IDDS AMAZON
PARÁ/BRA | 2016

TEAM CAMARÃO

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table of contents.

CONTEXT

Our team of six participated in IDDS Amazon (International Development Design Summit) in the town of Boa Vista de Acará, located in the Brazilian state of Pará. In partnership with the Association of Organic Producers of Boa Vista (*Associação de Produtores Orgânicos de Boa Vista*—APOBV), participants from all over Brazil and the world gathered with the community of Boa Vista to work on seven permaculture projects.

Our project, which went through a few evolutions, was first centered around the “water cycle”. Our project team includes Zach, Javier, Amanda, Agnes, Leandro, and Julianna.

Leandro is from Boa Vista and is a member of APOBV; our project was focused on his land. Leandro lives in a stilt house on the riverbank amidst açaí and cacao trees. Born and raised in Boa Vista, Leandro has an intimate understanding of the land and a special relationship within his community which he showed us in many ways: how he uses açaí leaves to construct a ‘peconha’ to climb up trees as tall as 20 meters, his eye for picking the sweetest cacao fruits for us to eat on our walks home, and his ability to catch shrimp using a traditional trap made of palm splints called ‘matapi’.




Photos: Views from Leandro’s house, Leandro picking açaí

PROJECT GOALS

Although Leandro lives on the river, he noticed that he and many others in his community were paradoxically traveling an hour to Belém, the nearest city, to purchase seafood for personal consumption. The fish and shrimp they were buying in the city was expensive and not fresh as it was frozen for transport. He is hoping to change this situation for the better.

Given his and his community's wish to eat fresh and affordable seafood, Leandro desired a way to achieve this close to home, which was the abstract for our project.

Initially, the organizers of IDDS had outlined a proposal to develop a prototype for creating a sustainable water cycle (e.g. recycling of greywater). However, in their conversations leading up to the Summit, APOBV expressed a desire to shift the focus of the project to fish farming. Thus, keeping in line with the principles of collaborative design, our original project goal was to create a way for Leandro to farm fish for both personal consumption and to sell within the Boa Vista community at more affordable prices. As our project evolved, however, we pivoted from building a fish farm on Leandro's property to creating a natural shrimp habitat. Our rationale is explained in the "Design Process" section.

Our goals were rooted in creating value across the following types of capital over time:

- Material (shrimp as food source)
- Financial (shrimp as potential source of income)
- Living (a self-sustaining ecosystem working on renewable energy and resources that is integrated into the dynamic of Leandro's property)
- Intellectual (documentation of our process and accrued shrimp farming know-how)

We understood that our project and goals have the potential to expand for Leandro and the Boa Vista community over time. For these two weeks, we focused on creating a prototype on Leandro's land for farming shrimp rooted in the principles of permaculture, making sure to document our thinking so that it can be shared and evolved. We knew that building a working shrimp farming operation takes longer than two weeks, so we focused on designing a solution that was small and modular that Leandro could experiment with and tweak as necessary.



Photos (left to right): Original pond at Leandro's house, shrimp we caught in the river, Ju and Leandro documenting in field

DESIGN PROCESS

We approached our project in four phases: information gathering, information synthesis, idea development, and build.

Given that our team had limited knowledge about the subject matter to begin with, our information gathering phase was aimed at learning as much as we could about the local ecosystem, the practice of fish farming in general, and the history of fish farming in the area. We observed Leandro's land, spoke with local stakeholders (primary sources), some of whom had fish tanks of their own, and searched the internet for general information (secondary sources). More information about our stakeholders and some key insights we learned from them can be found at the end of the report.

Photos (left to right, top row): Agostinho's river tank, Ademir's tank with nursery, Max's fish nursery in a large igarapé
Photos (left to right, bottom row): Agostinho & Amanda discussing water flow, interview with Genoir, information synthesis

During the information synthesis phase, we reviewed the information we gathered to find best practices and patterns. After our initial discussion about our findings, we did a roundtable brainstorming session and combined our ideas into two major concepts: 1) a floating fish cage in the river; and 2) a man-made, riverside fish pond. We split into two teams to flesh these ideas out further and then regrouped to present the ideas to the whole team for consideration. As we were developing our two concepts, we also consulted with IDDS design facilitators André and Jorge about how to align our prototype with the permaculture principles. André and Jorge urged us to consider everything from the happiness of the fish, the balance of the ecosystem (types of

fish species introduced, natural predator / prey patterns), waste management, ecological patterns with multiple borders, and the potential for regenerating the environment in the future.

