

## Advancing Student Centered Science at LSSU: Structured Labs, Experiential Learning and Professional Opportunities

### *Project Abstract/Executive Summary:*

There are several goals for my sabbatical proposal:

**Goal 1)** Revise the lab manuals for several classes with opportunities for hands-on activity.

**Goal 2)** Attract long-term funding for the Aquaculture Challenge competition developed by LSSU in 2016. Currently the competition is supported by sporadic grant funding, LSSU student labor and volunteer time, but we hope to attract ongoing funding to expand the scope of the competition and increase the visibility of LSSU in aquaculture.

**Goal 3)** Promote LSSU as a university of choice for aquaculture education, including cannabis aquaponics. This could include developing a BS in Aquaculture that includes both aquaponics and fin fish aquaculture, as well as working with chemistry to create a cannabis aquaponics concentration.

**Goal 4)** Complete and submit for publication @6 manuscripts with LSSU student co-authors. Peer reviewed publications reflect the quality of active student centered science at LSSU.

### **Description of Sabbatical Project**

**Goal 1) Revise the lab manuals for several classes with opportunity for hands-on activity.**

#### Introduction and Background

I teach a variety of lab intensive courses for which we have developed in-house lab manuals. Over the years these labs have been modified such that a number of versions exist. Initially we created a printed version for Introductory Biology I (BIOL131; formerly BIOL109), and Animal Physiology (BIOL330) which were sold at the bookstore, but later transitioned to the lab handouts being available on Moodle. I'm finding that although students are comfortable with electronic versions, they do prefer a hard copy for lab. Additionally, with resources only being available on Moodle, they are not keeping all their work together. Furthermore, the lab prep information and the background information (appendices) are not located in the same place. Given we have multiple instructors and student prep workers for courses such as BIOL131, I would like to consolidate all information into one printed book.

We also introduced the Scholar's Notebook for students to record all their lab activities in one place. Each week they record *Reflections* on the previous week's lab; *Objectives, Methods, Results, Conclusions, Vocabulary* and *2 Questions* of the current week's lab, as well as some *Activity*, such as a sketch or graph of their data. In the past, students used a duplicating notebook; turning in the copy and keeping the original. With Covid concerns, we no longer accepted paper copies, but had students scan or take a picture of their work and upload it to Moodle. This is partially successful, except that many are not keeping a notebook, and end up with an assortment of loose pages for their work. To address this, the revised lab book would also have space for the students to complete their lab assignments. They could still take pictures to submit to Moodle, but they would have all their information in one place.

I would use the same approach for updating the lab manuals for BIOL330, and also for creating a lab manual for BIOL433 (Histology and Pathology) and BIOL232 (Introduction to Aquaponics).

Outcome: Our overall goal is to develop our student's science skills, which includes attention to details. The lab activities teach them skills, but we want to get them in the habit of writing things

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down in their scholar's notebook. This allows them to reflect on their work throughout the semester, but they also are able to see what questions they posed that might be used for their open inquiry projects. Having all the information in one place will help the students, but will also provide consistency for courses where there are multiple lab instructors.

Timeline: I am currently teaching the BIOL131 labs and have started making some revisions to the labs already. However, I'm finding I don't have time to follow through with the updating the prep instructions and revisions of the appendices. Ideally, I will be able to make a start before the beginning of Fall 2023 and then work with the course instructors during Fall 2023 and Spring 2024 semester to finalize the copy for printing.

## **Goal 2) Attract long-term funding for the Aquaculture Challenge competition**

### Introduction and Background

The projected increase in world population to 10 billion people by the year 2050 creates a demand for increased food and other agricultural products; all of which requires access to land, freshwater, energy and nutrients (Goddeck et al., 2019). The concern is that many of these resources, especially nutrients are not available in an infinite supply, and so we need to rethink how we ensure food security. Feeding 2 billion additional people by 2050, (while also taking into account the desire for higher standards of living and eradicating hunger), is estimated to require a 50% increase in our current level of food production (FAO, 2017). Current trends for increased agricultural yields fall short of meeting these food demands by 2050 (Bajzelj et al., 2014). Aquaponics, the combination of aquaculture and hydroponics is seen as a key food production system that is anticipated to be a major part of the solution to future global food security (van Woensel et al., 2015). The ability to recycle water, nutrients and energy makes aquaponics a potentially unique solution to a number of environmental issues facing conventional agriculture. A key requirement for aquaponics development is training a workforce that understands the complexity of the science of aquaponic food production (Goddeck et al., 2019).

Bajželj B, Richards KS, Allwood JM, Smith P, Dennis JS, Curmi E, Gilligan CA (2014)

Importance of food-demand management for climate mitigation. *Nat Clim Chang* 4:924–929.

FAO (2017) The state of food and agriculture leveraging food systems for inclusive rural transformation. FAO, Rome

Goddek, S, Joyce, A, Kotzen, B, Dos-Santos, M. (2019) Aquaponics and Global Food Challenges In “Aquaponics Food Production Systems Combined Aquaculture and Hydroponic Production Technologies for the Future (Eds. Goddel, Joyce, Kotzen Burnell) SpringerOpen

van Woensel L, Archer G, Panades-Estruch L, Vrscaj D (2015) Ten technologies which could change our lives – potential impacts and policy implications. European Commission, Brussels

Aquaculture workforce development begins with STEM education at the high school level. The Aquaculture Challenge is a competition developed at LSSU, to create an incentive for high school teams to engage in the basic STEM disciplines addressed by aquaponics. Initially the teams were just from schools in the area of LSSU, but in recent years we have seen teams entered from as far away as Indiana, Pennsylvania and Minnesota. Given the virtual nature of the competition, there is no geographical boundary to limit a team being able to compete. Expansion

of the competition has the benefit of introducing LSSU to a much wider market. We began the competition in 2016 when LSSU engineering students suggested a scaled down version of what they were doing with the Programmable Logic Controller in the Superior AquaSystems hoophouse. This led to our first aquaculture challenge grant:

- “Recruiting Engineers for Aquaculture Automation”, B.I. Evans and C. Smith MI Stem Partnership Funded May 2016 \$14,575.35

This was followed up with USDA funding to develop the Youth Education in Aquaculture web page: [www.ncrac-yea.org](http://www.ncrac-yea.org)

- “Youth Education in Aquaculture” B.I. **Evans** and C. Smith NSERC-NIFA September 2016 \$34,907

and another grant to educate high school teachers in aquaponics

- “Educating a Workforce for the Aquaculture Industry: Matching Skill Needs of the Aquaculture Industry with US Career and Technical Education (CTE), B.I. **Evans PI**, H. Helal, C. Hartleb, K. Slemmins, D.A. Patillo NSERC-NIFA 9/17-8/19 Funded \$188,036.

