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Original Contribution

To Eat or not to Eat an Endangered Species: Views of Local Residents and Physicians on the Safety of Sea Turtle Consumption in Northwestern Mexico

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Abstract: Sea turtles have historically been an important food resource for many coastal inhabitants of Mexico. Today, the consumption of sea turtle meat and eggs continues in northwestern Mexico despite well-documented legal protection and market conditions providing easier access to other more reliable protein sources. Although there is growing evidence that consuming sea turtles may be harmful to human health due to biotoxins, environmental contaminants, viruses, parasites, and bacteria, many at-risk individuals, trusted information sources, and risk communicators may be unaware of this information. Therefore, we interviewed 134 residents and 37 physicians in a region with high rates of sea turtle consumption to: (1) examine their knowledge and perceptions concerning these risks, as a function of sex, age, occupation, education and location; (2) document the occurrence of illness resulting from consumption; and (3) identify information needs for effective risk communication. We found that 32% of physicians reported having treated patients who were sickened from sea turtle consumption. Although physicians believed sea turtles were an unhealthy food source, they were largely unaware of specific health hazards found in regional sea turtles, regardless of location. By contrast, residents believed that sea turtles were a healthy food source, regardless of sex, age, occupation, and education, and they were largely unaware of specific health hazards found in regional sea turtles, regardless of age, occupation, and education. Although most residents indicated that they would cease consumption if their physician told them it was unhealthy, women were significantly more likely to do so than men. These results suggest that residents may lack the necessary knowledge to make informed dietary decisions and physicians do not have enough accurate information to effectively communicate risks with their patients.

Keywords: bacteria, Baja California, Mexico, consumption, contaminants, human health, knowledge, parasites, risk communication, risk perceptions, sea turtles

INTRODUCTION

Sea turtles have traditionally been an important resource for many coastal inhabitants of Mexico and have been used

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throughout the region for food, medicine, and decoration (Garcia-Martinez and Nichols, 2000; Delgado and Nichols, 2005). Today, the consumption of sea turtle meat and eggs continues in northwestern Mexico despite well-documented legal protection and market conditions providing easier access to other more reliable protein sources (Gardner and Nichols, 2001; Mancini and Koch, 2009; Koch et al., 2006). Turtle meat is commonly served at weddings, Christmas, Mother's Day, Sundays, and most frequently at Easter, when Catholics consume sea turtles as a sanctioned substitute for red meat (Garcia-Martinez and Nichols, 2000; Nichols et al., 2003). Sea turtle blood is thought to cure anemia and asthma, oil is extracted to aid childhood respiratory problems, and internal organs are sometimes used in soups (Caldwell, 1963; Mack et al., 1982; Felger and Moser, 1987).

Four of the five species of sea turtles that inhabit the coastal waters of northwestern Mexico are listed as endangered or critically endangered (IUCN, 2009). Lack of law enforcement and strong traditional use of turtles has led to levels of consumption that continue to negatively impact populations (Gardner and Nichols, 2001; Nichols, 2003; Koch et al., 2006; Peckham et al., 2008; Mancini and Koch, 2009). Consumption of turtle meat, and to a lesser extent eggs, is especially high along the Baja California peninsula and Sonoran coast where annual sea turtle harvest and bycatch mortality is estimated to be 35,000 turtles year^{-1} (Nichols et al., 2002, 2003; Nichols, 2003), representing a region with one of the highest known sea turtle mortality rates in the world (Hays et al., 2003; Nichols and Safina, 2004; Peckham et al., 2008). A network of black market trade persists in which demand for sea turtle meat and eggs often exceeds supply (Garcia-Martinez and Nichols, 2000) with several locations along the Baja California peninsula supplying sea turtle meat to local, regional, and even international markets (Koch et al., 2006; Mancini and Koch, 2009). A single poacher, Francisco "Gordo" Fisher of San Ignacio Lagoon, Baja California Sur (BCS), Mexico, admitted to illegally poaching and selling more than 100 metric tons (5,000 turtles or approximately 625 turtles year^{-1}) of endangered east Pacific green turtle (*Chelonia mydas*) during an 8-year period (Nichols and Safina, 2004).