Even though we had heard from Genoir that a floating fish tank was the best technology for fish farming and that tambaqui sold for a lot of money, we weren't convinced that this was the right solution for Leandro. The floating fish tank was problematic insofar as the tanks were easy to steal and it did not align with permaculture principles (the cage is essentially a floating fish prison). Moreover, raising tambaqui is inherently a high-cost and high-maintenance operation since their natural life cycle to yield is 1.5 years. This scale would make future iteration and experimentation difficult and costly, for as we learned from Jorge, the quickest way to make a small fortune in fish farming is to start with a big one [fortune]. Some local fish farmers had also had issues with disappearing fish over the years.

With this new insight, we returned to Leandro's land to evolve our idea and settle on a concept to prototype. We considered:

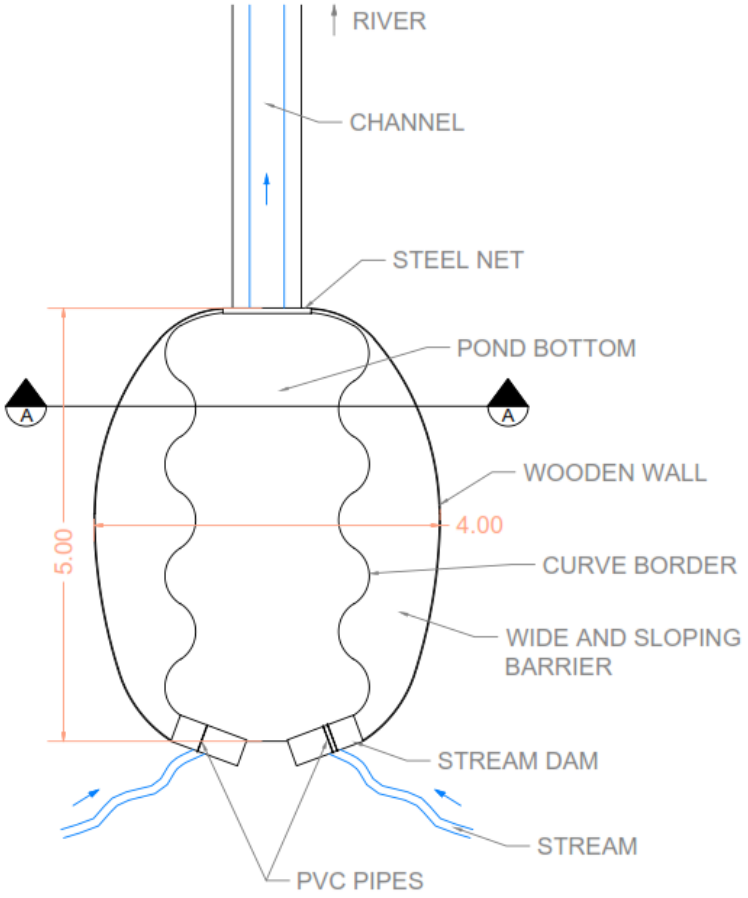
- The natural resources available on Leandro's property (water, açaí trees, etc.)
- The time and effort it would take to see results
- The health of the existing ecosystem
- Leandro's goals of personal consumption and income generation

