winged Parrot (*A. amazonica)* of Trinidad and Tobago and the Olive-throated Parakeet (*A. nana*) of Jamaica are legally taken as a crop pest (Bonadie & Bacon 2000, Wiley et al. 2004). On Tobago parrot population management through culling and hatchling removal is State-led (Ramsey 2009). On Jamaica private citizens may apply for permits to take parakeets. However, biologists believe that permits are rarely sought relative to the number of parakeets killed or captured and that the management of parakeets is also applied to the protected *Amazona* species.

Caribbean Parakeets

Caribbean parakeets are also sources of conflict. Today native parakeets are found only on three islands of the Neotropical Caribbean sub region, all within the Greater Antilles, namely Cuba (*Aratinga euops*), Hispaniola (*A. chloroptera*), and Jamaica (*A. nana*). Six of nine native parakeet species of this region became extinct, including all present within the Lesser Antilles, over the last 500 years. The Amazonian Caribbean sub region has one extant species (*A. pertinax*) (Harms and Eberhard 2003). Species of *Aratinga* have not been featured as State symbols or as flagship species. Additionally, despite a history of rapid decline and extinction regionally for this group, there is a strong tradition of research, conservation, and public education focus towards the

Amazona psittacines, relative to *Aratinga* species. It is not particularly surprising, therefore, that despite the illegal population management of *Aratinga* species as crop pests on Cuba, Hispaniola, and Jamaica over recorded history (Wiley et al. 2004, Latta et al. 2006, Raffaele et al. 1998) psittacine-agriculture conflict involving *Aratinga* species has garnered relatively little public interest or conservation focus. This is also evident among some questionnaire respondents. Respondents working in countries with native *Aratinga* species generally discussed crop losses associated with the *Amazona* parrots only. Similarly members of the 2009 focus group meeting focused exclusively on the parrots. Caribbean parakeets are persecuted as crop pests throughout their current ranges and commonly captured in agricultural areas. Correspondingly survey respondent (and Jamaican parrot biologist) Susan Koenig notes that given their history of vulnerability to extinction it is imperative that greater conservation interest be focused on parakeets to prevent them “slipping through the cracks” with ongoing human persecution.

Caribbean parakeets therefore provide an indication of the potentially powerful effect of the divergent value-oriented attitudes of both conservation experts and the public on psittacine species protection and also on whether people will complain about parrot-related losses. People will publicly debate wildlife topics and issues that they perceive as important and of significant cultural resonance (Wilson & Tisdell 2007). Therefore, an absence of crop damage reports to local conservation agencies or the local news media can be an erroneous indicator of the prevalence of actual crop losses. Alternatively a lack of reports and media coverage might reflect broad-based ignorance of the conservation importance of psittacines, a lack of awareness and regard for wildlife regulations, and/or and a lack of cultural importance of these species. By extension it is impractical to conclude that real crop losses and the retaliatory taking of psittacines are in fact more severe only where reports and social debate are most intense. Citrus growers on Jamaica indicate that parrots are just another orchard pest to be managed and see no benefit of alerting authorities about the issue. Similarly Parks (2010) notes that crop losses on Bonaire had garnered no media attention even though the field research indicated that losses could be extensive for some residents.

Conclusion & Recommendations

Much remains unknown, even at the most basic level, about the exact nature and extent of psittacine-related crop losses within the Caribbean region. While the knowledge and experience of regional experts provide invaluable insights towards a greater understanding of the phenomenon, in the absence of a quantitative study there are restrictions on the ability of these experts to provide detailed accounts. Indeed, local conservation experts are stakeholders themselves, and by extension (possibly unconsciously) participants within cultural debates and disputes about the importance, patterns, and implications of psittacine birds as crop frugivores. Local farmers facing psittacine frugivory frequently suggest that wildlife conservation scientists are either unaware or insensitive to the crop losses they experience (Conover & Decker 1991, Bucher 1992). Perceptions of conservation experts as biased and unsympathetic can also catalyze resentment and disagreement, and enhance conflict. These perceptions can easily form where psittacines are actively promoted by the State and conservation community as cherished national symbols and iconic conservation flagships. Social conflicts about psittacines may also be particularly difficult for conservation practitioners to engage with because local farming communities may disproportionately identify psittacines relative to other common causes of fruit loss due to their relatively large vocal presence and distinctive crop damage patterns. Avian-agriculture conflict experts therefore note that it is not possible to discuss objectively real or perceived psittacine-induced crop losses without concurrently understanding crop losses produced by other sources, including those caused by some song birds and rodents (such as rats) which are usually more numerous and widely distributed (Bomford & Sinclair 2002, Fleming et al. 2002). Furthermore local wildlife officers are not usually trained in conflict mitigation and frequently find themselves unprepared to engage with the public when protected wildlife becomes unpopular.

Monitoring and early conflict mitigation interventions to address crop damage and inter-stakeholder group disputes about real or perceived psittacine-related crop losses are however important. These can be critical because where inter-stakeholder group disputes are protracted they can foster entrenched feelings of hostility towards wildlife, their habitats, and the organizations that work to conserve them. Mistrust makes it more difficult to agree on mitigation measures in the longer term. Both the Cayman Islands and Dominica cases illustrate the real dangers of how parrot-agriculture conflict can become linked to broader economic concerns, cultural identity, and politically sensitive debates, potentially making discussions passionate and more challenging to gain the confidence and cooperation local stakeholders embroiled in conflict. This study indicates that even on those islands where there are very few reports of conflict the taking of psittacines in agricultural landscapes and in relation to real or perceived crop losses appears common. Correspondingly, with the exception of Puerto Rico and Cuba, parrot conservation survey respondents from every Caribbean country with extant species indicate that they would recommend that a quantitative investigation of crop loss attributed to psittacines be conducted in their country. While working to manage real crop losses, parrot conservation scientists must take the lead in framing the debate about psittacine-agriculture conflicts as they emerge. Alternatively, with the help of the media, even just a few disenfranchised stakeholders can dominate and control the discourse and significantly influence public perceptions towards parrots and their conservation.

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Appendix 1: Online Questionnaire

Dear member of the Caribbean parrot research/conservation community. Thank you for taking time to complete this short (twelve questions) online survey. The survey is about Caribbean psittacines and crop loss/damage. Your contribution to this useful exercise will be graciously acknowledged. Kindly contact Leo Douglas at lrd2107@columbia.edu should you desire additional information.

DIRECTIONS: If you work in more than one country (or territory) please fill out a separate questionnaire for each country (or territory) in which you work. If this is not possible, kindly complete the questionnaire for the countries (or territories) of greatest concern.

1. Do you agree that in this country currently, some type of psittacine causes some sort of crop loss/damage?

Yes □ No □ Not Sure □

If No, in your professional experience, has there been crop loss/damage from psittacines in the last 50 years?

Yes □ No □ Not Sure □

2. Do you agree that in this country currently, it is a common belief among some farmers that some type of psittacine causes some sort of crop loss/damage?

Yes □ No □ Not Sure □

If yes, in your experience, what species of psittacines are implicated in crop loss/damage?

___

3. In your professional experience, what kinds of cultivated fruit crops are reported damaged by these species?

□ Oranges/Tangerines (*Citrus sp.)*

□ Grapefruits (*Citrus sp.)*

□ Bananas/plantains (*Musa sp*.)

□ Mangos (*Mangifera sp*.)

□ Passion-fruit (*Passiflora sp*.)

□ Papayas (*Carica sp*.)

□ Cacao/Cocoa (*Theobroma sp*.)

□ Guava (*Psidium sp.)*

□ Tomatoes (*Solanum sp.)*

□ Grapes (*Vitis sp.)*

□ Peppers (*Capsicum sp*.)

□ Corn (*Zea sp.)*

□ Other crops

□ Don’t Know

Please specify any other damaged crops that were not listed above here:

____

4. Do you agree that these crop losses produce serious financial impacts for some local farmers in some areas?

□ strongly agree □ agree □ not sure □ disagree □ strongly disagree

As it relates to question # 4, what are your thoughts on seriousness of the issue?

____

5. In your professional experience, how often do you hear of farmers complaining to the relevant government agencies in charge of biodiversity conservation and/or agriculture about crop loss due to psittacines?

□ Often □ Occasionally □ Very Rarely □ Never at all

6. How often do you hear of reports of the killing or injury of psittacines because of the crop loss/damage (real or presumed) they produce?

□ Often □ Occasionally □ Very Rarely □ Never at all

7. To date, has there been at least one study of crop loss/damage due to psittacines in this country?

Yes □ No □ Study Incomplete □

If Yes, do you have a reference for any publications that were produced based on the study (including government reports)? ______________________________________

If No, would you recommend that there be such a study in your country or territory?

Yes □ No □ Not Sure □

8. Do you agree that human conflict with psittacines is an important conservation concern in your country or territory?

□ strongly agree □ agree □ not sure □ disagree □ strongly disagree

9. In the last five years has there been at least one item in the local news media about damage caused by some species of psittacine.

Yes □ No □ Not Sure □

10. Based on your professional experience, what would you say might be possible determinants of crop loss/damage by psittacine based on the reasons listed below (if any)?

□ Increasing psittacine population size.

□ Deforestation/habitat loss.

□ Farming close to, or within psittacine habitat.

□ Changes in local agricultural practices and/or crops cultivated.

□ Changes in habitat use by the psittacines.

□ Stochastic events (such as hurricanes, severe drought, fire etc).

□ Psittacines prefer to eat cultivated fruits.

□ Other

Kindly specify any other possible reasons:

____

11. In your professional experience, do you agree that some type of land use or farming practice advocated by conservation agencies in your country for buffer zone areas has facilitated crop damage by psittacines?

□ strongly agree □ agree □ not sure □ disagree □ strongly disagree

If you agreed kindly provide further information:

____

12. Please use this space to provide any other comments.

Consent Agreement:

□ I agree to have my name shared and printed in any publication that might result from this survey.

□ I agree to have my name and contact information shared and printed in any publication that might result from this survey.

□ I would like to remain an anonymous participant in this survey.

Appendix 2: Literature Review Methods

I reviewed documents accessible through the world-wide web databases: ISI Web of Knowledge. The objective of my research was a 40-year review of the subject. I therefore restricted my search to the period 1970 – August 2010. Furthermore, given the paucity of records older 1970, this cutoff point appeared sensible. Only English-language documents were selected for the review. I searched topics, titles, abstracts, and key words for the words: (parrot*, or parakeet*, or psittacine*, or psittacid*) in conjunction with the words and phrases: (pest*, "crop damage*"; agriculture*; conflict*; "human-wildlife conflict*"; "non-timber forest product*"; "human-dominated landscape*"; "modified landscape*"; "seed pred*"), but not including the words: ("coral reef*" or "reef*" or "coral fish*").

Using these search terms I obtained 224 possible records in ISI Web of Knowledge. All publications that did not discuss information related to unfavorable interactions, from a human perspective, between psittacines and plants in which humans had some economic, aesthetic, or cultural interest were excluded from the review. Therefore I excluded those publications that, for example, discussed avian feeding ecology of forest trees not used in agro forestry, non-timber forest products, and other agronomic human interests. Additionally all documents where the text discussed only: (1) the desired values of psittacines from a human perspective; (2) the human impacts on habitat size, quality, or suitability for psittacines; (3) parrots as nuisance species, such as the construction of nests on electrical installations, were also excluded from the review. Sixty papers met these criteria.

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Selecting for conflict? Citrus crop loss and fruit selection by Red-necked Parrots (*Amazona arausiaca*) on the island of Dominica.

Abstract:

Frugivory by the island endemic parrot, *Amazona arausiaca*, is a cause of citrus fruit loss and a focal point of conflict on the island of Dominica. In this field study, I investigated the importance of *A*. *arausiaca* as a cause of citrus crop loss on a national scale relative to other causes of loss. I also investigated the factors that determine the selection of some citrus varieties above others. I collected data on the quantity of fruit loss, individual fruit characteristics, tree height, and whether trees were shaded or grew in full sunlight. Finally, to better understand how fruit selection patterns influenced perceptions of crop loss, I examined land use, gathered citrus market price data, and conducted structured questionnaires with local stakeholders. The results indicate that both landscape and farm-level factors influenced parrot fruit selection. At the national level, citrus crop loss was related to the known distribution and relative density of parrots within forested areas. At the farm level, frugivory was density-dependent and correlated with variety-specific qualities related to nutrient characteristics. These characteristics were also influenced by whether the fruits were grown in shaded areas or in full sunlight. Frugivory was primarily on Valencia oranges. This fruit selection pattern favors the development of conflict with citrus farmers because Valencia oranges are the most profitable and culturally-favored variety of citrus. Additionally, perceptions of crop damage were enhanced because parrots disproportionately targeted trees that were generally closest to the areas where farm activities were concentrated.

Key Words: feeding ecology, density-dependent foraging, citrus, *Amazona arausiaca*, Dominica, human-wildlife conflict, agro-ecosystems, economic impact, crop damage, conservation.

Introduction

Psittacines are members of a large avian family in which approximately a third of the species are threatened with extinction, and within which the rates of species extinction are exceptionally high (Collar 2000; Forshaw 2006). Neotropical psittacines are canopy frugivores. Their diet consists primarily of seeds that they consume during the pre-dispersal fruit stage within the crowns of trees as well as varying amounts of fruit pulp and flowers (Francisco et al. 2008; Galetti and Rodrigues 1992; Haugaasen 2008; Renton 2001). Overall, the feeding ecology of psittacine birds is poorly investigated with no diet information for over 75% of recognized species (Haugaasen 2008; Ragusa-Netto 2007; Renton 2001). Understanding the feeding ecology of the group is an essential component of their conservation because food preferences influence habitat selection and use. In turn, such use has important implications for the exposure of psittacines to threats, such as human-wildlife conflict, hunting, and retaliatory killing, among other forms of population management regimes where food preferences encourage some species to utilize food resources of interest to humans. Cultivated fruits and seeds are sometimes attractive to psittacines and other wild animals because crops consumed by humans are usually of relatively high nutrient content and palatability compared to uncultivated food sources (Avery 2002; Naughton-Treves et al. 1998). Psittacines sometimes exhibit food preferences that include both cultivated crops and non-timber forest products gathered by humans. As a result, several species of psittacines are currently perceived as pests of agriculture, particularly within the Australian and Neotropical eco-regions (Forshaw 2006, Bucher 1992). While these concerns have catalyzed research on species ecology, phylogenetic systematics, population distribution, and threat status of several species in the Australian region (Doneley 2003; Fleming et al. 2002; Forshaw 2006), peer-reviewed research is largely lacking within the Neotropics (Matuzak et al. 2008; Wiley et al. 2004). The results of a literature review revealed that only two studies from the Neotropics available through the scientific citation index Web of Science involved any type of structured quantitative assessment of cultivated crop loss due to psittacines (specifically: Matuzak et al. 2008; Trivedi et al. 2004).

Conflicts involving psittacines of conservation interest are of growing concern throughout the Neotropics (Bucher 1992; dos Santos Neto and Gomes 2007; Forshaw 2006; Matuzak et al. 2008; Trivedi et al. 2004; Wiley et al. 2004). Such conflicts have already produced serious conservation outcomes. For instance, practitioners have noted that the perception of psittacines as pests has fostered controversial management policies such as the mass export of live birds and state-sanctioned population control using lethal methods in some countries (Forshaw 2006). Such conflicts also encourage the development of stakeholder animosity toward broader psittacine conservation and conservation practitioners, and can threaten support for biodiversity and protected area conservation. Several researchers have therefore urged greater focus on both the root causes and implications of psittacines as sources of conflict (Bucher 1992; Forshaw 2006; Raffaele et al. 1998; Wiley et al. 2004).

The study of animal feeding ecology can inform management interventions toward mitigating losses and reducing conflicts (Amano et al. 2004; Sitati et al. 2005). In general, animals preferentially select feeding areas and specific food items based upon the costs and benefits of nutrient and energy intake (Cody 1985). They therefore preferentially forage where food is most predictable, abundant, and easy to access. Once within these areas, wildlife generally focus on that subset of the available resources that maximizes their nutritional requirements while minimizing acquisition costs, among other risks such as predation (Galetti and Rodrigues 1992; Kunz and Linsenmair 2007; Pepper et al. 2000). Previous studies indicate that the selection of fruits and seed by psittacines is not random but determined by such factors as (1) nutritional content and/or protein to calorie ratio; (2) digestibility; (3) handling time; (4) tree height or size; and (5) total number of fruits (Francisco et al. 2008; Pepper et al. 2000; Villasenor-Sanchez et al. 2010)

Unfortunately, where conflicts involving real or perceived psittacine-induced crop losses exist, there is almost always not only an absence of research designed to decipher the ecological underpinnings, but also an absence of systematic studies of the associated agro-economic costs, human attitudes, and agricultural practices involved. How and why people come to perceive the interactions between themselves and wild animals as unfavorable is a social process (Herda-Rapp and Goedeke 2005). To best inform conservation, researchers therefore also need to examine the human dimensions of wildlife and the agricultural context within which these conflicts develop. In the absence of such integrated studies it is difficult to assess the relative importance of psittacine-induced losses objectively, understand and evaluate the claims of stakeholders, and achieve sustainable conflict management (Ogra 2009; Peterson et al. 2002; Wiley et al. 2004).

In this study I examined the feeding ecology of the Red-necked Parrot (*Amazona arausiaca*) and assessed the importance of the species as a source of citrus crop loss relative to other causes of loss, including damage caused by several species of passerine birds (Wiley 1993), on the island of Dominica. I investigated the factors that determine the selection of some citrus varieties above others by parrots, relative to the selection displayed by the other avian frugivores within the landscape. I also quantified the knowledge, attitudes, and practices of affected farmers as these related to local farming culture, citrus cultivation and sale, and perceptions about the quantity of farm-level crop losses using social science research techniques.

Study Context

Dominica is an island within the Lesser Antilles of the Eastern Caribbean with an area of 751 km^2. This island is 46.7 km long, 25.7 km at its widest, and rises to a height of almost 1,450 m. Approximately 65% of Dominica is forested (over 51,800 ha) and 21% of the island is included within a national system of protected areas (Reillo et al. 2002; Wiley et al. 2004). The island has two endemic parrots, the Imperial Parrot (*A.*

imperialis) and the Red-necked Parrot (*A. arausiaca*). The Imperial Parrot is listed as endangered and the Red-necked Parrot as vulnerable by the International Union for Conservation of Nature (IUCN) (Forshaw 2006; Reillo and Durand 2008). Crop losses attributed to the latter species have been a source of ongoing conflict on Dominica since the early 1990s (Christian et al. 1994; James et al. 2005; Wiley 1993). Since that period, *A. arausiaca*, which generally occurs at lower elevations and which is more tolerant of degraded habitat relative to *A. imperialis*, is increasingly implicated as a crop pest of citrus and other cultivated fruits. Biologists estimate that there are approximately 650-800 individuals of this species on Dominica (Reillo and Durand 2008).

A. arausiaca and the citrus orchards of Dominica are particularly suitable for research that seeks to assess the importance of avian frugivores quantitatively and explore the relationship between avian crop loss and fruit selection. Citrus varieties produce relatively short trees, their fruits are large and conspicuous, and, within citrus orchards, trees are generally evenly spaced at a density of no greater than 70 trees per acre. Counting fruits attached to individual trees and finding fallen fruit or fruit fragments on the ground derived from individual trees is therefore relatively straightforward. Additionally, unlike some other types of fruits, the tough, leathery pericarp of hesperidium berries (including *Citrus*) clearly retains the mandibular imprint of frugivores, permitting animal frugivory to be distinguished from other forms of fruit damage. On the part of the parrots, only one of the two psittacine species on Dominica is known to produce citrus fruit loss and psittacine bite marks are distinctive relative to the frugivory pattern produced by mammals and other birds within the citrus landscape.

The latter group is composed of several species within four Passeriformes families: Mimidae, Thraupidae, Emberizidae, and Coerebidae.

Agriculture on Dominica is dominated by small holdings or “garden-farms” of just a few acres (Jno. Lewis 1997; McElroy and DeAlbuquerque 1990). In 1995, when the last comprehensive assessment of agriculture was conducted on the island, the average farm size was 5.7 acres and experts believe that farm size on the island has decreased annually since then (GOV 2006). In 1996, it was estimated that there were more than 1,500 commercial citrus farmers, and that approximately 5,400 acres of land was covered by an estimated 334,700 citrus trees (Jno. Lewis 1997). Dominican farmers simultaneously cultivate multiple varieties of citrus for commercial sale. The four dominant varieties cultivated are: grapefruits (*Citrus paradisi*), Valencia oranges [*C. sinensis* (L.) Osbeck, cv], Ortanique oranges (*C.s.* x *C. reticulata* Blanco), and Washington Navel (also called Grafted or Seedless) oranges [*Citrus sinensis* (L.) Osbeck, cv]. Other types of citrus such as limes (*Citrus aurantifolia*) are also grown, but their wide-scale commercial production is relatively uncommon compared to that of oranges and grapefruits.

Affected farmers on Dominica complain about the economic burden they experience due to parrot frugivory, and beginning in 2008, one farmer with the support of others mounted a legal case in the local courts seeking financial compensation from the State for parrot damages to his citrus crops (Knight 2008; SUN 2008a, b). Farmers have also used the media to frame the issue and call for compensation for crop damage. These disputes have included threats of potential violence such as the shooting of parrots and personal threats directed at the staff of the Division of Forestry Wildlife and Parks (Irish 2009). While the state of conflict surrounding parrot-induced crop losses is considered serious, the current situation on Dominica is one of complete absence of empirical data on either the extent or severity of the (real or perceived) economic losses, the pattern and ecological mechanism of parrot frugivory within agricultural landscapes, or the process by which such frugivory has fostered animosity towards parrots (Wiley 1993; Wiley et al. 2004). It was my aim to address this information gap guided by the following research questions:

1. What are the most important causes of citrus fruit loss on Dominica, and what proportion is due to parrot frugivory?
2. Does the distribution of parrot frugivory vary geographically across the island?
3. Among the most commonly cultivated citrus varieties, are there significant differences in the amount of frugivory produced by parrots and passerine birds? If yes, what best explains these differences?
4. Do parrot fruit selection patterns influence farmer perceptions about crop loss and parrots as pests? If so, how?

Methods:

Study Sites

I chose 17 geographically dispersed citrus farms across the citrus growing areas of Dominica (Figure 1). Farms were not selected based on prior knowledge of each farm's experience with parrot-induced crop losses. Rather, farms were selected in a way that provided a relatively even and representative geographic coverage of the island and its citrus-producing areas. All farm sites were within the tropical rainforest belt where the vast majority of citrus is cultivated. With one exception, all farms immediately adjoined old growth secondary or climax forest in which native forest tree species such as Chatannyé (*Sloanea spp.*), Maho kochon (*Sterculia caribaea*), Gommier (*Dacryodes excels*), and Bwa Dyab (*Licania ternatensis*) were common. In the case of the one exception, this farm was separated from the forest by a distance of approximately 250 m by intervening citrus farms not included in the study. I also standardized my data collection sites so that they did not adjoin or approach either a primary or secondary vehicular roadway to minimize the potential influence of vehicular traffic on bird behavior. All these farms were also bordered by narrow forest corridors used as wind-breaks, composed of mature rainforest canopy tree species, on the margins not directly abutting the forest. The crowns of these trees commonly rise to approximately 30 m, with emergent trees reaching 50 m. These wind-break trees were particularly encouraged as an agricultural practice during the last half-century during which the economy of Dominica was overwhelmingly dependent on the export of bananas (Evans 1986a; Payne 2008), a plant that is highly susceptible to wind damage, especially during the annual tropical cyclone season. I did not sample abandoned or semiabandoned farm sites where the owner was not seeking annual sale for the citrus crops, or orchards where the land gradient would not allow fallen fruit to remain beneath the trees from which they fell. I monitored 13 of these farms in season 1 (November 2008 – April 2009) and nine farms during season 2 (October 2009 – April 2010). Citrus fruit maturity and harvest are at their peak on Dominica between November and March each year.

Crop Loss Assessments

I selected 255 sample trees (15 per farm) across the 17 farms included in the study using a random sampling approach, guided by a table of random numbers. I identified the citrus variety of each sample tree as a Valencia, Ortanique, Seedless orange, or grapefruit and labeled it with a unique number inscribed on an aluminum tag. For the analysis of geographic variation in frugivory levels I grouped the 17 sample farms according to the seven agricultural regions delineated by the Ministry of Agriculture. Two of these regions, the eastern (or Kalinago Territory), and south-eastern agricultural regions, have historically not grown citrus on a large commercial scale. Currently, neither of these regions has commercial citrus holdings. The 17 sample sites are therefore within the remaining five agricultural regions. I grouped the sites into sets of three or four, largely guided by these pre-existing agricultural zones, to form five groups (Figure 1).

I quantified the standing fruit crop by visually counting the total number of fruits on each tree. At the start of each season, I cleared the ground area under and around each study tree to remove any existing fruit or fruit fragments. Over the duration of each season, I then visited each farm and sampled trees once per week and inspected the ground area immediately under it to quantify the total number of: (1) parrot-eaten fruits; (2) parrot-picked fruits that were uneaten and otherwise undamaged (distinguishable by chew-marks through the peduncle); (3) passerine-eaten fruits; (4) fruit loss due to disease or damage by an animal that was not a parrot or passerine bird; and (5) un-eaten fruit on the ground due to natural fruit droppage (including high winds and senescence due to over-maturity) or for other reasons that were undeterminable based on fruit condition at the time of the survey.

I made 5,730 data collection visits to the 255 citrus survey trees over a period of 10 months and two harvest seasons. During this period, I collected, carefully examined, and confirmed the cause of crop loss of 41,238 citrus fruits. All fruits assessed in this way were collected and removed from the study area at the end of each farm visit to prevent recounting them during subsequent survey periods.

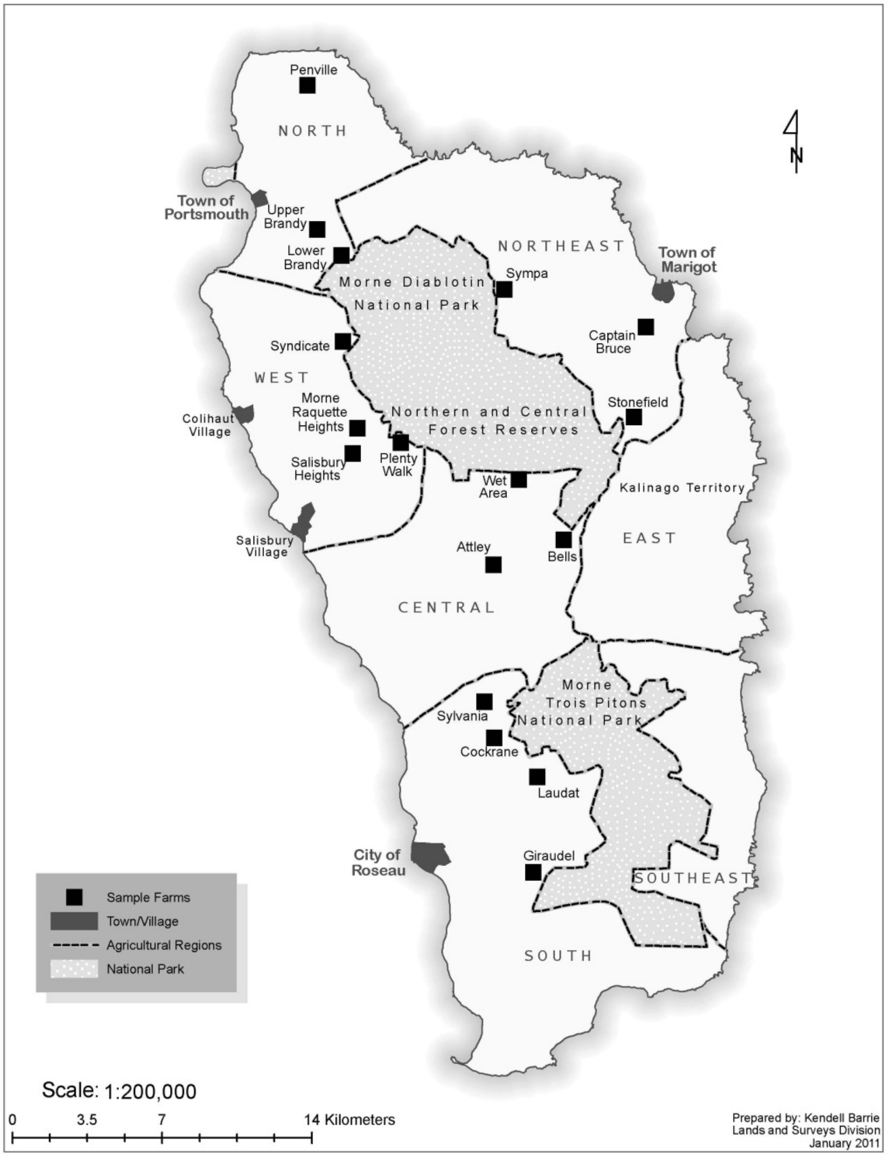

Figure 1: Map of the island of Dominica showing the 17 farm sites in five agricultural regions.

Fruit Quality Assessments

To relate the fruit characteristics of the four commonly-cultivated citrus varieties with data on the frugivory levels of parrots and passerine birds, I gathered data during the second season of field research from three of the farms that experienced the most significant parrot-induced crop losses in the first data collection season. On each of these three farms, I collected a minimum of 20 fruits from each of the four citrus varieties during early January and again in late March 2010. I used a pole to collect up to three fruits from no less than seven trees of each variety within each orchard using a nearest-neighbor method. I selected a subset of the 15 sample trees and then found the nearest neighbor of each of the four varieties. If the nearest neighboring tree was empty, I selected the next nearest tree until I obtained or exceeded my target number of fruits. I selected the highest fruits present within the crowns of each tree to represent the fruits that parrots would most likely eat. I chose 13 variables for analysis based on personal observations of *A. arausiaca* frugivory and previous studies that successfully used related parameters to understand fruit selection in psittacine birds (e.g. Pepper et al. 2000)

I measured and recorded data on the following 13 variables:

1. Fruit mass (g): measured using a portable digital scale to the nearest 0.1 g.
2. Fruit depth (mm): peduncle to apex, measured using a digital 12-inch caliper.
3. Fruit width (mm): equatorial diameter, measured using a digital 12-inch caliper.
4. Pericarp thickness of fruits cut along the equatorial diameter (mm). This measurement was collected at three points around the fruit at approximately 33 degree angles to each other. Measured using a digital 12-inch caliper.
5. Fruit ripeness based on pericarp color – graded on a scale from: 1 (very green) to 8 (over ripe).
6. Total number of seeds with visibly developed cotyledons.

7. Seed wet weight (g): measured using a portable digital scale to the nearest 0.1 g.
8. Soluble sugar concentration within the juice (°Brix: measured using a Extech RF15 0-32% Brix Portable Automatic Temperature Compensation Sucrose Refractometer, Extech Instruments Corporation, Waltham, Massachusetts, USA). Standardized using deionized H_2O.
9. Juice taste, taken as a subjective measure of the citric acid content – graded on a scale of 1 (very sour) to 7 (very sweet).
10. Mean mass of all seeds in the fruit.
11. Seed-fruit mass ratio
12. Sun-grown fruit vs. shade-grown fruit
13. Collection period (January 2010 vs. March 2010)

I measured the total number of seeds and seed wet weight by squeezing each fruit into a strainer. After checking to ensure that all the seeds were removed from the fruit, I subsequently washed all seeds present in the strainer using a steady stream of room-temperature water (approximately 25 °C), counted them, and after they were allowed to drain and air-dry, I then weighed them on a portable digital scale to the nearest 0.1 g. I calculated mean seed mass per fruit by dividing the total seed mass of each fruit by the total number of seeds. I calculated the ratio of seed to fruit mass or 'seed-fruit mass ratio' by dividing seed weight by fruit mass. On two of the three farms selected to measure fruit quality, I also collected citrus fruits from randomly selected trees growing immediately in the shadow of the windbreak forest trees along the periphery of the farms (within 25 m of the windbreak, the cut-off for shade-grown fruit). I compared the fruit quality variables of these fruits ("shade-grown") with those collected from trees away from the windbreak ("sun-grown"). I used a principal component analysis (PCA) to identify correlated groups of fruit characteristics, reduce the total number of variables, and determine which principal components accounted for most of the variance in the fruit characteristic data.

Tree Height

I measured the height (to the nearest cm) of all 15 sample trees from the 3 farms used in the fruit quality assessment study using an extendable pole and later tested the significance of tree height.

Social Science Research Methods

I pursued a mixed methods approach to data gathering, combining both quantitative and qualitative social science methods to examine the attitudes of citrus farmers towards parrot-induced crop losses. I conducted 107 structured (fixed-choice) interviews with citrus farmers to understand for how long, during what time of the year, and what crops were perceived to be affected by *A. arausiaca* frugivory. I conducted 62 semi-structured interviews to understand which citrus varieties were most profitable for farmers and for what reasons. To establish a good correspondence between the research questions and research subjects, I used a purposive (or stratified) sampling approach (Bryman 2004) identifying the respondents by visiting farming areas and contacting farmers directly regarding their participation in the study. While living in Dublanc village, close to the largest citrus-producing area of the island for 13 months, I also accompanied farmers on their farms, observed their practices, use of their farming space, and frequently returned to respondents to probe specific issues using follow-up questions at both the individual and group level.

Dominican farms are frequently divided into smaller plots separated by windbreak trees. I measured the size of each farm plot using a 100 m measuring tape. I calculated farm size using both the size of these individual farm plots and also by pooling all plots for each individual farmer to obtain the total land area under citrus cultivation. Finally, I created land use diagrams for each of the 17 farms and characterized how farmers used their farming spaces including where on the land they established a constructed shelter (farming shed), if they planted other crops such as tubers and vegetables, and where in the farming landscape these activities occurred.

Market Price Surveys

I collected weekly wholesale and retail market price data for Valencia, Seedless, and Ortanique oranges, and grapefruits for 13 months (November 2008 – March 2009) and (October 2009 – May 2010). I collected the wholesale market data from three merchants who purchase and export agricultural produce from Dominica to regional markets. I collected the retail market data from six informal open-air market vendors, three of whom sold citrus in the Roseau market in the south of Dominica and three who sold fruit in the Portsmouth market in the north-west.

Data Analysis

Crop Loss Analysis

I analyzed the crop loss data using a generalized linear model (negative binomial distribution with a log link function and a Type III sum of squares) using SAS software, GENMOD procedure (SAS Institute 2000). While Poisson distributions are widely used for the analysis of count data, a Poisson model resulted in excessive over-dispersion of the current dataset due to the relatively large number of trees and data collection days when there was zero crop loss data to record. This made a negative binomial model a more suitable distribution. I generalized estimating equations for the analysis models. The GEE approach, an extension of generalized linear models, is useful when there are repeated measures or pseudo-replicates across time for the dependent data (Li and Lindsay 1996). The GEE analysis produces parameter estimates, P-values and confidence intervals. I used Wald χ2 tests to assess the significance of variation in the least squares means (LS means) parameter estimates in both univariate and multivariate models. I examined the effect of region, citrus variety, total fruit production, and tree height in these models. Specifically I used the analysis of the effect of total fruit produced on the quantity of frugivory to investigate whether foraging was density-dependent. I tested the goodness-of-fit of the generalized linear model using Pearson's χ^2. I used parrot fruit loss and passerine fruit loss as the dependent variable in these analyses. More positive LS means indicate greater frugivory. Alpha = 0.05 for all tests.

Fruit Characteristics Analysis

As part of the GEE analysis, I used a z-test to assess the significance of all continuous variable parameter estimates of citrus fruits in explaining variation in frugivory patterns. For categorical explanatory variables predicting fruit loss, I used a Wald $\chi 2$ test. I controlled for the total amount of fruits on each tree in these analyses.

Social Science Data Analysis

I used descriptive statistics to analyze the data from the structured questionnaires and market surveys and a Pearson (two-tailed) correlation to examine the relationship between fixed choice answers about the profitability of different citrus varieties and coded unstructured answers explaining why these varieties were considered relatively more profitable. I used the SPSS Statistics 17 program to analyze the questionnaire data (SPSS, 2010).

Results

1. *Causes of citrus fruit loss*

Of the 41,238 fruits collected under sample trees, 13,209 (32%) showed clear evidence of parrot frugivory. Another 2,426 (6%) showed obvious signs that they had been picked by parrots but were dropped to the ground uneaten. The remaining fruit loss was primarily due to frugivory by passerine birds (23%), unexplained fruit droppage (26% - sometimes referred to as windfalls in the citrus cultivation literature), primarily in the mid-late citrus season. The remainder of 13% was the product of a variety of causes, but primarily the citrus brown rot fungal disease (caused predominantly by the pathogen *Phytophthora spp*.) (Suls and Martin 2009), frugivory by rats and opossums (*Didelphys marsupialis insularis*), natural fruit splittage, and an unidentified species of nocturnal fruit-piercing moth (Lepidoptera: Noctuidae) (Table 1). These findings were consistent across the two citrus harvesting seasons during which I collected data. These results show that parrots were significantly less likely to account for the majority of citrus fruit losses farmers experienced on a national scale relative to other sources of citrus crop loss (Wald $\chi 2$ = 2409.45, df = 1, $P < 0.0001$).

Table 1: Relative contribution of five different categories of citrus fruit loss in 17 orchards on Dominica.

<table>
<tr><th>Cause of crop loss</th><th>Total Fruits Lost</th><th>Percentage of total fruit loss</th><th>Percentage of fruit production</th><th></th></tr>
<tr><td>Parrot Frugivory</td><td>13,209</td><td>32%</td><td>14.8%</td><td rowspan="2">Parrot-related losses as a percentage of total production = 17.6%</td></tr>
<tr><td>Parrot Picked</td><td>2,426</td><td>6%</td><td>2.7%</td></tr>
<tr><td>Passerine Frugivory</td><td>9,355</td><td>23%</td><td>10.5%</td><td rowspan="4">Non-parrot losses as a percentage of total production = 28.7%</td></tr>
<tr><td>Fruit Droppage</td><td>10,888</td><td>26%</td><td>12.2%</td></tr>
<tr><td>Other causes</td><td>5,360</td><td>13%</td><td>6.0%</td></tr>
<tr><td>Total:</td><td>41,238</td><td>100%</td><td>46%</td></tr>
</table>

2. Geographical variation in parrot frugivory

I analyzed the data to determine whether different agricultural regions experienced comparable levels of crop loss due to parrot frugivory. The results indicate that farms in the eastern region, one of the smallest citrus-producing regions on the island (Jno. Lewis 1997), experienced the most crop losses (Table 2). The western and central regions experienced intermediate levels, while farms within both the northern and southern agricultural zones experienced minimal parrot frugivory.

Table 2: Results of GEE analyses of the variation in the quantity of *A. arausiaca* frugivory sustained by citrus farms in five agricultural regions. More positive ls means indicate greater frugivory.

