SMART LIGHT TRAP
INTELLIGENT CRAB MONITORING

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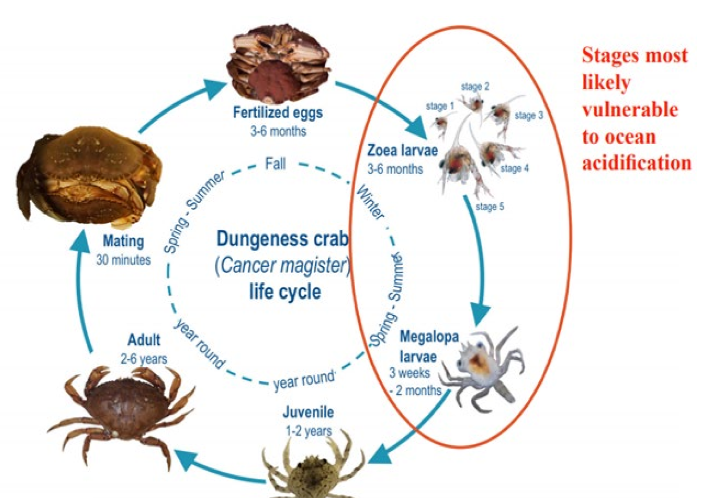
Project Motivation

- Government agencies, commercial industries, and researchers are seeking economical ways to track and collect data on West Coast Dungeness crab populations.
- There is substantial interest in understanding the relationship between crab populations, water quality, global warming, and ocean acidification.
- Current tools for collecting and counting crabs are labor-intensive and do not provide the related environmental data necessary to study these important relationships.
- In this project, I am presenting progress toward an automated system for counting Dungeness crab larvae, which will allow these relationships to be studied by adding water salinity measurement to an existing suite of environmental measurement.

Understanding Crab Populations

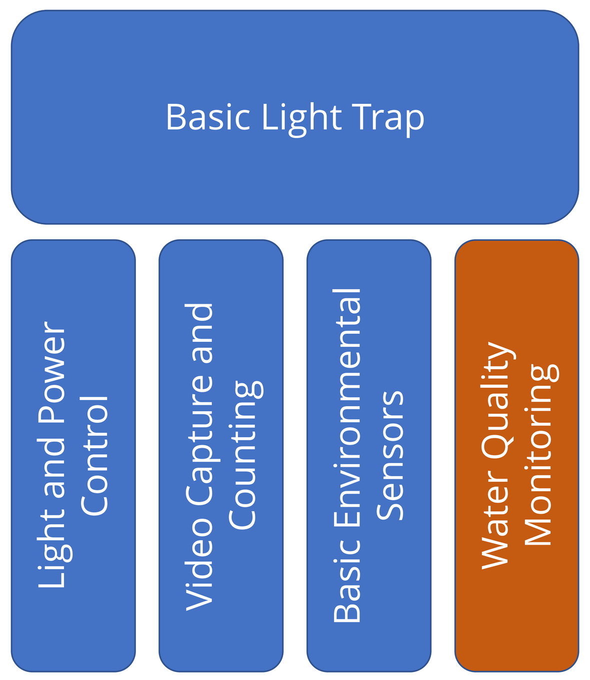
- Crab larvae are free floating in the water column making surface monitoring possible.
- Megalopae are the easiest to study as the largest larval form found on the surface before the juvenile crabs drop to the ocean floor.
- The abundance of megalopae can be used to predict future crab populations.
- As crabs are particularly vulnerable to harmful water conditions – like low pH seawater – in their early larval stages, the abundance of megalopae can also provide valuable data on water quality.



NOAA [1]

Extending the Light Traps Sensor Suite

- Light traps are routinely used to attract and capture larvae but counting is typically manual and they do not provide correlated environmental data.
- Last year's project addressed the need to automate the labor-intensive manual counting process and added basic environmental sensors – light, temperature, and motion.
- This year's project aimed to add improved water quality monitoring with the addition of a salinity sensor and various modifications to the code and user interface.
- Requirements:
  - Addition of direct water quality monitoring via salinity measurements taken utilizing a connectivity sensor.
  - Integrating technology into existing crab trap hardware and software system.
- The capacity to simultaneously collect 2+ days of water quality, temperature, light, and motion levels.
- Ability for users to view and interact with the conductivity sensor's readings in conjunction with existing sensors' data.



