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LOCAL KNOWLEDGE AND USE OF THE VALLE DE AGUÁN SPINY-TAILED IGUANA, *CTENOSAURA MELANOSTERNA*, IN HONDURAS

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***Abstract.*—The harvesting of wildlife has had a devastating effect on global biodiversity. Here we investigate the perceived status of the Critically Endangered Valle de Aguán Spiny-tailed Iguana, *Ctenosaura melanosterna*. We interviewed 132 residents of the Valle de Aguán, Honduras to: (1) examine their knowledge of the range and habitat preference; (2) document the use and trade; and (3) understand the level of awareness and openness to protection of this species. Our results indicate that these iguanas are primarily used for food. Though they are a small component of the local diet, consumption is occurring with a preference for gravid females. There are significant gender and geographic differences in consumption by humans. Though these harvesting actions contribute to the continuing decline of this species, our results demonstrate that there is a local belief that these iguanas are in danger of extinction, that conservation actions should occur, and that international involvement is welcome.**

Key Words.—conservation; hunting; reptiles; social-ecological systems; trade

INTRODUCTION

We are in the midst of a global mass extinction event, driven by human actions leading to habitat destruction, invasive species, disease spread, pollution, and over-harvesting for subsistence and commercial purposes (Gibbons et al. 2000; Myers and Knoll 2001; Wake and Vrendenburg 2008). In many areas of the world, particularly Africa, Asia, and Latin America, wildlife is an important resource for food and income (Ojasti 1996; Fitzgerald et al. 2004; Brashares et al. 2011). Actions associated with harvesting, however, have been shown to have a negative effect on a variety of threatened species of flora and fauna, often leading to decline and extinction (i.e. Fitch et al. 1982; Frias-Alvarez et al. 2010). The IUCN Redlist reports that 2,284 terrestrial animal species are threatened by intentional harvesting, and over 45% (1,030) of those are reptiles threatened by harvesting for biological resource use (IUCN 2014. The IUCN Red List of Threatened Species. Version 2014.2. Available from http://www.iucnredlist.org. [Accessed 1 May 2014]).

Reptiles have historically been collected for both subsistence and commercial use (e.g. Klemens and Thorbjarnarson 1995; Gibbons et al. 2000; Fitzgerald et al. 2004). Turtles (e.g. Ceballos and Fitzgerald 2004), tortoises (e.g. Brown et al. 2011), crocodilians (e.g. Fukuda et al. 2011), rattlesnakes (e.g. Means 2009), and iguanas (e.g. Fitch et al. 1982; Faria et al. 2010; Pasachnik et al. 2012a) are among the most well known examples of reptile population declines associated with harvesting. According to the IUCN, of the 1,030 reptile species around the world threatened by biological resource use, 10% are native to Mesoamerica (IUCN. 2014 *op. cit.*).

For the harvest of these Mesoamerican reptiles to be sustainable, conservationists need to work closely with the local people to create management plans that are well supported and accepted locally (Janzen 1988; Millennium Ecosystem Assessment 2005). Linking human social and ecological systems in a meaningful and mutually informative fashion through adaptive co-management structures will lead to the most viable conservation solutions (Olsson et al. 2004; Cinner et al. 2009), particularly when attempting to maximize resilience in both systems (Olsson et al. 2004; Folke 2006). The non-linear dynamics of linked social-ecological systems can be adaptively managed best when local perceptions, knowledge, social learning, and social structures are understood (Folke 2006) and local people are supportive of conservation (Millennium Ecosystem Assessment 2005). Support for conservation can result from an individual's connection to nature, thereby facilitating environmentally responsible behaviors, including sustainable wildlife use (Vaske and Kobrin 2001).

Most studies focusing on wildlife use in Latin America have been concentrated on moist tropical ecosystems (Ojasti 1996). However, the dry forests and sub-humid tropical areas are some of the most

endangered habitats in the world (Janzen 1988; Dinerstein et al. 1995), often harboring many narrow-range endemic and threatened species. The iguanas of Central America have traditionally been an important and widely used resource for many communities (Fitch et al. 1982; Werner 2000; Pasachnik 2006). Most studies concerning iguanas have focused on two widespread species, the Common Spiny-tailed Iguanas (*Ctenosaura similis*) and the common Green Iguanas (*Iguana iguana*; e.g., Fitch and Henderson 1978; Fitch et al. 1982; Ojasti 1996; Werner 2000; Stephen et al. 2011). Though these two species are the most commonly traded and consumed iguanas due to their abundance and large geographic range (Stephen et al. 2011), the negative effect of harvesting other, more narrow-range, endemics has the potential to be much more dramatic due to their limited distribution.

Understanding the degree of iguana harvesting that is occurring is extremely difficult as these actions are often prohibited and thus done in secret. This information, however, is vital to understanding and managing these threats. Likewise, landowners and members of local communities are often important species managers (Janzen 1988; Millennium Ecosystem Assessment 2005), through cooperative harvesting and communication about species status. Understanding local awareness and concern for threatened species is therefore an important component to any harvest management plan (Klemens and Thorbjarnarson 1995; Alves and Santana 2008). This is increasingly important when a potential conflict of interest between wildlife conservation and the local human community is involved, such as with the imposition of harvest quotas (Klemens and Thorbjarnarson 1995) or the popularization of historical social harvest taboos for conservation purposes (Colding and Folke 1997, 2001).