Although sea turtle is popular fare in northwestern Mexico and many other regions of the world, consuming the meat and eggs may be harmful to human health due to bioaccumulation of natural toxins (e.g., ciguatera) or environmental contaminants, such as heavy metals (e.g., mercury; cadmium) and organochlorines (e.g., DDT; DDE; PCBs) (Aguirre et al., 2006; Fussy et al., 2007). These compounds bioaccumulate in marine food chains and reach especially high concentrations in species, such as sea turtles, that are long-lived and occupy high trophic levels (Caurant et al., 1999). Sea turtles also may carry parasites, viruses, and bacteria, which, when consumed, may cause deleterious health effects, such as extreme dehydration, vomiting, diarrhea, and even death (Aguirre et al., 2006). Chelonitoxism, a type of food poisoning caused by eating sea turtle meat, has a high mortality rate and has been observed in many areas where sea turtles are consumed (Fussy et al., 2007). In addition, sea turtle meat often is sold on unregulated black market circuits where processing and transport may be of dubious sanitary quality, presenting special concerns about contamination.

Several documented cases exist in which serious illness or death has resulted from the consumption of sea turtle meat. In the Pacific, human illness or death have been reported from Japan, Tanzania, Madagascar, India, Sri Lanka, West Indies, Taiwan, Philippines, French Polynesia, Indonesia, Papua New Guinea, Australia, Gilbert Islands, Kiribati, and Fiji (Aguirre et al., 2006; Fussy et al., 2007). In some Latin American countries, including Mexico, there are reports of people becoming severely ill after consuming contaminated sea turtle meat (Nichols WJ, personal observation). Campos et al. (1996) reported that individuals were hospitalized after consuming raw turtle eggs in Costa Rica and at least one death is reportedly linked to consuming hawksbill turtle (*Eretmochelys imbricata*) eggs in Papua New Guinea (Likeman, 1975). Additionally, toxins from sea turtle meat are apparently transferable from breast milk to breastfed children (Dewdney, 1967; Ariyananda and Fernando, 1987) and the freshness, preparation, and cooking of sea turtle appears to have no effect on the levels of toxicity in the meat (Limpus, 1987).

Despite emerging information (Aguirre et al., 2006; Fussy et al., 2007) on the risks associated with consuming sea turtle meat and eggs, many residents and health care professionals may be unaware of this information. Whereas the risks of unsanitary water, red meat, poultry, and finfish/shellfish have been communicated extensively in the media and public health literature, much less attention has been given to the safety of sea turtle consumption, possibly because the practice is illegal. The paucity of reliable data is in part because many people who become sick from consuming sea turtles often live in remote geographical locations with little or no access to health care. The majority of available information documenting the health effects from

consuming sea turtle meat and eggs is scattered and has only been available to the scientific community, rather than the general public and health care community (Aguirre et al., 2006). Detailed clinical information is rare and mostly anecdotal in the form of testimonials from local fishermen. This is particularly evident in coastal communities of northwestern Mexico, because these areas often serve as major sites for poachers who supply turtle meat to residents of northern Mexican cities and occasionally U.S. border cities (Koch et al., 2006; Mancini and Koch, 2009). Many citizens of these communities consume sea turtles clandestinely and are less likely to discuss the practice with outsiders because it is illegal. As a result, the fear of legal sanctions may prevent individuals from seeking medical attention (Fussy et al., 2007).

This paper presents the views of residents and physicians on the safety of sea turtle consumption in northwestern Mexico. We developed this baseline study by conducting informal discussions with local fishermen, community members, and health care professionals. Our initial evaluation indicated that local residents and health care workers were unconcerned or unaware of potential health hazards found in regional sea turtles. This information suggested a need for additional research aimed at understanding the perceptions and attitudes of those individuals who may consume sea turtles (i.e., the general public) and those who may serve as a trusted information source or risk communicator (i.e., physicians), as well as how different factors (i.e., sex, age, occupation, education, and location) may or may not affect these perceptions. Rather than make broad assumptions (Morgan and Lave, 1990), we believed that more detailed information should be obtained from the target groups (Pflugh et al., 1999). Therefore, we interviewed 134 local residents and 37 regional physicians to: (1) examine their knowledge and perceptions concerning these risks, as a function of sex, age, occupation, education, and location; (2) document the occurrence of illness resulting from consumption; and (3) identify information needs for effective risk communication.

We interviewed citizens from a small coastal community with high levels of sea turtle consumption because these residents are more likely to consume sea turtles. Physicians from the same coastal community as well as a larger, inland urban center were interviewed to compare responses from the two communities and provide more data. We hypothesized that residents would believe that sea turtles were a healthy food source and that they would struggle to identify specific health hazards found in regional sea turtles, regardless of age, sex, occupation, or education. We also predicted that physicians would perceive sea turtles as an unhealthy food source, but they would generally be unaware of specific health hazards found in regional sea turtles, regardless of location.

