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LETTER

Changing Wild Meat Consumption: An Experiment in the Central Amazon, Brazil

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Abstract

Millions of people across the tropics rely on wildlife for food and income. However, overhunting to satisfy this demand is causing the decline of many species; an issue known as the wild meat crisis. We applied a before-after control-intervention design to assess the effects of social marketing (an information campaign and community engagement) with and without an economic incentive (discount coupons for chicken) on wild meat consumption. Coupons increased chicken consumption, as expected, but did not reduce wild meat consumption. In contrast, social marketing without the price incentive reduced wild meat consumption by ~62%. This study demonstrates how social marketing and price incentives may be effective at reducing demand for meat and other wildlife products.

Introduction

People across the tropics rely on wildlife for food and income, but overhunting to satisfy this demand is causing the decline of many species; an issue known as the wild meat crisis (Milner-Gulland *et al.* 2003; Lindsey *et al.* 2013). Reducing demands for wild meat, especially by urban residents who have access to alternatives, is an important approach to diminish the crisis (Milner-Gulland *et al.* 2003; Drury 2009). Although per capita wild meat consumption by urban residents may be lower than by rural residents, the aggregate consumption in urban areas can be much higher (van Vliet *et al.* 2012). When wild meat availability declines, urban people switch to domesticated alternatives, but rural people who rely on wild meat for subsistence and lack opportunities to switch to alternative foods are most vulnerable to shocks in food supply (Bennett 2002).

Although unsustainable hunting has been historically worse in Asia and Africa, it is an increasing concern in Amazonia as human population increases and evidence of urban demand for wild meat and its impacts on wildlife emerges (Parry *et al.* 2010, 2014; van Vliet *et al.* 2015). Human populations in Amazonia are increasingly urbanized (IBGE 2010) where small town hunters and consumers of wildlife can severely deplete populations in surrounding areas (≥100 km; Parry & Peres 2015). However, unlike in Asia and Africa, where international trade is widespread, most trade in Amazonia appears to be local or regional (Rushton *et al.* 2005; Baia *et al.* 2010; Parry *et al.* 2014; van Vliet *et al.* 2015), suggesting opportunities exist for

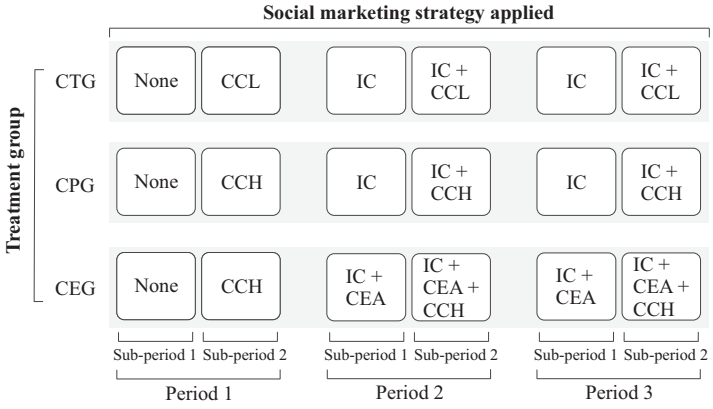

Figure 1 Treatment groups, timeline, and period of consumption monitored. Periods correspond to the time we monitored meat consumption of project participants. Each monitoring period lasted for approximately 20 days (10 days per subperiod). Period 1: May-Jun 2013. Period 2: Aug-Sep 2013. Period 3: Jan-Feb 2014. CEG: community engagement group, CPG: coupon group, and CTG: control group. IC: information campaign. CEA: community engagement activities. CCH: discount coupons for chicken. CCL: discount coupons for cleaning products. Information campaign and community engagement activities, once launched (July 2013), lasted until the end of the research (Feb 2014). Coupons for chicken and cleaning products were applied only during monitored periods.

regional actions to avoid wildlife collapses observed elsewhere.

Approaches to reduce wild meat demand must be based on an understanding of consumption. Taste preference (Schenck *et al.* 2006; Baia *et al.* 2010), price (Wilkie *et al.* 2005), availability of wild meat and substitutes (van Vliet & Mbazza 2011), wealth (Godoy *et al.* 2010), income (Wilkie & Godoy 2001; Parry *et al.* 2014), and market access (Chaves *et al.* 2017) are associated with wild meat consumption. However, interventions to assess how these factors influence consumption are lacking. We applied social marketing with and without an economic incentive to test whether providing information, skills, and social and economic support would reduce wild meat consumption.

