Warren J. Baker Endowment
for Excellence in Project-Based Learning
Robert D. Koob Endowment *for Student Success*

Proposal Cover Page

Title of Project:
Development and Prototyping of a Smart Wireless Tournament Scale and Supporting Long Range Mesh RF Network

Proposal Author : Johan Eide **Cal Poly Email:** jkeide@calpoly.edu

Student ID: 008580074 **Signature (Optional):**

Signature provides permission to check financial aid eligibility.

Previous Baker/Koob Endowment funding? (circle one): **Yes** **No**

Team Member(s)	Signature	Cal Poly Email	Department
Kye Miranda (008870533)		**kmiranda@calpoly.edu**	CPE
Johan Eide (008580074)		**jkeide@calpoly.edu**	BRAE

Faculty Advisor: Bo Liu **Department: BRAE**

Faculty Advisor email: BLiu17@calpoly.edu **Telephone: 805-756-2384**

Anticipated Start Date:11/30/2016

Anticipated End Date: 12/16/2017

Total Funds Requested ($): $4,667.00

Signature of Faculty Advisor: **Date:** 11/9/2016

Proposal Narrative:

I. Project Title:

Development and Prototyping of a Smart Wireless Tournament Scale and Supporting Long Range Mesh RF Network

II. Abstract:

As a competitive college angler competing for Cal Poly in Western United States, club vice president for the Cal Poly Fishing Club and local tournament angler I have seen fishing tournament format stay stagnant as technology has expanded exponentially in the 21st century. Seeing flaws in tournament fishing format and fish handling has lead us to apply our mechanical, electrical and computer programming coursework to introduce a solution. Our project aims to set aside all of the current tournament format's imposed stressors on fish by designing and creating a wireless smart fishing scale and network. This scale and network will result in a new tournament format that will now allow for fish to be caught and released directly back to where they were caught **in seconds**. **It is our hope that this scale will save hundreds of thousands of fish annually and give new life to the fishing industry, consequently improving angling recruitment, conservation and retention across all age levels.** It is critical that engineering and technology be congruent with wildlife conservation and the longevity of our country's vast natural resources.

"We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect."- Aldo Leopold 1949

III. Introduction:

In 2015, 33.1 million Americans went fishing in the United States. Anglers contribute $61.7 billion annually to the country's GDP. Additionally, over 15.5 billion is spent on just fishing equipment ever year.[1] In my home state of California, 1,651,053 residents purchased fishing licensees in 2015.[2]

In traditional tournament fishing format anglers put their best fish (usually 5 per day) in their live wells throughout the day. Next anglers navigate back to the dock or parking lot where the tournament is hosted. From here the fish are placed in bags and brought onto stage or to a weigh-in station where the total accumulative weight is recorded with no water in the bag at all. This transition time is usually managed to be as short as possible, but unfortunately it is common for this transfer time to be drawn out and neglected. Then fish are usually directly released back into the lake near the launch ramp or placed onto a "release boat" which drives away from the ramp. Uncontrollable environmental conditions and oxygen levels in tournaments contribute to a higher mortality rates.[5] Looking over all of these transition points, adding up all the time that fish spend out of the water and every stressor placed on the fish (i.e. temperature, pH, water quality, hypoxia etc.), it is not hard for anyone to recognize constraints and flaws that could possibly occur. In fact studies have shown when tournaments are not properly managed populations of fish caught can have a TM (total mortality) rate ranging from **0 to 30%**.[3,4] **With the unpredictability of nature, it is not without blatant neglect of fish life to not try to improve upon a uncontrollable mortality rate and often broken system.**

IV. Objectives:

1. Integrate digital scale analog signal to a digital signal to be sent by the Arduino MEGA 2650 through our long range RF XBee DigiMesh® network.
2. Conversion and Compression of fish images into TTL serial (transistor-transistor logic) to be transmitted wirelessly via XBee DigiMesh® network.
3. Develop LABview GUI or Digi Device Cloud Interface to Receive and Store Images, Weight and Time of Transmission at "judge" base station.

