## I. Abstract

Aquaponics is a rapidly expanding field that requires research and development in engineering, biology, horticulture, architecture and business. Cal Poly San Luis Obispo lacks an adequate facility that can support the growing interest amongst the student population and faculty. A small flagship system has been constructed on campus, but the current layout is too small to support the growth potential for interdisciplinary collaboration. The funds that are being requested would be applied towards expanding the current operation and fostering interdepartmental relationships that will allow for aquaponics at Cal Poly to thrive. The aquaponic's club constituents will serve as the designers, builders, and long-term stewards of the new facility deemed the "Living Lab." Once completed, existing Cal Poly courses will be able to utilize the facility as an immersive, teaching platform to transform classroom concepts into tangible applications.

## II. Introduction

Aquaponics is the bourgeoning field that pairs the concepts of recirculating aquaculture and hydroponics into a single dynamic field. In essence, aquatic organisms (typically fish) are reared in a tank and their waste byproducts are microbially transformed to naturally fertilize a food-based crop. The following figure sheds light on the basic system components.

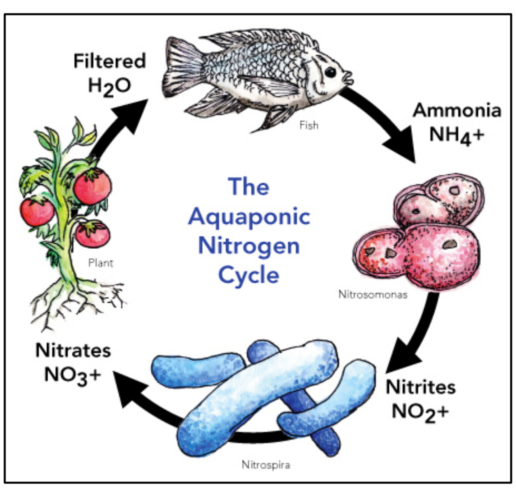


**Figure 1.** The nitrogen cycle is essential to the success of aquaponics. Many different system configurations can achieve this balance, however it is essential that the nitrification basin receives adequate oxygen. (Courtesy of feelgoodaquaponics.blogspot

The benefits of such a system are apparent in the drastic reduction in water usage, increased product yield, elimination of pesticides/herbicides, and improved energy efficiency relative to conventional agricultural practices. It is clear that the modern industrialized agriculture has its advantages, however the negative impacts associated with it are harming the biosphere. Some of the chronic ailments that are attributed to conventional practices include water and soil degradation, habitat loss, intensive greenhouse gas emission, and monoculture induced blight (Gleissman 1998).

One of the major concerns in California agriculture is access to sufficient amounts of clean water. Historical water shortages in California have become a part of local lore, however the effect has never been as devastating as the 2013 season. Last year marks the worst drought since recordkeeping began in 1849. Financial losses due to the drought conditions are still speculative, but some industry experts estimate the agricultural losses to be in the range of $7.5 billion for the 2014 season (new.farmwater.org). As the lead agricultural state in the US, that spells disaster.

Aquaponics has the potential to circumvent many of the issues modern day agriculture faces, especially those stemming from inefficient irrigation and the reliance on irregular rainfall. Because the system operates in a controlled, recirculating fashion, the water usage is estimated to be 95% less than conventional agriculture (Water usage 2009).

With the requested funds, we plan on expanding the current *PolyPonics* system into a more complete installation that will be much more beneficial to student learning. The expanded facility will present us with an opportunity to engage multiple disciplines in an effort to resolve some of the major crises of the future. Cal Poly San Luis Obispo is a well-respected leader in both agriculture and engineering and is positioned to stay on top. However, in order to stay at the forefront, we need to explore the innovative technologies that have the capacity to redefine the industry.

## III. Objectives

(1) Group Formation:

- Establish a group of committed students that will actively contribute to the growth of the project.

(2) Location Selection:

- Select a suitable location to expand the current system into a larger, more optimal site.

(3) Campus-wide Outreach:

- Collaborate with other departments to strengthen interdisciplinary connections and propagate interest.

(4) Educational Cultivation:

- Utilize the system as a tool for interactive, hands-on learning.

## IV. Methodology

(1) Group formation:

- In order to ensure the success of the project in the long term, we have taken the proper steps to create an official ASI club known as "*PolyPonics*." The members will serve as stewards of the core values of the club. We will focus on raising awareness about aquaponics in both the student population and faculty at Cal Poly San Luis Obispo. The support that the project has received since its inception has bolstered our confidence.

(2) Location Selection:

- Several underutilized sites on Cal Poly campus are being investigated.
- Implement additional aquaponic growing configurations. At present, only deep water culture is being utilized; capillary beds, media beds, nutrient film technique, and others would all contribute to the educational usefulness of the project.