Social marketing uses marketing techniques to change behavior, including identifying barriers and benefits to the promoted behavior and tailoring efforts to change behavior to segments of target audiences (Andreasen 1994; McKenzie-Mohr 2011). Studies on the effectiveness of social marketing within conservation and environmental applications, such as management of fish, forests, water, and energy (Andriamalala *et al.* 2013; Cole & Fieselman 2013; Martinez *et al.* 2013; Gregory-Smith *et al.* 2015) have shown encouraging results. Furthermore, social marketing has been recommended as a means to reduce demand for wildlife (Drury 2011; Challender & MacMillan 2014), but there is little information on its effectiveness in reducing demand or supply (but see Saypanya *et al.* 2013; Liu *et al.* 2016). Here, we do not assess social marketing's effects on wildlife populations, which requires longer-term research, nor do we intend to stop wild meat consumption, as it is a valued component of many cultures. Instead, we test whether social marketing is effective at reducing consumption. If wildlife can be conserved, cultural traditions of consuming wild meat can be retained. This work has practical implications for addressing demands for meat and other wildlife products, in Amazonia and other regions, through understanding consumers and reducing barriers to behavior change.

Methods

Study and sampling designs

We performed a before-after control-intervention study to assess the effects of social marketing with and without an economic incentive on wild meat consumption in the town of Tapauá, central Brazilian Amazon (see study site and Figure S1 in Supporting Information [SI]). We implemented a social marketing campaign aimed at increasing consumption of domesticated meat (chicken and pork) and fish, and decreasing consumption of wild meat. Our campaign planning and development included formative research to identify target audiences, barriers, and benefits to meat consumption (SI). Based on this research, we focused our campaign on making domesticated meat and fish more attractive through diversifying ways residents prepared their meals. We also provided residents with information about wildlife ecology and conservation, how overhunting affects wildlife, and connections between wildlife demand and supply. Our campaign encouraged residents to reduce wild meat consumption (see Figure S2 and SI for Theoretical Framework).

After mapping all houses in town (2,580), we randomly selected and assigned 157 households to one of three treatment groups (Figure 1) and monitored 141 of these households. During the research, 24 participants withdrew from the study, 8 from the community engagement group (CEG), 7 from the coupon group (CPG), and 9 from the control group (CTG). We monitored 8 of these participants before they withdrew (see SI and Tables S1 and S2 for differences among treatments and attrition information). Each treatment group (Figure 1) received a combination of social marketing strategies (Table 1). The information campaign reached all treatment groups, including CTG, but the reported exposure and recall of

Table 1 Social marketing strategies applied to treatment groups

Strategy	Treatment group	Output/activity	Description
Information campaign (IC)	CTG[a], CPG[b], CEG[c]	Visual media	250 posters promoting recipes with chicken; placed at local stores and markets.
			250 posters promoting recipes with domesticated meat (chicken, pork) and fish; placed at local stores and markets.
			4 billboards promoting new chicken recipes; placed at high traffic streets.
			4 billboards promoting recipes with domesticated meat and fish; placed at high traffic streets.
			2,000 stickers promoting wildlife conservation; given at local events.
		Mass media	2 radio spots promoting consumption of domesticated meat—each was played 3 times/week for 3 months; featured at the local radio and in cars with speakers.
		Giveaways	300 hats and 150 t-shirts promoting the project; given at local events.
		Print media	1,000 pamphlets describing the project; given at local events and houses visited.
			1,000 pamphlets promoting chicken consumption; given at local events and houses visited.
			1,000 pamphlets about ecology and conservation of mammals and birds; distributed at local events and houses visited.
			1,000 pamphlets about ecology and conservation of river turtles; given at local events and houses visited.
			2,000 booklets with local recipes for domesticated meat (i.e., chicken and pork) and fish; given at local events, local stores, and houses visited.
		Community outreach	4 local churches visited to promote wildlife conservation; participation in 2 local events to promote the project message.
Coupons for cleaning products (CCL)	CTG	Economic incentive	3 coupons provided to each household for each monitoring period. Households could redeem the coupons at local shops and markets when purchasing cleaning products. During period 1, (May-Jun 2013), coupons had a face value of R$3.00 (~$1.44). During periods 2 and 3 (Aug-Sep 2013 and Jan-Feb 2014, respectively), coupons had a face value of R$5.00.
Coupons for chicken (CCH)	CPG, CEG	Economic incentive	3 coupons provided to each household for each monitoring period. Households could redeem the coupons at local shops and markets when purchasing chicken. During period 1 (May-Jun 2013), the coupons had a face value of R$3.00. During periods 2 and 3 (Aug-Sep 2013 and Jan-Feb 2014, respectively), the coupons had a face value of R$5.00, equivalent to approximately 1 kg of chicken. With the coupons, chicken became much cheaper than wild meat
Community engagement activities (CEA)[d]	CEG	Door-to-door visit	800 houses visited (project participants and other residents) to promote domesticated meat recipes.
			400 houses visited (project participants and other residents) to promote wildlife conservation and ask for a commitment to reduce consumption of wild meat.
		Public commitment	400 posters promoting wildlife conservation. During door-to-door visits, we asked households to make a commitment to reduce consumption of wild meat. If they agreed, we asked them to display a poster of the project in front of their houses to make the commitment public; houses visited included project participants and other residents.
		Cooking course	3 cooking courses (20 hours each over 5 days); included new recipes of chicken, pork, and fish, that were attractive, easy to prepare, and with locally available ingredients; open to project participants and other residents.

