Optimization of Feed and Stocking Density for Early Life Stages of Golden Shiner (*Notemigonus crysoleucas*) in Indoor Aquaculture with Integration into STEM Education

Theme A: RAS 1) larval feed & care 2) education - youth

Chairperson: Amy Schrank, University of Minnesota Sea Grant

Co-Investigators: Julianne Grenn, University of Minnesota Sea Grant
Donald Schreiner, University of Minnesota Sea Grant
Emma Hauser, Wisconsin Sea Grant / University of Wisconsin- Stevens Point Northern Aquaculture Demonstration Facility
Allen Pattillo, Aquaculture IQ, LLC

Extension Liaison: Julianne Grenn

Industry Liaison: Marc Tye

Funding Request: $269,796

Duration: 1 January 2026 to 31 December 2027

Objectives:

1. Determine the most effective method to transition Golden Shiner (GOS) sac fry to commercially available dry feeds.
2. Determine which commercially available feed provides optimal growth to post-feed-trained GOS fry.
3. Determine what density of GOS feed-trained fry in tanks provides optimal growth, survival, and production.
4. Demonstrate grow-out of post-feed-trained GOS fry in a production sized recirculating aquaculture system (RAS).
5. Work with middle and high school teachers and students to grow GOS in the classroom and engage students in collecting data that directly support the project.

Proposed Budget:

Institution/Company	Principal Investigator(s)	Objectives	Year 1	Year 2	Total
University of Minnesota Sea Grant (MNSG) (MN)	Amy Schrank, Julia Grenn, Don Schreiner	1-5	$114,003	$113,037	$227,040
Wisconsin Sea Grant, University of Wisconsin - Stevens Point, Northern Aquaculture Demonstration Facility (WI)	Emma Hauser	5	$7,292	$7,515	$14,807
Aquaculture IQ, LLC (IA)*	Allen Pattillo	5	$15,350	$12,599	$27,949
Totals		1-5	$136,645	$133,151	$269,796

*****Note that the numbers in this table differ from our final budget because the supplies, travel, and contract that will support the work of Aquaculture IQ, LLC in Iowa are embedded within the MNSG budget. We have separated funds in this table to show the funding requested for each state.*

Project Summary

In the North Central Region (NCR), demand for Golden Shiner (GOS), *Notemigonus cryloseucas*, used as bait exceeds production. For example, GOS production in Minnesota has decreased by approximately 37,854 L (10,000 gallons) or 36,287 kg (80,000 pounds) from 2018 to 2022. Bait importation is prohibited in Minnesota to prevent the introduction of aquatic invasive species and fish pathogens. However, pressure to allow importation is increasing. Bait production throughout the NCR is challenged by declines in wild minnow populations, a short growing season, spread of invasive species, and increasing regulations that restrict wild harvest.

A solution to these challenges is to transition from wild harvest to indoor production in recirculating aquaculture systems (RAS) or aquaponic systems. Recent work by Minnesota Sea Grant (MNSG) has shown that raising GOS fully or partially indoors allows growers to produce market sized fish within eight to ten months instead of the two years required in unmanaged ponds. We propose **to increase the efficiency of indoor production by experimenting with early life stage feeds and determining optimal fish density for GOS grown indoors.** In addition, **we will develop an outreach program engaging middle and high school teachers and students in baitfish aquaculture.**

Justification

The Golden Shiner (GOS), *Notemigonus crysoleucas*, is a native minnow species in the NCR, has been used as a forage or bait species since at least the early 20th century (Stone et al. 2016), and rates among the top three baitfish sold in the NCR (Meronek et al. 1997). Within the region, the primary production method is to harvest GOS and hold them in ponds (either fed or unfed) for grow-out and eventual sale. A major challenge for growing wild GOS in the NCR is that the growing season is short (120-150 days) and it generally takes two years for GOS to reach market size in ponds, especially in northern parts of the region. In contrast, in Arkansas, supplier of the majority (> 75%) of GOS in the United States (USDA NASS 2023), growers have a 180-day culture season and can grow GOS to market size in a single year. The extra time needed to produce market sized fish in the NCR increases the time fish are exposed to risks such as extreme temperature conditions and bird predation (Gunderson and Tucker 2000, Engle et al. 2021).

There has been a shortage of GOS in the NCR for many years despite a high demand for this species (Meronek et al. 1997, Gunderson and Tucker 2000, MNDNR 2024). Reasons for this shortage include the prohibition of bait importation into Minnesota (Gunderson 2018), and in all states, increasing restrictions on wild harvest of baitfish because of private land ownership, the increasing spread of aquatic invasive species, and concern about wild bait populations (Gunderson and Tucker 2000). In states where bait importation is allowed, GOS shortages occur annually following the month of March because of the reduction in hauling of bait from Arkansas into the NCR due to a low GOS survival rate induced by a combination of handling and high temperatures (Meronek et al. 1997, Gunderson and Tucker 2000).

GOS are a relatively high value species with an average price of $13.10/kg ($5.93/lb) according to the 2023 census of aquaculture (USDA NASS 2024) and even higher wholesale values reported from the Midwest at $19-$22/kg ($9 - $10/lb, Tye 2013). Size of fish sold is important to consider in price. For example, current (September 2025) prices at Anderson Minnow Farm in AR for 8 cm (3 in) GOS are $176 per kg ($80/lb, andersonminnows.com). Current producers in the NCR indicate that prices can be as high as $386/kg ($175/lb) or $1.50 for 8 cm (3 inch) fish (see Tye letter of support). Because of their high value and high demand, indoor production of GOS has been suggested as an option to increase GOS supply in the NCR. However, additional research is needed to refine indoor production methods to provide GOS farmers with science-based information to make more informed husbandry decisions and encourage new producers to enter the market (Gunderson and Tucker 2000, MNDNR 2024). Moving toward indoor aquaculture production of GOS can relieve high harvest pressure on wild populations, increase supply while avoiding importation risks, and help mitigate bait shortages throughout the region. There are technical knowledge gaps that need to be resolved to improve indoor production methods for producers and these include aspects of raising GOS indoors at the fry stage that we address in this proposal.

Because GOS are tolerant of a wide range of water quality parameters (Stone et al. 2016) and can be grown indoors beyond the larval stages in tanks (Melandri et al. 2008), this species is a good candidate for use as a teaching tool in classrooms. Consumer research suggests that aquaculture is not a familiar concept in the NCR (Witzling et al. 2020,

Runge et al. 2021) and producers have indicated that consumer education is needed to advance the industry (Peterson et al. 2005, Moen et al. 2017, NCRAC 2020, 2023). Therefore, using GOS aquaculture as a teaching tool in middle and high school classrooms is an optimal way to introduce the concept of aquaculture and more specifically bait farming to future consumers and potential farmers. We propose to provide lesson plans, technical support, system materials, and feed-trained fish to teachers in three states to support their use of GOS aquaculture in the classroom.

Related Current and Previous Work

Past research has shown that indoor spawning and egg collection of GOS is possible (Morrison and Burtle 1989, Tye 2013, Stone et al. 2016). GOS are fractional spawners, releasing small batches of eggs continuously over an extended spawning season (Stone et al. 2016). If appropriate environmental conditions are maintained, egg production can occur continuously. For example, Clement and Stone (2010) found that in indoor pools, approximately 2.75 million eggs were produced by ≤ 200 broodfish over 111 days (March - July) and egg production increased with increasing water temperature. Other researchers have also successfully spawned GOS in indoor tanks (Rowan and Stone, 1995, Morris et al. 2010, Tye 2013).

Feeding GOS larvae in indoor tanks has been a bigger challenge due to their small mouth gape, their adaptation to live feed in the wild, and limitations of formulated feeds available for early life stages (Stone et al. 2016). Rowan and Stone (1995) achieved survival rates up to 46% seven days post-hatch for GOS held in tanks and fed a formulated diet, though researchers did not track growth or survival beyond seven days. Kent (2009) tested a variety of formulated diets fed to GOS from day one post-hatch to day 14 post-hatch and reported survival rates ranging from 1-28%; however, survival rates declined after 10 days. Tye (2013) had success feeding larval GOS with non-hatching decapsulated brine shrimp cysts and showed that newly hatched fry had survival rates of 71-100% at the end of 32 days, indicating that feed training of larval GOS indoors is possible. More research is needed on what specific diets optimize growth and survival of GOS fry.

In addition to larval feeding, information on appropriate larval tank densities that optimize both growth and production of GOS is limited. Densities in past feed studies vary widely. Hickman and Kilambi (1974) indicated that the highest individual growth of GOS fry in tanks occurred at the lowest density they tested (0.09 fry/L or 0.3 fry/gallon) but that the highest production occurred at 0.12 fry/L (0.5 fish / gallon). Roseberg and Kilambi (1975) determined that lower stocking densities of GOS in tanks showed higher growth rates and estimated that (0.09 fry/L or 0.3 fry/gallon) was the most appropriate density. Gatlin and Phillips (1988) use a density of 0.3 fish per L for their feed study. In contrast, Rowan and Stone (1995) stocked GOS at a density of 50 fry/L for their feed study, and Kent (2009) stocked fry at 8-40 fry/L. It should be noted that many past feed studies in tanks used GOS destined for pond grow-out. Determining appropriate fish density for growing larvae through early life stages and beyond in indoor systems is needed.

The Minnesota GOS Demonstration Project (Schreiner and Schrank 2024) is the most recent example of work in the NCR exploring how best to increase GOS production in one year. This project examined four strategies to increase GOS production including growing GOS in: 1) a RAS, 2) an aquaponic system, 3) constructed ponds stocked with sac-fry and 4) constructed ponds stocked with feed-trained fry. Preliminary results were encouraging, indicating that each strategy could produce market size GOS (6.4 to 10.2 cm or 2.5 to 4 inches) in eight to ten months. Information gaps revealed by this project were that to raise GOS indoors for part or all their life cycle, more specific information on larval feeds and rearing conditions (especially fish density) are needed. Consequently, the current proposal explores larval rearing requirements that optimize growth and production of GOS in RAS so producers can increase efficiency when scaling up indoor production in the NCR.

In addition to larval GOS research, producers, distributors, and retailers of seafood often express the need to introduce K-12 students to aquaculture to increase understanding and increase social license for aquaculture (Moen 2017, NCRAC 2020, 2023). Aquaculture is an ideal tool to teach STEM (science, technology, engineering and math) principles such as agriculture, biology, engineering, nutrition, chemistry, business/economics, technology, and food systems through hands-on, project-based learning (Conroy et al. 2000, Correia et al. 2020, Genello et al. 2015). Through recent NCRAC efforts, there are aquaculture materials now available to teachers for their students (MSNG 2024, Jescovitch-Stigers et al. *in revision*). However, many teachers need hands-on, individual support to build systems and having extension agents consult directly with teachers will help build this capacity. To introduce

aquaculture concepts to teachers and students, we will collaborate with schools in three NCR states (IA, MN, WI) to build classroom aquaculture/aquaponic systems, grow GOS, and encourage students to collect data on their fish.

Statement Regarding Duplication of Research

The USDA Current Research Information System (CRIS or REEport), the National Sea Grant Office funding page and NOAA Office of Aquaculture funding opportunities page were consulted to avoid duplication of previous research. We confirm that the proposed work is original research and does not duplicate any previously funded projects in the databases consulted. The main key words used in the search included: Golden Shiner, bait production, and larval feeding.

Anticipated Benefits

We anticipate our project will have the following **benefits** in the NCR.

Short-term benefits:

- Increase producer understanding of feed training larval GOS in indoor facilities
- Increase producer knowledge about best feed/density choices for early GOS life stage growth and production
- Increase understanding among producers about how to increase GOS production in RAS
- Increase understanding and knowledge of middle and high school students and teachers about aquaculture and the bait industry
- Increase the ability of teachers to use aquaculture to teach STEM topics

Medium-term benefits:

- GOS producers are increasingly interested in indoor GOS production
- Indoor GOS production becomes more accessible to producers
- Students and teachers understand what aquaculture is and the importance of baitfish aquaculture in their state
- Students and teachers understand how aquaculture systems work
- Students and teachers are more accepting of fish of all types produced by aquaculture

Long-term benefits:

- Increase GOS bait production in the North Central Region (NCR)
- Increase the capacity for producers to grow GOS indoors
- Reduce bait shortages in the NCR
- Increase aquaculture literacy among teachers and students
- Increase social license for aquaculture

Objectives

1. Determine the most effective method to transition GOS sac fry to commercially available dry feeds.
2. Determine which commercially available feed provides optimal growth to post-feed-trained GOS fry.
3. Determine what density of GOS post-feed-trained fry in tanks provides optimal growth, survival, and production.
4. Demonstrate grow-out of post-feed-trained GOS fry in a production sized RAS.
5. Work with middle and high school teachers and students to grow GOS in the classroom and engage students in collecting data that directly support the project.