(3) Campus-wide Outreach

- Partner with key departmental members in Bioresource Agricultural Engineering (BRAE), Horticulture and Crop Sciences (HCS), College of Agriculture, Food and Environmental Sciences (CAFES), Civil and Environmental Engineering (CE/ENVE), Biology, Computer Science, Electrical Engineering (EE), Business, Architecture, etc. Message dissemination will be conducted via departmental emails. Student may earn independent study credit for their individual project based achievements.
  a. CompSci/EE: Construct inexpensive environmental controllers.
  b. Biology/HCS: Optimize fish/plant pairing, pH, alkalinity, etc.
  c. Business: Employ a sustainable business model and implement in SLO.
  d. Additional promotion of the project through Mustang News

(4) Encourage relevant courses across multiple departments to visit the site. Potential courses include:

| Course Title and Description | |
|---|---|
| **ENVE 434** | "*Water Quality Measurements*" |
| **ENVE 438** | "*Water and Wastewater Treatment Design*" |
| **ENVE 536** | "*Biological Wastewater Treatment*" |
| **MCRO 421** | *"Food Microbiology"* |
| **BRAE 348** | *"Energy for a Sustainable Society"* |
| **CSC 232** | *"Programming for Scientists and Engineers"* |
| **HCS 124** | *"Plant Propagation"* |

## V. Timeline

| Starting Spring Quarter 2014 | Project Phase |
|---|---|
| Week 3 | Proposal submission and review |
| Week 6 | Disbursement of funds |
| Week 10 | Site Selection and Preparation |
| Week 14 | Complete Construction with *PolyPonics* Club |
| Week 20 | Interdisciplinary Collaboration |
| Week 28 | Campus-wide Outreach through *PolyPonics* |
| Week 34 | Cultivate Hands on Classroom Learning |
| Week 52 | Final Project Report Submittal |

## VI. Final Products and Dissemination

The culmination of the Baker Endowment will be an expanded aquaponics facility deemed the "*PolyPonics* Living Lab," that will be conducive to interdisciplinary collaboration and community outreach. After the construction is complete, the space will provide ample opportunity for future student-led projects to be conducted. We aim to raise awareness about the technology involved in aquaponic farming and bring that invaluable knowledge to the Cal Poly community.

## VII. Budget Justification

| Criteria | Cost | Materials | Source |
|---|---|---|---|
| Plumbing | $430.00 | Varios sizes of PVC pipe, bulkhead fittings, glue and primer, flexible hosing, ball valves, mesh filters, siphons, | homedepot.com |
| Construction | $800.00 | Lumber, hardware, paint, glue, HDPE barrels, | homedepot.com |
| Fish Basins | $1,200.00 | Commercial aquaculture tank(s) | http://www.dura-tech.ca/circular-tank-model-ct10-4 |
| Grow Basins | $540.00 | Duraskrim 20mil HDPE liner. | http://store.globalplasticsheeting.com/dura-skrim-20-white/ |
| Aquarium supplies | $200 | Fish food, air pumps, salts, pH adjuster, on site test kits | marinedepot.com |
| Fish Stock | $300.00 | Bluegill ($1.75/fish for 2"-4")<br>Channel Catfish ($2.00/fish for 2"-4") | http://www.proaqua.com/?cf=pricelist |
| Growing supplies | $430.00 | seedlings, 3/4" Black Lava Rock ($97cubic yd), | Air Vol Block, San Luis Obispo |
| Environmental controllers and data loggers | $500.00 | Open source hardware(arduino), atlas scientific probes (Dissolved oxygen, pH, organic reduction potential) | https://www.atlas-scientific.com/kits.html |
| Energy | $600.00 | Solar panels, inverters, wiring,deep cycle batteries | homedepot.com |
| | | | |
| **TOTAL** | $5,000.00 | | |

**This is not a complete list and represents our best estimates.

## VIII. References


Gliessman, Stephen R. *Agroecology: ecological processes in sustainable agriculture*. CRC Press, 1998.

"State Water Resources Control Board - San Francisco Bay." *State Water Resources Control Board - Chapter 2: Beneficial Uses*. CA EPA, Web. 10 Apr. 2014. <http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/basinplan/web/bp_ch1.shtml>.

"The California Farm Water Coalition - Food Grows Where Water ...." *California Farm Water Coalition*., 1 Jan. 2014. Web. 10 Apr. 2014. <http://new.farmwater.org/>.

"Water usage in recirculating aquaculture/aquaponic systems." . Food and Water Watch, 1 Aug. 2009. Web. 10 Apr. 2014. <http://www.lanikaifarms.com/Recirculating%20Aquaculture%20Systems%20(RAS).pdf>.

# PROPOSAL BUDGET

| | |
|---|---|
| **Student Applicant(s):**<br>**Alex Hill**<br>**Dylan Robertson** | |
| **Faculty Advisor:**<br>**Dr. Gregory Schwartz** | |
| **Project Title:**<br>***PolyPonics*** | **Requested Baker Endowment Funding** |
| **Travel** *subtotal* | **$** |
| Travel: In-state | **$** |
| Travel: Out-of-state | **$** |
| Travel: International | **$** |
| **Operating Expenses** *subtotal* | **$ 5000.00** |
| Non-computer Supplies & Materials | **$4500.00** |
| Computer Supplies & Materials | **$500.00** |
| Software/Software Licenses | **$** |
| Printing/Duplication | **$** |
| Postage/Shipping | **$** |
| Registration | **$** |
| Membership Dues & Subscriptions | **$** |
| Multimedia Services | **$** |
| Advertising | **$** |
| Journal Publication Costs | **$** |
| **Contractual Services** *subtotal* | **$** |
| Contracted Services | **$** |
| Equipment Rental/Lease Agreements | **$** |
| Service/Maintenance Agreements | **$** |
| **TOTAL** | **$5000.00** |