Though the mestizo people (those who are descendants of both European and indigenous ancestry) are often the main group using wildlife in Latin America, this group seems not to be aware of the importance of preserving wildlife (Ojasti 1996; Altricher 2006) even though it may be in their own long-term interest to sustainably harvest their resources. The community of the Valle de Aguán, Honduras, is made up primarily of mestizo people. This region of Honduras is also one of the poorest areas in the country, thus subsistence farming and harvesting is a major component of the livelihood for these small communities, scattered throughout the valley. These factors in turn create a situation where the interests of the community and the preservation of wildlife are often in conflict in the short-term, even though long-term solutions may not be in conflict.

Though three species of iguanas (*Ctenosaura similis*, *C. melanosterna*, *Iguana iguana*) occur in the Valle de Aguán, we were particularly interested in understanding the local knowledge, use, and awareness of *C. melanosterna* because it is endemic to the area, and is threatened according to the IUCN (Pasachnik et al. 2011b). *Ctenosaura melanosterna* also occurs within the Cayos Cochinos archipelago of coastal Caribbean Honduras; however, each population represents a different evolutionarily significant unit (Pasachnik et al. 2011a). Though both the island and mainland populations are listed as Endangered on the IUCN Redlist (Pasachnik et al. 2011b) and have recently been added to CITES Appendix II, the threats and protection associated with each population varies (Pasachnik and Ariano 2010; Pasachnik et al. 2011b).

Both the Cayos Cochinos and Valle de Aguán populations of *C. melanosterna* are threatened by habitat destruction and harvesting (Pasachnik and Ariano 2010; Pasachnik et al. 2011b). The restricted range (2.2 km^2) of the Cayos Cochinos population amplifies the severity of these threats, and makes this population highly susceptible to local extinctions following hurricanes (Hayes et al. 2004). The population within the Valle de Aguán is under a much-elevated threat level, due to large-scale habitat destruction and harvesting of adults and eggs (Pasachnik and Ariano 2010; Pasachnik et al. 2011b, 2012b). Though iguana consumption is typical in Central America (Werner 2000; Coti and Ariano-Sanchez 2008; Stephen et al. 2011), harvesting is greatly increased in the Valle de Aguán, particularly during a festival that celebrates the consumption of this endemic species during its reproductive season (Pasachnik et al. 2011b; Stephen et al. 2011). The Cayos Cochinos population is afforded protection because it is within the Cayos Cochinos Natural Marine Reserve (CCANMR) administered by the Honduran Coral Reef Foundation (HCRF), whereas the Valle de Aguán population is afforded little to no protection (Pasachnik et al. 2012b).

To better understand the situation in the Valle de Aguán, we conducted semi-structured interviews with members of the local community and accompanied local hunters into the forest. Our objectives were to: (1) examine local knowledge of the area of occupancy and habitat preference of this iguana; (2) document the use and trade of this species; and (3) understand the level of awareness and openness to protection of this endangered species as a function of human gender, age, occupation, and location. This information is vital to the construction of a long-term management plan, one that has the best chance of being supported by local stakeholders (Millennium Ecosystem Assessment 2005).

MATERIALS AND METHODS

Study site.—The Aguán Valley is located in the Department of Yoro, in the north central region of Honduras. The valley contains one of the only sub-humid tropical thornscrub forests in Central America

(Dinerstein et al. 1995). The region is heterogeneous, characterized by agricultural lands, large banana and palm plantations, and sub-humid tropical thornscrub forest remnants. As part of an ongoing complimentary project characterizing the distribution of *Ctenosaura melanosterna* in this area, we found that the dominant floral species were *Acacia riparia* (Leguminosae), *Opuntia* sp., *Stenocereus* sp. (Cactaceae), and to a lesser extent *Hematoxylum brasileto* (Caesalpiniaceae), *Ceiba* sp. (Malvaceae), and *Enterolobium* sp. (Fabaceae).

The valley is comprised of three municipalities: Olanchito, Arenal, and Jocón, which make up approximately 2,596.1 km^2; however, the area of occupancy of the focal species is approximately 1,315 km^2 (Pasachnik et al. 2011b). The Aguán River divides the valley, leaving the municipality of Arenal and Jocón on the southern side and most of the municipality of Olanchito on the northern side. The area is mostly rural, with the exception of the towns of Olanchito and Arenal. The total population for the three municipalities as of 2001 was 91,031. Over 70 small communities are scattered throughout the rural portions of the valley, and separated by approximately 1–10 km. Each small community has a mean of 28.3 households. Rural inhabitants have a subsistence economy based on small-scale cattle ranching, subsistence farming and, to a lesser extent, forest exploitation for charcoal. In addition, the Standard Fruit Company provides jobs for a large number of inhabitants in the region who work in the banana plantations.

