POLICY, DRINKING WATER QUALITY
AND HUMAN HEALTH IN REMOTE ECO-TOURISM

Constance J. Woodman[1]* and Amelia A. Min-Venditti[2]
[1]Department of Veterinary Pathobiology, Texas A&M University; *gryphus@gmail.com
[2]Department of Ecosystem Science & Management, Texas A&M University

Ecotourism can support communities and conservation programs. In the remote Amazon forest, sustainable ecotourism and ecolodges can offer local communities economic opportunities while simultaneously protecting the environment from extractive activities. As Krüger states, "the overall potential of ecotourism to generate revenues for conservation is enormous" (2005, p.580) However, human health issues, such as bacterial or viral outbreaks, can undermine local businesses and reputations, with tourism operators potentially incurring penalties and fines in addition to losing customers. Ultimately, human health issues, ecotourism, and conservation are intertwined, with the success of the latter two dependent on practices that limit the impact of the former.

As participants in the ABS Amazon Field School, we examined four remote rainforest ecolodges where despite sincere efforts at sanitation, fecal contamination was found in drinking water supplies (Table 1). We found that human health issues were tied to a complicated web of local, regional, and global policies. To our surprise, the War on Drugs, and the Sustainability movement might be, in a very unexpected way, contributing to making people sick and consequently putting the success of ecotourism at risk.

Over 18 days we were tasked with planning and executing a project related to water and the local socioenvironmental system. Before the field school began, we talked about what sort of scientific tools we could use to understand water issues and decided to build a kit and battery powered laboratory that we could fit into a backpack (Fig. 1). The ABS program and Dr. Georgianne Moore were able to offer us a number of water quality measurement tools, though we had to creatively build a portable bacteriology laboratory. After making modifications, the backpack functioned as a water quality test lab that could run off a portable battery (Figure 1). Working with Krystal Yashe, a microbiology PhD student in the Veterinary Pathobiology Department, we modified a set up used by USDA field agents to test for contamination of milk on extremely rural farms.

We didn't know what we would encounter, so we began building a literature review of heavy metal, sediment, and bacterial contamination and planned to test drinking water sources as well as water sources we had access to, such as rivers, sewage outflow, a lake, aquaculture ponds, mining run-off, trampled shorelines, and other impacted sites. We based our bacterial collection and incubation methods on review of three published methodologies: Standard Methods by the American Public Health Association (Rice et al., 2012), the U.S. Federal guidelines for coliform bacteria testing [40 CFR 141.21(f)], and the 3M Health Care company's methods as validated through the international AFNOR NF mark program ("3M Petrifilm", 2014). These guidelines outline steps such as incubation time and temperature, sample holding times, and describe when not to count a sample as valid.

To our surprise, all the samples of locally purified drinking water at ecotourism lodges, despite efforts to keep it clean, showed contamination with fecal bacteria (Fig. 2, 3, 4). Considering the water was treated in ways that included ozone purification, mechanical filters, and chemical tablets, we were curious as to what was driving this phenomenon. Serious illness caused by poor sanitation could harm a tourism operation, so what was going on? During discussion with lodge managers at

four ecotourism lodges we shared our bacterial culture results and discussed current hygiene measures. We were surprised that in several cases, only soap and water were used for sanitizing containers. We were told by two individuals that it was believed that chlorine bleach was banned in some way. If chlorine was banned, it would explain how contamination was occurring. Bleach is a standard agent for sanitizing containers and is also used to keep water clean. Residual bleach is used in water systems around the world, where a small amount of bleach is present, waiting to kill microbes when the water is inevitably contaminated. On recommendation of a researcher, we confirmed that there were strict rules and a permitting system regarding bleach. This was because bleach is associated with illegal drug manufacture.

Furthermore, we found another deterrent to using bleach; international ecotourism standards use phrasing that was seemingly "anti-chemical." Such phrasing can lead to an over-simplistic rejection of very useful sanitation techniques. Referred to as "chemonoia" or "chemophobia" (Ropeik, 2015), rejection of chemicals can be a feature of Sustainability communities. A prominent accreditation criteria set is The Global Sustainable Tourism Council (GSTC) Criteria. These guidelines require "… a review of each chemical used to identify available alternatives which are more environmentally innocuous" ("Criteria for Hotels", 2012). While this phrasing may sound noble, in the case of sanitation the most effective and well-studied chemicals may be the best choice despite not being classified as the most environmentally innocuous. In this case, any alternative may put safety at risk.