Agricultural Region	**ls means/log**	**SE**	**Wald χ2**	***P***	**95% CI**
Northern	-1.896	±0.352	29.09	<0.0001	-2.585 – -1.207
Central	-0.227	±0.225	1.01	0.3138	-0.669 – 0.215
Southern	-1.655	±0.413	16.02	<0.0001	-2.467 – -0.844
Western	0.741	±0.206	12.92	<0.0003	0.337 – 1.145
Eastern	1.560	±0.169	85.55	<0.0001	1.229 – 1.890

In pair-wise comparisons of the least squares means for the quantities of parrot frugivory of these regions, the eastern, western, and central regions were all significantly different from each other (Wald $\chi 2$ $P < 0.05$). Citrus frugivory by parrots in the eastern region was twice as high as in the western region, the next most affected region. Farms in the eastern region experienced an average loss of 44.8% of their total citrus fruit production because of a combination of parrot frugivory and fruits dropped by parrots, compared to 18.0% in the western region. Farms within the northern and southern agricultural regions, while statistically different from the other three regions, were not different from each other (northern: 2.6%, southern: 1.7%; $P = 0.6856$). The most northerly farm lost fewer than 20 fruits to parrot frugivory within a season and the most southerly farm experienced no parrot frugivory at all. The importance of parrot frugivory as a source of citrus crop loss therefore varied significantly across agricultural regions.

Detectable passerine frugivory was lowest in the eastern region, where parrot frugivory was highest (Table 3). Conversely passerine frugivory was highest in the north where parrot frugivory was lowest. In a pair-wise comparison of the ls means for the quantities of passerine frugivory across these regions, the eastern region experienced significantly lower levels of frugivory relative to all other regions ($p < 0.05$). There was, however, no significant difference in the amount of passerine fruit frugivory among the remaining four regions ($p > 0.05$).

Table 3: Results of the GEE analysis of the variation in the quantity of passerine frugivory sustained by citrus farms divided into 5 agricultural regions. More positive ls means indicate greater frugivory.

Agricultural Region	ls means/log	SE	Wald χ2	*P*	95% CI
Northern	0.391	±0.175	5.00	0.0253	0.048 – 0.733
Central	0.282	±0.158	3.18	0.0743	-0.028 – 0.591
Southern	0.175	±0.114	2.35	0.1253	-0.049 – 0.398
Western	0.364	±0.139	6.89	0.0086	0.092 – 0.636
Eastern	-0.765	±0.180	18.15	<0.0001	-1.117 – -0.413

3. *Farm level differences in the amount of frugivory produced by parrots and passerine birds*

In this section, I examine the influence of the following factors on citrus frugivory: (1) citrus variety; (2) the amount of fruit produced by the tree; (3) variety-specific fruit characteristics; (4) tree height; and (5) whether the trees were shaded by wind-break forest trees or not.

i) Influence of citrus variety.

I compared the parrot frugivory pattern among the four most commonly cultivated citrus varieties while controlling for the total amount of fruits produced per tree (Table 4). The results indicate that *A. arausiaca* frugivory was mostly on Valencia and Ortanique oranges. Parrots ate Seedless oranges the least. Valencia oranges were eaten in significantly greater quantities than both grapefruit and Seedless oranges (Table 5). While there was a trend towards an overall preference for the Valencia variety, the difference between the frequency of parrot frugivory of Valencia and Ortanique fruits was not significant.

Table 4: Results of the GEE analysis of the variation in the means of *A. arausiaca* frugivory among four cultivated citrus varieties, controlling for total fruit crop produced by trees.

Variety	ls means/log	SE	Wald χ2	*P*	95% CI
Valencia	1.212	± 0.173	49.22	< 0.0001	0.873 – 1.550
Ortanique	0.767	± 0.346	4.92	0.0266	0.089 – 1.446
Seedless	-1.364	± 0.247	30.49	< 0.0001	-1.849 – -0.880
Grapefruit	0.393	± 0.238	2.72	0.0993	-0.074 – 0.860

Table 5: Results of the GEE analysis comparing the least square means of *A. arausiaca* frugivory among four cultivated citrus varieties.

Variety	Variety	Mean Diff	Wald χ2	*P*
Valencia	Ortanique	0.241	0.36	0.5474
Valencia	Seedless	1.440	21.19	< 0.0001
Valencia	Grapefruit	0.780	5.71	0.0168
Ortanique	Seedless	1.199	7.51	0.0061
Ortanique	Grapefruit	0.539	1.45	0.2293
Seedless	Grapefruit	-0.660	3.14	0.0763

In regions where parrots were a significant cause of citrus fruit loss, these losses disproportionately affected specific varieties. For example, within the eastern region, where crop losses were highest, losses were overwhelmingly concentrated among Valencia oranges.

Figure 2: Parrot frugivory of Valencia Oranges from the eastern agricultural region. Photo taken on November 24, 2009 in Sympa (Woodford Hill Heights), St. Andrew parish. In this example a majority of the fruit of this variety was eaten before the maturation stage necessary for the fresh-fruit market.

Passerine birds had a very different fruit selection pattern relative to parrots (Tables 6 and 7). Ortanique oranges were selected most frequently by this species-group followed by Seedless and then by Valencia oranges. Despite the relatively clear preference for both Ortanique and Seedless oranges, however, all three orange varieties were selected by passerine birds at high rates, while grapefruits were selected significantly less often relative to all three oranges. A comparison of the least square means reveals that there was a significant and strong selection for Ortanique oranges (p <0.001) relative to the other citrus types among passerines.

Table 6: Results of the GEE analysis of the variation in the means of passerine frugivory among four cultivated citrus varieties (df = 1).

Variety	ls means/log	SE	Wald χ2	*P*	95% CI
Valencia	0.543	± 0.119	21.23	< 0.0001	0.312 – 0.774
Ortanique	1.463	± 0.179	66.83	< 0.0001	1.112 – 1.813
Seedless	0.688	± 0.104	44.05	< 0.0001	0.485 – 0.891
Grapefruit	-2.082	± 0.296	49.55	< 0.0001	-2.661 – -1.502

Table 7: Results of the GEE analysis comparing the least squares means of passerine frugivory among four cultivated citrus varieties (df = 1).

Variety	Variety	Mean Diff	Wald χ2	*P*
Valencia	Ortanique	-0.920	18.44	<0.0001
Valencia	Seedless	-0.145	0.86	0.3534
Valencia	Grapefruit	2.624	54.11	<0.0001
Ortanique	Seedless	0.775	14.12	0.0002
Ortanique	Grapefruit	3.544	105.45	<0.0001
Seedless	Grapefruit	2.770	78.03	<0.0001

ii) Influence of the amount of fruit produced by the tree

I first investigated whether different citrus varieties produced significantly different amounts of fruits. There was no significant difference in the amount of fruits that Valencia, Ortanique, or grapefruit trees in this study produced. However, Seedless oranges produced significantly fewer fruits relative to the other two citrus varieties (Tables 8 and 9).

Table 8: Descriptive statistics for the amount of fruit produced by each of the four varieties of citrus. N = number of trees of each variety. Mean = mean number of fruits produced by this variety.

Variety	N	Mean	Std Dev.	Min	Max
Valencia	122	295.4	218.71	0	1050
Ortanique	37	296.1	191.91	26	877
Seedless	75	161.7	144.98	6	592
Grapefruit	91	280.1	256.28	2	1568

Table 9: Results of GEE analyses comparing the least square means of the total amount of fruit produced by each citrus variety (df = 1; Alpha = 0.05).

Variety	**Variety**	**Mean Difference**	**Wald χ2**	***P***
Valencia	Ortanique	-0.0002	0.00	0.9869
Valencia	Seedless	0.6027	21.76	<0.0001
Valencia	Grapefruit	0.0535	0.21	0.6505
Ortanique	Seedless	0.6049	15.00	0.0001
Ortanique	Grapefruit	0.0557	0.15	0.7016
Seedless	Grapefruit	-0.5493	15.60	<0.0001

There was a strong and positive density-dependent effect for both Valencia and Ortanique orange varieties; i.e., parrots strongly selected individual trees that produced the most fruit. By contrast, a density-dependent effect related to grapefruit, while significant, was weak. There was no density-dependent effect for seedless oranges.

Table 10: Results of the GEE analysis of the variation in parrot frugivory due to the total amount of fruit produced by each citrus variety across all five agricultural regions.

Variety	**ls means/log**	**SE**	**Wald χ2**	***P***	**95% CI**
Valencia	1.424	± 0.165	74.38	< 0.0001	1.100 – 1.748
Ortanique	1.312	± 0.298	19.34	< 0.0001	0.727 – 1.896
Seedless	-0.016	± 0.221	0.01	0.9407	-0.450 – 0.417
Grapefruit	0.705	± 0.275	6.57	0.0104	-0.166 – 1.243

In the multivariate analysis of the effect of: (1) agricultural region, (2) citrus variety, and (3) the total fruit production of each tree on the level of parrot frugivory all three variables were significant predictors of frugivory levels. However region appeared to be the strongest predictor (region: Wald $\chi 2$ = 188.33, P <0.0001; total fruit production: Wald $\chi 2$ = 60.57, P <0.0001; citrus variety: Wald $\chi 2$ = 23.85, P <0.0001). In a multivariate analysis of the effect of these three variables on passerine frugivory again all three variables were significant predictors of frugivory. However for passerines region appeared to be the weakest predictor (region: Wald $\chi2 = 20.39$, $P = 0.0004$; total fruit production: Wald $\chi2 = 17.25$, $P < 0.0001$; citrus variety: Wald $\chi2 = 50.53$, $P < 0.0001$).

iii) Influence of variety-specific fruit characteristics on fruit selection

I measured and recorded 13 fruit characteristics from 596 fruits from the four citrus varieties studied. These fruits were collected from three of the farms most heavily impacted by parrot frugivory (Table 11). Two of the farms were from the eastern region (Sympa and Captain Bruce) and one from the western region (Salisbury Heights).

Table 11: Total number of fruits collected and measured from three separate farms that experienced the most intense crop loss due to parrot damage.

Variety	Count	% of Fruit Collected
Valencia	190	31.9
Ortanique	131	22.0
Seedless[1]	89	14.9
Grapefruit	186	31.2
Total	**596**	**100**

[1] All Seedless oranges were collected only during January 2010 (period 1) because this variety had been completely harvested when the second set of fruits was collected in March.

A principal component analysis identified six factors that were effective in differentiating among the four citrus varieties. Together these six factors explained 86% of the variance in the fruits examined (Table 12). The measured characteristics of fruit width and depth formed the first component of ‘fruit size.’ The ratio of seed-fruit mass and mean seed mass constituted the second component. The third component comprised indicators of pericarp color and whether the fruit was collected for measurement in either January or March, which together represented a ‘fruit ripeness’ factor. The fourth component was related to the acidity of the fruit, which was inversely related to whether the fruit was sun or shade-grown. Fruits grown in the sun were less acidic than fruits grown in the shade. The final two components were measures of the dissolved sugar concentration of the fruit juice and the thickness of the pericarp. The results indicated little multi-colinearity among the measured variables, indicating that the measured variables were independent characteristics of the fruits, and therefore that all six principal components should provide a meaningful contribution to our understanding of how each variety differs and by extension, to the explanation of what determines avian frugivory.

Because the first four factors identified by the principal component analysis contained two highly correlated fruit characteristics, I chose one variable from each of these four components for the GEE analysis of the relationship between fruit characteristics and the observed pattern of frugivory. The 6 variables used in the analysis were: fruit width, seed-fruit mass ratio, pericarp color, acidity, dissolved sugar concentration (°Brix), and mean pericarp thickness.

Table 12: Factor Analysis of fruit characteristics using measurements from 596 fruits of 4 citrus varieties.

Qualities/ Characteristics	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Fruit Width	0.999930					
Fruit Depth	0.999930					
Seed-Fruit Mass Ratio		0.99999				
Mean Seed Mass		0.99999				
Pericarp Color			0.81170			
Period of fruit collection			0.78222			
Sun/Shade Grown				0.80098		
Juice Taste (acidity)				-0.8907		
Dissolved Sugar Conc.					0.94438	
Mean Pericarp Thickness						0.98680

I also used feeding observations to inform the analysis of what determined parrot fruit selection. The feeding behavior observations indicated that *A. arausiaca* generally fed by picking selected fruits by first biting through the fruit peduncle to dislodge it. The parrot then transferred the fruit into one foot with which it could then be manipulated as the fruit was opened and the pulp and seeds eaten. In the case of very large citrus fruit varieties such as grapefruits, parrots more frequently opened and ate from the fruit without first detaching them from their stem. After extracting the seeds, the testa of each seed was first removed and discarded. Then the cotyledons were chewed and swallowed. The fruit and/or fruit fragments were dropped to the ground below the tree (For similar observations see: Navarro et al. 1991).

The z-test relating fruit characteristics to frugivory levels indicated that variety choice by *A. arausiaca* was significantly influenced by a combination of fruit: (1) pericarp color; (2) its concentration of dissolved sugars; and (3) its acid content (Wald $\chi 2 = 5.58$, $P = 0.2538$) or other characteristics that were correlated with these measured variables

(Table 13). Overall, *A. arausiaca* ate fruits of varieties that had high concentrations of dissolved sugars, whose pericarp appeared less ripe, and whose juice was relatively acidic, all characteristics associated with Valencia oranges at the fruit stage at which frugivory occurred relative to other varieties (Figure 3).

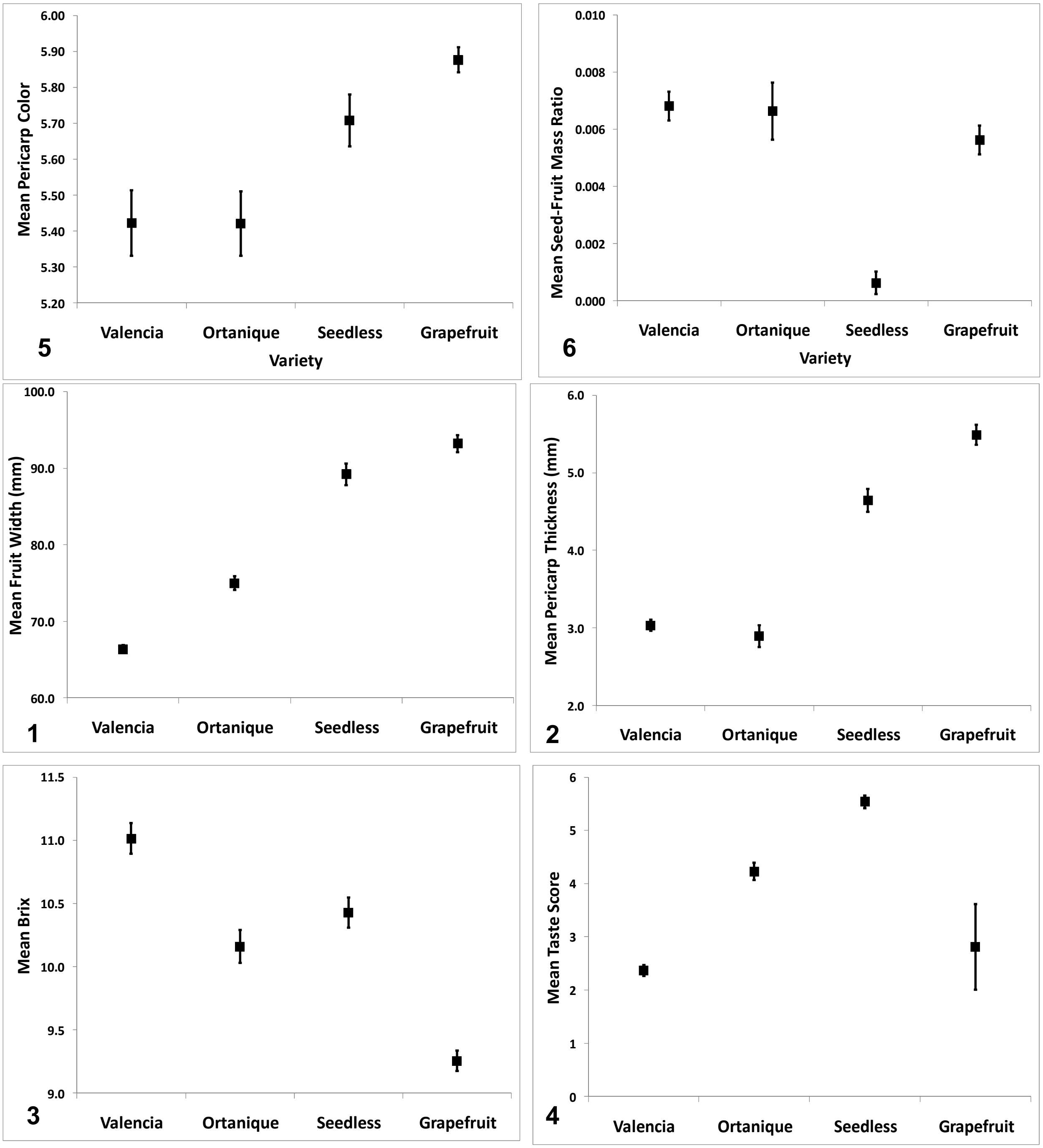

Figure 3: Differences in 6 fruit characteristics by citrus variety (sun-grown fruits only). Error bars: +/- 1 SE around the mean: **1** – mean fruit width as a measure of fruit size; **2** – mean pericarp thickness; **3** – °Brix as a measure of soluble sugar concentrations in the fruit juice; **4** – mean taste as a measure of the acidity of the fruit (scored between 1 = very sour to 7 = very sweet). **5** – mean pericarp color as a measure of the relative ripeness of the fruits when it was eaten (scored between 1 = very green to 8 = over ripe); **6** – mean fruit-seed mass ratio.

Table 13: Results of the Z-test analysis of the citrus fruit characteristics that best explained the frugivory pattern of *A. arausiaca;* controlling for the total amount of fruit that the tree produced.

Fruit Characteristic	df	Estimate	Z - test	P
Fruit Width	1	0.013	0.19	0.6607
Seed-fruit Mass Ratio	1	-32.515	1.08	0.2983
Pericarp Color	1	-0.850	6.95	0.0084
Dissolved Sugar (°Brix)	1	0.417	5.80	0.0160
Mean Pericarp Thickness	1	-0.226	0.74	0.3904

Passerine birds feed on citrus fruit by pecking holes through the pericarp through which they extract the juice, pulp, and seeds. Among this group of birds, the Bananaquit (*Coereba flaveola*) and the Lesser Antillean Bullfinch (*Loxigilla noctis*), were two particularly dominant species in citrus orchards in keeping with the results of Evans (1986). The results indicate a positive relationship between passerine frugivory and the sugar concentration (Table 14). However this measure was only marginally significant, indicating a trend.

Table 14: Results of the Z-test analysis of the citrus fruit characteristics that best explained the frugivory pattern of passerine birds; controlling for the total amount of fruit that the tree produced.

Fruit Characteristic	df	Estimate	Z - test	P
Fruit Width	1	0.192	1.70	0.1918
Seed-fruit Mass Ratio	1	38.459	0.81	0.3684
Pericarp Color	1	-0.566	0.67	0.4146
Dissolved Sugar (°Brix)	1	0.623	3.29	0.0695
Mean Pericarp Thickness	1	0.800	2.88	0.0895

iv) Sun-grown versus shade-grown fruit

On a plot level, average plot size within a farm was 3.85 acres, whereas the average total farm size was 5.96 acres. Overall, farms were, therefore, generally small. Mapping of each field revealed that farms overwhelmingly had either a hut or some other form of shelter towards the general center of the plots and/or towards the edge of the farm that faced the farm road. Collectively, these general areas were the hub of human activities on the farms and provided a vantage point of greatest access to the farm as a whole. To discuss the significance of the observation that parrots avoided shaded trees and preferentially ate from trees that received more sunlight, I compared the fruit characteristics of the shaded Valencia trees (all trees that grew within 25 meters of the windbreak forest trees), with trees grown in full sun towards the general center of each farm. Farm areas with the most sunlight were disproportionately areas where crops such as vegetables, hot peppers and tubers were cultivated and therefore overlapped with areas of the farming landscape that were more frequented by farmers. Sun-grown fruits, while not statistically different in size or pericarp thickness, were significantly riper in appearance, had significantly higher dissolved sugar concentrations, had twice the seed-fruit mass ratio, and also were less acidic relative to fruits from the randomly-selected shaded trees (Table 15).

Table 15: Differences in fruit characteristics between sun-grown versus shade-grown Valencia fruits from three of the farms most heavily affected by parrot frugivory. Shade-grown fruit N = 48; Sun-grown fruit N = 53.

Fruit Characteristic	df	mean (sun-grown)	mean (shade-grown)	F value	P
Fruit Width	1	72.59	71.01	0.86	0.3566
Seed-fruit Mass Ratio	1	0.008	0.004	8.87	0.0037
Pericarp Color	1	5.85	4.94	38.65	<0.0001
Acidity	5	3.48	2.57	10.05	0.0023
Dissolved Sugar (°Brix)	1	11.20	9.97	30.42	<0.0001
Mean Pericarp Thickness	1	2.60	2.83	2.52	0.1154

v) Influence of tree height on fruit selection by parrot and passerine birds

I examined the effect of tree height on frugivory levels using the tree height data from the 45 sample citrus trees on the three farms used in the fruit characteristics analysis while using total amount of fruit the tree produced as a covariate. The relationship between tree height and parrot frugivory was significant (Wald $\chi 2$ = 5.28, P = 0.0215), that is, not only were trees which produced more fruit much more likely to experience parrot frugivory, but also taller trees were more likely to experience parrot frugivory. The effect of tree height on passerine frugivory was, however, not statistically significant (Wald $\chi 2$ = 0.64, P = 0.4227). Tree height and fruit production were positively correlated (Pearson Correlation: r = 0.415 P = 0.005). In a multivariate analysis of the effect of tree height on parrot frugivory with both total fruit production and citrus variety as covariates all three variables were significant predictors of parrot frugivory. However citrus variety appeared to be the strongest predictor (tree height: Wald $\chi 2$ = 6.38, P = 0.0116; total fruit production: Wald $\chi 2$ = 3.75, P = 0.0529; citrus variety: Wald $\chi 2$ = 24.85, P = <0.0001).

4. *Does the fruit selection pattern of parrots influence farmer perceptions about crop loss and parrots as pests?*

i) Perceptions about the most-affected fruit crops

Of the 107 farmers interviewed, 101 (94%) reported that parrots damaged some type of crop offered for commercial sale on their farm or on the farms of their close family at some time in the past (not necessarily ongoing or annual losses). I asked each of these respondents to choose from a list of 12 cultivated crops (based on previous semi-structured interview responses used to formulate the structured survey instrument) which ones they either had personal knowledge of, or had heard reports about, crop losses due to parrots. Each respondent was instructed to choose as many crops from the list as were affected by parrot frugivory and indicate other crops that were affected if they were not already listed. Of the 101 affected respondents, 91.1% indicated that the parrots consumed some variety of orange, 63.4% indicated that parrots consumed grapefruits, while 33.7% and 16.8% respectively indicated that they consumed tangerines and passion-fruit (*Passiflora edulis*: Passifloraceae) (Figure 4). The cultivated crop perceived to be the most affected by *A. arausiaca* was, therefore, citrus fruits, particularly the orange varieties.

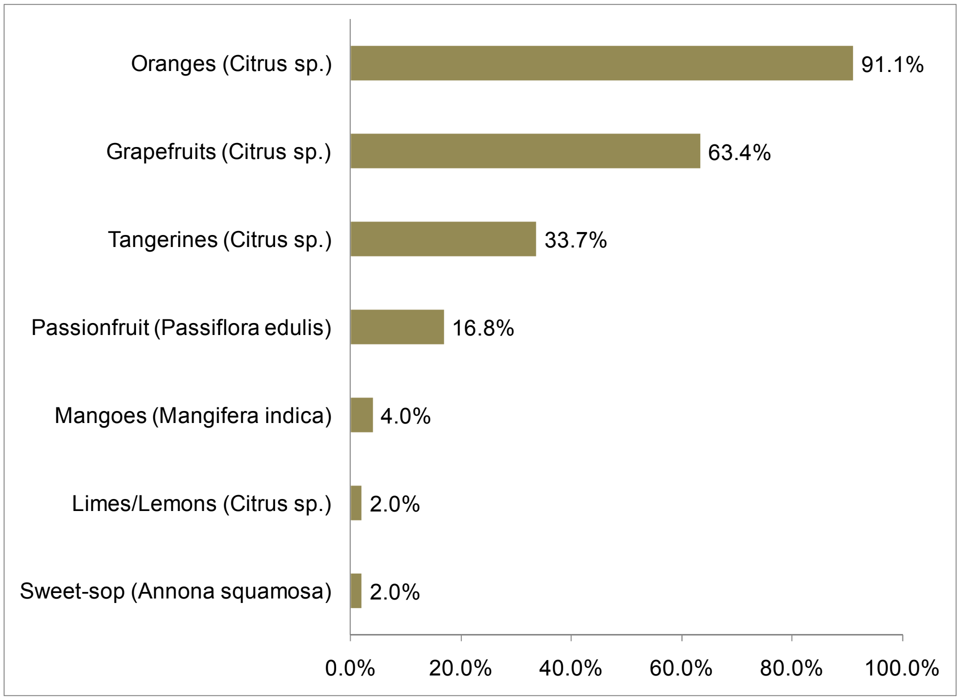

Figure 4: Questionnaire results of the percentage of respondents who indicated that specific cultivated crops were affected by *A. arausiaca* frugivory. This table excludes all crops only mentioned by a single respondent (N = 101 respondents).

I asked respondents to indicate in which months they observed citrus crop loss, at any noticeable level, caused by parrots within their fields. The responses indicated that farmers generally started noticing parrot-induced crop losses at the end of September, extending until the end of March of the following year (Figure 5). Respondents consistently noted that the majority of these losses were in the months of October through February, with a peak in intensity around December-January.

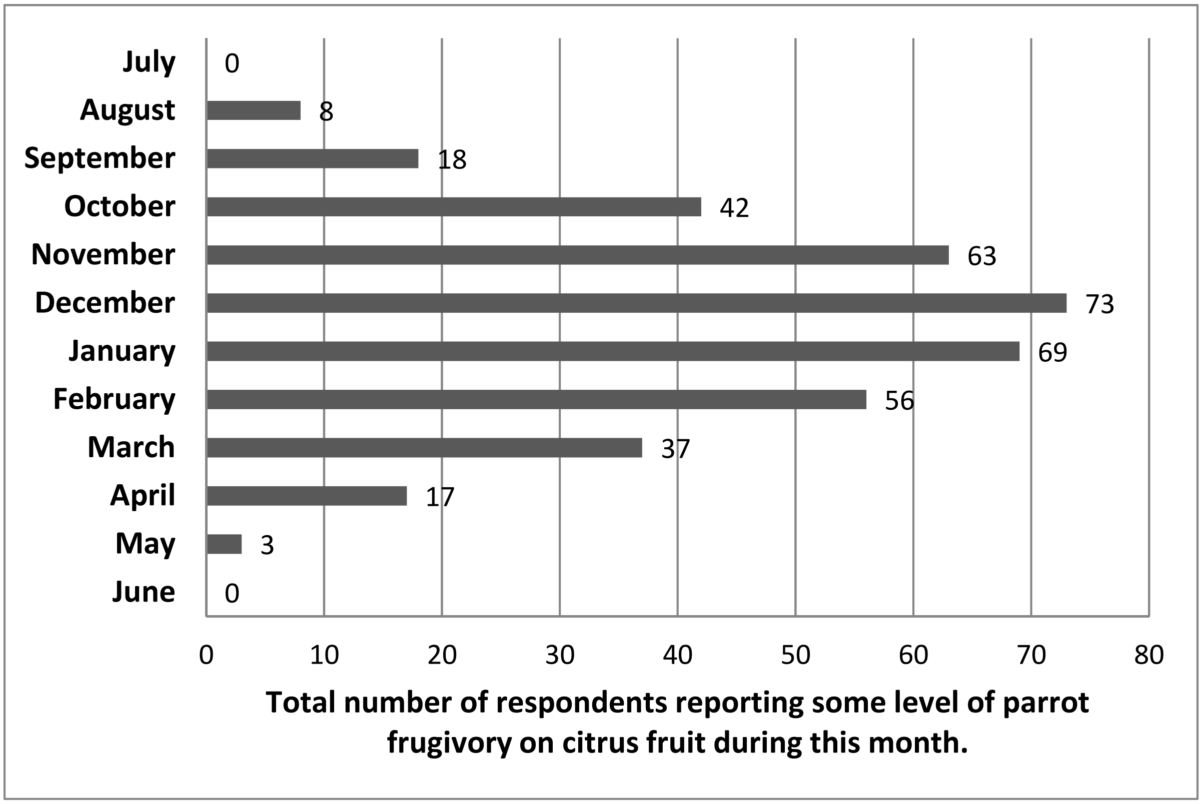

Figure 5: Questionnaire results indicating the months of the year that respondents indicated that some variety of citrus fruit on their farm was affected by *A. arausiaca* frugivory. N = 94 respondents.

ii) Differential valuation of citrus varieties by Dominican farmers

Using a separate questionnaire administered eight months later to a subset of the initial respondents, I then investigated the profitability of all the commonly-grown citrus varieties on the island (Valencia, Ortanique, and Seedless oranges, grapefruits), in addition to tangerines, Mandarin oranges, lemons, and limes. In this questionnaire, respondents were asked to identify what citrus varieties were currently the most and least profitable for them and to provide explanations for their stated choices. The results indicated that the most profitable varieties were Valencia and Seedless oranges. Overall grapefruits were perceived as the most unprofitable (Table 16).

Table 16: Responses to the questions (a) “What citrus variety is currently the **most** profitable for you?” *N* = 50 respondents; and (b) “What citrus variety is currently the **least** profitable for you?” *N* = 37.

	Valencia	**Ortanique**	**Seedless**	**Grapefruit**	**Tangerine**	**Mandarin**	**Lime**
(a) Most Profitable	28%	6%	28%	20%	6%	0%	8%
(b) Least Profitable	11%	19%	14%	43%	5%	3%	3%

The reasons offered as to why these three varieties were the most profitable or unprofitable were, however, different. Valencia oranges were considered profitable primarily because the fruits were relatively hardy and it was a “late season crop” available at a time of year when the other oranges were absent from the market. On the other hand Seedless oranges were profitable because there was strong market demand for this variety even though the fruit was perceived as the most susceptible to over-ripening and spoilage (Table 17). Ortaniques had the advantage of being less susceptible to parrot frugivory relative to Valencia oranges even though they were not considered particularly profitable in the market place relative to the other oranges. Grapefruits were a common citrus variety primarily for historical reasons.

Table 17: Pearson (two-tailed) correlation of the relative profitability of each citrus variety with the reasons offered to explain why the fruits of these citrus varieties were considered the most profitable for citrus farmers (N = 47 respondents). Citrus variety columns = Pearson correlation coefficient - *r (P)*.

Stated reason for profitability	Valencia	Ortanique	Seedless	Grapefruit
Late Season Crop	0.70** (<0.0001)	0.02 (0.893)	-0.40** (0.005)	-0.09 (0.552)
Favorable market price	-0.08 (0.615)	-0.004 (0.979)	0.32* (0.030)	-0.37** (0.010)
Strong market demand	-0.27 (0.065)	-0.004 (0.979)	0.42** (0.004)	-0.02 (0.301)
Less damaged by parrots	-0.14 (0.357)	0.38** (0.009)	0.09 (0.533)	-0.11 (0.463)
Less affected by fruit diseases	0.30* (0.039)	-0.08 0.595	-0.03 (0.831)	-0.16 (0.287)
Primary citrus variety owned (for historical reasons)	-0.34* (0.020)	-0.14 (0.363)	-0.11 (0.457)	0.62** (<0.0001)

** Correlation is significant at the 0.01 level.
* Correlation is significant at the 0.05 level.

The results of the market survey (Figure 4) support the interview results presented in Tables 17 and 18 by illustrating that the Seedless oranges disappear from the wholesale and retail market relatively early in the season by the end of the calendar year. The price for Ortanique oranges was, in general, low and this variety disappeared from the market by early February. After the beginning of March, Valencias were the only orange variety available in local markets and the price of Valencia fruits doubled between January and March. Beyond February farmers expect returns of above $45 per 100 (Eastern Caribbean Dollars) for their Valencia oranges.

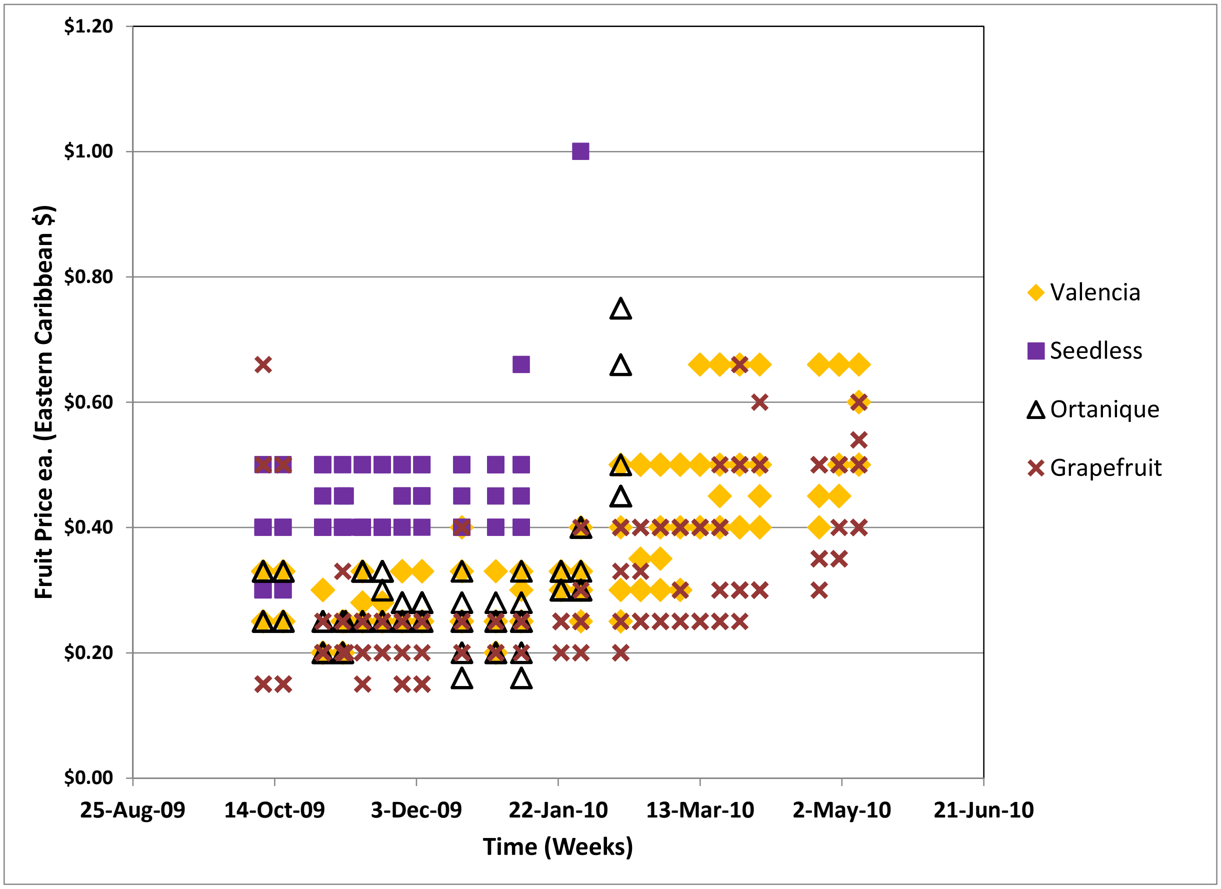

Figure 6. Sale price for individual citrus fruits from the four citrus varieties between October 2009 and May 2010. Each symbol within the plot area represents the asking price from one citrus seller for that week. Currency: Eastern Caribbean (EC) Dollars.

Discussion

This study examined a set of ecological factors across the scale of the landscape to the level of individual farms, fruit variety, and trees, and related these to socio-economic data of the affected stakeholders on the island of Dominica. The results provide empirical evidence that parrot frugivory on Dominica is driven by factors at both the national and farm levels. At the national level, the location of the farms in the rain forest belt within the *de facto* 'buffer zones' of those parks and forest reserves that are the stronghold of the species, is an important deterministic factor contributing to parrot frugivory of citrus fruits. In this sense, crop losses due to frugivory by *A. arausiaca* mirror the known distribution and relative abundance of this species in forested areas across Dominica. Losses are disproportionately concentrated to the east, south-east, and south-west of the Morne Diablotin National Park and Northern Forest Reserve (Figure 1), areas where the highest forest populations of *A. arausiaca* have been recorded on the island (Wiley et al. 2004).

The findings further clearly illustrate that the fruit selection pattern of *A. arausiaca* at the farm level is non-random. Parrot frugivory was strongly correlated with citrus variety, the number of fruits that trees produced, tree height, specific fruit characteristics, and the environmental conditions under which individual trees were grown in citrus orchards. Similar to the study of Pepper et al. (2000), some of these variables, such as tree height and the total amount of fruit produced by individual trees, were correlated. These authors noted in their study of the feeding ecology of glossy black cockatoos on the gymnosperm Drooping Sheoaks (*Allocasuarina verticillata*) in Southern Australia that larger trees produced more cones, contained larger seeds and more seeds per cone, had high ratios of seed-to-cone mass, and more nutritious seeds. While there was not a correlation between citrus variety and fruit production or tree height in this study, citrus frugivory was strongly density dependent for Valencia and Ortanique oranges, the varieties that they preferentially selected. The results further suggested variety-specific characteristics of citrus fruits strongly influenced this selection by both parrots and passerine birds. Based on the analysis of the differences in the characteristics between shade-grown and sun-grown fruits of the same variety, the results also indicated that *A. arausiaca* used food quality to distinguish between the trees of individual varieties to determine not only what varieties they fed on but also what trees and by extension what areas within individual farm plots that they prioritized for feeding.

Nutrient and energy composition of the fruits was a more important driver of fruit selection relative to characteristics such as fruit size. The results presented here also indicate that, similar to another important frugivore of citrus in Neotropics, the Blue-fronted Amazon (*A. aestiva*), both the citrus seeds and fruit pulp may be an important dietary component for *A. arausiaca* and not just the seeds as is usually cited for the species group as a whole (Ragusa-Netto 2007). Feeding observations indicated that A. arausiaca consumed both fruit pulp and seeds. From results from the sun-grown/shade-grown fruit analysis, the fundamental difference between the fruits was that sun-grown fruit were of higher quality for parrots with twice the seed-fruit mass ratio and significantly higher concentration of dissolved sugars (Table 15). Additionally the analysis of the effect of the variety-specific fruit characteristics indicated that the dissolved sugar concentration of Valencia oranges was an important variable driving fruit selection of this variety. Overall, the results of the latter analyses of the impact of fruit characteristics on fruit loss must, however, be considered a coarse indicator since the fruits measured, while of the same variety and from the same area of the fields, were not either the exact fruits that the birds had actually selected or from the 15 randomly selected trees used for the fruit damage assessments. Several studies have shown not only that quality of fruit can vary with individual trees but it can also vary substantially between trees of the same species/variety even when they occur in the same area in ways that influence animal frugivory (Francisco et al. 2008; Pepper et al. 2000). By pooling selected fruits from several trees within a given area, however, I hoped to minimize these random effects. There was also a noticeable temporal component to these losses as well. Generally parrots ate citrus of the Valencia variety at an earlier stage of fruit maturity in the eastern region, sometimes before fruits had attained their typical size and pericarp color at full maturity (Figure 2), while less preferred varieties such as grapefruits were eaten more intensely at a later stage of maturity, usually after the Valencia oranges were exhausted. Passerine frugivory was not correlated with crop size, but with the concentration of dissolved sugars in the fruit juices. Unlike large birds such as parrots, that require greater quantities of protein for maintenance, smaller-bodied birds such as passerines generally require significantly more sugars to fuel their relatively higher metabolic rates and their correspondingly higher energy needs (Matuzak et al. 2008).