4. Design external waterproof hand-held scale housing and an RFID proximity automated release sensor.
5. Incorporate precautionary sensors to wireless scale; adapt Arduino code order of operations to run through sensor cycle before data transmission.
   Precautionary Sensors: **a.)** Metal Detector *(Protection against metal objects inside fish)* **b.)** Secondary Image at Time of Release **c.)** Accelerometer *(Protection from sharp scale movement)*
6. Re-Develop Nextion LCD touch screen GUI, PCB board and scale housing for ergonomic function and ease of use. Re-build 3-D printed housing

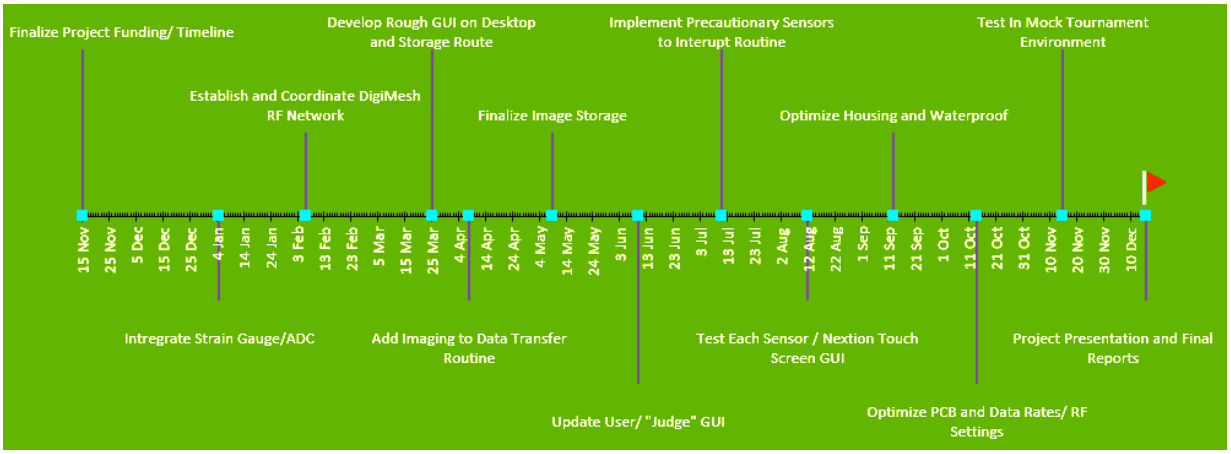
These **project objectives are measurable and attainable given the time and financial constraints** and are ordered in a way to first establishing a usable solution before fine-tuning precautionary sensors. Most importantly they are **project based, Learn by Doing** experiments.

V. Methodology

To determine the initial interface of a digital hand-held scale (small strain gauge) to an Arduino MEGA 2650. These weight values now will be transmitted through a Xbee DigiMesh® 900 MHz network allowing for self healing, secure and long range data transfer. A mesh RF network at 900 MHz data transfer will allow for data transfer rates 120 kb/s and a LOS (line of sight) range of 65 miles and in areas with high interference or RF traffic a range of 9-11 miles and a 10kb/s data rate. This cuts out the historical constraint of point-point-point data transfer (i.e. a Home Wifi System) and allows each boat on the water to form a chain link of transmission nodes back to base server, website or cloud storage judging system.(See Figure 1) Once received weights will stored and summed to the users best 5 total fish and accumulative weight to be displayed on a GUI.

Once long range wireless weight data transfer and storage has been debugged, inserting the transfer of two timed images will be added to the entire transmission process. The first image will be taken facing directly downward on the fish hanging from the hand-held scale. The image will be taken exactly as the weight is recorded. This will provide verification that of what is being weighed is this actually a largemouth, smallmouth or spotted bass (*Micropterus Salmoides/Dolomieu /Punctulatus*) and if anyone is trying to pull down on the scale. Parameters to the scale will include precautionary sensors and an automatic release system. The second image will be taken as the scale is touched to the side of the boat's outboard. A RFID tag with a fixed range (i.e. a security pass card used to open doors) will release an electric solenoid to drop the fish into the water, eliminating any question that the fish was weighed twice. The selected camera will automatically convert each image to TTL serial to be transmitted over the wireless RF network, over a backup satellite or cellular network and to be stored onto a backup SD card or memory inside the handheld scale.