We just received another grant that is supporting the Aquaculture Challenge (a bit), and adding a seafood cleaning and cooking component to the competition.

- Shank, A. **Evans, B.I.**, Jescovitch, L., Nelson, E. “Development of Consumer Education Materials on Seafood and Aquaculture. NSERC-NIFA Funded 9/1/21-8/31/23. \$225,505.

Upon entering the competition, a high school team designs and builds an aquaponics system. They need to demonstrate how they monitor the water chemistry and other physical parameters and are encouraged to incorporate and program a microcontroller with sensors. They have the option to develop a business plan to market their design and, new last year, show how they might add fish recipes to their diet. At the end of the competition, the teams upload videos of their system and demonstrate how they have met the challenge. Judges evaluate the submissions and awards are presented in a webinar showcase at the end of each year.

The initial design of the Aquaculture Challenge competition was based on "FIRST Robotics", but we wanted to remove barriers such as the cost of the build materials and the cost of travel. The Aquaculture Challenge competition itself is virtual, with the teams building systems at their schools or at home, and then sharing them electronically. The cost of the build was covered in our first grant, but we have not been able to continue that funding in recent competitions. The competition depends on volunteers and student labor, but additional funding is needed to support and expand the challenge.

Since beginning at LSSU, I have been successful in attracting local and federal funding from diverse sources. In total I have been involved with ~\$1.7 million in grants, with just over \$500,000 of my grants specifically for aquaculture education. I am confident that funding is obtainable by approaching the aquaculture industry in the Midwest. For example, companies such as Nelson and Pade Inc, Superior Fresh, Plymouth Springs Fish Co. and AquaBounty have indicated that skilled aquaculture labor is difficult to find, and they are supportive of efforts to increase the pool of qualified applicants for their companies. Corporate sponsorship of the

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competition would allow us to increase the scope and range of the competition. Another source of funding may be the recent infrastructure bill passed by congress. Apparently, a significant amount of money is addressing aquaculture for food security. It remains to be seen how these funds will be made available, but billions are being allocated to aquaculture infrastructure. Also, the Senate Committee on Commerce, Science, and Transportation introduced the bipartisan Advancing the Quality and Understanding of American Aquaculture (AQUAA) Act of 2021. A major goal of the AQUAA Act would fund research and extension services to support innovation and the growth of aquaculture in the United States.

<https://www.commerce.senate.gov/2021/10/wicker-schatz-rubio-introduce-aquaa-act-to-advance-american-aquaculture>

**Outcome:** Long-term funding of the Aquaculture Challenge would benefit the aquaculture industry by increasing the visibility of sustainable aquaculture. Ideally it will also encourage high school students to pursue aquaculture as a career, first by gaining expertise at a post-secondary institution such as LSSU, and later finding employment at an established facility or starting their own aquaculture business.

**Timeline:** Initially I plan to research any new federal funding opportunities for aquaculture. This will likely begin in August-September 2023. Depending on the grant submission deadlines, I will then write grant proposals to address funding for the competition. Beginning also in Fall 2023, I will also contact a variety of aquaculture companies and see if they are willing to be sponsors of the competition. This may involve travelling to the company sites and/or inviting company representatives to LSSU. I am currently an elected member of the North Central Regional Aquaculture Center (NCRAC), one of 5 aquaculture centers established by the US congress to advance the aquaculture industry. I will work with NCRAC industry representatives to ascertain options for corporate support. The work will continue throughout the 2023-24 academic year and beyond.

### **Goal 3) Promote LSSU as a university of choice for aquaculture education, including cannabis aquaponics.**

#### Introduction and Background

We are currently one of a few midwestern universities where students can get hands on training in aquaculture. For over 30 years, the LSSU Aquatic Research Laboratory gave students the opportunity to learn about the Atlantic salmon life cycle from collecting brood stock, fertilizing eggs and rearing the fry and juvenile fish until their release in the St. Marys river. About 10 years ago, a group of LSSU students interested in aquaculture formed a student company called Superior AquaSystems (SAS) LLC. They entered many business plan competitions, and were awarded \$5000 in the Michigan Clean Energy Venture Challenge. They used some of these funds to build a hoophouse on the LSSU campus, as a site for a donated aquaponics system. So, for the past 10 years, students have also had the opportunity to design and redesign an aquaponics system and brainstorm ways to overcome the thermal challenges of hoophouse systems (too hot or too cold). In 2019 the group established themselves as an LSSU club (LSSU Aquaculture) and established the Aquaponics Learning Lab (ALL) in the basement of Crawford Hall. They are also a student subunit of the US Aquaculture Society (USAS) which is a chapter of the World Aquaculture Society (WAS). The Aquaculture Club students maintain the ALL and SAS hoophouse systems and raise money by selling plants and fish that they grow. Although these are great experiences for the students, until recently there was nothing on their academic

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transcripts or on our university website that reflected these activities. Only recently have we developed curricula that gives students academic credit for their experiences. We now have minors in Aquaculture and Aquaponic Production, as well as an Associate of Applied Science degree in Aquaponics Entrepreneurship.

While this gives our current students credit for their work, it is not enough to recruit new students. Ideally, we need a BS in Aquaculture that incorporates the skill needs of the aquaculture industry. Several years ago, the College of Science and the Environment was tasked with developing a BS in Aquaculture that included strengths from both schools in the college. We came up with a draft proposal that included a core of basic biology, chemistry and math; engineering and shop skills; business/marketing and discharge/regulations. Beyond the core requirements, students could choose to specialize in either Salmonid Culture or Aquaponics (see draft below).

**BS Aquaculture (124 credits)**  
**College of Science and the Environment**

<b>BS Aquaculture Core (85 Credits)</b>					
<b>Foundation Courses (24 credits)</b>			<b>Energy/Automation (11 credits)</b>		
BIOL131	General Biology: Cells	4	CSCI105	Intro to Computer Programming	3
BIOL132	General Biology: Organisms	4	CSCI163	Troubleshoot/Repair Personal Computer	3
CHEM115	General Chemistry I	5	EGRS215	Introduction to Robotics	2
CHEM116	General Chemistry II	5	EGNR261	Energy Systems and Sustainability	3
MATH111	College Algebra	3			
NSCI103	Environmental Science	3	<b>Shop skills (6 credits)</b>		6
			BIOL290	Independent Study in (Discipline)	
<b>Business/Marketing (10 credits)</b>			Disciplines: Carpentry		
ACTG132*	Principles of Accounting I	4		Power tools	
BUSN121	Introduction to Business	3		Acrylic/plexiglass	
MRKT281*	Marketing Principles and Strategy	3		Plumbing/pumps	
				Small engines	
<b>Discharge/Regulations (9 credits)</b>				Other as advised	
EVRN311	Environmental Law	3			
EVRN317	Environmental Health Applications	3	<b>General Education (25 credits)</b>		25
EVRN435	Environmental Systems	3			

