ANNUAL REPORT 2023

Aquaculture Research Institute

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University of Idaho

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DIRECTOR'S MESSAGE

The University of Idaho's Aquaculture Research Institute is one of a kind. Through our in-house partnerships with the US Department of Agriculture and the Columbia River Inter-Tribal Fish Commission (CRITFC), we address the needs of Idaho aquaculture, US trout farming, global needs for sustainable fish nutrition, and regional fisheries management issues with approaches ranging from nutritional biochemistry to next generation genomics and bioinformatics. I think it is fair to say that no other university-based, coldwater, aquaculture and fisheries program in the Americas matches the breadth and capacity of our facilities and people. It is no wonder ARI is internationally recognized in fish nutrition, health, physiology, genetics and genomics as it applies to coldwater aquaculture and fisheries management.

Over the past year we have maintained a robust collaborative and cross-disciplinary research program, while also gaining momentum in extension and outreach, both regionally and internationally. When considering competitive and appropriated funding together, our 16 affiliated faculty manage over a million dollars per capita in research funding annually. Furthermore, we are uniquely established to work with industry partners and consistently administer more industry projects than any other unit at the university.

This past year was also an important one for our tribal collaborations. In working with the College of Natural Resources (CNR) and CRITFC, we established a new tenure-track position in the "Tribal Dimensions of Fisheries." I'm excited to see this position role out and look forward to strengthening our tribal research, teaching, outreach and mentoring in our aquaculture and fisheries programs in CNR and ARI. This position is just the start of great things to come.

As I look back over the year, there is so much to brag about, but most of all I'm proud to work with some of the brightest minds in our field and lead a group of people who push the science forward while providing solutions to critical problems for our stakeholders.

Go Vandals!

Brian C. Small, PhD
ARI Director, Office of the Vice President for Research and Economic Development
Professor, Fish and Wildlife Sciences
Affiliate Professor, Animal, Veterinary & Food Sciences

HIGHLIGHTS

Feeds and Nutrition

- Collaborated with industry partners to advance sustainable ingredients for trout feeds
- Advanced research on feed intake, efficiency and nutrient utilization in rainbow trout
- Evaluated a high omega-3 LC-PUFA oil from transgenic canola on growth and safety of rainbow trout and Pacific white shrimp
- Awarded “Top Cited Article” in The Journal of the World Aquaculture Society (https://doi.org/10.1111/jwas.12948)

Genetics and Genomics

- ARI selectively bred trout commercially produced and marketed for export into Peru
- Implemented integrated approaches to select for feed efficient rainbow trout families to enhance soy protein utilization
- Supported the development of commercial burbot culture and pioneered improvements in hatchery production and chromosomal manipulation
- Continued work with tribal supplementation programs to measure the effects of hatchery rearing across multiple generations

Physiology, Health, and Management

- Started a pilot study to estimate the epigenetic signatures of hatchery rearing
- Discovered and validated candidate genes associated with salmonid migratory traits
- Advanced biochar use after water treatment as fertilizer for rare earth extraction

  Awarded “Best Paper” in the Transactions of the American Fisheries Society (https://doi.org/10.1002/tafs.10359)

Extension and Outreach

- Provided extension support to local trout farm conducting an on-farm feeding trial in collaboration with industry partners
- Provided an update on the “Sustainability of U.S. Raised Rainbow Trout as a Human Food-Choice” for the Monterrey Bay Aquarium-Seafood Watch Program
- Established plan and relationships for bolstering trout culture education, extension, and outreach in the Republic of Georgia
- Advanced “Aquaculture in the Classroom” at several Idaho schools

BY THE NUMBERS

2023

OUTPUTS

61 peer-reviewed journal articles
15 extension and outreach events
44 abstracts & presentations
10 technical & trade articles
16 books & book chapters

FUNDING

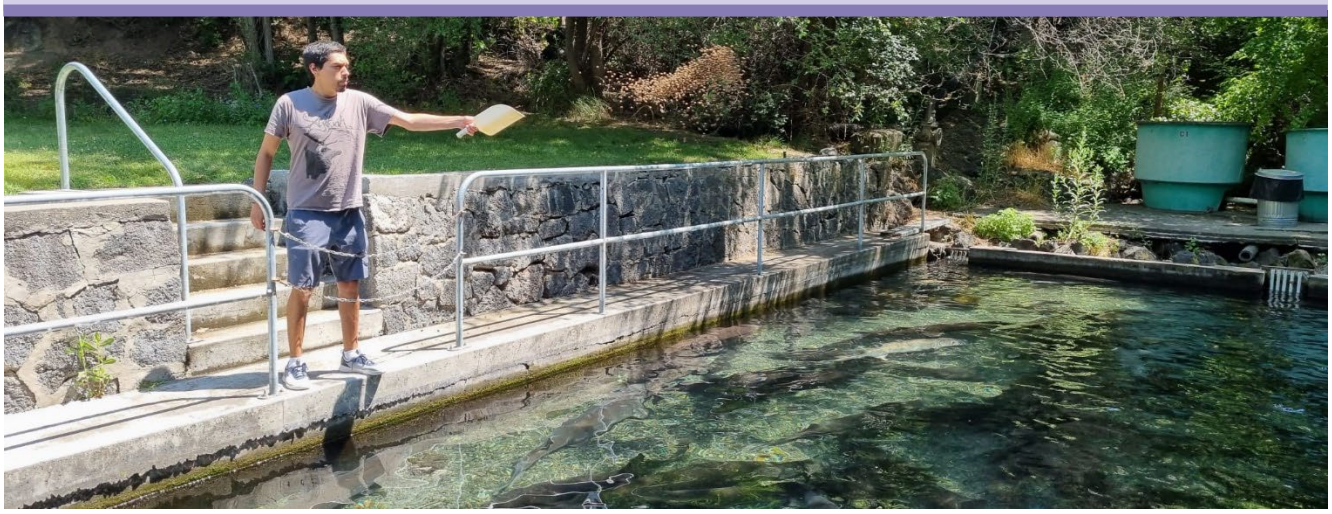
$6 million in newly funded sponsored projects
$4.4 million in continuing sponsored projects
8 tribal and governmental cooperative agreements

TRAINING

11 postdocs, research scientists & visiting scholars
15 Ph.D. students
17 M.S. students
2 undergraduate interns

Extension

1,572 direct contacts and ~25,000 indirect contacts



ABOUT ARI

Established in 1988, the Aquaculture Research Institute (ARI) at the University of Idaho stands as a premier interdisciplinary hub, dedicated to advancing aquaculture and related fisheries research. Its mission encompasses a broad spectrum of activities including food production, fisheries management, and restoration of fish stocks. ARI serves as a nexus for faculty from diverse disciplines across the university, pooling expertise in fish nutrition, genetics, genomics, physiology, immunology, and water quality.