Methods

Study Area

The state of BCS is located in Northwestern Mexico between 28° 00' N and 22° 52' N and 109° 25' W and 115° 05' W (Fig. 1), is approximately 900-km long, and has the longest coastline of all Mexican states (approximately 2222 km). BCS has an estimated population of 512,170 residents, with the majority of people living in La Paz or Los Cabos. The remaining population is distributed among more than 4,000 villages and small towns scattered across the peninsula. Puerto San Carlos is a small coastal community with approximately 13,000 inhabitants. The town is situated alongside Bahia Magdalena, a large (1200 km^2)

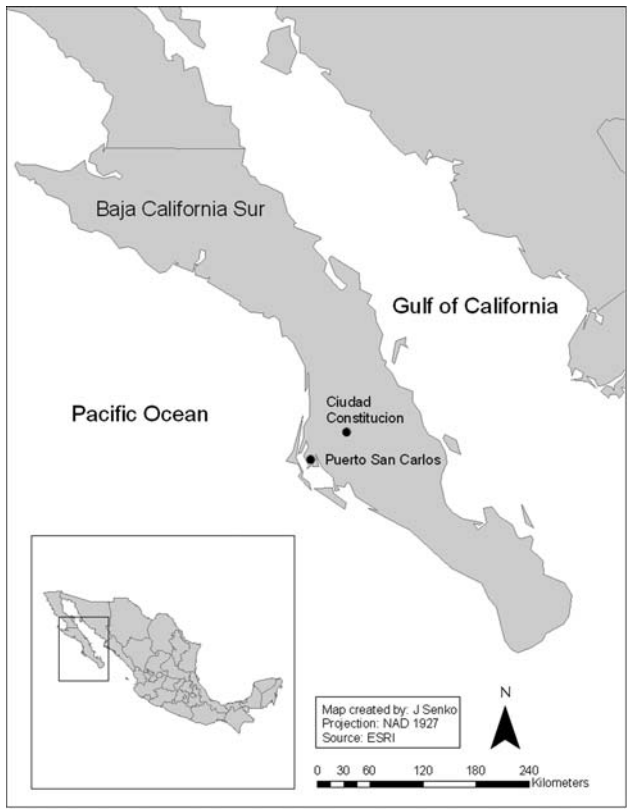

Figure 1. Map of the Baja California Sur, Mexico region where residents (Puerto San Carlos) and physicians (Ciudad Constitución and Puerto San Carlos) were interviewed.

Figure 2. Sea turtle is a coveted item in northwestern Mexico and the meat is considered an illegal delicacy. In this photo, a resident prepares a recently cleaned endangered east Pacific green turtle (*Chelonia mydas*), known locally as the black turtle, for cooking in Baja California Sur, Mexico. Photo © Jeffrey Brown. Used with permission.

and highly productive coastal lagoon located on the Pacific coast of BCS. Artisanal fisheries employ at least one third of the working population directly, with many more residents dependent on the sector. Consumption of sea turtles at this small coastal community is especially high (Gardner and Nichols, 2001; Nichols, 2003; Koch et al., 2006; Mancini and Koch, 2009; Senko, 2006) (Fig. 2). Ciudad Constitución is a larger, more urban inland community with roughly 56,000 inhabitants. Agriculture and cattle production employ at least one third of the working population (INEGI, 2005).

Data Collection and Analysis

We initiated semistructured interviews with local residents and physicians by asking individuals if they were willing to participate in our study. Before conducting each interview, we explained the purpose of our study, the independent affiliation of the principal investigator (JS), guaranteed the participant strict confidentiality, and assured respondents that their identity was not being recorded (they did not provide their names). Due to the clandestine nature of sea turtle consumption, there was an inherent risk that participants might bias the information to conceal illegal behavior (Sheil and Wunder, 2002; Mancini and Koch, 2009). To mitigate this potential bias, a trusted local citizen (Julio Solis) was present at all interviews to establish a reciprocal feeling of trust and rapport, minimize any chance of miscommunication, and acquire a sense of credibility. Semistructured interviews were used to make the respondent feel more at ease and each individual was interviewed separately. The surveyor collected information from the interviewee in a relaxed but guided manner. We followed the approximate order of survey questions but allowed participants to bring up topics as they wished. In general, interviews lasted approximately 20 to 30 minutes but sometimes took longer depending on the number of questions asked. Finally, we requested availability of respondents for follow-up interviews and almost all agreed. Conversations were initiated with each individual over several days, repeating and confirming previous information and building a composite response to our question set from each participant. Total follow-up conversations ranged from 15 minutes to several hours and sometimes spanned several days. Individuals were thanked for their time and invited to visit the School for Field Studies – Center for Coastal Studies in Puerto San Carlos.