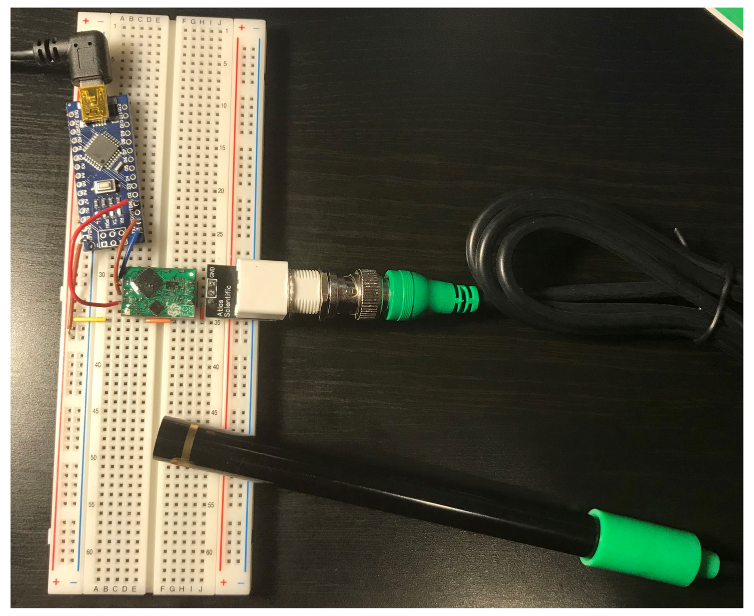
Conductivity/Salinity Sensor Integration

Sensor Selection

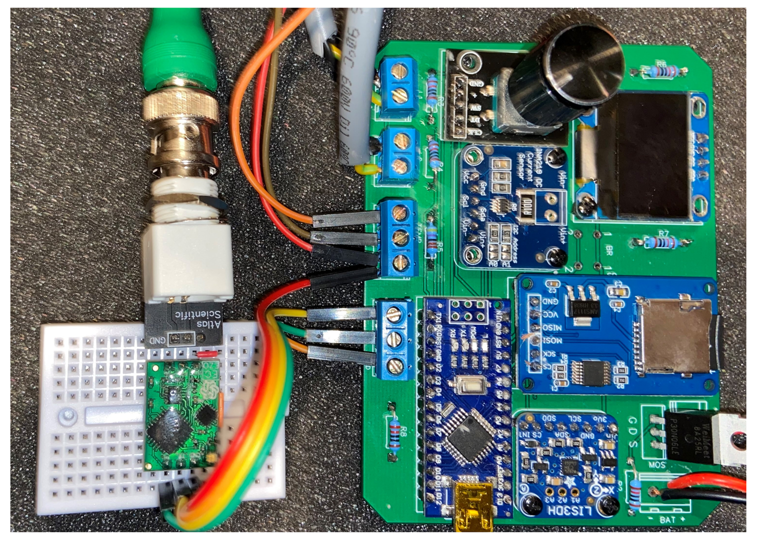
1. Sponsor requested the addition of a low power, lightweight, fully submergible, and low-cost conductivity sensor.
2. I found that the sensor would need to be compatible with an Arduino Nano and existing sensors. It would also need to be able to accurately measure the salinity of sea water for multiple days in an ocean environment without being damaged.
3. A corrosion-resistant toroidal conductivity sensor was originally preferred but I found that they were too expensive.
4. After extensive research, I selected the EZO Conductivity Circuit and the AtlasScientific K 1.0 Conductivity Probe because it could accurately measure conductivity, TDS, salinity, and specific gravity. It also supported two point calibration, temperature compensation, and UART and I^2C data protocols.

Sensor Integration

1. Got conductivity sensor working separately with an Arduino Nano in UART mode.
2. Calibrated conductivity sensor and tested it.
3. Modified code and setup to work with limited available Arduino pins.
4. Physically integrated the sensor and other parts to work with the original crab trap system.
5. Attempted integration of working conductivity sensor code into overall system code.
6. Discovered that due to limited open Arduino pins, limited program storage space, and conflicting libraries, I couldn't integrate the conductivity sensor in UART mode.
7. Got conductivity sensor working separately in I^2C mode and physically integrated it with overall system.
8. Integrated conductivity sensor code into overall system code, being careful to use as little program storage space as possible.
9. Modified code to record conductivity sensor data on sd card, take a new reading every minute, and avoid conflicting with other sensor using I^2C mode every second.
10. Adjusted sensor settings and code to switch from recording conductivity to salinity.
11. Modified code to add temperature compensation for sensor readings.
12. Modified physical setup of conductivity sensor and related parts to fit inside protective case.
13. Tested conductivity sensor and overall system and verified that it could collect accurate data.