Deliverables

1. A report detailing the results of our GOS feed and tank density studies aimed at producers
2. A report detailing the results of our GOS grow-out in RAS using our findings on optimal feed type(s) and tank density aimed at producers

3. At least one manuscript describing the results of our feed and tank density studies to be submitted to a peer reviewed journal
4. A video or recorded webinar describing the results of our feed and tank density studies and how producers can best use these results
5. Two to three presentations at state aquaculture meetings and one presentation at a NCRAC and national aquaculture conference
6. Three to five lesson plans aligned to Next Generation Science Standards (in each state) related to growing GOS in aquaculture systems
7. A series of teacher professional development videos addressing how to build, manage, and troubleshoot an aquaculture/aquaponic system for the classroom
8. Delivery of tours to teachers and students at the MNSG Aquaculture Lab and University of Wisconsin - Stevens Point (UWSP) Northern Aquaculture Demonstration (NADF) facility to learn about different types of commercial aquaculture systems

Procedures

Objective 1: Determine the most effective method to transition GOS sac fry to commercially available dry feeds. One major challenge to indoor production of GOS is the transition of sac fry to dry feed (Tye 2013). We will acquire GOS sac fry from Tye Fish Solutions in MN and test three to five different types of commercially available feeds using a combination of live (rotifers and artemia) and dry feeds in replicated flow through tanks. We plan to focus on commercially available feeds in the NCR (brands such as Otohime, Skretting, Ziegler, other local companies, etc.) so the results from this work will be applicable to local producers. This work will build on early research by Tye (2013) who showed that GOS survived for 32 days on a diet of decapsulated brine shrimp. We will use three to four replicates for each of three to five feed types (Figure 1) in two sets of four-week trials. After feed trials are complete, data collected will include growth, condition, feed amount, survival, and production.

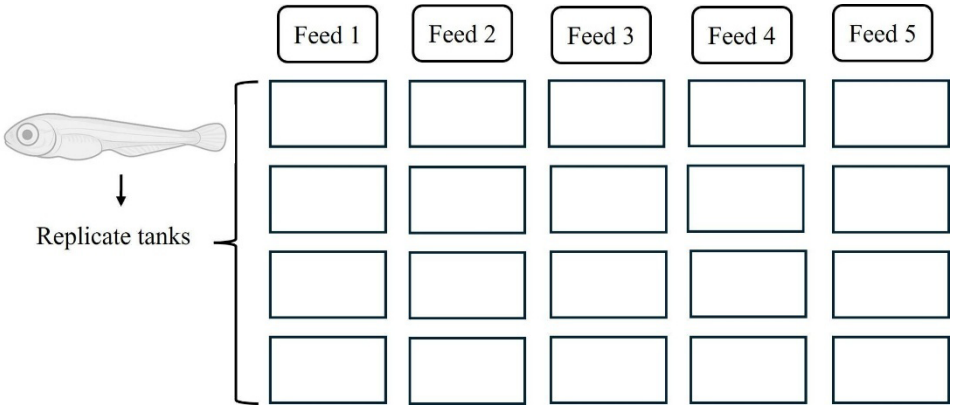


Figure 1. Diagram indicating project experimental design testing five feed types for GOS sac fry. We will conduct two four-week trials based on this design.

Personnel: PI Schrank and co-PI Grenn will be responsible for this objective and will supervise the graduate student in completing this project. The aquaculture extension associate will be responsible for directing the lab set up and assisting the graduate student with fish lab logistics. We will consult with our industry liaison about feed recommendations and sourcing. Co-PI Schreiner will help direct this objective by providing input based on previous GOS research and industry producers.

Objective 2: Determine which commercially available feed provides optimal growth to post-feed-trained GOS fry. Once fry are feed-trained, producers struggle to determine what feeds work best for early rearing of GOS indoors. To address this common need, we will acquire feed-trained GOS fry from Tye Fish Solutions in MN. Three to five types of commercially available feed will then be tested to determine which results in the best growth, survival, and production of the post-feed-trained fry. We will focus on feeds that are commercially available in the NCR with advice from our industry liaison so the results from this work will be applicable to local producers. We will use three to four replicates for each of three to five feed types for two four-week trials (Figure 2). Data collected will include growth, condition, feed amount, survival, and production.

Personnel: PI Schrank and co-PI Grenn will be responsible for this objective and will supervise the graduate student in completing this project. The aquaculture extension associate will be responsible for directing the lab set up and assisting the graduate student with fish lab logistics. We will consult with our industry liaison about feed recommendations and sourcing. Co-PI Schreiner will help direct this objective by providing input based on previous GOS research and industry producers.

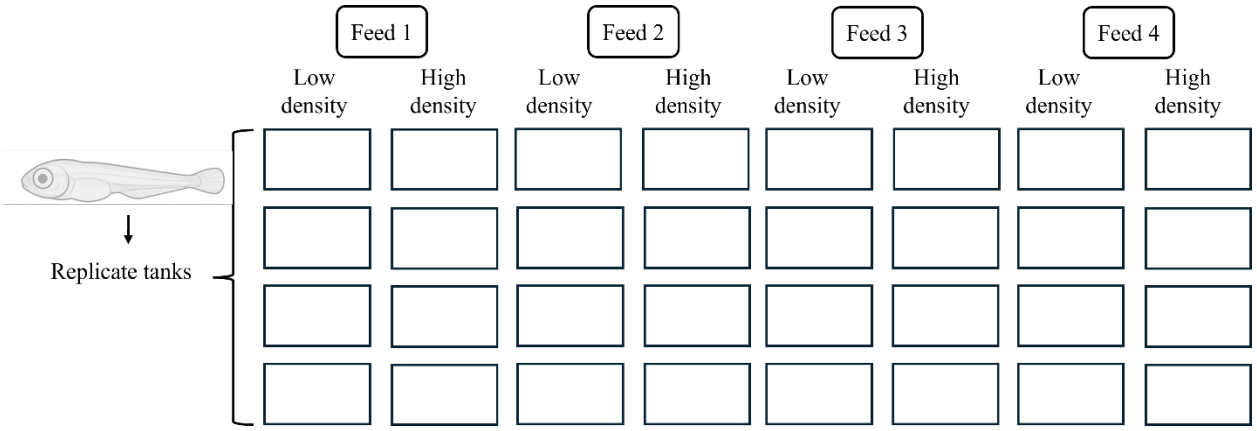


Figure 2. The anticipated experimental design for objectives two and three is shown. This example illustrates an experiment with four feed types and two fish densities with four replicate tanks per variable.

Objective 3: Determine what density of GOS fry in tanks provides optimal growth, survival, and production.
In addition to feed questions, producers do not have reliable information to determine what stocking density maximizes production of GOS larvae. To address this objective, we will include different fish densities in our feed study described in objective two. We will replicate our feed trials with both low and high densities of GOS in flow through tanks (Figure 2). Tank densities will be based on previous work examining GOS feeding rate and survival for pond grow-out and early work on tank production ranging from approximately 1 fry/L to 50 fry/L (Hickman and Kilambi 1974; Roseberg and Kilambi 1975, Rowan and Stone 1995; Kent 2009; Stone et al. 2016). Data collected will include growth, condition, survival, and production.

Personnel: PI Schrank and co-PI Grenn will be responsible for this objective and will supervise the graduate student in completing this project. The aquaculture extension associate will be responsible for directing the lab set up and assisting the graduate student with fish and lab logistics. We will consult with our industry liaison about feed recommendations and sourcing. Co-PI Schreiner will help direct this objective by providing input based on previous GOS research and industry producers.

Objective 4: Demonstrate grow-out of post-feed-trained GOS fry in production sized RAS.
Once we have determined what the most successful combination of GOS feed and density are for post-feed-trained fry, we will continue to grow fish out using this combination of variables in two larger RAS facilities. One system will be located at the University of Minnesota, and the second will be located at a private aquaculture farm, Aquatic Resource Management, an industry partner in Manning, IA. During grow-out in these systems, we will monitor growth, feed amount, and time to reach market size. We will determine total production at harvest.

Personnel: PI Schrank, co-PI Grenn, and the aquaculture extension associate will be responsible for grow-out and data collection of GOS in Minnesota at the MNSG Aquaculture Lab. Co-PI Pattillo will be responsible for ensuring grow-out and data collection of GOS at Aquatic Resource Management in Manning, IA. All personnel will contribute to report development.

Objective 5: Work with middle and high school teachers and students to grow GOS in the classroom and engage students in collecting data that directly support the project.
We will work with schools in Minnesota (three or more schools), Wisconsin (eight schools), and Iowa (up to five schools) to equip teachers and students in their classrooms with the materials they need to grow GOS in aquaculture or aquaponic (Figure 3) systems and collect data from these systems. Classrooms will be provided with feed-trained

fry that students will grow out to market size (6.4 to 10.2 cm or 2.5 to 4.0 inches). Students will collect data that might include feed amount, fish density, water quality, and growth. In addition, teachers and students will learn about the production of baitfish in their state and how aquaculture contributes to recreational fishing. Finally, all teachers and students will have access to technical expertise through our extension project partners in each state.

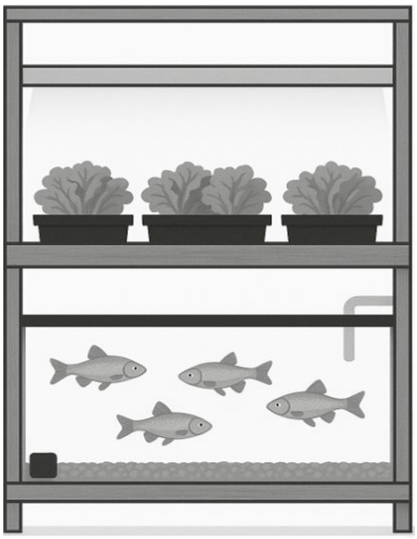


Figure 3. Example aquaponic system that will be used for Iowa schools. These aquaponic systems will consist of a 170 to 208 L (40 to 55 gallon) glass fish tank, flood and drain grow beds, clay pellet growing media, pumps and plumbing, grow light, and a wooden structure to house the

Support for teachers and classrooms will be provided throughout the school year through both virtual and in-person visits to schools in each state. This support will include technical assistance to build new aquaculture systems or renovate current systems for rearing GOS, help preparing systems for fish, and delivery of fish to schools. Regular meetings throughout the school year will be organized to provide additional technical assistance as well as gather data on GOS performance (growth and survival) raised in the different school systems. These meetings will also connect schools so students and educators can share their experiences and findings. Importantly, incorporation of aquaculture into curricula will be guided by extension agents/consultants (Grenn, Hauser, and Pattillo) and industry partners with technical expertise to support teacher and student success. We will also connect teachers to additional resources for aquaculture education including the regional Aquaculture Challenge program (https://seagrant.umn.edu/programs/education-and-workforce-development-program/aqua-challenge), aquaculture resources from previous NCRAC work (MNSG 2024), and other aquaculture education activities through the Great Lakes Aquaculture Collaborative (GLAC, https://greatlakesaquaculture.org/).

Pattillo will lead the curriculum development component of this objective, provide professional development for teachers, and create 3-5 lesson plans that meet Next Generation Science Standards that will be customizable by state. The teacher training will include 1) building the aquaponic system, 2) conditioning the water and starting the biofilter, 3) acclimating, quarantining, and introducing fish, 4) fish feeding practices and data recording, 5) measuring, recording, tracking, and interpreting water quality data, 6) starting plants for aquaponics from seed, 7) seedling care and transplanting into the grow-beds, 8) plant care, pest and disease monitoring, and nutrient deficiency diagnosis and treatment, 9) harvesting produce with food safety in mind, and 10) how to shut down the system for summer break. Pattillo will record these lessons on Zoom, make them accessible via captioning, and make them available to teachers and on the websites listed above. Lesson plans will be on topics relevant for and desired by teachers and appropriate for the grade level. Potential lesson plan topics include 1) the water cycle, 2) the nitrogen cycle, 3) aquatic ecology, 4) trophic levels, 5) photosynthesis and cellular respiration, 6) soil and sustainable agriculture, 7) the scientific method, 8) fish life cycle, 9) plant life cycle, 10) genetic selection and improvement, 11) GOS and bait production. Pattillo will incorporate teachers, particularly Jim Blankman, into the planning and development of curriculum. Additional resources provided will include the Iowa State Extension video library for aquaponics, presentation slides, and recorded lessons. All curriculum and additional materials will be made available through the MNSG, UWSP NADF, and NCRAC websites. We will also investigate sharing through the Extension Foundation web portal.

Personnel: co-PIs Grenn (MN), Hauser (WI), and Pattillo (IA) will oversee objective five and connect with teachers and classrooms in their respective states. Pattillo will lead curriculum development, ensure it aligns with Next Generation Science Standards that will be customizable for each state, and ensure that curriculum is shared with the full team. Our extension liaison (Grenn) will collaborate on material creation and dissemination. All personnel working on this objective will ensure that their programs are evaluated within each state and that resulting outreach materials are shared at the venues described above.

Outreach and Evaluation Plan

To ensure our GOS larval rearing results reach producers, once our experiments are completed and data are analyzed, we will develop a public facing report and short video or recorded webinar detailing our findings regarding larval feed and fish density. We will develop a similar report detailing the results of GOS grow-out in our RAS. We will also develop a manuscript for publication in a peer reviewed journal to report our results to the research community. In addition, we will post project products on social media to increase our reach to the public and other communities. Our report and other outreach materials will be shared on the MNSG and UWSP NADF websites and the NCRAC website if appropriate. Outreach materials will also be shared with all state aquaculture associations in the NCR and we will present our results at state and regional aquaculture conferences.