The institute spearheads and facilitates research, education, and extension efforts across various scientific domains, collaborating closely with multiple departments and colleges within the university. ARI's partnerships also extend beyond academia, forging formal collaborative ties with federal, state, and tribal agencies, as well as commercial enterprises.

ARI's research portfolio spans fundamental and applied investigations in aquaculture, fisheries, and aquatic resources. While rainbow trout serves as a focal species, ARI researchers explore a wide array of native and non-native organisms including Pacific salmon and trout, Atlantic salmon, sturgeon, lamprey, burbot, tilapia, catfish, shrimp, and zebrafish. Research endeavors encompass not only fish rearing studies but also delve into the molecular, cellular, and organismal dynamics governing responses to environmental stimuli, diet, and pathogens by employing cutting-edge techniques such as next-gen sequencing, proteomics, metabolomics, and bioinformatics.

Key research thrusts at ARI encompass fish nutrition, physiology, health, selective breeding, genomics, water quality, and sustainability. ARI is dedicated to mitigating the environmental footprint of aquaculture while unraveling the intricate interplay between genetics and the environment in shaping phenotypic traits. In essence, ARI is committed to fostering environmentally sustainable aquaculture and fisheries management through cutting-edge research and the cultivation of future leaders in these vital fields.

FACILITIES

Hagerman Fish Culture Experiment Station

The Hagerman Fish Culture Experiment Station is in south-central Idaho approximately 90 miles southeast of Boise, Idaho, the state capital. The University of Idaho leased the facility from the US Fish & Wildlife Service in 1996 and took possession of the 4-acre property in 1998. In 2006, a new 14,000 ft^2 building was dedicated, and included offices, a classroom, and analytical laboratories. A six-bedroom dormitory and additional fish rearing buildings were also constructed, augmenting existing fish rearing facilities and providing housing for trainees and visiting scholars.

Hagerman Station features a 6000 ft^2 wet lab supplied with 2000 gpm, 14.5°C, gravity-fed, first-use spring water. The wet lab contains 142 38-gallon (145-liter) and 42 152-gallon (450-liter) tanks for conducting comprehensive experimental procedures. Egg incubators and hatchery small troughs are used for incubating eggs and start-feeding trout fry. Quarantine facilities with the capacity to heat or chill water and to sterilize the effluent are in a separate, biosecure building. Physiological and behavioral studies can be conducted in a common garden environment consisting of six recirculating aquaculture systems and utilizing state-of-the art swimming, respirometry, and cardiac output chambers. Thirty covered outdoor tanks utilize second-use water and are suitable for raising groups of fish to maturity. Outdoor, 1/3 scale raceways (8 total) complete the fish rearing facilities. The Hagerman Station also has extensive analytical laboratories used to support research in feeds, molecular biology, population genetics and genomics, including next-generation sequencing.

Cold Water Laboratory

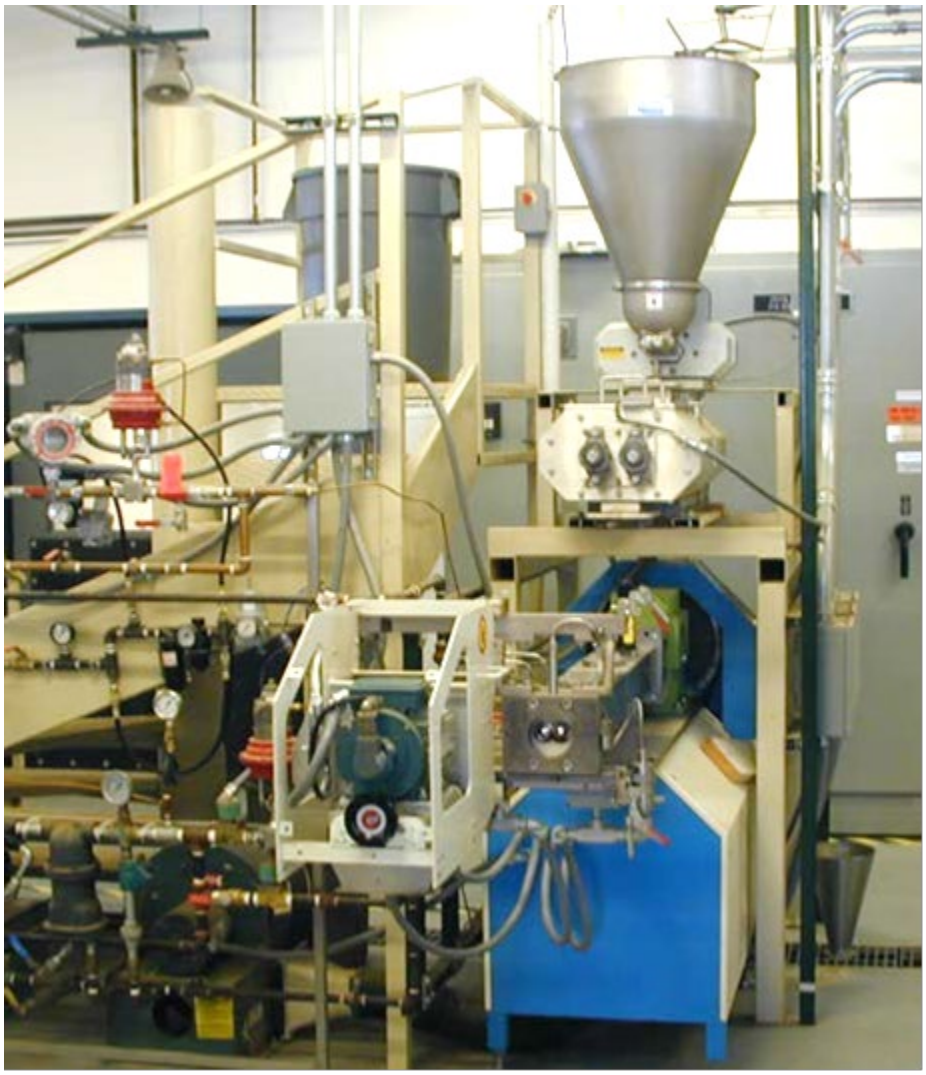
The 8000 ft^2 Cold Water Laboratory operates on the Moscow campus as a water-limited recirculating facility. There are currently seven independent recirculating systems on backup power that can accommodate a variety of cold-water species, including salmonid species and sturgeon. The facility also maintains one warmwater system for rearing tilapia. Each system has independent chilling/heating, biofiltration, and UV treatment. The largest system has four four-meter diameter tanks for rearing of large populations or broodstock. The other systems are high-replicate systems, comprised of as many as 66 tanks. The Cold Water Lab has the capabilities to incubate eggs in Heath tray incubators and McDonald jars. Fry can also be held in fiberglass troughs and fed with either single-pass or recirculating water. Temperatures in the systems can be maintained between 4 °C and 20 °C. The Moscow Cold Water Lab facilities are available to researchers across the University for a nominal fee.