We present the percentage of people giving a specific answer to each question we asked. We used a likelihood ratio test (G) to examine: (1) differences in local resident responses as a function of sex, age, occupation, and education; and (2) differences in physician responses as a function of location. Differences were considered significant at a probability of 0.05 or less.

General Public

We conducted a total of 134 semistructured interviews with citizens from the town of Puerto San Carlos, BCS, Mexico in June 2005 (Appendix 1). A non-probability convenience sampling approach was used because this technique is useful for baseline studies dealing with sensitive topics (Bernard, 2000). Residents were chosen opportunistically by visiting local markets, restaurants, and downtown areas. We (JS and Julio Solis) approached people in restaurants after they finished eating as well as those individuals in local markets and downtown areas who seemed unoccupied. Participants were excluded from the study if they were younger than aged 18 years. Demographic data were recorded first, followed by survey questions. Approximately 75% of residents agreed to participate in an interview. Refusal was due to the sensitivity of the topic or lack of sufficient time. Interviews attempted to gather information on: (1) their perceptions and knowledge on the safety of sea turtle consumption; (2) whether they knew someone who had ever become sick from consumption; and (3) their willingness to cease consumption if their physician told them it was unhealthy.

Table 1. Demographic data from Puerto San Carlos residents interviewed in our study and BCS, Mexico

Demographic data	Current study	BCS, Mexico[b]
Male:female ratio	2:1	1:1
Mean age (yr)	29.5	30.0
Mean education[a]	9.7	8.9
Employment	Fisheries: 22%	Fisheries: 15%
	71% employed	64.7% employed

[a]Mean highest level of education: 1–6 = elementary school; 7–9 = middle school; 10–12 = high school. Residents who completed high school and attended college were given a value of 12, regardless of whether or not they finished.
[b]*Source*: INEGI (2005).

One possible criticism of this technique is the inevitable sampling bias with interviewing people at designated places (Bernard, 2000). To reduce this potential bias, we conducted interviews in different sections of town and at all times of the day (from 8 AM to 10 PM), on all days of the week. We also approached everyone that we encountered and experienced a relatively low refusal rate, thereby reducing any potential bias associated with the selection of participants (Burger et al., 1999a). We believe our method of interviewing residents gives a good overview of a public health concern that is difficult to assess, and although our sampling approach prohibits making any claims about general views of residents, we believe our population segment is reasonably representative of local demographics (Table 1).

Physicians

We conducted semistructured interviews with 32 physicians practicing in Ciudad Constiución and 5 physicians practicing in Puerto San Carlos in July and August 2005 (Appendix 2). We attempted to census every physician from both towns by visiting them at their practice location (office or home) during regular business hours. We were able to interview all (100%) of physicians in the town of Puerto San Carlos and more than half (52%) of physicians in Ciudad Constitución. Those physicians in Ciudad Constitución who were unable to interview did not have sufficient time because they were busy with patients. We followed all steps for interviewing residents, except no demographic data were recorded. Interviews addressed to physicians were designed to gather information on: (1) their perceptions and knowledge on the safety of sea turtle consumption; and (2) the extent to which their patients became sick from consumption. We believe our sample of physicians is reasonably representative of the overall population of doctors in both communities because all physicians practicing in Puerto San Carlos were interviewed and $>50\%$ of physicians practicing in Ciudad Constitución were interviewed (Table 2).

Results

General Public

Our sample contained a higher male to female sex ratio, more fishermen, and a higher education level than was reported earlier for BCS (INEGI, 2005). The only comparable demographic variables that we could test statistically were sex and education. Compared with the overall population of BCS, our sample contained a significantly higher proportion of males ($G = 20.26$, $P < 0.001$), because more males (70%) than females were interviewed. Our sample also contained more high school graduates and less uneducated residents than the overall population of BCS ($G = 53.14$, $P < 0.001$). The demographics of the general public yielded a wide range in age, education, and profession. Respondents ranged in age from 18–67 (mean = 29.5 ± 9.0) years, with 63% of respondents younger than aged 30 years. Most residents

Table 2. Differences as a function of location for physicians interviewed in BCS, Mexico

Question/region (sample size)	Puerto San Carlos ($n = 5$)	Ciudad Constitución ($n = 32$)	G (P)	Totals/averages ($N = 37$)
% that believed sea turtle was a healthy food source	40%	6%	3.65 (0.056)	11%
% that treated patients sickened from consumption	40%	31%	0.147 (0.702)	32%
% aware of specific hazards in regional sea turtles	20%	19%	0.004 (0.947)	22%
% interested in more info	100%[a]	97%	0.295 (0.587)	97%

[a]Nonadditive; all physicians (100%) in PSC were interested in more info.