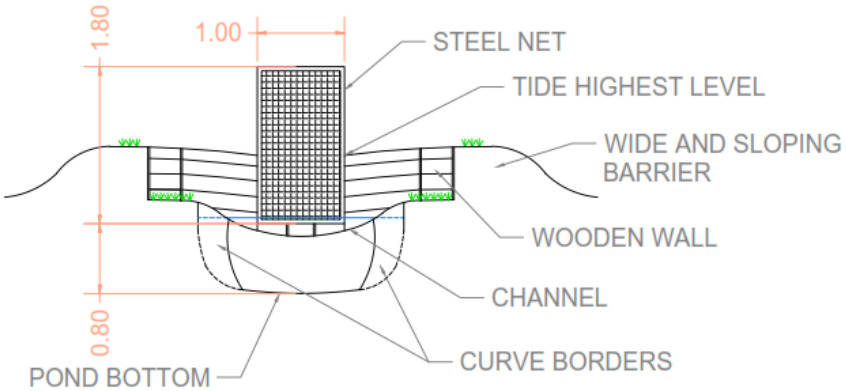
When visiting Leandro's land again, we observed the river during high and low tide (noting how the water levels could change during rainy season). We noted that Leandro already had begun to dig a canal from the river, leading to a small pond near his house, which could easily be expanded. We tested the pH of the water, which was around 5-6. And perhaps most importantly, we also noticed that the small pond Leandro had dug already had shrimp in it! We caught a few small fish and shrimp in the pond. During this moment of observation and interaction with Leandro and his property, the solution became increasingly clear.

Photos (left to right): Channel leading to Leandro's pond, attempt to catch shrimp in the existing pond, Maicky showing the baby shrimp living in the pond

FINAL CONCEPT

To create an enclosed, riverbank shrimp habitat that is low-cost, low-maintenance and uses renewable resources.





We decided on this final concept because it worked well with our considerations:

- **Natural resources:** the concept took advantage of the existing infrastructure on Leandro's property as well as the available renewable resources. We would create the shrimp habitat using the pre-existing canal and pond. The habitat's water would be regulated by the high and low tide of the river in addition to recycled rainwater. Lastly, it would be populated by the vegetation (e.g. *aninga*) and wildlife (e.g. shrimp) that already existed in the river.
- **Time and effort:** Shrimp only take 3-4 months to grow, whereas tambaqui could take 1.5 years to grow. We wanted to see how the pond was flourishing within a shorter time frame than 1.5 years so shrimp seemed like a great prototype.
- **Health of existing ecosystem:** Shrimp are native to the river, yet the shrimp population has been diminished due to the growing human population on the riverbank. By farming shrimp, we introduce possibility of regenerating the shrimp population without risking the introduction of a harmful fish species. It was important to us to maintain the natural balance of the ecosystem.
- **Original goals:** Leandro consumes shrimp and has the potential to sell shrimp to Boa Vista and possibly even in Belém.

Furthermore, our final concept was in line with a few permaculture principles. The permaculture is an approach to life on Earth that seeks to consciously create landscapes that reproduce patterns and relationships found in nature and, at the same time, produce food, fiber and energy in abundance and enough to supply local needs. Within this approach, 12 design principles were created to that guide the planning and design of human settlements.
The principles we took into account in our final concept were:


Observe and interact: we saw the ebbs and flows of the river and the life that was already flourishing on Leandro's property, which is what ultimately swayed us to farm shrimp and go with a pond habitat near the river.


Catch and store energy: we wanted to take advantage of the river's currents and tides to oxygenate the water, as well as rainwater in case the river does not reach the pond during low tide in dry season.


Value renewable resources: We wanted to avoid artificial fish food and adding any man-made elements. In our shrimp habitat, the river and rainwater oxygenate the water, shrimp use plant roots as natural habitats and food, and can also eat crabs that thrive in the pond today.

 **Use and value the borders/ marginal:** we wanted to create enclaves within the larger pond to give the shrimp various environments and also to slow the water from the river down during high tide in rainy season.

 **Use and value diversity:** we wanted to celebrate the diversity that already existed in the river and create multiple environments within the pond (for example, various depths) that would be good for plants, crabs, shrimp, and any other species that's natural to the ecosystem.

 **Creatively use and respond to change:** by farming shrimp, we are still answering our original goal but changed our solution to be more in line with the natural environment.