These results are also diagnostic of studies that have attempted to assess and highlight the relative importance of seed predation by Neotropical frugivores. Haugaasen (2008), for example, discusses the relative importance of psittacines as pre-dispersal seed predators by comparing the levels of seed predation in his study with the cited levels of seed predation by other Neotropical psittacines reported by other authors. However, these studies were generally restricted in location and region and therefore most likely missed regional variations in frugivory patterns. The current study suggests that such comparisons might not be informative as a basis for generalizations when the aim of research is to determine whether the level of fruit losses (on either cultivated or uncultivated plants) are high, relative to the losses caused by other species or to similar plants across different areas. This is because levels of psittacine frugivory might vary dramatically across a landscape even when selection patterns at the more local scale of individual trees or plant varieties are consistent. These findings also emphasize the conclusions of Vallasenor-Sanchez et al. (2010) and Ragusa-Netto (2007) who note that the general lack of knowledge about the parrot-food resource relationships makes it difficult to meaningfully discuss the importance of parrots as pre-dispersal seed predators. This appears to be particularly true within fragmented and human-dominated landscapes (Francisco et al. 2008; Matuzak et al. 2008).

Frugivory was overwhelmingly of oranges as opposed to grapefruits. This result is consistent with those of Navarro (1991) and Matuzak et al. (2008), which indicate that grapefruits were selected far less often relative to orange varieties by the Neotropical *Amazona* parrots in their studies. These authors did not, however, assess the factors that might account for this disparate fruit selection pattern. The result that parrots selectively target Valencia oranges, frequently at an early stage of ripening, is an important one because, on Dominica, different citrus varieties are valued differentially by rural agriculturalists based on variety-specific qualities. The most important of these qualities are: (1) their expected market demand and price; (2) period of the year when the fruit reaches peak maturity; (3) field durability; (4) resistance to pests and diseases; and (5) their traditional culinary uses and values. Therefore, farmers engaged in cost-benefit analyses to decide which fruit varieties they preferred to own and which varieties they prioritized for sale at different times of the year. Farmers hedged on expectations of increasing fruit price across a season, and favored delaying fruit harvest until prices are most favorable, especially for Valencia oranges but also for grapefruits, which are better able to last on the tree if not harvested. As one farmer noted, “that is when we can make a little money”. After the beginning of March each year, farmers expect returns of above $45 (Eastern Caribbean Dollars) per 100 for their Valencia oranges, one of (if not) the smallest and therefore relatively easiest citrus variety to transport for sale. Collectively, these factors make Valencia oranges a particularly prized citrus variety. Furthermore, because a majority of citrus farmers obtain income from citrus only seasonally, their sales decision-making process also encourages them not to sell either a portion or the entirety of the fruit crop in years when the market is perceived as particularly unfavorable. Comparable decision-making by citrus farmers in response to expected fruit price increases were reported in northwestern Argentina (Bucher 1992 page 206) where similar speculative harvesting practices were linked to delays in citrus harvesting and concurrent increases in Blue-fronted Amazon frugivory. Where mature crops are left on the tree for extended periods, damage due to wildlife (among other factors) is frequently more extensive because the standing crops permit greater crop recognition and damage buildup by frugivores and disease (Bucher 1992; Rowley 1990; Wiley 1993). Furthermore interview data further indicated that even in years when there was little local and export market for citrus fruit, farmers were nevertheless still inclined to complain to the government about parrot frugivory.

Understanding the agricultural cycle in relation to annual patterns of crop frugivory should help the mitigation of crop losses. In Australia, avian crop damage is mitigated by coordinating harvests at the time of year when crop damage is least likely (Bomford & Sinclair 2002). Other studies have, however, indicated that the farming culture of an agricultural society may be a significant barrier for mitigation measures that seek to modify the types of crops produced, farm management, or farming strategies (Bomford and Sinclair 2002; Bucher 1992). These studies indicated that farmers may be opposed to changes to their management practices even when these changes can decrease crop losses due to frugivores. Farmers may consider fruits harvested early, and not fully tree and sun-ripened, to be of inferior flavor, quality, and marketability (Bomford & Sinclair 2002, Bucher 1992, page 206). This resistance to early harvesting was also expressed by many Dominican citrus farmers both during interviews and in the print media (See media example in: Joseph 2010).

An important implication of this study is that a broad analysis of the fruit selection patterns of a species involved in agricultural damage can inform our understanding about why the loss of citrus is perceived as egregious by some farmers. The sale of citrus fruits provides an important, seasonal source of income for many such rural farmers. Of the available citrus varieties on Dominica, *A. arausiaca* preferentially selects the most economically and culturally valuable variety of citrus, the Valencia, and the most productive trees of this variety because of density-dependent foraging. Similar to other regional citrus growing areas such as the state of Florida (Nordby and Nagy 1977; Sauls 1998), Valencia oranges begin to ripen around the end of the year and reach their peak maturity on Dominica March through May/June each year. This is a distinctive quality of the Valencia orange variety because most other orange varieties do not generally last on the tree once they mature. Typically, once citrus fruits reach full maturity, they then begin to soften and soon fall (Sauls 1998). For example, Seedless oranges usually hold until December-January when the variety matures, after which they begin to dry out and eventually fall within a relatively short period of weeks at most. Valencia orange fruits will, however, generally hold for much longer (2-4 months) than other orange varieties, and, furthermore, the longer the fruit remains on the tree the sweeter they become (Sauls 1998). This is largely because younger Valencia fruits contain the highest concentrations of ascorbic acid (responsible for the sour taste) while fully matured fruits contain the least (Nagy 1980). Because of its durability, the variety is frequently referred to as a late season citrus. This characteristic has important economic advantages for farmers on Dominica. In a country where pre and post-harvest losses are high for fruits and vegetables due to a lack of a stable market, appropriate storage facilities, or a significant agro-processing industry, citrus varieties that are resistant to senescence, if un-harvested, are highly favored by the farmers because they provide farmers with the flexibility to harvest if and when there are favorable market prices and strong consumer demand. Valencia oranges are, therefore, traditionally harvested after the other orange varieties have all disappeared from the market, usually around February onwards, when the prices for Valencia oranges becomes highly favorable and the fruits are at their sweetest (Figure 6). Seedless oranges mature primarily between September and December. This variety is usually sweet to taste even before full maturity and is the only variety of orange that is easily pealed without the aid of an instrument such as a knife. Seedless oranges are therefore popular as “eating oranges”, as opposed to the other orange varieties that are predominantly used to make juice-drinks sweetened with sugar to counteract the sour taste. For this reason, in addition to the fact that mature Seedless orange trees produce fewer fruits than mature Valencia orange trees, are relatively scarce, and the fruits degrade relatively quickly, the market price for this variety is good during the early citrus season, providing a strong incentive for the harvest and sale of the Seedless variety of oranges as soon as they mature. Respondents who indicated that grapefruits were their most profitable variety overwhelmingly indicated that this was the case, not because of its relatively favorable market price, but because this was the predominant variety that they had on their property. Up to the 1970s, Dominica was a major exporter of grapefruit fruits to the United Kingdom. Many trees from this period are still in production (Honychurch 1997). Therefore, it is for historical reasons that grapefruits are in general retained, and by extension, contributed to farmer income. By contrast, grapefruits were the single most unprofitable variety of citrus and respondents noted that there was poor local demand for this variety especially during the periods of the year when oranges were in season and when there is frequently a glut in the market for citrus. Furthermore, grapefruits were cited as more bulky, relatively heavy, and overall more costly to transport especially for farmers without personal vehicles for transportation.

This analysis indicated that parrots selected trees in the more frequented areas of these farms. While crop losses occurred predominantly on sun-grown rather than shade-grown fruits and in areas where farmers were actively farming other crops, there is another possible explanation why parrots might preferentially select trees in areas more central to each farming plot. Farmers generally inter-cropped vegetables, tubers, or bananas among the citrus trees. These areas were more frequently treated using organic or inorganic fertilizers, cleared, and tilled relative to the shaded boundary sections. These differences may have contributed to the increased fruit production and higher nutritional quality of fruits in sunny areas of the property. Nagy (1980) notes that both greater exposure to direct sunlight and the addition of fertilizers positively influence both citrus fruit quality and yield.

A few methodological issues are important when interpreting the results of this research. First, I standardized my data collection by choosing farms that abutted forest. Farms that adjoin high quality wildlife habitat usually experience the most agricultural losses due to wildlife (Naughton-Treves and Salafsky 2004; Nyhus and Tilson 2004; Riley 2007). In general, such damage should decrease with distance from forested areas. Therefore the design of this project was biased toward areas where crop loss due to forest dependent psittacines should be greatest. By contrast, I was unable to evaluate how distance from the forest affected the prevalence of each of the other causes of crop loss identified in this study. However because passerine birds are more widely distributed across the agricultural landscape (Evans 1986c) crop losses due to passerine birds is most likely a more important factor further away from forest edges.

Second, in my analysis of the influence of the fruit characteristics on frugivory levels, I did not collect the individual fruit characteristics measures from the same trees that I collected the fruit damage data. This was not done for three reasons: (1) removing fruits from citrus trees might compromise the fruit selection if foraging was density-dependent; (2) fruits dropped/discarded uneaten by parrots could not be used for measurements because their characteristics/qualities might be different from those that were actually eaten (see Haugaasen 2008); (3) fruits that were eaten were usually destroyed to a level that many of the variables of interest, such as the number of seeds per fruit, could no longer be assessed.

Broader Conservation Implications

Human-wildlife interactions are complex phenomena, even in the absence of situations of overt stakeholder conflict. This research suggests that more detailed knowledge of parrot feeding strategies in human-dominated landscapes can aid our understanding of whether and how their ecology can impact and influence stakeholder perceptions. This study therefore highlights the importance of assessments of the ecological underpinnings of conflict and underscores that it is imperative that human-wildlife conflict research include ecological, land use, and human dimensions research in consort. Relating ecological data directly to social science data holds great potential for improving our understanding of conservation challenges.

This study also points to specific action points. In regions of Dominica that experience moderate levels of parrot-induced crop losses, such as western and central Dominica, interventions that facilitate early fruit harvesting could substantially reduce the amount of fruit losses due to a broad range of factors, including parrot frugivory. For example, a newly established citrus processing plant has the potential to increase the harvesting and utilization of citrus fruits (Reillo et al. 2002). However, where frugivory is most severe (such as on farms in the eastern agricultural region), facilitating early harvest might be ineffective in reducing frugivory levels because frugivory may disproportionately occur during earlier stages of fruit maturity, when fruits may still be unfit for any of the traditional uses such as out-of-hand eating, juicing, or sale to retailers. The analysis further indicates that the success of such ventures will depend not only on greater market access but also in farmer perceptions of acceptable market prices for their fruits which will ultimately determine time of harvesting.

Losses due to parrot frugivory are not trivial and can result in significant losses in potential income for some farmers. Rural farmers are key stakeholders of biodiversity protection in the Neotropics. The results also show that the losses due to windfall and passerine birds, among other causes, are also substantial, and overall, are more important causes of citrus fruit loss in Dominica. In total, parrot frugivory destroys less than one fifth of fruit production. Nevertheless, the perception of parrots as crop pests is pervasive among the citrus farming community and has a powerful influence on the attitudes that farmers hold toward wildlife, and by extension, their support for conservation efforts. The relatively early fruit stage at which parrot frugivory can occur, and the propensity of parrots to concentrate frugivory on only certain varieties and disproportionately on certain areas within a farm plot, encourages a heightened sense of parrot-induced losses. In the total farming landscape however, including farms far from protected areas, non-parrot induced crop losses might well be more important causes of crop loss. Nevertheless, because the influence of crop loss on development and the escalation of conflict about parrot conservation have potential to further threaten *Amazona* parrots, both real and perceived crop losses must be treated seriously. Because of the psittacine conservation successes of the last two to three decades, a period in which agriculture expanded dramatically throughout Latin America, Neotropical parrots are increasingly in conflict with agriculture in many countries (Bucher 1992; Wiley et al. 2004). I hope that this project will stimulate further interest in future research in this poorly investigated area of psittacine conservation. By so doing the mechanism fostering wildlife-induced crop losses will be better understood and illuminate further insights for management and mitigation of conflicts between humans and this threatened species group.

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Parrots, Bananaquits, and Commensalism: Can psittacine frugivory affect the habitat quality of passerine frugivores?

Abstract:

The circumstances under which frugivores such as psittacines influence resource availability and habitat quality for other frugivores has been poorly investigated. I examined six indices of habitat quality for Bananaquits independently across two habitat types (old growth forest vs. citrus orchards) and three treatments of habitat quality. The three treatments were orchards divided into those that had no parrot frugivory and those with high levels of frugivory and forest as the control treatment. I then examined how the variables of elevation, rainfall, and citrus fruit maturity influenced the measured indices of habitat quality. I analyzed the agreement of these measures to investigate the consequences of citrus agriculture and parrot frugivory of citrus on Bananaquits. The results suggest that both the level of parrot frugivory, and fruit maturity at the time of frugivory, influenced the habitat quality of Bananaquits. The findings show that parrot frugivory can facilitate a commensal trophic association with smaller avian frugivores. This strengthens our understanding of the important ecological role of Neotropical psittacines as mediators of habitat quality for the wider avian community. The importance this trophic relationship may be particularly critical within Caribbean island ecosystems where psittacines have historically been the dominant apex consumers of forest canopy fruits and seeds.

Key Words: *Amazona arausiaca*, agriculture, commensalism, *Coereba flaveola*, food supplementation, trophic cascade, apex consumer, parrot.

Introduction

Where associations between members of two different species benefit one while the other is unaffected, the relationship is described as commensal. Studies reporting that interspecific associations facilitate improvements in foraging efficiency are not uncommon both within and across a variety of animal taxa (King & Cowlishaw 2009). For example, commensal associations exist between primates and bird such as Rock Kestrels (*Falco rupicolus*) and Chacma Baboons (*Papio ursinus*) (King & Cowlishaw 2009); ungulate-bird commensal associations such as between Brown-headed Cowbirds (*Molothrus ater*) and livestock (Goguen & Mathews 2001); cetacean-bird associations such as between Hector's Dolphins (*Cephalorhynchus hectori*) and White-fronted Terns (*Sterna striata*) (Brager 1998); and bird-bird relationships for example between Red-shouldered Hawk (*Buteo lineatus*) and Wild Turkeys (*Beleagris gallopavo*) (Graves 2004). Such studies have used (1) behavior observations (Ubaid 2011, Kajiura et al. 2009, Graves 2004, Renfrew 2007); (2) habitat occupancy, density and abundance (Brager 1998, Tsurim et al. 2008, Goguen & Mathews 2001); and (3) feeding/foraging rates (Hino 1998, Ruggiero & Eves 1998) to identify and describe these commensal relationships.

To date, however, studies of commensal associations have not explicitly demonstrated whether and how these observed interspecific associations affect more robust indices of fitness and habitat quality such as individual body mass, reproductive condition, and parasite load. This might be because it is usually impractical to capture and measure the animals participating in an association and compare them with other groups. Outside of methods of quantifying density and abundance, measures of fitness and habitat quality usually require extensive effort, large data sets, and site/population replicates (Johnson et al. 2006). Unfortunately, density and abundance measures can be misleading indicators of individual fitness and habitat quality if considered in isolation. Furthermore, studies of commensal associations have also overwhelmingly neglected to assess and disaggregate the habitat and environmental variables that could potentially influence habitat occupancy and our perceptions of species associations (King & Cowlishaw 2009).

Food quality and availability are key determinants of habitat occupancy and the habitat quality of wild birds (Briceno-Linares et al. 2011; Golawski and Golawska 2008; Martin 1995). Generally, greater access to supplemental food produces increases in local density, body mass, and earlier breeding dates, among other measurable improvements in the distributional, demographic, and individual body condition indicators of habitat quality (Begg and Kushnir 2011; dos Santos Neto and Camandaroba 2008; Johnson 2007). Quantifying the effect of feeding associations on habitat quality therefore appears to be a critical determinant of the importance of species associations.

Study Context

I examined a feeding association between a Neotropical psittacid and a passerine bird. Neotropical psittacids are important canopy frugivores because they are a large proportion of the biomass of canopy seed eaters, they can open well protected fruits using their strong beaks, and they are able access and potentially remove large volumes of the fruit production during the pre-dispersal fruit stage (Haugaasen 2008; Trivedi et al. 2004; Villasenor-Sanchez et al. 2010). For these reasons several studies have noted that psittacines are important seed predators and “fruit thieves” in Neotropical forests capable of significantly influencing forest-tree fitness and affecting recruitment rates of canopy forest trees (Galetti 1993; Howe 1980; Villasenor-Sanchez et al. 2010). However, almost nothing is known about the existence of feeding associations involving psittacines. Whether and to what degree psittacines make food resources available for other canopy frugivores is therefore poorly understood. This issue is particularly challenging to investigate because the feeding ecology of upper-canopy frugivores in Neotropical ecosystems is usually hard to observe and onerous to quantify because it is particularly difficult to capture and measure individuals within the upper forest canopy. Furthermore because of the ecological complexity of tropical ecosystems it is usually impossible to link feeding associations to any particular food source.

In the Caribbean sub-region of the Neotropics where large mammals that eat canopy fruits, such as primates, are absent, psittacines occupy a particularly visible niche as apex fruit consumers. Historically, an estimated 34 species of psittacines were present on these islands. Of these, 19 species or 56% have gone extinct within the last 500 years, and of those 15 species that survive, 10 are listed as threatened and one as near-threatened by the IUCN Red Data List (Wege and Anadon-Irizarry 2008; Wiley et al. 2004). The endemic Red-necked Parrot (*Amazona arausiaca*) is an important frugivore of cultivated citrus fruits on the island of Dominica in the eastern Caribbean, where the species produces economically important fruit loss in some citrus-growing regions of that island (Wiley 1993, Wiley et al. 2004). Cultivated fruits, such as citrus, are usually attractive to a variety of birds because of their relatively high nutrient content and palatability compared to uncultivated fruits (Avery 2002). Citrus orchards therefore potentially provide predictable and concentrated nutrient-rich feeding sites for fruit-loving birds. Within Dominican citrus orchards *A. arausiaca* frugivory produces large quantities of partially eaten fruits, sometimes up to 50% of total orchard production (Chapter 2 – Douglas 2011), greatly augmenting food resources available to secondary frugivores (Douglas 2008-2010 personal observations). Several species of passerine birds, can also produce economic loss of citrus fruit by piercing holes through the exocarp through which they extract juices and pulp. Within orchards where levels of parrot frugivory of citrus is greatest, fruit loss due to passerines is significantly lower suggesting that parrots are able to make food available for these passerines that would otherwise be out of reach or at least more difficult to obtain (Appendix 1).

The Bananaquit (*Coereba flaveola*; Coerebidae - A.O.U. 1998) a widely distributed Neotropical songbird found from southern Mexico to northern Argentina and on most of the Caribbean islands (Merola-Zwartjes 1998). The Bananaquit, or “Sikyé” (French Creole for sugar-bird) as it is locally called on Dominica, is a common species within both natural and human-dominated habitats on that island. Bananaquits feed primarily on nectar and fruit juices and, to a lesser extent, insects and arachnids (Greenlaw 1990; Lack 1976; Mata and Bosque 2004; Wunderle 1982; Wunderle et al. 1987).

In this study Bananaquits were observed following and immediately feeding on the Citrus fruits opened and abandoned by foraging parrots in citrus orchards. I hypothesize that parrot frugivory of citrus fruits improves habitat quality of Bananaquits within citrus orchards, thus constituting a commensal ecological relationship. To test this hypothesis I measured specific habitat attributes, variables associated with individual birds, and population variables (Johnson 2007; Latta and Faaborg 2001). For the individual and population level indicators of habitat quality, I chose measures that previous studies suggested would be sensitive over a comparable time period to that of this field study of 6-7 months (Johnson 2007; Johnson et al. 2006; Latta and Faaborg 2001; Starfield et al. 1998).

Based on previous research I predicted that food supplementation due to parrot frugivory should increase the proportion of the Bananaquit population that: (1) are adults, (2) are in breeding condition, (3) stored more body fat, and (4) were of relatively high mean body mass. I also quantified the ratio of males to females and insect parasite load because these can indicate habitat quality (Johnson 2007; Moller et al. 2004). Elevation and rainfall were two possible confounding factors. Wunderle (1982) indicated that rainfall was a cue for breeding in the species, and Diamond (1973) indicated that Bananaquit body size was positively correlated with altitude.

Methods

Study Area

This study was conducted on the island of Dominica (751 km^2) in the eastern Caribbean between October, 2009, and April, 2010. Dominica is 46.7 km long, 25.7 km at its widest, and rises to a height of almost 1,450 meters. I collected data on 4 citrus farms, two that experienced fruit losses of 30% (Salisbury Heights) and 47% (Captain Bruce) due to parrot frugivory, and two that experienced fruit losses of 0.7% (Sylvania) and 0% (Giraudel) during the six-month study. All four farms sites were within the tropical rainforest belt of the island where the vast majority of citrus is cultivated. All farm sites immediately adjoined old growth secondary or climax forest in which native forest tree species such as Chatannyé (*Sloanea spp.*), Maho kochon (*Sterculia caribaea*), Gommier (*Dacryodes excels*), and Bwa Dyab (*Licania ternatensis*) were common. In these citrus orchards, the four dominant varieties cultivated were: Grapefruits (*Citrus paradise*), Valencia [*Citrus sinensis* (L.) Osbeck, cv], Ortanique (*C.s.* x *C. reticulata* Blanco), and the Washington Navel (also called Grafted or Seedless) orange [*Citrus sinensis* (L.) Osbeck, cv]. The dominant variety on all four farms was the Valencia. These trees were between 30 – 40 years old, between 4 and 6 meters high, and managed minimally through the application of inorganic fertilizers, usually towards the end of the harvesting season. Citrus tree density was relatively consistent at around 28 trees per hectare. Neither the foliage nor the fruits of these citrus trees were treated with chemicals to control pests or disease agents. The grass and herbaceous layer of all four orchards was treated once per year with the broad-spectrum herbicide Roundup (active ingredient glyphosate). None of these farms cultivated any other plant of interest to Bananaquits.

I established a control site within old-growth secondary forest. This forest site is located within a protected area, the Central Forest Reserve of the island (established in 1952 - 410 ha), over 2.5 kilometers away from the nearest cultivated areas. The Central Forest Reserve is itself joined along its northern boundary by the 5475 ha Northern Forest Reserve. I collected weekly rainfall data at all farm sites and obtained rainfall data for the Central Forest Reserve from the Forestry, Wildlife, and Parks Division of the Ministry of Agriculture. Both the farm site rainfall data and the data obtained from the Forestry Division were gathered using identical rain gauge apparatus. I measured elevation and GPS positions with a hand-held GPS receiver (Garmin eTrex Series; accuracy 15 m/49’) at all sites (See Appendix 1 for further details on the study sites).

Crop Frugivory and Fruit Quality Assessment

I selected 15 trees per farm using a random sampling approach, guided by a table of random numbers. I identified the citrus variety of each sample tree as a Valencia, Ortanique, Seedless orange, or Grapefruit, and labeled it with a unique number inscribed on an aluminum tag. I visited these 60 survey trees once per week over a period of 10 months between October 2009 and April 2010. During each visit I collected, carefully examined, and confirmed the cause of crop loss of all citrus fruits immediately under the trees to quantify the total number of: (1) parrot-eaten fruits; (3) passerine-eaten fruits; (3) fruit loss due to other causes. I also recorded the average fruit maturity stage by scoring each tree on a scale from: 1 (very green) through 8 (over ripe) (for a more detailed description of these methods see Chapter 2 - Douglas 2011).

I gathered fruit quality data from the two farms that experienced the most significant parrot-induced crop losses (Salisbury and Captain Bruce). On each of these farms, I collected a minimum of 20 fruits from each of the four citrus varieties during early January and again in late March 2010. I used a pole to collect up to three fruits from no fewer than seven trees of each variety within each orchard using a nearest-neighbor method by selecting a subset of the 15 sample trees and then finding the nearest neighbor belonging to each of the four varieties. If the nearest neighboring tree was empty, I selected the next nearest tree until I obtained or exceeded my target number of fruits. I selected the highest fruits present within the crowns of each tree to represent the fruits that parrots would most likely eat. I then measured and recorded data on the following variables:

1. Pericarp color as a subjective measure of fruit maturity – graded on a scale from 1 (very green) to 8 (over ripe).
2. Soluble sugar concentration within the juice (°Brix: measured using a Extech RF15 0-32% Brix Portable Automatic Temperature Compensation Sucrose

Refractometer, Extech Instruments Corporation, Waltham, Massachusetts, USA). Standardized using de-ionized H_2O.

3. Juice taste, taken as a subjective measure of the citric acid content – graded on a scale of 1 (very sour) to 7 (very sweet).

Bird Sampling & Measurements

I used mist nets (12 m x 2.5 m x 30 mm) to capture birds in three different seasons: (1) October (the general start of parrot frugivory and early citrus harvesting season)[1], (2) early January (the general period within which most parrot-citrus frugivory occurs and the general middle of the citrus harvesting season), and (3) late March - early April – hereafter termed April (the end of parrot frugivory = late citrus harvesting season, corresponding with the start of the avian breeding season on Dominica and also with the middle of the island's usual dry season). October and early January periods were both non-breeding seasons. October is traditionally part of the wet season and January the early dry season. On each farm site I used 3-5 mist nets for 5-7 hours each day for 1 day during each sample period. Because capture rates within the forest sites were comparatively low, I used 10 -12 mist nets for 8-10 hours each day for 2-3 days during each period. I concentrated the nets within the forest sites along a narrow ridge along which there were shallow passages that encouraged both canopy and understory species moving across the range to travel closer to the ground. At first capture, all individuals were banded with a uniquely numbered aluminum band beginning with the prefix 'DM'.

[1] Note: I have no data for October from the Captain Bruce farm.

To assess habitat quality, I collected data on birds' age and sex, individual body condition, and breeding status. Age was classified as adult (after-hatch-year birds) or juvenile (or hatch-year birds) based on a combination of plumage characteristics and skull ossification following Prys-Jones (1982) and Wunderle (1994). Adult Bananaquits on Dominica have a bright white supercilium stripe and uniformly dark-gray throat, whereas juveniles have a more yellowish and indistinct supercilium and yellowish-gray throat. While male Bananaquits are, on average, slightly larger than females (Diamond 1973; Prys-Jones 1982), the species is sexually monomorphic. I therefore determined sex based on the presence of either a brood patch or cloacal protuberance, observable on breeding individuals. For the analysis of breeding condition and sex ratio I used only adult birds. To assess individual body condition, I quantified the following indices: (1) total body mass, (2) unflattened wing chord, (3) furcula fat levels, (4) pectoral muscle mass, and (5) feather parasite load. I measured total body mass to the nearest 0.1 gram using a digital scale, and unflattened wing chord to the nearest millimeter with a steel ruler (Pyle 1997; Wunderle 1994). I visually examined and scored subcutaneous fat levels in the furcula depression (tracheal pit) using a scale that ranged from 0 (no fat) through 6 (great bulging of fat) following Wunderle (1994). I scored pectoral muscle mass on a four-point scale of 0-3, where "0" was a sharp sternum with concave muscle and a detectable ribcage, and "3" a sternum that was indistinguishable and the muscle convex (Wunderle 1994). I quantified the insect parasite load by scoring the percentage of the primary and secondary feathers of the right wing on which insect eggs were present, where 0 equaled no insect eggs through 3 where over 94% of the feathers had parasite eggs present.

Data Analysis

I captured, banded, and measured 703 Bananaquits. Of these, I recaptured 41 individuals during one subsequent period and 4 individuals within the two subsequent banding periods. I therefore recaptured 5.8% of the original 703 banded birds. Unfortunately, this was an insufficient number of recaptured individuals for a statistically meaningful analysis of the changes in individual body condition across the 3 data collection periods. I corrected body mass for structural body size by adding unflattened wing chord as a covariate in the analysis. Similarly, I added furcular fat deposit scores as a covariate to control for the influence of variations in fat on the measures of body mass. I also controlled for capture time in the comparative analyses involving furcular fat deposits because body fat scores varied significantly by time of day. I tested for statistical differences in the measured indices between sample period and study site. I investigated the variance in size-corrected body mass with respect to site, period, and age of the birds caught. I also calculated the means of the response variables of fat scores, insect-feather parasite load, and pectoral muscle scores for adult birds and investigated the variances in these means across the sites by period. The variation in size-corrected body mass, insect parasite load, fat content, and pectoral muscle mass was compared using an analysis of variance (ANOVA) in a mixed procedure in the program SAS (SAS Institute 2000). Mean comparisons were adjusted using a Tukey-Kramer test[2]. All the individual body condition response variables followed a normal

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[2] The Tukey-Kramer Test is a single step multi-comparison method used to find which means are significantly different from each other. The test involves a simultaneous set of pair-wise comparisons in which there is an adjustment to the *p* value based on the number of mean differences being compared so that the likelihood of obtaining a statistically significant result by chance is reduced.

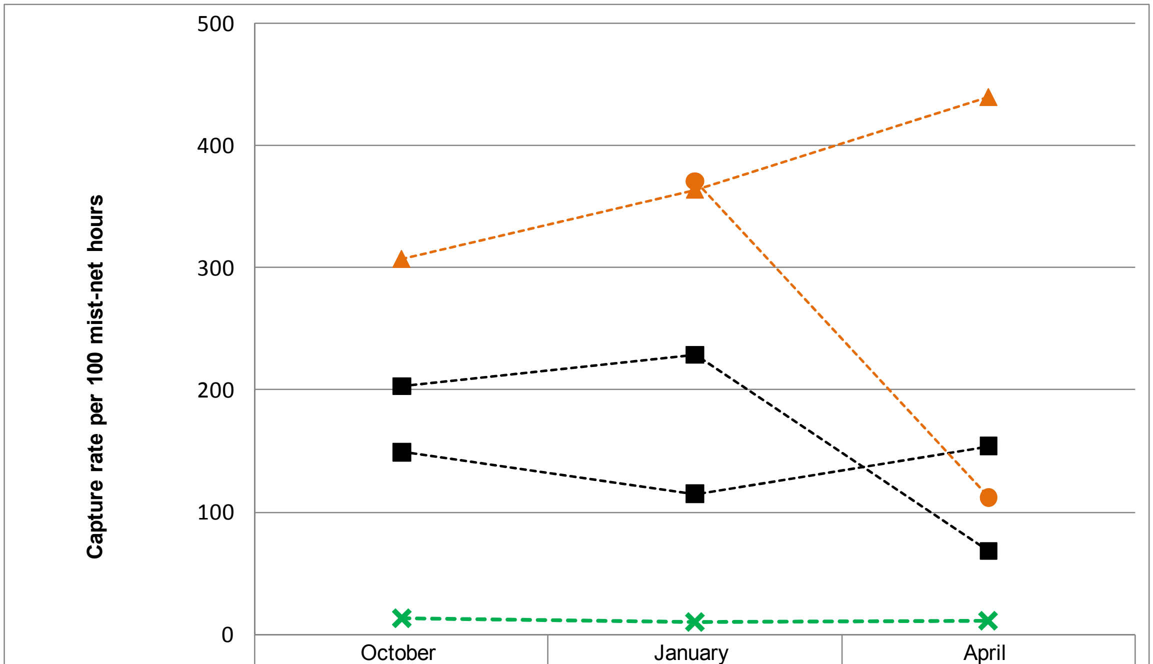
distribution pattern. I calculated Bananaquit capture rates for each site according to the three data collection periods per 100 mist-net hours as an index of bird abundance during each sample period. One 12 m mist-net opened for 1 hour = 1 mist-net hour.

Differences in breeding condition between sites was potentially an important response variable in this study. I therefore examined the ratio of individuals showing cloacal protuberances (males) and brood patches (females) across the sites by period, and compared these by way of a Wald chi-square logistic procedure. Male Bananaquits do not develop brood patches because they do not assist in the incubation of the eggs (Wunderle 1984). Because a previous study indicated that Bananaquits can react directly to the increased availability of moisture and initiate breeding independent of their regular annual breeding season (Wunderle 1982), I examined the potential impact of rainfall as a predictor of corrected body mass and the breeding condition using a regression analysis. I used two measures of rainfall: (1) total rainfall across the period October 2009 through April 2010; and (2) the rainfall for only February and March, which correlated with the rainfall for the dry season, the period I anticipated should be the most influential for the timing of breeding (Wunderle 1982). I also investigated the importance of elevation above sea level as a predictor of body size. Finally I compared the stage of maturity at which fruits were either eaten by parrots (or alternatively harvested for those farms with no parrot-related crop loss) to determine if this influenced breeding status and body condition.

Results

Relative Abundance

I spent an average of 200 mist-net hours within the forest and 32 mist-net hours within citrus orchards respectively per period capturing Bananaquits. Capture rates within citrus orchards were at least an order of magnitude greater than that within the forest for the first two periods. Capture rate was higher but relatively more similar to the forest in April with the exception of in the Salisbury Orchard, where capture rate remained high across all three periods (Figure 1). Bananaquit relative abundance was much higher in October and January on farms that experienced parrot frugivory relative to those that did not. In April, however, Bananaquits were not generally higher in abundance on farms with parrot frugivory, as indicated by the low capture rate at Captain Bruce.



	October	January	April
Forest	13	10	11
Sylvania (NP)	203	229	68
Giraudel (NP)	149	115	154
Captain Bruce (P)		371	112
Salisbury (P)	307	364	440

Figure 1: Changes in the relative abundance of Bananaquits as indicated by the capture rate per 100 mist-net hours at one forest site and four farm sites of different levels of parrot frugivory on Dominica. "X" represents forest; squares farms without parrot frugivory (NP); triangles and circles farms with parrot frugivory (P).

Breeding Condition and Sex Ratio

For the analysis of breeding condition and sex ratio I used only adult birds. No individual caught during the October or January banding period either possessed a cloacal protuberance or a brood patch in any of the five sites. In the April period, however, individuals showing evidence of a cloacal protuberance comprised between 45-65% of the birds caught in all 5 habitats (Figure2). There was no significant difference in the number of males in breeding condition relative to the total number of birds caught at each site (Wald $\chi 2$ = 5.49, df = 4, p = 0.2405). In contrast, with the exception of the

Captain Bruce farm (one with parrot damage), no site had more than one individual with evidence of a brood patch. Among the proportion of the population in breeding condition in April, therefore, the sex ratio was significantly male biased. Twelve (or 19.4%) of the birds caught on the Captain Bruce farm had developed brood patches. The number of females in breeding condition on sites outside of the Captain Bruce farm was too few for further statistical analysis.

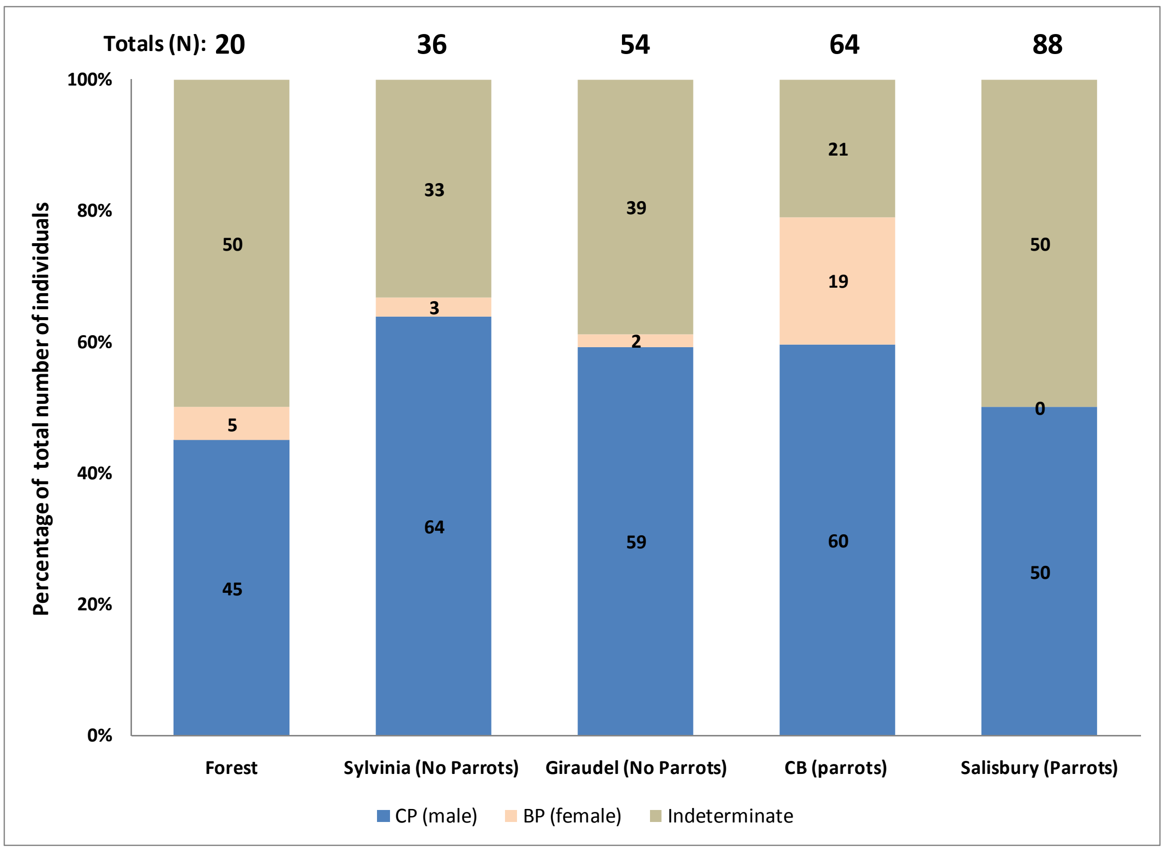


Figure 2: Males and female birds in breeding condition as a percentage of the total number of adult birds caught in April at one forest site and four farm sites on Dominica. The total number of adult birds caught at each site is shown in bold print above each column. Individuals with a cloacal protuberance (CP) are male while individuals with a brood patch (BP) are female. Those individuals with no obvious CP or BP were recorded as sex indeterminate.

Age Ratio

Age ratio varied significantly by sites [F(4) = 6.28, *p* = <0.0001]. Of all sites, the forest had the highest ratio of adults to juveniles. Farms with no parrot-related crop loss and the Salisbury Heights farm had intermediate ratios while the Captain Bruce farm had the lowest ratio of adults to juveniles (Figure 3).