<b>Salmonid Culture Concentration (39 credits)</b>			<b>Aquaponics Concentration (39 credits)</b>		
NRES250	Quantitative Biology	3	BIOL204**	General Microbiology	4
NRES310*	Ichthyology	3	BIOL232**	Introduction to Aquaponics	4
NRES345*	Limnology	4	BIOL235**	Protected Horticulture	3
NRES372*	Freshwater Fish Culture	3	BIOL315**	Plant Science: Structure and Function	4
NRES389*	Internship in (Aquaculture)	3	BIOL389**	Internship in (Aquaponics Discipline)	3
BIOL389*	Internship in (Fish Health)	3			
<b>Capstone</b>			<b>Capstone</b>		
NRES199	Freshman Seminar	1	BIOL199	Freshman Seminar	1
NRES299	Sophomore Seminar	1	BIOL299	Sophomore Seminar	1
NRES399	Junior Seminar	1	BIOL399	Junior Seminar	1
NRES495	Senior project	2	BIOL499	Senior Seminar	1
NRES499	Senior Seminar	1			
<b>Free electives</b>		15	<b>Free electives</b>		17

\*Aquaculture minor

\*\*Aquaponic Production minor



Unfortunately, a disconnect between the two schools halted discussion of this proposal. As part of this sabbatical, I plan to work with all faculty involved with diverse aspects of aquaculture and attempt to restart these discussion. I also hope to engage CFRE with our vision for aquaculture. There was a previous attempt to bring Superior AquaSystems and the Aquaculture Challenge into the Aquatic Research Lab, but we were told this was not the direction they wanted to go with the ARL. Now that CFRE is focusing heavily on high school education, we may be able to find some common ground. I also recognize that we would benefit from having a full time aquaculture faculty member, but perhaps we can at least get a discussion going about how to proceed. Having an aquaculture program in place may be a way to attract aquaculture faculty.

Aquaponics is also becoming a very successful business model for cannabis production. The fish provide the large quantities of nutrients needed for cannabis production, reducing or eliminating the need for commercial fertilizer. The large volume of water keeps the temperature fairly constant, reducing the need for heating and cooling. Both factors have been demonstrated to greatly reduce the cost of cannabis production when compared with hydroponics systems.

Outcome: A BS in Aquaculture degree will allow us to attract students interested in aquaculture. With the field being one of the fastest growing sectors of the food market, the need for skilled workers is only going to increase. At the same time, we need to encourage innovation in the food production sector, so encouraging the growth of aquaponics is seen as a mechanism to train a new cohort of skilled workers. It's also my hope that a joint degree will help to unify the college to work towards common goals. Additionally, identifying courses that students could take to concentrate in cannabis aquaponics may increase enrollment and retention in a number of our degree programs.

Timeline: Beginning in August 2023, and with guidance from the college dean, I will approach faculty in the college with expertise and interest in developing a 4 year degree in aquaculture and also explore the interest for cannabis aquaponics. We will work to address the skill set needed and also determine if there are gaps in the skill set of our faculty. We will address marketing needs to ensure that information about the programs are widely disseminated. Hopefully we can come to a consensus during the fall semester and submit to the curriculum committee by December 2023. The goal would be to have the Aquaculture degree in place, no later than Fall 2024.

**Goal 4) Complete and submit for publication @6 manuscripts with LSSU student co-authors.**

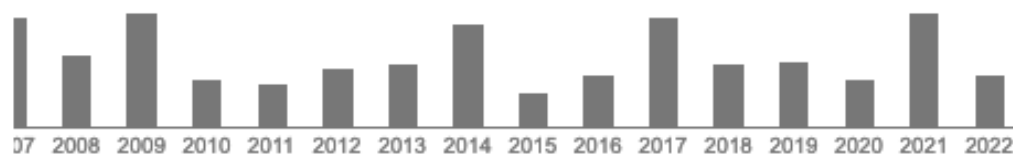
#### Introduction and Background

My interest in aquaculture arose from my research focused on early life history of fish, in particular, the feeding behavior and retinal development of the larval fish. My work was well received with numerous publications and grants to support my research. My Ph.D. dissertation identified a novel "saltatory" search behavior used for detecting cryptic prey.

My Ph.D. advisor published an article using the results of my dissertation. This work is still cited with new species being identified that use this tactic, as well as applications for Artificial Intelligence.

O'Brien, W. J., H. I. Browman and B. I. **Evans**. 1990. Search Strategies of Foraging Animals. American Scientist 78:152-160.

Total citations Cited by 425



My postdoctoral research established connections between the life history strategy of fish, and key developmental events that also occur in human development. Through this work, I gained expertise in histology and molecular biology that I have passed on to many LSSU students. About 10 years ago I realized that globally, we are facing some major issues with respect to future food supply, and that perhaps my studies of eye development could wait. My recent work addressed access to aquaculture education by students and high school teachers, and it feels like we are gaining ground. At the same time, I have still been pursuing some of my larval fish work (for fun), and there are some interesting discoveries that should be published. In particular some novel discoveries of the muskellunge larval retina; the development of the arctic grayling retina and an interesting structure found in the larval sturgeon brain. Most of these projects have included LSSU student researchers, and I hope to be able to publish with them as co-authors. Some potential manuscripts are listed below (\*student author):

Caskey\*, B., B.I. **Evans** and S, Kolomyjec “Manipulating the Aquaculture Microbiome” Note the paper was presented at the Aquaculture 2022 World Aquaculture Society meetings San Diego CA February 28-March 4, 2022

**Evans**, B. I.; Odykirk\*, C., Watson, N. “Foraging behavior of the arctic grayling and implications for the developmental trajectory of the larval retina”. Note the paper was presented at the MIAFS meeting March 16-18, 2022, Sault Ste Marie MI

**Evans**, B.I. (BIOL433\* students) (in prep) “Implications of cone photoreceptor mosaic structures in juvenile and larval muskellunge (*Esox masquinongy*). Note the paper was presented at the MIAFS meeting in 2019 and the AFS Larval Fish meetings in 2020.

**Evans**, B.I.; D. Patrick\*, J. Bauman\* and J. Li “Investigations on Immune-like Cell Clusters in the Larval Lake Sturgeon Brain”. Note the paper was presented at the Fish Health Section, American Fisheries Society, Charlottetown, PEI

Furman-Albin\* A. and B.I. **Evans** “Morphology of Embryonic and Larval Lake Sturgeon. For Environmental Biology of Fishes”. Note the paper was presented at both the Lake Sturgeon Coordination Meeting SSMA MI and MIAFS Higgins Lake MI in 2005

**Marks\***, K. and B.I. **Evans** “An examination of saltatory search behavior in leghorn chicks.”

Outcome: My goal is to finalize all manuscripts listed above, and hope that most are accepted for publication. Specifically, the vision research work has identified an interesting arrangement of cone photoreceptors in the muskellunge retina. The function of this arrangement is unknown, and I have only found reference to it in the Northern pike. My colleagues in vision research say they have never come across this arrangement before. There are also several aquaculture related papers that are on the forefront of the field. Adding these papers to the literature will not only encourage development in these disciplines, but will also reinforce that LSSU is an institution that produces good student centered science.