During our travels, we witnessed attitudes among tourists and researchers that could be summarized as "what doesn't kill you makes you stronger" and "the local people are immune to this, foreigners are just weak." There is a body of literature showing that in the developing world, fecal contamination is a serious concern. "Disease-causing

Fig 1. Portable water quality lab, run off a portable battery, while incubating water samples for bacterial testing (credit: CM, AMV).

organisms (pathogens) transmitted via drinking water are predominantly of fecal origin… " and unfortunately "drinking water is a major source of microbial pathogens in developing regions" (Ashbolt, 2004). While many people attribute tourists' upset stomachs to other causes such as lack of sleep or strange food, in fact traveler's diarrhea, called "TD", is actually caused by bacteria. "Bacterial pathogens are the predominant risk [for TD], thought to account for 80%–90% of TD" (Connor, 2015). Most infections causing TD spontaneously clear, but infections by pathogens that cause traveler's diarrhea can be serious, causing complications such as Hemolytic Uremic Syndrome, a type of kidney failure ("E. coli bacteria", 2015)

In 1997 an international outbreak of E. coli 0157 was caused by hotels using an unsafe well. Symptoms included intestinal bleeding and Hemolytic Uremic Syndrome, at least 14 tourists went back to their home countries carrying disease from the well (Peabody et al., 1999). Recently, a tourism resort associated with ecotourism and sustainability in New York suffered a viral outbreak caused by norovirus, a virus spread through fecal contamination. The resort filed to settle the resulting class action lawsuit for $875,000 in 2016. (Platt, 2016). A smaller ecotourism operation could collapse under similar circumstances. Any environmental benefits gained through the ecotourism would cease.

To evaluate direct observations of human health, we observed 10 of our companions during our travels. We also spoke with personnel at the state-of-the-art lodges, where staff had experience with long-term visitors. We met with a lodge manager, a personnel manager, a tour guide and two embedded researchers. Seven out of ten companions became obviously ill. The embedded researchers discussed frequently observed bouts of illness and one praised the antibiotic drug Ciprofloxacin as an important tool for getting people back in the field and working quickly. We were both ill at different times during our trip.

While lodge staff were familiar with illness in longer term guests, the majority of guests had short two or three day stays at lodges as a part of longer regional tours. Because bacterial infection requires an incubation period before illness occurs, it may be that short visits ended before illness began in a way that would be visible to staff. Each lodge manager identified TripAdvisor.com as a major source of reviews and feedback regarding their facility. To our surprise, out of hundreds of TripAdvisor reviews, there were very few mentions of illness. For example, Lodge 4 over had over 350 reviews, with only eight reviews mentioning illness of any sort, several of which pointed blame for illness on factors other than the lodge. Four water quality comments existed, all which discussed purified "good" water being plentifully available. This was at odds with both the knowledge that longer term guests reliably became ill and the water contamination we observed.

In reviewing literature and interviewing locals, we observed several co-occurring factors potentially hindering recognition and treatment of local water contamination. First, a federal laws bans bleach in wilderness areas without difficult permitting and record keeping processes. Second, an anti-chemical and anti-health bias was held by guests and international recommendations whereby chemicals were considered bad or undesirable and being sick was considered a way to strengthen one's immune system. Third, the major source of reviews was largely devoid of any indication that health could be an issue, as apparently the frequently ill long-term guests did not report their illness on TripAdvisor. Fourth, bacterial testing kits were not in use by the lodges, including inexpensive "H2S" color changing bacterial presence/absence indicator tests. Finally, lodge managers appeared to trust their water purification methods without considering the potential for contamination after initial treatment.

As a follow up to our study, we have written up a list of recommended actions and shared our results with a regional accrediting body, an industry leader with influence within the lodge association, individual lodge owners, and researchers working in the region to discuss possible solutions. We are currently working on a shopping list of low cost tests for bacterial contamination that lodges can use, along with recommendations to reduce fecal contamination after purification. In order to enable stakeholders to solve this issue from a legal standpoint, we are helping them locate the relevant law and legislators as well as providing sources about best water quality policies.

References

3M™ Petrifilm™ E. coli/Coliform Count Plate Interpretation Guide. (2014). Retrieved August 25, 2016, from http://multimedia.3m.com/mws/media/236246O/petrifilm-ecoli-coliform-interpretation-guide.pdf

Ashbolt, N. J. (2004). Microbial contamination of drinking water and disease outcomes in developing regions. Toxicology, 198(1), 229-238.

Rice, E. W., Baird, R. B., Eaton, A. D., & Clesceri, L. S. (2012). Standard methods for the examination of water and wastewater. American Public Health Association, American Water Works Association and Water Environment Federation: Washington, DC, USA.

Connor, B. A. (2015, July 10). Travelers' diarrhea. Retrieved August 25, 2016, from http://wwwnc.cdc.gov/travel/yellowbook/2016/the-pre-travel-consultation/travelers-diarrhea

Criteria for Hotels & Tour Operators. (2012, February 23). Retrieved August 25, 2016, from http://www.gstcouncil.org/en/gstc-certification/gstc-criteria/criteria-for-hotels-and-tour-operators.html

E. Coli bacteria - diseases and conditions - publications - public information - MOHLTC. (2015, November 10). Retrieved August 25, 2016, from http://www.health.gov.on.ca/en/public/publications/disease/ecoli.aspx

Environmental Protection Agency (EPA) "Revised Total Coliform Rule (RTCR)" 78 Federal Register 10269 (13 February 2013).