[a]Control Group.
[b]Coupon Group.
[c]Community Engagement Group.
[d]Although we visited a large number of houses during the campaign, we only collected data from participants assigned to the project. Participants from the CPG (information campaign + coupons for chicken) and CTG (information campaign + coupons for cleaning products) did not receive house visits related to community engagement activities.

campaign messages was significantly higher for CEG than for other groups (SI and Table S3).

We performed pre- and post-treatment interviews (30-45 minutes each) with the heads of households from all treatment groups to assess their knowledge of wildlife ecology, attitudes toward wildlife trade, and stated preference for different meats. Furthermore, we monitored households' self-reported consumption

during three periods (Figure 1). Although self-reporting may present bias (Bernard 2011), we followed several steps to ensure valid estimates, including performing a pilot test to determine the best recall period, having different people monitor consumption and implement interventions, and building a trusting relationship with participants before collecting consumption data. We also asked participants about their meals and, periodically, verified the meals they were preparing. We did not detect discrepancies among meat consumed, meals eaten, and meals prepared (SI). The term consumption refers to meat purchased, harvested, or otherwise obtained. The term wild meat refers to wild mammals, birds, and river turtles, but we report mammals and birds separately from river turtles (see formative research in SI). In each monitoring period (Figure 1), we visited households 3 days/week (Mondays, Wednesdays, and Fridays) and inquired about meat consumption (kilogram) in the previous two (for Wednesday and Friday visits) or 3 days (for Monday visits). We were unable to estimate turtle weights and used consumption frequency instead.

Data analyses

We used Bayesian linear and generalized linear mixed models (Kéry 2010) to assess treatment effects on consumption—mixed effects logistic regression and linear mixed model for chicken, processed meat, and fish; mixed effects negative binomial regression for wild mammals and birds; mixed effects overdispersed Poisson regression for river turtles - using R studio and package rjags (Plummer *et al*. 2016; R Core Team 2014; SI). We included a random intercept for household to account for baseline differences in household consumption. We also included monitoring periods (Figure 1) to account for differences in consumption at different times of the year (SI). The method of obtaining wild meat (purchased vs. obtained otherwise) did not influence consumption (Table S4), and domesticated meat was obtained almost exclusively through purchase, so we excluded this variable from our analysis. A concern regarding our design was that past exposure to coupons might influence behavior even when coupons were no longer being offered (i.e., carryover effects). To evaluate this, we reran our analysis after removing part of our data to check if participants, once exposed to coupons, remained influenced by coupons. Our main results (related to wild meat and chicken consumption) did not change (Table S5). Finally, we used Wilcoxon signed-rank, two-tailed test (Hollander & Wolfe 1999) to assess treatment effects on knowledge about wildlife ecology, attitudes toward wildlife trade, and stated preference for different meats (using R studio, function wilcox.test; R Core Team 2014).