Interviews.—We conducted 132 face to face, verbal, semi-structured, 20–30 min interviews in Spanish over the course of three field seasons: from May to June 2008, from January to February 2009, and during June 2009. We conducted interviews primarily within the range of *C. melanosterna*; however, recent niche models (Pasachnik et al., unpubl. data) indicate that we conducted 26 interviews just outside of the potential range of this species. We visited approximately 80% (n = 58) of the communities within the region, and conducted a mean of 2.3 interviews in each community to capture attitude diversity across the entire range of the species. We compared attitudes inside and outside the range of the species. We chose interviewees randomly, with the caveat that we tried to interview an even number of males and females as well as people of different ages to gain a broad understanding of how the community as a whole relates to the iguana.

We obtained verbal consent from participants before conducting interviews. During verbal consent, we informed participants about the interview, its purpose, and how the data would be used. At times participants gave their names, but we stripped identifier information from the data file for analysis. We did not compensate participants. Edoardo Antúnez and Carlos Roberto Carias conducted all interviews. Both were students at the Universidad Nacional Autónoma de Honduras at the time of this study, are Honduran nationals, and are from outside the study area.

We aimed to keep the respondent comfortable when answering the questions to have reliable information. Thus, we used a standardized, semi-structured interview with the aim of answering specific predetermined questions by the interviewer but without having a sheet with the questions in view. We did not comment on responses and were encouraging and accepting throughout the discussion to help build trust with the respondents and cultivate openness in their answers. Instead of using printed interview forms, we obtained information through a directed discussion and then subsequently recorded it once out of the presence of the respondent. During these discussions, we gathered information to address three main topics: (1) local knowledge of the area of occupancy and habitat preference; (2) use and trade of this species; and (3) level of awareness and openness to protection of this endangered species (Appendix I). In point three, we were interested in knowing the receptivity of local people to potentially working with international conservation organizations. Not all respondents answered all questions, and as such, the numbers of respondents per question varies and are reported below. When respondents did not provide adequate information about a particular point after one query, we directed the discussion back to that point a second time. If no information was given that was relevant to any particular question, we left that field blank.

Because many people in this area know that it is technically prohibited to hunt iguanas it was important to keep the conversation friendly and less formal. Overall we feel confident that interviewees were providing truthful information. If an individual seemed particularly uncomfortable during the interview or seemed evasive, we made note of this and discarded the data. This included only two interviews (i.e. two of 134, and we completely discarded those two).

In addition, we took field excursions with local hunters where we obtained additional information concerning hunting practices and basic natural history data on an *ad hoc* basis. During complimentary studies a subset of us worked closely with hunters in order to locate and capture iguanas in the field for ecological and molecular studies (Pasachnik et al. 2011a, 2012b). During this work we became close with these hunters, building a trusting relationship, in which they shared much information with us.

Because there are three different species of iguanas (*Iguana iguana, C. similis,* and *C. melanosterna*) occurring in the Valle de Aguán, and because we were most interested in information concerning *C. melanosterna*, we assessed the respondents' ability to

recognize the different species. We did this by showing photographs of the three local species and asking people to identify each species if they could. We used two photographs of adult male *C. similis*, one of a male *C. melanosterna*, one of a female *C. melanosterna*, and one of an adult *Iguana iguana*.

Analyses.—We analyzed ability to identify species and consumption frequencies by home location inside or outside the distribution range of *C. melanosterna*, as well as by sex, using χ^2 tests, evaluating the null hypothesis of equal consumption frequency ($P \leq 0.05$). We separated respondents into four age classes to have roughly equivalent numbers of participants in each class and graphed the responses of each group in respect to their support for conservation. The correlation among respondents who said that protecting the species directly benefitted them and their support for the efforts of international conservation organizations was evaluated using a Wilcoxon Signed Ranks Test ($P \leq 0.05$). The remaining responses were summarized using descriptive statistics.

RESULTS

Of the 132 respondents, 42% were female (n = 56) and 58% were male (n = 76). The respondents ranged in age from 12 to 79, with the majority of respondents being between 31–60 y old (62%; n = 82). Of those responding to our question about their current occupation (n = 80), the largest group were farm and ranch employees (35%; n = 28), followed by homemakers (20%; n = 16), business employees (18%; n = 14), business owners (16%; n = 13), farm and ranch owners (9%; n = 7), those unemployed (1%; n = 1), and students (1%, n = 1). The four age classes and the numbers of respondents in each were 12–29 years (n = 27), 30–39 years (n = 27), 40–49 years (n = 32), 50–79 years (n = 39) with seven participants not giving their age.

