Sustainability Project

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On the Beam Reach program one of the things we learn is how to live sustainably. We spend half of the course living on a catamaran sailboat called the Gato Verde. Being on a boat, a self-contained ‘ecosystem’ if you will, allows us to measure our use and production of resources.

Water is one of the most important substances for life. When on a boat, though you are surrounded by water on all sides, there is only as much drinkable water as you can bring and store on board. This means that water must be used very carefully and rationed appropriately in order to not have water as a limiting factor.

On the Gato Verde we had a few strategies to try and conserve water. The first was to give up taking showers while on the boat. Showers waste a lot of water, about 2.5 gallons every two minutes, and aboard the *Gato Verde*, are unnecessary excepting extenuating circumstances . Another was implemented by our captain and owner of the Gato Verde, Todd. He had installed a saltwater pump in the kitchen sink so we could use salt water, instead of our fresh supply, to rinse off the dishes before applying soap. We only used the fresh water to do one last quick rinse. The sink was not the only system that utilized salt water instead of fresh; in addition the heads were flushed sing salt water. Lastly we used Purell hand sanitizer frequently to cleanse our hands instead of washing them with the water running. Aside from rinsing dishes, fresh water was only used for drinking, cooking, teeth brushing and the occasional hand washing.

Our fresh water use was pretty consistent over the 5 weeks we spent on board with an average daily use per person of about 1.88 gallons. This was significantly less than the previous two years. In 2008 an average of 4.68 gallons/person/day were used, while in 2009 an average of 3.02 gallons/person/day were used.

The large discrepancy between both 2009 and 2010 water use and 2008’s water use is partially due to the fact that the 2008 students took showers, which, as noted before, uses water at a very quick rate. The difference between our water use and 2009’s may be because they may have used a bit more water for washing the dishes or washing faces, hands etc. In both previous years the groups rationed food using the NOLS rations which meant that they were re-hydrating a lot more food. Their use of water for cooking was probably much higher than ours.

The total fresh water use followed the weekly trend with 2008 use at 982.06 gallons for the trip, 2009 use at 826.14 gallons and 2010 use of 460.18 gallons. It should also be noted that both the 2008 and 2009 groups had more people on board on average than in 2010, so the overall water used would have been higher regardless.

In order to conserve more water in the future there are a few steps that could be taken to reduce water use even more. One way is to have a better flow control mechanism on the sink faucet. Because the water tends to either come out full blast or an un-useable trickle, we wasted a lot of water trying to get the correct flow every time we turned it on. Todd suggested getting a faucet with a stick coming from the middle so that water only flows when the stick is pushed thus mitigating the amount of water is wasted while turning it on and off. Another way to reduce water usage is to not cook foods like pasta and soup that calls for a large amount of water. Lastly using only Purell hand sanitizer to cleanse hands would lesson water use.

The most limiting factor to trip planning on a boat is the capacity of the holding tank for sewage. It needs to be pumped out when full to avoid any messy situations with sewage overflow. To lessen the time between pump outs we decided to spend as much time docked at harbors with land heads as we could. We also lived by the wise words “if it is yellow let it mellow, if it is brown flush it down” and used the hatch in the head when possible so as not to use the toilet, although in later weeks I think that hatch window use declined.

For the first two weeks we spent most nights at docks with access to land heads. Our gallons/person/day average over the five weeks aboard the Gato Verde reflected this. Our sewage production was the lowest during the first two week. Later weeks we spent more and more time at anchor with no access to land heads and our sewage output rose slightly and peaked the last week since we didn’t stay at many docks with access to land heads at all.

Our sewage production was pretty good compared to previous years. Week by week across all three years there was a lot of variation in weekly sewage production, but we consistently produced fewer gallons/person/day than the 2008 group and, excepting week three, the 2009 group as well. Overall we generated less sewage than both 2008 and 2009, but this could partially be due to the fact that they had more people onboard on average than we did, resulting in more overall sewage generation.

The discrepancy in gall/person/week probably has more to do with how frequently individuals flushed and how accessible land heads were. Flushing adds a lot of water into the holding tank, and the number of pumps might significantly affect the total volume of the holding tank contents.

In order to generate less sewage and lengthen our time between pump outs using a system, like a composting toilet, that doesn’t need extra water to flush it would be a good idea. The water, more than anything else, is what fills the tank up. Another step that could be taken is greater use of the hatch in the head. Staying the night at docks with access to land heads as much as possible is another way to drastically lesson the time between pump outs.

Our last limiting factor, and most polluting, is our biodiesel usage. To charge the electric motors the generator must run, and the generator runs on biodiesel. Outside of the propulsion system, all of the lights and electronic equipment onboard runs off of the batteries which the generator also charges.

To mitigate biodiesel use we tried to sail as much as possible and use the currents instead of the motors as a driving force. We also tried not to leave too many electronics plugged in when unneeded.

Because the generator also powers all of the electronics on the boat, it is good to look at the total kWhrs used. Our total kWhrs were less than used in both 2008 and 2009. 2009 had the largest number of kWhrs of 836.97 followed by 2008 with 330.10. We used a total of 197.49. Because this is a total amount used both 2008 and 2009’s usage should have been greater because of the larger number of people on board who had more computers and other electronics using energy.

Our kWhr/gal mirrored this trend with 2009 at the lead with 6.41 followed by 2008 with 2.20 and lastly 2010 with 1.56. This I find very interesting. It seems that in 2009 more kWhrs were generated per gallon meaning that they used less diesel to generate more electricity. Why was this the case? What can we do to get more kWhr/gall?