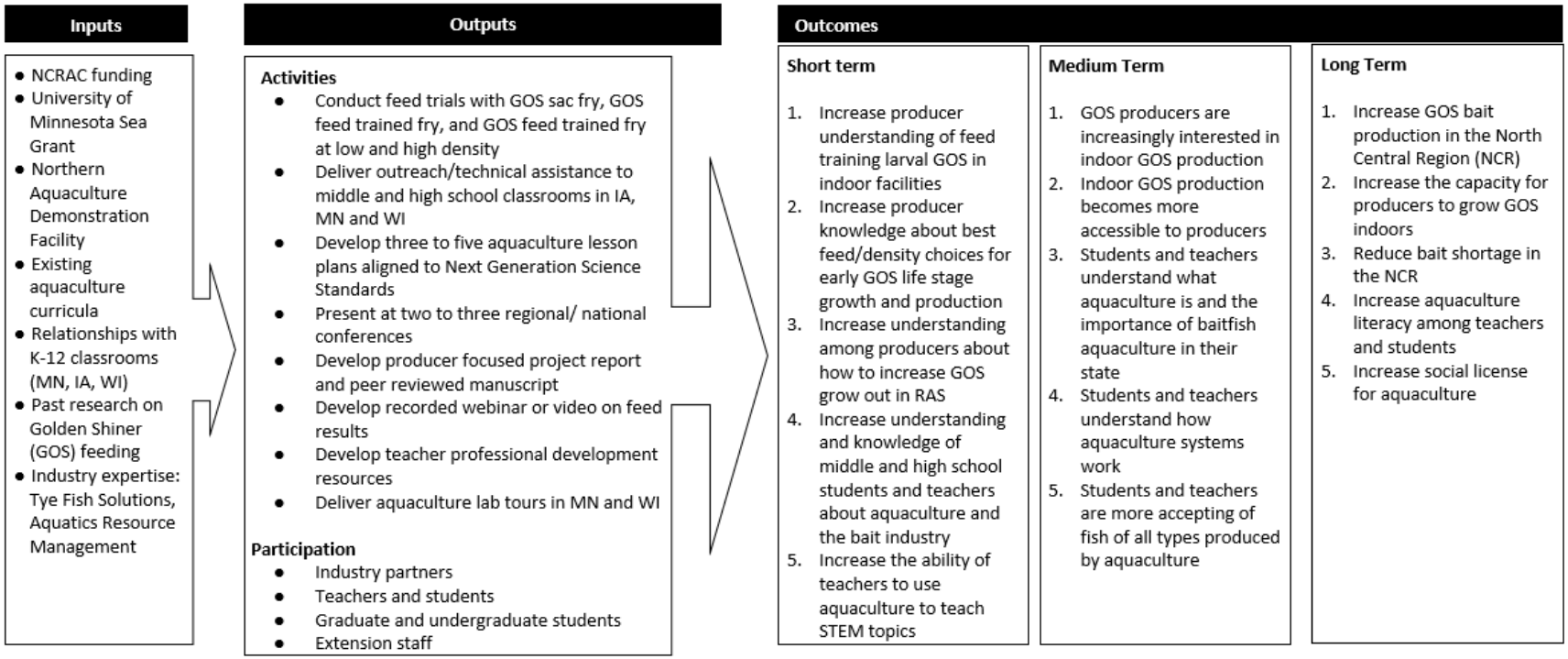
We have explicitly built outreach to teachers and students into this project through objective five, in which we propose working directly with middle and high school classrooms by helping teachers and students rear GOS in the classroom with technical and curriculum support from project extension staff. Our lesson plans, teacher training videos and other materials will be made available on the MNSG, GLAC, and UWSP NADF websites, and the NCRAC website if appropriate. In addition, we will offer tours of the MNSG Aquaculture Lab at the University of Minnesota and at the UWSP NADF to producers, teachers, and students where they will be able to learn about and interact with a variety of aquaculture systems in action.

Overall, this project will contribute to workforce development of multiple age groups including middle and high school students and undergraduate and graduate students. Through objectives one through four MNSG project members will train one graduate student and two to four undergraduate students over two years in aquaculture research and production methods and outreach strategies. Through objective five, middle and high school students will work directly with aquaculture systems and gain an understanding of the bait industry in their state. Building the aquaculture work force by training middle school through graduate students may help with job creation in rural communities where the bait industry could use an influx of a younger more technologically inclined workforce.

We will gather feedback on our project directly from producers as we work with industry partners on this project, present and share our results at state aquaculture association meetings, and as producers tour our aquaculture facilities in Minnesota and Wisconsin. We will evaluate the effectiveness of our outreach with schools by reporting the number of schools, teachers, and students engaged in this project. In addition, we will assess knowledge gained by teachers and students as well as the effectiveness of our lesson plans and other teaching material through before and after surveys from students and teachers as well as informal interviews. We will obtain appropriate university Institutional Review Board (IRB) support as needed. We will collect data about how many people interact with social media, websites, and videos to measure the reach of our outreach materials.

Project title: Optimization of Feed and Stocking Density for Early Life Stages of Golden Shiner (GOS) in Indoor Aquaculture with Integration into STEM Education

Goals: 1) Increase the efficiency of indoor production by experimenting with larval feeds and determining optimal fish density in tanks. 2) Develop an outreach program engaging middle and high school teachers and students in baitfish aquaculture.



Assumptions: The baitfish industry is interested in moving to indoor GOS production. Teachers are interested in using aquaculture in the classroom.

External factors: Baitfish market, producer flexibility to adopt new practices, ability of teachers to incorporate new teaching methods (time and interest),

Evaluation: Number of teachers and classrooms participating in the project, number of students engaged, knowledge gained by students and teachers through pre and post surveys for teachers and classrooms, feedback from producers at aquaculture meetings and conferences and from outreach materials, how many people interact with websites, videos, and social media posts

Facilities

University of Minnesota Sea Grant: Dr. Amy Schrank, Dr. Julia Grenn, Don Schreiner and the Aquaculture Extension Associate have access to facilities at both University of Minnesota Twin Cities and University of Minnesota Duluth campuses. The MNSG Aquaculture Lab on the St. Paul Campus of the University of Minnesota has both flow through and recirculating aquaculture systems including access to greenhouse space for aquaponic systems. MNSG has communications personnel who can support dissemination of project materials, specifically video content, social media, and other online information. Other available facilities include offices, dry-labs, wet-labs, aquaculture facilities, classrooms, and online educational module technical support.

University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility (UWSP NADF) has been in operation since 2002, working with all audiences including students, educators, researchers and private industry to support sustainable aquaculture through research, demonstration, education and extension. The facility works with K-12 schools across Wisconsin and beyond to assist in bringing aquaculture into the classroom for STEM education and workforce development. These partnerships have led to students working as interns or technicians at the UWSP NADF, leading to job placement in the industry. UWSP NADF, through the work of Emma Hauser, has strong existing relationships with schools across the state to partner on this project. Through UWSP NADF involvement, these schools will not only be provided the support to culture baitfish species in aquaculture systems but also have connections to current aquaculture research as well as exposure to commercial systems through virtual and in person tours at UWSP NADF.

Aquaculture IQ, LLC: Dr. Allen Pattillo is in central Iowa and will be the liaison to provide GOS to Iowa schools and producers, provide extension and technical assistance, coordinate data collection, and lead curriculum development to meet Next Generation Science Standards. Aquaculture IQ, LLC has computing capabilities and appropriate software to develop and deliver high-quality educational experiences. Additionally, Aquaculture IQ, LLC is equipped with a 74m^2 (800 ft^2) fabrication shop and appropriate tools to pre-fabricate classroom-scale aquaponics systems described above. Pattillo will partner with Jim and Trevor Blankman, the owners and operators of Aquatic Resource Management (ARS) (https://www.iowafishfarmer.com/index.html), a family-owned aquaculture farm and pond management business in Manning, IA to grow and deliver fish and educational materials to Iowa schools.

Aquatic Resource Management (ARS): This facility provides management services to pond owners, lake associations, sportsmen clubs, housing development corporations and recreational fisheries. Services include growing and stocking native fish, aquatic vegetation management and control, fishery sampling services, population analysis and maintenance, both windmill and electric pond aeration systems as well as youth and adult educational seminars on aquaculture and fishing. In addition to eight aquaculture ponds, the ARS farm includes a 15 m by 24 m (50 ft by 80 ft) tank facility that includes 4 x 1136 L (300 gallon) circular tanks, and 4 x 3,785 L (1,000 gallon) circular tanks with center drains and access to both pond water and dechlorinated city water that can be run as flow-through or RAS (Figure 4). ARS also has a fish hauling truck with oxygenation/aeration equipment for pickup and delivery of GOS. Additionally, Jim Blankman is a middle school science teacher that has used aquaculture as a teaching tool in the classroom for nearly 30 years and will partner with Pattillo and Iowa K-12 schools to provide fish, fish hauling services, technical assistance to teachers, and contributions to curriculum development.

Figure 3. Image from Aquatic Resource Management showing tank facilities including 4 x 1136 L (300 gallon) circular tanks, and 4 x 3,785 L (1,000 gallon)

References

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Project Leaders

State	Project Leader and Institution	Area of Specialization
Minnesota	Amy Schrank, University of Minnesota Sea Grant	Fisheries and aquaculture research and extension
Minnesota	Julia Grenn, University of Minnesota Sea Grant	Aquaculture research and extension including K-12, RAS and aquaponic systems
Minnesota	Don Schreiner, University of Minnesota Sea Grant	Fisheries and aquaculture research and extension
Wisconsin	Emma Hauser,Wisconsin Sea Grant, UWSP, NADF	Aquaculture research and extension including K-12 and RAS
Iowa	Allen Pattillo, Aquaculture IQ, LLC	Aquaculture research and extension including K-12, RAS and aquaponic systems

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0039
Expires 03/31/2004

ORGANIZATION AND ADDRESS Regents of the University of Minnesota 450 McNamara Alumni Center, 200 Oak Street SE Minneapolis, MN 55455-2070 PROJECT DIRECTOR(S) Amy Schrank				USDA AWARD NO. Year 1: Objective 1-5_			
				Duration Proposed Months: 12 Funds Requested by Proposer	Duration Proposed Months: ____ Funds Approved by CSREES (if different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (if required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages 1. No. of Senior Personnel	CSREES FUNDED WORK MONTHS Calendar	Academic	Summer	5,835			
a. _1__ (Co)-PD(s)	0.6						
b. _3__ Senior Associates	2.64			13,996			
2. No. of Other Personnel (Non-Faculty)				0			
a. ___ Research Associates-Postdoctorates . . .							
b. ___ Other Professionals				0			
c. ___ Paraprofessionals				0			
d. _1__ Graduate Students				36,335			
e. _2__ Prebaccalaureate Students				15,860			
f. ___ Secretarial-Clerical				0			
g. ___ Technical, Shop and Other				0			
Total Salaries and Wages □				72,026			
B. Fringe Benefits (If charged as Direct Costs)				15,987			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) □				88,013			
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)				0			
E. Materials and Supplies				15,800			
F. Travel				4,540			
G. Publication Costs/Page Charges				0			
H. Computer (ADPE) Costs				0			
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)				0			
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)				21,000			
K. Total Direct Costs (C through I) □				129,353			
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)				0			
M. Total Direct and F&A/Indirect Costs (J plus K) . □				129,353			
N. Other □				0			
O. Total Amount of This Request □				129,353			
P. Carryover -- (If Applicable) . . . . . **Federal Funds: $**				**Non-Federal funds: $**		**Total $**	
Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)						Leave Blank	
Cash (both Applicant and Third Party) □							
Non-Cash Contributions (both Applicant and Third Party) □							

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

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ORGANIZATION AND ADDRESS Regents of the University of Minnesota 450 McNamara Alumni Center, 200 Oak Street SE Minneapolis, MN 55455-2070 PROJECT DIRECTOR(S) Amy Schrank				USDA AWARD NO. Year 2: Objective 1-5 Duration Proposed Months: 12 Funds Requested by Proposer	Duration Proposed Months: ____ Funds Approved by CSREES (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages	**CSREES FUNDED WORK MONTHS**						
1. No. of Senior Personnel	Calendar	Academic	Summer	6,010			
a. _1__ (Co)-PD(s)	0.6						
b. _3__ Senior Associates	2.64			14,415			
2. No. of Other Personnel (Non-Faculty)				0			
a. ___ Research Associates-Postdoctorates				0			
b. ___ Other Professionals							
c. ___ Paraprofessionals				0			
d. _1__ Graduate Students				37,425			
e. _2__ Prebaccalaureate Students				16,336			
f. ___ Secretarial-Clerical				0			
g. ___ Technical, Shop and Other				0			
Total Salaries and Wages □				74,186			
B. Fringe Benefits (If charged as Direct Costs)				16,466			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) □				90,652			
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)				0			
E. Materials and Supplies				7,000			
F. Travel				7,006			
G. Publication Costs/Page Charges				0			
H. Computer (ADPE) Costs				0			
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)				0			
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)				20,978			
K. Total Direct Costs (C through I) □				125,636			
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)				0			
M. Total Direct and F&A/Indirect Costs (J plus K) . □				125,636			
N. Other □				0			
O. Total Amount of This Request □				125,636			
P. Carryover -- (If Applicable) . . . . . **Federal Funds: $**				**Non-Federal funds: $**		**Total $**	
Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)						Leave Blank	
Cash (both Applicant and Third Party) □							
Non-Cash Contributions (both Applicant and Third Party) □							