Table 3. Percentage of residents interviewed who were aware of each of the potential contaminants and health hazards found in sea turtles ($N = 134$)

Awareness	Yes (%)	No (%)
Organochlorines	1	99
PCBs	1	99
Mercury	15	85
Marine biotoxins	10	90
Pathogen *Chlamydiosis*	1	99
Pathogen *Cryptosporidiosis*	1	99
Parasite *Learedius learedi*	17	83
Bacteria	14	86
Virus fibropapilloma	2	98
Average	8	92

(71%) were employed and nonprofessionals were the largest group (64%), followed by professionals (21%) and students (15%). Almost half were employed in labor (27%) or fisheries (22%). Most respondents (89%) were educated higher than elementary school and 64% had obtained a high school education or above.

Most (71%) residents believed that sea turtles were a healthy food source, regardless of sex ($G = 0.474$, $P = 0.491$), age ($G = 3.417$, $P = 0.491$), occupation ($G = 0.644$, $P = 0.422$), and education ($G = 4.937$, $P = 0.085$). On average, only 8% of residents claimed to know specific health hazards (Table 3), with $>10\%$ awareness for the parasite *Learedius learedi* (17%), mercury (15%), and bacteria (14%), whereas 32% of residents were able to identify at least one health hazard regardless of age ($G = 3.489$, $P = 0.480$), occupation ($G = .254$, $P = 0.614$), and education ($G = 5.918$, $P = 0.52$). Men were significantly more likely to identify at least one health hazard compared with women ($G = 4.5$, $P = 0.034$). Nearly all (92%) residents claimed not to know someone who encountered health problems from consuming sea turtles, and it was impossible to test whether demographic variables influenced responses to this question because of the small number of people who indicated that they knew someone who became sick. When asked if they would cease consumption if their physician told them it was unhealthy, the majority (81%) of respondents indicated that they would, whereas 13% were unsure, and 6% said no, regardless of age ($G = 5.286$, $P = 0.727$), occupation ($G = 0.549$, $P = 0.760$), and education ($G = 7.325$, $P = 0.120$), with women significantly more likely to answer yes compared with men ($G = 6.367$, $P = 0.041$) (Table 4).

Physicians

The majority of physicians (89%) believed that sea turtle meat and eggs were an unhealthy food source, and 32% had treated patients who they believed were sickened from sea turtle consumption. In Puerto San Carlos, a relatively small coastal community, 40% of physicians believed that sea turtle was a healthy food source and 40% had treated patients sickened from consuming sea turtles. Comparatively, in the larger urban center of Ciudad Constitución, only 6% of physicians believed that sea turtle was a healthy food source and 31% had treated patients sickened from consumption. However, there were no significant differences between the two communities in the belief that sea turtles were a healthy food source ($G = 3.65$, $P = 0.056$) and the frequency of physicians who treated patients apparently sickened from consumption ($G = 0.147$, $P = 0.702$). Of the

Table 4. Demographic variables affecting the perceptions and knowledge of local residents on the safety of sea turtle consumption in BCS, Mexico. Values shown G (P)

	Do you believe sea turtle is a healthy food source?	Are you aware of health hazards that sea turtles may carry?[d]	If a doctor told you that eating sea turtle was unhealthy, would you continue?
Age (yr)[a]	3.417 (0.491)	3.489 (0.480)	5.286 (0.727)
Sex	.474 (0.491)	4.500 (**0.034**)	6.367 (**0.041**)
Occupation[b]	.644 (0.422)	.254 (0.614)	.549 (0.760)
Education[c]	4.937 (0.085)	5.918 (0.52)	7.325 (0.120)

[a]Age partitioned into five categories (18–29; 30–44; 45–59; 60–74; 75+).
[b]Occupation partitioned into two categories (fishermen; non-fishermen).
[c]Education (completed) partitioned into three categories (<high school; high school; college).
[d]Awareness of one or more potential health hazard found in regional sea turtles.

12 physicians who treated patients sickened from consumption of sea turtles, 38% reported intoxication and food poisoning as the most common deleterious health effect, followed by Salmonella (19%) and obesity (13%). Pathogens, parasites, high cholesterol, high uric acid, and hypetyrogliceridine also were reported, all at 6% ($N = 1$). Regardless of location ($G = 0.004$, $P = 0.947$), 78% of physicians were unaware of specific health hazards found in regional sea turtles. Of the 12 physicians who treated patients apparently sickened from sea turtle consumption, 8 (67%) reported treating patients at least once per week, whereas the remaining 4 (33%) reported treating patients at least once per month. Almost all (97%) of the physicians were interested in receiving more information, regardless of location ($G = 0.295$, $P = 0.587$).