Species knowledge.—In regards to photograph recognition, 26% (n = 33) of the 125 respondents interviewed (seven of the overall pool were not interviewed in this regard) could recognize all three of the iguana species occurring in the valley, whereas another 58% (n = 73) could recognize two of the three, and 14% (n = 18) could recognize only one species. When using photographs of the three species to gain an understanding of local knowledge, there were noticeable differences associated with the respondent's gender and location. Correct identification of iguana species from photographs was significantly more likely in men than women (n = 96, $\chi^2 = 8.20$, $P < 0.05$; 64% correct identification by men, n = 80; 36% correct identification by women, n = 16) and this was true in comparisons across gender when respondents were separated into each of the four age categories or whether or not they were local to the range of *C. melanosterna*. Of the respondents from outside of the distribution of *C. melanosterna,* 16% (n = 4) of 25 interviewees were able to correctly identify *C. melanosterna* from a photograph. In contrast, interviewees who were more likely to have encountered *C. melanosterna*, such as those from within the distribution of *C. melanosterna* in the rural and urban area of Olanchito (66%, n = 100) were significantly more successful in identifying the species from photographs than those from outside the species range (n = 125, $\chi^2 = 32.30$, $P < 0.001$).

When considering the relative number of correct answers for identifications of each iguana species in each human age class, the results are fairly consistent, with middle-aged men and older women having the most correct answers. In addition, 12 local hunters (all adult males) from different communities demonstrated specific knowledge of all three species. All 12 hunters knew exactly where to encounter each of the three species and could easily tell them apart from a few meters. Thus, those individuals providing iguana meat for the valley communities seem to be able to easily differentiate between the species.

We asked a series of questions related to the natural history of *C. melanosterna.* In regards to the range of the species and where it could be found, the answers included specific locations, with the vast majority of people mentioning locations on both the north and south sides of the river Aguán, with only a few individuals mentioning areas outside of the actual range. Responses also include habitat types such as areas near water sources, specific trees, cacti, *Hematoxylum brasileto* (Caesalpiniaceae), *Acacia riparia* (Jamacoao), *Guazuma ulmifolia* (Cablotes and Chaparro), holes in trees, and holes in the ground. All of these are accurate depictions as to where the iguana has been found, given our knowledge and observations of the iguanas in this area.

When asked about the behavior of the focal species, 61% (n = 81) of the 132 respondents did not provide an answer. Of the 51 people that answered, responses focused on reproduction, diet, and aggressiveness. Several (22%; n = 11) stated that this species lays eggs in June and has 10–50 eggs (the majority saying between 15–30 eggs), with larger females having more eggs. Though little is known concerning the reproductive biology of this particular population, we have substantial information concerning the Cayos Cochinos population of *C. melanosterna* (Chad Montgomery, pers. comm.), captive collections (Evert Henninghiem, pers. comm.), and closely related species (Andrea Martinez, pers. comm.), and can conclude that the responses of our interviews were most likely correct. With regards to diet, people mentioned the consumption of a variety of leaves, fruits, and flowers, which is typical of iguanas.

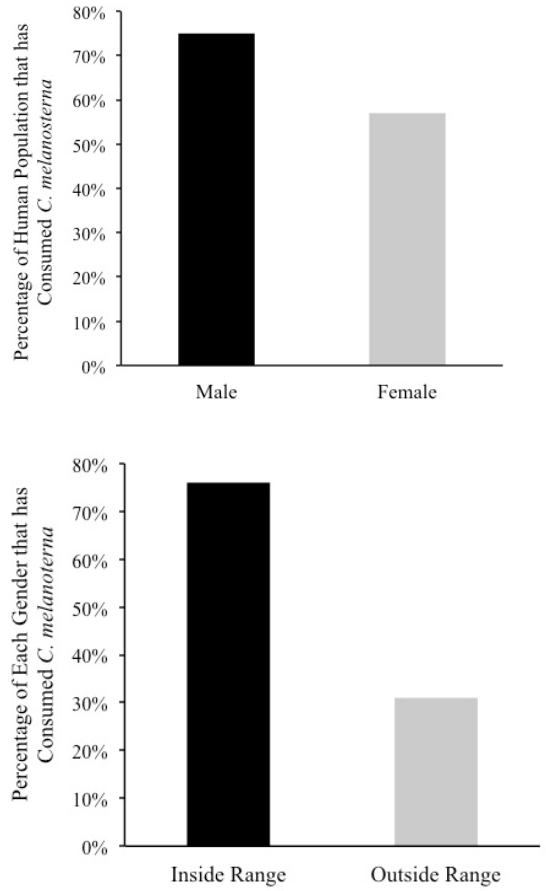

FIGURE 1. Differences in percentage human consumption of *Ctenosaura melanosterna* by location (whether they are located within the species range or not; top) and by gender (bottom)

One individual mentioned communal living in regards to *C. melanosterna*, which would be a novel finding.

No one said that this species is venomous or poisonous. Of those who commented on whether *C. melanosterna* is aggressive or harmless, the majority (15 of 23) thought that they were aggressive by biting and tail whipping. However, half of these people were from outside of the range of this species. As is well known about iguanas, it is correct that this species is not venomous, and accurate to say that this species will likely only be aggressive when threatened, such as in capture events.