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

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ORGANIZATION AND ADDRESS Regents of the University of Minnesota 450 McNamara Alumni Center, 200 Oak Street SE Minneapolis, MN 55455-2070 PROJECT DIRECTOR(S) Amy Schrank				USDA AWARD NO. Year All: Objective 1-5_ Duration Proposed Months: 24 Funds Requested by Proposer	Duration Proposed Months: ____ Funds Approved by CSREES (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages	**CSREES FUNDED WORK MONTHS**						
1. No. of Senior Personnel	Calendar	Academic	Summer				
a. _1__ (Co)-PD(s)				11,845			
b. _3__ Senior Associates	1.2			28,411			
	5.28						
2. No. of Other Personnel (Non-Faculty)				0			
a. ___ Research Associates-Postdoctorates				0			
b. ___ Other Professionals							
c. ___ Paraprofessionals				0			
d. _1__ Graduate Students				73,760			
e. _2__ Prebaccalaureate Students				32,196			
f. ___ Secretarial-Clerical				0			
g. ___ Technical, Shop and Other				0			
Total Salaries and Wages □				146,212			
B. Fringe Benefits (If charged as Direct Costs)				32,453			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) □				178,665			
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)				0			
E. Materials and Supplies				22,800			
F. Travel				11,546			
G. Publication Costs/Page Charges				0			
H. Computer (ADPE) Costs				0			
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)				0			
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)				41,978			
K. Total Direct Costs (C through I) □				254,989			
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)				0			
M. Total Direct and F&A/Indirect Costs (J plus K) . □				254,989			
N. Other □				0			
O. Total Amount of This Request □				254,989			
P. Carryover -- (If Applicable) . . . . . **Federal Funds: $**				**Non-Federal funds: $**		**Total $**	
Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)						Leave Blank	
Cash (both Applicant and Third Party) □							
Non-Cash Contributions (both Applicant and Third Party) □							

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0039
Expires 03/31/2004

ORGANIZATION AND ADDRESS University of Wisconsin Stevens Point 2100 Main St Stevens Point, WI 54481 PROJECT DIRECTOR(S) Emma Hauser				USDA AWARD NO. Year 1: Objective 5 Duration Proposed Months: 12 Funds Requested by Proposer	Duration Proposed Months: ____ Funds Approved by CSREES (if different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (if required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (if Different)
A. Salaries and Wages 1. No. of Senior Personnel	CSREES FUNDED WORK MONTHS Calendar	Academic	Summer	0			
a. ___ (Co)-PD(s)							
b. ___ Senior Associates				0			
2. No. of Other Personnel (Non-Faculty)				0			
a. ___ Research Associates-Postdoctorates . . .							
b. ___ Other Professionals				0			
c. ___ Paraprofessionals				0			
d. ___ Graduate Students				0			
e. ___ Prebaccalaureate Students				0			
f. ___ Secretarial-Clerical				0			
g. ___ Technical, Shop and Other				0			
Total Salaries and Wages □				0			
B. Fringe Benefits (If charged as Direct Costs)				0			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) □				0			
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)				0			
E. Materials and Supplies				2,800			
F. Travel				4,492			
G. Publication Costs/Page Charges				0			
H. Computer (ADPE) Costs				0			
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)				0			
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)				0			
K. Total Direct Costs (C through I) □				7,292			
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)				0			
M. Total Direct and F&A/Indirect Costs (J plus K) . □				7,292			
N. Other □				0			
O. Total Amount of This Request □				7,292			
P. Carryover -- (If Applicable) . . . . . **Federal Funds: $**				**Non-Federal funds: $**		**Total $**	
Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)						Leave Blank	
Cash (both Applicant and Third Party) □							
Non-Cash Contributions (both Applicant and Third Party) □							

NAME AND TITLE (Type or print)	SIGNATURE (required for revised budget only)	DATE
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

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ORGANIZATION AND ADDRESS University of Wisconsin Stevens Point 2100 Main St Stevens Point, WI 54481 PROJECT DIRECTOR(S) Emma Hauser				USDA AWARD NO. Year 2: Objective _5 Duration Proposed Months: 12 Funds Requested by Proposer	Duration Proposed Months: ____ Funds Approved by CSREES (if different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (if required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (if Different)
A. Salaries and Wages	**CSREES FUNDED WORK MONTHS**						
1. No. of Senior Personnel	Calendar	Academic	Summer	0			
a. ___ (Co)-PD(s)							
b. ___ Senior Associates				0			
2. No. of Other Personnel (Non-Faculty)				0			
a. ___ Research Associates-Postdoctorates							
b. ___ Other Professionals				0			
c. ___ Paraprofessionals				0			
d. ___ Graduate Students				0			
e. ___ Prebaccalaureate Students				0			
f. ___ Secretarial-Clerical				0			
g. ___ Technical, Shop and Other				0			
Total Salaries and Wages □				0			
B. Fringe Benefits (If charged as Direct Costs)				0			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) □				0			
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)				0			
E. Materials and Supplies				2,888			
F. Travel				4,627			
G. Publication Costs/Page Charges				0			
H. Computer (ADPE) Costs				0			
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)				0			
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)				0			
K. Total Direct Costs (C through I) □				7,515			
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)				0			
M. Total Direct and F&A/Indirect Costs (J plus K) . □				7,515			
N. Other □				0			
O. Total Amount of This Request □				7,515			
P. Carryover -- (If Applicable) . . . . . **Federal Funds: $**				**Non-Federal funds: $**		**Total $**	
Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)						Leave Blank	
Cash (both Applicant and Third Party) □							
Non-Cash Contributions (both Applicant and Third Party) □							

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
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ORGANIZATION AND ADDRESS University of Wisconsin Stevens Point 2100 Main St Stevens Point, WI 54481 PROJECT DIRECTOR(S) Emma Hauser				USDA AWARD NO. Year 1&2: Objective 5 Duration Proposed Months: 24 Funds Requested by Proposer	Duration Proposed Months: ____ Funds Approved by CSREES (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages	**CSREES FUNDED WORK MONTHS**						
1. No. of Senior Personnel	Calendar	Academic	Summer				
a. ___ (Co)-PD(s)				0			
b. ___ Senior Associates				0			
2. No. of Other Personnel (Non-Faculty)							
a. ___ Research Associates-Postdoctorates				0			
b. ___ Other Professionals				0			
c. ___ Paraprofessionals				0			
d. ___ Graduate Students				0			
e. ___ Prebaccalaureate Students				0			
f. ___ Secretarial-Clerical				0			
g. ___ Technical, Shop and Other				0			
Total Salaries and Wages □				0			
B. Fringe Benefits (If charged as Direct Costs)				0			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) □				0			
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)				0			
E. Materials and Supplies				5,688			
F. Travel				9,119			
G. Publication Costs/Page Charges				0			
H. Computer (ADPE) Costs				0			
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)				0			
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)				0			
K. Total Direct Costs (C through I) □				14,807			
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)				0			
M. Total Direct and F&A/Indirect Costs (J plus K) . □				14,807			
N. Other □				0			
O. Total Amount of This Request □				14,807			
P. Carryover -- (If Applicable) . . . . . **Federal Funds: $**				**Non-Federal funds: $**		**Total $**	
Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)						Leave Blank	
Cash (both Applicant and Third Party) □							
Non-Cash Contributions (both Applicant and Third Party) □							

NAME AND TITLE (Type or print)	SIGNATURE (required for revised budget only)	DATE
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

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ORGANIZATION AND ADDRESS Regents of the University of Minnesota 450 McNamara Alumni Center, 200 Oak Street SE Minneapolis, MN 55455-2070 University of Wisconsin Stevens Point 2100 Main St Stevens Point, WI 54481 PROJECT DIRECTOR(S) Amy Schrank				USDA AWARD NO. Year All: Objective 1-5_ Duration Proposed Months: 24 Funds Requested by Proposer	Duration Proposed Months: ____ Funds Approved by CSREES (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages 1. No. of Senior Personnel	**CSREES FUNDED WORK MONTHS** Calendar	Academic	Summer	11,845			
a. _1__ (Co)-PD(s)	1.2						
b. _3__ Senior Associates	5.28			28,411			
2. No. of Other Personnel (Non-Faculty)				0			
a. ___ Research Associates-Postdoctorates . . .							
b. ___ Other Professionals				0			
c. ___ Paraprofessionals				0			
d. _1__ Graduate Students				73,760			
e. _2__ Prebaccalaureate Students				32,196			
f. ___ Secretarial-Clerical				0			
g. ___ Technical, Shop and Other				0			
Total Salaries and Wages □				146,212			
B. Fringe Benefits (If charged as Direct Costs)				32,453			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) □				178,665			
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)				0			
E. Materials and Supplies				28,488			
F. Travel				20,665			
G. Publication Costs/Page Charges				0			
H. Computer (ADPE) Costs				0			
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)				0			
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)				41,978			
K. Total Direct Costs (C through I) □				269,796			
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)				0			
M. Total Direct and F&A/Indirect Costs (J plus K) . □				269,796			
N. Other □				0			
O. Total Amount of This Request □				269,796			
P. Carryover -- (If Applicable) . . . . . **Federal Funds: $**				**Non-Federal funds: $**		**Total $**	
Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)						Leave Blank	
Cash (both Applicant and Third Party) □							
Non-Cash Contributions (both Applicant and Third Party) □							

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

Budget Justification
University of Minnesota Sea Grant
Amy Schrank
Year 1

1. Salaries, Wages, and Fringe benefits ($88,013)
    a. For Amy Schrank, Assistant Extension Professor at the University of Minnesota Sea Grant (MNSG), with an annual salary of $116,691 (36.6% fringe) and 5% assigned to this project: $7,971 is requested. Schrank will oversee all components of the project, supervise the graduate student, ensure deliverables are met, and ensure reporting is completed
    b. For Julianne Grenn, MNSG Fisheries and Aquaculture Extension Educator, with an annual salary of $65,000 (36.6% fringe) and 10% assigned to this project: $8,879 is requested. Grenn will assist with supervising the graduate student and lead the outreach component of the project including providing technical assistance to schools.
    c. For Don Schreiner, MNSG Fisheries Specialist, with an annualized salary of $74,776 (32.3% fringe) and 2% assigned to this project: $1,979 is requested. Schreiner will liaise with Minnesota bait dealers and project partners, coordinate GOS fry procurement, and contribute to research and outreach.
    d. For the Aquaculture Extension Associate (to be determined), with an annual salary of $60,000 (36.6% fringe) and 10% assigned to this project: $8,196 is requested. The Aquaculture Extension Associate will oversee all aspects of lab facilities including permitting, experiment setup and plumbing, troubleshooting, grow-out of GOS in RAS, and oversee the personnel involved in fish care.
    e. For one graduate student with an annual salary of $58,136 (24.2% fringe) and assigned to this project at 50% time during the academic year (9 months) and full time for the summer (3 months): $45,128 is requested. The graduate student will conduct feeding trials, collect and analyze data, oversee the undergraduate who will assist with the project, assist with outreach and data collection by schools, and participate in writing up the final report and manuscript.
    f. For two undergraduate students with annual salaries of $31,720 and 25% time assigned to this project (0% fringe): $15,860 is requested. The undergraduate students will assist in the lab feeding fish, cleaning tanks, and assisting the graduate student with feeding trials, data entry, and outreach to schools.

2. Nonexpendable Equipment ($0)
    a. None

3. Materials and Supplies ($15,800)
    a. For research lab supplies to include but not limited to fish tanks, oxygen supplies, plumbing supplies, water quality equipment and supplies, dry and live fish feed and other miscellaneous supplies, $6,000 is requested.
    b. For outreach and educational materials for Minnesota schools to include but not limited to fish feed, filters, water sampling materials, and other aquaponics system construction needs, $4,900 is requested.
    c. For outreach and educational supplies for Iowa schools, including but not limited to fish feed, water filters, water sampling materials, aquaculture system needs $4,900 is requested.

4. Travel ($4,540)
    a. For travel to visit four schools within Minnesota including:
        i. Vehicle rental and mileage for 10 days and 500 miles: $64/day x 10days + $0.20/ mile x 500 miles = $740
        ii. Lodging for two project personnel for five nights = $150 x 2 x 5 = $1,500
        iii. Per diem for two project personnel for 10 days = $80 x 2 x 10 = $1,600
    b. Non-employee travel (Pattillo) to visit 5 Iowa schools twice with systems, water quality supplies, and technical support to prepare and grow GOS in the classroom the following travel is requested.
        i. Mileage = 1,000 miles at $0.70/ mile = $700

5. All other Direct Costs ($21,000)
    a. For printing costs to deliver educational materials and curriculum to IA, MN and WI schools, $400 is requested
    b. For a professional contract to our industry partner, Tye Fish Solutions, an aquaculture producer and GOS expert in Minnesota who will provide GOS sac fry, feed trained fry, and expertise on project methods, $7,250 is requested.
    c. Lab space cost for the MNSG Aquaculture Lab where fish will be housed and where students and teachers can visit to learn about aquaculture: $300/month x 12 months = $3,600
    d. For a professional contract to Allen Pattillo, Aquaculture IQ, LLC (Located in Ankeny, IA), will contribute 110 hours @ $50/hr in year 1: $5,500 is requested. Pattillo is permanently located in Iowa and will partner with Iowa K-12 schools to help address objective 5 of this project. He will be the liaison to provide GOS to Iowa schools, provide technical assistance, coordinate data collection and lead curriculum development.
    e. Contract to our industry partner, Jim and Travor Blankman and Aquatic Resource Management, a family-owned aquaculture farm and pond management business in Manning, Iowa for $4,250. Additionally, Jim Blankman is a Middle school science teacher that has used aquaculture as a teaching tool in the classroom for nearly 30 years. Jim Blankman will contribute 50 hours of labor at $45/hr ($2,250) to contribute to objectives 4 and 5 and Trevor Blankman will contribute 50 hours of labor at $40/hr ($2,000) to contribute to objective 4 on their fish farm. Jim Blankman will partner with Pattillo and Iowa K-12 schools to help address objective 5 of this project. He will provide fish, fish hauling services as needed, technical assistance to teachers, and contribute to curriculum development.