Aquatic Animal Research Facility

In 2019, the University completed construction of the Aquatic Animal Research Facility (AARF) on the Moscow campus. Adjacent to the Cold Water Laboratory, this two-story facility boasts office and classroom space coupled with a state-of-the-art 4000 ft^2 wet lab. The AARF also operates as a water-limited recirculating facility. There are currently four independent recirculating systems with backup power. Three of these systems were specifically designed to facilitate new species development. A live-feed room to produce artemia and rotifers supports this work. The fourth system is a dedicated, high-replicate marine system suited for shrimp and marine fish research.

Bozeman Fish Technology Center

Through a cooperative agreement with the USDA/ARS Trout Feeds Program, ARI researchers have access to state-of-the-art diet manufacturing equipment for making fish feeds at the Bozeman Fish Technology Center, Montana. This includes a variety of equipment including a hammer mill, air swept pulverizer, mixers of various sizes and types, pelleting equipment including a Buhler twin screw extruder, feed drier, and a vacuum coater for oil addition.



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Trainees

Postdoctoral Fellows, Research Scientists & Visiting Scholars

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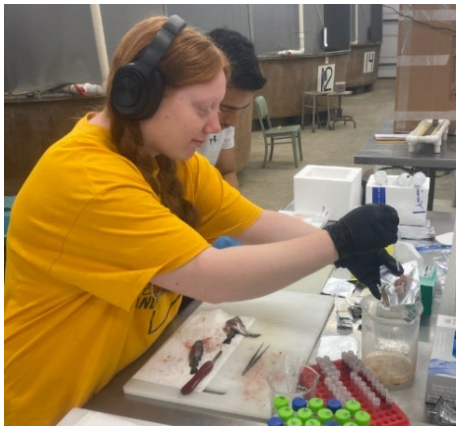
Kathryn Rapp, Mississippi State University
Kira Long, Postdoctoral fellow
Luke Oliver, Postdoctoral fellow
Marina Subramanium, Postdoctoral fellow
Nathan Redman, Genomics Research Scientist
Shannon Blair, Postdoctoral fellow
Susana Frias Gomez, UNAM, Mexico City
Vandana Dharan, Mississippi State University
Yoandy Coca, PhD Student, UC Chile

Graduate Students

Adam Wicks-Arshack, Ph.D. in Water Resources
Aldwin Keo, M.S. in Natural Resources
Anna Chase, M.S. in Environmental Science
Alonso Longoria, Ph.D. in Animal Physiology
Brent Vulgar, M.S. in Natural Resources
Clayton Mabey, M.S. in Animal Physiology
Christine Trahan, M.S. in Natural Resources
Daniel Assan, Ph.D. in Natural Resources
David Arthaud, Ph.D. in Natural Resources
Elaine Harvey, Ph.D. in Natural Resources
Ethan Struhs, Ph.D. in Biological Engineering
Gabriella Goodwill, M.N.R
Jacob Styhl, M.S. in Biological Sciences
Joe Hirsch, M.S. in Biological Sciences
Jonathan Masingale, Ph.D. in Natural Resources
Jose Ortiz, M.S. in Natural Resources
Kimia Kajbaf, Ph.D. in Animal Physiology
Krishna Singha, Ph.D. in Animal Physiology
Maryam Deghani, M.S. in Animal Physiology
Marina Rubio Benito, Ph.D. in Animal Physiology
Matt Glimm. M.S. in Biological Sciences
Melanie Regan, Ph.D. in Natural Resources
Megan Cox, M.S. in Natural Resources
Megan Roberts, M.S. Environmental Science.
Mosope Abanikannda, Ph.D. in Animal Physiology
Moureen Matuha, Ph.D. in Natural Resources
Nicholas Hoffman, Ph.D. in Biological Sciences
Nicole Nance, M.S. in Animal Physiology
Rachael Valeria, M.S. in Biology
Rance Bare, Ph.D. in Biological Engineering
Ryan Maxwell, M.S. Natural Resources
Susana Frias-Gomez, PhD, UNAM
Veronica Myrsell, M.S. in Natural Resources

Undergraduate Interns

Hallie Morris, B.S. in Ecology and Conservation Biology
Emma Walker, B.S. in Environmental Science



OUTPUTS AND ACCOMPLISHMENTS

Formal Agreements

1. Nagler, J.; Columbia River Inter-Tribal Fish Commission (CRITFC) (Formal agreement on multiple projects (steelhead trout, Chinook salmon, Pacific lamprey) with Dr. Andrew Pierce [CRITFC research scientist] and Mr. Neil Graham [CRITFC field technician], both on-site at the UI Moscow campus, Est. 2009.
2. Overturf, K. coPIs: Welker, T., Liu, K., Sealey, W.; USDA Agricultural Research Service, Hagerman, ID. (In-House Appropriated project); Est. 1999.
3. Overturf, K. coPI Sealey, W.; US Fish and Wildlife Service. Bozeman Fish Technology Center (Cooperative Agreement); Est. 2005.
4. Overturf, K.; Ovaseed (Formal agreement with for providing selectively bred trout that are now being reared in Peru with plans to move these stocks to Ecuador and Columbia); Est. 2022.
5. Small, B.C.; Columbia River Inter-Tribal Fish Commission (Memorandum of Understanding); Est. 2000.
6. Small, B.C.; USDA Agricultural Research Service, Franklin, ME (Cooperative Agreement); Est. 2017.
7. Small, B.C.; USDA Agriculture Research Service, Aberdeen, ID (Cooperative Agreement); Est. 1999.
8. Small, B.C.; Columbia River Inter-Tribal Fish Commission (CRITFC) (between CRITFC and UI for joint faculty position in Tribal Dimensions of Fisheries in the Department of Fish & Wildlife Sciences.); Est. 2023.