Use, trade, and hunting.—Out of 131 respondents, 68% (n = 89) acknowledged eating *C. melanosterna* at some point in their lives. There was a significant difference by gender in consumption (n = 132, χ^2 = -0.19, P = 0.035) with men more likely to consume than women (75% of men [n = 75] vs. 57% women [n = 56], Fig. 1). Of the 72 respondents who provided frequency of consumption data, 64% (n = 46) said that they do not eat it or that they had not eaten the species in more than two years. Of the 26 people who consumed *C. melanosterna* and gave quantifiable consumption estimates, the answers ranged from one per year to a single individual who reported eating three per week, or 156 per year. Thus, of those who ate *C. melanosterna* and gave frequency of consumption answers, a mean of 20.8 (s = 33.33) lizards were consumed per person, per year. With the removal of one avid consumer, the mean drops to 15.4 (s = 19.12) lizards per person annually. There was a strong correlation between living within the range of *C. melanosterna* and consuming this species (n = 132, χ^2 = 15.52, P < 0.001), in that over 76% (n = 80) of the 105 within the range consume *C. melanosterna*, but only 31% (n = 8) of the 26 outside the range do so (Fig. 1). Of those who consume *C. melanosterna,* 60% (n = 53) stated that they prefer to eat gravid females. Of the 16 people who cited a specific time of the year that they eat *C. melanosterna*, all but one do so during Easter or summer, which loosely coincides with the gravid period. Interviewees stated that the meat and eggs are most commonly prepared in a soup with coconut milk.

Of the 71 respondents who commented on use of the species, 38% (n = 27) stated that the consumption of the focal species is medicinal, and the rest said it was only a source of nourishment. Specific medicinal purposes ranged widely but included: source of vitamins, increase in appetite, cure for cancer, malnutrition, diabetes, reduced cholesterol, fever, and scars. Specific body parts are thought to have different uses. For example, fat is thought to be useful for asthma and earaches, and blood useful for respiratory diseases.

Of the 77 who responded that they captured *C. melanosterna*, 88% (n = 68) said it was for their own consumption, while only 12% (n = 9) of respondents said they trade the species commercially. The mean price per individual of the focal species was the equivalent of approximately USD $9.25 (n = 73, s = $5.11), with higher estimates coming from those in the city of Olanchito, and 68% (n = 50) of respondents stating that Olanchito is where the most money could be made selling them. Of those responses concerning juvenile capture, 33% (n = 76) said that they do so most frequently to keep as pets or for breeding purposes.

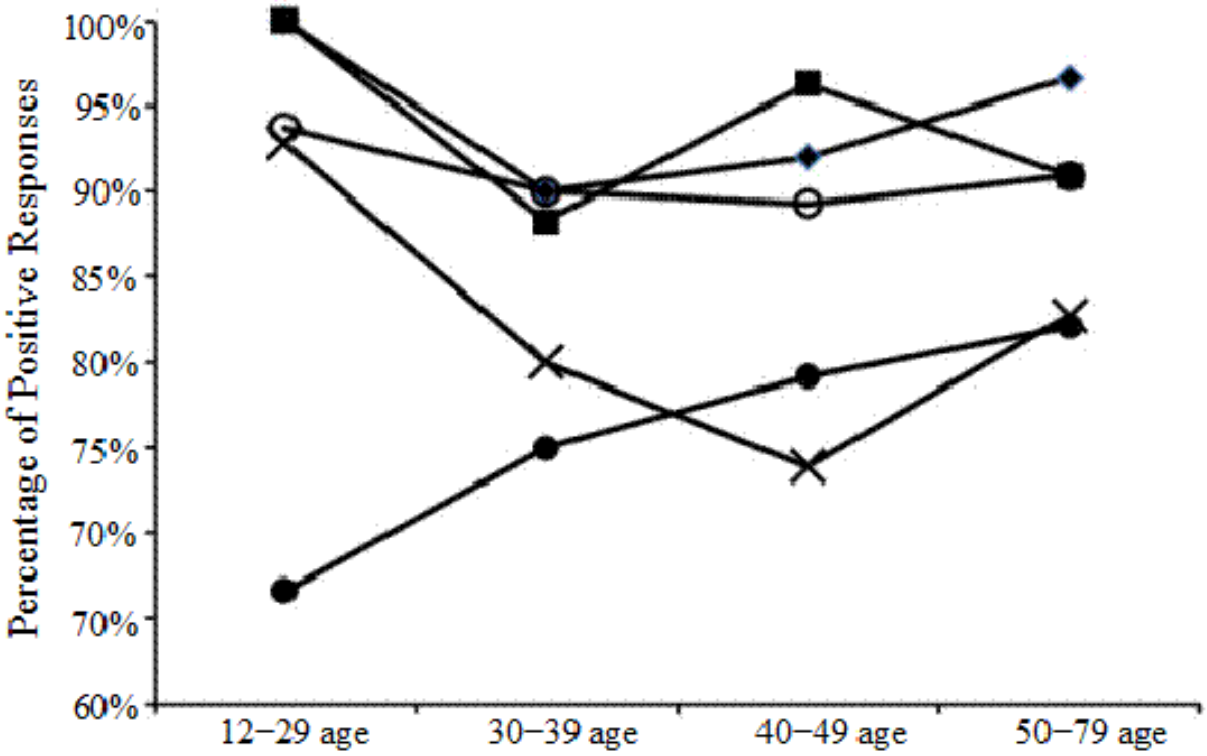

FIGURE 2. Percentage of positive responses by age category of humans to assertions supportive of the conservation of *Ctenosaura melanosterna* (maximum n = 132), in the Valle de Aguán, Honduras, in the following categories: diamonds = there are fewer *C. melanosterna* now, squares = favorable opinion of international conservation NGOs, closed circles = hunting of *C. melanosterna* is not sustainable, X = *C. melanosterna* may go extinct, open circles = protecting *C. melanosterna* helps people.