Results

Fish was consumed most often, followed by chicken, wild mammals and birds, processed meat, and beef (Table 2; Figure S3). Participants' knowledge about wildlife ecology increased for most treatment groups, indicating the information campaign had an effect across treatments, but percent change was larger for CEG participants (Table 3). Only CEG participants (Figure 1) changed their attitudes about wild meat trade (Table 3) and increased their stated preference for chicken, beef, and fish (Table 4). Stated preference for wild meat did not change (Table 4), as this was not a focus of our campaign. Among households in CEG, 92% made a public commitment to reduce wild meat consumption.

There were no treatment effects on whether people consumed chicken, processed meat, or fish (Table S6). However, for households that consumed these meats, coupons for chicken increased chicken consumption and decreased fish consumption (Table 5). Coupons had no effect on consumption of wild mammals and birds, river turtles, beef, or processed meat (Table 5), indicating that chicken is not a substitute for these meats. CEG participants did not change consumption of chicken, beef, fish, or processed meat (Table 5). Finally, CEG participants decreased consumption of wild mammals and birds (by ~62%), but not river turtles (Table 5). Across all meat types, adding coupons for chicken to CEG did not have an effect (no interaction; Table 5).

Discussion

We demonstrated that social marketing can change behavior with regard to wild meat consumption. CEG participants, who received community engagement activities during time intervals lacking coupons, decreased consumption of mammals and birds even without increased consumption of other meats. One possible reason is that wild meat represented a small portion of overall meat intake (Table 2), so a reduction in wild meat consumption may not have necessitated compensatory increases from other protein sources. Nevertheless, we recommend that food security be assessed in future work targeting meat consumption to identify and minimize potentially adverse effects of interventions. Although wild meat was a small proportion of people's diet, it represented a large amount of meat if extrapolated to the entire town (dressed weight of mammals and birds >145,000 kg/year; see Table 2 for number of animals). In turn, it is likely that the 62% reduction of consumption attributable to the social marketing campaign could have significant positive effects on local wildlife populations. We note that such extrapolations should be treated carefully

Table 2 Meat consumed by households in the study site

				Study sample		Extrapolated to town	
Group	Common name	Scientific name	Species authority	Kg[a]	Units[b]	Kg/year[c]	Units/year[d]
Wild mammals				**1,275.84**[e]	**70.03**[e]	**142,016**[e]	**7,795**[e]
	Lowland tapir	*Tapirus terrestris*	Linnaeus, 1758	271.96	2.52	30,272	281
	White-lipped peccary	*Tayassu pecari*	Link, 1795	333.69	16.35	37,144	1,820
	Collared peccary	*Pecari tajacu*	Linnaeus, 1758	32.81	2.37	3,652	264
	Brocket deer	*Mazama* spp.		176.12	13.35	19,604	1,486
	Spotted paca	*Cuniculus paca*	Linnaeus, 1766	183.06	34.43	20,377	3,832
	Amazonian manatee[e]	*Trichechus inunguis*	Natterer, 1883	273.7	1.01	30,466	112
	Unidentified primate			2.5		278	
	Unidentified mammal			2		223	
Wild birds				**32.79**[e]	**11.98**[e]	**3,650**[e]	**1,334**[e]
	Razor-billed curassow	*Mitu tuberosum*	Spix, 1825	18.72	8	2,084	891
	Spix's guan	*Penelope jacquacu*	Spix, 1825	0.83	0.98	92	109
	Tinamou	*Tinamus* spp.		1.95		217	
	Muscovy duck	*Cairina moschata*	Linnaeus, 1758	8.29	3	923	334
	Unidentified bird			3		334	
Turtles/tortoise					**160**[e]		**17,810**[e]
	South-American river turtle	*Podocnemis expansa*	Schweigger, 1812		34		3,785
	Six-tubercled river turtle	*P. sextuberculata*	Cornalia, 1849		90		10,018
	Yellow-spotted river turtle	*P. unifilis*	Troschel, 1848		27		3,005
	Big-headed Amazonian river turtle	*Peltocephalus dumerilianus*	Schweigger, 1812		6		668
	Unidentified turtle				2		223
	Yellow-footed tortoise	*Chelonoidis denticulata*	Linnaeus, 1766		1		111
Fish				3,818.64		425,061	
Chicken				3,257.69		362,620	
Beef				630.01		70,128	
Eggs/processed meat				882.95		98,283	

[a]Total dressed weight consumed based on 141 households monitored over ~60 days monitored.