Timeline: If I am awarded sabbatical, I would start working on these papers over the summer of 2023, and as time permits throughout the 2023-24 academic year.

## Previous sabbatical work

The work I have proposed is ambitious, but I have a good track record of completing the work I set out to accomplish.

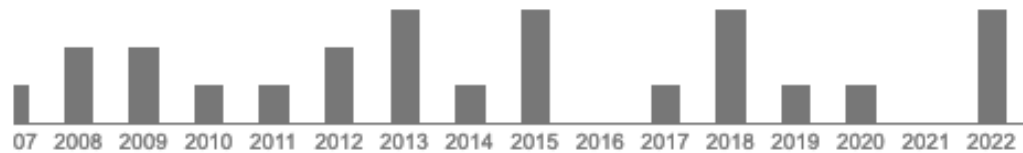
2000: For my first sabbatical, I proposed to pursue funding for a DNA gene analyzer and publish papers from my post-doctoral research. I was successful in both these endeavors being awarded NSF funding for an ABI310 Gene Analyzer in my first proposal.

“Acquisition of DNA Sequencer for Undergraduate Research/Training” (B.I. Evans PI; co PI’s Hansen, Kirkpatrick) Funded 2001-2004 (NSF-0116086) \$133,200.

I also published two review papers on the implications of my research. Both have been well received, and continue to be cited in the literature.

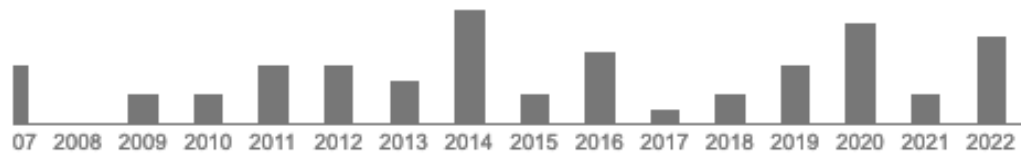
**Evans, B.I.** 2004. A Fish’s Eye View of Habitat Change. In: von der Emde G., Mogdans J., Kapoor B.G. (eds) *The Senses of Fish. Adaptations for the reception of natural stimuli.* Narosa Publishing House, New Delhi, pp 1-30.

Total citations Cited by 26



**Evans, B.I. and H.I. Browman.** 2004 Variation in the Development of the Fish Retina. In: *The Development of Form and Function in Fishes and the Question of Larval Adaptation* (Ed. J. J. Govoni) American Fisheries Society Symposium 40: 145-166.

Total citations Cited by 64



2008: For my second sabbatical I proposed to develop a BS in Fish Health. This was identified by the Michigan DNR as a major skill need in fisheries and aquaculture. In addition to development of the degree, I travelled to the Fish Health Annual meeting in PEI Canada and gave presentations on my research and also showcased LSSU’s degree programs.

**Evans, B.I., D. Patrick\*, J. Bauman\*.** 2008 “Melanomacrophage Aggregates in the Brain of Larval Lake Sturgeon (*Acipenser fulvescens*)” Fish Health Section, American Fisheries Society, Charlottetown, PEI

I also oversaw the faculty search for a fish health researcher and the hiring of Dr. Jun Li, an internationally recognized immunologist. Although the term “fish health” is commonly used in aquaculture, we had difficulty attracting students to this degree, so it is currently suspended. However, our new expertise in this area led the Biology department



to adopt the “One Health” model for the entire biology curriculum. Basically, to be healthy we need clean air and water, good food and healthy livestock to ensure human health. We restructured our Biology degree to include these concepts and created the Animal Biology concentration. The fish/animal health classes are still available and can be selected through this concentration.

The Animal Biology concentration is helping us retain our pre-vet students who still want a career in veterinary science, but will not be accepted to vet school. Typical acceptance rates to vet school are 1 in 20, so many qualified students will not be admitted. Although I was disappointed to see the Fish Health degree suspended, I can see that the work was worthwhile as it led to the Animal Biology concentration. Last fall, our freshman enrollment in Biology is 38% pre-med, 26% pre-vet with another 26% choosing Animal Biology. So clearly, we are attracting students to the Animal Biology concentration.

## CURRICULUM VITAE

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### POSITIONS HELD

- 2006 – present Professor of Biological Sciences, Lake Superior State University (LSSU)
- 2015-2021 Director, Hunt Creek Field Station, Lewiston MI
- 2005-2006 Acting Co-director Aquatic Research Laboratory (ARL) LSSU
- 1997-2006 Associate Professor Biology, LSSU (Tenured 1998)
- 1996- 2000 Department Chair, Department of Biology, LSSU
- 1994-1997 Assistant Professor of Biology, LSSU
- 1991-1993 Postdoctoral Scholar (NRSA/NIH). Stanford University, Neurosciences Program
- 1987-1991 Postdoctoral Fellow (NSERC) University of Oregon, Institute of Neuroscience
- 1990-1991 Guest Investigator, Woods Hole Oceanographic Institution, Environmental Systems Lab, Woods Hole MA
- 1988 Visiting Assistant Professor of Biology, University of Oregon
- 1986-1987 Post-doctoral Research Associate, University of Kansas
- 1986 Post-doctoral Researcher Toolik Lake Arctic Research Station, Alaska
- 1984-1985 Graduate Research Assistant, Toolik Lake Arctic Research Station, Alaska
- 1980-1986 Graduate Research Assistant, University of Kansas
- 1981 Volunteer Research Assistant, Australian Institute of Marine Science (AIMS)
- 1980 Research Assistant, Department of Biology University of Ottawa, Canada

### EDUCATION

- B.Sc. Biology 1980, University of Ottawa, Canada (cum laude)  
Honors thesis: Visual Cues of Prey Recognition in Sunfish, *Lepomis* spp.
- Ph.D. Biology (Systematics and Ecology), 1986, University of Kansas, Lawrence Ks. (honors)  
Dissertation: Strategies and Tactics of Search Behavior in Salmonid and Centrarchid Planktivorous Fish.