DESIGN REQUIREMENTS

Our final pond habitat prototype was designed to be an experiment in sustaining life amidst changing weather patterns (high and low tide in both dry and rainy season). The design builds on naturally recurring patterns to make it as low-cost and low-maintenance as possible.

Requirement	**Measurement**
Time to yield (shrimp)	< 6 months
Cost to build	< 500 reais
Biodiversity	3+ living species
Maintenance	< 10 hours per week
Functionality during high / low tide during dry / rainy season	< 30% impact on yield due to changing water levels

HOW IT WORKS

The shrimp habitat is a manmade pond that is at least 1.5 meters deep. The habitat contains rounded enclaves within the design to multiple borders thus creating numerous micro-environments for the inhabiting species to thrive (e.g. lay eggs, hide for protection from predators, etc). The pond is surrounded by elevated walls built from the mud carved from the pond and reinforced by wooden planks recycled from Leandro's old chicken coop. These

barriers provide protection from flooding by the high tide during the rainy season. The pond is surrounded by natural vegetation, such as *açaí* palm trees and *aninga-açu*.

The pond has three water sources: 1.) Groundwater that surfaces from digging the pond; 2.) River water that flows in and out through the canal; 3.) Rainwater harvesting system (made of PVC pipes) attached to Leandro's house. There is an aluminum net where the pond and canal meet that allows water to flow in and out from the river while keeping the shrimp from escaping. There are two small dams on the opposite end of the pond outfitted with PVC pipes that enclose the structure and allow for water to circulate during high tide.

Initially, the shrimp will be caught in the river and transferred to the pond. The shrimp will eat what's naturally available in the pond, such as dead *sarará* crabs, crushed snails and phytoplankton stimulated by plant life. These natural food sources can be complemented by *farinha* (manioc flour) and dead fish matter.

The performance of the habitat will be determined by how many shrimp Leandro can successfully farm and by how resilient the design is to high and low tide fluctuations during both rainy and dry seasons. Leandro's stated goal is to reach a yield of 5 kilograms of shrimp per month, which can be used for personal consumption and/or for sale. We estimate a range of 60-100 shrimp per kilogram.

BUILD PROCESS AND MATERIALS

Our design and build process was as follows:

1. Observe Leandro's home and the surrounding natural environment (e.g. water pH and temperature, soil composition, winds, rain, sun, etc.) to understand the dynamics of the area, Leandro's lifestyle, and to identify the available renewable resources.
2. Measure the highest level that the tide reaches during the year using watermarks on Leandro's house and trees in his backyard. This measurement will determine the height of the barriers needed to insure against damaging flooding.
3. Dig the pond with several curved borders to multiply micro-ecosystems and therefore encourage biodiversity. Optimal depth is 1.5 meters. The length and width can be adjusted depending on the desired yield and available space.
4. Construct barriers using the mud removed during the digging phase and reinforce with wooden walls. The barriers have to be wide and sloped to prevent a collapse caused by the tide. It can also be reinforced with branches, broken tiles and other materials.
5. Construct two dams at the far end of the pond to enclose the structure and to allow for the circulation of natural spring and river water (at high tide). The dam consists of two parallel wooden walls filled with mud from the pond and with a PVC pipe running through the center.
6. Frame the steel net and install it on the side of the pond facing the channel that comes from the river.

7. Install rainwater collection system for third water source.
8. Clean the area by storing the materials and tools used and by clearing the tree matter and any other debris from the channel.

Photos (from left to right): Observing the tide during dry season, digging the pond deeper and with curves, building curved sloping walls made of mud, reinforcing the walls with wood, building a dam to enclose the pond, view of both dams






Photos (from left to right): Amanda picking açaí to reinforce the wet walls, sculpting the walls and reinforcing with açaí, installing the aluminum net at the mouth of the channel, creating the rainwater harvest system, our final prototype, Leandro using matapi to catch shrimp from the river

Our goal was to buy as little as possible for this ecosystem. We used the following materials:

- 2.5 m x 1 m Aluminum Net (mesh: 3,5 x 6,5) (1)
- Matapi Shrimp Trap (2)
- 1 m 100mm PVC pipes (3)
- 10 m 100mm PVC pipes (4)
- 100mm PVC Elbow (1)
- Mosquito net
- Tools (nails, hammer, shovel, drill, saw, machete)
- Recycled Wood
- Açaí branches
- Plants

NEXT STEPS

Continuity Model

1. **Finish build:** Close the net; Add netting to PVC pipes; Install rainwater harvesting system; Increase wall height as necessary (1-2 weeks)
2. **Observe habitat & maintenance:** Allow mud to settle; Monitor functionality of pond (e.g. water circulation); Make any necessary adjustments to structure; Test rainwater pH for continuity. (2-3 weeks)
3. **Survey pond for life:** Use mosquito net to gather life samples to verify the habitability of the pond. Note if there are any dead fish, shrimp, etc. in the pond.
4. **Plant vegetation:** Plant naturally occurring species like *aninga-açu* both on banks of pond and in pond. (1 week)
5. **Catch shrimp:** Catch approximately 50 shrimp from the river using the *matapi* and insert into the pond. Separate pregnant females into nursery. (1-2 weeks)
6. **Raise shrimp:** Survey pond once per week to track shrimp growth; Complement food supply by feeding shrimp once per day if necessary. (3-4 months)
7. **Measure yield, Set production goals & Create business plan:** Based on the pond's ability to successfully raise shrimp, set production goals for the next 6 months per habitat's capacity.

Anticipated Risks and Challenges

- We did not design a nursery for pregnant shrimp; during our final presentation, Ivan recommended that we do so. This may be a potential risk and we recommend Leandro monitors the pond for pregnant shrimp to assess whether they are surviving without one.
- There is a risk that water will not circulate effectively during low tide in dry season
- There is a risk that the barriers we built are not high enough to accommodate high tide during rainy season (since we built off of estimation)

- There is a risk that the barriers surrounding the pond get destroyed during high tide in the rainy season (or become very muddy)
- There is a risk that plants will not thrive in the pond because soil is muddy
- There is a risk of predatory fish eggs get in the pond and kill off the shrimp population
- There is a small risk that rainwater might change the pH of the pond (we did not measure rainwater)
- Other stakeholders we spoke to experienced fish mysteriously disappearing from their ponds (the reason why is still unresolved) and this could potentially be a risk for Leandro
- There is a challenge in isolating variables when assessing whether the pond habitat is doing well or not
- There is a small challenge in expanding the pond if it is successful because of how much manual labor it takes to dig the pond

Team Engagement: Roles & Responsibilities

Because our project is site-specific, our continued team engagement is mostly rooted in ongoing communication. We created a group chat in WhatsApp (the primary means of local communication with international reach) where we plan to do monthly check-ins about the status of the pond. The group also makes the team available to Leandro as a resource to discuss ideas or conduct research online as needed.

Leandro will continue the build of the pond to completion and at time of writing is procuring additional wood for the build.

Project Viability and Other Design Opportunities

At this juncture of the project, there are multiple threads running from Leandro's shrimp habitat which can be carried towards creating new design opportunities.

We highly encourage and support any future iterations which seek to integrate the shrimp habitat with the other six projects developed during IDDS Amazon. Community engagement is undoubtedly a future priority. For example, the idea of creating some sort of weekly community market or exchange (harkening back to the barter system that existed a couples generations back in Boa Vista between those living inland and those on the riverbanks) arose out of a conversation with one community member after our first presentation open to the public.

Another idea born of our dialogue with Ivan (local shrimp fisherman) is to cultivate a partnership with the local schools in the interest of creating on-site educational opportunities. Perhaps there might be field trips to Leandro's shrimp farm, where students can learn both about current shrimp farming techniques (construction process, harvesting process, permaculture principles, etc.) as well as the traditional shrimp fishing techniques (matapi, net, etc.).

Initially, another team was going to be a complementary polyfarming prototype at Leandro's house. In the interest of spreading the opportunities throughout the community, this team moved

their project to another home. Seeking to integrate polyfarming with the shrimp habitat would be another viable future project.