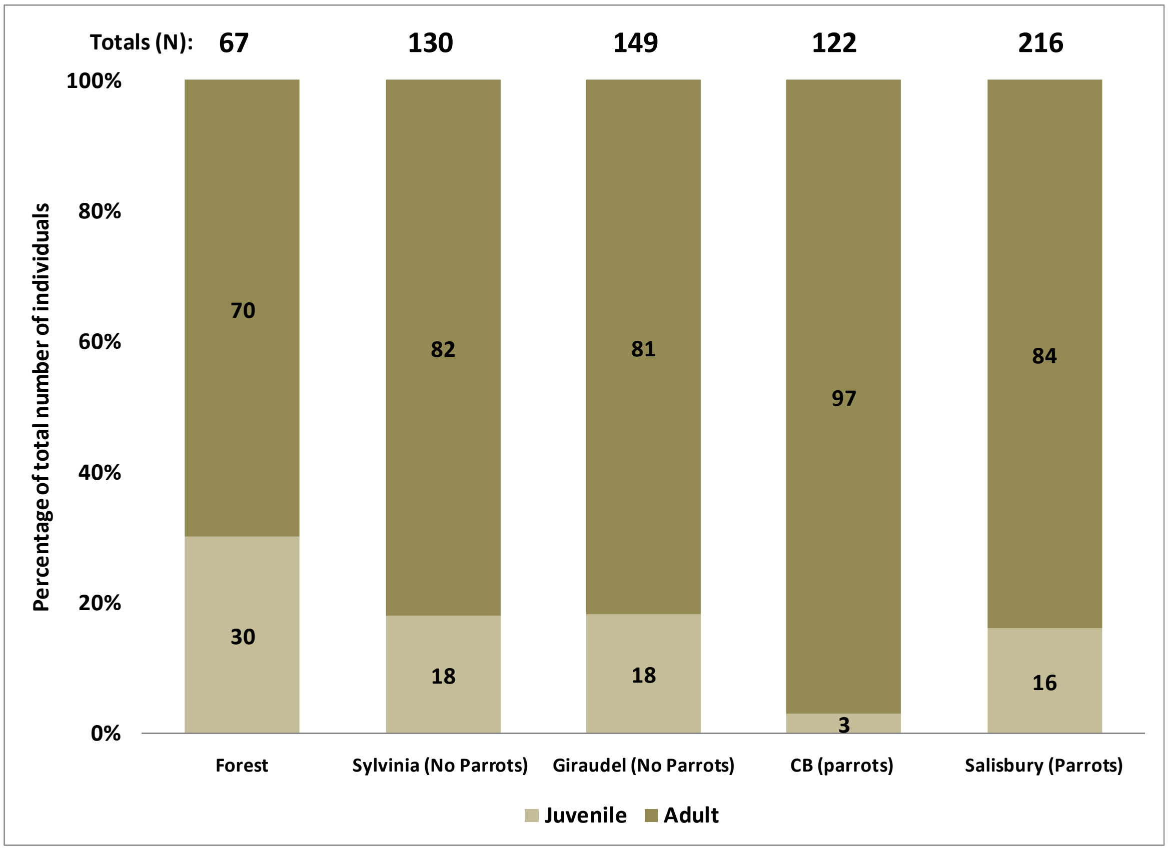


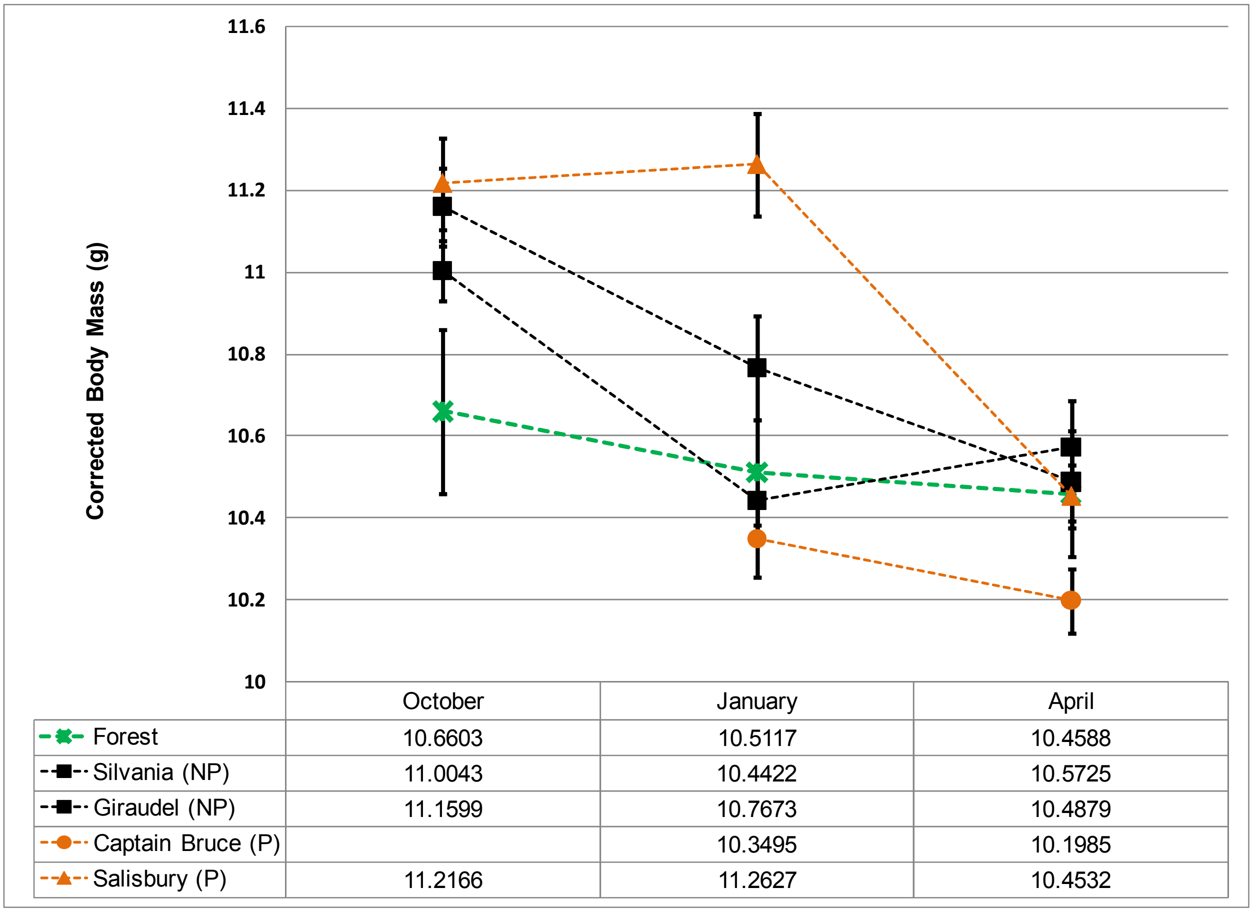
Figure 3: Bananaquit adult to juvenile ratio expressed as a percentage of the total number of individuals caught at one forest site and four farm sites of different levels of parrot frugivory on Dominica. Total number of adults = 573. Total number of juveniles = 110. The total number of birds caught at each site is shown in bold print above each column.

Body Condition Indices

Corrected body mass differed significantly (p <0.0001) with respect to both site and period (Table 1). In general, birds lost body mass between the early and the last citrus season (Figure 4) at all sites. The pattern of this change across the three periods was significantly different among the sites [F (7, 33) = 7.79, *p* <0.0001]. On one farm, namely Salisbury (one of 2 high parrot damage farms), body condition did not change significantly between period 1 and 2. In the forest however, the decrease in body mass was relatively constant and less dramatic. While adults were, on average, heavier than juveniles (10.75 g versus 10.67 g, respectively), this difference was not significant (*p* = 0.4986) and corrected body mass did not differ significantly across either site or period with respect to bird age. The interaction between both age and site, and age and period were similarly not significant. While the mean body mass was significantly different for the earlier periods, by April, mean corrected body mass did not differ significantly across sites.

Table 1: Statistics for the relationship between Bananaquit corrected body mass and the variables of age, site and period.

Indices	**df**	**F Value**	***P***
Age (adults 536; Juvenile 110)	1, 6	0.52	0.4986
Site	4, 647	10.41	<0.0001
Period	2, 32	19.53	<0.0001
Site x Period	7, 32	3.77	0.0043

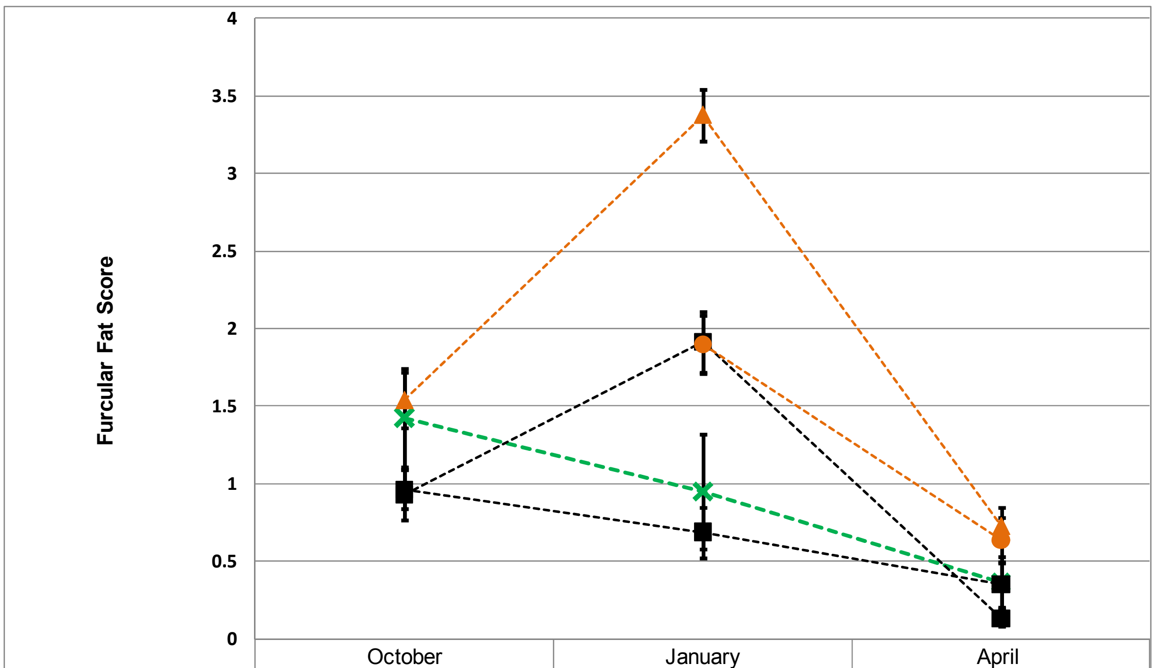


	October	January	April
Forest	10.6603	10.5117	10.4588
Silvania (NP)	11.0043	10.4422	10.5725
Giraudel (NP)	11.1599	10.7673	10.4879
Captain Bruce (P)		10.3495	10.1985
Salisbury (P)	11.2166	11.2627	10.4532

Figure 4: Relationship between corrected body mass for Bananaquits at one forest site and 4 farm sites of different levels of parrot frugivory on Dominica. Each point is the mean for the significant interaction between site and period (mean +/- 1 SE). "X" represents forest; squares farms without parrot frugivory (NP); triangles and circles farms with parrot frugivory (P).

Fat

Capture time was a significant predictor of furcula fat levels [$F(1,42) = 26.06$; $p < 0.0001$]. I therefore controlled for capture time in a comparison of differences in individual body fat across sample period and site by including capture time as a covariate in the analysis. Furcular fat levels differed significantly between sites [$F(4,675) = 23.63$; $p < 0.0001$]. Between periods, furcular fat levels also differed significantly by sample site [period x site interaction $F(7,33) = 10.95$; $p < 0.0001$]. Overall, Bananaquits on farms that experienced parrot damage had greater fat storage while farms with no parrot damage had lower levels similar to the storage levels of birds within the forest. Differences in furcular fat deposits were most extreme during January. The differences in fat deposits, however, largely disappeared by April (Figure 5).

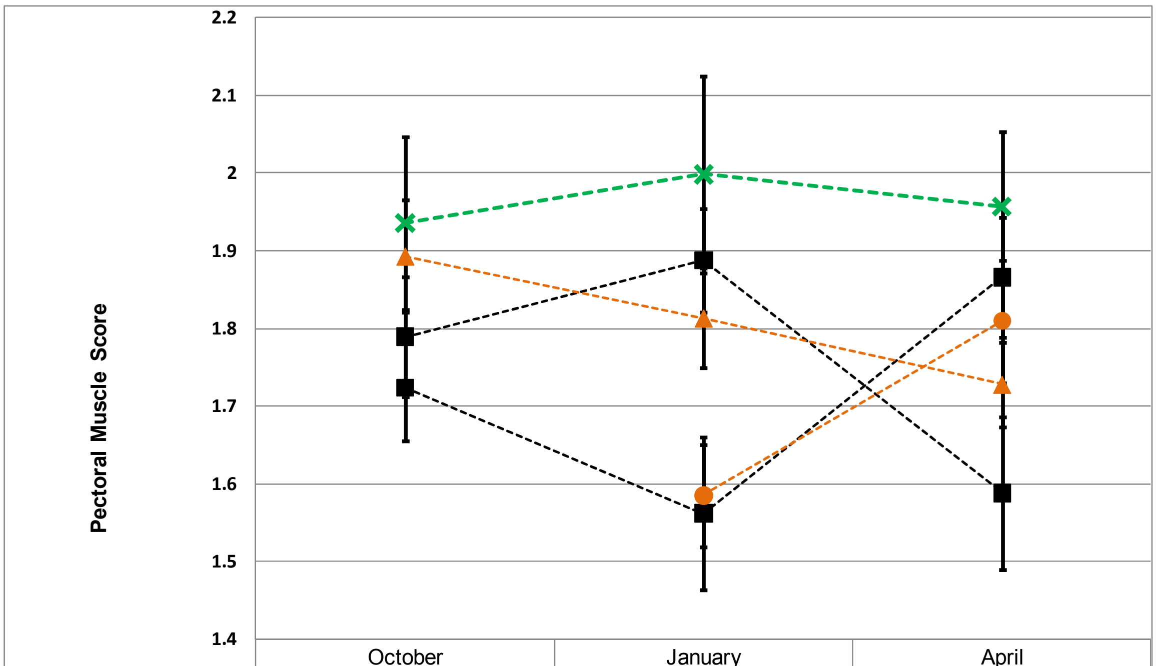


	October	January	April
Forest	1.4263	0.9514	0.3626
Sylvania (NP)	0.9649	0.6889	0.3547
Giraudel (NP)	0.9288	1.9132	0.1344
Captain Bruce (P)		1.8993	0.6367
Salisbury (P)	1.5386	3.3744	0.7286

Figure 5: Relationship between furcular fat deposit scores for Bananaquits at one forest site and 4 farm sites of different levels of parrot frugivory on Dominica. Each point is the mean for the significant interaction between site and period (mean +/- 1 SE). Fat scored on a scale from: 0 = no fat through 6 = great bulging of fat. “X” represents forest; squares farms without parrot frugivory (NP); triangles and circles farms with parrot frugivory (P).

Pectoral Muscle Score

There was a trend of higher pectoral muscle mass in the forest relative to all the farm sites across all three periods. However, among the farms there was no dominant trend in how pectoral muscle mass varied (Figure 6).

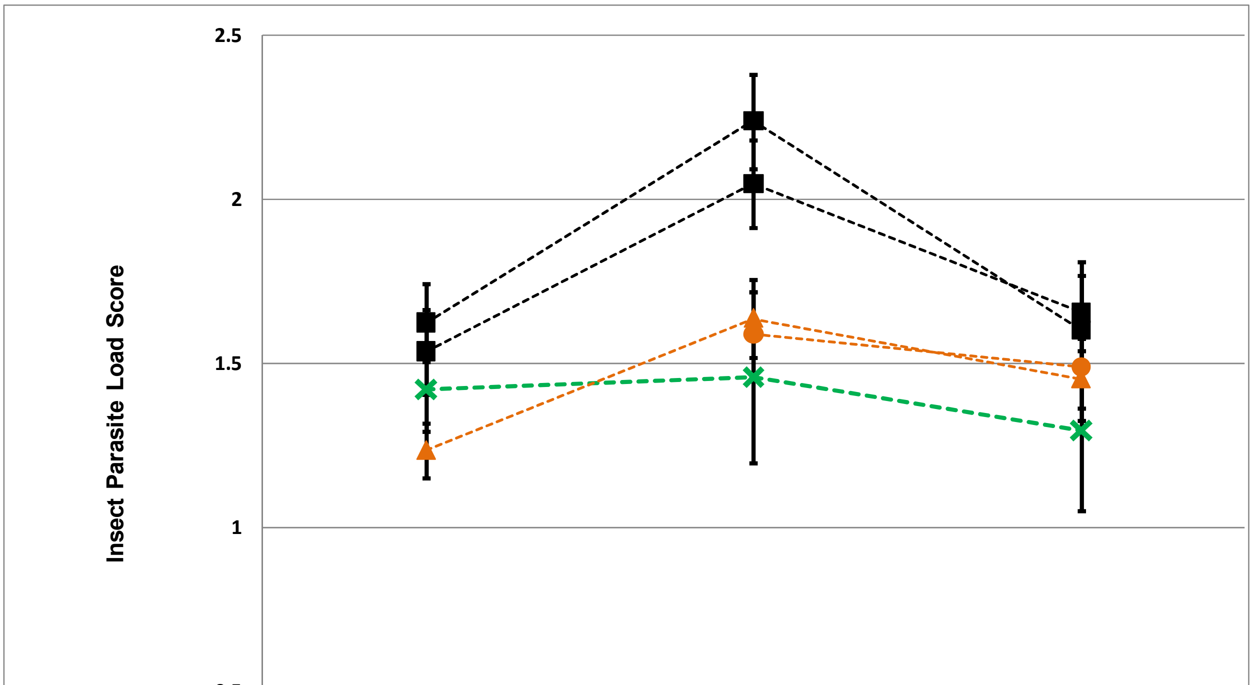


	October	January	April
Forest	1.9355	1.9984	1.9567
Sylvania (NP)	1.7894	1.8874	1.5882
Giraudel (NP)	1.7241	1.562	1.866
Captain Bruce (P)		1.5848	1.8095
Salisbury (P)	1.8931	1.8133	1.7279

Figure 6: Relationship between pectoral muscle mass scores for Bananaquits at one forest site and 4 farm sites of different levels of parrot frugivory on Dominica (mean +/- 1 SE). Muscle scored on a scale form: 0 - sharp sternum with concave muscle and a detectable ribcage to 3 - sternums that was indistinguishable and the muscle was convex. “X” represents forest; squares farms without parrot frugivory (NP); triangles and circles farms with parrot frugivory (P).

Insect Parasite Load

Overall, Bananaquits within the forest had the lowest scores for insect parasite egg load on their wing feathers. Birds on farms that experienced no parrot damage had the highest levels while farms that experienced significant levels of parrot frugivory were intermediate but more similar to the forest (Figure 7). There was a significant difference in parasite load by site [$F(4,678) = 4.96$; $p < 0.0006$]. Parasite load also varied significantly between period [$F(2,32) = 7.45$; $p < 0.0022$]. The site by period interaction was, however, not significant [$F(7,32) = 1.05$; $p = 0.4194$].



	October	January	April
Forest	1.4194	1.4567	1.296
Sylvania (P)	1.624	2.2391	1.6017
Giraudel (P)	1.5366	2.049	1.6541
Castle Bruce (P)		1.5879	1.4901
Salisbury (P)	1.2339	1.6366	1.4521

Figure 7: Relationship between insect parasite egg load on the primary and secondary feathers of the right wing for Bananaquits at one forest site and 4 farm sites of different

levels of parrot frugivory on Dominica (mean +/- 1 SE). “X” represents forest; squares farms without parrot frugivory (NP); triangles and circles farms with parrot frugivory (P).

Rainfall

Total rainfall was not correlated with corrected body mass [F (1, 40) = 0.54, *p* = 0.4669]. Similarly, rainfall during the dry season (during the 8 weeks preceding data gathering during the April period) was not correlated with corrected body mass [F (1, 252) = 0.64, *p* = 0.4241]. Additionally, in a logistic analysis dry season rainfall was unrelated to the number of females in breeding condition (Wald $\chi 2$ = 0.2173, df = 1, *p* = 0.6411).

Fruit Stage

I examined the differences between the stages at which fruits were either eaten by parrots or alternatively harvested from those farms with no parrot-related crop loss (Figure 8). Citrus fruits were generally the most mature on the Salisbury farm, the least mature on the Captain Bruce farm, while the two farms without parrot frugivory were in between. Fruit maturity was significantly correlated with citrus juice sugar concentrations [F(1) = 41.20, *p* = <0.0001] at the Captain Bruce and Salisbury sites (Chapter 2 – Douglas 2011). Based on an analysis of almost 500 randomly selected fruits in both January and March, citrus fruits had significantly higher concentrations of dissolved sugar (measured in Degrees Brix) [F(1) = 24.05, *p* = <0.0001] and were marginally more acidic [F(1) = 3.581, *p* = <0.068] on the Salisbury farm relative to the Captain Bruce farm.

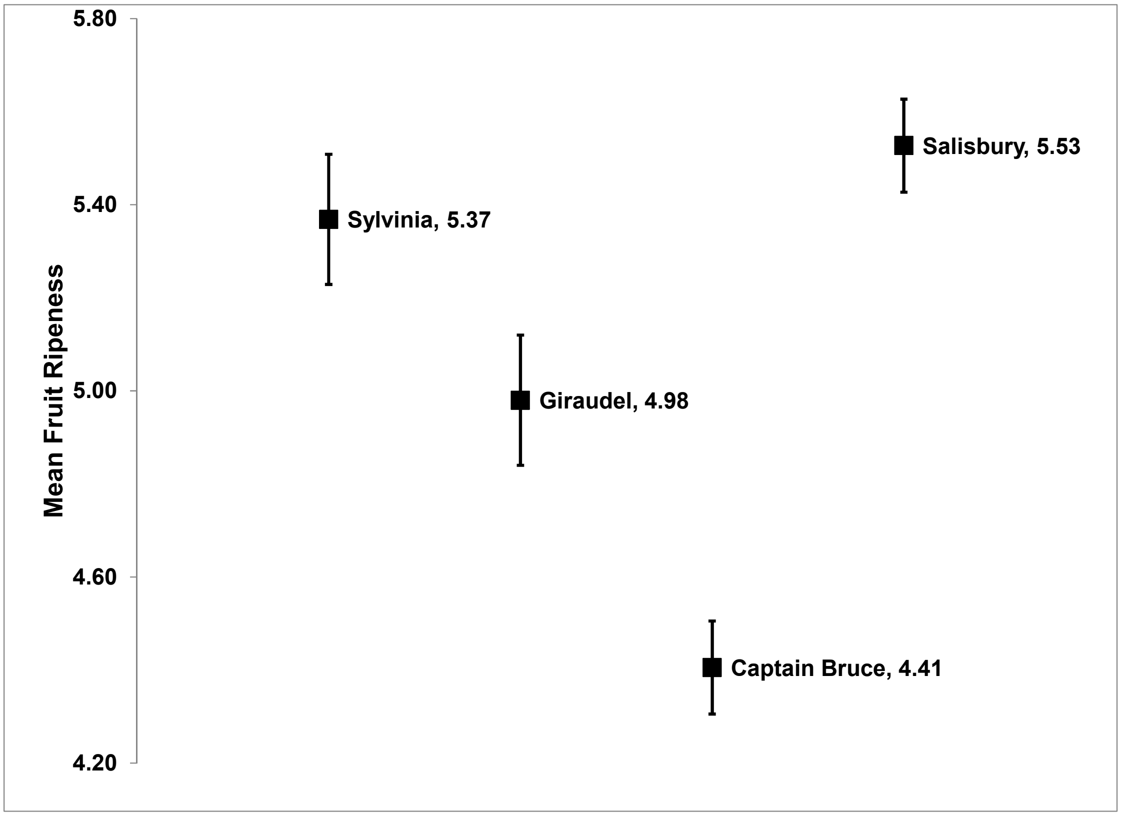


Figure 8: Mean stage of maturity of citrus on 4 farm sites of on Dominica. Quantified based on weekly scoring of the pericarp color of fruits on 15 randomly selected trees from which citrus fruit loss data were collected on each farm over the entire citrus season (mean +/- 1 SE). Fruits were ranked on the following scale: 1 – very green, 2 – green, 3 – green/just yellowing, 4 – just yellowing, 5 – just yellowing/yellow ripe, 6 – yellow ripe, 7 – yellow ripe/softening-overripe.

I examined the possible effect of fruit maturity stage on three measures of body condition: furcular fat levels, corrected body mass, and pectoral muscle mass on the four sample farms. Fruit maturity was strongly correlated with furcular fat scores [$F(3, 609) = 18.75$; $p < 0.0001$]. The more mature the fruits that Bananaquits had access to, the more fat they stored. Similarly, the more mature the fruits that Bananaquits had access to, the higher their corrected body mass [$F(3,585) = 21.30$; $p < 0.0001$]. Fruit maturity was, however, not significantly related to pectoral muscle mass [$F(3,613) = 1.20$; $p = 0.3106$].

Elevation

Following Diamond (1973) I regressed adult Bananaquit unflattened wing chord against the elevation of each site. Elevation was not a significant predictor of body size [$F(1,676) = 2.05$; $p = 0.1524$] in the present study.

Discussion

I eliminated rainfall and elevation as possible drivers of the measured differences in the body condition and the breeding status of Bananaquits. Contrary to expectations, rainfall levels were not correlated with corrected body mass. Similarly, rainfall was not related to female breeding condition. Indeed, both farms that experienced the highest levels of parrot frugivory were generally the driest sites in the study (Appendix 1). This result is inconsistent with the findings of Wunderle (1982) in the dry forests of Grenada where surface moisture, particularly in the early breeding season (dry season), was a cue for the onset of breeding in Bananaquits. This may well be because the current study was within a rainforest life zone where moisture is less of a limiting factor during the most of the year. Despite the documented breeding flexibility of Bananaquits, no birds in breeding condition were captured during the two non-breeding periods of October or January at any of the five sites. When breeding condition is compared with the proportion of juvenile birds, the results further suggest that there was no significant breeding during the study period of October through April and together the results do not support the prediction that either citrus orchards or areas with high levels of parrot frugivory are an important factor that influence when Bananaquits enter breeding condition. The results were also inconsistent with the findings of Diamond (1977) in that elevation was not a predictor of Bananaquit body size. This might be for two reasons: (1) I conducted research within a narrower elevation range of 345 m on Dominica compared with the range of 1,100 m on Jamaica in Diamond’s study, and (2) I collected data within a single life zone while Diamond examined birds across not only an elevation gradient but also rainfall/habitat gradient that encompassed several different life zones from dry coastal thorn-scrub forest over limestone through montane cloud forest over volcanic rock.

Farm Sites vs. Forest

Relative abundance was very different in the forest when compared with all farm sites. The high relative abundance of Bananaquits within citrus orchards was a reflection of the geographic concentration of a food resource in the form of citrus fruits. This was particularly the case during the January period, which coincides with the general middle of the citrus harvesting season when fruits are maturing and also the period during which frugivory by parrots was at its peak on farms where parrots ate citrus. Bananaquit relative abundance was much higher on farms where parrots ate citrus, suggesting that parrot-opened fruit was an important determinant of high Bananaquit abundance. The overall results, however, appear equivocal on the question of whether the citrus agriculture on its own improved habitat quality for Bananaquits. Farms were, on average, disproportionately populated by adult birds and birds with more fat. Taken together these results might suggest greater fitness and habitat quality. On the other hand, forest birds had greater pectoral muscle mass and tended to have fewer feather parasites. There was not a clear trend in the response variables of corrected body mass or in the ratio of males to females in breeding condition between forest and farm sites. The greater pectoral muscle mass of forest birds might reflect the necessity to fly further distances to access less clumped distributions of food resources within forest areas.

Farms with Parrots vs. Farms without Parrots

Contrary to my prediction, among the citrus orchards the response variables were generally the most divergent between the two farms that experienced the highest levels of parrot-related crop loss. On the Captain Bruce citrus farm, the site with the most parrot-related crop loss, corrected body mass and pectoral muscle mass were the lowest of all four farms. This orchard was dominated by adult birds and was the only site that had a significant number of female birds in breeding condition during the early breeding season (and dry season) in April. These results appear to contradict the hypotheses that parrot frugivory enhances habitat quality by way of a reduction of the acquisition costs and increasing the availability of food. However, the correlation of both corrected body mass and furcular fat with fruit maturity stage across all farms suggests a mechanism for the observed disparity. Of all the farms included in the study, the citrus fruits on the Captain Bruce farm were the least mature because of the intensity of parrot frugivory and concurrent increased frequency of fruit harvest by the orchard owner to negate economic losses (Figure 8).

These results suggest that what ultimately influences habitat quality of Bananaquits might be more nuanced than the mere presence of citrus fruits or the quantity of parrot frugivory. Despite high food availability, the quality of the food resource within the Captain Bruce orchard may be relatively poor because the fruits were younger. Generally as citrus fruits mature their ascorbic concentration decreases and their dissolved sugar concentration increases (Nagy 1980). Previous research has demonstrated that under manipulative experimental conditions Bananaquits show strong preferences for the most concentrated sugar solutions available. They compensated for decreases in concentration by increasing feeding time, and at lower levels of sugar concentration Bananaquits lost body mass (Mata and Bosque 2004). In contrast to the relatively well studied association between sugars and nectivore biology, little is known about how organic acids and other secondary compounds within the pulp and juice of fruits influence food choice, energetic and nutritional value, and palatability (Cody 1985; Leseigneur et al. 2007). Immature fruits may not only be less nutritionally and energetically valuable for small birds with high energy needs; they may also contain more chemical defenses that affect fitness. By contrast psittacines have a high tolerance of chemicals that act as feeding deterrents in green fruits, allowing them to eat fruits at less mature fruit stages relative to many other vertebrate frugivores (Norconk et al. 1997).

If fruit chemistry in the relatively younger fruit on the Captain Bruce farm was responsible for lower habitat quality, this might explain the lower body mass and overall smaller size of birds at this site (Figure 4). Additionally, if reproductive success is affected by a reduction in food quality it may suggest why immature birds were less frequent on the Captain Bruce site, because both fledging success and survival may be impacted. Wunderle (1984) suggests that in areas where resources were of higher quality male Bananaquits engage in a more active monopolization of these resources and may, by extension, exclude females[3]. This might explain why the Salisbury farm was male-dominated, whereas females were more common on the Captain Bruce farm, where food resources were of lower quality and perhaps more similar to those available within the adjacent forest. Because males are on average larger than females (Prys-Jones 1982) this might also indicate why body size in Captain Bruce was lower and that of the Salisbury Heights farm high.

Bananaquit density was clearly influenced by parrot frugivory (Figure 1). Density did not, however, mirror other measures of habitat quality such as corrected body mass. This result supports the findings of seminal papers that suggest that density alone can be a poor indicator of habitat quality, especially when studies involve comparisons between natural and human-dominated habitats (Bock and Jones 2004; Vanhorne 1983; Vickery et al. 1992). Furthermore, because those measures of habitat quality that improved most dramatically during the middle of the citrus season (such as body mass and furcular fat levels) decreased significantly by the end of the season, a period that coincides with the traditional dry season when food limitation is greater, it is difficult to predict how parrot frugivory influenced longer term indices such as survival.

[3] Bananaquits construct nests for both sleeping and reproduction. There was no evidence that citrus farms were commonly used for either of these purposes. This may suggest that citrus field were used primarily as foraging areas while the adjoining forests were used for breeding.

Neotropical psittacines are frequently described as destructive and wasteful apex fruit predators able to effectively track and opportunistically feed on widely dispersed forest resources but with little, if any, known direct impact on the structure and function of canopy communities (Haugaasen 2008; Trivedi et al. 2004). The current study was initiated because of the observation that Bananaquits (among other passerines) pursued feeding *A. arausiaca* parrots and fed from the citrus fruits they abandoned. The study provides empirical evidence that canopy feeding psittacines can make food available for secondary frugivores because of their ability to open well protected fruits and, by so doing, provide access to resources that might otherwise be out of reach or at least more costly for them to obtain. Psittacines may therefore potentially exert strong trophic cascade effects influencing resource use and availability for other species. The importance of psittacines as top-down controllers of rainforest ecosystem dynamics therefore appears unappreciated because these effects are both difficult to observe and measure in natural systems where they occur at widely dispersed landscape level scales, while empirical studies of species interactions are usually conducted at small spatial scales (Estes et al. 2011). These findings provide important insights into our understanding of the importance of Neotropical psittacines as modifiers of resource availability and potential mediators of ecosystem structure and function within forest ecosystems. The common assertion that psittacines are wasteful feeders might in fact have important trophic consequences for forest passerines that are seed dispersers and pollinators. The findings further suggest that the dramatic changes in distribution and abundances of these apex consumers due to their extinction in so many islands of the Caribbean within recent history may have had far reaching consequences for both the habitat quality of individual species and also for the overall structure and dynamics of these systems (Estes et al. 2011).

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Appendix 1: Site Descriptions
Note: The GPS coordinates for the forest site was not recorded at the exact location of mist nets because the density of the forest canopy prevented a sufficiently strong GPS signal.

Site Name	GPS Location	Elevation (m)	Total Rainfall (mm)	Feb-March Rainfall (mm)	Total # of Citrus Trees	Mean Fruit maturity*	Percent Parrot Crop Loss	Percent Passer. Crop Loss
Central Forest Reserve	N 15° 28.00 W 61° 18.87	445	1174	52	N/A	N/A	N/A	N/A
Sylvania	N 15° 21.91 W 61° 21.60	531	1082	146	997	5.37	0.7%	22%
Giraudel	N 15° 17.59 W 61° 20.36	664	1385	298	851	4.98	0%	19%
Captain Bruce	N 15° 31.38 W 61° 17.52	319	803	120	1120	4.40	47%	8%
Salisbury Heights	N 15° 28.19 W 61° 24.92	628	454	92	1463	5.53	30%	7%

* Fruit maturity based on a weekly score of the pericarp color of the fruits over beginning in October until the fruits disappeared from the trees. This score is therefore an indication of the fruit stage at which the fruits were either harvested or experienced frugivory – graded on a scale from: 1 (very-green) to 8 (over-ripe). The score is strongly correlated with both the sugar and acid concentration of the fruits.

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The flipside of the flagship – Can the social construction of species for conservation affect the cultural and conservation value of their congeners?

Abstract:

Stakeholder attitudes can have a profound influence on conservation behavior and wildlife managers are increasingly interested in a more complete understanding of why this is so. Flagship species are an important element of conservation efforts that involve engaging stakeholder support for species and habitat protection, and for fund-raising. This paper discusses whether conservation flagship species can negatively influence conservation attitudes and behaviors towards conserving other species. I provide empirical evidence based on field work collected on the island of Dominica which has two endemic globally threatened Amazona parrots. I triangulate three social science research methods: (1) questionnaires; (2) a quantitative content analysis of 31 years of the island's longest running newspaper; and (3) photographic archive data to understand the disparate meanings, knowledge, and value-oriented attitudes that stakeholders on the island hold towards the two parrot species. The study illuminates the power of successfully developing species as iconic conservation flagships. It further highlights a potential unintended effect of the use of the flagship species approach. Specifically, the results show that the development of a successful flagship may marginalize other closely related species within local culture, and that this may be particularly important when human-wildlife conflicts are present.

Key Words: *Amazona,* Caribbean, human-wildlife conflict, flagship species, identity.

Introduction:

Flagship species are common components of conservation efforts where they are used as symbols and focal points to engage support for species and habitat protection and for fundraising. Flagships generally differ from other focal species used within conservation (such as indicator, umbrella, or keystone species) in that, by definition, they are single species, and their primary role is usually sociopolitical (Caro and O'Dotherty 1999; Simberloff 1998). Nevertheless, successful flagship species generally share a few common characteristics. They are usually large, charismatic, threatened, and endemic or restricted to a particular ecosystem (Caro and O'Dotherty 1999). Many studies indicate that these characteristics are particularly useful to secure public interest in flagships, and, by extension, to advance conservation objectives for those “less charismatic” species that share their habitat (Caro and O'Dotherty 1999; Meuser et al. 2009; Simberloff 1998). Conservation organizations have frequently chosen flagship species for their public education, advocacy programs and to raise funds. Furthermore, funds available for wildlife conservation are disproportionately used to support these select species (Clucas et al. 2008; Simberloff 1998). These funded species are primarily chosen based on public “charismatic” appeal as opposed to ecological criteria (Clucas et al. 2008; Kontoleon and Swanson 2003; Metrick and Weitzman 1996; Restani and Marzluff 2002).

Exposure to messages promoting the conservation of flagships can substantially influence the attitudes of stakeholders towards these species and, by extension, their willingness to support their conservation (Butler 1992; Simberloff 1998; Smith and

Sutton 2008; Verissimo et al. 2009). To become an effective flagship, however, a species must first be successfully promoted, or in other words socially constructed, so that its favored iconic status becomes a widely accepted, and a collectively-held belief within society. The development and effectiveness of flagship species can thus be analyzed within the context of social constructionism, the social theory that explains how social realities are produced or developed by groups of people. The meanings, concepts, or practices so developed are called social constructions or social constructs and those who produce them are commonly called the ‘claims-makers’. Social constructionist theory contends that what we know as facts are actually meanings we have acquired from our culture about things beyond their physical presence. Constructs are developed and spread within a society through social interactions such as discourse and symbolic representations. They are important because, if successful, the significance society attaches to them may become engrained components of a culture, may be difficult to change, and can significantly influence attitudes (our beliefs and evaluations of goodness or worth) and behavior (Bryman 2004). The amount of influence that claim-makers possess is usually instrumental in the development and acceptance of a construct because the more politically or socially powerful, by way of their access to resources and status, usually provide more authoritative and, therefore, more influential interpretations of social constructs (Herda-Rapp and Marotz 2005).

As with other aspects of our environment, people routinely socially construct wildlife by ascribing meaning to them above and beyond their physical existence. Within a culture, these meanings become the foundations that dictate appropriate and accepted people-animal relationships and interactions (Herda-Rapp and Goedeke 2005). For conservation purposes, it is common for conservation organizations to develop programs that aim to construct, or reconstruct, species as flagships because of the recognized advantages that successful flagships can create among the important stakeholder groups such as local residents, the general public, donors, policy makers, and politicians among others (Andelman and Fagan 2000). Quite often, therefore, significant resources are invested by conservation scientists to develop species as flagships with the expectation that, over time, the constructs associated with them will be leveraged to conservation's advantages on many levels.

The dominant consensus has been that the development of successful flagships benefits conservation efforts through their ability to influence the meanings, knowledge, and practices that a society holds towards local biodiversity as a whole, in particular for those species that share the flagship's habitat and which are vulnerable to the same threats. Some scholars have been somewhat critical of the flagship concept, however. For example, some researchers have questioned the cost-effectiveness of the approach noting that the conservation focused on flagship species and their habitat requirements is usually undertaken at great expense, sometimes to the neglect of more species-rich or threatened habitats, conservation sites, or other threatened species (Clucas et al. 2008; Restani and Marzluff 2002; Simberloff 1998; Tisdell and Swarna Nantha 2007). The have also noted that funding has been disproportionately allocated to these species based on their public “charismatic” appeal as opposed to ecological criteria (Andelman and Fagan 2000; Kontoleon and Swanson 2003; Metrick and Weitzman 1996; Restani and Marzluff 2002). Additionally, single species management approaches, of which the flagship approach is but one form, have produced management conflicts with other species that share a common landscape predominantly in cases where *in situ* management programs were designed to the primary or exclusive benefit of one species and its needs (Gibbs et al. 2010; Simberloff 1998).