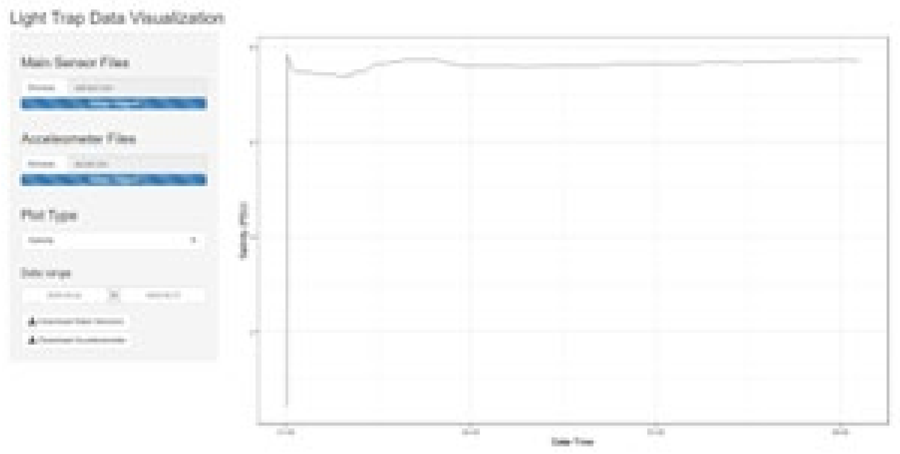
Conductivity sensor operating separately with Arduino Nano in UART mode



Addition of salinity monitor
- Running in existing code base
- Compatible with existing enclosure

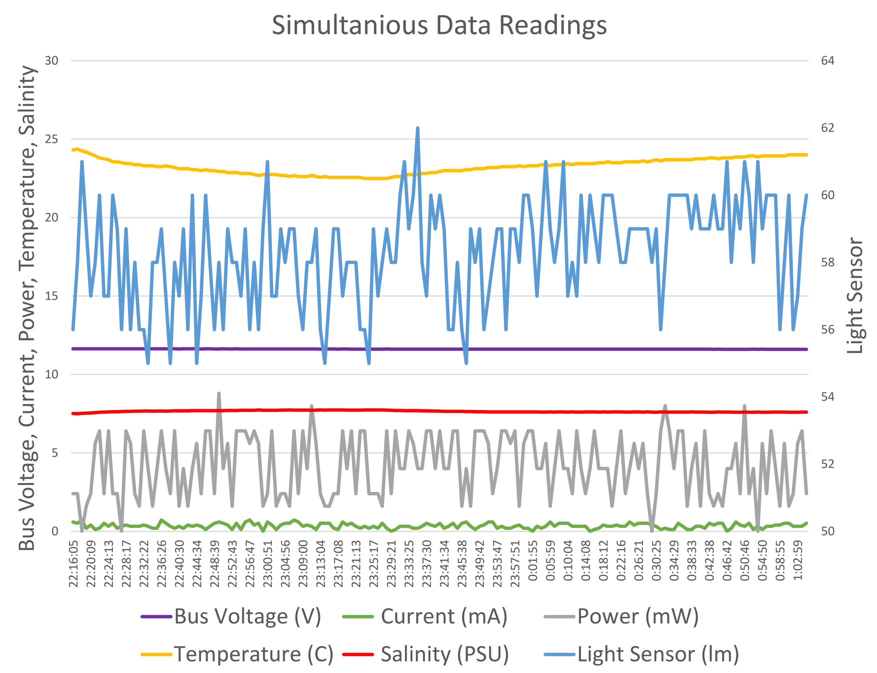
User Interface

1. Learned R and how to make a Shiny app.
2. Extended the existing user interface capabilities to allow new sensor data to be displayed and easily downloaded.
3. Displayed salinity over time as shown in the image to the right.



Integrated System Testing

- Verified that the conductivity sensor was taking accurate readings by testing it using calibration solutions and other saltwater mixtures.
- When possible, I checked the accuracy of the readings being taken by some of the other sensors by comparing them to their expected values.
- Since it wasn't possible to test it in the actual ocean, I ran tests in a container of saltwater to verify that the fully integrated light trap would properly work and take accurate readings in a saltwater solution.



Integrated Smart Light Trap with conductivity sensor

Conclusion

My project expands on past work to improve the smart light trap's ability to monitor environmental conditions. By adding a salinity monitor, we now have a direct indication of the water quality that can be correlated with the prior environmental data (motion, light , and temperature) so that researchers can better understand the relationship between megalope populations and water quality. This was accomplished by adding water quality monitoring with the addition of a salinity sensor and various modifications to the code and user interface.

Future Work, References, and Acknowledgments

Future Work:
- Further system optimization with new pcb design and integration with new power source and solar panels.
- Modifications to allow radio transmission of sensor data.
- Field testing in ocean.

Acknowledgments:
Faculty: Dr. Rania Hussein
Industry mentor: Dr. Paul McElhany

References:
[1] "Dungeness Crab Case Study." Ocean Acidification Communication Toolkit: Dungeness Crab Case Study | National Marine Sanctuaries, NOAA, sanctuaries.noaa.gov/education/crab-toolkit.html.

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