Discussion

In many areas of the world where sea turtles are consumed, clean drinking water and food availability/safety issues are of broad concern. Where we conducted interviews, citizens have relatively easy access to clean drinking water, food (including reliable protein sources), health care, and shelter (INEGI, 2005). Nevertheless, we recognize that in areas where basic needs are lacking, including many small towns and villages of northwestern Mexico, concerns about the safety of sea turtle consumption may be interpreted as incongruous or even disingenuous, especially in the context of other food/water-related illnesses and availability issues.

Apparent Health Effects

Deleterious health effects resulting from sea turtle consumption in northwestern Mexico appear to be more prevalent than previously recognized. Nearly one third (32%) of physicians had treated patients apparently sickened from sea turtle consumption. We believe this number may be conservative given that some physicians most likely consume or have consumed sea turtle and some mentioned during interviews that they were reluctant to share such sensitive information. We specifically asked physicians about the timing and frequency of deleterious health effects from consuming sea turtles, and all physicians who treated patients apparently sickened from sea turtle consumption noted that this was an ongoing, frequent, and chronic problem. However, the ability of physicians to definitively determine the etiology of illnesses (e.g., diarrhea, food poisoning, extreme dehydration, vomiting) is unclear. Even so, our limited sample size suggests that consuming sea turtles in northwestern Mexico may represent a nontrivial problem to the Mexican health care sector and further investigation and monitoring of the impact of sea turtle consumption on human health seems warranted (Aguirre et al., 2006).

The majority (92%) of residents claimed not to know anyone who encountered health problems from consuming sea turtles. Many residents may not have known someone who became ill because consuming sea turtles has been illegal for almost two decades and the practice may not be openly shared with others outside immediate family members and close friends. Individuals may not directly attribute becoming ill with consuming sea turtles because there is little available information on potential risks and most residents believed sea turtles were a healthy food source.

Perceptions and Knowledge

In Puerto San Carlos, 40% of physicians believed that sea turtles were a healthy food source compared with only 6% in the more urban center of Ciudad Constitución, although there was no significant difference between responses from the two communities. The disparity in responses may be a result of either Ciudad Constitución being a larger and wealthier urban center or that physicians in Puerto San Carlos may be more likely to eat sea turtles and consequently less likely to attribute sicknesses to consumption. Distance from source (the ocean) to consumption center (typically a fishing camp, home, or restaurant) also may play a role. In Ciudad Constitución, an inland community, sea turtle meat may be of unknown origin and handling time, increasing the chances of bacteria-related illnesses. In Puerto San Carlos, sea turtles are typically kept alive and slaughtered on site before preparation and consumption. Although physicians were able to observe symptoms, they were unable to identify specific causes (e.g., toxins, contaminants, parasites, etc.) and most (78%) were unaware of specific hazards found in regional sea turtles, regardless of location.

More than two thirds (71%) of residents believed that sea turtles were a healthy food source, regardless of age, sex, occupation, and education. The general public might find it difficult to believe that consuming sea turtles could cause deleterious health effects because the potential harm may not have immediate ill effects or risks may be perceived to

be too far in the future and too hypothetical to be taken seriously (Pflugh et al., 1999). Additionally, if the choice is between providing a meal for their families now or potentially becoming sick in the future, the perception of risk may be further diminished (Pflugh et al., 1999). On average, only 8% of residents were aware of specific health hazards found in regional sea turtles, regardless of age, occupation, and education. More than 10% of residents were able to identify mercury, bacteria, and the parasite *Learedius learedi* (Table 3). These health risks are familiar to many citizens, which suggests that respondents may have identified hazards that were common or otherwise recognizable to them. In particular, the parasite *Learedius learedi* is known by local fishermen to be found in sea turtles and is easily identifiable, whereas other hazards (e.g., PCBs, organochlorines, pathogens) are not easily identifiable or well known. Why men were significantly more likely than women to identify at least one contaminant is unclear. It is possible that males may have been more inclined to indicate that they were aware of potential health risks even if they were not; however, we do not have sufficient evidence from follow-up interviews that might support this.

Most respondents (81%) indicated that they would cease consumption if their physician told them it was unhealthy, with women significantly more likely to do so than men (zero women and 8.5% of men said they would continue consumption). Women may be more likely to cease consumption over safety concerns for their family and because they prepare and cook the majority of meals for their family. This is particularly encouraging because women may ultimately decide what goes on the table and pregnant women (and children) are in the high-risk group for consuming sea turtles (Aguirre et al., 2006).