VI. Timeline:



VII. Final Products and Dissemination:

The end result of this project is to have a practical and reliable alternative to using live wells and physical fish detainment for tournament fishing. Including an easy to operate GUI on the scale and base station. A final report of the development process and outreach through leading wildlife conservation groups (i.e. Trout Unlimited, B.A.S.S, Congressional Sportsmen's Foundation) throughout the United States will be conducted at the time of project completion.

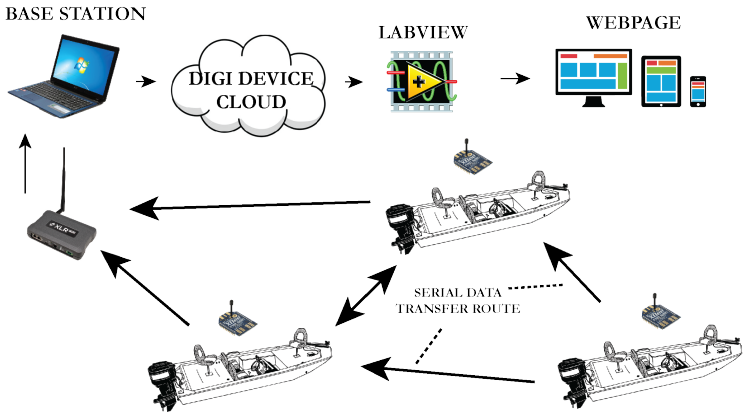


Figure 1: Mesh Network Overview/Data Flow Chart

VIII. Budget Justification:

The cost of the project is made up mostly of compiling the mesh RF networking system. A budget extending over personal funds is necessary to build the entire network and not just a single hand held scale, which does not convey the purpose of changing tournament structure. Two XBee SX PRO transceivers **($198.00)** will serve at an allowable "mock" group of tournament boats and will transmit at a practical distance to the XBee XLR PRO **($899.00)** modem. A reliable initial development kit is necessary to troubleshoot and fine tune optimized networks settings**. ($199.00)** The XLR modem will serve as a link to cloud based storage and a "base" receiver with a suitable data rate to receive multiple incoming RF signals in rural environments.

The mobile base station configuration of a DC power converter **($207.00)**, the XLR PRO, Lenovo ThinkPad **($769.00**), Version Jetpack **($199.99),**Tripp Lite dc power converter **($207.00)** and an external hard drive **($99.00)** will serve as a mobile central location for data collection almost anywhere. The remaining items listed on the project budget are composed of all supporting hardware to make the wireless fishing scale and network possible. **($914.00)** This hardware includes mounting brackets, Arduino, Arduino shields, batteries, antennas, adapters, electrical components and LCD screens. To make our design unique, ergonomic, usable in harsh environments we need to design and build PCB boards. PCB printing will be contracted out to OSH PARK, because we can not physically high quality PCB boards with the tools available to us at Cal Poly.**($200.00)** Additionally 3D Solidworks drawing files for the scale housing and fish release solenoid system will need to be quickly developed, adapted and 3D printed as the project progresses. **($660.00)**

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[1] *U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.*

[2] *U.S. Fish and Wildlife Service. "WSFR Historical License Data." U.S. Fish and Wildlife Service, 22 Sept. 2015. Web. 22 Aug. 2016.<http://wsfrprograms.fws.gov/Subpages/LicenseInfo/Hunting.htm>.*

[3] *Cooke, Steven J., et al. "Physiological impacts of catch-and-release angling practices on largemouth bass and smallmouth bass." American Fisheries Society Symposium. American Fisheries Society, 2002.*

[4] *Wilde, Gene R. "Tournament-associated mortality in black bass." Fisheries23.10 (1998): 12-22.*

[5] *Suski, C. D., et al. "The influence of environmental temperature and oxygen concentration on the recovery of largemouth bass from exercise: implications for live–release angling tournaments." Journal of Fish Biology 68.1 (2006): 120-136.*

Warren J. Baker Endowment
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CAL POLY
SAN LUIS OBISPO