When asked about the number of hunters per village or per family, most people did not answer or stated that there were none (52% [n = 69] and 77% [n = 102], respectively). The mean numbers of hunters per village and mean per family reported (3.1 for n = 51 and 0.7 for n = 69, respectively) was quite low. From working with iguanas and hunters in the area for years on this and other projects, two of the authors (SAP and JPC) found that nearly all hunting is practiced by men and often occurs opportunistically. However, some people would go into the forest specifically to hunt *C. melanosterna*, especially when females are gravid and in preparation for the local festival that celebrates the consumption of this species. The most common hunting methods include the use of dogs and machetes for removing individuals from crevices in trees, but firearms, slingshots, and nooses are also used. Most individuals hunt within a few kilometers of their homes and walk or ride bikes to hunting areas. Most hunting occurs in the early morning, and many hunters prefer to be in the forest before sunrise.

Awareness and openness to protection.—Of the total number of interviewees, 22% (n = 29) said that *C. melanosterna* could be found on their property, 43% (n = 57) said that it could not, and 35% (n = 46) did not respond. When asked if they had seen a decline in the number of individuals, 95% (n = 94) of the 99 respondents said yes, and one respondent believed they no longer exist. Of the 91 respondents across all age categories, 80% (n = 73) felt that the species would go extinct if protective actions were not taken. Likewise, 73% (n = 67) of the 92 respondents across all age categories stated that hunting is not sustainable. When asked about the status of the species, 78% (n = 38) of the 49 respondents said that it is endangered. However, only a minority answered the question, indicating that they may not have understood the terms used.

When asked who is currently protecting the species, people gave various responses including federal governmental offices, the Environmental Ministry, the military, civil and municipal police, Pico Bonito National Park, the Town Council of Arenal, and people within certain local communities. Of those respondents who said that there were agencies responsible for protecting the iguana, 79% (n = 42) of them were correct

in attributing them to an agency that should have a role in protecting *C. melanosterna*, though most are currently inactive in such protective measures. A slight majority (58%, n = 101) thought that the species is not protected, which in reality is true when considering that the laws are rarely enforced in regards to iguanas.

Across the four age categories, 90% (n = 89) of the 99 respondents stated that protection of *C. melanosterna* is beneficial, including all responses in the youngest age category. No significant differences were observed across age classes, although the youngest group had the most extreme responses by percentage in support of *C. melanosterna* conservation (Fig. 2). The sole exception to this trend was that the youngest age group had the smallest percentage of respondents saying that current hunting rates are unsustainable, possibly because of a lack of historical knowledge.

When asked about the potential of internationals helping in the protection of this species, 94% (n = 94) of the 100 respondents agreed that it was a good option. In fact, respondents who thought that protecting the species directly benefitted them did so in part because it could lead to sustainable harvests over the long term and additional medicinal products that could be derived from the iguanas for future generations. These individuals who were aware of the direct benefits of iguana conservation were significantly correlated with supporting the efforts of international conservation organizations *(*n = 95, Z = -2.53, *P* = 0.011). This trend was strongest among those who lived within the range of *C. melanosterna*, and among those who were most concerned that the species could go extinct, where the majority of both groups (80%, [n = 106] inside range and 88% [n = 73] of those who thought it would go extinct) supported the aid of international Non Governmental Organizations.

DISCUSSION

Wildlife harvesting has traditionally been an important resource for people around the world. Within Central America, as the larger species quickly disappear near human settlements, smaller wildlife become targeted (Altricher 2006). Iguanas have been heavily hunted as a source of protein within the new world tropics (Fitch et al. 1982; Werner 2000). Over time this has caused local extirpations to which the local communities demonstrate a sense of loss and desire for its return (Werner 2000). Though harvesting is widely acknowledged as a threatening force, few studies have attempted to gain a detailed understanding of these actions (Coti and Ariano-Sanchez 2008; Stephen et al. 2011). Local knowledge of these factors is often the most appropriate means by which to gather this information. Designing strategies to manage such harvesting is complicated yet crucial, and often, local communities are the best stewards for this work (Bennett and Robinson 2000; Stearman 2000). This type of study opens the door to start those conversations with locals, such that we may begin to work towards co-management strategies.

Though not all respondents could correctly identify the three different species from the photographs we presented, all but two (of n = 125) respondents could correctly identify at least one of the three species in the area. The high rate of misidentification is most likely due to the quality of the photographs used, as is highlighted by the varying responses to the two *C. similis* photographs. Within the range of *C. melanosterna*, most people could recognize it and were able to correctly discuss varying aspects of its natural history and behavior, demonstrating real knowledge of the species. Locals are familiar with where it can be found, what it eats, and its reproductive behavior. Interestingly, most people do not fear this species as poisonous or venomous as is often the case with iguanas (Stephen et al. 2011). Considering gender, men were able to identify all species consistently better than women, across locations and age categories. Men are often opportunistic hunters, and are more frequently in the forests potentially interacting with the iguanas. Experience with the animals, not surprisingly, seems to improve the identification abilities of local people.