Budget Justification
University of Minnesota Sea Grant
Amy Schrank
Year 2

1. Salaries, Wages, and Fringe benefits ($90,652)
    a. For Amy Schrank, Assistant Extension Professor at the University of Minnesota Sea Grant (MNSG), with an annual salary of $120,192 (36.6% fringe) and 5% assigned to this project: $8,209 is requested. Schrank will oversee all components of the project, supervise the graduate student, ensure deliverables are met, and ensure reporting is completed
    b. For Julianne Grenn, MNSG Fisheries and Aquaculture Extension Educator, with an annual salary of $66,950 (36.6% fringe) and 10% assigned to this project: $9,145 is requested. Grenn will assist with supervising the graduate student and lead the outreach component of the project including providing technical assistance to schools.
    c. For Don Schreiner, MNSG Fisheries Specialist, with an annualized salary of $77,019 (32.3% fringe) and 2% assigned to this project: $2,038 is requested. Schreiner will liaise with Minnesota bait dealers and project partners, coordinate GOS fry procurement, and contribute to research and outreach.
    d. For the Aquaculture Extension Associate (to be determined), with an annual salary of $61,800 (36.6% fringe) and 5% assigned to this project: $8,442 is requested. The Aquaculture Extension Associate will oversee all aspects of lab facilities including permitting, experiment setup and plumbing, troubleshooting, grow-out of GOS in RAS, and oversee the personnel involved in fish care.
    e. For one graduate student with an annual salary of $59,880 (24.2% fringe) and assigned to this project at 50% time during the academic year (9 months) and full time for the summer (3 months): $46,482 is requested. The graduate student will conduct feeding trials, collect and analyze data, oversee the undergraduate who will assist with the project, assist with outreach and data collection by schools, and participate in writing up the final report and manuscript.
    f. For two undergraduate students with annual salaries of $32,672 and 25% time assigned to this project (0% fringe): $16,336 is requested. The undergraduate students will assist in the lab feeding fish, cleaning tanks, and assisting the graduate student with feeding trials, data entry, and outreach to schools.

2. Nonexpendable Equipment ($0)
    a. None

3. Materials and Supplies ($7,000)
    a. For research supplies for GOS lab systems including but not limited to fish feed, water quality sampling kits, and other repair or miscellaneous supplies, $3000 is requested.
    b. For lab and educational supplies to include but not limited to fish feed, filters, water sampling materials, aquaculture system needs for both MN and Iowa schools $4,000 ($2000 each) is requested.

4. Travel ($7,006)
    a. For travel to visit four schools within Minnesota including:
        i. Vehicle rental and mileage for 10 days and 500 miles: $64/day x 10days + $0.20/ mile x 500 miles x 3% inflation = $762
        ii. Lodging for two project personnel for five nights = $150 x 2 x 5 x 1.03 = $1,545
        iii. Per diem for two project personnel for 10 days = $80 x 2 x 10 x1.03 = $1,648
    b. Non-employee travel (Pattillo) to visit 5 Iowa schools twice with systems, water quality supplies, and technical support to prepare and grow GOS in the classroom the following travel is requested.
        i. Mileage = 1,000 miles at $0.70/ mile x 1.03 = $721
    c. Travel for project PI or co-PI to present this work at a national aquaculture conference (for example Aquaculture America), $2,330 is requested.
        i. Airfare = $650

ii. Registration = $500
iii. Lodging = $250 for 3 nights = $750
iv. Ground transportation to and from the airport = $100
v. Per diem @$80 for 4 days x 1.03= $330

5. All other Direct Costs ($20,928)
    a. For printing costs to deliver educational materials and curriculum to all school in IA, MN,and WI, $250 is requested
    b. For a professional contract to our industry partner, Tye Fish Solutions, an aquaculture producer and GOS expert in Minnesota who will provide GOS sac fry, feed trained fry, and expertise on project methods, $7,250 is requested.
    c. For a professional contract to Allen Pattillo, Aquaculture IQ, LLC (Located in Ankeny, IA), will contribute 110 hours @ $50/hr in year 2: $5,500 is requested. Pattillo is permanently located in Iowa and will partner with Iowa K-12 schools to help address objective 5 of this project. He will be the liaison to provide GOS to Iowa schools, provide technical assistance, coordinate data collection and lead curriculum development.
    d. Lab space cost for the MNSG Aquaculture Lab where fish will be housed and where students and teachers can visit to learn about aquaculture: $300/month x 12 months x 1.03 = $3,600
    e. Contract to our industry partner, Jim and Travor Blankman and Aquatic Resource Management, a family-owned aquaculture farm and pond management business in Manning, Iowa for $4,250 x 1.03 = 4,378. Additionally, Jim Blankman is a Middle school science teacher that has used aquaculture as a teaching tool in the classroom for nearly 30 years. Jim Blankman will contribute 50 hours of labor at $45/hr ($2,250) to contribute to objectives 4 and 5 and Trevor Blankman will contribute 50 hours of labor at $40/hr ($2,000) to contribute to objective 4 on their fish farm. Jim Blankman will partner with Pattillo and Iowa K-12 schools to help address objective 5 of this project. He will provide fish, fish hauling services as needed, technical assistance to teachers, and contribute to curriculum development.

Budget Justification
University of Wisconsin-Stevens Point
Emma Hauser
Year 1

1. Salaries, Wages, and Fringe benefits ($0)

2. Nonexpendable Equipment ($0)
    a. None

3. Materials and Supplies ($2,800)
    a. For water quality equipment, aquaculture system needs, fish feed, and other miscellaneous supplies to support aquaculture in eight high schools ($350 per school) = $2,800.00 is requested.

4. Travel ($4,492)
    a. Collaboration with Southern Wisconsin Schools: Pulaski, Wabeno, Cadott, Chilton: Hauser will travel from Bayfield to University of Minnesota in Saint Paul, MN to pick up fish and transport to the 4 schools (4 days, 3 nights, 852 miles). This trip will be completed twice per year to either transport additional fish over the course of the year or provide technical assistance.

Accommodations	$555.00 ($185/night for 3 nights)
Per diem	$368.00 ($92 per day for 4 days)
Mileage: 852 miles	$596.00 ($0.70 per mile)
Total Cost:	**$1519.00 (x2) = $3038.00 of travel**

    b. Collaboration with Northern Wisconsin Schools: Port Wing, Bayfield, Washburn & Ashland: Hauser will travel from Bayfield to University of Minnesota in Saint Paul, MN to pick up fish and transport to the 4 schools: 511 miles. This trip will be completed twice per year to either transport additional fish over the course of the year or provide technical assistance.

Accommodations	$185.00 ($185/night for 1 night)
Per diem	$184.00 ($92 per day for 2 days)
Mileage: 511 miles	$358.00 ($0.70 per mile)
Total Cost:	**$727.00 (x2) = $1454.00 of travel**

5. All other Direct Costs ($0)

Budget Justification
University of Wisconsin-Stevens Point
Emma Hauser
Year 2

6. Salaries, Wages, and Fringe benefits ($0)

7. Nonexpendable Equipment ($0)
    a. None

8. Materials and Supplies ($2,888)
    a. For water quality equipment, aquaculture system needs, fish feed, and other miscellaneous supplies to support aquaculture in eight high schools ($361 per school) = $2,888 = is requested.

9. Travel ($4,627)
    a. Collaboration with Southern Wisconsin Schools: Pulaski, Wabeno, Cadott, Chilton: Hauser will travel from Bayfield to University of Minnesota in Saint Paul, MN to pick up fish and transport to the 4 schools (4 days, 3 nights, 852 miles). This trip will be completed twice per year to either transport additional fish over the course of the year or provide technical assistance.

Accommodations	$555.00 ($185/night for 3 nights)
Per diem	$368.00 ($92 per day for 4 days)
Mileage: 852 miles	$596.00 ($0.70 per mile)
Total Cost:	**$1519.00 x 2 x 1.03 = $3129 of travel**

    b. Collaboration with Northern Wisconsin Schools: Port Wing, Bayfield, Washburn & Ashland: Hauser will travel from Bayfield to University of Minnesota in Saint Paul, MN to pick up fish and transport to the 4 schools: 511 miles. This trip will be completed twice per year to either transport additional fish over the course of the year or provide technical assistance.

Accommodations	$185.00 ($185/night for 1 night)
Per diem	$184.00 ($92 per day for 2 days)
Mileage: 511 miles	$358.00 ($0.70 per mile)
Total Cost:	**$727.00 x 2 x 1.03 = $1498 of travel**

10. All other Direct Costs ($0)

Budget Summary

Proposed Summary Budget for Year 1; For all participating institutions

	NCRAC Funds			
	Objective	University of Minnesota Sea Grant (Amy Schrank)	Wisconsin Sea Grant/ University of Wisconsin Northern Aquaculture Demonstration Facility (Emma Hauser)	Project Total
Salaries, Wages, and Fringe Benefits	1-5	$88,013	$0	$88,013
Nonexpendable Equipment	1-5	$0	$0	$0
Materials and Supplies	1-5	$15,800	$2,800	$18,600
Travel	4-5	$4,540	$4,492	$9,032
All other Direct Costs	1-5	$21,000	$0	$21,000
Total	1-5	$129,353	$7,292	$136,645

Proposed Summary Budget for Year 2; For all participating institutions

	NCRAC Funds			
	Objective	University of Minnesota Sea Grant (Amy Schrank)	Wisconsin Sea Grant and University of Wisconsin Northern Aquaculture Demonstration Facility (Emma Hauser)	Project Total
Salaries, Wages, and Fringe Benefits	1-5	$90,652	$0	$90,652
Nonexpendable Equipment	1-5	$0	$0	$0
Materials and Supplies	1-5	$7,000	$2,888	$9,888
Travel	4-5	$7,006	$4,627	$11,633
All other Direct Costs	1-5	$20,978	$0	$20,978
Total	1-5	$125,353	$7,515	$133,151

Proposed Summary Budget for all years; For all participating institutions

	NCRAC Funds			
	Objective	University of Minnesota Sea Grant (Amy Schrank)	Wisconsin Sea Grant and University of Wisconsin Northern Aquaculture Demonstration Facility (Emma Hauser)	Project Total
Salaries, Wages, and Fringe Benefits	1-5	$178,665	$0	$178,665
Nonexpendable Equipment	1-5	$0	$0	$0
Materials and Supplies	1-5	$22,800	$5,688	$25,488
Travel	4-5	$11,546	$9,119	$20,665
All other Direct Costs	1-5	$41,978	$0	$41,978
Total	1-5	$254,989	$14,807	$269,796

Schedule for Completion of Objectives

Table 1: The project timeline is 1 January 2026 through 31 December 2027. The timeline for project tasks is shown by objective. The months of each year are indicated by letters in columns two through 13 starting with J for January.

Objectives and Tasks	Year 1						Year 2					
	J F	M A	M J	J A	S O	N D	J F	M A	M J	J A	S O	N D
Objective 1												
• Set up lab systems	X	X										
• Conduct feed trial one			X									
• Conduct feed trial two				X								
• Record photos and videos from feed trials			X	X	X	X						
• Analyze data					X	X						
• Write manuscript and report							X	X	X	X		
• Present results at conferences							X	X	X			
Objective 2 and 3												
• Set up lab systems						X	X					
• Conduct feed/density trial one								X				
• Conduct feed/density trial two									X	X		
• Record photos and videos from feed trials							X	X	X	X		
• Write manuscript and report										X	X	X
• Present results at conferences and gather feedback from producers										X	X	X
• Develop webinar or video									X	X	X	X
Objective 4												
• Stock RAS with feed trained fry and grow out					X	X	X	X	X	X	X	X
Objective 5												
• Make contact and develop a list of schools who will participate in this project	X	X	X									
• Develop and revise curriculum to share with schools	X	X	X									
• Develop and share teacher training materials	X	X	X									
• Implement aquaculture systems in the classroom in all states					X	X	X	X	X			
• Conduct pre-and-post surveys and interviews with teachers and students					X				X			
• Share outreach materials online and via websites and social media						X	X	X	X	X	X	X
NCRAC reporting					X	X					X	X

Participating Institutions and Principal Investigators

University of Minnesota Sea Grant
Grenn, Julia
Schrank, Amy
Schreiner, Donald

University of Wisconsin Stevens Point, Northern Aquaculture Demonstration Facility
Hauser, Emma

Aquaculture IQ, LLC
Pattillo, Allen

Potential Proposal Reviewers

Karolina Kwasek
Assistant Professor, Biological Sciences
University of New Hampshire
(603) 862-2112
Karolina.Kwasek@unh.edu

Jim Burris
Director, Aquatics Research Center
Morgridge Institute for Research
(608) 265-6889
jburris@morgridge.org

Edward D. Aneshansley, P.E., MPS
President
EDA-Aquatic Design Services, LLC.
eda@eda-aquatics.com
Mobile: 978-578-2589

Amy J. Schrank
University of Minnesota Sea Grant
1985 Buford Ave.
173 McNeal Hall
Saint Paul, MN 55108

Phone: (612) 301-1526
E-mail: aschrank@umn.edu

EDUCATION

B.S. University of Michigan, 1995, Biology and Spanish
M.S. University of Michigan, 1997, Resource Ecology and Management: Aquatic Ecology
Ph.D. University of Wyoming, 2002, Zoology and Physiology, Minor: Statistics

POSITIONS

2023 – present Extension Program Leader, Minnesota Sea Grant College Program
2025 – present Associate Extension Professor, Minnesota Sea Grant College Program
2020 – present Assistant Extension Professor, Minnesota Sea Grant College Program
2017 – present Adjunct Assistant Professor, Department of Fisheries, Wildlife and Conservation Biology (FWCB), University of Minnesota
2004 – present Lecturer - University of Michigan Biological Station (UMBS), Pellston, MI
2017 – 2018 Researcher 6, Teaching Specialist – FWCB, University of Minnesota
2013 – 2017 Research Assistant Professor – School of Forest Resources and Environmental Science (SFRES), Michigan Technological University
2004 – 2013 Adjunct Assistant Professor - SFRES, Michigan Technological University
2002 – 2003 Visiting Assistant Professor: Ecology Department, Montana State University, Bozeman, MT

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

- American Fisheries Society: including the Minnesota Chapter and Fish Culture Section
- Minnesota Aquaculture Association
- North Central Regional Aquaculture Center: Technical Committee-Extension
- World Aquaculture Society

SELECTED PUBLICATIONS

Jescovitch-Stigers, L., Smith, K., Evans, B.I., **Schrank A.J**. *In Review*. Aquaculture extension: expanding the audience beyond producers. Journal of Extension.