[b]For mammals and birds, estimates are based on the amount of dressed weight consumed by the sampled households (assuming dressed weight corresponds to an average of 65% of total weight and species average weight provided by the literature; Pantera database; Begazo & Bodmer 1998; Prado *et al.* 2012). For turtles/tortoises, we were unable to assess the weight and registered the number of individuals consumed.

[c]Kg of dressed weight when extrapolated to 2,580 households for a period of 1 year.

[d]Estimated number of animals when extrapolated to 2,580 households for a period of 1 year.

[e]Total amount consumed.

[f]250.00 kg corresponded to one animal consumed by one household.

(given sampling uncertainty and potentially nonrandom attrition), and further tested with long-term assessments of wildlife consumption and populations. However, our extrapolations were based on randomly selected households and suggest social marketing has the potential to help address the wild meat crisis.

Coupons for chicken did not decrease wild meat consumption. CEG participants reduced wild meat consumption without coupons, but did not decrease consumption further after receiving coupons. CPG participants increased chicken consumption (see also Wilkie *et al.* 2005), but did not decrease consumption of wild mammals and bird or river turtles. Coupons for chicken decreased fish consumption. These findings indicate that chicken is a substitute for fish (similar to Wilkie & Godoy 2001) but not for wild meat. Our results suggest that subsidizing chicken is not effective for reducing wild meat consumption but can reduce fish consumption, which is not desirable as fish is harvested locally, whereas chicken is mostly imported. It is possible that reducing price of uncommon meats, such as lamb and goat, would generate a different outcome (chicken consumption was already much higher than wild meat consumption, so replacing wild meat for chicken was not an attractive option).

Table 3 Knowledge about wildlife ecology and attitudes toward wildlife trade before and after treatments

Variable	Treatment Group	Mean pretreatment	Mean post-treatment	*Z*-score	Effect size[a]	*p*
Knowledge of mammal's and birds' role in nature	CTG[b]	2.27 ± 0.16	2.36 ± 0.17	0.12	0.02	0.55
	CPG[c]	**2.18 ± 0.08**	**2.38 ± 0.08**	**2.06**	**0.34**	**0.02**
	CEG[d]	**2.05 ± 0.05**	**2.41 ± 0.08**	**3.42**	**0.56**	**0.0003**
Knowledge of river turtles' role in nature	CTG	**2.03 ± 0.08**	**2.33 ± 0.09**	**2.66**	**0.46**	**0.004**
	CPG	**2.00 ± 0.05**	**2.29 ± 0.08**	**2.84**	**0.47**	**0.002**
	CEG	**2.03 ± 0.05**	**2.43 ± 0.08**	**3.70**	**0.61**	**0.0001**
Attitude toward buying wild meat (mammals and birds)	CTG	1.91 ± 0.16	1.94 ± 0.17	0.80	0.14	0.79
	CPG	1.97 ± 0.15	2.16 ± 0.18	0.85	0.14	0.20
	CEG	**1.78 ± 0.12**	**2.13 ± 0.17**	**1.75**	**0.29**	**0.04**
Attitude toward selling wild meat (mammals and birds)	CTG	2.27 ± 0.16	2.36 ± 0.17	0.12	0.02	0.55
	CPG	2.35 ± 0.14	2.51 ± 0.16	0.64	0.10	0.26
	CEG	**2.00 ± 0.12**	**2.47 ± 0.18**	**2.19**	**0.36**	**0.01**
Attitude toward buying live turtles	CTG	2.18 ± 0.17	2.12 ± 0.16	0.56	0.10	0.71
	CPG	2.32 ± 0.16	2.11 ± 0.17	0.64	0.10	0.26
	CEG	**1.78 ± 0.11**	**2.27 ± 0.18**	**2.36**	**0.39**	**0.009**
Attitude toward selling live turtles	CTG	2.67 ± 0.17	2.51 ± 0.17	0.85	0.15	0.20
	CPG	2.70 ± 0.15	2.65 ± 0.17	0.50	0.08	0.69
	CEG	**2.25 ± 0.18**	**2.64 ± 0.17**	**1.67**	**0.27**	**0.05**

Range of knowledge about wildlife's role in nature: 1 (participants believe wildlife does not have a role in nature), 2 (participants do not know if wildlife has a role in nature), and 3 (participants believe wildlife has a role in nature and can describe the role; e.g., seed disperser, seed predator, engineer species). Range of attitude toward trade: 1 (completely right to trade), 2 (partially right to trade), 3 (partially wrong to trade), and 4 (completely wrong to trade).