Student Applicant(s): Johan Eide/ Kye Miranda		
Faculty Advisor: Bo Liu		
Project Title: Development and Prototyping of a Smart Wireless Tournament Scale and Supporting Long Range Mesh RF Network		**Requested Endowment Funding**
	Quantity	
Travel	*subtotal*	**$**
Travel: In-state		$0.00
Travel: Out-of-state		$0.00
Travel: International		$0.00
Operating Expenses	*subtotal*	**$**
Non-computer Supplies & Materials		**$2,609.89**
ARDUINO MEGA 2560 REV3	2	$45.95
SparkFun Triple Axis Accelerometer Breakout - ADXL335	2	$14.95
5" Nextion HMI LCD Touch Display	2	$68.15
SparkFun RFID Starter Kit	2	$49.95
LinkSprite JPEG Color Camera TTL Interface - Infrared	2	$49.95
SparkFun XBee Explorer Dongle	2	$25.00
XBee SX RF Module Dev Kit	1	$199.00
XBee-PRO SX, 1W, DigiMesh, Point to Multipoint, SMT, U.FL, North America	2	$99.00
Digi XLR PRO™	1	$899.00
DIN Rail and Wall Mount Bracket Kit for Digi XLR PRO	1	$10.00
U.FL to RPSMA adapter cable	2	$4.99
Antenna - 900 MHz, half wave dipole, 2.1 dBi, RPSMA male, articulating	3	$9.00
Li-Ion Rechargeable Batteries 5000 mAh+ (+ wiring harness)	3	$25.00
Electronic Handheld Scale Strain Gauges	3	$7.99
Multiprotocol Radio Shield for Arduino	2	$52.99
Tripp Lite PowerVerter PV1000HF DC-to-AC Power Inverter	1	$207.99
Seagate Expansion Desktop 3 TB External HDD - 3.5" - STBV3000100 - USB 3.0	1	$99.99
Misc. Electrical Components (Buttons, Wires, Solder,Breadboards)	1	$200.00
Sparkfun Solenoid - 5v (small)	2	$4.95
MicroSD card breakout board+ For Arduino	2	$7.50
SanDisk Ultra 32GB microSD	2	$10.59
Computer Supplies & Materials		**$769.00**
Lenovo W530 i7 3740QM 2.70GHz 16GB 256GB SSD 15.6" FHD (1920x1080) Win 7 Pro	1	$769.00
Software/Software Licenses		$0.00
Printing/Duplication		**$728.00**
PCB Prototype Printing- OSH PARK (/sq-in on 3 boards)	40	$5.00
3D Printing (Per/ Inch ^3)	400	$1.32
Postage/Shipping		$0.00
Registration		$0.00
Membership Dues & Subscriptions		**$559.99**
Verizon Jet Pack Mobile Hotspot (per month) -months	6	$60.00
Verizon Jet Pack Mobile Hotspot Modem	1	$199.99
Multimedia Services		$0.00
Advertising		$0.00
Journal Publication Costs		$0.00
Contractual Services	*subtotal*	**$**
Contracted Services		$0.00
Equipment Rental/Lease Agreements		$0.00
Service/Maintenance Agreements		$0.00
	TOTAL	**$4,666.88**

CAL POLY
SAN LUIS OBISPO
College of Agriculture, Food & Environmental Sciences
BioResource and Ag. Engineering Department

11/09/2016

Baker and Koob Endowments Office of the Provost & Executive Vice President for Academic Affairs San Luis Obispo, CA, 93407

Dear Baker and Koob Endowments Committee,

It is my pleasure to write a letter in support of the application of Johan Eide and Kye Miranda for this year's Baker and Koob Endowments. Mr. Johan Eide is a senior student in the BRAE department and I have known him for two years.

He took *BRAE 328 Measurement and Computer Interfacing* with me early this year, and he was one of the top students in my class. He and his group members developed a brain-wave control robot in the class, and expressed all the students in that class and many faculty members as well. He is extremely interested in sensors, data collection and applications in an agricultural context, specifically, wireless sensor networks. This area is very new and promising, but also requires a multidisciplinary background to get involved in. Mr. Johan Eide is one of the most intelligent and hard-working students I have met here at Cal Poly. He also has a strong background in electronics, engineering design, and programming, therefore he is capable of doing this project. The award is very important for him to purchase necessary supplies and materials to develop a novel Smart Wireless Tournament Scale and Supporting Long Range Mesh RF Network to make this project successful and significant.