While some authors have queried whether exposing the public to only the chosen upper gentry of species and the select sample of conservation concerns they face might affect public perceptions (Clucas et al. 2008; Sitas et al. 2009) to date, however, no study has explicitly examined whether the flagship species approach is able to produce a scenario in which the cultural importance and conservation value of other wildlife are disadvantaged by the flagship’s success. Using an empirical approach, I discuss and question whether successful flagship species programs can inadvertently compromise the value-oriented attitudes that society places on their con-specific congeners. Because stakeholder attitudes can have a profound influence on conservation behavior, wildlife managers are increasingly interested in a more complete understanding of why attitudes towards wildlife vary so greatly within and among human populations and what are the bases of stakeholder attitudes towards both wild animals and their management (Kaltenborn et al. 2006; Manfredo and Bright 2008). I discuss how an analysis of stakeholder attitudes may inform our understanding of existing conservation behaviors and potentially explain and predict important behavioral intentions. Finally, I discuss why such knowledge might be particularly important for conservation practitioners when and if conflict surrounding wildlife-induced crop losses exists. I do so through an investigation of a case involving psittacines (birds within the parrot family) used as conservation flagships within the Caribbean sub-region of the Neotropics.

Study Context:

The Caribbean region is a global focal point for psittacine conservation. Historically, an estimated 34 species of psittacine were present on the archipelago. Of these, 19 species (56%) became extinct within the last 500 years. Psittacines within the Lesser Antillean islands (the eastern Caribbean region) were particularly affected during this period. Here, some 78% (14 of 18) of the native psittacines became extinct (Wiley et al. 2004). In the 1980s, the four remaining psittacines of the Lesser Antillean islands present on Dominica, St. Lucia, and St. Vincent, all parrots within the genus *Amazona,* became the focus of intense, proactive, and highly successful conservation interventions based on concerns about their endangered status. Through these interventions, largely facilitated through international non-governmental organization (NGO) support, the parrots of these three eastern Caribbean islands became the focal points of national flagship species programs that are collectively credited with the rescue of these island endemic parrots from near extinction (Wiley et al. 2004). At the time that these flagship conservation interventions were initiated, the native parrots of the Lesser Antilles had been selected as national symbols of each of these newly independent island nations. All three islands gained their independence from Great

Britain between 1978 and 1979. In spite of their prominent symbolic State representations on Dominica, St. Lucia, and St. Vincent, however, little changes in the effectiveness of parrot conservation occurred in the immediate years before and after State independence despite important legislative revisions to boost compliance and enforcement. Authors reported widespread apathy about parrot conservation, rapid loss of native forest habitat, and the common taking of parrots for food or for the local and international pet trade prior to the implementation of the flagship species programs (Butler 1992; Evans 1991; Willie 1991). Furthermore, some authors noted the local challenges and cultural stigma associated with the enforcement of wildlife laws on such small islands where a majority of the inhabitants were familiar with each other and where the consumption of wildlife was a popular aspect of local culture (Butler 1992; Christian 1993; Evans 1991; Honychurch 1995; Willie 1991).

An important challenge and opportunity for the conservation community was therefore elevating the importance, relevance, and conservation value of parrots within these island cultures. The chosen approach was to transform the State symbols into popular conservation flagships. At the core of the flagship interventions within the Lesser Antilles was therefore a renegotiation of the cultural meanings of, and beliefs associated with these national birds, and their reconstruction as iconic symbols of national pride and indelible cultural identity. By so doing, practitioners aimed to secure the long-term conservation of parrots, promote the establishment of national parks and protected areas, and effect legislative changes in support of broad-based biodiversity conservation (Butler 1992; Christian et al. 1996; Christian et al. 1994; Manzanero 2004;

Reillo 2000; Wiley et al. 2004; Willie 1991). Collectively the approach was known as the "*Conservation through Pride"* campaigns and, overall, their timing closely following state independence was fortuitous as these island states were actively seeking to exert their uniqueness, cement their new global identity, and secure their individual national heritages. On both St. Lucia and St. Vincent, with their single extant *Amazona* parrot species, the choice for the conservation flagship was both self-evident and unequivocal. On Dominica, however, there were two endemic and globally threatened parrots, the Imperial (*Amazona imperialis*) or Sisserou Parrot and the Red-necked (*Amazona arausiaca*) or Jaco Parrot. Among ornithologists, the Sisserou Parrot was already long distinguished as the largest member of the genus *Amazona*. It was part of the nation's coat-of arms and at independence from Great Britain on November 3rd 1978 this parrot was added as the central figure of the country's national flag and engraved on the State mace (the symbol of authority in the government's legislative house of assembly). While parrot conservation efforts have always included both species of parrots, Dominica's flagship conservation programs would overwhelmingly focus their campaigns on the Sisserou, the more threatened of the two species (Butler 1992; Christian et al. 1994; Reillo et al. 2002; Willie 1991). The main thrust of the Dominican flagship species program began in 1989 when "Project Sisserou" was launched in collaboration with the Rare Center for Tropical Bird Conservation's Caribbean Conservation through Pride Program (also known as the Rare Pride Campaign). Rare is a U.S. based NGO dedicated to the conservation of tropical birds and their habitats.

Under Project Sisserou, messages focused on the Sisserou parrot were successfully promoted island-wide through popular music, theatre, the mass media, school programs, religious, and community leaders. Local businesses were explicitly encouraged to associate their products with parrot conservation via images of the Sisserou parrot and local groups commonly adopted the name as a quintessential symbol of national pride and State identity (Butler 1992; James et al. 2005; Reillo 2000; Willie 1991). Butler (1992) used a structured questionnaire to survey 1% of Dominica's population before and after the 12-month Conservation through Pride Program of 1989/9. His survey showed that over this period there was a statistically significant ($p < 0.05$) increase in the number of Dominicans able to correctly identify the Sisserou parrot: (1) by name; (2) as a Dominican endemic species; (3) as endangered, and; (4) also the legal penalties associated with the taking of the species. Both regional and international parrot experts agree that the 'Rare Pride' programs were highly successful on Dominica and elsewhere in the eastern Caribbean (Butler 1992; Manzanero 2004; Reillo et al. 2002; Wiley et al. 2004; Willie 1991). As a result of these proactive conservation efforts that also included legislative changes and the promotion of aggressive enforcement activities, as well as the expansion of parrot habitat, the parrot populations of both species grew with time on the island. Estimates from 1980, just after the island was struck by two successive hurricanes[4], indicated that there were approximately 80 Imperial and 150 Red-necked Parrots (Evans 1991). In 2008, there were an estimated 200-220 Imperial Parrots and 650-800 Red-necked Parrots on

[4] Dominica was hit directly by Hurricane David in 1979 and by Hurricane Allen in 1980. Hurricane David was a category 4 storm when it hit Dominica on August 29th, 1979.

Dominica (Reillo and Durand 2008). As parrot populations increased, one species, the Red-necked Parrot (*Amazona arausiaca*), which generally lives at lower elevations and is more tolerant of degraded habitats, is increasingly implicated as a crop pest of citrus and other cultivated fruits (Wiley et al. 2004). Frugivory by *A. arausiaca* within human-dominated landscapes has facilitated an enhanced population recruitment rate and a gradual range expansion over the last approximately 25 years (Reillo et al. 2002; Wiley et al. 2004). The development and intensification of conflict about these crop losses is of concern, not only because it potentially jeopardizes continued species and habitat conservation programs, but also because it resurrects an important cause of the historical extinction of psittacine species within the Caribbean. Historically several native Caribbean psittacines were hunted, in part, because of a perception that they were crop pests (Raffaele et al. 1998; Wiley 1993; Wiley et al. 2004).

Here, I aim to identify the socially constructed meanings, place, and importance of parrots in Dominican society. By so doing, I discuss how the choice and production of a species as a conservation flagship may become a defining factor in conservation-related behavior that stakeholders exhibit towards other closely related species. I suggest that an understanding of these constructions is particularly critical in the presence of real or perceived conflict about wildlife-induced crop losses because the escalation of such conflict may provide the stimulus necessary to channel attitudes towards behaviors and activities that hinder or directly counter conservation objectives. In order to do this, I investigated the following 5 research questions on Dominica:

1. How were parrots socially constructed as flagship species?

2. What are the socially constructed meanings of parrots on Dominica?
3. Do Dominicans possess significantly different value-oriented attitudes towards each of their two species of parrots?
4. If yes, what are these value-oriented attitudes?
5. Do these value-oriented attitudes influence conservation behavior differently for each species?
6. Are there conservation lessons for how conservation flagship species are chosen, developed, and managed?

Methods:

Data Collection

I triangulate three social science research methods that combine both quantitative and qualitative approaches. The purpose of this triangulation is both to enrich and extend our understanding of the magnitude and implications of the findings and to add further confirmation of the phenomenon under investigation (Bazeley 2004). Overall, the direction of the study is quantitative. However, I also incorporate qualitative research techniques at various stages because proponents of constructionist approaches to the study of human-wildlife interactions argue that quantitative methods alone may be insufficient to determine more nuanced characteristics of people-wildlife related value-orientations, the process by which these orientations are produced, the extent to which they are entrenched, and more subtle belief systems, ideologies, and assumptions that exist within a society that could significantly inform conflict management, mitigation, and reconciliation (Herda-Rapp and Goedeke 2005). The three methods employed were: (1) a semi-structured and structured questionnaire; (2) a quantitative content analysis of a national newspaper; and (3) a quantitative content analysis of a photographic archive.

1. Questionnaires

Questionnaire Development and Administration

I developed a structured questionnaire following a 5-step process guided by grounded theory: (1) I developed a preliminary list of research questions based on a literature review of agriculture and parrot conservation on Dominica; (2) I conducted unstructured and semi-structured interviews with US-based researchers who previously worked on Dominica and with Dominican nationals; (3) I administered 31 semi-structured questionnaires on Dominica between March 10-31, 2008 to a cross-section of stakeholders of agriculture and parrot conservation (see Appendix 1 for a copy of the semi-structured interview); (4) I identified themes and designed questions for a structured questionnaire which I piloted on Dominica over three months (October – December 2009); (5) I administered the final questionnaire from January through April 2009 and October 2009 through April 2010. During structured interviews, respondents were asked to indicate their agreement to successive statements on a 5-point Likert-type scale, that ranges from 5 (strongly agree) through 3 (not sure) to 1 (strongly disagree). Additionally I used a semantic differential scale to assess the value-oriented attitudes of Dominicans towards the two *Amazona* parrot species. In a semantic differential scale test, the interviewer presents the respondent with a target concept and asks respondents to rate their feelings towards it using a series of paired bipolar adjectives (e.g. “good” vs. “bad”). The method assumes only that respondents have some level of knowledge of the target concept and not necessarily intimate and personal experiences with it (Bernard 2006). In this study, I use Dominica’s two parrots as the target concept and a 7-point scale to identify the affective meanings and value-oriented attitudes that respondents attach to parrots based on ten paired bipolar adjectives. The potential usefulness of a semantic differential scale approach to assess attitudes related to social choice emerged during stage two of the questionnaire development process and the bipolar adjective pairs were identified based on descriptive words used during interviews in stages two, three and four.

Names can be deeply emblematic of the relationships between claim-makers and wildlife and reflective of value-orientations towards them. I investigated the connotative and symbolic meanings that respondents associated with the names of each species of parrot and the extent to which these meanings appear to be collectively adopted and agreed upon within Dominican society. That is, I aimed to determined how successful these meanings were as social constructs of each species. I conducted this investigation by first asking respondents to indicate whether or not the names of each parrot had a specific meaning. If yes, I asked these individuals to say, in their own words, what these meanings were. I then coded their unstructured qualitative responses.

Respondent Selection

To establish a good correspondence between the research questions and the population under investigation, I used a purposive (or stratified) sampling approach following Bryman (2004). I identified and interviewed members of the following seven stakeholder groups: (1) police; (2) farmers affected by parrot-related crop loss; (3) unaffected farmers; (4) traders in agricultural produce; (5) ministry of agriculture personnel (including the Division of Forestry, Wildlife, and Parks); (6) tourism industry workers; (7) the general "unaffected" public. With the exception of the police, I identified the respondents by visiting those areas of the island where these respondents were known to reside or work and then contacting them directly regarding their participation in the study. In the case of the national security officers, I first contacted the island's commissioner of police and obtained permission to interview members of the police force, after which I chose 9 police stations distributed evenly across the island and interviewed 3 officers at each station. These were generally the officers present and willing to participate.

2. Quantitative Content Analysis of the Chronicle Newspaper

The news media was a key component in the social construction of parrots on Dominica for conservation. I therefore conducted a quantitative content analysis of 31-years of Dominica's longest running newspaper – "The Chronicle", a weekly publication. I chose the 31-year review period to cover the years since the State independence in 1978 to 2009 when the data were collected. The overall objective of the analysis was to better decipher the value-oriented attitudes, affective meanings, and history of constructing parrots on Dominica. I surveyed all issues of the newspaper (including newspaper inserts and supplements) available in the library of the National Archives of Dominica (Roseau City) for topics, photographs, and captions that implicitly or explicitly mentioned or alluded to parrots on Dominica in any context. I included photographic illustrations of parrots where no text specifically naming the species was given. I excluded from the archive all depictions of either the national flag of Dominica or the coat-of-arms (both of which illustrate the Sisserou parrot) that did not separately also discuss or refer to the Sisserou parrot by name or using a separate (independent) illustration. I then captured the data using a pre-defined coding schedule and coding manual according to Bryman (2004). I developed and tested the coding schedule and manual during my research visit of March 10-31, 2008. I explored the following two questions in this content analysis:

(1) What is the frequency with which *A. imperialis* and *A. arausiaca* are mentioned in The Chronicle?

(2) How are Dominica's parrots depicted (symbolic or otherwise) in the media?

For each media item (press release, editorial, etc.) included in the archive, I recorded the frequency of mention of any species identified only once, irrespective of how many times it was referenced within each individual media item. If, however, the context in which that species was discussed varied, I coded and recorded all contexts indicated.

3. Analysis of Visual Archive using Quantitative Content Analysis

Visual materials are central to the cultural construction of social realities in contemporary western societies (Rose 2007). While living and traveling around Dominica for over 13 months, I compiled a photo archive by photographing representations of parrots or the use of the name Jaco or Sisserou within public and residential spaces as I encountered them. I excluded representations of parrots in: (1) body tattoos; (2) within retail outlets that catered to foreign tourists, and; (3) representations of the national flag of Dominica. When I the observed the likeness of a parrot, but there was no indication of the name or type of the parrot illustrated, I identified the person who had either produced the image, who owned it, or, in their absence someone otherwise associated with the image to ask them to identify what parrot was illustrated. Alternatively, in those instances in which the name Sisserou or Jaco was observed unaccompanied by some representation of a parrot, I inquired about the significance of the use of the name. In the analysis of the visual archive, my goals were to determine:

1. the frequency with which *A. imperialis* and *A. arausiaca* were illustrated;
2. if the frequency and context within which different species were depicted varied according to the stakeholder group or claim-makers that produced it;
3. the context in which images were presented.

The underlying assumption of the content analysis of both the newspaper and photographic archive is that the frequencies with which certain words, subjects, and themes are present are of importance because they reflect an indication of the relative interest shown in the subjects and themes. Additionally, they may provide an indication of the intentions of claim-makers in generating public interest or to frame an issue and thereby influence public perceptions. That is, they may reflect the intention of claim-makers to engage in the social construction of the subject matter. The method therefore assumes a positive relationship between the occurrence of these subjects and themes and their importance and/or level of interest to either the producers, target audience, or both (Bryman 2004; Rose 2007).

Data Analysis

I used the SPSS Statistics 17 program to analyze the questionnaire data (SPSS, 2010). For the quantitative analyses, I used a combination of pair-wise t-test comparisons, linear regressions, and general linear model (GLM) analyses of within and between subject effects. Alpha = 0.05 for all tests.

Results

Structured Questionnaire

210 respondents participated in the structured questionnaire, a 95% response rate. Of the total of 210 participants, 87 % or 183 respondents participated in the semantic differential scale. The other 13% were excluded because of one or both of the following reasons:

(1) They indicated that they only know that there were parrots on the island but could not distinguish between them.

(2) They could not accurately state the names (local/common or English) of both parrots.

When presented with the 10 bipolar adjective pairs, Dominicans across all stakeholder groups ranked the Sisserou parrot higher. They consistently chose more positive adjectives to describe the Sisserou relative to the Jaco on the scale from 1, which signified the more undesirable attribute, to 7 which signified more desirable attributes. To analyze the differences in these value-oriented attitudes I used pair-wise *t*-test comparisons of the mean responses, a method frequently used in studies of preferences, voting systems, and social choice where comparing entities in paired groupings can reveal which of each pair is preferred (Himes 2007). For all 10 paired bipolar adjectives, the mean response for the Sisserou Parrot was significantly higher ($p < 0.0001$) (Table 1).

Table 1: Results of the pair-wise t-test comparison of the mean responses for the Sisserou and Jaco parrot to 10 paired bi-polar adjective presented in a semantic differential scale analysis.

	Adjective Pairs	**Mean Diff.**	**SE Mean**	**t**	**df**	***p* (2 - tailed)**
Pair 1	Sisserou vs. Jaco: Unimportant – Important	1.240	0.124	9.97	182	<0.0001
Pair 2	Sisserou vs. Jaco: Servant – King	1.492	0.145	10.32	182	<0.0001
Pair 3	Sisserou vs. Jaco: Boring – Exciting	0.907	0.145	6.24	182	<0.0001
Pair 4	Sisserou vs. Jaco: Not respected – Respected	1.049	0.133	7.92	181	<0.0001
Pair 5	Sisserou vs. Jaco: Ugly – Beautiful	1.028	0.118	8.20	180	<0.0001
Pair 6	Sisserou vs. Jaco: Useless – Useful	0.852	0.115	7.39	182	<0.0001
Pair 7	Sisserou vs. Jaco: Demon – Saint	0.939	0.136	6.90	179	<0.0001
Pair 8	Sisserou vs. Jaco: Runt – Pure Breed	1.254	0.140	8.96	180	<0.0001
Pair 9	Sisserou vs. Jaco: Un-Dominican – Dominica	0.769	0.108	7.14	181	<0.0001
Pair 10	Sisserou vs. Jaco: Not unique to island – Unique	0.967	0.129	7.47	181	<0.0001

The analysis further indicated that respondents identified a dichotomy between the species, particularly with respect to 5 of the 10 adjective pairs, namely their relative: (1) importance – pair 1; (2) their kingship or “seniority” – pair 2; (3) how respected they were by Dominicans – pair 4; (4) beauty – pair 5; and (5) “breeding”, or pedigree – pair 8. The latter evaluative adjective pair was presented in the questionnaires using the Dominican (French Creole) phrase for the English words ‘runt’ which is “gaté waas” (using the specific recommendations from the pilot of the questionnaire). This expression, whose literal translation to English is ‘spoiled breed’, has additional connotative meanings. The phrase is used to describe a thing that is imperfectly developed or a midget. The expression is also used to describe an animal that lacks pedigree such as a domestic dog which is perceived to be of an inferior or indeterminate breed. The expression ‘gaté’ is also used to describe human behavior when such behavior is stereotypically characterized as that of the social underclass, uncouth, or uncultured. Overall, however, respondents separated these species the most using the adjective pair servant vs. king. This adjective pair appeared to capture the essence of several of the other attributes. In articulating their choices using this adjective pair, respondents sometimes noted, for example, that the purple on the Sisserou’s breast represented royalty, that the species was revered, and its rarity was in keeping with its kingly stature. One respondent remarked (respondent #29) *“You don’t see a king as you want - You will not see the Sisserou as you want!”* The respondent remarked that the greater beauty of the Sisserou was undeniable: *“You can see it! The colors!”* He also remarked that the Sisserou was a *“bigger race of bird.”* Concurrently, the respondent repeatedly referred to the Jaco parrot using the name “the Ordinary Parrot”, noting that it was small, more common, and more friendly - in keeping with the deportment of a servant: *"The ordinary parrot, they are easily seen and observable."* Similarly, other respondents while agreeing with the description of the Sisserou as "king" suggested synonyms for the use of the term 'servant', to represent the Jaco. Some examples of these are: "*maybe not necessarily servant, but "just a relative of the Sisserou*" or "*the butler*".

While the Jaco parrot scored relatively highly on being Dominican (mean score = 6.13) the Sisserou parrot scored its highest mean average on this attribute (mean score = 6.90). This specific evaluative adjective, and its synonyms, were a common theme in the semi-structured questionnaires used to formulate the structured survey. Because it appeared that the connotative meanings of this expression were complex, I further investigated the reasons why respondents would perceive the Sisserou as more "Dominican" by way of a pre-coded filter question (Table 2).

Table 2: Pre-coded responses to the filter question for respondents who scored the Jaco parrot less than the Sisserou using the paired bipolar adjectives Un-Dominican vs. Dominican. Specifically, the question asked "Why do you think that Jaco is less-Dominican than the Sisserou?" Respondents were permitted to choose multiple reasons, or to suggest new reasons. N = 59.

Coded response	**% of N**
Jaco is not part of the flag or other state symbols - therefore does not represent Dominica.	48%
Jaco is found on other Caribbean islands.	44%
Culturally we identify with the Sisserou, not the Jaco.	37%
Jaco is not exotic or endangered.	10%
Jaco is more "ghetto" in behavior.	5%
New/Other Reason: Dislike of the Jaco parrots. There is no other reason.	5%

These results indicate that there were three main reasons why the Sisserou was perceived as more "Dominican": (1) The Jaco was not reflected in symbols associated with national identity; (2) The Jaco parrot was perceived to be not a Dominican endemic species. For example, respondents frequently indicated that Jaco parrots also occurred on other Caribbean islands. Some questionnaire respondents further indicated that the Jaco parrot was brought by man to Dominica from elsewhere and was therefore not of either conservation or cultural importance for the island; (3) There was a perception that the Jaco parrot had not been publicly promoted or enshrined in local society. Respondents frequently noted that the news media did not feature Jaco parrots. Respondents commonly indicated that they recalled government officials speaking only of the Sisserou parrot. As one respondent notes: *"You only hear them talking about Sisserou, Sisserou, Sisserou."*

I recorded the responses to the following three Likert-scaled statements:

a. Dominica would be just as nice without both of its two parrots:

b. Dominica would be just as nice without just one parrot, the Jaco:

c. Dominica would be just as nice without just one parrot, the Sisserou:

Respondents generally strongly disagreed that Dominica would be just as nice without the Sisserou parrot (Figure 1c) and were more equivocal about whether Dominica would be just as nice without the Jaco parrot (Figure 1b). I compared the mean responses to all three statements using a t-test. The responses to the statements involving the Sisserou only and both parrots, while statistically different [$t(188) = 2.43$; $p = 0.02$], were more similar than the comparisons between the mean response related to the Jaco parrot only and the other two statements. When the mean response related to the Jaco parrot was compared with the means of the statements related to the Sisserou only as well as the Jaco/Sisserou combination, the difference was highly significant ($p < 0.0001$).

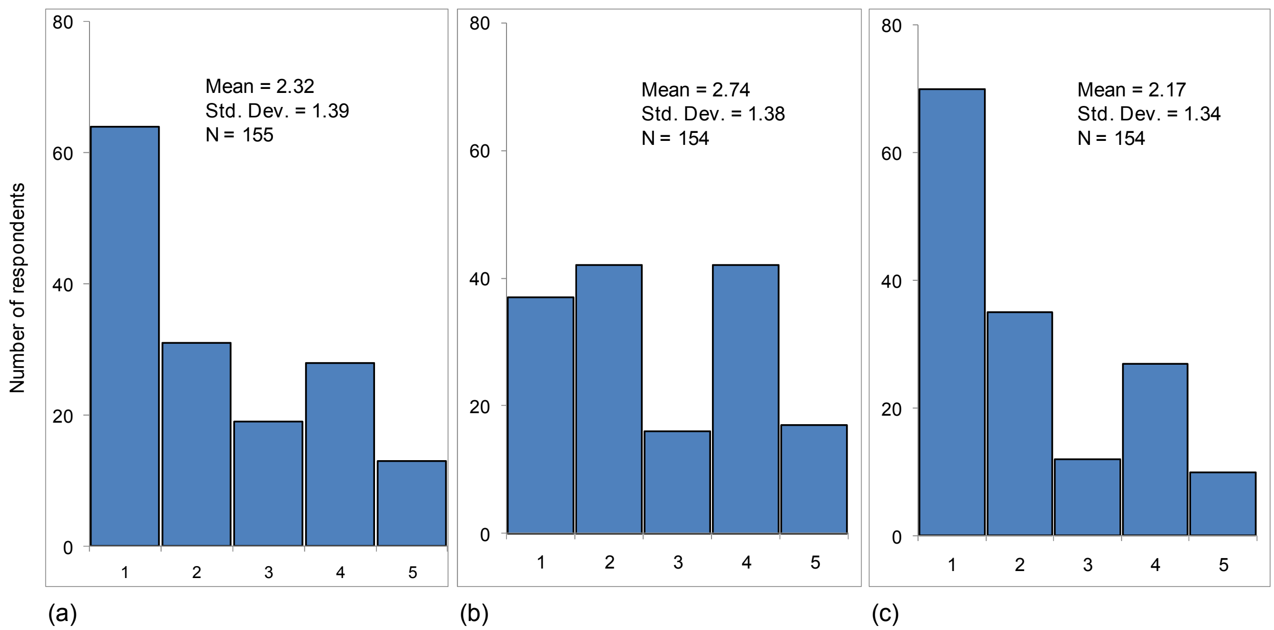

Figure 1: Descriptive statistics for responses to the question - Dominica would be just as nice without: (a) both of its two parrots; (b) the Jaco parrot (; (c) the Sisserou Parrot. Likert-type scale: 5 (strongly agree) through to 3 (not sure) to 1 (strongly disagree). N = number of respondents. Histograms shown (left to right) in the order in which the statements were presented to respondents.

Effect of exposure to parrot-related crop loss

I compared those respondents who had either direct/personal experience of parrot-induced crop losses or who were aware of family, friends, or colleagues who had such experiences with those respondents who had no experience or exposure to this information at all. Of the 183 individuals who responded to this question, 136 had some degree of exposure to parrot-induced crop losses and 47 indicated that they had none. I tested the statistical significance of this relationship in two ways, by using:

(1) A linear regression analysis to examine the effect of experience on the Likert 5-point scaled responses to the questions outlined in Figure 1.

(2) General linear model (GLM) to examine the effect of experience on responses to each of the 10 bi-polar adjectives of the semantic differential scale from Table 1.

There was no relationship in the regression analysis between previous exposure to parrot-related crop losses and responses to the statements that Dominica would be just as nice without either or both of its two parrots ($p > 0.05$ in all three cases). Similarly, in the GLM analysis experience with crop loss did not affect the greater preference for the Sisserou or, alternatively, the lesser preference for the Jaco Parrot. The analysis indicates, however, that for two sets of the bi-polar adjective pairs, experience had a significant impact on the value-oriented attitudes of the respondents, namely: (1) demon vs. saint; and (2) useless vs. useful (Table 3). Respondents with crop loss experience gave lower scores to both species of parrot relative to respondents with no experience using these two adjective pairs. However, the higher ranking of the Sisserou parrot relative to the Jaco was unaffected. This was especially the case for the adjective-pair *demon vs. saint* in which respondents who had experience with crop loss were significantly more likely to give both parrots a lower score (p <0.0001).

Table 3: Results of General Linear Model (GLM) test of the Between-Subjects Effect of experience with parrot-induced crop loss on value-oriented attitudes to both species of parrots as measured using the bi-polar adjectives in the Semantic Differential Scale.

	Bi-polar Adjectives	F	Mean Sq	*P*
1	Important vs. Unimportant	2.920	3.424	0.089
2	Servant vs. King	0.014	0.048	0.906
3	Boring vs. Exciting	0.588	2.587	0.444
4	Not-respected vs. Respected	0.359	3.307	0.550
5	Ugly vs. Beautiful	0.016	0.030	0.900
6	Not Unique to Island vs. Unique	1.761	4.721	0.186
7	Useless vs. Useful	4.542	22.387	0.028
8	Demon vs. Saint	18.064	91.921	<0.0001
9	Runt/Gate vs. High Breed	2.774	9.880	0.098
10	Un-Dominican vs. Dominican	0.045	1.299	0.832

I further investigated whether experience affected the relative degree to which respondents either favored the Sisserou or disfavored the Jaco parrots. I tested this using a GLM analysis of the within-subjects effects. This analysis revealed that experience produced no statistically significant variation in how much the respondents either relatively favored the Sisserou parrot or disfavored the Jaco parrot ($p > 0.1$ for all bipolar adjective pair comparisons).

Effect of respondent occupation

I investigated the effect of respondent occupation on the attitudes illustrated in Figure 1 on two levels. I first investigated the effect for farmers in general (including citrus farmers) and secondly for farmers for whom citrus was an important component of their annual income. Respondent occupation as general farmers did not influence their value-oriented attitudes towards parrots ($p > 0.1$ for all three cases). Similarly, citrus agriculture did not generally influence these attitudes (Table 4). The results, however, indicated there was a trend that citrus farmers were marginally more likely to indicate that Dominica would be just as nice without the Jaco parrot.

Table 4: Results of the regression analysis of the relationship between three measures of value-oriented attitudes towards parrots and respondent occupation as a citrus farmer.

Dependent Variables	t	df	P	F	95% CI	
					Lower	Upper
Dominica would be just as nice without both of its two parrots	1.397	198	0.167	1.925	-0.12	0.68
Dominica would be just as nice without just one parrot, the Jaco	1.919	188	0.056	3.684	-0.01	0.76
Dominica would be just as nice without just one parrot, the Sisserou	0.541	194	0.589	0.292	-0.28	0.50

Impact of attitudes on tolerance, complaints, management behavior

I investigated whether and how these value-oriented attitudes (Figure 1) indicated the behavioral intentions of respondents towards tolerance of parrot-induced crop losses, the likelihood that they would lodge complaints with the government, and their likely support of parrot population management by whatever means as a crop loss mitigation measure. I assessed these behavior-intensions using responses to the following statements:

1. We need to live with the parrots, even if they eat crops.
2. If parrots damage my crops, I will complain to the government and request compensation.
3. The government should reduce the total number of parrots on Dominica to a more manageable amount.

The more strongly respondents agreed that Dominican would be just as nice without its parrots, the less likely they were to agree that Dominicans need to live with parrots even if they ate crops (Table 5).

Table 5: Regression analysis of the relationship between three measures of value-oriented attitudes and responses to the statement (dependent variable): We need to live with the parrots, even if they eat crops.

Predictor variables:	**t**	**df**	**P**	**F**	**95% CI**	
					Lower	Upper
Dominica would be just as nice without both of its two parrots.	- 3.374	199	0.001	11.382	-0.36	-0.10
Dominica would be just as nice without just one parrot, the Jaco.	-4.387	188	<0.0001	19.248	-0.44	-0.17
Dominica would be just as nice without just one parrot, the Sisserou.	-2.636	195	0.009	6.950	-0.32	-0.05

The more strongly respondents agreed with the statement that Dominica would be just as nice without the Jaco parrot the more likely were they to agree that they would complain and request compensation (Table 6). Attitudes related to either the Sisserou or both parrots together were, however, not related to the propensity to complain and request compensation.

Table 6: Regression analysis of the relationship between three measures of value-oriented attitudes and responses to the statement (dependent variable): If parrots damage my crops, I will complain to the government and request compensation.

Predictor variables:	t	df	P	F	95% CI	
					Lower	Upper
Dominica would be just as nice without both of its two parrots.	0.813	199	0.417	0.661	-0.09	0.22
Dominica would be just as nice without just one parrot, the Jaco.	2.289	188	0.023	5.237	0.03	0.36
Dominica would be just as nice without just one parrot, the Sisserou.	1.273	195	0.204	1.622	-0.06	0.27

Similarly, value-oriented attitudes associated with the Jaco parrot were significantly related to support for government control/regulation of parrot population numbers (Table 7). The relationship was also significant for the analysis that included both species of parrots but not for attitudes exclusively related to the Sisserou Parrot.

Table 7: Regression analysis of the relationship between three measures of value-oriented attitudes and responses to the statement (dependent variable): The government should reduce the total number of parrots on Dominica to a more manageable amount.

Predictor variables:	t	df	P	F	95% CI	
					Lower	Upper
Dominica would be just as nice without both of its two parrots.	2.587	199	0.010	6.694	0.05	0.36
Dominica would be just as nice without just one parrot, the Jaco.	3.231	188	0.001	10.441	0.11	0.43
Dominica would be just as nice without just one parrot, the Sisserou.	1.770	195	0.078	3.132	-0.02	0.30

Value-oriented attitudes and the Constructed Meanings of Parrots

Based on the qualitative replies of respondents who indicated that the names Jaco and Sisserou had meanings I identified 12 categories of meaning (Table 8).

Table 8: Coded responses to the question: What does the name Jaco and Sisserou mean? N = 42 (Jaco): N = 31 (Sisserou).

Codes for the connotative/symbolic meanings of parrots based on qualitative responses.	**Jaco**		**Sisserou**	
	Frequency	**% of N**	**Frequency**	**% of N**
Symbol of Dominica	-	-	9	29
Name from the Kalinago language	3	7	7	23
Slave name	29	69	8	26
Person who speaks too much	6	14	-	-
Amazona imperialis	-	-	2	7
An Amazon parrot	1	2	-	-
Endemic species	-	-	1	3
Endangered species	1	2	-	-
Word from the French language	2	5	1	3
Purity	-	-	1	3
Bird of many colors	-	-	1	3
Flying to greater heights and freedoms (national motto)	-	-	1	3
Total	**42**	**100**	**31**	**100**

Forty-two or 20% of the respondents interviewed said that they knew what the name Jaco meant. These respondents indicated that two dominant meanings for the name of Jaco existed and, together, these meanings explained over 80% of the proposed meaning of the name of the Jaco parrot. The dominant explanation for the name was attributed to slavery and a prominent local Maroon leader called Jaco, including historical locations named after him such as Jaco Flats and Jaco Steps (69%). Maroons were runaway slaves who established and commanded remote settlements on many Caribbean islands, including Dominica, during the colonial period (Honychurch 1995; Price 1973). Jaco (also spelt Jacko or Jacco) was the name given to a noted African-born slave who arrived in Dominica in the 1760's. He would become one of the most referenced chiefs of the 'maroon wars' of Dominica within the period 1763-1814 (Cracknell 1973). The second most common meaning for the name Jaco was 'someone who spoke too much', who is sometimes referred to as a 'Jaco' in Dominican culture (14%). Respondents sometimes referred to Dominican (French) Creole expressions such as: "*Oui mangé buda Jaco*" (Translated in English as "you eat Jaco bottom) or: "*Ka parlé kon un Jaco*" (Translated in English as "talking like a Jaco") to illustrate their point. One respondent remarked (#203):

*"I would not have given it that name. Because a Jaco is something that is retarded and cannot talk, that we cannot understand. It talks, and cannot make sense or be understood. I hear people from Grand Bay say that the Jaco talks but cannot be understood. The Jaco will curse you, and tell you '**** you!' It has no sense! It represents something that repeats things and cannot be understood."*

This constructed meaning of the name used in the context of human speech also has some political resonance in Dominican society as political figures who are perceived to be all talk and no action were sometimes associated with this expression, or, more generally, as simply 'a parrot'. This use of the expression is similar to a more regionally known reference to parrots. The mimicry of human speech by psittacines in relation to people - who are purported to either 'speak too much', who are 'talebearers', or who are perceived to simply copy or mimic popular words and actions without reasoning or thought - is a cultural association in many Caribbean cultures (Huggan 1994), and, therefore, overall, the construct is not surprising. The reasons why the expression is overwhelmingly associated with the Jaco parrot on Dominica is, however, unclear. The name Jaco parrot was also used interchangeably with the names, the “Local Parrot” or “Common Parrot”. The use of these attributive adjectives in relation to the name, while appearing only to allude to the relative abundance of the Jaco parrot, also offer important connotative meanings in the context of Dominican culture. On Dominica, the words ‘local’ and ‘common’ are not only adjectives used to evaluate the geographic location or numeric abundance of an attitude object, they also are evaluative of its pedigree, as in reference to a ‘commoner’, as distinguished from, or relative to, an individual or thing of high status, rank, or society. Similar to the their use in relation to the Jaco parrot, these attributive adjectives had the same connotative meaning when they were associated with other animals such as dogs (called ‘local dogs’ or ‘common dogs’) or domestic poultry (‘local fowls’ or ‘common fowls’). In each case, the adjective served to distinguish the pure-bred varieties from their mixed-breed, coarse bred relatives. This constructed meaning was therefore closely related to the construct of the Jaco parrot as gaté (or as a gaté waas) or as the servant, relative to the Sisserou, as expressed in the semantic differential scale.

Thirty-one or 15% of the respondents interviewed said that they were aware of what the name Sisserou meant. Therefore, relative to the name of the Jaco parrot, fewer respondents indicated that they were aware that the name of this parrot had any specific meaning. Additionally, respondents indicated less consensus as to what the name Sisserou meant. Of these, 29% indicated that the name meant either ‘national bird’ or a symbol of Dominican statehood. 23% indicated that the name was derived from a leader of the Kalinago people and/or derived from the Kalinago language (the native-American people of Dominica who were previously called the Carib Indians). Another 26% indicated that Sisserou was attributed to slavery (Table 9). These explanations combined accounted for 77% of the meaning attributed to the name Sisserou. In keeping with the mechanism through which the Sisserou parrot was constructed both during the national independence process and as a conservation flagship through the Conservation through Pride program, the dominant connotative meaning associated with the Sisserou is related to Dominican identity. However, the association between the name and the indigenous people was also strong. As one respondent (# 187) remarked: “*It is a Carib name. It is a national name. It is from that language, and so it is suitable for the national bird.”* Hence, the name of the Sisserou is linked to a separate but also culturally important and celebrated national identity, the indigenous Kalinago people and their unique language. Dominica is the only island in the Caribbean on which a functioning pre-Columbian society has survived (Honychurch 1995) and this is an important source of pride and distinction for the country. With respect to the Jaco, this respondent goes on to note in keeping with the dominant meaning associated with the Jaco parrot: *“The name means the slave Jaco. Runaway slave, and they push themselves in the heights (hills).”* The respondent also alludes to both the contested meanings associated with the legacy of slavery and the known history of the Maroon leader[5]. What it means to be the descendants of slaves and how Afro-Caribbean people self-identify racially with this history are themselves contested social constructions. The affectively constructed meaning of the name Jaco in this historical context is therefore undoubtedly both important and profound.

Correspondingly, another respondent noted (Respondent # 136): *"For whatever reason, although the Jaco is named after one of our ancestors who fought for us, the Sisserou has been identified and chosen as our national bird. The Sisserou is more protected, and not the Jaco. If I heard that someone just killed a Jaco, I would be like…, ok! But if I heard that someone killed a Sisserou I would say "WHAT!!!" Maybe they did not want something that was named after a slave as the national bird. Because the people who were calling the shots were French[6]. It may be that some prejudice was involved there why the Jaco was not chosen."*

The latter respondent is a tertiary educated, middle-ranked police officer. This construct is interesting because, in fact, the literature clearly indicates that Sisserou was also the name of a prominent Maroon slave leader of the Dominican maroon wars of 1763 -

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[5] Many respondents indicated that the identity, meaning, and legacy of Chief Jaco were contested. For example this was expressed in his descriptions as rebellious, runaway, African, slave, freedom-fighter, hero, and ancestor.