New Sponsored Projects

1. Bledsoe, J.W. 2023: Exploring the adaptive potential of mucosal microbiomes to increased temperature regimens in rainbow trout (*Oncorhynchus mykiss gairdeneri*) populations locally adapted to disparate ecotypes. Idaho EPSCoR Small SEED Grant. (**$29,000**).
2. Bledsoe, J.W. 2023-2026: Agriscience Technology Pathways (ATP). USDA-NIFA-AFRI-FANE. (**$750,000**).
3. Bockus, A., Gaylord, T.G., Powell, M.S., Bledsoe J.W. 2023-2026. Enhancing trout performance through dietary acidification. Western Regional Aquaculture Center, USDA-NIFA. (**$292,044**).
4. Johnson, C., Cain, K.D. 2023-2025: Developing Freshwater Cod (Burbot; *Lota Lota*) Into A Commercial Aquaculture Species. USDA SBIR Phase I. (**$175,000**).
5. Kumar, V., Ma, J., Cain, K. 2023-2024: A nutrigenomic strategy to increase the soybean meal utilization in aquaculture finfish: Determination of optimum levels for the enhancement of non-specific pathogen resistance without inducing enteritis. Soy Aquaculture Alliance. (**$99,589**).
6. Nagler, J. 2023: Assessment of sex and reproductive maturation in Pacific lamprey. Columbia River Inter-Tribal Fish Commission. (**$54,907**).
7. Nagler, J. 2023: Evaluation of plasma levels of insulin-like growth factor-1 as a tool for assessing growth in juvenile salmonids under field conditions. Columbia River Inter-Tribal Fish Commission. (**$28,650**).

8. Nagler, J. 2023: Thermal tolerance for the western ridged mussel. Confederated Tribes of the Umatilla Indian Reservation. (**$62,106**).
9. Nagler, J. 2023-2026: Persistence of small bull trout populations in Idaho sub-alpine lakes. US Fish & Wildlife Service, Idaho Fish and Wildlife Office. (**$57,599**).
10. Narum, S.R. 2023-2025: Genetic Assessment of Columbia River Stocks. Bonneville Power Administration, Accords Grant. (**$1,400,000**).
11. Powell, M., Kendeh, A. 2023: Mandela Fellowship Reciprocal Exchange with Sierra Leone. US Dept of State. (**$5000**).
12. Roe, A.J., Powell, M.S, Ross, C.F., Johnson, S.L., Lee S.G., Bledsoe, J.W. 2023-2028: Increasing trout consumption in young children and families for cognitive and mental health benefit. USDA-NIFA-AFRI. (**$1,150,000**).
13. Small, B.C. 2023: Aquaculture technician support 3. USDA Agricultural Research Service. (**$57,961**).
14. Small, B.C. 2023: Hagerman Lab Supplies. Columbia River Inter-Tribal Fish Commission. (**$955,240**).
15. Small, B.C. 2023-2024: Fish Tank. Private Company. (**$145,170**).
16. Small, B.C. 2023-2024: Precision Resilient Inland Aquaculture. USDA Agricultural Research Service. (**$225,000**).
17. Small, B.C., Bledsoe, J., Powell, M. 2022-2023: Bolstering fish culture education, extension, and outreach in the Republic of Georgia. USDA, Foreign Agricultural Service. (**$94,295**).
18. Small, B.C., Bledsoe, J.W., Powell, M. 2023-2024: Bolstering fish culture education, extension, and outreach in Georgia. USDA Foreign Agriculture Service. (**$264,052**).
19. Small, B.C., Hamidoghli, A. 2023-2024: Evaluation of ANDVantage 50Y in rainbow trout (*Oncorhynchus mykiss*) feeds. Private Ingredient Company. (**$64,535**).
20. Small, B.C., Kumar, V. 2023-2024: Evaluation of oil from DHA Canola on growth and safety of Pacific white shrimp (*Litopenaeus vannamei*). Private Ingredient Company. (**$57,523**).
21. Welker, T.L. 2023-2024: Evaluation of Corn DDGS in Practical Feeds of Tilapia. USDA Cooperative Research Agreement with US Grains Council (Kuala Lumpur, Malaysia) and Ohio Corn and Wheat Council Project. (**$32,879**).

Continuing and/or Terminating Sponsored Projects

1. Bledsoe, J.W. Evaluating inclusion of commercial pistachio by-product as functional ingredients in rainbow trout fishmeal and plant-meal based diets. University of Kansas Center for Research, USDA-NIFA. (**$183,805**).
2. Cain, K.D. & Ma, J. 2022-2023: Efficacy and immunomodulatory properties of the probiotic Enterobacter C6-6 for early life stage management of coldwater and columnaris disease and related co-infections. USDA-NIFA. (**$295,930**).
3. Cain, K.D. & Ma, J. 2022-2023: Evaluation of immune response and survival of single or dual pathogens in juvenile rainbow trout fed commercial health-promoting diets. Private Feed Company. (**$29,741**).
4. Cain, K.D. & Ma, J. 2022-2024: Coldwater vaccine optimization for licensing and commercialization. Private Animal Health Company. Ongoing project since FY 14 = $1,545,453. (**$256,523**).