Lishawa, S., **Schrank, A.J.**, Lawrence, B., Monks, D., and Albert, D. 2023. Aquatic connectivity treatments increase fish and macroinvertebrate use of *Typha*-invaded Great Lakes coastal wetlands. Freshwater Biology. http://doi.org/10.1111/fwb.14141

Jescovitch, L., Nelson, E., Seilheimer, T., Wiermaa, E., and **Schrank, A.** 2022. Learning from the best: virtual fish farm tours with the Great Lakes Aquaculture Collaborative. World Aquaculture Magazine 53(3).

Jescovitch, L., Nelson, E., Seilheimer, T., Wiermaa, E., and **Schrank, A.** 2021. Introducing the Great Lakes Aquaculture Collaborative: Fostering an aquaculture event during COVID-19. World Aquaculture Magazine 52(1): 45-48.

Pettit, S., Rockwell, J., Vance, B., Zhou, H., Chandramouli, S., Goldstein, S.M., **Schrank, A.J.,** and D.R. Schreiner. 2021. Lake Superior commercial fishing and aquaculture supply chains in Minnesota. Carlson Consulting Enterprise Final Report. Available from: https://z.umn.edu/MNSG-CCE-AQ-supply-chain.

Schrank, A.J. and Lishawa, S.C. 2019. Invasive cattail reduces fish diversity and abundance in the emergent zone of a Great Lakes coastal wetland. Journal of Great Lakes Research 45: 1251-1259.

Bansal, S., Lishawa, S., Newman, S., Tangen, B.A., Wilcox, D., Albert, D., Anteau, M.J., Chimney, M.J., Cressey, R.L., DeKeyser, E., Elgersma, K.J., Finkelstein, S.A., Freeland, J., Grosshans, R., Klug, P.E., Larkin, D.J., Lawrence, B.A., Linz, G., Marburger, J., Noe, G., Otto, C., Reo, N., Richards, J., Richardson, C., Rodgers, L., **Schrank, A.J.**, Svedarsky, D., Travis, S., Tuchman, N., Windham-Myers, L. 2019. *Typha* (cattail) Invasion in North American Wetlands: Biology, Regional Problems, Impacts, Ecosystem Services, and Management. Wetlands 39(4): 645-684.

Julianne M. Grenn
University of Minnesota Sea Grant
1985 Buford Ave.
173 McNeal Hall
Saint Paul, MN 55108

Phone: (313) 550-9853
E-mail: jgrenn@d.umn.edu

EDUCATION

B.S. Lake Superior State University, 2020, Biology, Minors: Aquaponic Production and Environmental Policy
Ph.D. Virginia Institute of Marine Science (VIMS), College of William & Mary (W&M), 2025, Marine Science: Commercial Shellfish Aquaculture

POSITIONS

2025 – present	Assistant Extension Professor - Minnesota Sea Grant College Program
2023 – present	Virginia Sea Grant Graduate Research Fellow - VIMS, W&M
2021 – present	Graduate Research Assistant - VIMS, W&M
2021 – 2022	Farm Technician - Cappahosic Oyster Company, Gloucester, VA
Jan. – Oct. 2021	Aquaculture Outreach Assistant - Minnesota Sea Grant
May – Aug. 2020	Hatchery Manager - Grayling Fish Hatchery, Grayling, MI
May – Aug. 2020	Summer Intern - Michigan Sea Grant
2019 – 2020	Aquaculture Challenge Intern - Michigan Sea Grant
2019 – 2020	Hatchery Technician - Center for Freshwater Research and Education
May – Aug. 2019	Field Technician - Hammond Bay Biological Station, Millersburg, MI

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

- Minnesota Aquaculture Association
- World Aquaculture Society
- National Shellfisheries Association

SELECTED PUBLICATIONS, CONTRIBUTED COLUMNS, AND DIGITAL PRODUCTS

Albert, B.I., **J. Grenn,** M. Pitsenbarger, K. Hudson, & W. Walton. 2024. VIMS Shellfish Aquaculture Program Story Map. Virginia Sea Grant and VIMS Shellfish Aquaculture Program.

Grenn, J., M. Walsh, K. Hartman, C. Engle, A. Kelly, D. Cline, R. Lochmann and D. Straus. 2024. USAS Student Subunits: History and Impact. World Aquaculture Magazine, 55(3):64-65.

Grenn J. and M. Walsh. 2024. Student Sub-Units: The Future of USAS. World Aquaculture Magazine, 55(2):18-19.

Grenn J. 2023. The Mystery Oyster: What's in the Bag? Virginia Scientists and Educators Alliance.

Grenn, J. 2021. Seasonal Live-Streaming Trout Camera. Grayling Fish Hatchery. https://www.graylingfishhatchery.org/313-2/.

Grenn. J. 2021. Aquaponic Blog Article Series (10 Articles). Aquaponic AI. July-November 2021. https://aquaponics.ai/community/authors/julianne-grenn.

Grenn, J. 2020. Grayling Hatchery Gazette. Michigan Sea Grant Fellows and Interns Blog. http://msgfellowship.blogspot.com/2020/08/julianne-grenns-graylinghatchery.html.

Grenn, J. 2020. Grayling Hatchery Update Summer 2020. Au Sable River Property Owners Association. https://arpoa-mi.org/grayling-hatchery-update-summer-2020/.

EXTERNAL SERVICE

2025 – present	United States Aquaculture Society Seafood Messaging & Marketing Sub-Committee
2024 – present	United States Aquaculture Society Student Liaison
2023 – 2025	Letters to Potential Scientists
2023 – 2025	Virginia Oyster Trail Outreach and Extension Committee

Donald R. Schreiner
University of Minnesota Sea Grant
Chester Park Building, 31 West College Street
Duluth, Minnesota 55804

Phone: (218) 276-7375
E-mail: schr0941 @d.umn.edu

EDUCATION:
B.S. Zoology, North Dakota State University, Fargo, ND (1976)
M.S. Fisheries Biology, University of Minnesota, St. Paul, MN (1980)

POSITIONS:
2016 - present - Minnesota Sea Grant College Program, Fisheries Specialist - PT
2016 - Project Consultant Senior, MN DNR Ecological & Water Resources
2014-2015 - Project Consultant Senior, MN DNR Fisheries
1989 - 2014 - Lake Superior Area Fisheries Supervisor, MN DNR Fisheries
1986 - 1989 - Glenwood (Alexandria) Area Fisheries Supervisor, MN DNR Fisheries (1986 to 1989)
1981-1986 - Fergus Falls Area Fisheries Specialist, MN DNR Fisheries (1981 to 1986)

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS:

- American Fisheries Society: including the Minnesota Chapter, Fish Culture and other sections
- National Aquaculture Association
- Minnesota Aquaculture Association

SELECTED PUBLICATIONS:

Pettit, S., Rockwell, J., Vance, B., Zhou, H., Chandramouli, S., Goldstein, S.M., Schrank, A.J., and D.R. Schreiner. 2021. Lake Superior commercial fishing and aquaculture supply chains in Minnesota. Carlson Consulting Enterprise Final Report. Available from: https://z.umn.edu/MNSG-CCE-AQ-supply-chain.

Moen, S.M., D.R. Schreiner, J. Coburn and N. Jacob. 2017. Food-Fish Aquaculture in Minnesota: A Synthesis of the 26-27 April 2017 Workshop. Minnesota Sea Grant, A26. 88 pp

Schreiner, D.R., C.A. Goldsworthy, M.T. Negus, P.J. Schmaltz and K.A. Reeves. 2019. Lake Trout Rehabilitation in the Minnesota Waters of Lake Superior, 1962-2014. Minnesota Department of Natural Resources, Special Pub. 187. 95 pp.

Schreiner, D.R., and M.T. Negus. 2019. Atlantic Salmon Management in the Minnesota Waters of Lake Superior, 1980-1998. Minnesota Department of Natural Resources, Special Pub. 185. 39 pp.

Schreiner, D.R., M.T. Negus, and J.E. Blankenheim. 2019. Chinook Salmon Management in the Minnesota Waters of Lake Superior, 1974-2014. Minnesota Department of Natural Resources, Spec. Pub. 186. 48p

Schreiner, D. R. 2008. Coaster brook trout rehabilitation in Lake Superior: introduction. North American Journal of Fisheries Management 28:1305-1306.

Schreiner, D. R., K. I. Cullis, M. C. Donofrio, G. J. Fischer, L. Hewitt, K. G. Mumford, D. M. Pratt, H. R. Quinlan, and S. J. Scott. 2008. Management perspectives on coaster brook trout rehabilitation in the Lake Superior basin. North American Journal of Fisheries Management 28:1350-1364.

Schreiner, D. R., C. R. Bronte, B. R. Payne, J. D. Fizsimons, and J. M. Casselman. 1995. Use of egg traps to investigate lake trout spawning in the Great Lakes. Journal of Great Lakes Research 21(Supplement 1):433-444.

Schreiner, D. R., J. E. Luey, L. D. Jacobson, C. C. Krueger, and I. R. Adelman. 1984. Stock structure of rainbow smelt in western Lake Superior: biochemical genetics. Transactions of the American Fisheries Society 113:701-708.

Emma M. Hauser
Aquaculture Outreach Specialist
UW-Stevens Point Northern Aquaculture Demonstration Facility
Wisconsin Sea Grant
P.O. Box 165
Bayfield, WI 54814

Telephone: (715)779-3262
Email: ehauser@uwsp.edu

EDUCATION

B. S., Ecology and Environmental Biology, 2012. University of Wisconsin-Eau Claire

POSITIONS

Aquaculture Outreach Specialist, University of Wisconsin Stevens Point Northern Aquaculture Demonstration Facility, University of Wisconsin-Stevens Point and Wisconsin Sea Grant Institute (2014-present)
Aquaculture Technician, University of Wisconsin Stevens Point Northern Aquaculture Demonstration Facility, University of Wisconsin-Stevens Point (2014)
Program Coordinator, Alliance for the Great Lakes, Duluth, MN (2013-2014)
Research Assistant, University of Wisconsin-Eau Claire (2011)
Education Program Coordinator, Longfellow Elementary School, Chippewa Falls, WI (2010-2011)

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

World Aquaculture Society/U.S. Aquaculture Society- Promotion & Membership Outreach Committee Member
Wisconsin Aquaculture Association- Member
North Central Region Aquaculture Center -Technical Advisory Committee for Extension/Board Member
Sea Grant Fisheries, Aquaculture and Seafood Group
National Aquaculture Extension Steering Committee Member

PROFESSIONAL CERTIFICATIONS:

Working with Fish in Research Settings – Collaborative Institutional Training Initiative (CITI) 2023
PIs and Students Working with Fish- Collaborative Institutional Training Initiative (CITI) 2023

SELECTED PUBLICATIONS:

Neibauer J, Branville C, Holmes K, Hauser E and Firkus T (2024) Unobserved mortality occurs early in larval walleye (*Sander vitreus*) aquaculture. *Front. Aquac.* 3:1387495. doi: 10.3389/faquc.2024.1387495

Hauser, E., T. Firkus, K. Holmes, J. Neibauer, C. Branville, C. Hartleb, G. Fischer. 2023. Walleye Culture Guide. University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility. Bayfield, Wisconsin.

Seilheimer, T.S., E. Hauser, and L.N. Jescovitch. 2021. "Fisheries, Hatcheries, and Aquaculture—What's the Difference?" Choices. Quarter 4. Available online: https://www.choicesmagazine.org/choices-magazine/theme-articles/the-economics-of-us-aquaculture/fisheries-hatcheries-and-aquaculturewhats-the-difference

Jescovitch, L., Nelson, E., Titus Seilheimer, T., Hauser, E., and A. Schrank. (2021, March). Introducing the Great Lakes Aquaculture Collaborative: Fostering an Aquaculture Event during COVID-19. Aquaculture Magazine. 52(1), 45-48.