In terms of structural iterations, there is good cause for considering a future expansion of the pond to increase productivity or perhaps even to incorporate fish into the system. Additionally, we recommend that Leandro monitors pregnant shrimp to assess whether he needs to build a separate nursery for them. Moreover, thinking even bigger picture, there could be a project to expand upon the regenerative potential of the shrimp pond in terms of reviving the wild shrimp population in the area.

LESSONS LEARNED

Our project was an incredible learning opportunity across permaculture, participatory design, ecological factors, teamwork, and much more. Below are some key lessons we took away:

- Emulating harmony with the environment was essential to our project and our general approach to the design process. For our team, one of the most memorable moments of IDDS Amazon was the night of the bonfire. As we gathered around the bonfire, singing, dancing and making music, it started pouring rain. Unphased by the rain, we continued to dance around the fire and do whatever we could to keep the fire going (breathing oxygen, digging channels to divert the water away from the fire, etc.), all of which made the storytelling session that happened later that night possible. It was an incredible metaphor for community and for working together with Nature to achieve a mutually beneficial solution between what we hoped for and what was occurring naturally.
- Being in the natural environment inspired our decision making. For example, when we were considering two design concepts in greater detail, returning back to Leandro's land to observe the tide and natural resources made the decision more clear. It was also helpful to host meetings in natural settings like in the forest and at the igarapé; it helped our team be more present with one another and our overall goals.
- Gathering best practices around technical solutions from experts is important but should not blindly be accepted as the best solution in every situation. For example, Secretary Genoir highly recommended using a floating fish cage as the best technology but this was not appropriate for Leandro's context.
- We recognized that we had to be careful about setting expectations around what we could realistically accomplish within 2 weeks, both within our own team and the broader community. We did not claim to be experts in fish farming and made sure to explain to each stakeholder that we were only here for 2 weeks experimenting with a design process. Do not promise to do anything you don't know you can do for sure.
- Team wellbeing was held as a high priority for our group. We communicated openly about our emotions and developed close bonds. Each day before we started any work, we went around in the circle to check in about our goals, priorities, and feelings.
- Our design facilitator, Ju, did an amazing job at setting the tone for our team with her respectful demeanor, patient approach, and steady, loving energy.

- Although we took our project seriously, we did not try to force the process or the solution. We took our time to listen to one another, consider options, and gather inspiration. At times, we had to take a break or walk away when our energy was low to take care of ourselves. Our project never felt like work because each day we approached it as an adventure, seeing what we would uncover and learn as a team. If you commit to having fun together, you will.
- Each team member brought something unique to the team. Recognizing one another's strengths allowed each team member to contribute in the way that was best for them. Each team member was honest about what they wanted to do and stepped back / leaned in accordingly.
- General housekeeping (documenting your process as you go along, keeping track of papers / post-its / etc.) is easy to overlook but causes rework if not done properly. Having multiple people on the team who are responsible for this ensures that it gets done.
- Especially in a bilingual environment, take care with the words you choose to avoid jargon and any potentially offensive words. For example, the word "iteration" (which is hard to translate to Portuguese) caused confusion and the word "empowerment" was offensive to some (insinuating that without a solution, someone is without power). In the bilingual environment, take the time to ensure that each person (regardless of language ability) fully understands the situation and feels welcome to participate

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Project team (from left to right): Javi, Amanda, Ju, Leandro, Agnes and Zach.

STAKEHOLDERS

Name	Context (Why we interviewed them)	Key Insights (What we learned from them)
Ademir	Built fish tank (*tambaqui*) on riverside property (*várzea*) in neighboring community of Guajará; water from river	1.) Currently on third iteration of tank (1 yr) 2.) How to factor in high and low tide from both rainy and dry seasons into prototype design (height of walls) 3.) Nursery technique: built a wooden cage outfitted with metal wire that was pegged to two wooden poles and kept afloat in tank by makeshift booies. It is essential to raise the baby fish separately.
Augustinho	Carved out 2 fish ponds (*tambaqui* and *pirarucu*) on inland property (*terra firme*) in neighboring community of	1.) Ponds not operational (8 yrs experience) 2.) Never achieved successful yield