5. Cain, K.D. 2022-2023: Production of juvenile burbot for support of commercial aquaculture venture. InCity Farms. (**$179,719**).
6. Caudill, C.C. & Nerkowski, S. 2021-2022: SLIME B: Stream and Lake Invertebrate Molecular Ecology and Biomonitoring. Vertically Integrated Project course proposal submitted to the NSF Idaho EPSCoR GEM3 program. (**$11,780**).
7. Caudill, C.C., Bellmore, J.R. & Dunkle, M. 2019-2023: Investigating the influence of watershed variability on meta-food web dynamics and salmonid growth in southeast Alaskan streams. Joint Venture Agreement with USFS, Pacific Northwest Research Station. (**$277,741**).
8. Kumar, V. 2022 – 2023: Enhancing the soybean utilization in Atlantic salmon (*Salmo salar*) diet via using insect meal as complementary ingredient. Soy Aquaculture Alliance. (**$59,963**).
9. Kumar, V. 2022 – 2023: Impacts of dietary inositol and phytase enzyme on performance and gut microbiome of white-leg shrimp, *Litopenaeus vannamei*. Private ingredient company. (**$61,675**).
10. Kumar, V. 2022 – 2023: Proteomics investigation of oxidized feed on the robustness and muscle quality of juvenile white-leg shrimp, *Litopenaeus vannamei*. Private ingredient company. (**$65,732**).
11. Kumar, V. 2023 – 2024: A blend of oils as a fish oil replacer for Atlantic salmon (Salmo salar) and Rainbow trout rainbow trout (*Oncorhynchus mykiss*) diets. Private ingredient company. (**$195,584**).
12. Kumar, V. 2023 – 2024: A nutrigenomic strategy to increase the soybean meal utilization in aquaculture finfish- Determination of optimum levels for the enhancement of non-specific pathogen resistance without inducing enteritis. Soy Aquaculture Alliance. (**$99,589**).
13. Kumar, V. 2023 – 2024: Comparative nutritional evaluation of different experimental diets in Rainbow trout (*Oncorhynchus mykiss*). Private ingredient company. (**$35,602**).
14. Kumar, V. 2023 – 2024: Dietary inclusion of whole insect larval meal and organic acid (sodium butyrate) improve the soybean meal utilization in Rainbow trout diet. U.S. Soybean Board. (**$88,000**).
15. Kumar, V. 2023 – 2024: Improving the soybean meal utilization in commercial strains of rainbow trout (*Oncorhynchus mykiss*). Ohio Soybean Council. (**$71,931**).
16. Kumar, V. 2023 – 2024: Nutritional assessment of feed ingredients in-vivo digestibility in Rainbow trout (*Oncorhynchus mykiss*). Private ingredient company. (**$33,380**).
17. Kumar, V. 2023 – 2024: Nutritional evaluation of frass (byproduct of insect industry) in Nile tilapia. Private ingredient company. (**$35,895**)
18. Kumar, V. Optimizing the soybean meal (SBM) inclusion in different life stages of Atlantic salmon (Salmo salar) diet and increasing the SBM level in Yellow Perch (Perca flavescens) diet. Ohio Soybean Council. (**$105,031**).
19. Nagler, J. 2023: Effect of parent age on rate of minijack production among male progeny of spring Chinook Salmon IX. Columbia River Inter-Tribal Fish Commission. (**$207,616**)
20. Nagler, J. 2023: The physiology of kelt reconditioning XV: developing strategies to increase iteroparity in Snake River steelhead. Columbia River Inter-Tribal Fish Commission. (**$252,125**)
21. Nelson, J., Baxter, C., Forbey, J., Hardy, R. 2018-2023: NSF-EPSCoR. RII Track-1: Linking Genome to Phenome to Predict Adaptive Responses of Organisms to Changing Landscapes. (**$24,000,000**).
22. Powell, M.K. Overturf, K., Gaylord, G. & Sealey, W. 2022-2023: Improving utilization of alternate protein and oil sources in rainbow trout. USDA Agricultural Research Service. Aquaculture technician support 2. (**$62,018**).

23. Sealey, W.M., Powell, M.S. & Gross, J.A. 2021-2024: Mixing up an optimal diet for white sturgeon grow out. USDA-NIFA (Hatch project). (**$2,125**).
24. Small, B.C. 2019-2024: Improving the Competitiveness of Rainbow Trout Production by the Integrated Development of Improved Feedstuffs, Feeds, and Trout. USDA Agricultural Research Service. (**$1,446,600**).
25. Small, B.C. 2022-2023: US Fish & Wildlife Service. Banbury Springs Limpet Captive Holding & Rearing Project. (**$22,000**).
26. Small, B.C. 2022-2023: USDA Agricultural Research Service. Research Towards Precision Salmonid Feeds. (**$18,000**).
27. Small, B.C. 2022-2023: USDA Foreign Agriculture Service. Bolstering fish culture education, extension, and outreach in Georgia. (**$94,295**).
28. Small, B.C., Bledsoe, J. & Powell M. 2022-2023:. Evaluation of ProCap Gold DDGS as a fishmeal replacement for Atlantic salmon. Private ingredient company. (**$69,310**).
29. Welker, T., Powell, M. & Gaylord, T.G. 2019-2023: Waste management and water quality improvement on commercial trout farms through nutritional strategies. Oct. 2019-Sep 2023. Western Regional Aquaculture Center, USDA-NIFA. (**$132,759**).

Peer-Reviewed Manuscripts

1. Andrews, K. et al. Whole genome resequencing identifies local adaptation associated with environmental variation for redband trout. Molecular Ecology (2023).
2. Andrews, K.R., et al. Whole genome resequencing identifies local adaptation associated with environmental variation for redband trout. Molecular Ecology 32:800-818 (2023).
3. Bare, R. et al. Controlling Eutrophication of Aquaculture Production Water Using Biochar: Correlation of Molecular Composition with Adsorption Characteristics as Revealed by FT-ICR Mass Spectrometry, Processes (2023).
4. Bare, R. et al. Engineered, Porous-structured Biomaterials for Removing Harmful Nutrients from Downstream Water of Aquaculture Facilities, Processes, 11(4), 1029 (2023).
5. Bare, W.R. et al. Engineered Biomaterials for Removing Harmful Nutrients from Downstream Water of Aquaculture Facilities. Scientific Reports (2023).
6. Carrillo-Longoria, J.A. et al. Effect of temperature on growth, survival, and chronic stress responses Arctic Grayling juveniles. Transactions of the American Fisheries Society (2023).
7. Chen, Y. et al. Retrospect of fish meal substitution in Pacific white shrimp (*Litopenaeus vannamei*) feed: Alternatives, limitations and future prospects. Reviews in Aquaculture (2023).
8. Cisar, J.O., et al. Structural and Genetic Basis for Binding of a Mouse Monoclonal Antibody to Flavobacterium psychrophilum Lipopolysaccharide. Journal of Fish Diseases – special issue on Flavobacterium (2024).
9. Collins, E.E., et al. Genetic monitoring of steelhead in the Klickitat River to estimate productivity, straying, and migration timing. North American Journal of Fisheries Management (2023).
10. Delomas, T.A. and Willis, S.C. Estimating microhaplotype allele frequencies from low-coverage or pooled sequencing data. BMC Bioinformatics 24 (1), 415 (2023).
11. Dunkle, M. et al. Resource asynchronies in cryospheric riverscapes: declining meltwater contributions increases synchrony of physico-chemistry and resource availability. Submitted to Global Change Biology, Nov. (2023).
12. Dunkle, M.R. et al. Contrasting diversity and secondary production of benthic stream macroinvertebrates across a rapidly changing glacial meltwater landscape. In press, Limnology and Oceanography, Nov. (2023).