Our use of biodiesel, though pretty consistent, compared to the other years varies from week to week. Overall 2010 used fewer total gallons of biodiesel than 2008, 146.41 gal and 150.29 gal respectively and a lot more than the total of 130.62 gal 2009 used.

Our daily average mirrored the total biodiesel use trend with 2008 using the most at 5.01 gal/day followed by 2010 burning 3.97 gal/day and 2009 using the least at 3.63 gal/day.

The discrepancy between 2009 and both 2008 and 2010 may be due to many different reasons. In 2009 there were unspecified engine troubles although how that may have effected their biodiesel usage it would depend on what kind of trouble it was. They may have also been much more efficient than we in both traveling from place to place and electronic use. Compared to 2008 we may have had more windy days where we didn’t have to use the generator to power the motors. We also had only a few days when chasing whales required us to fight strong currents. We experienced a variety of weather conditions; on some days we would have to motor everywhere because we didn’t have any wind while others we only had to run the generator to motor back into harbors. We had a tendency to leave the inverter on and our electronics plugged in using electricity passively.

The amount of biodiesel used for the house bank vs. propulsion follows the same trend as overall usage between 2010 and 2009. Overall 2010 used more gallons of biodiesel for both the house bank and propulsion. Propulsion, however, uses a much larger percent (71%) of the total biodiesel use than the house bank (29%).

Some ways to reduce biodiesel use are to only plugging in electronics when they were running out of battery and trying to use the sail and currents for us as much as possible.

One of the biggest concerns not only on the Gato Verde but for global sustainability in general is human pollution of the environment through pollution. The sinks in the Gato Verde drain directly into the ocean meaning anything we poured down them ended up wherever we were, be it in Haro Strait or Westcott Bay.

We use soap every day to wash our dishes and hands. Soap, by its nature, is full of surfactants. Surfactants are molecules made up of a hydrophilic (water liking) tail and hydrophobic (disliking water) head. These molecules, in certain concentrations in an aqueous solution will surround lipids on all sides creating a ‘bubble’ of oil separated from water called a micelle. This allows ‘grease’ to be broken up and washed down the drain. Anionic surfactants are some of the more widely used surfactants in common soaps and detergents such as Joy. One of the major problems with surfactants is biodegradation (not mineralization, when the molecule is broken down into stable inorganic forms of nitrogen, carbon, phosphorous etc.) but when the molecule is broken into other organic compounds (Sales et al. 1999). It has been shown that the anionic surfactant sodium linear alkylbenzene sulphonate (LAS) doesn’t break down well in cold saltwater conditions. After 21 days there was only 36% degradation at temperatures of 10°C and even lower percent of 4.2 at 5°C. This is particularly problematic in areas where these temperatures coincide with the reproductive cycle of various marine organisms, as their young are especially susceptible to negative effects from contact with surfactants (Sales et al. 1999).

Anionic surfactants, in certain concentrations, are very lethal to many aquatic organisms, saltwater organisms even more so (Van De Plassche et al. 1999). Various anionic surfactants such as linear alkyl benzene sulfonate, alcohol ethoxylates and alcohol ethoxylated sulfates have resulted a 50 percent mortality rate for various marine organisms in concentrations higher than dissolved levels ranging from 0.042-3.7 mg/L depending on the anionic surfactant. While a lot of soap would be needed to reach these concentrations in a body of water like a bay, the accumulative effects of many boats might be significant.

Because the sinks in the Gato Verde dump directly overboard, we were dumping surfactants in the water whenever we washed our dishes and hands. During two of our daily meals we are cooked and washed dishes in small harbors and bays. Depending on the tidal exchange we could have been introducing a measurable amount of surfactants into the ecosystem potentially damaging the organisms therein. I calculated the tidal exchange and residency based on three different tidal heights for four of the bays we used multiple times during our 5 weeks on the water. These harbors include: Mitchell Bay, Westcott and Garrison Bays (which I counted as one bay), North Jones and Reid Harbor. Mitchelll Bay has the best tidal exchange (tidal exchange being the percent of total volume that leaves the bay from one tide peak to the next) followed by Westcott and Garrison Bays, Reid Harbor and finally North Jones (Figure 1). Flushing Mitchell bay also takes the least amount of time (flushing a bay is the time it takes for the total volume of water to be replaced with new water), followed by Westcott & Garrison Bay, North Jones and lastly Reid Harbor (Figure 2).

Figure 1. The percent of the total volume of each bay and harbor that leave from one tidal peak to the next (high to low).

Figure 2. The number of days it takes for the total volume of each bay or harbor to be replaced with new water.

Different bays and harbors have very different rates of exchange and residency making some more susceptible to pollution effects than others.

We can mitigate our impact on the bays and harbors we use in a few different ways. We can be more conscious of our impact and choose our anchorage for the night taking into account what the current tidal difference is, how well exchanged the bay or harbor we are staying in is, and how many days the surfactants will remain in that harbor or bay. We can also change our soap to one with less or no surfactants. Some alternatives are Ms. Meyer’s Dish Soap, a soap that has ‘natural’ plant derived surfactants in it which are at least better than completely artificial or petroleum based ones due to the fact that although they go through a chemical process they occur naturally ad may be broken down easier; Dr. Bronner’s Magic Pure Castile Liquid Soap, a multi-purpose soap with no surfactants; and Aubrey Organics Earth Aware All-Purpose Cleaner, another all-purpose cleaner with no surfactants. A grey water system put into the galley would also allow the Gato Verde to choose a location to dump surfactants so they would end up in very high flow areas like Haro Strait instead of small low exchange harbors like Reid Harbor.

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