[6] Throughout its early colonial history Dominica exchanged hands between British and French colonial control.

1814 (Honychurch 1995). In contemporary Dominica, however, the name is overwhelmingly ascribed to the Kalinago language from which the word is thought to have originated.

Quantitative Content Analysis of the Chronicle Newspaper

The name or image of the Sisserou appeared prominently either in headings, as a photograph, in captions, or, in other prominent ways, 89 times in the weekly newspaper, The Chronicle, between the years 1978 and 2009 (Table 9). By contrast, the name or image of the Jaco appeared 10 times (Table 10). Therefore, the Sisserou was featured 9 times more frequently than the Jaco parrot and, even then, in general, when entries discussed both species only an illustration of the Sisserou Parrot accompanied the entry. This was particularly the case after 1989, the year Project Sisserou was implemented. Of the 10 references to the Jaco parrot, 7 or (70%) were in relation to parrot conservation and/or national parks and protected areas. Eighty-five percent of the context related to the Sisserou was categorized into 3 groups, namely;

(1) The names of local organizations, industries, or products – 33.3%. Common examples of such local organizations, industries, or products are the national chorale of Dominica - the Sisserou Singers, Sisserou Beer, the Sisserou Hotel, and Sisserou Water.

(2) In relation to objects, activities, and events related to state identity, independence, and national patriotism – 29.5%. Common examples include the nation's State award -- the Sisserou Award of Honor -- given annually to distinguished Dominican nationals.

(3) In relation to the parrot conservation and/or national park and protected areas – 30.8%.

Table 9: Context in which the name of the Sisserou parrot appeared within the thematic content analysis of The Chronicle newspaper.

Context	**Frequency**	**Percent**
Name of an organization/place/thing	26	33.3
Conservation	24	30.8
State identity/nationalism	23	29.5
Species found on Dominica	5	6.4
Total	**78**	**100**

Table 10: Context in which the name of the Jaco parrot appeared within the thematic content analysis of The Chronicle newspaper.

Context	**Frequency**	**Percent**
Conservation	7	70
Human-Wildlife Conflict	1	10
State identity/nationalism	1	10
Species found on Dominica	1	10
Total	**10**	**100**

I also compared the variability in the frequency with which each parrot occurred in The Chronicle newspaper with time (in years) (Figure 2). This analysis shows that, in the years after independence leading up to 1989/90 when 'Project Sisserou' was implemented, and in the years immediately after, there was a dramatic increase in newspaper coverage related to the Sisserou. Additionally, with the beginning of Project Sisserou, the number of organizations and commercial products adopting the name Sisserou boomed (see also Butler 1992). Over a similar period, coverage related to the Jaco was minimal but relatively unchanged. After 1993, however, there is a striking absence of any media coverage related to the Jaco parrot for another 14 years. In contrast, over the period of the archive, with the exception of 1980, there was never a year in which there was not at least one entry related to the Sisserou parrot[7].

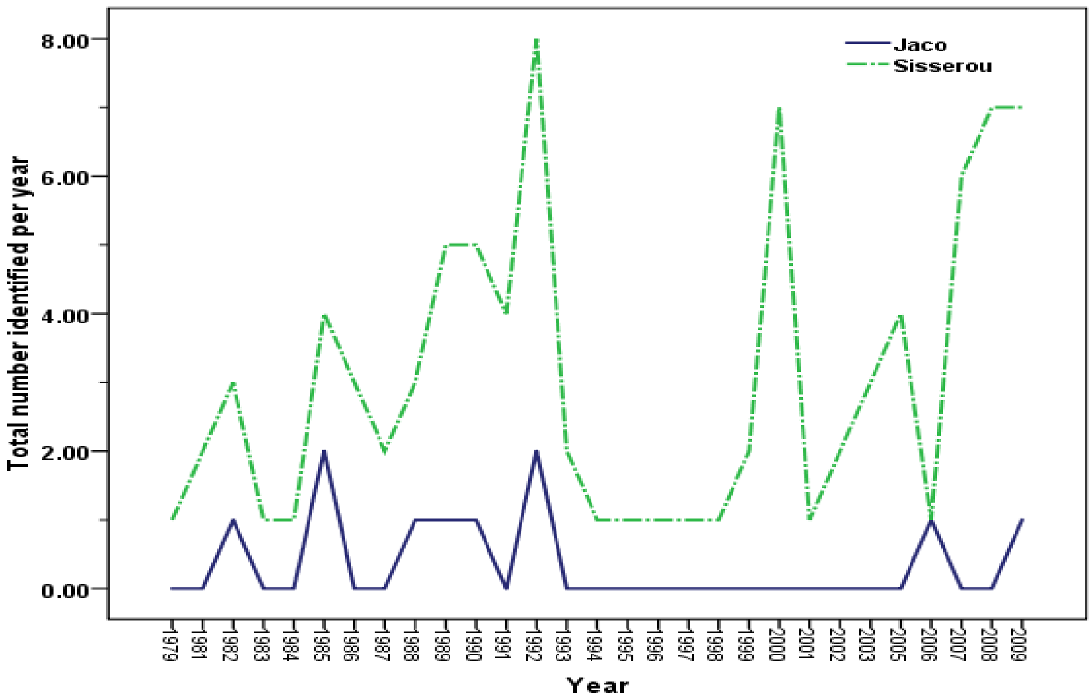

Figure 2: Frequency of appearance of the name or image of the Sisserou and Jaco parrots in *The Chronicle* Newspaper between 1978 and 2009.

Quantitative Content Analysis of Visual Archive

I identified 62 photos showing an image of a parrot or the use of the name of one of Dominica's two parrot species. These photographs illustrated items of clothing, oil

[7] Note: if this analysis included representation such as silhouettes, logos, etc., the numbers for the Sisserou parrot would be higher. However I chose not to quantify the use of these representations because it was not possible to objectively state the identity of the parrot if there was no explanatory text even though a majority was based on variations of the iconic representation of the Sisserou parrot used in the 1989 Project Sisserou campaign.

paintings in residential and commercial spaces such as in community grocery stores, air-brush artwork on the sides of vehicles, advertising posters, carnival costumes, posters in public school classrooms, stickers, table mats, decorative balusters, road signs, commercial packaging, and street art among others. The Sisserou parrot or the name Sisserou was illustrated on its own in 53 (or 85.5%) of the 62 photographs. In contrast, the Jaco parrot or the name Jaco was illustrated on its own only twice (or 3.2% of the entries). Both species were illustrated together on seven occasions. One of the two occasions in which the Jaco appears on its own in the archive was the use of the name Jaco for sign advertising a recently developed waterfall tourist attraction (See Figure 3, # 2). In this instance, multiple individuals associated with this location indicated that the name, as used on the sign, was in reference to the Maroon chief and slave Jaco. This was the only instance in which the use of the name of one of Dominica's parrots was not used to signify a parrot. Incidentally, a waterfall that predated the site in question called Sisserou Falls, also used as a tourist attraction, was also present in the same general area of the island. The second instance in which the Jaco parrot was illustrated alone was on a 1989 poster of the species prepared the Rare Center for Tropical Bird Conservation. . This poster illustration was on a wall in the offices of the Division of Forestry, Wildlife, and Parks. Of the seven instances in which both species were illustrated together, six were produced in collaboration with or for the programs of the Division of Forestry, Wildlife, and Parks (See for example Figure 3, # 4). The seventh instance in which the both parrots were illustrated was in a folk-art painting. Therefore, of the 62 items in the archive, the Jaco parrot was never illustrated on its own by any non- Forestry Division related organizations such as businesses, corporations, or local artists, and the Jaco parrot was only illustrated once, along with the Sisserou, by any of these non-Forestry Division groups.

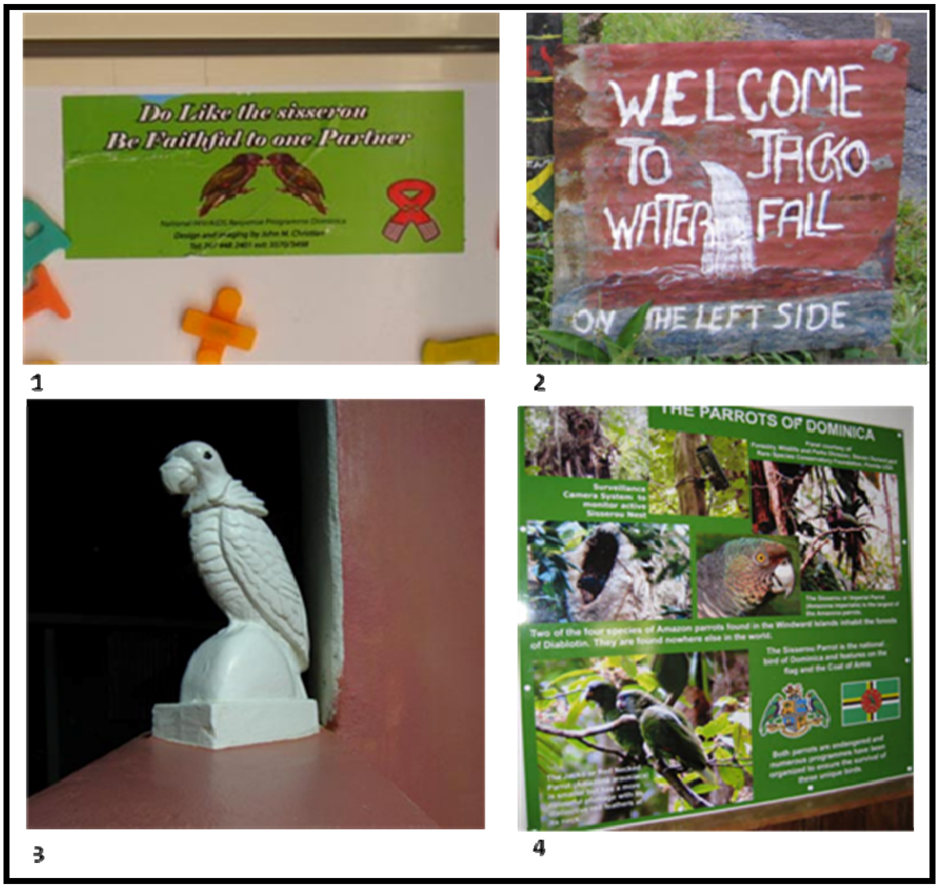

Figure 3: Photographs from the visual archive. 1 – HIV/AIDs sticker on household refrigerator illustrates a pair of Sisserou Parrots; 2 – Road sign for the recently established Jaco Falls tourist attraction; 3 – Decorative Sisserou baluster on the front porch of a residential property; 4 – Division of Forestry, Wildlife, and Parks illustrative visitor information sign about the parrots of Dominica. The sign illustrates the Sisserou using four separate photographs, in addition to its representation as part of the flag and coat-of-arms. The poster also shows a pair of Jaco parrots in the lower left-hand corner.

Discussion

The social construction of the Sisserou was successful

These results clearly demonstrate that Dominicans have very different value-oriented attitudes towards the island's two species of parrots. Overwhelmingly, Dominicans have positive attitudes towards the Sisserou parrot. The results also demonstrate that the affective meanings associated with the Sisserou parrots are in keeping with the process of its construction during the establishment of self-governance and by the Conservation through Pride program that, in concert, constructed meanings rooted in national identity, cultural symbolism, and pride. By extension, what the Sisserou Parrot means to Dominicans is in many ways an embodiment of what Dominicans perceive as the concentrated essence of meritorious Dominican culture, that is global uniqueness and importance, unspoiled natural beauty, and rich local culture. Overall, therefore, the construction of the Sisserou parrot as an iconic venerated flagship species illustrates the power of conservation and government to successfully construct species, influence attitudes and behaviors, and validates the claims that wildlife can be successfully developed into powerful iconic conservation flagships. Indeed, even 20 years after Project Sisserou was implemented on Dominica, the cultural beliefs surrounding the Sisserou parrot have all the characteristics of a successful construction in that what the Sisserou means and represents in Dominican culture is widely accepted, is an engrained aspect of local culture, and is actively maintained and reinforced through language, symbolic representation, and story-building even in the absence of overt interventions by conservation practitioners to substantiate the construct.

Disfavor of the Jaco

I now return to the issue raised in the paper title, whether or not the social construction of the Sisserou as an iconic conservation flagship has affected the cultural and conservation value of its conspecific congener, the Jaco parrot. Undoubtedly, some of the constructed meanings of the Jaco parrot existed before the Sisserou parrot was canonized in the imagination of Dominican society in the 1980s. For instance, the association of the Jaco parrot with the Maroon leader, Jaco, may have existed from the 1800s when Chief Jaco lived and died. Unfortunately, there is no way of knowing with certainty what and how widely established these constructed meanings were prior to the Conservation through Pride program. Our only two points of reference are the recollections of respondents and the newspaper archive. Some respondents indicated that, prior to the 1980s, the general population of the island was relatively less informed about the characteristics of both species as a whole including their relative rarity and behavior outside of the traditional ecological knowledge of hunters as well as dedicated nature enthusiasts who were predominantly restricted to the island's elite. These respondents also suggest that, relative to the Jaco parrot, the Sisserou was generally less known by the public because of its high interior mountain forest habitat and secretive behavior. These claims appear to be supported by the newspaper archive that provides some evidence that, until around 1988, the name of the Jaco parrot was apparently relatively better known by the general Dominican public (See for example page 12. *April 1, 1988. Saving the parrots. The New Chronicle*).

The findings of this research, however, make clear that the process of the construction of the Sisserou parrot as an iconic state symbol and venerated conservation flagship re-cast this species as more worthy of esteem and preservation. Additionally, the process appears to have substantiated existing negative constructs and produced others that, collectively, cast the Jaco parrot as the less-favorable, expendable, and less-significant "other". The process of social construction in many ways produced a construction of the Jaco as the Sisserou's antithesis. The language used in construction of the Sisserou for the public has frequently been one of comparison and contrast and the symbolic representations of the species frequently portrayed the Sisserou as the 'prima donna assoluta'. In the newspaper archive and other local literature, the Sisserou was constructed both objectively and subjectively in terms of its size[8] (largest representative of its genus), its features such as its call (unusual and un-parrot like), its biology (reproductively faithful to one breeding partner for its life). For example a local guide book by (Evans and James 1997) note that *"The cry of the red-necked is a harsh and high-pitched squawk; that of the imperial is more modulated, like a trumpet call."* The Dominican public not only accepted these constructs, they extended the descriptions and comparisons offered by conservation practitioners to almost all aspects of the biology, identity, and "place" of the two species. Furthermore, respondents exhibited tendencies to selectively extract information provided by the Division of Forestry Wildlife and Parks to support their constructs of the Jaco parrot. For example, some respondents noted hearing, reportedly by way of the Division of Forestry Wildlife and

[8] Note: While the Sisserou parrot is larger than the Jaco, both species are among the four largest of the surviving nine parrot species of the Caribbean region.

Parks that the Jaco "fought" with Sisserou parrots for nest cavities and competed with the Sisserou for food and space (See for reference Raffaele et al. 1998). A few respondents therefore further suggested that the success of the Jaco parrots was, by extension, the bane of the Sisserou.

Flagships are generally espoused as ambassadors of those less charismatic, less interesting, relatively less threatened species that share their habitat and which are vulnerable to the threats that the flagship itself faces. As such, the role of the flagship is ideally one that should effectively mediate, circumvent, or negate the negative constructs, especially of their closest relatives, to the conservation benefit of these other species. The results of this research project, however suggest that, at least in some instances, the successful social construction of flagship species may in fact culturally marginalize such species and have the opposite effect.

While relatively recent surveys of the national distribution and abundance of the Jaco parrot suggests a relatively stable population (Reillo and Durand 2008; Reillo et al. 2002), further legitimization of prevailing constructs must be treated seriously given the current public escalation of hostility among local claim-makers and the trend within the last few years in which some farmers have mobilized legal authority[9] and the public news media to frame the issue of parrots as crop pests for both the affected and

[9] In 2008 one farmer initiated a law suit to force the government to address the losses farmers face from parrots by compensation or other means.

unaffected public. Social construction is a constantly evolving dynamic process and, given the current direction of the escalating stakeholder-stakeholder conflict surrounding real and perceived parrot-induced crop losses on Dominica, we should expect that the negative claims about the Jaco parrot will continue to be reinforced to support the lobby for government-sanctioned population management and/or compensation for losses and to rationalize the social acceptability of the covert taking of birds for food and for the international trade in endangered species. This is highly plausible because the findings indicate that the disregard for the conservation of the Jaco is already a successful social construct. This is best illustrated by the statements of police officers who voluntarily articulated their position on the taking of Jaco parrots. Specifically, 3 of the 23 (or 13%) police officers interviewed voluntarily indicated that they would, in general, not consider the taking of Jaco parrots serious and worthy of arrest. This is alarming because both of Dominica's parrots are globally threatened, listed as specially protected species under Dominican law, and are CITES Appendices I[10] listed species. Not only was it surprising that some members of this stakeholder group held this position, the fact that the stated attitudes of the three officers were so similar and that they were comfortable volunteering these enforcement practices in an interview setting was a telling indication that these practices were, for them, socially acceptable and also possibly a cultural-institutional norm. The taking of a Sisserou parrot was, however, clearly indicated as a point of unassailable and zealous law enforcement by all of these respondents.

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[10] CITES Appendix I species are those that are listed by the IUCN as in potential danger of extinction given the nature of the threats they face. The RNP has been listed as a CITES Appendix 1 species since 1987 (Reillo et al. 1999; Wiley et al. 2004).

Some respondents also indicated that they were themselves cognizant of the fact that the disparate attitudes towards the parrots not only existed, but that they influenced stakeholder behaviors. For example, respondent #189 noted: *"We don't see the services of the Jaco. It is only there as a wildlife. But the one of the flag is more useful. It is beautiful, and shows who we are. The Sisserou is well respected and honored. So sometimes if people don't like you, they look for you. But if they like you, they don't mind what you do, and it is the same for with the parrots. People don't like the Jaco parrots".* This respondent is a retired school teacher, minister of religion, and citrus farmer.

Did the flagship concept support Jaco Parrot conservation overall?

An important perspective in the final analysis of the subject of this paper is how much the flagship species concept supported the conservation of the Jaco parrot since its implementation. While this is not a definitive consideration in the analysis of whether or not the flagship species concept has and can produce negative constructs of other species, it is nevertheless a valid and highly relevant question. What we know is that the Conservation through Pride program has been effective in creating positive attitudes towards the Sisserou's conservation. To what extent has it done the same for the Jaco? It is noteworthy that those respondents who exhibited the least familiarity about the differences between the two species were also those most likely to show high favorability to Jaco parrots. These respondents, as a group, were particularly likely to see both species as identical and to refer to both species as the national birds. For this reason, the association with the Sisserou does support conservation attitudes towards the Jaco, albeit by way of poor knowledge and/or error, among such individuals. In contrast, those stakeholder groups that reportedly have had the most influence on the illegal taking of parrots (namely some; hunters, law enforcement officers, and bird/nature-guide operators), are stakeholders that are particularly relatively well-versed with the distinction between the species and, among which, the disparate constructs and attitudes are particularly strong. That is, among these groups attitudes towards each species exhibited greater certainty, centrality, were based on a deeper knowledge and showed less ambivalence as to the culturally accepted place and meaning of each parrot species in local society. So, among these key stakeholder groups, the blurring of the identities between the species appeared less likely to allow the positive attitudes developed about the Sisserou to support conservation behavior towards the Jaco.

Butler (1992) notes that the ability to see wild parrots flying in the skies over the islands of St. Lucia, St. Vincent, and Dominica is a testament to the success of the parrots as conservation flagships. Indeed, parrot conservation on Dominica overall has been very successful in securing the establishment of national parks and protected areas which has benefits for all forest dwelling species including both species of parrots. Furthermore, with Project Sisserou the level of awareness about environmental laws was significantly improved and Dominican nationals are generally well informed about the legal implications of the taking of parrots (even though it was a common misconception that it was only the Sisserou parrot to which protection was to be extended – in practice or in the law). Wildlife law enforcement is led by a highly dedicated staff of the Department of Forestry, Wildlife and Park whose capacity was greatly improved through their engaged support of the international conservation initiatives of the last 20-30 years. The analysis further suggests that the flagship concept has supported Jaco parrot conservation to a meaningful degree. This was reflected in the fact that when both species were grouped together in the evaluation of value-oriented attitudes using the question “Dominica would be just as nice without both of its two parrots,” the inclusion of the Sisserou with the Jaco appeared to temper attitudes towards the Jaco (Figure 1). Whether or not this contribution sufficiently compensates for the development of the opposing constructs is however undeterminable. The rebound of the Jaco parrot numbers is also due to their advantage in eating cultivated crops which has enhanced their population recruitment rates (Reillo et al. 1999; Reillo et al. 2002). Given this advantage Red-necked Parrots commonly has a clutch size of three and fledges two chicks per nesting, an average twice the fledging rate of the Sisserou Parrot.

At first glance, the root cause of human-wildlife conflicts the world over may appear obvious - certain wild animals produce real or perceived (albeit non-malicious) economic harm for local stakeholders which, in turn, fosters disfavor and animosity towards these species. However, similar to those of other studies of species such as wolves (Goedeke 2005), these results suggest that cause and effect relationships that produce the observed value-oriented attitudes towards wild animals may be far from this straightforward (Wilson 1997). In reality, the underlying reasons for disfavor may be more systemic, insidious, and complex. In some cases, the disfavor of species involved in human-wildlife conflicts may pre-date the development of such conflicts and, as such, losses attributed to wildlife become but an added dimension to a pre-existing history of unfavorable value-oriented attitudes. This study clearly shows that the negative attitudes associated with the Jaco parrot do not have their genesis in the modern conflict surrounding crop losses. They are independent pre-existing constructs which now have the potential to define and channel attitudes and conservation behavior in the presence of parrot-induced crop losses.

One methodological issue should be considered when interpreting the results of this study. Unfortunately, the 31 years of the Chronicle Newspaper were not available electronically. Therefore it was not possible to identify words of interest using a computer-based search function and it was impractical to thoroughly read the text of the entire 31 year archive. So, it is possible that I did miss some references to parrots where these were not either mentioned or alluded to in story titles, topics, photographs and their captions, or other prominent ways.

Conservation Implications

This paper is, in part, an appraisal of an important conservation success. Overall, both parrots on Dominica have benefited from the conservation efforts of the past 2-3 decades of which the flagship species concept was an important component. However, the investigation also identified the need for caution and reevaluation. The effects of the construction of iconic venerated conservation flagships may not be all positive and success may come with unintended effects. The study is also an affirmation that human-wildlife conflict research that seeks only to document trends and develop solutions without first examining the deeper mechanisms that may fuel these conflicts may be unexpectedly challenging. Conflicts involving wildlife can be very difficult to manage because, more often than not, they are the result of a complex mix of behaviors (of both human and wildlife), attitudes, socioeconomics, politics, cultural beliefs, traditions, and history much of which might not be immediately obvious (Nyhus et al. 2005). Human-dimensions researchers therefore argue that solutions based solely on the analysis of biological and agronomic data ignore the fact that communities facing conflict are usually already entrenched in their own system of beliefs, deep-rooted cultural values, and valuations of nature that may eclipse the best science-based reasoning and the most well-meaning conflict resolution interventions and policy recommendations (Bagchi and Mishra 2006; Herda-Rapp and Marotz 2005; Naughton-Treves et al. 2003; Peterson et al. 2002). The analysis of constructions surrounding the human dimensions of wildlife-centered conflicts should therefore be an essential step in addressing wildlife-related conflict with the expectation that such analyses will produce meaningful insights that can guide conservation actions and improve the effectiveness of biodiversity conservation programs (Herda-Rapp and Goedeke 2005). Because of the complexity and the culture-specific connotative use of language and symbolic representation, these results would most likely have been missed if a more general survey of wildlife attitudes was the basis for this study (Bazeley 2004; Herda-Rapp and Goedeke 2005). The results therefore speak not only to the need for human-dimensions research but also the vital importance of carefully designed and culturally sensitive approaches.

Social construction, like other social processes, involves, depends on, and produces both inclusions and exclusions as part of the process of the creation of a social reality by way of language and visual representation (Fitzpatrick 2007; Rose 2007). As such, conservationists should be aware and account for both of these effects, their existence, meaning, and implications when designing public programs. The results draw attention to the need for care on the part of conservation practitioners about the process by which species that are intended to serve as conservation flagships are socially constructed. The results clearly illustrate that it is possible that, in the process of the production of a flagship, opposing symbolic meanings of other species with which the flagship might be invariably compared can also be created - meanings that may negatively affect their conservation. I therefore hope these findings will encourage conservation practitioners using the flagship species concept to examine more strategically the impacts and legacy of existing flagships on conservation attitudes and behavior and permit them to avoid the establishment of negative constructs that might facilitate a loss of support for the conservation of the species or the ecosystems that they are expected to conserve.

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Appendix 1: Semi-structured interview administered to 31 respondents on Dominica, March 10-31, 2008.

Introduction:

As you may know, over the past twenty years or so, there have been many activities to try to conserve Dominica's forests and also to protect the island's wildlife. I am doing a study to explore the relationship between nature, wildlife, culture, and agriculture. I would like to ask you some questions regarding Dominica's environment and wildlife and their relationship to agriculture and the culture of the people. To learn about this I intend to speak with a wide range of people to get their opinions and experiences. These interviews are completely confidential. Neither your name, nor any information that could identify you will be shared or printed in the report of this study. This is important to ensure that everyone can speak comfortably and freely.

Interview Questions:

1. Do national parks and protected areas have advantages and disadvantages for Dominica and its people?

2. If yes, what do you think are the most important advantages and disadvantages?

3. What do you know about the Red-necked Parrot (give details)? What name do you call it?
4. What do you know about the Imperial Parrot (give details)? What do you call it?
5. Which of the two do you like the most? Why? (Encourage elaboration and record all adjectives used carefully).
6. Did you (or your friends) ever own one? If yes, which one of the two was it?
7. Are there any problems with or about any of these parrots that you know of? Is there any group(s) of people of Dominica obviously positively or negatively affected by the parrots?
8. If yes, is it serious or not so serious?
9. Have you or anyone you know personally (family/friends) had firsthand experience of problems with parrots?
   a) If yes, give details.
   b) If no, how did you hear about this problem?
10. What do you think is the best way to resolve the current conflict/problem? What actions would you suggest?
11. Who should take these actions?
12. Do you feel that your views (and those of your friends and relatives) are included in the discussion of what happens to the national park or parrot conservation?
13. Are there any groups that strongly favor or disfavor the National Parks that my study might benefit from speaking with?

14. Are there any groups that strongly favor or disfavor Parrots whose opinion you think my study might benefit from?
15. Is there anything else that you would like to add (something that we did not cover or something important to the topic that was not mentioned)?
16. Is it ok for me to speak with you again in another few months when my study is further developed?

End/Thanks

I would like to thank you for agreeing to meet with me and share your thoughts. It is very important to learn from the experiences of people who understand the local situation and culture well. This was very helpful and it will definitely help me to think about my research more clearly. I look forward to seeing you again!

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Parrots, bananas, and Neoliberalism: A systems view of human-wildlife conflict on Dominica.

Abstract:

Human-wildlife conflicts are often complex non-linear issues that frequently become conjoined with or surrogates for pre-existing, broader socio-economic struggles between stakeholder groups. During the 1980s on the island of Dominica, the island's endemic *Amazona* parrots became the focus of intense and proactive conservation interventions based on concerns about their endangered status. Through these interventions the parrot populations rebounded and farmers began reporting parrot frugivory of their citrus crops in the early 90s. Concurrently, the enforcement of international neoliberal free trade policies during the 1980s and 90s led to significant and far-reaching economic, social, and political changes on the island. Using a grounded theory approach I demonstrate that conflict between local stakeholders about parrot-induced crop losses is inherently a product of an unintended and unanticipated collision of State-facilitated parrot population recovery efforts and its post-banana agricultural diversification policies. Furthermore, conflict is largely about festering grievances related to the loss of economic power, financial security, and social status among farmers living in Dominica's post-banana era. Additionally, the conflict is an expression of fear about the loss of citrus, which has become an important form of retirement planning for many in a society in which farmers receive no state or corporate pension benefits and where the average farmer's age is beyond the retirement age of workers within the non-agricultural sector. Overall crop loss attributed to parrots on

Dominica is now a surrogate issue and focal point within a larger, volatile public dispute about the state of agriculture and the security of farmers. The findings indicate that, given its complexity, efforts to understand and mitigate this conflict in a traditional linear manner as purely a wildlife-crop loss issue will be unproductive. Furthermore, it illustrates the advantages of a multidisciplinary systems perspective both in the study and management of this and similar conflicts.

Key Words: Grounded theory, systems-thinking, Caribbean, grievance-based conflict, *Amazona arausiaca*, frugivory.

Introduction

Conflicts involving wildlife are now an important concern within global conservation efforts. Where they exist, such conflicts potentially jeopardize both species and habitat conservation programs and are costly in time, expertise, and resources. Such conflicts are frequently disputes between groups of people about wild animals as well as undesirable interactions between people and the animals themselves (Marshall et al. 2007). Because of this characteristic, human-wildlife conflicts (HWC) are inherently complex social phenomena, strongly influenced and contextualized by local culture, identities, local history, values and politics, and, by extension, may be difficult both to comprehend and effectively resolve (Bartos and Wehr 2002; Herda-Rapp and Goedeke 2005; Peterson et al. 2002). Understandably, approaches to conflict management that occur within a social and political vacuum can be ineffective and even aggravate rather than mitigate conflict (Marshall 2007, Peterson 2002, Naughton-Treves 2003). If the range of the causes, contributing factors, and the historical context within which conflicts develop are poorly-known or misunderstood it is unlikely that either sustainable management or amicable solutions will be identified or widely supported (Bartos and Wehr 2002). For this reason, it is important that the causes that produce conflicts be analyzed to inform action. A partial analysis can have negative effects, however, if, for example, it only confirms specific assumptions or perspectives about the nature, level, and implications of conflict (Engel and Korf 2005).

Because of the complexity of social conflict systems, these nuanced perspectives are potentially valuable ways of both analyzing and addressing wildlife-related conflict because, by their very nature, conflicts are dynamic, non-linear, interactive processes usually composed of many interrelated issues and factors (Bartos and Wehr 2002; Engel and Korf 2005; Thompson 2002). Understanding the causes of human-wildlife related disputes is therefore by necessity multidisciplinary and requires a departure from the traditional linear cause and effect reductionist paradigms of study, management, and resolution that have historically defined our way of understanding, investigating, and managing the natural world (Bynum et al. 2009; Nandalal and Simonovic 2003; Sterling et al. 2010; Thompson 2002). In this study, by examining conflict centered on parrot frugivory on the island of Dominica, I demonstrate the value of systems thinking perspectives and discuss the importance of this approach in conflict analysis. I also discuss the strength of the approach as a management and resolution tool within the context of a facilitated conflict resolution process.

Study Context

I analyze a conflict centered on citrus crop loss attributed to *Amazona* parrots on the island of Dominica. Dominica has an area of 751 km^2. The island is 46.7 km long, 25.7 km at its widest, rises to a height of almost 1,450 meters, and has a population of approximately 70,000 people. Since European colonization and settlement in the 1700s the basis of the national economy has been agriculture. The economy is small, vulnerable and traditionally highly specialized (Payne 2008; Wiley 1998). Dominica's economic prosperity during the early to mid-1900s was largely dependent on citrus (primarily limes, grapefruits, and their products) exports to the United Kingdom; up to the 1970s, the island was a major exporter of grapefruits to the United Kingdom (Honychurch 1995). Since World War II, however, bananas have been the foundation of the political economy[11] of the country. Stimulated by the protection and price-supported market access to the United Kingdom and the European Union (EU) under the Lomé Convention agreements, banana production boomed during the 1970s and 80s, a period frequently referred to as the "Green Gold" bonanza of the banana-producing islands of the Caribbean (Honychurch 1995; McElroy and DeAlbuquerque 1990; Wiley 1998). During this period, the production of bananas contributed substantially to the socio-economic development of the island and was pivotal in the decision to gain state independence from Great Britain in 1978. For example, in 1992, banana production was responsible for much of the country's Gross Domestic Product (20.1%) and a sizable

[11] Political economy**:** economic processes such as production and trade including how these activities interact with politics, laws, and the distribution of wealth in a society.

percentage of the total exports of goods and non-factor services[12] (48.0%) (Payne 2006). At its peak, thousands of rural households benefited substantially from the financial surpluses and increased spending power generated from the industry (Honychurch 1995) and approximately a third of the island's population was employed directly in banana production (Data from Dominica Banana Producers Limited – DBPL). As Payne (2008) described it, Dominica was the "quintessential banana island". However the highly favorable market prices and guaranteed access of bananas to the UK/EU market were challenged and eventually eliminated as international neoliberal free trade policies were enforced by the newly institutionalized World Trade Organization (WTO). The history of and reasons for global market liberalization including its underlying ideology and socio-political effects on the banana-producing small island developing states of the Eastern Caribbean is well documented and will not be reexamined here in great detail (Moberg 2005; Myers 2004; Payne 2006; Payne 2008; Wiley 1998). On Dominica, the subsequent rapid decline of the banana industry (known as the "banana shock") of the 1990s produced significant and far-reaching economic, social, and political changes. With the accelerating decline of the banana industry due to declining banana prices, increasing competition in the international market, and plummeting confidence among local farmers in the industry, Dominica experienced particularly rapid declines in economic growth rates between 1997-2001 (Moberg 2005; Payne 2008). In response, the government of Dominica pursued a dramatic program of economic diversification. Overall the economy was reoriented to capitalize on tourism, manufacturing, energy, and offshore finance with a smaller, more

[12] An index of trade including transactions by government agency personnel abroad.

diffused focus on agriculture as opposed to the traditional large state-led mono-crop farming systems. The government's economic diversification plan for the agricultural sector involved the promotion of nontraditional agricultural exports (NTAEs) a significant proportion of which was investments in tree crops, primarily mangoes, oranges, cocoa, and avocadoes, in addition to cash crops such as passion-fruit, root crops, peppers, ginger, and cut flowers. Farmers were provided with training, subsidies, and incentives through aid and grants from organizations such the Caribbean Agricultural Research and Development Institute (CARDI) and foreign agencies such as the British Development Division (BDD) and European Development Fund (EDF) (Division of Agriculture 1994; Evans 1986b; Henderson-Brewster and Johnson 1994; Wiley 1998). Despite these efforts, the economic exclusion and marginalization of farmers grew and has remained an unresolved issue for the State (Figure 1). Indeed, over the last two decades, thousands of famers have been displaced, youth unemployment has grown, and the undercapitalization and a lack of access to agricultural credit for farmers within an overall increasingly harsh agro-economic climate has deepened (GOV 2006; Maynard 2007; Payne 2006; Payne 2008).

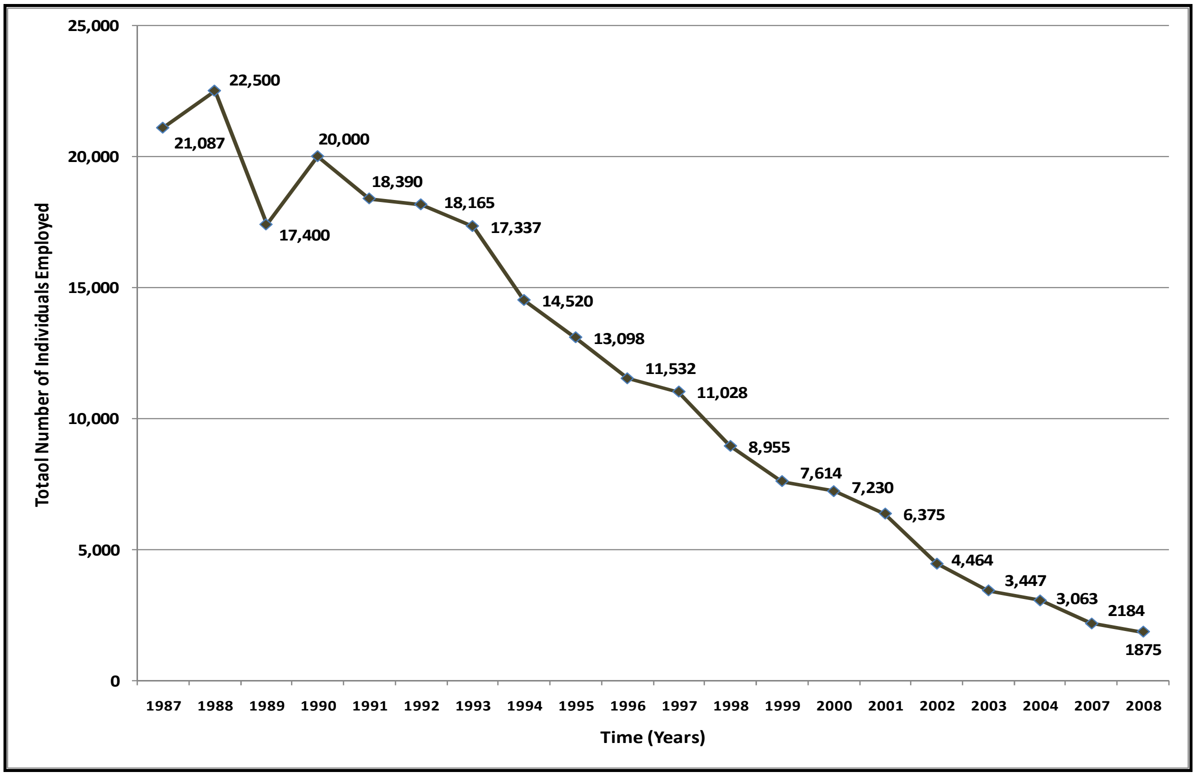

Figure 1: Number of individuals directly involved in the production of banana fruit for export between 1987 and 2008 on Dominica. No data were available for the years 2005 & 2006. (Data used to compile this graph were provided by the Dominica Banana Producers Limited – DBPL).

Concurrently, during the banana boom of the 1980s, Dominica's threatened endemic parrots became the subject of intense, proactive, and highly successful conservation interventions, based on concerns about their endangered status (Wiley et al. 2004). Dominica has two endemic parrots, the Imperial Parrot (*Amazona imperialis*) and the Red-necked Parrot (*Amazona arausiaca*). The Imperial Parrot is listed as endangered and the Red-necked Parrot as vulnerable by the International Union for Conservation of Nature (IUCN) (Forshaw 2006; Reillo and Durand 2008). In 2008, there were an estimated 200-220 Imperial Parrots and 650-800 Red-necked Parrots on Dominica (Reillo and Durand 2008). The Imperial Parrot is recognized as the national bird of

Dominica. This species is also part of the nation's coat-of-arms, the central figure of the country's national flag, and is engraved on the State mace (the symbol of authority in the legislative House of Assembly) of the Parliament of Dominica. Due to effective conservation education efforts, parrots, in particular the Imperial Parrot, are iconic symbols of national pride and identity on Dominica (Butler 1992; Reillo 2000). Through a 1988 amendment to the Forestry and Wildlife Act both parrots were elevated to "specially protected birds" (James 1992a) permitting harsher penalties and legal deterrents for their taking relative to the other wild birds of the island (GOV 1991).