All hunters with whom we interacted had extensive familiarity with the different species in the area, indicating that the providers of this food source are extremely knowledgeable. Our findings that hunters behave opportunistically is consistent with that found of the mestizo people (Redford and Robinson 1987). This is indicative of an impoverished community in which people are hunting whatever they can to provide an adequate amount of protein to their family or community. This finding may be beneficial when considering alternative protein sources (see below). Hunting practices are also similar to what others have found for the mestizo people in terms of weaponry and proximity to home (Ojasti 1996; Altricher 2006).

Consumption patterns of *C. melanosterna* were mostly consistent with expectations. Those who live near the animals are more likely to consume them given availability and familiarity. Similarly, men were more likely to consume than were women, possibly due to gender biased perceptions of iguanas. Given what we know about the human population size in the Valle de Aguán (2001 population estimate of 91,031), the percentage of people who currently consume *C. melanosterna* (36%), and the number consumed annually per capita among our interview population, and assuming that they are representative of other individuals in the area, we may create a very rough estimate of annual consumption of iguanas in the Valle de Aguán. Possible annual consumption of iguanas may be between 504,676 (15.4/person annual mean) and 681,640

(20.8/person annual mean) in this area. A few sources of error should be considered with regard to the accuracy of this very rough estimate. First, this may be a gross over estimate, as consumption rates are unlikely to be uniform across the Valle de Aguán, and the same single iguana may be used to partially feed a group or family of people. In turn however, our observed hesitancy of people to report consumption of this technically protected species, and the fact that our human population estimate is 12 years old, may lead to underreporting, and thus ours may be an under estimate of the annual consumption.

Irrespective of the accuracy of the estimated consumption rates, even an extremely conservative interpretation, such as each person consuming only one iguana per year, suggests that the consumption in the Valle de Aguán is unlikely to be sustainable, as the population is thought to be less than 5,000 mature individuals (Pasachnik et al. 2011b). A robust estimate of the iguana population size is not available but even in the best-case scenario, the population will not be able to handle even a small fraction of the consumption that has been estimated for an extended period of time. Our calculations are not meant to in anyway assume a time to extinction, given the errors associated with the consumption rate and our lack of a robust population estimate of this species but rather just to demonstrate that consumption of this species is occurring in this area, is threatening, and should be addressed, particularly as it is an illegal activity. Further, in the Valle deAguán, as with iguana consumption throughout Central America, gravid females are preferred for their eggs as they are thought to have medicinal effects (Coti and Ariano-Sanchez 2008; Stephen et al. 2011). Thus, there is an increase in hunting pressure during the nesting season, which can have dramatically negative effects on the population structure and the overall stability of the species (Faria et al. 2010; Pasachnik et al. 2012a). This also seems to be the case in the Valle de Aguán population, where a highly male-biased sex ratio has been observed (Pasachnik et al. 2012b). In addition, there seems to be an overall lack of large individuals in this population (Pasachnik et al. 2012b), which coincides with our findings herein of reduced juvenile capture, and preference for adults.

Because people seem to be hunting mostly for subsistence and not for the pet trade and sales of meat, we do not expect the hunting pressure to increase dramatically over the coming years due to individual demand, though human population size increases may cause a rise in consumption. Avenues of mitigation are however, complicated, as *C. melanosterna* does seem to be an important part of the local diet. This is particularly true during culturally important events. However, the locals in this area seem to have an understanding that this species is in danger and that action must be taken to ensure its existence. Overwhelmingly, the respondents were supportive of conservation of *C. melanosterna*, and most thought that protecting the species would benefit local people directly through improving hunting over the long term and additional medicinal products that could be derived from the iguanas for future generations. Although only 32% of the respondents gave the name of any agency responsible for protecting the iguana, 79% of those that did respond were correct in identifying an agency that should in fact have a role in protecting this species. Because the majority of people are unaware that this species is protected, it may be inferred that enforcement is lacking in this area, and increased education is needed.

Ctenosaura melanosterna is one of the most threatened species of iguana in Central America. Within the Valle de Aguán region, not only are people supportive of conservation, they are knowledgeable about the species, its status, the need for protection, and in part the agencies that should be protecting the species. Because this iguana is harvested primarily for subsistence, management efforts that focus on providing protein sources to the community while enhancing the chances of iguana persistence, and to a lesser extent alternative incomes may be most successful (Werner 2000). As two other species of iguanas exist in this area and are far less threatened, shifting the focus to these other species should be explored. The Smithsonian Tropical Research Institute and the Pro Iguana Verde Foundation of Panama have investigated many options for Green Iguana (*Iguana iguana*) farming and harvesting as a means of relieving pressure on the natural iguana populations (Werner 2000).