### RESEARCH INTERESTS and SKILLS

#### Interests

- Visual sensory physiology related to fish feeding behavior
- Neural retinal development of fish in relation to their visual ecology
- Youth education in aquaculture and aquaponics, workforce development, food security

#### Skills

- Histology: thin sectioning; Light and electron microscopy; Immunocytochemistry; Autoradiography
- Molecular Biology: PCR, DNA sequencing (Sanger and NGS), population genetics, *in situ* hybridization
- Fish Behavior: response to controlled visual stimuli; natural responses to food, predators
- Limnological Research Sampling Methods (water chemistry, plankton, macro-invertebrates, fish)
- Aquaculture (early life history fish rearing, water chemistry monitoring, aquaponics, IPM)

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## FINANCIAL SUPPORT OF RESEARCH (~\$1.7 million at LSSU, ~\$500K in support of aquaculture)

- S.H. Kolomyjec et al. **BI Evans** (senior research personnel). "MRI: Acquisition of a low vacuum scanning electron microscope (SEM) with EDS detector and STEM capability to advance research and undergraduate research training. August 2022-2025 funded \$197,808.
- Shank, A. **Evans, B.I.**, Jescovitch, L., Nelson, E. "Development of Consumer Education Materials on Seafood and Aquaculture. NSERC-NIFA Funded 9/1/2021-8/31/2023. \$225,505.
- "Educating a Workforce for the Aquaculture Industry: Matching Skill Needs of the Aquaculture Industry with US Career and Technical Education (CTE), **B.I. Evans PI**, H. Helal, C. Hartleb, K. Slemmins, D.A. Patillo NSERC-NIFA September 2017 Funded \$188,036
- "Youth Education in Aquaculture" **B.I. Evans** and C. Smith NSERC-NIFA September 2016 \$34,907
- "Recruiting Engineers for Aquaculture Automation", **B.I. Evans** and C. Smith MISTem Partnership Funded May 2016 \$14,575.35.
- "Preventing Symptoms of Iron Loading with Early Diagnosis" L. Meehan and **B.I. Evans** Funds for LSSU Feb 2016 Funded \$1500.
- "Effect of Dietary  $\beta$ -glucan Derived from Algae on Growth Performance, Disease Resistance and Immune Response in Atlantic Salmon Fry" 2015 J. Li and **B.I. Evans** Algal Scientific Funded \$26,746
- "Engaging Active STEM Education through Aquaponics" **B.I. Evans** and S. Glowinski. Michigan STEM Partnership. June 1, 2014-April 30 2015. Funded \$7436.
- "LSSU Aquaculture Project: Startup Venture and Talent Development in Emerging Sector of Michigan Agriculture" **B.I. Evans** PI The Michigan Initiative for Innovation and Entrepreneurship (MIIE): Talent, Innovation & Entrepreneurship (TIE) May 2012-Aug 2013 Funded \$25,000.
- "Biotic Integrity and Habitat Assessment within the St. Marys River AOC. (PI. M. Werner, Co.PI's **B. Evans**, B. Keller, G. Zimmerman). Funded 2004-2007 EPA/GLNPO \$712,500.
- "Population Genetics of Brook Trout in the Ottawa National Forest Drainages". 2004 Challenge Cost-Share Agreement with Ottawa National Forest. **B. Evans** PI Funded \$3000.
- "Acquisition of DNA Sequencer for Undergraduate Research/Training" (**B.I. Evans** PI; co PI's Hansen, Kirkpatrick) Funded 2001-2004 (NSF-0116086) \$133,200.
- "Fostering Undergraduate Scientists through Research and Inquiry (**B.I. Evans** co-PI with Roese, Back and Kirkpatrick) Funded 2000-2003 (NSF-9980685) \$124,734.
- "Retinal Neurogenesis During Metamorphosis" National Institute of Health (NIH) **B. Evans**, Postdoctoral Fellowship Funded 1990-1993 (F32 EY06325-03)
- "Morphological, Physiological and Behavioral Changes in Early Development of the Flounder Visual System. Grass Foundation Fellowship in Neurophysiology. **B.I. Evans** (Post-doctoral) Funded 1990, declined.
- "Development of the Feeding Behavior of Larval Winter Flounder, *Pseudopleuronectes americanus*" Gallager, S.; Stoecker, D; and **B. Evans**, WHOI New Initiative Grant, Funded 1990.
- "Environmental and Behavioral Effects on the Feeding Ecology of Two Planktivorous Fish". NSF Ecology Program, (W. John O'Brien PI; **B.I. Evans**, Co-author and named post-doctoral investigator) Funded July 1988- July 1990. (BSR-8717454)
- "Compromise between Foraging and Vigilance in Plankton Feeding Fish". Natural Sciences Engineering Research Council of Canada (NSERC) **B.I. Evans** Post-doctoral Fellowship Funded 1987-89.

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**PEER-REVIEWED PUBLICATIONS (undergraduate student authors\*)** <http://goo.gl/3VPnWn>