Crop losses attributed to the Red-necked Parrot have been a source of concern on Dominica since the early 1990s (Christian et al. 1994; James et al. 2005; Wiley 1993). Since that period, this species, which generally occurs at lower elevations and is more tolerant of degraded habitat than the Imperial Parrot, is increasingly implicated as a source of fruit loss in citrus, passion fruit, and mangoes, among other cultivated fruits in some agricultural areas of the island (Wiley et al. 2004). Affected farmers on Dominica, who are predominantly citrus farmers, complain about the economic burden they experience due to parrot frugivory and there are infrequent reports of retaliatory killing of parrots with at least one such case leading to arrest and court prosecution. Farmers have also increasingly used the media to frame the issue and call for compensation for crop damage. These debates have included threats of potential violence such as the killing of parrots and personal threats directed at the staff of the Division of Forestry Wildlife and Parks (Irish 2009). Additionally, beginning in 2008 one farmer, with the support of others, mounted a legal case in the local courts seeking financial compensation from the State for parrot damages to his citrus crops (Joseph 2010; Knight 2008; SUN 2008a, b).

Previous research (Wiley 1993, Wiley 2004) demonstrated that Red-necked Parrots are important sources of citrus fruit loss for some citrus farmers and that parrot frugivory of citrus was concentrated in two of the island's five citrus-producing agricultural regions. The region experiencing the majority of these losses was, however, one of the smaller citrus producers by virtue of the total number of trees and registered citrus farmers (Jno. Lewis 1997). Based on 10 months of quantitative citrus fruit loss assessments Douglas (Chapter 2 – Douglas 2011) demonstrated that, on a national level, 17.6% of the fruits produced by citrus trees were lost to parrots. As a percentage of the total amount of fruits lost for any reason this figure represents 38% ,while the remaining 62% of fruit losses was primarily due to either frugivory by passerine birds (23%) or to windfall fruit droppage (26%). An additional 13% of fruit loss was the product of a variety of causes but primarily because of citrus brown rot, a fungal disease (caused predominantly by the pathogen *Phytophthora sp*.), frugivory by rats and opossums (*Didelphys marsupialis insularis*), natural fruit splittage, and an unidentified species of nocturnal fruit-piercing moth (Lepidoptera: Noctuidae). These results showed that, on a national level, relative to the other sources of citrus crop loss combined, parrots were significantly less likely to account for the majority of citrus fruit losses farmers experienced. In this study, I aim to identify the socio-economic causes of conflict related to real and perceived parrot frugivory of citrus on Dominica.

Methods

A fundamental entry point of conflict management is conflict analysis (Bartos and Wehr 2002; Engel and Korf 2005). According to Engel and Korf (2005), an analysis of natural resource-based conflict is vital because it creates a mechanism to decipher the system's structure and dynamics by: (1) Identifying the motivations and values of stakeholders through an illumination of their positions, perceptions, needs, and their perspectives of the conflict; (2) Identifying and clarifying the fundamental factors and root causes involved; (3) Providing an understanding of the extent and nature of the relationships between stakeholders; (4) Providing an indication of possible links between conflict and other socio-political or economic contexts; and (5) Indicating the severity and implications of the conflict.

Because effective conflict analysis is based on a wide range of perspectives relevant to the possible reasons and sources of conflict (Engel and Korf 2005), I chose grounded theory as my primary research methodology. By so doing, the research process itself guided the generation of theories about the reasons for the state of conflict while also illuminating unrecognized or unappreciated causes and contributing factors influencing the state of conflict. Grounded theory is a dynamic research method that encourages the development of theory as part of a process of systematically gathering and analyzing data so that the process iteratively informs and suggests whether and what types of information should be subsequently examined, the possible sources of these data, and the theoretical interrelationships between various categories of information (Bryman 2004).

Data collection on Dominica took place over a period of 13 months during which I resided in the farming and fishing community of Dublanc on the northwestern coast of the island. The mixed-methods data collection approach employed included a combination of open-ended, semi-structured and structured interviews, as well as participant-observation of stakeholders within farms, villages, and at both State and community organized meetings. I identified and examined video footage and minutes of such meetings at which I was not present. I also identified and examined news media items from both radio and print media sources that directly addressed parrot-related conflict or was related to underlying and contributing causes identified by the research process. Because of the need to gain access to a diverse range of perspectives relevant to the research issue, I used a combination of snowball and purposive sampling approaches following Bryman (2004). The combination of these approaches ensured that a wide range of stakeholders were represented within the total sample population by virtue of their distinct characteristics such as their group membership, occupation, and familiarity with (and/or geographic separation from) the regions of the island experiencing parrot-related crop losses. All interviews were conducted in-person, privately, and confidentially to provide respondents with an environment in which they could discuss their personal experiences, perceptions, and concerns freely.

I began the initial data collection process by conducting in-depth unstructured and semi-structured interviews with US-based researchers in both the natural and social sciences who had previously worked on Dominica, as well as with recently arrived Dominican nationals residing in New York City (where I was based during the project's development phase) in an effort to better understand the issues surrounding the conflict between farmers and parrots on Dominica, the farming culture of the island, and the stakeholders of parrots and agriculture. I coded the responses from these interviews following a general qualitative content analysis methodology in order to identify themes for further investigation. I then used these themes to produce research questions for a semi-structured questionnaire that I administered to 31 key informants from 4 stakeholder groups on Dominica: farmers; staff of the Forestry, Wildlife & Parks Division; staff of the Division of Agriculture; and traders in agricultural produce - locally known as hucksters. During these interviews, I asked respondents to discuss: (1) the state of agriculture on the island, the main challenges that the sector faced, and possible solutions for these challenges; (2) any problems related to parrots about which they were aware, including their perceptions of the seriousness of these problems; (3) groups who were either positively or negatively affected by parrots and their conservation, and how these effects were experienced; (4) how they gained knowledge about these problems, and whether there were individuals with whom they recommended that I speak; (5) whether they believed that their views were included or otherwise represented in the discussions about the problem(s); (6) how they would recommend that the current problem(s) be resolved and what action(s) should be suggested/recommended; (7) who should take these actions; and (8) what (if any) other factors and issues that are important to the topic they would like to discuss, or recommend I discuss with others. I used the data from these interviews to identify themes and to develop questions for a structured (or fixed-choice) questionnaire instrument. I then piloted and used this structured questionnaire to assess the relevance, relative importance of, and the relationships between the different causes and contributing factors identified by the 31 key informants interviewed.

I interviewed 210 individuals using the structured questionnaire instrument with a 95% response rate. I subsequently analyzed these questionnaire data and, along with data obtained from ethnographic research following a participant-as-observer role that included unstructured interviews with key informants, I identified further emerging themes that appeared to be important uninvestigated components of the conflict. I then used this information to formulate a second structured questionnaire instrument that I piloted and later administered to 62 individuals. 37 of these were a randomly-selected subset of farmers who participated in the original structured questionnaire. I also identified an additional 25 respondents (all active farmers) following the purposive sampling methodology. I identified these new farmers by visiting yet unvisited sections of the island and asking farmers to participate in the study. The time period between the administration of these two sets of structured questionnaires was approximately 10-12 months.

During all structured interviews, respondents were asked to indicate their agreement on a 5-point Likert-type scale that ranges from 5 (strongly agree) through 3 (not sure) to 1 (strongly disagree) to successive statements. Additionally some questions required respondents to rank items by their importance or seriousness. Furthermore, in addition to the pre-coded responses to the structured questionnaires, during all interviews I recorded the comments, anecdotes, and suggestions of respondents that were not represented among the fixed-choice responses and later examined these qualitatively guided by content and discourse analysis to capture explanatory details. I used the SPSS Statistics 17 program to analyze the structured questionnaire data (SPSS, 2010) using a combination of pair-wise t-test comparisons, Pearson Chi Square, one-way analysis of variance (ANOVA), and linear regressions. I used a statistical significance level of 0.05.

In the latter stages of data gathering, I examined the newspaper narrative across 31 years of the island's longest running newspaper -- "The Chronicle" -- to better understand the history, perspectives, and constructed meanings associated with the identified causes and contributing factors of the conflict. I chose the 31 year review period to cover the years since the independence of the island from Great Britain in 1978 to 2009. I surveyed all issues of the newspaper available in the library of the National Archives of Dominica (Roseau City) for topics, photographs, and captions that explicitly referenced the conflict factors identified. I also conducted a series of in-depth individual-level interviews with key informants identified using a snowball sampling methodology. These informants were particularly acquainted with the events, institutions, policies, processes, fundamental interests, values, and needs that were important to the conflict. These respondents included a former Minister of Agriculture of Dominica and senior officers within the Ministry of Agriculture, Fisheries and the Environment, the Dominica Banana Producers Limited (DBPL), an international aid and development organization, as well as local religious and community leaders.

Finally, I compared the value-oriented attitudes of 16 citrus farmers on whose farms I spent 10 months assessing crop loss due to parrots among other causes. I compared their attitudes about parrots and their conservation, parrot population management, and possible compensation for crop losses with citrus crop loss data from their farms. These crop loss data were collected over two successive citrus harvesting seasons (Chapter 2 - Douglas 2011). I related the attitudinal responses of these farmers to the amount of citrus fruits lost to parrots on their farms (calculated as the amount of the crop eaten by parrots as a percentage of the total amount of fruits that the citrus trees produced).

Research Questions

The research was guided by the following questions:

1. What perceptions and attitudes do Dominicans have about wild animals that eat cultivated crops including parrots?
2. Are attitudes about parrot frugivory of citrus related to perceptions about the state of agriculture on Dominica, and, if so, how?

3. Does the amount of crop losses experienced determine attitudes towards parrots, stakeholder support of population management, and compensation for crop losses, and if not, what predictors best explain these attitudes?
4. What values, attitudes, and practices associated with citrus agriculture have important influences on farmer perceptions of crop loss related to parrots?
5. Does a systems view of this case assist our comprehension of this conflict including potential resolution strategies?

Research Findings

Respondent Characteristics

234 respondents participated in structured surveys. Survey respondents were mostly male (78.3%). Half of the respondents (51.1%) had either not attended or completed high school. High school was the highest level of education obtained by another 15.3% of respondents. 32% had some level of associate or college degree level education even if they had not completed their program (this includes tertiary education at teacher's colleges, agricultural colleges and bachelor's degree granting institutions), and 1.7% had obtained post-graduate university degrees. It was common for respondents to be engaged in more than one form of livelihood activity. For example, farmers could simultaneously be fishermen, construction workers, and/or a small-business owner. 65.4% of respondents indicated that one of their most important forms

of livelihood was farming and 51.9% described themselves as citrus farmers, indicating that citrus cultivation was an important source of their annual income. For the remainder of this paper I describe this 51.9% as citrus farmers. The arithmetic mean age of respondents who were not citrus farmers was approximately 32 (median age category 30 - 39; modal age category 20 - 29). The arithmetic mean age of respondents who were citrus farmers was approximately 50 (median age category 50-59; modal age category 50 - 59). Citrus farmers were significantly more likely to be male [one-way ANOVA: F = 16.942, df = 1, p = >0.0001] and less likely to have attended or completed high school [F = 23.909, df = 1, p = >0.0001].

Perceptions about the State of Agriculture on Dominica

I asked respondents to tell me how much they agreed or disagreed with the statement "I believe that farming on Dominica has a bright future" by using the Likert-type scale that ranged from 5 (strongly agree) through 3 (not sure) to 1 (strongly disagree). In general respondents agreed with the statement that farming on Dominica has a bright future [mean (210) = 3.83, s.d. = 1.194]. In a one-way ANOVA, this response was not significantly influenced by respondent age, level of education, political leaning, section of the island in which they resided, respondent occupation, or their reported experience with parrot-related crop loss on their farms. However, economic wealth, as indicated by the amount of land owned, and gender were significant predictors of respondent beliefs about the future of farming. Individuals with more land were more likely to agree that farming has a bright future [F = 4.041, df = 1, p = 0.046] as were men compared with women [F = 5.923, df = 1, p = 0.016]. I encouraged each respondent to elaborate on the reasons for their stated answer and later coded the reasons to further analyze respondents' agreement or disagreement with the statement (Table 1).

Table 1: Coded responses for why respondents either agreed or disagreed that farming on Dominica has a bright future. 210 respondents responded to this statement. Note: I omitted from this table any reason that was indicated by less than 10 percent of the total respondents.

Reason for Agreement:	**No. of respondents that indicated this reason**	**% of respondents that indicated this reason**
Tradition – This is what I/we know how to do.	57	27.1
History – Agriculture has been the backbone of the country.	47	22.4
Environment– The island's climate and soil are ideal for agriculture compared to our other island neighbors.	39	19.6
Economy – Agriculture is an important aspect of our economy currently and will remain so.	28	13.3
Food Security – We need to grow enough to feed ourselves.	22	10.5
Reason for Disagreement:		
Lack of Market – We have no markets for our produce.	43	20.5
Political Issues – The government is not interested in supporting farming and farmers.	40	19.7
Lack of Support Services – There is a lack of adequate infrastructure, expertise, research and other support services in the sector.	33	15.7
Lack of Laborers – Farmers are not staying in agriculture and the youth are not choosing agriculture as a profession.	33	15.7
Sector Decline – The good days of agriculture are over. The direction that the country is heading is changing.	26	12.4
Loss of Bananas – Bananas, our main industry, has collapsed.	22	10.5

Respondents predominantly expressed faith in the agricultural sector based on historical and traditional grounds. Indeed 49.5% of the reasons for the belief that the future of farming on Dominica was bright were for these two reasons. Respondents, in particular males, consistently described agriculture as their life, that of their elders, inextricable from the existence of rural communities, and, by extension, the foundation of the culture and economy of the nation. Concerns and misgivings were grounded in the recent history of decline in the agricultural sector as a whole, exemplified by the banana crisis. The single most important concern of farmers was the lack of a secure market to accept the agricultural produce they generated. Respondents frequently noted that this was a drastic departure from the 1970s, 80s, and early 90s when there was a guaranteed market for bananas, a crop whose production, centralized collection, purchase, and export was largely supported and managed by the State. Many respondents noted that the government now provided less extension support, subsidies for agricultural supplies, equipment, and inputs. Furthermore, the construction and maintenance of farm roads and agricultural infrastructure were neglected, and training and agricultural innovation were relatively obscure. By extension, farmers framed these changes in the context of a government no longer interested in agriculture and which was, overall, pursuing policies targeted at expanding and improving the non-agriculture sectors of the economy. Perceptions surrounding the demise of the banana industry and the general decline of the agricultural sector were therefore closely tied to the perceptions about the ineptitude or disinterest of government in the sector and the abandonment of support services that benefited farmers.

Challenges facing Farmers

I asked respondents to identify the three most important challenges facing farmers on Dominica using seven categories derived from the unstructured and semi-structured interview data (Table 2). I then asked each respondent to rank their three choices from the most important to the least important for Dominican farmers (Figure 2) and asked them to comment on their rank order. I combined the responses from citrus farmers with those respondents who were not citrus farmers because, with the exception of perceptions about the importance of road conditions and the lack of access to vehicular transportation, the responses of these two stakeholder groupings were not statistically different. Citrus farmers were significantly less likely to indicate that bad roads and a lack of access to vehicular transportation was one of their most important challenges (Pearson Chi Square $\chi2 = 4.521$, df = 1, $p = 0.033$). They were also marginally more likely to indicate that wildlife damage to crops was one of their most important challenges (Pearson Chi Square $\chi2 = 3.076$, df = 1, $p = 0.079$).

Table 2: Responses to the question: "What are the most important challenges for farmers on Dominica?" The total number of respondents responding to this question was 209 (107 citrus farmers and 102 respondents who were not citrus farmers). N = the total number of respondents indicating each perception. (*) indicates a significantly different responses between groups, $p > 0.05$.

Is the respondent a citrus farmer?		**Lack of Market**	**Lack of access to Finance**	**Bad roads & Lack of access to transportation**	**Lack of adequate farm Labor**	**Diseases and Invertebrate Pests**	**Bad Weather**	**Crop damage from Wildlife**
No	N	76	62	47*	36	28	23	18
	% of group	74.5	60.8	46.1	35.3	27.5	22.5	17.6
Yes	N	80	56	35*	42	30	33	31
	% of group	74.8	52.3	32.7	39.3	28.0	30.8	29.0
Total Responses		**156**	**118**	**82**	**78**	**58**	**56**	**49**

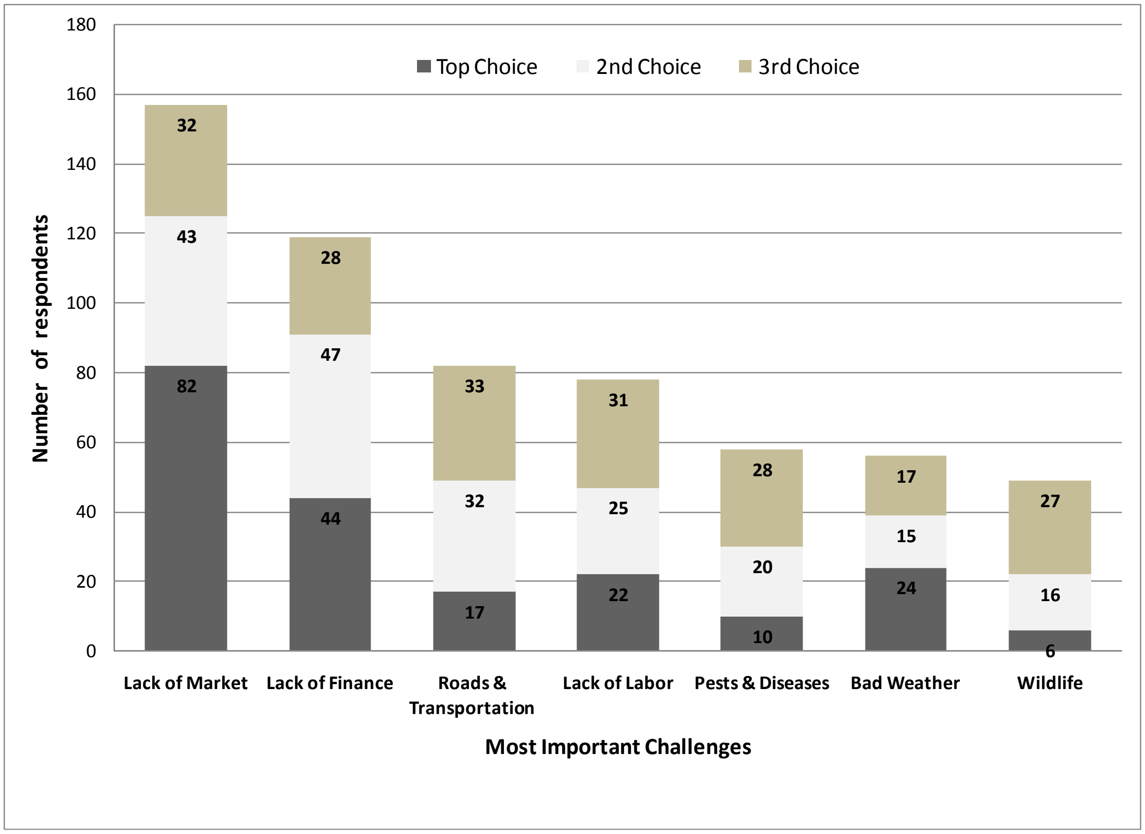

Figure 2: Rank order of responses to the question: "What are the most important challenges for farmers on Dominica? Respondents were asked to rank their top 3 challenges. N = 209.

Similar to the results in Table 1, these results indicate that both citrus farmers and non-citrus farmers on Dominica overwhelmingly agree that the most important challenge facing farmers on Dominica is the lack of a guaranteed market for agricultural produce. Farmers complained that, in the absence of either state-operated or privately owned depots that purchased the most commonly produced agricultural goods, it was difficult to market crops given the island's small local population and economy, lack of local agro-processing industries, or accessible export markets. By extension, farmers indicated that, regrettably, agricultural produce was commonly left to spoil. The second most important challenge identified was the unavailability of loans, grants, and subsidies for farmers from local banks, government-related agencies, and ministries. Farmers reported that during the banana era, bank loans were much easier to obtain because commercial banks had the assurance that banana farmers would receive a guaranteed weekly paycheck from an established buyer. Farmers noted that, in the current absence of guaranteed markets, banks were unwilling to use fruit and vegetable crops as collateral. Additionally, the ability of the government to provide financial support to the farming sector had fallen with the economic collapse that accompanied the banana crisis. The challenge of finance was therefore linked to the number-one challenge of a lack of market. Similarly, farmers associated their concerns about the state of roads, inadequate transportation and their inability to afford farm labor to the two dominant challenges of a lack of market and inadequate financial support, noting that their increasing economic marginalization and the undercapitalization of the sector had precipitated these challenges. They noted that, in the post-banana era, not only were existing roads poorly maintained, but their own weakened financial status also meant that many could not afford farm vehicles to transport their produce. Similarly, respondents noted that the lack of profitability of and investment in agriculture was a disincentive for existing farmers to remain farmers and for youth to choose to work within the sector. For these reasons, they increasingly needed to hire workers, further increasing production costs.

Overall, real or perceived wildlife-related crop loss was the least important challenge that respondents identified. For citrus farmers, wildlife-related crop losses were of approximately the same degree of concern as crop losses due to plant diseases and invertebrate pests or due to unfavorable weather (such as drought, excessive rain, or tropical storm systems, including hurricanes) – See Table 2. Of 107 respondents who were citrus farmers, wildlife-related crop loss was one of the three most important concerns for 29% (or 31 respondents). Furthermore, of these only 4 indicated that it was their primary concern, suggesting that, overall, wildlife-related crop losses were a relatively minor challenge for citrus farmers as a group.

Most important biological sources of crop loss

I examined the perceptions of respondents to determine the most important causes of crop loss on Dominica due to biological sources using eight categories derived from unstructured and semi-structured interview data (Table 3). I asked each respondent to rank their three top choices in order of importance (Figure 3). I omitted from this analysis any cause (either pre-coded in the questionnaire or suggested during the interview) that was mentioned by fewer than 3 respondents. Similar to the results in Table 1, both citrus farmers and other stakeholder groups generally agreed about the factors that were the most important causes of crop loss. Citrus farmers were, however, significantly more likely to indicate that parrots were among the most important biological sources of crop loss relative to respondents who were not citrus farmers (Pearson Chi Square $\chi 2 = 10.288$, df = 1, $p = 0.001$) and they were significantly less likely to indicate that Opossums (*Didelphys marsupialis insularis*) were among the most important sources of crop loss (Pearson Chi Square $\chi 2 = 4.814$, df = 1, $p = 0.028$) (Figure 4). Both citrus farmers and other respondents considered invertebrate pests and diseases as the most significant cause of agricultural crop losses. Among the vertebrate agents of crop loss, rats, passerine birds, and parrots were perceived as the most important causes. Furthermore, there was no significant difference in how important citrus farmers perceived rats, passerine birds, or parrots as sources of crop loss. Among the group of animals traditionally considered as wildlife (which therefore excludes diseases, invertebrates, and rats), birds (both passerine birds and parrots) were perceived to be the most important causes of crop loss.

Table 3: Responses to the question: "Which of the following causes the most damage to crops on Dominica overall?" The total number of respondents responding to this question was 209 (107 citrus farmers and 102 respondents who were not citrus farmers). N = the number of respondents indicating this perception. % = the percentage of 'N' indicating this response. Table omits any cause mentioned by less than 3 respondents. (*) indicates a significantly different responses between groups (farmer versus non-farmer), *p* > 0.05.

Is the respondent a citrus farmer?		**Plant Diseases & Pests**	**Rats**	**Passerine Birds**	**Parrots (*Amazona* sp.)**	**Agouti (*Dasyprocta sp.*)**	**Wild Pigs (*Sus scrofa*)**	**Opossums (*Didelphys marsupialis insularis*)**
No	N	80	43	46	28*	33	16	16*
	%	78.4%	42.2	45.1	27.5	32.4	15.7	15.7
Yes	N	78	58	54	55*	28	25	7*
	%	72.9	54.2	50.5	50.9	26.2	23.4	6.5
Total Responses		**158**	**101**	**100**	**83**	**61**	**41**	**23**

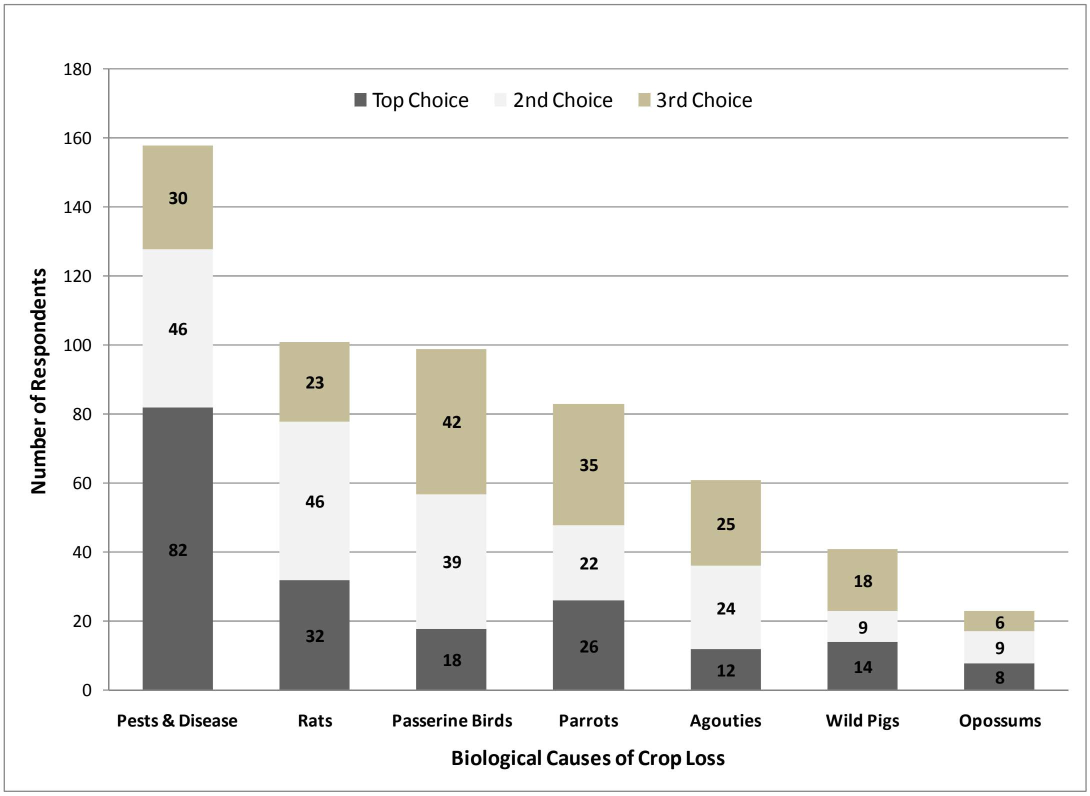

Figure 3: Responses to the question: “Which of the following causes the most damage to crops on Dominica overall? Respondents asked to rank their top 3 challenges. N = 209 (107 citrus farmers and 102 respondents who were not citrus farmers).

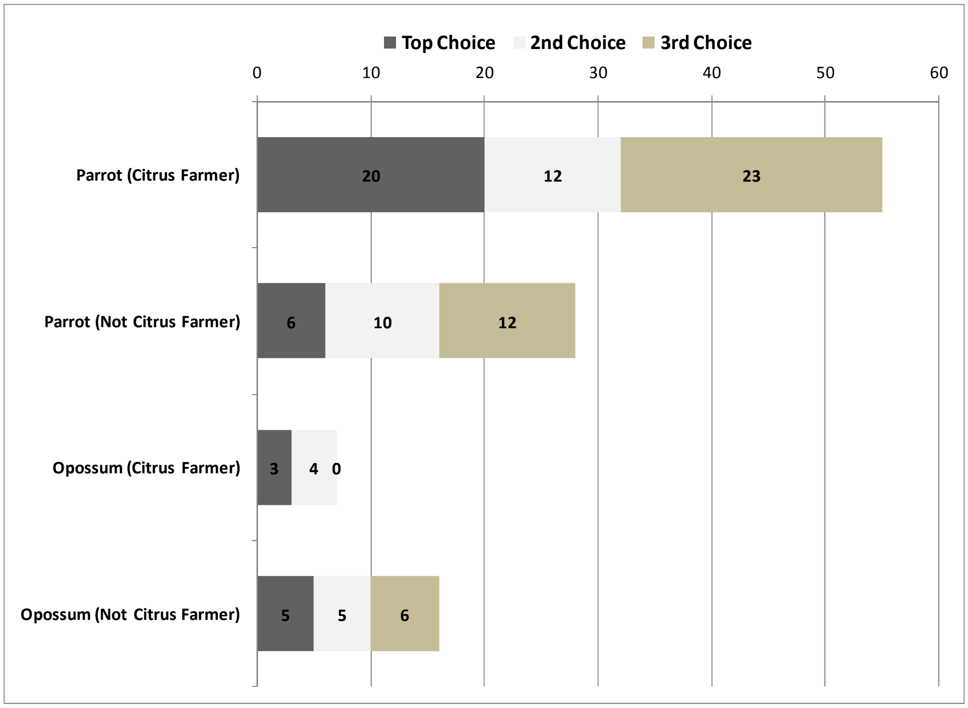

Figure 4: Responses to the question - "Which of the following causes the most damage to crops on Dominica overall?" - Citrus farmers and respondents who were not citrus farmers provided significantly different responses about their perceptions of the importance of both parrots and opossums as a source of crop damage.

Attitudes towards wildlife sources of crop loss

To investigate the relationship between these animals and the current public dispute about parrot-related crop losses, I asked respondents to tell me how much they either agreed or disagreed with a statement that asked whether they would complain to the government and request compensation for crop losses they attributed to each of the 4 most important wildlife sources of crop losses identified in Table 2 (Figure 3), namely passerine birds, parrots, agouties, and wild pigs. For respondents who were not farmers, I asked them to respond based on their opinions of how they would react if they were a farmer faced with this form of crop loss (Table 4). While non-citrus farmers were generally less likely to indicate that they would complain to the government and request compensation for crop losses, there was no significant difference in a one-way ANOVA test of the means (p > 0.05) in mean responses related to wild pigs, agoutis and passerine birds between respondents who were either citrus farmers or not. For crop losses attributed to parrots, however, citrus farmers were significantly more likely to indicate that they would complain to the government and request compensation [F = 5.351, df = 1, *p* = 0.022].

Table 4: Comparisons of the mean responses to a statement of whether respondents would complain to the government and request compensation if: (1) wild pigs; (2) agoutis; (3) parrots; or (4) passerine birds damaged their crops. N = 207 (106 citrus farmers and 101 respondents who were not citrus farmers).

Is the respondent a citrus farmer or not?		If **wild pigs** damage my crops, I will complain to the government and request compensation.	If **agoutis** damage my crops, I will complain to the government and request compensation.	If **parrots** damage my crops, I will complain to the government and request compensation.	If **passerine birds** damage my crops, I will complain to the government and request compensation.
NO	Mean	2.24	2.33	3.02	1.75
	Std. Deviation	1.320	1.305	1.497	.932
YES	Mean	2.60	2.52	3.53	1.96
	Std. Deviation	1.465	1.402	1.657	1.257
Total	Mean	2.43	2.43	3.28	1.86
	Std. Deviation	1.405	1.356	1.598	1.112

I used the total means (that is the combined means of both stakeholder groups in Table 4) to conduct a paired samples t-test comparison of the mean responses to the four questions. These means were significantly different from each other (*p* > 0.0001) with the exception of the mean responses to the statements related to wild pig and agouti crop damage, whose means were identical. Overall, therefore, respondents were significantly more likely to indicate that they would complain and request compensation about parrot-related crop losses relative to losses caused by any of the other types of vertebrate wildlife, while they were significantly less likely to complain about crop losses related to passerine birds. I encouraged each respondent to elaborate on the reasons for their answers to each of the four statements, and later coded their qualitative responses into fourteen categories (Table 5).

Table 5: Coded qualitative responses of 207 respondents for the reasons why they either agreed or disagreed that they would complain to the government and request compensation about wildlife-related crop damage attributed to four types of wildlife. Note: Respondents were permitted to provide multiple reasons or none at all, depending on their choosing.

	Reasons why respondents agreed or disagreed with statements about whether they would complain and request compensation for crop losses related to four types of wildlife.	Parrot	Passerines	Agouti	Wild Pigs
1	No. Wildlife crop damage is not the responsibility of government.	26	33	36	38
2	No. Because wildlife have to eat somehow to survive.	26	30	22	22
3	No. It is natural and traditional. The problem will always be there. I am accustomed to them and I will have to live with them.	5	46	24	20
4	No. These species perform important roles in the environment and provide some sort of ecosystem service.	2	15	2	2
5	No. These species perform an important role for economy/tourism.	9	2	1	2
6	No. Because damage from this species can be prevented or managed for example by using protective measures.	1	24	7	8
7	No. Because damage is minimal and not sufficiently economically taxing.	5	22	18	7
8	No. I can kill (and/or eat) them. So I don't have to complain or ask for help to manage them.	4	6	57	65
9	No. This is not a protected species so I can deal with it how I see fit.	0	6	1	19
10	No. Because the Government will not help anyhow. They will not give any kind of compensation or assistance.	42	24	33	28
11	These species are not regarded by government as much as parrots so they will not pay compensation for this type of damage.	N/A	6	1	1
12	Yes. Because the damage is significant and economically taxing.	35	10	16	24
13	Yes. The government/law protects it. It is the property of the State. Therefore they should pay.	75	7	25	12
14	Yes. Because farmers need help financially and better support services.	46	22	30	36

Attitudes about crop loss due to passerine birds were shaped by perceptions of such losses as traditional and unoffending, and within a range that was tolerable. Crop loss due to this group of birds was perceived to be potentially manageable by using nets, especially for farmers of small, high value crops such as peppers. Additionally, relative to other forms of wildlife, passerine birds were perceived to provide important ecosystem services such as pollination that, at least in part, compensated for the crop losses they produced. Furthermore, respondents frequently described passerine birds as delightful and aesthetically pleasing, like the "flowers of the landscape". Overwhelmingly, respondents indicated that both wild pig and agouti populations could be managed at the community level through hunting. Under the Forestry and Wildlife Act (Ch. 60:02) of Dominica wild pigs can be hunted legally throughout the year while the agouti may be taken during the declared hunting season that currently extends from October through December. For all four species groups, respondents commonly expressed the perception that it was futile to complain to the government because their concerns would be ignored. This perception was especially common among citrus farmers. In a one-way ANOVA, citrus farmers were significantly more likely to believe that government was not sympathetic to their losses [F = 18.283, df = 1, p = > 0.0001]. Furthermore respondents disproportionately indicated that crop loss due to parrots was particularly economically taxing and that, because the farming sector was already in need of support overall, it was imperative that government assist. Respondents commonly noted that the state compensated for crop losses and implemented assistance programs after destructive events such as severe weather and that parrot-related crop losses deserved, perhaps not equal, but some level of attention. Farmers also indicated that, because parrots were specially protected species and a national symbol which could not be legally hunted, it was not feasible to expect that farmers could manage the problem on their own.

Predictors of attitudes towards parrots, compensation and population management

I related field-based crop damage assessment data from 16 farms (Douglas 2011) to how much the owners of these farms agreed or disagreed with the following three questions using a linear regression analysis:

1. Dominica would be just as nice without both of its two parrots.
2. The government should reduce the total number of parrots on Dominica to a more manageable amount.
3. If parrots damage my crops, I will complain to the government and request compensation.

There was no relationship between the amount of parrot-related crop loss experienced and the Likert-type responses to questions 1 and 3, [t (14) = -0.422; p = 0.680] and [t (14) = 0.886; p = 0.390] respectively. That is, irrespective of the amount of actual crop loss experienced, these citrus farmers were just as likely to indicate that Dominica would be just as nice without both of its two parrots. Similarly, the propensity to complain and request compensation from the government was unrelated to the amount of crop losses experienced. Indeed, some of the most publicly vocal proponents of the seriousness of parrot-related crop losses (by way of the print and audio-visual media) experienced less than 6% crop loss to parrots and over 40% due to other causes, and, when interviewed, indicated that issues such as the fungal disease citrus brown rot, a lack of market access, and passerine birds were their most important causes of fruit loss on their farms. There was, however, a marginally significant relationship between the amount of crop loss experienced and support of government-led parrot population reductions as a means of reducing parrot frugivory of cultivated fruits [$t(14) = 2.007$; $p = 0.064$]. Farmers who experienced higher percentages of crop loss were marginally more likely to agree that the government should reduce the total number of parrots on Dominica. In a Pearson's correlation analysis, there was no relationship between actual crop loss experienced and the reported levels of crop losses by these farmers ($r = 0.414$; $p = 0.125$).

To further investigate the possible predictors of the attitudes indicated by these three questions, I compared the responses to these questions to other variables, including demographic information (Table 6).

Table 6: Results of linear regression analysis of the possible predictors of attitudes measured using Likert-type scaled responses to the following questions (used as the dependent variables):

1. Dominica would be just as nice without both of its two parrots.
2. The government should reduce the total number of parrots on Dominica to a more manageable amount.
3. If parrots damage my crops, I will complain to the government and request compensation.
   (Statistically significant results shown in gray boxes and in bold print).

Independent Variable	**Question 1: Just as nice without Parrots**			**Question 2: Population Management**			**Question 3: Complaints & Compensation**		
	t	**df**	**p**	**t**	**df**	**p**	**t**	**df**	**p**
Reported quantity of crop loss experienced last season (% of crop)	-0.33	114	0.743	**3.99**	**119**	**> 0.0001**	**3.06**	**118**	**0.003**
Attitudes towards the Prime Minister	**-2.43**	**114**	**0.017**	**-2.27**	**118**	**0.001**	**-1.98**	**118**	**0.050**
Frequency with which reports about wildlife-related crop loss are made to the Ministry of Agriculture	0.92	198	0.362	**6.364**	**206**	**> 0.0001**	**5.19**	**205**	**> 0.0001**
Degree of satisfaction about the response of the MoA in response to wildlife-related damage reports	-0.66	62	0.512	**-4.63**	**62**	**> 0.0001**	**-2.87**	**62**	**0.006**
Belief that the farming on Dominica has a bright future	**-1.99**	**199**	**0.047**	**-3.20**	**208**	**0.002**	0.04	206	0.965
Whether the respondent would encourage farmers to get out of farming and do something else	**2.03**	**198**	**0.044**	**2.57**	**207**	**0.011**	0.33	205	0.739
Ability to recognize and distinguish between Dominica's two native parrots	**-2.75**	**198**	**0.007**	1.14	207	0.258	**2.07**	**205**	**0.04**
Occupation (citrus farmer vs. other livelihood)	1.39	198	0.167	**5.31**	**207**	**> 0.0001**	**2.31**	**205**	**0.022**
Age (years)	1.07	199	0.285	**4.16**	**208**	**> 0.0001**	1.89	206	0.060
Wealth (acres of land owned)	0.42	189	0.674	**2.88**	**197**	**0.004**	1.44	195	0.151
Gender	0.85	199	0.852	-0.13	208	0.056	**-2.27**	**206**	**0.024**

Those respondents who reported the most damage on their farms and who had a history of reporting crop losses related to wildlife were significantly more likely to indicate that the parrot population should be reduced and that they would complain to the government and ask for compensation. These individuals were also more likely to say that they were dissatisfied with how the Ministry of Agriculture (MoA) had responded to their reports. Not surprisingly, therefore, respondents who were citrus farmers were significantly more likely to agree that there should be parrot population management and also that they would complain and request compensation for crop losses. Respondents who believed that the future of farming on Dominica was not bright were significantly more likely to agree that Dominica would be just as nice without its parrots [t (199) = -1.99; p = 0.047] and were also more likely to agree that the government should reduce parrot population numbers [t (208) = -3.20; p = 0.002]. Additionally, respondents who held more unfavorable views of the Prime Minster of Dominica were significantly more likely agree that: (1) Dominica would be just as nice without its two parrots [t (114) = -2.43; p = 0.017]; (2) the government should reduce parrot population numbers [t (118) = -2.272; p = 0.001]; and (3) that they would complain and request compensation for parrot related crop losses [t (118) = -1.98; p = 0.050].