13. FiveCrows, J.A. et al. Sharing biological information across generations: Parallels between indigenous knowledge and genetics for fisheries recovery in the Columbia River Basin. Molecular Ecology Resources (2023).
14. Frias-Gomez, S.A. Effect of dietary protein, lipid and carbohydrate ratio on growth, digestive and antioxidant enzyme activity of prawn *Macrobrachium acanthurus* postlarvae. Aquaculture Reports 30:101578 (2023).
15. Frias-Gomez, S.A. Growth performance and gene expression of FAS, CPT1, G6P and HK in juveniles of the freshwater prawn *Macrobrachium acanthurus*, fed diets with different levels of protein, lipids, and carbohydrates. Journal of the World Aquaculture Society (2023).
16. Glencross, B. et al. Harvesting the benefits of nutritional research to address global challenges in the 21st century. Journal of the World Aquaculture Society (2023).
17. Hargrove, J.S. Efficient population representation with more genetic markers increases performance of a steelhead (Oncorhynchus mykiss) genetic stock identification baseline. Evolutionary Applications, 00, 1–16 (2023).
18. Heckman, T. et al. Atypical Flavobacteria Recovered from Diseased Fish in the Western United States. Front. Cell. Infect. Microbiol. 13:1149032 (2023).
19. Hess, J.E. et al. The return of the adult Pacific Lamprey offspring from translocations to the Columbia River. North American Journal of Fisheries Management 43:1000-1016 (2023).
20. Hoffman, N.F. Partial-year continuous light treatment reduces precocious maturation in age 1+ hatchery reared male spring Chinook Salmon (*Oncorhynchus tshawytscha*). Conser. Physiol. 11: coac085 (2023).
21. Hong, J. Balancing dietary plant-based lipids and cholesterol to increase fillet omega-3 deposition in rainbow trout (*Oncorhynchus mykiss*) fed a diet without animal ingredients. Aquaculture, 578, p.740029 (2023).
22. Horn, R. L. and Narum, S. R. Genomic variation across Chinook salmon populations reveals effects of a duplication on migration alleles and supports fine scale structure. Molecular Ecology, 32:2818-2834 (2023).
23. Horn, R. L. Utility of parentage-based tagging for monitoring Coho salmon (*Oncorhynchus kisutch*) in the interior Columbia River basin. Evolutionary Applications, 00, 1–15 (2023).
24. Horn, R.L. Multigeneration Pedigrees to Monitor Hatchery Broodstock Composition and Genetic Variation of Spring/Summer Chinook Salmon in the Columbia River Basin. North Am J Fish Manage. 43:794-820 (2023).
25. Hossain, M.S. et al. Insect lipid in fish nutrition: recent knowledge and future application in aquaculture. Reviews in Aquaculture (2023).
26. Hossain, S.H. et al. Utilization of functional feed additives to produce cost-effective, ecofriendly aquafeeds high in plant-based ingredients. Reviews in Aquaculture (2023).
27. Hunt, E.P. et al. Interrelationships and biogeography of the New World pufferfish genus Sphoeroides (Tetraodontiformes: Tetraodontidae) inferred using ultra-conserved DNA elements. Molecular Phylogenetics and Evolution 189, 107935 (2023).
28. Jenkins, L.E. et al. Effects of post-spawning ration restriction on reproductive development and the growth hormone/insulin-like growth factor-1 axis in female rainbow trout (*Oncorhynchus mykiss*). Comp. Biochem. Physiol. Part A 285: 111510 (2023).
29. Jenkins, L.E. et al. Feeding after spawning and energy balance at spawning are associated with repeat spawning interval in steelhead trout. Gen. Comp. Endocrinol. 332:114181 (2023).

30. Jones E.M. and Cain K.D. An Introduction to Relevant Immunology Principles with Respect to Oral Vaccines in Aquaculture. Microorganisms. 11(12):2917 (2023).
31. Kajbaf, K. et al. Integrated alternative approaches to select feed-efficient rainbow trout families to enhance the plant protein utilization. Scientific Reports (2024).
32. Ma, J., et al. Characterization of maternal immunity following vaccination of broodstock against IHNV or *Flavobacterium psychrophilum* in rainbow trout (*Oncorhynchus mykiss*), Fish and Shellfish Immunology (2023).
33. Ma, J., et al. Genome Sequence of the Virulent *Aeromonas salmonicida* Atypical Strain T30 Isolated from Sablefish with Furunculosis. Microbiology Resource Announcements 2023 Oct 19:e0053523 (2023).
34. Mathua, M. et al. Optimizing early weaning protocols for burbot (*Lota lota*) larvae. North American Journal of Aquaculture (2023).
35. Mitra, A., et al. Climate Change and Reproductive Biocomplexity in Fishes: Innovative Management Approaches towards Sustainability of Fisheries and Aquaculture. Water 2023, 15, 725 (2023).
36. Narum, S. et al. Editorial 2023. Molecular Ecology Resources 23:1-9 (2023).
37. Narum, S.R. et al. Genetic variation associated with adult migration timing in lineages of Steelhead and Chinook Salmon in the Columbia River. Evolutionary Applications, 00, 1-24 (2023).
38. Naughton, G.P. Prespawn mortality of Spring Chinook Salmon in three Willamette River populations. North American Journal of Fisheries Management 43(3): 715-729 (2023).
39. Oliver, L.P. and Cain, K.D. Life history and aquaculture methods for burbot (*Lota lota*). Reviews in Fisheries Science and Aquaculture (2024).
40. Oliver, L.P. et al. Development of a monoclonal antibody specific to burbot (*Lota lota*) IgM and optimization of an ELISA to measure anti-*Aeromonas* sp. antibody titers following pathogen challenge. Fish & Shellfish Immunology 137, 108775 (2023).
41. Oliver, L.P. et al. Partial dietary fishmeal replacement with soy products in grow-out-stage Burbot. North American Journal of Aquaculture (2023).
42. Oliver, Luke P., et. al. Triploid burbot, *Lota lota*, production: Optimization of thermal and hydrostatic parameters, tetraploid induction, and confirmation of triploid sterility. Journal of the World Aquaculture Society 54, 1522-1533(2023).
43. Oliver, L.P. Performance, gastric evacuation rate, and digestibility in grow-out stage burbot (*Lota lota* maculosa). Aquaculture (submitted)
44. Oliver, Luke P., et. al. Optimization of thermal and hydrostatic parameters, tetraploid induction, and confirmation of triploid sterility. Journal of the World Aquaculture Society, 54(6), 1522-1533 (2023).
45. Ragaza, J.A. et al. Editorial: Innovative, non-conventional ingredients for sustainable aquafeeds. Frontiers in Sustainable Food Systems (2023).
46. Schiebulhut, L.M. et al. Genomics and conservation: guidance from training to analyses and applications. Molecular Ecology Resources, 2:e13893 (2023).
47. Seaborn, T. Simulating plasticity as a framework for understanding habitat selection and its role in adaptive capacity and extinction risk through an expansion of CDMetaPOP. Molecular Ecology Resources 00:1-15 (2023).