- Caroffino\*, D., A. Mwai\* and B.I. Evans 2011 Population Genetics of Walleye and Yellow Perch in the St. Marys River. *Journal of Great Lakes Research* 37(supplement 2):28-34.
- Turschak\*, B., A. Moerke, and B.I. Evans 2011 Spatial and seasonal changes in the zooplankton community of the St. Marys River. *Journal of Great Lakes Research* 37(supplement 2):21-27.
- Keller, B.J., R.C. Back, J. Westrick, M. Werner, B.I. Evans, A. Moerke, G. Zimmerman, D.D. Wright, D.D. E. Grenfell\*, and J. Courneya\*. 2011 Sediment quality at select sites in the St. Marys River Area of Concern. *Journal of Great Lakes Research* 37(supplement 2):12-20.
- Kirkpatrick, N.S., D. Everitt\* and B.I. Evans (2007) Asymmetric Hybridization of Pink (*Oncorhynchus gorbusha*) and Chinook (*O. tshawytscha*) Salmon in the St. Marys River, Michigan. *Journal of Great Lakes Research* 33:358-365.
- Hoke, K. L., B. I. Evans and R. D. Fernald 2006 Remodeling of the Cone Photoreceptor Mosaic during Metamorphosis of Flounder (*Pseudopleuronectes americanus*) *Brain Behav. & Evol.* 68:241-254.
- Evans, B.I. 2004. A Fish's Eye View of Habitat Change. In: von der Emde G., Mogdans J., Kapoor B.G. (eds) *The Senses of Fish. Adaptations for the reception of natural stimuli.* Narosa Publ., New Delhi, pp 1-30.
- Evans, B.I. and H.I. Browman. 2004 Variation in the Development of the Fish Retina. In: *The Development of Form and Function in Fishes and the Question of Larval Adaptation* (Ed. J. J. Govoni) American Fisheries Society Symposium 40: 145-166.
- Hagedorn, M., A. Mack, B. I. Evans, and R.D. Fernald. 1998. The Embryogenesis of Rod Photoreceptors in the Cichlid Retina, *Haplochromis burtoni*. *Developmental Brain Research* 108: 217-227.
- Evans, B. I. and R. D. Fernald. 1993. Retinal Transformation at Metamorphosis in the Winter Flounder *Pseudopleuronectes americanus*. *Visual Neuroscience* 10:1055-1064.
- Evans, B. I., F. Harosi and R.D. Fernald. 1993. Photoreceptor Spectral Absorbance in Larval and Adult Winter Flounder *Pseudopleuronectes americanus*. *Visual Neuroscience* 10:1065-1071.
- O'Brien, W. J. and B. I. Evans. 1992. Simulation Model of the Planktivorous feeding of arctic grayling: laboratory and field verification. *Hydrobiologia* 240: 235-245.
- O'Brien, W. J. and B. I. Evans. 1991. Saltatory Search Behavior in Five Species of Planktivorous Fish. *Verh. Internat. Verein. Limnol.* 24:2371-2376.
- Evans, B. I. and R. D. Fernald. 1990. Metamorphosis and Fish Vision. *Journal of Neurobiology* 21(7):1037-1052.
- O'Brien, W. J., H. I. Browman and B. I. Evans. 1990. Search Strategies of Foraging Animals. *American Scientist* 78:152-160.
- Browman, H. I.; W. C. Gordon; B. I. Evans and W. J. O'Brien. 1990. Correlation Between Histological and Behavioral Measures of Visual Acuity in a Zooplanktivorous Fish, the White crappie *Pomoxis annularis*. *Brain Behavior and Evolution* 35:85-97.
- O'Brien, W. J., B. I. Evans and H. I. Browman. 1989. Flexible Search Tactics and Efficient Foraging in Planktivorous Fish. *Oecologia* 80:100-110.
- Evans, B. I. and W. J. O'Brien. 1988. A Re-evaluation of the Search Cycle of Planktivorous Arctic Grayling, *Thymallus arcticus*. *Canadian Journal of Fisheries and Aquatic Sciences* 45:187-192.
- Evans, B. I. and W. J. O'Brien. 1986. An Analysis of the Feeding Rate of White crappie. *Developments in Environmental Biology of Fishes* 7:299-306.
- O'Brien, W. J., B. I. Evans and G. L. Howick. 1986. A New View of the Predation Cycle in a Planktivorous Fish. *Can. J. Fish. Aquat. Sci.* 43:1894-1899.
- O'Brien, W. J., B. I. Evans and C. Luecke. 1985. Apparent Size Choice of Zooplankton by Planktivorous Fish: Exceptions to the Rule. *Env. Biol. Fishes.* 13:225-233.

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## PRESENTATIONS AT PROFESSIONAL MEETINGS

- Caskey\*, B., B.I. Evans and S. Kolomyjec "Manipulating the Aquaculture Microbiome" Aquaculture 2022 World Aquaculture Society meetings San Diego CA February 28-March 4, 2022 (Invited talk)
- Evans B.I., E. Nelson and C. Hartleb "Educational supply lines for developing an aquaculture workforce" Aquaculture 2022 World Aquaculture Society meeting San Diego CA February 28-March 4, 2022. (Invited talk plus panel discussion member at conclusion of session)
- Nelson, E. and B.I. Evans "Creating workforce pathways by educating youth through aquaculture" Aquaculture 2022 World Aquaculture Society meeting San Diego CA February 28-March 4, 2022
- Spencer\*, P.Q., Mansell C. and B.I. Evans "Conserving Michigan Waters through Aquaponics" MIAFS meeting March 16-18, 2022 Sault Ste Marie MI
- Caskey\*, B. "Manipulating the Aquaculture Microbiome" MIAFS meeting March 16-18, 2022, Sault Ste Marie MI
- Odykirk\*, C., Watson, N. and B.I. Evans "Retina Development in Larval Arctic Grayling (*Thymallus arcticus*)" MIAFS meeting March 16-18, 2022, Sault Ste Marie MI
- Villeneuve\*, J., Kolomyjec S., and B.I. Evans "The Effect of Atlantic Salmon Life History Stage on the Bacterial Community of Two Northern Michigan Hatcheries" MIAFS meeting March 16-18, 2022, Sault Ste Marie MI
- Evans, B.I. "Planetary Boundaries: Limits to Growth and Possible Solutions. LSSU Library Sustainability Series March 24, 2022
- Evans, B.I. and E. Nelson, 2022 Invited to host the K-12 education session at the joint Wisconsin Aquaculture Association and Minnesota Aquaculture Association conference 2/18-19, 2022 Eau Claire WI (cancelled due to Covid-19)
- Evans B.I. and E. Nelson, 2021 "The Aquaculture Challenge: A Competition to Engage Youth in Aquaculture" Invited MFW Aquaculture Symposium presentation. 81st Midwest Fish & Wildlife Conference, February 3, 2021
- Evans, B.I. "Implications of cone photoreceptor mosaic structures in juvenile and larval muskellunge (*Esox masquinongy*). AFS 1st Larval Fish Virtual Science Town Hall 23 June 2020 **Note:** this paper was one of only 16 talks accepted for the meeting.
- Evans B.I. "Developing an Effective Workforce for Aquaculture" NCRAC 2020 Conference January 29-31, 2020, Columbus Ohio
- Evans, B.I. "Workforce Development Through Youth Education in Aquaculture (YEA)" Wisconsin Aquaculture Association Annual meeting March 5-7, 2020, Marshfield WI
- Evans B.I. "Prevalence of hemochromatosis-associated HFe mutations in the Eastern Upper Peninsula, MI" Medical Lab Sciences & Molecular Genetics Symposium, NMU September 26-28, 2019
- Evans, B. I., W. Van Amberg et al., 2019. Implications of cone photoreceptor mosaic structures in juvenile and larval muskellunge (*Esox masquinongy*). MIAFS Gaylord MI.
- Evans, B.I. and J. Li 2014 "Investigations on the Function of Immune-like Cell Clusters in the Larval Lake Sturgeon Brain" Larval Fish Conference, August American Fisheries Society Quebec City Canada
- Evans, B.I. and J. Li 2012 "Immune Cells in the Brain of Larval Lake Sturgeon" Lake Sturgeon Coordination Meetings. Dec 2012 Sault Ste Marie MI
- Benedict\*, L. N., Knoll, L. J., Hook, K. J., Evans, B., & Garvon, J. (2012). Comparison of *Toxoplasma gondii* cyst localization in mouse neural tissue. Program No. 442.14. 2012 Neuroscience Meeting Planner. New Orleans, LA: Society for Neuroscience, 2012. Online.
- Comben\*, J. and B.I. Evans 2008 "Genetic Study of Lake Sturgeon in the St. Mary's River System" Lake Sturgeon Coordination Meeting Port Huron MI
- Comben\*, J., A. Moerke and B.I. Evans 2008 "Assessment of Lake Sturgeon in the St. Marys River", MI Midwest Fish & Wildlife Meeting