	Santa Rosa; water from natural spring and igarapé	3.) Introduced the PVC water circulation system 4.) Augustinho introduced us to his brother, Ademir, as well as the former Sagri engineer, Genoir. 5.) Seek and accept feedback. Augustinho's input reminded us of the importance of this principle. Despite enlisting Genoir's help at the beginning of the building process, Augustinho had never invited him back to assess any of the iterations of his fish ponds. This is likely one of the factors that contributed to the lack of yield. 6.) Reminder to be mindful about communications and expectations within the community. When we invited Augustinho to participate in the brainstorming phase, he showed up ready to negotiate a business partnership.
Daísa	Sister of President of APOBV; PhD student in Pedagogy; Engaged our group in a discussion after giving supportive feedback during our first presentation to the community.	1.) A couple generations ago, the community of Boa Vista had a barter system. People living on the riverbanks traded fish, shrimp and açaí; people living inland traded the *mandioca* (cassava) they harvested on their land plots; and people living nearer to the forest traded hunted animals. 2.) Conversation with Daísa gave rise to the possibility of a community market on Sundays in which people like Leandro could bring their goods to trade with one another. The market would also provide alternative leisure for the community.

		3.) Also gave rise to the idea of a partnership with the local schools to run field trips to Leandro's home to learn about shrimp farming.
Max	Built successful fish pond (*tambaqui*) on inland property in Boa Vista; water from igarapé; potential partner for Leandro	1.) The watch-goose pattern: build a fenced-off goose pond adjacent to fish pond for sustainable alarm system. Since Max's house is a couple hundred meters away from the pond, his fish were vulnerable to poaching. 2.) Be careful of collateral damage: runoff from a nearby igarapé where Max's father stores manioc killed many fish. 3.) Constant maintenance: Max's pond was successful so long as he tended to it. It is very important to keep a watchful eye on your tank but also to design something that responds to and accounts for naturally-occurring factors like the tide and predators.
Ivan	Local shrimp fisherman	1.) Decline in shrimp population on riverbanks due to increasing human occupation of riverbanks. The construction of stilt houses along the banks has compromised shrimp habitats. Fewer and fewer people are catching shrimp as a result-- the culture is fading. 2.) When catching shrimp from the river, check for pregnant females (you can see eggs on the underbelly) and separate them in small tank or receptacle until the babies are large enough to compete for resources in the tank. 3.) Said he would not purchase

		shrimp or fish from Leandro because he prefers to catch himself but others might.
Genoir	Former agricultural engiengineer of Pará State Secretariat of Agriculture (Sagri); supplied fingerlings and technical assistance to Augustinho	1.) Check for water temperature and pH because soil in the area tends to be acidic. Limestone is often used to lower water pH. The river is warmer than the igarapé. 2.) Do not overcrowd your pond-- many fish farmers use a starter batch of a thousand where only two/three hundred is appropriate.
Wendy	Forest engineer with family aquaculture business in Altamira, PA	1.) Avoid the trapfall of building something too modern that costs to much to maintain 2.) Even with the help of fishing and agricultural engineers, it has taken Wendy's family years to get their fish farming system fully operational. She reminded us of our desired scale and the permaculture principle of small and slow solutions.

APPENDIX

Permaculture Principles

1. Produce no waste
2. Capture and store energy
3. Design from pattern to detail
4. Small and slow solutions
5. Observe and interact
6. Value renewable resources
7. Seek and accept feedback
8. Value diversity
9. Value the borders / marginals
10. Integrate instead of segregate
11. Obtain a yield
12. Answer creatively to change

Permaculture Resources Consulted:

- How I Fell in Love with a Fish TED Talk by Ted Barber
- How to Restore the Rainforest TED Talk by Willie Smits
- Living Machines by John Todd
- Chanampa Pattern
- Constructed Wetlands Pattern
- A Pattern Language by Murray Silverstein, Sara Ishikawa and Christopher Alexander