Unless specifically informed by health care workers, residents might be skeptical and reluctant to believe that consuming sea turtles may lead to deleterious health effects, at least to the extent that they would stop or reduce their consumption. Several interviewees noted that they would only stop consumption if their physician or a health care professional told them it was unhealthy and some felt that environmentalists might be making up the information in a vain attempt to reduce illegal consumption. Although 81% of respondents indicated that they would cease consumption if their physician told them it was unhealthy, changing consumption behaviors will be especially challenging in a region where people continue to enjoy the opportunity to consume sea turtles despite well-documented legal protection and easier access to other more reliable protein sources.

Implications and Recommendations

Food choice is a dynamic process that is influenced by a variety of biological, psychological, social and cultural factors (Furst et al., 1996), and life experiences (Bisogni et al., 2002). Given the multitude and complexity of these factors, it is unclear whether individuals or families will shift diet patterns and consume sea turtles less often when presented with detailed risk information. Nevertheless, people cannot make informed dietary decisions without access to information and adequate knowledge is the first step to making such decisions (Burger and Gochfeld, 2006). Although it does not guarantee behavioral changes (dietary shifts), without knowledge, informed decisions cannot be made (Burger, 2005; Burger and Gochfeld, 2006).

In a study of fishermen in New York, Knuth et al. (2003) found that, when health risks were high, people would consume less fish regardless of the benefit levels. Harris et al. (2009) found that only 15% of fishermen from Chesapeake Bay, Virginia would eat fish from a location where a health advisory warning existed, regardless of age, gender, occupation, and education. Burger et al. (1999b) reported that 85% of fishermen in New Jersey said they would stop consuming locally caught fish if it increased their cancer risk, whereas 96% indicated that they would encourage women in their family to stop consumption if there was a risk to their babies. Other studies have reported that seafood consumption may decrease after the onset of advisories (Oken et al., 2003; Shimshack et al., 2005) or new information (Johnson, 2004). However, many studies (Reinart et al., 1991; Velicer and Knuth, 1994; May and Burger, 1996; Pflugh et al., 1999; Burger, 2000; Jardine, 2003) also have found that people continue to eat fish from contaminated waters despite advisories, although this may be a function of not communicating to the specific target audience (Connelly and Knuth, 1998).

Liu et al. (1998) found that individuals responded more quickly to negative media attention (risks) than to positive information (benefits) concerning fish consumption. In fact, it has been shown that unfavorable news weighs five to seven times more heavily in consumer decisions compared with favorable news (Mizerski, 1982; Verbeke and Ward, 2001). This is especially encouraging because it would be both inappropriate and unethical to advertise any possible benefits of illegally consuming an endangered species.

It is difficult to assess how generalizable any of these findings are to our study given that sea turtles are funda-

mentally different from other sources of potentially unhealthy seafood (i.e., finfish and shellfish). This is because: (1) the complete moratorium on the use of sea turtles and their endangered status in Mexico has led to a decrease in supply and an increase in demand (Garcia-Martinez and Nichols, 2003); (2) the cultural importance and historical nature of sea turtle exploitation in the region (Delgado and Nichols, 2005); (3) sea turtles remain a welcome and embraced bycatch (Koch et al., 2006); (4) sea turtle consumption is an increasing sign of wealth and status (Mancini and Koch, 2009); (5) sea turtle meat is still considered a delicacy and the eggs are still considered an aphrodisiac (Nichols and Safina, 2004); and (6) sea turtles are considered tastier than fish, shellfish, or chicken (Delgado, 2005). However, at least one documented case exists in which a health advisory was successful for a non-fish marine megavertebrate with similar historical and cultural importance as a food source. Weihe et al. (2005) reported a significant decrease in pilot whale consumption (which was subsequently confirmed in hair-mercury levels) by Faroe Island women after the issuing of advisories for pregnant women.

Even if people are aware of the risks from consuming seafood, they need to trust that the information is true (Burger, 2000; Jardine, 2003). Burger (2005) found that, in a cohort of residents from Central New Jersey, there were significant differences in trust among possible information sources (friends, family, fishermen, doctors, government officials, university professors) for knowledge about the risks of fish consumption, with individuals trusting doctors more than any other source of information, including friends and family. As long as physicians and health care workers in northwestern Mexico remain largely unaware of consumption risks, their patients may be less likely to believe this information in the form of a public health campaign. When asked if more information would be helpful, 97% of physicians reported ''yes,'' regardless of location.