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- Evans, B.I., D. Patrick\*, J. Bauman\*. 2008 "Melanomacrophage Aggregates in the Brain of Larval Lake Sturgeon (*Acipenser fulvescens*)" Fish Health Section, American Fisheries Society, Charlottetown, PEI
- Patrick\*, D. and B.I. Evans 2006 "Melanomacrophage Aggregates in the Brain of Larval Lake Sturgeon" MIAFS Lansing MI.
- Evans, B.I. 2006. Retinal Development and Response to Light in Lake Sturgeon" Larval Fish Conference, American Fisheries Society Sept. Lake Placid NY.
- Furman-Albin\*, A. and B.I. Evans 2005 "Morphology of Embryonic and Larval Lake Sturgeon" MIAFS Higgins Lake MI
- Caroffino\*, D. and B.I. Evans 2004 "Genetic Influence of Stocked Walleye in the St. Marys River. Michigan" Chapter of American Fisheries Society (MIAFS) Marinette WI
- Everitt\*, D. and B.I. Evans 2004 "Asymmetric Hybridization of Pink (*Oncorhynchus gorbuscha*) and Chinook (*O. tshawytscha*) Salmon in the St. Marys River MIAFS Marinette WI
- Furman-Albin\*, A. and B.I. Evans 2004 Morphology of Embryonic and Larval Lake Sturgeon. Lake Sturgeon Coordination Meeting SSMA MI
- Evans, B.I. 2002 "Variation in Development of the Fish Retina" AFS ELHS Larval Fish Conference, July American Fisheries Society Bergen Norway
- Evans, B.I. 2001. "Fate of Proliferating Inner Nuclear Cells (PINC)s When Rods are Scarce". (Association for Research in Vision and Ophthalmology (ARVO Abstr #2054) Invest. Ophthalm. Vis. Sci. 42(4):S381.
- Evans, B.I.; K. Beck\* and R.D. Fernald. 1994 "Thyroxine Effects on Putative Rod Progenitor Cells in the Developing Fish Retina" (ARVO Abstr #1197) Invest. Ophthalm. Vis. Sci. 35(4):1152 (1)
- Evans, B.I. T.L. Kasten, M. Nadal-Vicens and R.D. Fernald. 1993. "PCR Sequence of Larval and Adult Opsin Proteins in Winter Flounder" (Society for Neuroscience, Abstr # 493.9) Soc. Neurosci. Abs. 19:1200.
- Evans, B.I., N. Ong\* and R. D. Fernald. 1993 "Retinal Metamorphosis in Winter Flounder" (ARVO Abstr. #877) IOVS 34(4):877
- Evans, B. I., F. I. Harosi and R. D. Fernald. 1992. "Retinal Morphology and Spectral Absorbance in Larval and Adult Winter Flounder (*Pseudopleuronectes americanus*). (ARVO Abstr. #1836) IOVS 33(4):1059 (2)
- Graf, W., B. I. Evans and S. M. Gallager. 1991. "Vestibular System Development in the Flatfish" Society for Neuroscience, Abstr.#128.2) Soc. Neurosci. Abs. 17:315
- Browman, H. I., W. C. Gordon, B. I. Evans and W. J. O'Brien. 1989. "Correlation Between Histological and Behavioral Measures of Visual Acuity in a Zooplanktivorous Fish, the White Crappie *Pomoxis annularis*. Int. Symp. Fish Vision., Eur. Neurosci. Assoc. Oristano, Sardinia.
- Evans, B. I. and R. D. Fernald. 1989. "Timing of Rod Neurogenesis and Developmental Strategies". ARVO, Sarasota FL.
- Evans, B. I. and W. J. O'Brien. 1989. "Field Test of a Feeding Rate Model of Planktivorous Arctic Grayling". American Society for Limnology and Oceanography (ASLO). Fairbanks, AK.
- O'Brien, W. J. and B. I. Evans. 1989. "Comparison of the Saltatory Search Behavior of 4 Species of Freshwater Zooplanktivorous Fish". Soc. Int. Limnol. Munich, FRG.
- Evans, B. I. and W. J. O'Brien. 1988. "Active Versus Passive Mechanisms of Size Selective Planktivory". Int. Soc. Behav. Ecol. Vancouver Canada.
- Evans, B. I. and W. J. O'Brien. 1987. "Foraging of Planktivorous Fish at High Turbidity and Low Light". American Society for Limnology and Oceanography (ASLO), Madison WI.
- Evans, B. I. and W. J. O'Brien. 1986. "Feeding Rates and Food Preferences in the Arctic Grayling, *Thymallus arcticus*". ASLO, Kingston RI.

## **PROFESSIONAL SOCIETY MEMBERSHIPS and TECHNICAL COMMITTEES**

- North Central Regional Aquaculture Center (NCRAC) Technical Committee/Research Subcommittee
  - Executive Committee for Research Subcommittee grant review
  - Re-elected for third consecutive term Jan. 1, 2022 to Dec 31, 2025
- American Fisheries Society (2001-present)
  - Early Life History Section, Fish Health Section, Fish Culture Section
- Member "US Aquaculture Society (USAS) and USAS Aquaculture Education Committee" (Ad Hoc)
- Member "Michigan Generally Accepted Agricultural and Management Practices (GAAMP) for the Care of Farm Animals" Advisory Committee. My role is related to Aquaculture.
- Member Aquaponics Association (includes US and EU aquaponics society)
- Member Michigan Aquaculture Association

## **TEACHING, CURRICULUM DEVELOPMENT and SYNERGISTIC ACTIVITIES**

### **Awards and Recognition**

- 2007 Michigan Distinguished Professor of the Year, nominated by LSSU for 2007 Honoring faculty providing undergraduate education of the highest quality. (President's Council State Universities of MI)
- 1990-1993: National Eye Institute/National Institute of Health, NRSA Postdoctoral Fellowship
- 1990: Grass Foundation Post-doctoral Fellowship in Neurophysiology, MBL Woods Hole MA declined
- 1987-1989: NSERC Post-doctoral Fellowship (Canada)

### **Courses Developed and Taught at LSSU and University of Oregon\***

- Introduction to Aquaponics BIOL232
- Animal Physiology BIOL330
- Histology BIOL433
- General Biology I Cells BIOL131
- Survey of General Biology BIOL104
- Histotechniques BIOL300
- Animal Behavior BIOL405, BL124\*
- Limnology BIOL445
- Aquatic Entomology BIOL275
- Ichthyology BIOL310
- Controversy (and the Freedom to Question) HONR101
- Sophomore Seminar BIOL299
- Environmental Science NSCI103/104
- Scientific Literacy BIOL300

### **Curriculum Development**

- Aquaculture minor
- Aquaponics Production minor
- Aquaponics Entrepreneurship AAS
- One Health concentrations for Biology: BS Biology (Animal Biology), BS Biology (food and Ecology)