University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility. (2021, March 17). Commercialization of Walleye - Out of Season Spawning [Video]. YouTube. https://www.youtube.com/watch?v=Swfdbp1mW5k&t=4s

University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility. (2020, December 15). Nanobubble Oxygenation in Recirculating Aquaculture Systems [Video]. YouTube. https://www.youtube.com/watch?v=emr0Qfxi_3k

University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility. (2020, November24). Aquaculture Systems- A Basic Overview [Video]. YouTube. https://www.youtube.com/watch?v=8pMxhXdrEo8

D. Allen Pattillo
Aquaculture IQ, LLC.
503 NE 57th Court
Ankeny, IA, 50021

Phone: (404) 274-8052
E-mail: dapattillo@gmail.com
ORCID ID: 0000-0002-0152-9518

EDUCATION

B.S. University of Georgia, 2008, Fisheries and Aquaculture
M.S. Auburn University, 2010, Aquaculture
Ph.D. Auburn University, 2021, Aquaponics

POSITIONS

2025 – Present Owner/Operator of Aquaculture IQ, LLC
2021 – Present Shellfish Aquaculture Technology Specialist, University of Maryland Extension
2018 – 2021 National Needs Fellow and Graduate Research Assistant, Auburn University
2017 – 2018 Project Manager, INMED Partnerships for Children/INMED Caribbean
2011 – 2017 Fisheries and Aquaculture Extension Specialist, NCRAC / Iowa State University
2008 – 2010 Graduate Research Assistant, Auburn University

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

- World Aquaculture Society & United States Aquaculture Society
- The Aquaponics Association
- National Shellfisheries Association: including East Coast and Pacific Coast Shellfish Growers Associations
- American Fisheries Society: including the Iowa Chapter and Fish Culture Section
- National Association of County Agricultural Agents

SELECTED PUBLICATIONS

Xu, M., N. Karapetyan, K. Rajasekaran, A. Williams, **D.A. Pattillo**, P. Tokekar, B. Hudson, Y. Tao, D. Webster, M. Gray, M. Yu. (2025). Machine-Learning Based Classification of On-Bottom Oyster Farms using a Mechanical Scanning Sonar. IEEE Sensors Journal (Early Access). DOI: 10.1109/JSEN.2025.3563788.

Wang, C, G.N.A.D. Peethambari, Y. Shen, W. Chen, S.S.S. Kumar, A. Long, A. Williams, G. Magnusson, **D.A. Pattillo**, D. Webster, M. Gray, M. Yu, Y. Tao. (2024). ShellCollect: A Framework for Smart Precision Shellfish Harvesting Using Data Collection Path Planning. IEEE Access. 177829 - 177843. DOI: 10.1109/ACCESS.2024.3505849.

Cline, D., **D.A. Pattillo**, and P.J. Waters. (2023). Perceived Usefulness of Aquaponics to Teach Agriculture, Stem, and Life Skills in the Classroom. NACAA Journal. 16(1). https://www.nacaa.com/journal/b5002cdc-a2cd-4ec1-9989-28bd8f084320

Lin, X., C. Liu, **D.A. Pattillo**, M. Yu, Y. Aloimonos. (2022). SeaDroneSim: Simulation of Aerial Images for Detection of Objects Above Water. Proceedings of the 1st Workshop on Maritime Computer Vision 2023. https://doi.org/10.48550/arXiv.2210.16107

Pattillo, D.A., Cline, D.J, Hager, J.V., Roy, L.A., & Hanson, T.R. (2022). Challenges Experienced by Aquaponic Hobbyists, Producers, and Educators. The Journal of Extension, 60(4). https://doi.org/10.34068/joe.60.04.13

Pattillo, D.A., J.V. Hager, D.J. Cline, L.A. Roy, and T.R. Hanson. (2022). System design and production practices of hobbyists, producers, educators. PLoS ONE 17(4): e0266475. https://doi.org/10.1371/journal.pone.0266475.

Pattillo, D.A., D.J. Cline, J.V. Hager, L.A. Roy, and T.R. Hanson. (2021). Knowledge Levels and Training Needs of Aquaponic Stakeholders. NACAA Journal. 14(2). https://www.nacaa.com/file.ashx?id=42052aa8-07d7-4dd5-b3c5-a47784d72d9f.

Pattillo, D.A., D.J. Cline, J.V. Hager, L.A. Roy, and T.R. Hanson. (2021). Information Accessibility and Resource Usage by Aquaponic Stakeholders. NACAA Journal. 14(2). https://www.nacaa.com/file.ashx?id=a4cc304a-fc37-48ea-868f-e134168a92b3.

Pattillo, D.A., W.G. Foshee, E.K. Blythe, J. Pickens, D. Wells, T.A. Monday, and T.R. Hanson. (2020). Performance of Aquaculture Effluent for Tomato Production in Outdoor Raised Beds. HortTechnology. 30(5). https://doi.org/10.21273/HORTTECH04655-20.

North Central Regional Aquaculture Center

Liaison Letter of Intent

In accordance with the Guidelines for Extension Involvement in the North Central Regional Aquaculture Center (adopted in 1994), directives of the NCRAC Board of Directors and USDA-NIFA guidance, all NCRAC-funded projects must include an Extension Liaison that is funded to do extension and outreach activities associated with that project. NCRAC projects must also include an Industry Liaison who will serve as a contact between project PI(s) and the Industry.

Name (Appointed Liaison): Marc Tye

Title of Project: Optimization of Feed and Stocking Density for Early Life Stages of Golden Shiner (*Notemigonus crysoleucas*) in Indoor Aquaculture with Integration into STEM Education

Project Duration: 1/10/2026 – 12/31/2027

The conditions and terms of the offer being made to you are outlined below:

Position (Extension or Industry): Industry

Primary Duties/Activities of Liaison: Contact between the project team and industry and consultation on project activites

Appointment offered by: Amy Schrank 9/16/2024
Project Chair **Date**

Offer approved by: _____
NCRAC Director **Date**

I have read and I understand the offer and its terms and conditions, and I agree to these terms and accept this offer. The terms of this offer may be modified only by subsequent written agreement signed by both parties.

Liaison Signature: _____ 9-15-25
Date

Please return this letter by: _____ **to the Project Chair**

Liaison Letter of Intent

In accordance with the Guidelines for Extension Involvement in the North Central Regional Aquaculture Center (adopted in 1994), directives of the NCRAC Board of Directors and USDA-NIFA guidance, all NCRAC-funded projects must include an Extension Liaison that is funded to do extension and outreach activities associated with that project. NCRAC projects must also include an Industry Liaison who will serve as a contact between project PI(s) and the Industry.

Name (Appointed Liaison): Julianne Grenn

Title of Project: Optimization of Feed and Stocking Density for Early Life Stages of Golden Shiner (*Notemigonus crysoleucas*) in Indoor Aquaculture with Integration into STEM Education

Project Duration: 1/01/2026 - 12/31/2027

The conditions and terms of the offer being made to you are outlined below:

Position (Extension or Industry): Extension Liaison

Primary Duties/Activities of Liaison: Share the results of this study through the outlined/proposed methods.

Appointment offered by:_____Amy Schrank_____9/16/2025_____
Project Chair **Date**

Offer approved by:_____
NCRAC Director **Date**

I have read and I understand the offer and its terms and conditions, and I agree to these terms and accept this offer. The terms of this offer may be modified only by subsequent written agreement signed by both parties.

Liaison Signature: Julia Grenn **9/16/2025**
Date

Please return this letter by: _____ to the Project Chair

TYE FISH SOLUTIONS LLC

24182 306th St. LeSueur, MN 56058 | 612-386-8942 | tyefishsolutions@gmail.com

September 15, 2025

NCRAC Review Committee:

This letter is in support of the proposal titled "Optimization of Feed and Stocking Density For Early Life Stages of Golden Shiner in Indoor Aquaculture with Integration into STEM Education" to the 2025 NCRAC Research and Outreach Funding Program.

Many producers with RAS facilities are looking for a high value species that can be cultured in less than one year to cash flow their operations. Golden Shiner (*Notemigonus crysoleucas*) are one of those potential options. Wholesale prices for Golden Shiner in Minnesota average $12-$15/lb. ($100-$130 per gallon) while retail prices can be as high as $175/lb. ($1.50 for one 3" fish).

The Minnesota Sea Grant has recently demonstrated that Golden Shiner can be cultured year-round in indoor recirculating systems achieving marketable size in nine months. As a result of that research several producers have contacted me with interest in culturing Golden Shiner and all have asked the same two questions: Which food should I use? How many fish can I fit in a tank? This information is crucial for planning and operation of a RAS facility and to date has not been studied. Most producers are either not interested or don't have the capacity to gather that critical data and thus don't pursue culturing Golden Shiners.

Feed efficiency can make or break an aquaculture business. Pond culturists can get by with suboptimal feeds because some natural foraging occurs which can supplement what the pellet food lacks. However, in a RAS natural forage does not occur and feeding suboptimal feeds results in poor growth and sick fish which leads to unprofitability. Can Golden Shiner grow well on feeds that contain soy protein? What about insect meal? Is a high protein high fat diet best? These basic questions need to be answered for industry to proceed. In addition, while it is true that optimal fish density will vary between facilities, a baseline of information is needed for producers to go from.

In addition, the educational component of this proposal would help educate young people on fish biology, RAS mechanics, water chemistry, and fish care. Golden Shiners would be a great fit in K-12 educational programs as they grow to marketable size within one school year and could be sold or used by the students when they are most wanted: the spring fishing season.

As a producer I strongly urge you to consider funding this proposal which will help advance indoor culture in our region and add valuable youth educational opportunities.

Sincerely,

Marc Tye
Tye Fish Solutions LLC

ESOTAAQUACULTURE ASSOCIATION

May 1, 2025

Dear Review Committee,

I am writing to support the proposal titled: "Optimization of feed and stocking density for early life stages of Golden Shiner in indoor aquaculture with integration into STEM education" to the FY 2025 NCRAC Research and Outreach Funding Program. Golden Shiner are a baitfish in high demand by anglers in the North Central Region. The economic value of the bait industry is routinely greater than 50% of aquaculture production as reflected in the USDA Census of Aquaculture. Unfortunately, the in-state supply of Golden Shiner does not meet the demand in many states. In Minnesota in particular the shortage is difficult because current laws do not allow importation of baitfish to avoid the introduction of invasive species and fish diseases. Other challenges to the bait industry include decreases in wild minnow populations, a short growing season, and increasing ranges of invasive species and disease that restrict wild harvest 1.

Optimizing indoor production of Golden Shiner is an important step to overcoming these challenges to the industry. The objectives in this proposal are to help producers understand what feed and fish densities work best in indoor production systems and will provide important information to the bait industry. It is particularly important that this research emphasizes using commercially available feed in the Midwest region because this provides a realistic picture of how producers in the region can proceed 2.

Having an educational component to this work is critical because we need young people to understand how important aquaculture is to both our recreational and wild fisheries as well as food production. Putting aquaculture into classrooms in a hands-on way is an effective way to change perceptions of aquaculture for the better 3.

As the President of the Minnesota Aquaculture Association, I urge you to strongly consider funding this proposal given its importance to the region, the useful information it will provide to producers to advance indoor production, and the value of the education components 4.

Sincerely,

Clarence Bischoff

Clarence Bischoff, President

Minnesota Aquaculture

Association

May 1, 2025

Dear Review Committee:

I am writing to support the proposal titled: “Optimization of feed and stocking density for early life stages of Golden Shiner in indoor aquaculture with integration into STEM education” to the FY 2025 NCRAC Research and Outreach Funding Program. Golden Shiner are a baitfish in high demand by anglers in the North Central Region. The economic value of the bait industry is routinely greater than 50% of aquaculture production as reflected in the USDA Census of Aquaculture. Unfortunately, the in-state supply of Golden Shiner does not meet the demand in many states. In Minnesota in particular the shortage is difficult because current laws do not allow importation of baitfish to avoid the introduction of invasive species and fish diseases. Other challenges to the bait industry include decreases in wild minnow populations, a short growing season, and increasing ranges of invasive species and disease that restrict wild harvest

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Having an educational component to this work is critical because we need young people to understand how important aquaculture is to both our recreational and wild fisheries as well as food production. Putting aquaculture into classrooms in a hands-on way is an effective way to change perceptions of aquaculture for the better.

As the Director of Education and Outreach for the Minnesota Aquaculture Association, a beginning aquaculture farmer, and an avid sportsman, I urge you to strongly consider funding this proposal given its importance to the region, the useful information it will provide to producers to advance indoor production, and the value of the education components.

Sincerely,

Thad S. Erickson

Thad S. Erickson
Director of Education and Outreach
Minnesota Aquaculture Association
640 Prior Ave
St. Paul, MN 55104

May 1, 2025

Dear Review Committee:

I am writing to support the proposal titled: "Optimization of feed and stocking density for early life stages of Golden Shiner in indoor aquaculture with integration into STEM education" to the FY 2025 NCRAC Research and Outreach Funding Program. Golden Shiner are a baitfish in high demand by anglers in the North Central Region. The economic value of the bait industry is routinely greater than 50% of aquaculture production as reflected in the USDA Census of Aquaculture. Unfortunately, the in-state supply of Golden Shiner does not meet the demand in many states. In Minnesota in particular the shortage is difficult because current laws do not allow importation of baitfish to avoid the introduction of invasive species and fish diseases. Other challenges to the bait industry include decreases in wild minnow populations, a short growing season, and increasing ranges of invasive species and disease that restrict wild harvest

Optimizing indoor production of Golden Shiner is an important step to overcoming these challenges to the industry. The objectives in this proposal are to help producers understand what feed and fish densities work best in indoor production systems and will provide important information to the bait industry. It is particularly important that this research emphasizes using commercially available feed in the Midwest region because this provides a realistic picture of how producers in the region can proceed.