[a]Percent change.

[b]Control Group: information campaign + coupons for cleaning products.

[c]Coupon Group: information campaign + coupons for chicken.

[d]Community Engagement Group: information campaign + community engagement activities + coupons for chicken.

Relative meat prices have changed dramatically in recent years, suggesting a changing context for wild meat supply and consumption. In 2011, 1 kg of wild mammal or bird was ~R$1.50 (Brazilian Reais) and 1 kg of chicken was R$3.50. In 2014, 1 kg of wild mammal or bird was ~R$5.50 and 1 kg of chicken was ~R$5.00 (exchange rate was ~R$2.4 to 1.00 US dollar in Feb 2014). Prices of other meats only increased slightly, and households reported that wild meat was less available than in recent years. Although other factors may also be influencing these changes (e.g., increased enforcement and domesticated meat availability), such changes indicate that wild meat consumption is likely unsustainable.

Our treatments did not change turtle consumption, perhaps because turtle consumption is associated with special occasions, a source of pride (e.g., residents proudly say that Tapauá is "the land of turtles"), and a status symbol (i.e., people are willing to pay high prices; e.g., $100.00 for one 40 kg turtle). Thus, approaches to altering turtle consumption may require a longer timeframe, a focus on people's sense of place and pride (Jorgensen & Stedman 2001; Ervin *et al.* 2010), and efforts to alter social norms (Clayton & Myers 2015). Our participants were randomly selected, precluding us from using groups and associated norms in our campaign. However, social norms influence behavior (McKenzie-Mohr 2011) and can be used when communities (e.g., churches, neighborhoods) comprise the sampling unit.

Social marketing has been recommended to address wildlife trade and consumption issues (Drury 2011; Challender & MacMillan 2014). Evidence of its effectiveness in different contexts is growing, such as in increasing reporting of illegal hunting and conserving seabirds, fisheries, forests, and water (Andriamalala *et al.* 2013; DeWan *et al.* 2013; Martinez *et al.* 2013; Saypanya *et al.* 2013). However, to our knowledge, this is the first time social marketing was successfully used to reduce wild meat consumption. Like other successful campaigns, we went beyond providing information; we engaged participants in discussions about their behaviors and in activities to promote alternative behaviors, bringing habits into consciousness. Although participants' knowledge about wildlife increased for most treatment groups (Table 3), only households in CEG changed attitudes about trading wild meat (mammals and birds), increased preference for domesticated meat, and reduced consumption of wild mammals and birds. Just providing information was not sufficient to change attitudes, meat preference, or meat consumption. Information, while necessary, is rarely the only barrier to changing behavior (Schultz 2002). People in CEG may have changed their behavior before reflecting on their attitudes (Geller 2002), which may explain

Table 4 Household stated preference for domesticated meat, wild meat, and fish before and after treatments