Relationship between bananas and citrus agriculture

I investigated the reasons why respondents who cultivated citrus became citrus farmers, their wider concerns about citrus agriculture (for example, the loss of citrus trees due to disease), and the economic value and cultural significance of citrus agriculture for them. I interviewed 62 farmers for this section of the study. Of these, fifty-three (or 87%) described themselves as banana farmers at some point during their lives. Forty-seven individuals (or 76% of the total number of respondents) indicated that they planted their citrus during the period when they were still banana farmers (intercropping). The remaining fifteen individuals either began cultivating citrus before they became banana farmers or had never cultivated citrus for the purpose of sale. The latter group was predominantly characterized by younger and/or landless farmers. I asked all the respondents who cultivated citrus to explain the reasons why they originally planted the citrus they had on their lands (Table 7).

Table 7: Stated reasons why respondents planted citrus. 47 respondents answered this question. Where N = number of respondents providing this response. % = number of responses in this category as a percentage of the total number of respondents answering this question.

	Permanent Crop & Companion crop for bananas	**Government subsidized post-banana diversification program**	**Pension Crop**	**Additional income**	**That was the culture and tradition of the time**	**For the previously existing international market for grapefruits**
N	29	24	16	11	10	10
%	62%	51.1%	34.0%	23.4%	21.3	21.3

A majority of respondents indicated that they were encouraged to plant citrus during the years that they were banana farmers for three main reasons:

1. The Ministry of Agriculture encouraged farmers to include permanent (tree) crops to improve soil conservation, to support wind-damage protection of the banana plants, and to create a source of income in the years when tropical cyclones destroyed the banana crop. Additionally farmers noted that, unlike vegetables, root crops, and banana cultivation, tree crops were attractive for land owners because, should they abandon the land, permanent crops such as citrus trees could survive unattended for years. These trees could therefore ensure a relatively immediate source of future income should they return to the land and, by extension, tree crops increased property (sale) value.
2. Approximately one half of the respondents noted that they were actively encouraged by successive local government administrations to diversify their agriculture into areas such as tree crops for two reason: (a) a mono-crop system produced economic vulnerability for individual farmers and the national economy, and (b) fears about future unfavorable rulings by the WTO in the festering banana free trade dispute. Some farmers noted that the government facilitated and subsidized their entry into citrus agriculture by providing on-farm training, free or subsidized planting materials and chemical inputs, and they received regular visits from extension officers to encourage diversification and support proper husbandry practices of their citrus trees. Respondents noted that these diversification initiatives also included the conversion of a subset of their grapefruit trees (many of which had been planted for a pre-existing grapefruit export industry) into orange varieties (such as Valencia) and limes through a

process known as top-working to improve the marketability of citrus in regional markets and for agro-industries that were to be developed.

3. Thirty-four percent indicated that that their primary interest in citrus was its potential to serve as a pension crop. This rationale is partially related to reason 1, in that respondents noted that the resilience of tree crops, including the minimal labor required to maintain them in a productive mode, made them suitable for older farmers. Furthermore, because land sale was a common means of raising funds for retirement, the value-added effect of tree crops was an incentive to plant those trees that were perceived to be of both economic and cultural value.

Cultural Importance of Citrus

I further investigated cultural importance of citrus by asking respondents to tell me how much they either agreed or disagreed with the following two statements: (1) “As farmers get into their senior (old age) years, their preference for tree crops increases”; and (2) “Some farmers use their citrus as a type of pension plan for their senior years (old age)”. Additionally, I asked farmers to indicate whether and how the importance of citrus agriculture had changed for them by asking them to respond to the question: “Compared to approximately 12 - 15 years ago, is citrus currently more or less important for your annual income?” I directed respondents to respond by using a scale from 5 – which indicated “much more important,” through 3 – “about the same,” to 1 – “much less important” (Table 8). I chose 12-15 years to reflect the approximate period during which the banana industry began its rapid decline in the banana-producing states of the eastern Caribbean region.

Table 8: Responses of 62 survey respondents to three questions investigating the cultural and economic importance of citrus and other tree crops for farmers on Dominica.

Questions	N	Mean	SD	Mode	Median
As farmers get into their senior (old age) years, their preference for tree crops increases.	62	4.56	0.716	5	5
Some farmers use their citrus as a type of pension plan for their senior years (old age).	62	4.82	0.426	5	5
Compared to approximately 12 - 15 years ago, is citrus currently more or less important for your annual income?	53	3.89	1.613	5	5

Overwhelmingly, respondents noted that older farmers on Dominica preferred tree crops. I asked respondents to explain the reason for this preference and I later coded these qualitative responses (Figure 5). These reasons were largely interrelated and were based on the relative ease of cultivation and harvest which encouraged their traditional use as crops that could support rural residents when they no longer had the physical strength to undertake regular and strenuous manual labor.

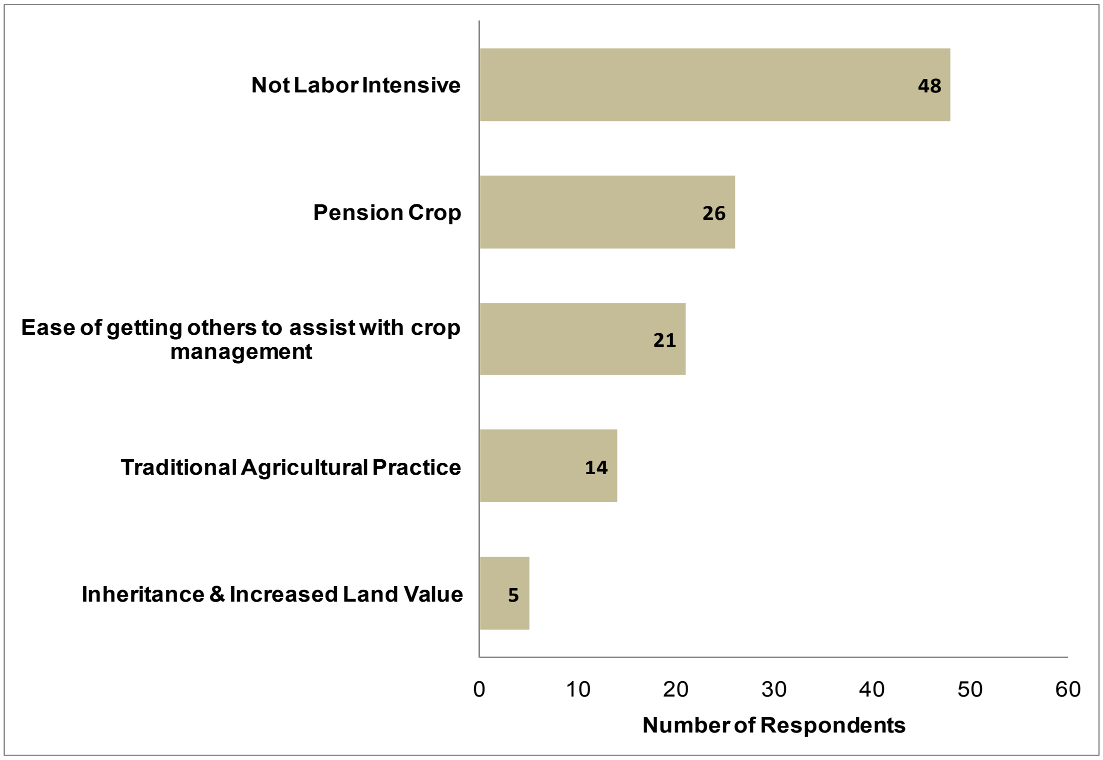

Figure 5: Reasons provided by respondents for why a preference for tree crops increases as farmers get into their senior years. Reasons given by 3 or less individuals are omitted from the table.

I asked these respondents to identify what they believed were the most common types of crops on Dominica that were used in this type of retirement planning (Table 9). Respondents indicated that the most common tree crops used for this cultural practice were citrus trees, avocado, cacao, coconut, and mango, in that order. Respondents also overwhelmingly strongly agreed with the statement that some farmers use their citrus as a type of pension plan for their old age (Table 8). Respondents noted that citrus was particularly valuable for the aged because the relatively short trees permitted more senior farmers to pick the fruits from the ground either by hand, with a stick, or with the aid of an adolescent family member or a community member. Some other types of tree crops, such as coconuts, were less appealing because they usually required more skilled individuals for harvesting due to the characteristically tall trees and well protected nuts. Respondents also noted that other crops such as cacao and coffee were less desirable because harvesting was labor intensive and they required extensive post-harvest processing (such as shelling, washing, and drying) before they were ready for sale.

Table 9: Perceptions of respondents about the types of fruit trees that are most commonly preferred by older farmers on Dominica ranked order of preference. N = 62 respondents.

	Common Name	**Scientific Name**	**No. of respondents indicating this tree as the most commonly preferred of senior farmers.**
1	Citrus	*Citrus spp.*	59
2	Avocado	*Persea americana*	34
3	Cacao	*Theobroma cacao*	28
4	Coconut	*Cocos nucifera*	26
5	Mango	*Mangifera indica*	17
6	Coffee	*Coffea arabica*	9
7	Breadfruit/Breadnut	*Artocarpus sp.*	7
8	Nutmeg	*Myristica sp.*	6
9	*Annona* Fruits	*Annona spp.*	5
10	West Indian Cherry	*Malpighia emarginata*	4
11	Cinnamon Bark	*Cinnamomum sp.*	3
12	Carambola	*Averrhoa carambola*	3

While a majority of respondents indicated that citrus agriculture was more important to them now relative to approximately 12 – 15 years ago (Table 8), some respondents prefaced their answers by indicating that there were intervening factors that influenced the issue (Table 10). A majority of respondents who indicated that citrus was more important to them now indicated that this was because they now had mature productive citrus trees either planted during their time as banana producers or previously existing tree stock that was resuscitated as part of diversification initiatives. Similar to the response to the previous questionnaire statements in Table 8, several respondents also indicated that, by virtue of their current age, citrus agriculture was now a more practical form of agriculture. In contrast, some respondents noted that they had hoped and expected that citrus agriculture would, at this point, be more important for them. However, they indicated that citrus tree disease or tree age had led to the death of some or all of their trees and, as a consequence, citrus agriculture had become less profitable.

Table 10: Reasons why respondents indicated that citrus agriculture was either more or less important to their annual income relative to approximately 12-15 years ago. N = 53

More Important	No. of responses
Loss of bananas as major crop income source elevated the importance of citrus.	25
Because citrus trees are what I have on my land and what I decided to focus on.	20
Because I am now older and this is what I can physically manage to cultivate.	13
Because citrus is more profitable now because it has become scarcer due to the death of citrus nationally due to disease	6
The Same or Less Important	
It should be more important, but intervening factors (such as tree disease on my farm) has prevented it from being so.	15
I have other sources of income so I don't need to depend on my citrus.	5
I only (or primarily) cultivate grapefruits and the grapefruit market is relatively poor compared to that for other forms of citrus fruit (such as oranges and limes)	4
In the absence of bananas the trees produce less fruit because they are not as frequently treated with the agricultural inputs that were available for banana production.	3
Parrots destroy my citrus crops so I cannot reap the desired benefits.	2

Impact of citrus tree death on the value of citrus

I investigated perceptions surrounding the importance and implications of citrus tree disease by asking respondents to tell me how much they agreed with statements that indicated that, due to citrus tree disease there would be a serious scarcity of (a) oranges and (b) grapefruits on Dominica within the next few years (Table 11). Respondents generally strongly agreed with the statement that there would be a serious scarcity of oranges on Dominica within the next few years. Respondents reported that they had either personally seen or heard that there was a total die-off of citrus in the south of the island and that other areas were now affected. Many respondents also indicated that citrus trees on their farms or those of others with whom they were acquainted had been affected by disease agents that resulted in the death of their citrus trees (Figure 6).

Table 11: Responses to questions about the possibility of scarcity of citrus due to citrus tree disease. Total number of respondents = 62.

Questions	N	Mean	SD	Mode	Median
Due to citrus tree disease there will be a serious scarcity of **oranges** on Dominica within the next few years.	61	4.36	0.984	5	5
Due to citrus tree disease there will be a serious scarcity of **grapefruits** on Dominica within the next few years.	61	3.89	1.156	4	4

Respondents indicated less agreement with the statement that there would be a shortage of grapefruits in the next few years, noting that the grapefruit trees were more resistant to disease agents, and, in their experience, this citrus type survived when others died. Respondents noted that grapefruit trees were primarily affected by the age of the trees as there had been no replanting or rehabilitation of this variety in recent years/decades. I asked the respondents to rank the seven most commonly cultivated varieties of citrus on Dominica to reflect their relative susceptibility to death due to factors such as disease over the last 5 years (Figure 7). These varieties are: Grapefruits (*Citrus paradisi*); Valencia oranges [*Citrus sinensis* (L.) Osbeck, cv]; Ortanique oranges (*C.s.* x *C. reticulata* Blanco); Seedless oranges (also called Grafted or Washington Navel oranges) [*Citrus sinensis* (L.) Osbeck, cv]; Mandarins (*Citrus reticulata*); Tangerines [*Citrus reticulata* (x *tangerina*)]; and Limes (*Citrus aurantifolia*).

Figure 6: Dead and diseased Valencia and Ortanique citrus trees within the southern agricultural region of Dominica affected by the Citrus Tristesa Virus – CTV (left). A 2008 Ministry of Agriculture pamphlet produced for CTV farmer education (right).

Valencia, Tangerines, and Ortaniques were reportedly the most severely affected by diseases that led to tree death on the respondent’s farms. While respondents reported that there was a more gradual loss of grapefruit citrus varieties, primarily due to their old age, they reported a rapid and escalating loss of Valencia, Tangerine, and Ortanique trees within their orchards since 2007. Based on their experiences respondents indicated that the most severe citrus tree loss of recent decades was currently occurring, and they identified the period 2007 through 2009 as the most intense period of tree loss for them individually.

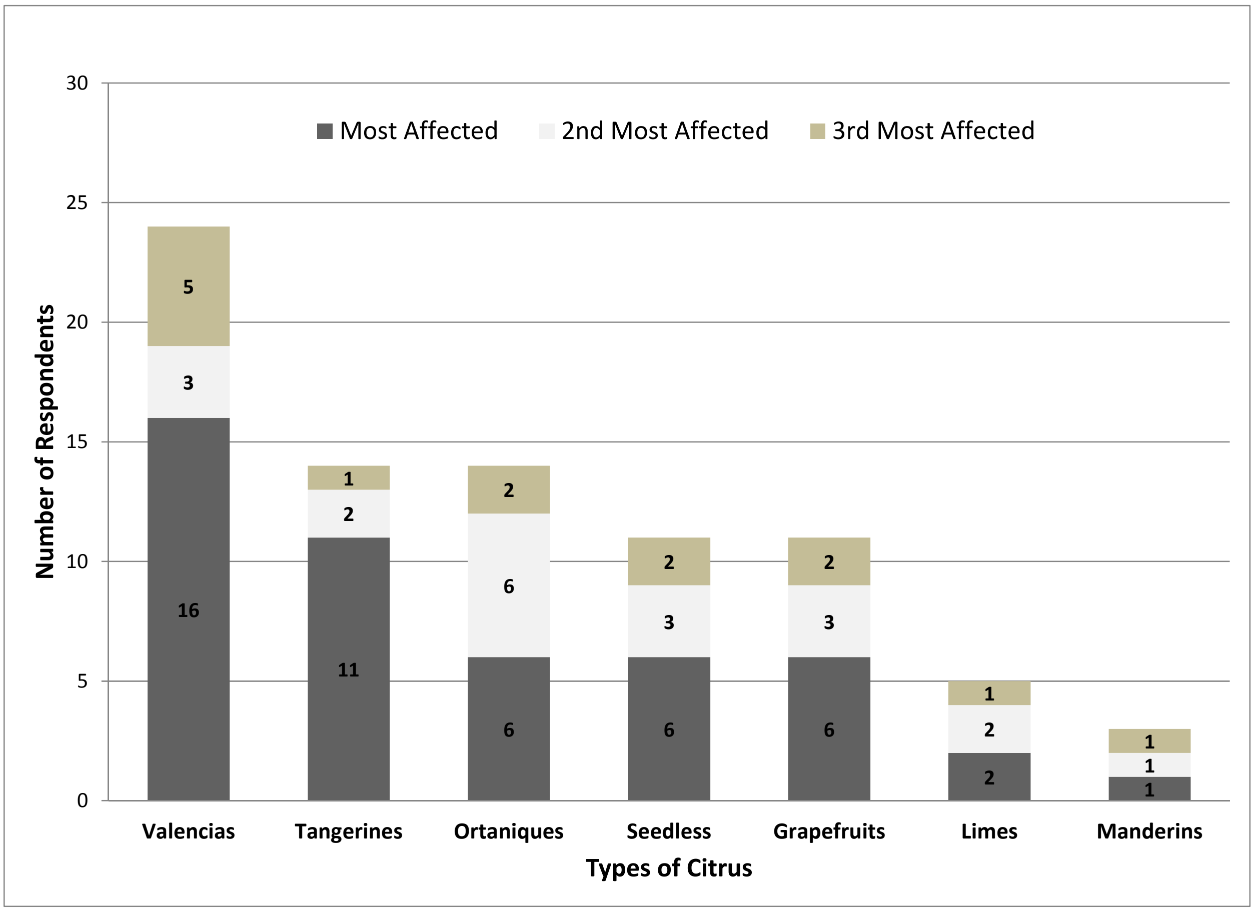

Figure 7: Types of cultivated citrus ranked by their reported susceptibility to tree death due to disease and other factors over the last five years based on the individual experience of farmers on their personal farms.

Discussion

These results demonstrate that conflict on Dominica surrounding parrot-induced crop losses is a multifaceted phenomenon that cannot be reduced to the quantity or duration of experience with either real or reported parrot-related crop loss. On the contrary, conflict surrounding parrot frugivory of cultivated fruit is not only rooted in parrot ecology, it is a complex system of interconnected and interacting concerns, grievances, histories of unresolved economic issues, and the unintended consequences of disparate State-led initiatives on the island. In concert, these interacting multiple causes and effects that include feedbacks and non-linear relationships produce what we observe as parrot-centered human-wildlife conflict on Dominica.

During the banana boom of the 1970s and 80s, large sections of prime parrot habitat were removed for agricultural development, bringing parrots and agriculture into direct contact. While there was a century-old history of the production of limes and grapefruits on the island (Honychurch 1995), parrot frugivory of citrus was, however, reportedly unknown up to this time. It is probably not coincidental that, immediately after the national consciousness about parrots was raised following Dominica's intensive and encyclopedic parrot education campaign, epitomized by the highly commended "Conservation Through Pride" program implemented in 1989/1990 (Butler 1992; Manzanero 2004; Willie 1991), the first known recorded reports of farmer complaints about parrot frugivory of citrus appeared in 1992 (James 1992a; James 1992b). A central theme of the "Conservation Through Pride" campaign was the promotion of the cultural symbolism of parrots as icons of national pride and identity. Given the political and economic vulnerability created by economic dependence on bananas and the island's historical familiarity with the production of tree crops, it is also understandable that diversification efforts included an emphasis on tree crops such as citrus. The conflict is, however, much more than the unintended and unanticipated collision of Dominica's banana diversification policy and State-facilitated parrot recovery and public education efforts. Neither is the conflict simply a production of the real or perceived incompatibility of citrus production and the increasing numbers of the island's threatened parrot population. Parrot-related crop losses have become a surrogate issue within a much wider dispute about unresolved grievances and fears ruminating from the demise of Dominica's agricultural sector as a whole.

In the wake of the banana shock, dramatically declining economic growth of the 1990s and early 2000s, and the structural adjustment of Dominica's economy following the country's turn to the International Monetary Fund (IMF) for assistance, ordinary Dominicans faced serious economic hardship (Moberg 2005; Payne 2008). The economic exclusion and marginalizing effect that farmers faced is evident in the displacement of farmers and farm workers, many of whom either migrated, entered the wider unskilled labor force commonly as bus drivers, security guards, and construction workers, or simply entered semi-retirement during which they opportunistically attempted to capitalize on market conditions to sell crops such as fruit when there was sufficient demand (Myers 2004; Wiley 1998). Others turned to a mushrooming underground industry in marijuana production and the trans-shipment of cocaine (Moberg 2005, page 8). With declining confidence in agriculture, there are high rates of rural out-migration and unemployment among rural youth. Less than five percent of all farmers are under 25 years old. By extension, the age of the island's farmers is steadily increasing, and the average age of a farmer on Dominica is 55-60, which is above the retirement age of workers in the non-agricultural sector (GOV 2006). Furthermore, because no crops that approach bananas in terms of lucrative financial returns or stable market access have been found, Dominica's farmers are, overall, much less financially secure than they were prior to the enforcement of global neoliberal free trade policies. As a result, other crops, in particular permanent crops such as citrus, became increasingly important within Dominican agro-economy for a few important reasons (financial, historical, and cultural):

(1) Permanent crops planted during the banana era remain established, productive, and economically valuable fruiting trees within a landscape that is now largely abandoned banana-producing lands.
(2) Citrus is a particularly favored crop the by the island's aging farming population because it requires little manual labor, attention, agricultural inputs, and harvesting effort relative to other commercially viable crop types such as vegetables.
(3) Permanent crops are fundamental aspects of the rural landscape where they are important components of the pension planning of full-time farmers none of whom received any type of State or company retirement benefits[13], and, to a lesser

[13] Since 2007 a pension system, the first of its kind on Dominica, managed by the Fair Trade Foundation was established to provide a lump sum payment to currently active banana farmers on retirement who choose to pay into the scheme. However the scheme is unpopular with older

degree for the investment and retirement planning of blue and white collar workers who own land.

(4) The most important form of wealth and financial security in rural Dominica is land/property ownership, and permanent crops increase land value.

The analysis shows that conflict between the stakeholders of parrot conservation about parrot-induced crop losses is inherently also one about the loss of economic power, financial security, and social status among farmers living in post-banana Dominica. It is in part an expression of farmer hostility towards the State because of its perceived failure to effectively sustain and secure the profitability of agriculture and to provide quality financial and technical support for ailing agriculturalists. Furthermore, it is an expression of fear about the loss of citrus, which is a key source of retirement funding of an aging generation of farmers. Parrot-agriculture conflict has therefore become a surrogate issue in a dispute about unresolved grievances and fears ruminating from the demise of Dominica's agricultural sector as a whole. As one respondent (Unique ID# 44) who, while not a farmer, resides within Salisbury Village - one of the largest farming communities of the island- notes:

"The farmers do not have much problem with wildlife. They are upset about the disregard and discouraged by the neglect by the government. The farmers are regarded as the lowest class of the society! The government must move first so that when the farmers complain, they can help the farmer so that the parrot can be protected in turn. There is no assistance! So it is left to the farmer to kill them silently or just live with it".

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farmers who are weary of further deductions from what they consider are already meager returns and who believe that their time to retirement is too short for the scheme to benefit them.

This response underscores that a root cause fueling the conflict is the sense of injustice and disenfranchisement that farmers feel. Generally, farmers indicated that compared to the support they received from the State in the past (such as subsidies, marketing assistance, direct financial support and agricultural extension services), they receive far less now, if any at all. With the demise of agriculture, farmers have also concurrently suffered a loss of social status and political power on the island[14]. Such feelings are particularly prevalent among individuals and within communities (when compared with data from the Electoral Office of Dominica) which have, in recent years, voted in support of the opposition party of government. Following the stipulations of the IMF, the incumbent political party on Dominica (the Dominica Labor Party – DLP) led by Prime Minister Roosevelt Skerrit since 2004 has pursued public sector reforms geared to redirecting the political economy in a new direction in which private investment drives economic progress and decreases what the Prime Minister has described as the traditional "over-reliance on Government for economic growth and employment creation" (Payne 2008). That is, central government has sought to follow a general neoliberal approach, devolving the State of some of its traditional managerial roles in sectors such as agriculture. From the perspective of citrus farmers on Dominica however, uncompensated crop losses attributed to parrots, the symbol of the State, is the quintessential example of the misplaced value-system of government. A value system that produces laws, policies, and frameworks that continue to marginalize farmers and the agricultural sector while promoting an alternative vision for the country,

[14] Farmers were historically considered the voting bloc that decided the outcome of national elections since State independence in 1978.

one in which agriculture is relegated to a back burner (Figure 8). One stakeholder (Unique Identifier # 150 – a medical practitioner and farmer) described it this way:

“*Compensation would indicate how seriously the government takes the issue. But with no compensation, it indicates that the government prefers parrots. Why is the parrot protected to that extent?!”* The respondent goes on to note: “*The problem of the parrots emerged just around the time that there was a significant deterioration in farming, so it is just another reason to say, well … time to leave farming!*”

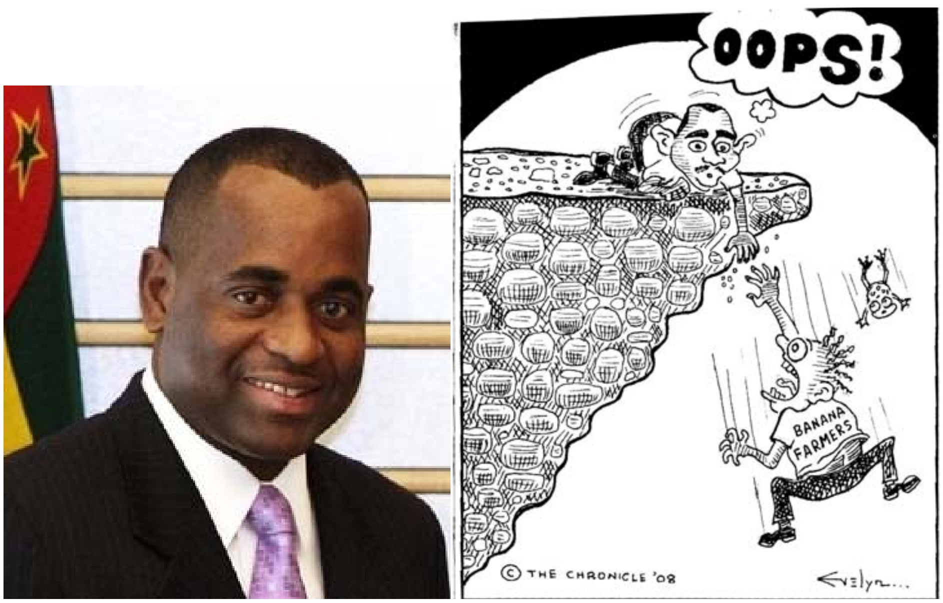

Figure 8: Prime Minister of Dominica, the Honorable Roosevelt Skerrit (left – photo source: Dominica NewsONLINE website). Cartoon from The Chronicle newspaper (right) depicting the Prime Minister allowing banana farmers to slip over the edge of a cliff (dated 27/6/2008).

Agricultural Practice and Valencia Oranges

The political underpinnings of the conflict can, however, be overstated because, as Douglas (Chapter 2 – Douglas 2011) identifies, not only can the worst affected farmers experience parrot frugivory of up to 30-40% of their fruit production, parrots overwhelmingly selected Valencia oranges, the most favored citrus variety of Dominican farmers. Valencia is a “late season citrus,” ripening at the end of each year and reaching peak maturity on Dominica between February and May (as it does throughout the hemisphere), well after the other commonly cultivated citrus varieties are harvested. Not only do Valencia oranges ripen later in the season, they generally hold for much longer on-tree (for 2-4 months) than other orange varieties that usually ripen, soften, and fall within weeks of reaching maturity (Sauls 1998). This distinctive quality of Valencia oranges has important economic advantages for farmers on an island where pre- and post-harvest losses for all fruits and vegetables are high due to a lack of either a stable market or appropriate storage facilities and functional agro-processing industry. Citrus varieties that are resistant to senescence, if un-harvested, are therefore highly favored by the farmers because they provide them with the flexibility to harvest if and when favorable market prices and strong consumer demand emerge. As one farmer puts it, “That is when we can make a little money”. Valencia oranges are therefore traditionally harvested at a time of year when the other orange varieties have largely disappeared from the market. This practice of hedging on the increasing sale price for Valencia oranges over the citrus harvesting season in itself has important implications for crop loss as the extended harvesting season of Valencia fruits increases the probability of frugivory by parrots in addition to crop loss due to the other common pests and diseases of ripe fruits such as passerine birds, mammals, and citrus brown rot. The results here indicate that respondents reported that it was also the Valencia variety that was the most affected by CTV on their farms. CTV is one of the world's most destructive diseases and the most economically important viruses of citrus trees (Niblett et al. 2000; Rocha-pena et al. 1995). The insect vector of CTV, the Brown Citrus Aphid (*Toxoptera citricida*), was discovered on Dominica in the 1990s and produced widespread death of limes, one type of citrus that is particularly susceptible to the virus (Ministry of Agriculture 2008) (Figure 6). In keeping with respondent reports, I observed that, with the exception of the southern agricultural region where the disease had already produced citrus tree death approaching 100% in the most southerly areas, the death of citrus in other agricultural regions of the island appeared, in general, to be recent - within the last few years. In letters that farmers submitted to the Ministry of Agriculture about their concerns about parrot-related crop losses, multiple individuals also noted their concern that their farms were simultaneously affected by CTV (Burton 2009).

Collectively, these findings have critical implications for conflict resolution on the island because they suggest that there is a suite of underlying, deep rooted, and identity issues embedded and fueling the state of conflict surrounding real and perceived parrot-induced crop losses. This knowledge is particularly important because it illustrates that complete and immediate resolution will be difficult. Indeed even the most effective and well meaning efforts at reducing parrot frugivory may by themselves have little effect to appease stakeholder animosity about parrot-related crop losses. Furthermore it suggests that developments and events that enhance (or appear to enhance) the marginalization and relative deprivation[15] of farmers around affected areas will encourage conflict escalation (Bartos and Wehr 2002; Gurr 1970). For example, perception of an unfair and unequal distribution of government aid to farmers following the passage of Hurricane Dean in 2007 encouraged disgruntled farmers to frame the issue of parrot-related crop loss as emblematic of the hostile political system and this event served as a trigger for farmers to become more organized as a conflict group (See for similar example: Herda-Rapp and Marotz 2005). Farmers reported attending meetings held between 2007/2008 to discuss strategies to advance their concerns and advocate for change. Some respondents, however, noted that a subset of farmers declined a more open show of strength due to either fear, their political affiliations, or concerns of even further financial isolation or State retribution with respect to the withholding of future benefits, choosing to alternatively adopt a wait-and-see approach for the time being.

Conservation Implications

This paper presents empirical evidence on the relationship between global neoliberal free trade policies, the development of what stakeholders perceive as incompatible agricultural and conservation goals, and the growth of a sense of injustice, feelings of grievance, and disenfranchisement among farmers, a key stakeholder group of parrot

[15] Relative Deprivation is a key concept within Political Science and of influential conflict theorists who explain that one crucial component of many social conflicts is the development of grievances that emerge when parties/groups feel that they have been either treated inequitably or unfairly compared to their entitlements in the past and/or in relation to what they believe that they were promised. See Gurr (1970), Bartos & Wehr (2002), Pruitt & Kim (2004).

conservation on Dominica (Figure 9). The analysis underscores the notion that conflicts surrounding human-animal interactions are usually complex. They involve many causes and interconnected factors that may not be immediately obvious, that stakeholders may not readily volunteer, or even consciously understand (Bartos and Wehr 2002; Engel and Korf 2005; Thompson 2002). The traditional view of psittacine-agriculture conflict in the Caribbean is that successful conservation programs led to increases in parrot numbers and easy access to cultivated fruits encouraged frugivory (see dash lines in Figure 9) (Wiley et al. 2004). The findings, however, underscore the importance of going beyond these linear cause and effect descriptions that commonly define such conflict studies, and suggest that systems-thinking approaches are imperative for studying this and other wildlife-conservation centered conflicts.

Systems-thinking could also be a key approach towards management and resolution of the conflict on Dominica. Social conflict research suggests that where stakeholders cannot either appreciate or agree on the key components of a conflict, it is unlikely that they can move towards acceptable and sustainable management and mitigation (Bartos and Wehr 2002; Engel and Korf 2005; Pruitt and Kim 2004). By using a systems-thinking based facilitated process, a mediator could assist stakeholders to improve their understanding of the causes and implications of a conflict and encourage agreement on whether and how best to manage it. Such an intervention requires the involvement of all the key stakeholders in a process that allows simultaneous active learning, analysis, and evaluation of the range of causes of conflict and also encourages the participatory consideration of resolution strategies that stakeholders perceive as practical, constructive, and respectful of all parties (Engel and Korf 2005; Nandalal and Simonovic 2003). In such a process, a third party facilitator would engage entire stakeholder groups or sub-groups in an analysis of the issues, causes, and interrelationships in a manner that the session constructs its own systems diagram as illustrated in Figure 7. The methods and tools for facilitating such a process are explained in detail in Engel and Korf (2005).

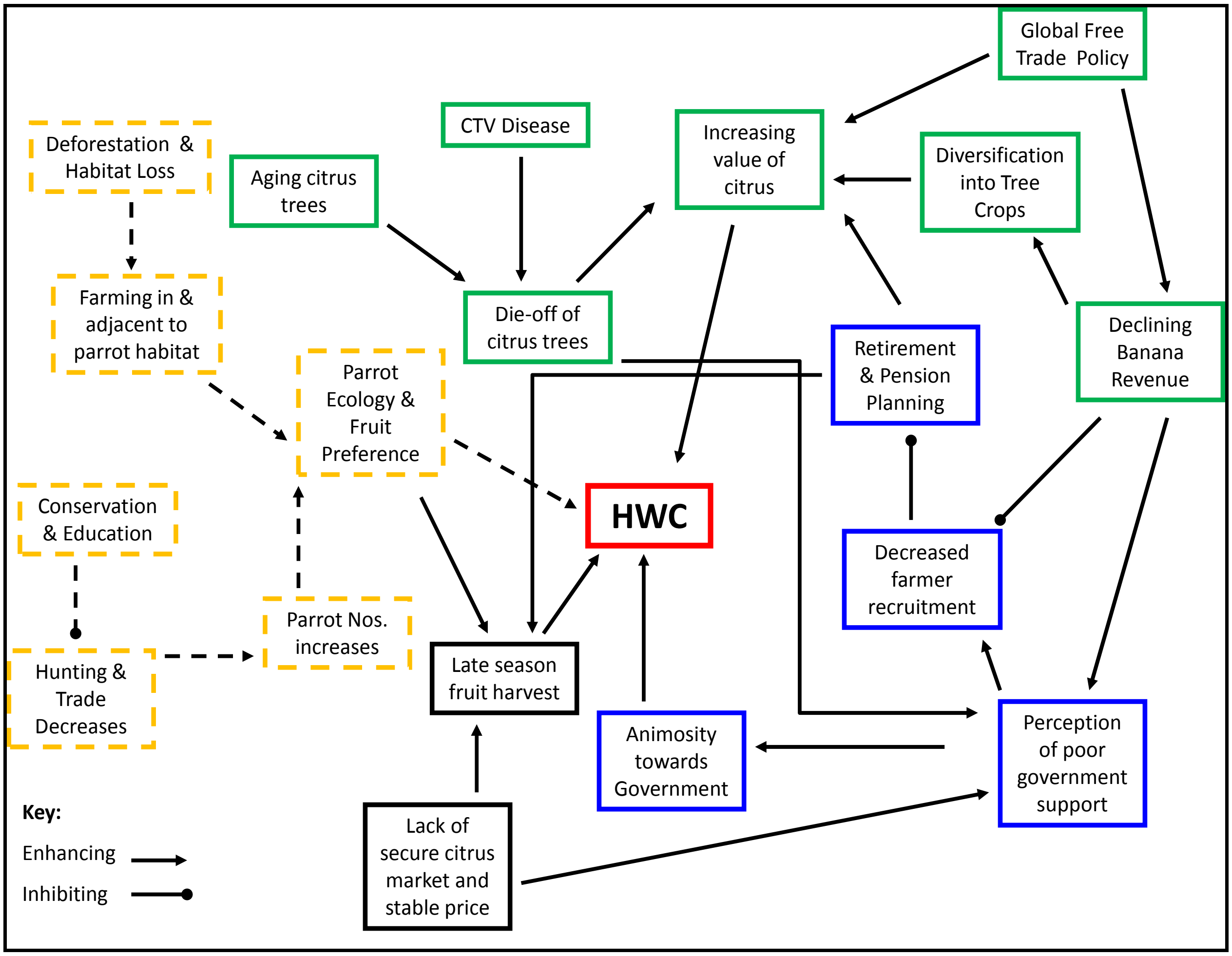

Figure 9: Systems archetype diagram of the causes of conflict centered around parrot-induced crop losses on the island of Dominica. Dash lines represent the traditional view of conflict between parrots and agriculture in the Caribbean – See Wiley et al. (2004). Adapted from: Sterling et al. 2010.

Management of this conflict is vital because one cause of the historical endangerment of the parrots of Dominica was hunting, and the perception of parrots as crop pests is an important justification for the hunting of parrots in several Caribbean islands historically (Raffaele et al. 1998). Hunting of game birds and other wildlife as "Creole food" is still an engrained annually celebrated aspect of cultural life on Dominica. Indeed, as the issue of parrot-induced crop losses has been framed for the public in the news media (for example two newspaper headlines read “Parrots Plague Farmers” (Joseph 2010) and “Driving Farmers Crazy” (SUN 2008b) and after local courts dismissed legal proceedings by farmers hoping to obtain compensation from the government[16] (SUN 2008a), owners of citrus orchards noted that they were approached by local game hunters interested in “assisting” them to manage the “parrot problem”. Field-based ethnographic evidence indicates that such activities are already covertly practiced in some sections of the island. A challenge for the parrot conservation community is therefore to assist local authorities to recognize the state of conflict in its entirety – as a system, and beyond this, undertake systems-sensitive resolution strategies that are cognizant of the dynamics and complexity of conflict, and, by so doing, reframe the debate in favor of more meaningful and sustainable conservation outcomes. Using such a systems-based management approach the likelihood of conflict escalation, the continued demonization of parrots in the news media, and the emergence of more destructive outcomes may be thwarted.

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[16] The case brought by farmer Mr. Walter Williams against the State seeking compensation for crop losses due to parrots was dismissed in the Roseau High Court on September 19, 2008 on the grounds that there was no constitutional basis for such claims under Dominican law. A subsequent appeal was also dismissed.

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