- **BS Fish Health:** The Michigan DNR was concerned about the increases in disease outbreaks in wild and hatchery raised fish. They are also concerned that few universities train students in aquatic animal medicine. Looking at our programs, I realized we could create a hybrid between our BS Fisheries Management degree and our BS Medical Laboratory Science degree to create the BS in Fish Health. This was the only undergraduate degree of it's kind in the country, and we are being asked for advice in this area from as far away as China. The degree meets the academic requirements for an American Fisheries Society certified Fish Pathologist. (Note due to low enrollment the degree was suspended, however we expanded the scope to include all animals as an Animal Biology concentration in Biology.
- **AD Marine Technology:** I was asked to develop a degree in Marine Technology, to allow the local Coast Guard staff to be able to get an academic degree during the stationing in Sault Ste Marie.
- **BS Biology Secondary Education:** In 2002, I took on the task of developing a DA specialty teacher education program in Biology. The program is currently on hold, as we assess the need for teachers with a more general integrated science certification. We are now discussing realigning the degree with DI test objectives.
- **Environment and Society Minor:** Students in my Environmental Science class indicated a desire to bridge disciplines of sociology and environmental science. I worked with faculty across campus to address the gap between science and non-science majors in solving environmental problems. We created a minor that allows students to complete a course of study in environmental science, economics, political science and sociology. A capstone senior seminar course brings together disciplines across campus to discuss the issues facing society.

### Synergistic Activities

- **Tall Ship Program :** From 2010-2013, I coordinated the offering of LSSU classes on board the tall ship Inland Seas. We have offered classes in Archeology, Native American Culture, Great Lakes Ecology, Oceanography, and Boat Handling and Navigation. Students lived on the boat for 4-5 days as part of the class. This was described as an amazing Study Aboard experience in MI.
- **Superior AquaSystems LLC:** In the fall of 2011, I began advising an interdisciplinary group of students who are developing a prototype for sustainable aquaculture. The students are from diverse disciplines including engineering, business, fish health, and biology, and have been pitching their business ideas at a number of statewide competitions. To date they have won the judges choice award at the Michigan Clean Energy Venture Challenge in 2012; have been in the semi-finals of the Accelerate Michigan Innovation Competition student section for 3 straight years and this year qualified to participate in the Michigan Collegiate Innovation Prize competition. They have attracted funds from donations and grants and are building a prototype on the LSSU campus inside a hoop house, which they also constructed. The project has continued and the students are now also involved in the Youth Education in Aquaculture project, and the Aquaculture Challenge, modeled after FIRST Robotics.
- **Michigan Arctic Grayling Initiative:** I am working with Nicole Watson a graduate student at MSU, to characterize the development of the grayling retina from hatching. This continues my postdoctoral work with arctic grayling in Toolik Lake Alaska. Nicole has raised the fish from eggs, and has preserved the fish for me to thin sections and analyze the developmental timetable in conjunction with the behavior.
- **LSSU Aquaculture Club:** The students of Superior AquaSystems organized as an official club in the Fall of 2019. In the Fall of 2020, they were invited to become a student sub-unit of the US Aquaculture Society. Their application was accepted in early 2021, and they received \$500 as a stipend. They used these funds to replace the two layers of plastic on the SAS hoop house.

## LSSU UNIVERSITY SERVICE

- LSSU Aquaculture Club, faculty advisor 2019-present
- Chair, Steering Committee for Hunt Creek Field Station 2015-2021
- Co-Chair LSSU Shared Governance Infrastructure Committee, Term 2013-2016
- Biomedical Summer Camp (co-taught 1 week camps) 2005-present
- Careers in Natural Resources Summer Camp-coordinator 2016-present
- Superior AquaSystems LLC, faculty advisor 2011-present
- Individualized Study Committee member 1995- present
- Project Kaleidoscope F21 Faculty for the 21<sup>st</sup> Century- 1999- present
- Institutional Animal Care and Use Committee (IACUC) member 2000- present
- LSSU Faculty Association Executive committee, member at large- 2004-05
- University Sabbatical Committee- 2002-2003
- Environmental Awareness Club, faculty advisor 1995-2008
- Ad Hoc Committee for Faculty Enhancement 2002
- Essential Faculty Committee- 2001
- University Curriculum Committee- 1995-96
- Core Science and Social Science Course Committee- committee chair 1996
- Recycling Committee- 1995- 97
- Crawford Hall Renovation Committee- 1995-96

## PUBLICATIONS IN PREPARATION

**Evans, B. I.** (in prep) Foraging behavior of the arctic grayling and implications for the developmental trajectory of the larval retina.

**Evans, B.I.** (in prep) "Implications of cone photoreceptor mosaic structures in juvenile and larval muskellunge (*Esox masquinongy*). Note the paper was presented at the MIAFS meeting in 2019 and the AFS Larval Fish meetings in 2020.

**Evans, B.I.** and **J. Li** Investigations on Immune-like Cell Clusters in the Larval Lake Sturgeon Brain  
**Furman-Albin A.** and **B.I. Evans** Morphology of Embryonic and Larval Lake Sturgeon. For Environmental Biology of Fishes

**Marks, K.** and **B.I. Evans** An examination of saltatory search behavior in leghorn chicks.

**Evans, B.I.** and **R.D. Femald.** Thyroxine Effects on Putative Rod Progenitor Cells in the Developing Teleost Retina (*Pseudopleuronectes americanus*)

**Evans, B. I.** and **W. J. O'Brien.** The Search Cycle and Energy Budget of White Crappie and Bluegill: A Discussion of Habitat Partitioning. Limnology and Oceanography (in revision)

## MANUSCRIPT REVIEWER

- Journal of Morphology
- Environmental Biology of Fishes
- Journal of Comparative Neurology
- Visual Neuroscience
- Marine Ecology Progress Series
- Canadian Journal of Fisheries and Aquatic Sciences
- Journal of Comparative Physiology-A
- Transactions of the American Fisheries Society
- Journal of Fish Biology

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## Description of Sabbatical Project

- *Project Description: A detailed description of the sabbatical project with the following sections:*
  - *Introduction:* Provide an introduction to the topic/field of study.
  - *Background:* Provide information regarding previous work/activities related to the project.
  - *Outcome:* Describe the work to be completed and state the specific outcome(s) of the project. This section must address at least one of the following.
    - i. The strength of the relationship between the sabbatical leave proposal involving applied or theoretical research related to professional activities and the advancement of knowledge within disciplinary areas.
    - ii. The strength of the relationship between the sabbatical leave proposal involving an external, professionally-related experience/study in a business, industrial, health care, scientific or educational setting and the improvement of instructional/professional activities at the University.
    - iii. The strength of the relationship between the sabbatical leave proposal involving travel or advanced study and its yield in improving the quality of instruction at the University.
  - *Timeline:* Provide a timeline for the proposed project activities.