Meat type	Treatment group	Mean pretreatment	Mean post-treatment	*Z*-score	Effect size[a]	*p*
Chicken—frozen	CTG[b]	3.30 ± 0.22	3.00 ± 0.17	0.89	0.15	0.19
	CPG[c]	3.05 ± 0.19	3.38 ± 0.17	1.05	0.17	0.15
	CEG[d]	**2.81 ± 0.20**	**3.57 ± 0.16**	**3.73**	**0.61**	**<0.0005**
Pork	CTG	2.52 ± 0.27	2.52 ± 0.27	0.33	0.06	0.89
	CPG	2.19 ± 0.25	2.33 ± 0.19	0.19	0.04	0.54
	CEG	2.11 ± 0.23	2.22 ± 0.20	0.92	0.15	0.60
Beef	CTG	3.64 ± 0.22	3.58 ± 0.24	0.67	0.11	0.75
	CPG	3.57 ± 0.23	3.83 ± 0.17	1.36	0.06	0.36
	CEG	**3.19 ± 0.24**	**3.76 ± 0.19**	**1.40**	**0.23**	**0.05**
Fish	CTG	4.48 ± 0.17	4.57 ± 0.13	0.45	0.08	0.67
	CPG	4.84 ± 0.07	4.86 ± 0.06	0.64	0.11	0.74
	CEG	**4.62 ± 0.11**	**4.86 ± 0.07**	**1.56**	**0.25**	**0.06**
	CTG	3.97 ± 0.20	3.84 ± 0.22	0.41	0.07	0.66
Lowland tapir (*Tapirus terrestris*)	CPG	3.62 ± 0.25	3.81 ± 0.20	0.17	0.03	0.43
	CEG	3.58 ± 0.22	3.89 ± 0.20	1.01	0.16	0.15
White-lipped peccary (*Tayassu pecari*)	CTG	3.88 ± 0.26	3.75 ± 0.25	0.05	0.01	0.52
	CPG	3.38 ± 0.25	3.27 ± 0.20	0.56	0.09	0.72
	CEG	3.30 ± 0.25	3.44 ± 0.23	0.57	0.09	0.72
Collared peccary (*Pecari tajacu*)	CTG	2.80 ± 0.28	2.70 ± 0.24	0.26	0.05	0.61
	CPG	2.94 ± 0.24	2.53 ± 0.22	1.25	0.22	0.11
	CEG	2.66 ± 0.24	2.57 ± 0.21	0.31	0.05	0.62
Brocket deer (*Mazama spp.*)	CTG	3.19 ± 0.27	2.90 ± 0.26	1.52	0.27	0.12
	CPG	2.57 ± 0.24	2.43 ± 0.18	0.39	0.06	0.65
	CEG	2.05 ± 0.22	2.16 ± 0.16	0.16	0.03	0.56
Spotted paca	CTG	2.74 ± 0.29	2.94 ± 0.26	0.69	0.12	0.24
(*Cuniculus paca*)	CPG	3.17 ± 0.24	3.08 ± 0.20	0.46	0.08	0.68
	CEG	2.58 ± 0.23	2.64 ± 0.21	1.58	0.26	0.94
Amazonian manatee (*Trichechus inunguis*)	CTG	4.22 ± 0.18	4.00 ± 0.27	1.52	0.29	0.44
	CPG	3.72 ± 0.23	3.58 ± 0.22	0.39	0.06	0.49
	CEG	3.48 ± 0.28	3.51 ± 0.24	0.16	0.03	0.94
South American river turtle (*Podocnemis expansa*)	CTG	4.09 ± 0.25	4.00 ± 0.19	0.89	0.16	0.82
	CPG	3.83 ± 0.23	3.83 ± 0.18	1.28	0.21	0.90
	CEG	3.97 ± 0.23	3.81 ± 0.16	0.18	0.03	0.42
Six-tubercled Amazon river turtle *P. sextuberculata*	CTG	4.16 ± 0.22	4.31 ± 0.18	0.25	0.05	0.40
	CPG	4.23 ± 0.24	4.43 ± 0.15	0.71	0.12	0.24
	CEG	4.08 ± 0.17	4.11 ± 0.17	0.90	0.14	0.82
Yellow-spotted river turtle (*P. unifilis*)	CTG	4.44 ± 0.18	4.59 ± 0.13	0.68	0.12	0.25
	CPG	4.50 ± 0.20	4.67 ± 0.14	0.73	0.12	0.88
	CEG	4.46 ± 0.14	4.64 ± 0.12	1.45	0.23	0.12

Range of stated preference: From 1 (participant does not like the meat) to 5 (participant likse the meat a lot).

[a]Percent change.

[b]Control Group: information campaign + coupons for cleaning products.

[c]Coupon Group: information campaign + coupons for chicken.

[d]Community Engagement Group: information campaign + community engagement activities + coupons for chicken.

why only people who chanced consumption of mammals and birds also changed their attitudes about trading these animals. Conversely, changes in attitudes and preferences alone rarely change behavior. For instance, CEG participants changed attitudes about turtle trade and preference for domesticated meat, but did not ultimately change their consumption of turtles or domesticated meat.