The implementation of a sustainable harvesting program for this species itself, however, may be a beneficial first step as has been done in Guatemala. An NGO, Zootropic, has built a successful community conservation program, lead by converted hunters, to protect the sister species of *C. melanosterna*, in the Valle de Motagua, Guatemala. The success of this program is based on having a constant presence of the NGO, which now even has a small research station in the focal region. Thus, jobs are created, harvesting is regulated, and protection is enforced through the local community. The community structure in this area of Guatemala is very similar to that in our focal region, thus we feel that the same could be achieved in the Valle de Aguán, given a strong commitment by a local or international organization.

Incorporating the community into a conservation and management strategy that links human social systems with the ecology of the area is vital to any program's success (Janzen 1988; Olsson et al. 2004; Cinner et al. 2009). Within the Valle de Aguán, the community, particularly the younger generations, seems open to international entities helping to conserve this species,

which will allow for adaptive management (Millennium Ecosystem Assessment 2005). As such, it is our hope that interested conservationists will seriously consider working in this area when determining sites for future intervention and conservation of Central American biodiversity. Elucidating the relationship between production and harvest to find a sustainable balance is not only interesting, but also vital to the persistence of this species and local traditions (Bennett and Robinson 2000). Though we have presented encouraging information concerning local beliefs, additional data on social structures and learning patterns, and the economics and politics of the area, must be better understood to develop the most reasonable management plan for the future (Bennett and Robinson 2000; Werner 2000; Folke 2006). If action is not taken immediately, the future of *C. melanosterna* is uncertain.

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APPENDIX I. Topics of conversations during open-ended, semi-structured discussion interviews in the Valle de Aguán, Honduras, to gain information regarding *Ctenosaura melanosterna*.

Name: Age:
Gender: Date:
Village: Local: Y / N Time living in area:
Occupation:

How many iguana species does the interviewee know exist in the area?
Correct identification of photos:
1____2____3____4____5____
(*similis* A, *similis* B, *melanosterna* male, *melanosterna* female, green iguana)

Where can *Ctenosaura melanosterna* be found?

What is the behavior of this species?

Can *Ctenosaura melanosterna* be found on the interviewees property?

Does the interviewee have a farm or plantation on their property: Y / N
If so, what type:

Does the interviewee ever eaten *C. melanosterna*? Y / N
If so, how often?

How many *C. melanosterna* are needed per meal?

Are they caught for:
food sale both other

How many hunters are in their:
village family

How are *C. melanosterna* captured (techniques)?

How are *C. melanosterna* kept?

What is the preferred type of *C. melanosterna*: female gravid female male juvenile

What is the price to purchase this species?

Have the prices changed?

Does the interviewee feel that there are more or fewer individuals of this species now than in the past?

Does the interviewee know that this is an endangered species?

Does the interviewee know if anyone is in charge of protecting this species? If so who?

What is the interviewees opinion about them?

Does protection benefit the iguana?

Is this species dangerous? If so, how?

Is this species beneficial? If so, how?

Does the interviewee think that this species will ever go extinct?

Is hunting sustainable?

Where can one make the most money selling this species: their village Olanchito other

Would the interviewee agree to internationals working to protect this species?

Additional observation from the interviewer:

STESHA PASACHNIK began her research career as an undergraduate at Earlham College, in Richmond, Indiana, where she received her bachelor's degree under the mentorship of Dr. John Iverson. She completed her Ph.D. at the University of Tennessee researching various aspects of the *Ctenosaura palearis* clade using conservation genetics tools. After completing her doctorate, she worked as Conservation Director for the Roatan Branch of the Bay Islands Foundation in Honduras. She is now a Postdoctoral Research Associate at the Institute for Conservation Research (San Diego Zoo Global), in San Diego, California. (Photographed by Dennis Baulechner).

JAMES DANOFF-BURG is Director of the Conservation Education Division at the San Diego Zoo Institute for Conservation Research, where he and his team help enhance the success and sustainability of the conservation projects around the world. His team does this by ensuring that conservation efforts are aligned with community interests. He was a Postdoctoral Researcher at the University of Vermont and was awarded a Samuel Research Fellow at the American Museum of Natural History in New York City. He was a Community Ecologist, Researcher, and Professor at Columbia University for 14 y before coming to San Diego Zoo Global in 2011 to originate and lead the Conservation Education Division. (Photographed by Sharon Danoff-Burg).

EDOARDO E. ANTÚNEZ completed his Bachelor's in Biology at the Universidad Nacional Autónoma de Honduras. In 2008 Edo had the opportunity to attend the IUCN Iguana Specialists Group meeting on Utila, Honduras. At that point, he began working on a collaborative project with iguanas in Honduras. He is currently looking to pursue a Master's degree in Ecology and Conservation. (Photographed by Edoardo Antúnez).

JEFFREY CORNEIL obtained his Bachelor's degree from the University of Washington in 2005, with a focus in biology. During *Ctenosaura* field studies in Honduras, he relished the opportunity to discuss the status of these unique creatures with the local communities. Jeff is currently in a Master's program at Truman State University focusing on the natural history and ecology of *Ctenosaura oaxacana*. (Photographed by Stesha Pasachnik).