Questions that might help risk managers and risk communicators include: do people know about potential risks and do they know specific information about those risks (Burger and Gochfeld, 2008). The lack of knowledge about possible deleterious health effects and the perception that sea turtles are safe to eat could be a barrier to effective risk communication. Our data suggest that effective risk communication will need to target all sectors of the population, because individuals believed sea turtles were a healthy food source regardless of age, sex, occupation, and education. In addition, if people merely know that there are potential risks from eating sea turtles, but do not know why sea turtles may be unhealthy, they might be less likely to change their dietary behaviors. Residents and health care workers, particularly those from small coastal communities, should be provided with detailed and specific information on the risks from consuming sea turtles. We believe that it is naïve to assume that such information is too complicated for the general public. The lack of details is a critical component of ineffective risk communication (Burger et al., 2003; Burger and Gochfeld, 2008) and providing specific, detailed information makes the risk more real and pertinent (Burger et al., 1999b).

As a first step in risk communication, we recommend educating health care professionals throughout northwestern Mexico, allowing information to trickle down to patients and ultimately the general public. We suggest dissemination of this information via brochures, pamphlets, and personal guidance from physicians. Scherer et al. (2008) found that pamphlets and brochures may be especially effective at targeting sensitive populations. In those small towns and villages lacking direct access to healthcare, targeting respected community leaders who believe in and understand the possible risks associated with consuming sea turtles may be an additional means of effectively disseminating this information. These efforts should be broad based and include, where appropriate, other long-lived marine vertebrates that occupy high trophic levels and may be unhealthy to consume.

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Appendix 1

Questions asked during semistructured interviews with citizens

Date_____ Location_____

Surveyor_____

Baja California Sur Sea Turtle Survey

We are administering a survey with the aim of knowing your opinions about the importance of sea turtles in the region where you live. Your answers are very important to us and will help us in the development of a community-based communication and education program for the benefit of all. It is not necessary to give us your name and answering this questionnaire will take only a few minutes. Thank you very much!

1. Gender (***MARK WITHOUT ASKING***)
   [] Male [] Female
2. How old are you? _____
3. What is your highest level of schooling? _____

   DID YOU FINISH? [] YES [] NO
4. How are you employed? _____
5. Do you believe that sea turtle is a healthy food source?

   [] Yes [] No
   PLEASE SPECIFY WHY OR WHY NOT
6. Do you know anyone who has ever had any health related problems associated with eating sea turtle?

   [] Yes [] No
   IF YES, PLEASE SPECIFY
7. Are you aware of any contaminants, toxins, parasites, etc. that sea turtles may carry? If so, please indicate which ones

   Organochlorine pollutants Mercury
   PCB's Infectious virus *Fibropapillomatosis*
   Marine biotoxins Bacteria
   The pathogen *Chlamydiosis* The parasite *Learedius learedi*
   The pathogen *Cryptosporidiosis* Other (list)
   MARK
8. If a doctor told you that eating sea turtle meat was unhealthy because it might contain contaminants, bacteria or parasites, would you continue to eat it?

   [] Yes
   [] No
   [] Maybe
   PLEASE SPECIFY WHY OR WHY NOT

Appendix 2

Questions asked during semi-structured interviews with physicians

Date_____ Location_____

Surveyor_____

Baja California Sur Sea Turtle Survey

We are administering a survey with the aim of knowing your opinions about the importance of sea turtles in the region where you live. Your answers are very important to us and will help us in the development of a community-based communication and education program for the benefit of all. It is not necessary to give us your name and answering this questionnaire will take only a few minutes. Thank you very much!

1. Do you believe sea turtle is a healthy food source?

   [] Yes [] No
   PLEASE SPECIFY WHY OR WHY NOT
2. How often do your patients tell you they eat sea turtle?

   PLEASE SPECIFY TO YOUR BEST ABILITY
3. Have you ever treated any patients sickened from sea turtle consumption?

   [] Yes [] No
   IF YES, PLEASE SPECIFY HOW MANY TIMES AND HOW OFTEN
   (Once per week / Once per month / Once per year / Other - MARK)
4. What were the diagnoses (e.g., *E. coli*, salmonella, toxic poisoning, etc)?

   PLEASE SPECIFY TO YOUR BEST ABILITY
5. Are you aware that regional sea turtles may contain the following health hazards: organochlorines, mercury, PCBs, biotoxins, pathogens, parasites, bacteria or viruses?

   [] Yes [] No
   IF YES, PLEASE SPECIFY WHICH ONES

6. If your answer to number 5 was "No," would this information be useful to you and your patients **OR** would you be interested in receiving more information on the topic?

   [] Yes [] No

   PLEASE SPECIFY WHY OR WHY NOT

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