We acknowledge that ethical concerns exist regarding social marketing; it can be a powerful tool for social change (McKenzie-Mohr 2011) and could be misused. However, we argue that our campaign was transparent and did not mislead people. Behavior change was voluntary and we did not use disincentives to impose change. Although we requested public commitments in our campaign, which can create a sense of responsibility by which people may feel compelled to follow their pledge (McKenzie-Mohr 2011; Terrier & Marfaing 2015), we emphasized to participants that they were free to decline commitment, and that we would not judge them for doing so. Furthermore, meat consumption could not be

Table 5 Parameter estimates for treatment effects on meat consumption (frequency for river turtles and kg for other meat types) based on the linear mixed model (for chicken, processed meat and eggs, and fish), mixed effects negative binomial model (for wild mammals and birds), and mixed effects overdispersed Poisson model (for river turtles)

Meat type	Treatment group/strategy applied[a]	Estimate[b]	IRR[c]
Chicken	CEG without coupon[d]	-0.15 [-0.42, 0.12]	0.86
	CEG with coupon (interaction)[e]	0.04 [-0.29, 0.37]	1.04
	Coupon[f]	**0.24 [0.05, 0.44]**	**1.27**
Processed meat and eggs	CEG without coupon	-0.14 [-0.39, 0.12]	0.87
	CEG with coupon (interaction)	0.05 [-0.27, 0.36]	1.05
	Coupon	-0.02 [-0.21, 0.16]	0.98
Beef	CEG without coupon	-0.13 [-0.67, 0.41]	0.88
	CEG with coupon (interaction)	0.47 [-0.24, 1.18]	1.60
	Coupon	-0.32 [-0.73, 0.10]	0.72
Fish	CEG without coupon	-0.01 [-0.21, 0.20]	0.99
	CEG with coupon (interaction)	0.07 [-0.18, 0.32]	1.07
	Coupon	**-0.17 [-0.31, -0.03]**	**0.84**
Wild mammals and birds	CEG without coupon	**-0.96 [-1.80, -0.12]**	**0.38**
	CEG with coupon (interaction)	-0.19 [-1.23, 0.86]	0.83
	Coupon	0.12 [-0.51, 0.77]	1.13
River turtles	CEG without coupon	0.03 [-0.68, 0.71]	1.03
	CEG with coupon (interaction)	-0.04 [-0.95, 0.88]	0.96
	Coupon	0.11 [-0.51, 0.70]	1.12

[a]Baseline = CTG (Control Group - all data for this group) and the other two treatment groups (CEG [Community Engagement Group] and CPG [Coupon Group]) before any strategy was applied.
[b]Values in brackets correspond to 2.5% and 95% credible interval.
[c]Incidence rate ratio.
[d]CEG without coupon (information campaign + community engagement activities).
[e]CEG with coupon (information campaign + community engagement activities + coupons for chicken).
[f]CPG (information campaign + coupons for chicken) and CEG before applying the community engagement activities (i.e., door-to-door visits, cooking courses, and public commitment).

directly observed, and we relied on participants' reports. Thus, even if participants made a commitment, all data they provided were kept confidential and other people would not know if they followed their pledge (i.e., there was no shaming). Participants could have underreported wild meat consumption to show compliance, but this is unlikely as we detected no simultaneous decrease in consumption of turtles and mammals and birds, and have no reason to suspect participants misreported consumption of one meat versus another.

Reducing wild meat consumption to ecologically sustainable levels is imperative for conserving wildlife. Although we do not know how unsustainable the consumption is in Tapauá, changes in price and recent perceived decreases in availability of wild meat suggest that current consumption is likely unsustainable. Our research shows that communication strategies providing information, skills, and social support can be effective at changing behavior and economic incentives are not always necessary. This work reveals a path toward reducing wild meat consumption via better understanding consumers and addressing barriers to behavior change and has practical implications for reducing demand for other wildlife products.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

Table S1 Comparison of project participants assigned to different treatment groups

Table S2 Comparison of project participants who withdrew from the research and were never monitored and participants that were monitored one, two, or three periods during research

Table S3 Assigned score to recall of campaign message

Table S4 Parameter estimates for treatment effects on meat consumption (frequency for river turtles and kilogram for other meat types), accounting for method of obtaining the meat (% of meat purchased or otherwise obtained, such as harvested or gifted)

Table S5 Parameter estimates for treatment effects on meat consumption (frequency for river turtles and kilogram for other meat types) after removing subperiods 2 and 3 (subperiods without coupons for chicken) to check for carry-over effects of coupons

Table S6 Parameter estimates for treatment effects on whether people consumed chicken, processed meat and eggs, and fish based on mixed effects logistic regression model

Figure S1 Town of Tapauá and surrounding region in the central Amazon, Brazil.

Figure S2 Part of the Theory of Planned Behavior (Ajzen 1991) used to explain meat consumption.

Figure S3 Consumption of meat per household in the town of Tapauá, Amazonas, Brazil, during monitoring period (approximately 60 days).

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