I strongly believe in Learning-by-Doing and engaging students with real world problems currently faced by agriculture and industry, and also highly encourage Cal Poly students to participate into research projects which can provide students with an ongoing source of one-on-one mentorship, experience of balancing collaborative and individual work, an opportunity of discovering their passion for research. Mr. Johan Eide is a perfect example of discovering an area of interest through undergraduate research.

I am his faculty advisor and will provide technical guidance and support this year. I will also ensure the project budget is followed and all the purchased supplies are kept in good condition, once this project is funded. The Ag. Mechatronics Lab in the BRAE department will provide space, essential electrical equipment, and software for him to complete the project.

In conclusion, I highly support the efforts of Mr. Johan Eide as he seeks this funding opportunity to support this research project.

Sincerely,

Bo Liu, Ph.D.
Assistant Professor 8-106, 1 Grand Ave.
BioResource and Ag. Engineering Department
California Polytechnic State University
San Luis Obispo, CA, 93407
Phone: 805-756-2384
Website: http://www.liubo.org

CAL POLY
SAN LUIS OBISPO
College of Science and Mathematics
Biological Sciences Department

November 7, 2016

Dear Baker-Koob Endowment Proposal Reviewers,

I am pleased to have the privilege to provide a letter supporting the application of Mr. Johan Eide and Mr. Kye Miranda for a Warren J Baker – Robert D. Koob Endowment award for 2016-2017.

Mr. Eide and Mr. Kye are proposing a project titled "Development and Prototyping of a Smart Wireless Tournament Scale and Supporting Long Range Mesh RF Network," which proposes to develop a wireless smart scale connected to a long range radio frequency (RF) network that will be used for measuring and reporting fish weights during competitive fish angling tournaments. Over 30,000 competitive angling events occur annually in North America, and the most commonly used method for reporting fish weights during these tournaments is to place a caught fish into a live well (i.e., aerated container) where it is held for several hours until it can be transported back to a tournament 'weigh-in' station for official measurement. Even though live wells are designed to provide aeration and minimize temperature variation, it is well established that holding fish in live wells for extended periods can expose the fish to a variety of stresses including temperature changes, low dissolved oxygen, and crowding stress, all of which have been shown to detrimentally impact the health and survival of fish. Recent studies have found that up to nearly one third of the fish caught and maintained in live wells during an angling tournament may die from these stresses prior to or shortly after release back into the wild.

Mr. Eide and Mr. Kye are proposing an innovative solution to this major problem for fish conservation: the development of a new, wireless network-based method of quantifying and reporting the weights of fish caught in tournaments. Reducing the confinement time of fish in live wells – and therefore the intensity and duration of stressor exposure – has the potential to greatly reduce the mortality of fishes caught during angling tournaments. The project proposed here by Mr. Eide and Mr. Kye will significantly reduce the time of live well holding by enabling fish to be weighed on the site of capture, with the weight data then transmitted directly via a RF network to officials running the angling tournament. That change in weighing method not only greatly reduces the time of holding for a given fish, but also allows for near immediate release of fish back into the same habitat where they was caught, rather than displacement of the fish to a new site of release several hours later in the day following the weigh-in.

As engineering students here at Cal Poly, Mr. Eide and Mr. Kye are proposing a pioneering solution to what has become a major conservation and welfare issue for native fishes. Indeed, the project that they are proposing is no less than impressive, and speaks directly to the spirit of originality and problem-solving that we, as instructors, strive to instill in Cal Poly's students: to generate innovative solutions that resolve ecological and society problems
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As a fish physiologist whose own scholarship address problems concerning the conservation of endangered native fishes, I intend this letter both to speak to my support for this proposed project and to validate the considerable need for reducing fish mortality arising from competitive angling tournaments. Mr. Eide and Mr. Kye are proposing an innovative solution to this conservation challenge here with their proposed Baker-Koob project, and I encourage you to give their project proposal full consideration for funding support.

If you have additional questions, please feel free to contact me personally.

Very sincerely,

Sean C. Lema
Associate Professor
Biological Sciences Department
California Polytechnic State University
San Luis Obispo, CA 93407