Having an educational component to this work is critical because we need young people to understand how important aquaculture is to both our recreational and wild fisheries as well as food production. Putting aquaculture into classrooms in a hands-on way is an effective way to change perceptions of aquaculture for the better.

As a bait dealer, wholesale bait dealer and more importantly, minnow/leech farmer, I urge you to strongly consider funding this proposal given its importance to the region, the useful information it will provide to producers to advance indoor production, and the value of the education components.

Sincerely,

Steven Renneberg

Kristina Winkelman

ARROWHEAD OUTDOORS
BAIT TACKLE HUNT CAMP

WASHBURN
HIGH SCHOOL

May 5, 2025

Dear Review Committee:

I am writing to support the proposal titled: "Optimization of feed and stocking density for early life stages of Golden Shiner in indoor aquaculture with integration into STEM education" to the FY 2025 NCRAC Research and Outreach Funding Program. We would look forward to the opportunity to partner with the project team to learn how to grow Golden Shiner in our classroom and use this as an opportunity to teach students about aquaculture and the aspects of engineering, biology, water chemistry, marketing, and entrepreneurship that are involved with growing fish in an aquaculture system.

At the Washburn School District, we currently have two Nelson and Pade raft systems that we use to grow herbs and greens for use in the cafeterias across our district, as well as for donation or sale to local food banks and a sliding scale cafe. We have a cold-water system with Arctic char and a warm-water system with walleye. Our independent study Aquaponics students are the primary managers of these systems- performing regular water quality checks, flushing and cleaning them, harvesting produce, replanting into the grow beds, and experimenting with new crops. We involve HS Biology, Ecology, and Food, Science, and the Environment classes with our aquaponics lab and the Aquaponics students give tours to elementary classes throughout the school year as well. The students tend to be more excited about the walleye as they are a local fish that kids often have real-life experience with from fishing or eating it outside of school. They really enjoy getting to learn more about this species and its ecology in our area. Many of our students go fishing with their families and spend time on local waterways and participating in this project on Golden Shiner would be extremely rewarding to them.

Growing minnows in the classroom provides a manageable opportunity for students to experience aquaculture firsthand and an excellent context for students to learn and apply a number of STEM skills. The opportunity for students to participate in data collection to support this project will teach students elements of research and engage them in the process of science. The supplies and technical assistance that will be provided by this project will ensure that teachers receive the support they need to repeat these projects for future students.

The educational component to this work will also introduce teachers and students to the idea that aquaculture is important to both our recreational and wild fisheries. Raising bait in the classroom might also offer students the opportunity to consider a marketing strategy to sell the fish they raise either to local bait shops or anglers.

As the aquaponics caretaker at the Washburn School District, I work closely with students and science classes and urge you to strongly consider funding this proposal. It is a beneficial opportunity to introduce aquaculture to classrooms as a hands-on way to teach STEM principles, provide teachers and students with a background in aquaculture in general, and raise fish that support recreational fishing, an important economic driver in many communities.

Sincerely,

Alex Prediger

Alex Prediger, Washburn School District Garden/Aquaponics Caretaker

Chilton Public Schools

530 W. Main Street
Chilton, WI 53014

Telephone: (920) 849.8109
Fax:(920) 849.2708

Susan Kaphingst, Superintendent
Samantha Woelfel, Business Manager

May 1, 2025

Dear Review Committee:

We are writing to support the proposal titled: "Optimization of feed and stocking density for early life stages of Golden Shiner in indoor aquaculture with integration into STEM education" to the FY 2025 NCRAC Research and Outreach Funding Program. We would look forward to the opportunity to partner with the project team to learn how to grow Golden Shiners in our classroom and use this as an opportunity to expand our teaching about aquaculture & aquaponics and the aspects of engineering, biology, water chemistry, marketing, and entrepreneurship that are involved with growing fish in an aquaculture system with our students.

Chilton High School implemented aquaculture & aquaponics in 2016 when we started the Trout in the Classroom program. Since then, the 10th grade biology students have raised and released thousands of brown and brook trout into a local stream in order to rehabilitate the only trout stream in Calumet County. Students learn fish husbandry, data collection and water quality testing techniques, calculate food amounts, and the importance of the nitrogen cycle in aquaculture, aquaponics, and in natural ecosystems. In 2019, the school installed a small scale commercial aquaponics system to enhance student learning opportunities. This is an experimental system where students learn how to raise different species of food fish, like tilapia, walleyes, and bluegills. Students also experiment growing different types of vegetables that may be suitable for aquaponics systems, while growing different lettuce varieties that are used for school lunches. The Golden Shiner project would be implemented in our aquaponics system, while continuing to raise trout through the Trout in the Classroom program.

Growing minnows in the classroom provides a manageable opportunity for students to experience aquaculture & aquaponics firsthand and an excellent context for students to learn and apply a number of STEM skills. The opportunity for students to participate in data collection to support this project will teach students elements of research and engage them in the process of science. The supplies and technical assistance that will be provided by this project will ensure that teachers receive the support they need to repeat these projects for future students.

The educational component to this work will also introduce teachers and students to the idea that aquaculture & aquaponics is important to both our recreational and wild fisheries. Raising bait in the classroom might also offer students the opportunity to consider a marketing strategy to sell the fish they raise either to local bait shops or anglers.

As a classroom teacher, and as the superintendent of Chilton Public Schools, we urge you to strongly consider funding this proposal given the beneficial opportunity to enhance our aquaculture/aquaponics classroom programs with a hands-on way to teach STEM principles, provide teachers and students with a background in aquaculture in general, and raise fish that support recreational fishing, an important economic driver in many communities.

Sincerely,

Tracy Bartels
Science Teacher
Chilton High School
Chilton, WI 53014

Susan Kaphingst
Superintendent
Chilton Public Schools
Chilton, WI 53014

May 1, 2025

Dear Review Committee:

I am writing to support the proposal titled: “Optimization of feed and stocking density for early life stages of Golden Shiner in indoor aquaculture with integration into STEM education” to the FY 2025 NCRAC Research and Outreach Funding Program. We would look forward to the opportunity to partner with the project team to learn how to grow Golden Shiner in our classroom and use this as an opportunity to teach students about aquaculture and the aspects of engineering, biology, water chemistry, marketing, and entrepreneurship that are involved with growing fish in an aquaculture system.

Currently, in the classroom we grow Blue Gill, Trout, Perch and Tilapia. These are raised and cared for by several different classes in the Agriscience Program. They include Urban Food Production, WI Natural Resources and I also plan to incorporate this into my Sustainable Ag class next school year as well.

Growing minnows in the classroom provides a manageable opportunity for students to experience aquaculture firsthand and an excellent context for students to learn and apply a number of STEM skills. The opportunity for students to participate in data collection to support this project will teach students elements of research and engage them in the process of science. The supplies and technical assistance that will be provided by this project will ensure that teachers receive the support they need to repeat these projects for future students.

The educational component to this work will also introduce teachers and students to the idea that aquaculture is important to both our recreational and wild fisheries. Raising bait in the classroom might also offer students the opportunity to consider a marketing strategy to sell the fish they raise either to local bait shops or anglers.

As a classroom teacher, I urge you to strongly consider funding this proposal given the beneficial opportunity to introduce aquaculture to classrooms as a hands-on way to teach STEM principles, provide teachers and students with a background in aquaculture in general, and raise fish that support recreational fishing, an important economic driver in many communities.

Sincerely,

Rachel Ziegler

Agriscience Teacher, Green Bay Southwest

Email: rmziegler@gbaps.org

Phone: 920.614.9215

SCHOOL DISTRICT *of* BAYFIELD

May 7, 2025
Dear Review Committee:

I am writing to support the proposal titled: "Optimization of feed and stocking density for early life stages of Golden Shiner in indoor aquaculture with integration into STEM education" to the FY2025 NCRAC Research and Outreach Funding Program. I would like to partner with the project team to learn how to grow Golden Shiner in my classroom and use this as an opportunity to teach students about aquaculture and the aspects of engineering, biology, water chemistry, marketing, and entrepreneurship that are involved with growing fish in an aquaculture system.

I have worked with NADF in the past raising Saugeye. The focus of that experiment was to primarily understand stocking densities and water chemistry. The fish became a favorite classroom pet growing upwards of 11 inches in a few years. The size became a bit of a liability to our systems.

Growing minnows in the classroom will provide a more manageable opportunity for students to experience aquaculture firsthand and an excellent context for students to learn and apply a number of STEM skills. The opportunity for students to participate in data collection to support this project teaches students elements of research and engages them in the process of science. The supplies and technical assistance that will be provided by this project will ensure that I have the support I need to repeat these projects for future students.

The educational component to this work will also provide a greater focus on the idea that aquaculture is important to both our recreational and wild fisheries. Raising bait in the classroom will offer students the opportunity to consider a marketing strategy to sell the fish they raise either to local bait shops or anglers.

As a classroom teacher, I urge you to strongly consider funding this proposal given the beneficial opportunity to introduce aquaculture to classrooms as a hands-on way to teach STEM principles, provide teachers and students with a background in aquaculture in general, and raise fish that support recreational fishing, an important economic driver in our community.
Sincerely,

Mark ONeill
Bayfield High School

Beth Paap | District Administrator 715 779 3201 Ext. 101
Shellie Swanson | 6-12 Principal 715 779 3201 Ext. 506
Michael Peterson | 4K-5 Principal 715 779 3201 Ext. 317
Lynn Lindahl | SpEd & Pupil Services Director 715 779 3201 Ext. 103

September 12, 2025

Dear Review Committee:

I am writing to support the proposal titled: "Optimization of feed and stocking density for early life stages of Golden Shiner in indoor aquaculture with integration into STEM education" to the FY 2025 NCRAC Research and Outreach Funding Program. We would look forward to the opportunity to partner with the project team to learn how to grow Golden Shiner in our classroom and use this as an opportunity to teach students about aquaculture and the aspects of engineering, biology, water chemistry, marketing, and entrepreneurship that are involved with growing fish in an aquaculture system.

Growing minnows in the classroom provides a manageable opportunity for students to experience aquaculture first hand and an excellent context for students to learn and apply a number of STEM skills. The opportunity for students to participate in data collection to support this project will teach students elements of research and engage them in the process of science. The supplies and technical assistance that will be provided by this project will ensure that teachers receive the support they need to repeat these projects for future students.

The educational component to this work will also introduce teachers and students to the idea that aquaculture is important to both our recreational and wild fisheries. Raising bait in the classroom might also offer students the opportunity to consider a marketing strategy to sell the fish they raise either to local bait shops or anglers.

As a classroom teacher, I urge you to strongly consider funding this proposal given the beneficial opportunity to introduce aquaculture to classrooms as a hands-on way to teach STEM principles, provide teachers and students with a background in aquaculture in general, and raise fish that support recreational fishing, an important economic driver in many communities.

I was very fortunate to work with Julia Grenn when she supported my students' work in the Aquaculture challenge during the 2024-2025 school year. Julia's knowledge, passion for aquaculture, communication, and excellent support of the students' work really made the experience one of the students' favorite projects. I have no doubt that many of the skills that the students practiced will translate to new challenges they face in the classroom and beyond.

Sincerely,

Brian Scott

Harbor CIty International School

Duluth, Minnesota

North Central Regional Aquaculture Center

Checklist for Submission of Full Proposals

Follow guidelines with the exception of the budget sheets.

- ✓ Format manuscripts for 22 x 28 cm (8½ x 11 inch).
- ✓ Number *all* pages sequentially.
- ✓ Use 10-12 font; Times New Roman. Do not justify right margins.
- ✓ Format headings appropriately.
- ✓ Leave at least a 2.5-cm (1-inch) margin on all sides.
- ✓ Use metric units of measurement with English units in parenthesis, e.g. 2.54 cm (1 inch).
- ✓ Define all abbreviations the first time they are used.
- ✓ Express ratios by using a slant line (e.g. mg/L).
- ✓ Scientific names should accompany common names in the title and when they are first mentioned in the abstract and in the text. Authority for scientific names need not accompany the genus and species unless needed for clarity.
- ✓ Spell out one to ten unless followed by a unit of measurement (e.g. four fish, 4 kg, 14 fish). Do not begin a sentence with a numeral. Use 1,000 instead of 1000; 0.13 instead of .13; and % instead of percent.
- ✓ Use the 24-hour clock for dial time: 0830, not 8:30 a.m. The calendar date should be day month year (7 August 1990).
- ✓ Include signed Letters of Intent for identified Extension and Industry Liaisons.
- ✓ Signed Authorized Organization Representative (AOR) form from each funded PI's institution are welcomed but not required at this time.
- ✓ Include the required three (3) Letters of Support from Industry members who are not directly involved in the proposed project.
- ✓ Assemble the full proposal in this order: Title Page, Project Summary, Justification, Related Current and Previous Work, Statement Regarding Duplication of Research, Anticipated Benefits, Objective(s), Deliverables, Procedures, Project Deliverables, Evaluation and Outreach (Logic Model included), Facilities, References, Project Leaders, Budget, Budget Explanation per Institution, Budget Summary, Schedule for Completion of Objectives. References, Participating Institutions and Principal Investigators, Curriculum Vitae for Principal Investigators (PIs).
- ✓ Provide names of three possible reviewers who will not have a Conflict of Interest
- ✓ All identified co-PIs have been provided a final draft of the full proposal.
- ✓ Submit proposal (including all required documentation) in single MS Word document.

If the NCRAC Administrative Office cannot verify inclusion of any element, the Full Proposal will not be accepted.

Principal Investigator Signature — Date

Amy J Schwartz — 9/18/2025