48. Shen, K. et al. Dietary supplementation of β-1, 3-glucan improves the intestinal health of white shrimp (*Litopenaeus vannamei*) by modulating intestinal microbiota and inhibiting inflammatory response. Frontiers in Immunology. 14:1119902 (2023).
49. Singha, K.P. et al. A strategic roadmap for carbohydrate utilization in crustaceans feed. Reviews in Aquaculture (2023).
50. Timoshevskaya, N. et al. An improved germline genome assembly for the sea lamprey Petromyzon marinus illuminates the evolution of germline-specific chromosomes. Cell Reports 42:112263 (2023).
51. Tiwari, A. and Kumar, V. Diatom assisted sustainable aquaculture. Reviews in Aquaculture (2023).
52. Tsai, T.-Y. Effects of dietary soybean meal inclusion on calcium-binding protein expression and inflammatory gene markers in liver and intestine of Atlantic salmon (*Salmo salar*, L.) Aquaculture Reports 30:101624 (2023).
53. Villasante, A. Creatine in sustainable aquaculture. Reviews in Fisheries Science & Aquaculture, 31:420-451 (2023).
54. Wang, H.M. Does extreme point sampling affect non-extreme simulation in machine learning? Remote Sensing, Sept. (2022).
55. Welker, T. and Overturf, K. Effect of dietary soy protein source on effluent water quality and growth performance of rainbow trout reared in a serial reuse water system. Animals. 13(19), 3090 (2023).
56. Welker, T.L. and Barrows, F.T. Improved fecal particle size profile in Rainbow Trout fed feeds containing different ratios of animal meal and plant protein concentrates: Effect on nitrogen and phosphorus partitioning. North American Journal of Aquaculture. 86(1): 84-94 (2024).
57. Welker, T.L. et al. Digestibility of corn distiller's dried grains with solubles (DDGS) in practical feeds with phytase and xylanase treatment fed to Nile Tilapia. North American Journal of Aquaculture. 86(1): 154-162 (2024).
58. Willis, S. et al. A genomic region associated with iteroparous spawning phenology is linked with age-at-maturity in female steelhead trout. Evolutionary Applications, 00, 1-11 (2023).
59. Willis, Stuart, et al. "Contrasting patterns of sequence variation in steelhead populations reflect distinct evolutionary processes." Evolutionary Applications 17.1 (2024): e13623.
60. Willis, S.C. et al. PoolParty2: An integrated pipeline for analyzing pooled or indexed low coverage whole genome sequencing data to discover the genetic basis of diversity. Molecular Ecology Resources, 00:1-15 (2023).
61. Wu, S., et al. Effects of Apple Polyphenols and Taurine on Growth Performance, Tissue Morphology, and Lipid and Glucose Metabolism in Rice Field Eel (*Monopterus albus*) Fed High Oxidized Fish Oil. Aquaculture Nutrition (2023).

Trade Articles and Technical Bulletins

1. Bledsoe, J.W. and Abanikannda, M. Comparing microbial ecology in desert and mountain populations of redband trout to understand how fish genetics, temperature, and the environment influence fish microbiomes. In *The Researcher: Idaho NSF EPSCoR April Newsletter* (pp 9-10). Idaho NSF EPSCoR. (2023).
2. Cain, K. Black Cod, the “Wagyu Beef” of the Sea – Soon Raised in Northwest Waters? Seattle Post Alley, 26th. (2023)

3. Cain, K. NOAA and Indigenous tribal partner advance aquaculture with science. NOAA – Technology Partners Office Feature Article on Cooperative Research. (2023).
4. Cain, K. Science is a strategy, But will it sway Washington state regulators to re-open net pen farming for sablefish? Aquaculture North America. July/August Issue. Volume 14 (4) (Cover Story). (2023).
5. Cain, K. The pioneers seeking to put the burbot on the main stage of commercial aquaculture. The Lutz Report, The Fish Site. (2023).
6. Choi, W. et al. Effect of four functional feed additives on growth, serum biochemistry, antioxidant capacity, gene expressions, histomorphology, digestive enzyme activities and disease resistance in juvenile olive flounder, *Paralichthys olivaceus*. Antioxidants 12, 1494. (2023).
7. Hamidoghli, A. et al. Evaluation of yeast hydrolysate in a low-fishmeal diet for whiteleg shrimp *Litopenaeus vannamei*. Animals 13, 1877. (2023).
8. Local News 8: https://localnews8.com/news/2024/02/11/university-of-idaho-tests-new-ways-to-mine-rare-metals/KTVB: https://youtu.be/QsmlaRCuNdI?si=CcOc5TNc1VMXuclB
9. Olowe, O.S. et al. The effects of two dietary synbiotics on growth performance, haematological parameters, and non-specific immune responses in Japanese eel (*Anguilla japonica*). Journal of Aquatic Animal Health 10212 (2023).
10. Pontigo, J.P. et al. *Salmo salar* Skin and Gill Microbiome During *Piscirickettsia salmonis* Infection. Animals 2024:14:97, doi.org/10.3390/ani14010097. (2023).