Krüger, O. (2005). The role of ecotourism in conservation: panacea or Pandora's box?. Biodiversity & Conservation, 14(3), 579-600.

Platt, F. M. (2016, February 6). Class action settlement announced in Mohonk mountain house norovirus lawsuit. Retrieved August 25, 2016, from http://www.newpaltzx.com/2016/02/06/class-action-settlement-announced-in-mohonk-mountain-house-norovirus-lawsuit/

Ropeik, D. (2015). On the roots of, and solutions to, the persistent battle between "chemonoia" and rationalist denialism of the subjective nature of human cognition. Human & experimental toxicology, 34(12), 1272-1278.

Sobsey, M. D., & Pfaender, F. K. (2002). Evaluation of the H2S method for detection of fecal contamination of drinking water. World Health Organization.

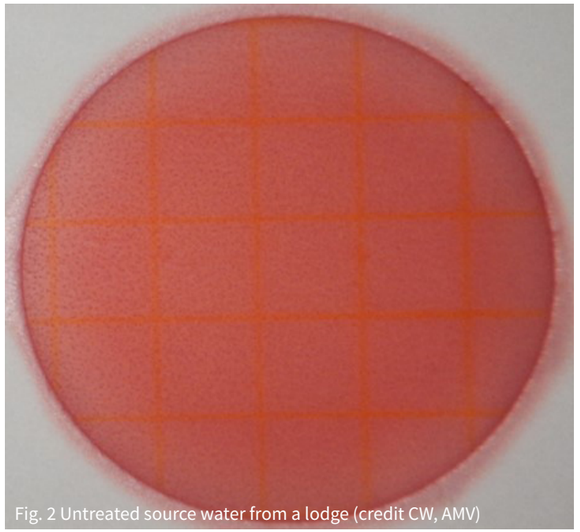

Fig. 2 Untreated source water from a lodge (credit CW, AMV)

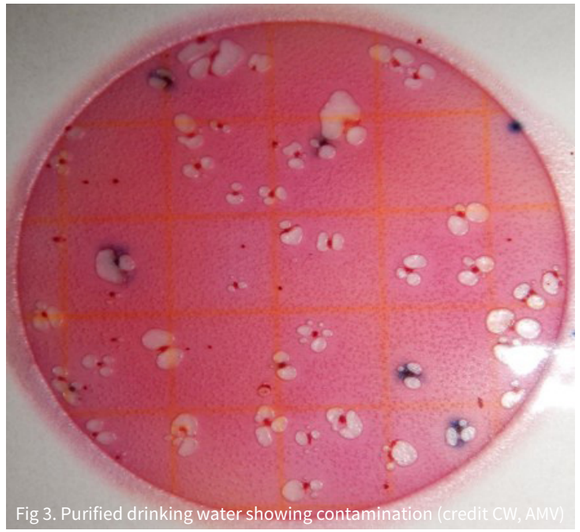

Fig 3. Purified drinking water showing contamination (credit CW, AMV)

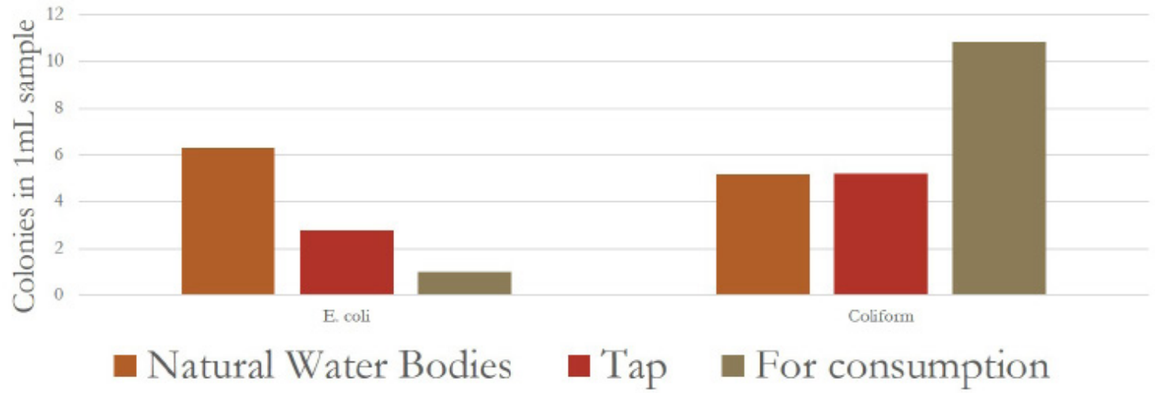

Fig 4. (credit: CM, AMV).