Books and Book Chapters

1. Bai, S.C., Hamidoghli, A., Wang, A. & Davies, S. Feed additives. In *Nutritional Physiology in fish and shellfish* (Elsevier, under review).
2. Bledsoe, J.W. & Small, B.C. Finfish Microbiota and Direct-Fed Microbial Applications in Aquaculture. In *Direct-Fed Microbials and Prebiotics for Animals* 249-300 (Springer, 2023).
3. Cain, K.D. & Polinski, M.P. Infectious Diseases of Coldwater Fish in Fresh Water. In *Climate Change on Diseases and Disorders of Finfish in Cage Culture* (CABI, 2023).
4. Cleveland, B, Biga, P. & Overtruf, K. Muscle Physiology. In *Principles of nutrition and Metabolism in Fish and Crustaceans* (Elsevier, under review).
5. Eisch, E., Yesaki, T., Bledsoe, J.W., Kusnierz, L., Niewolny, L., Cochran, M. & Wiseman, C. Water quality. In *Fish hatchery management, 3rd. edition. (American Fisheries Society,* 2024).
6. Kumar, V. & Mitra A. Renewable waste feedstocks for a sustainable aquaculture industry. In *Bio Products: Green Materials for an Emerging Circular and Sustainable* (De Gruyter academic publishing, 2023).
7. Kumar, V. & Sahu, N.P. Chemistry and sources of Carbohydrates. In *Nutrition and Physiology of Fish and Shellfish*: *Feed Regulation, Metabolism, and Digestion* (Elsevier, 2023).
8. Kumar, V. Feed Regulation, Metabolism, and Digestion. In *Nutrition and Physiology of Fish and Shellfish* (Elsevier, under review).
9. Kumar, V. Introduction: Importance of analysis in seafood and seafood products, variability and basic concepts. In *Handbook of Seafood and Seafood Products Analysis* (CRC Press, 2023).
10. Kumar, V. Nutritional Management. In *Feed and Feeding for Fish and Shellfish* (Elsevier, 2024).

11. Kumar, V. Ragaza, J. & Glencross, B. Chemistry and sources of Protein and Amino Acids. In *Nutrition and Physiology of Fish and Shellfish: Feed Regulation, Metabolism, and Digestion* (Elsevier, 2023).
12. Kumar, V., Mitra A. & Ragaza, J. Digestive Physiology of Marine Larvae: An Overview of Adaptations and Mechanisms. In *Marine Larvae: Developments and Applications* (CRC Press, 2023).
13. Kumar, V., Ragaza, J. & Gisbert, E. Nutrition and Reproduction of Fin Fish. In *Feed and Feeding for Fish and Shellfish: Nutritional Management* (Elsevier, 2023).
14. Kumar, V., Singh, S.K., & Meena, D.K. Zero-waste technologies towards circular economy in Aquaculture. In *Global Perspectives and Methods* (Elsevier, Currently editing).
15. Olivaa-Teles, A., & Kumar, V. Nutrient and energy requirements for fin fish. In *Feed and Feeding for Fish and Shellfish: Nutritional Management* (Elsevier, 2023).
16. Small, B.C. & Hamidoghli, A. Bioenergetics in Aquaculture Settings. In Encyclopedia of Fish Physiology (Second Edition) 620-631 (Elsevier, 2024).

Abstracts and Presentations

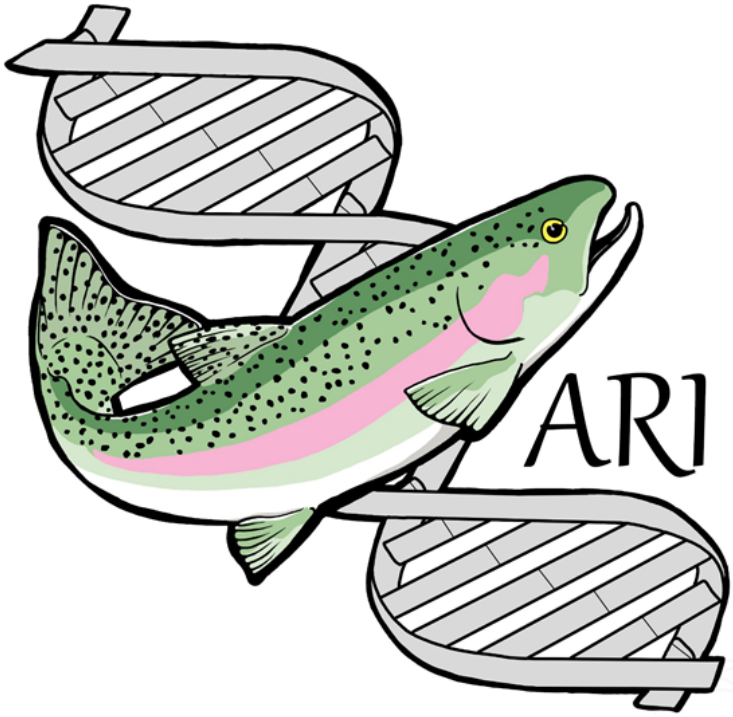
1. Bailey, A. et al. Developing methods to assess growth morphology in freshwater mussels in relation to environmental factors. Idaho Conference on Undergraduate Research. (2023).
2. Benito, M.R. & Kumar, V. Dietary supplements to mitigate the soybean meal-induced enteritis in rainbow trout *Oncorhynchus mykis*. 39thMeeting of Fish Feed & Nutrition Workshop. (2023).
3. Brent M. et al. Assessment of Virulence and Live-attenuated BCWD Vaccine Cross-Protection Efficacy Against Rainbow trout (*Oncorhynchus mykiss*) exposed to Novel family Flavobacteriaceae Isolates of the Western United States. AFS-FHS. (2023).
4. Cain, K.D. Aquaculture and fish health research; past, present, and future. Puget Sound Restoration Fund – Chew Center meeting. Manchester Research Station, Port Orchard. (2023).
5. Cain, K.D. Aquatic Animal Health Research at the Northwest Fisheries Science Center: Past, Present, and Future. NOAA – One Health Conference. (2023).
   Cain, K.D. Disease Impacts on Aquaculture Production: Co-infection of Rainbow trout (*Oncorhynchus mykiss*) with Infectious Hematopoietic Necrosis Virus and *Flavobacterium Psychrophilum*. University of Florida, Gainesville, FL. (2023).
6. Cain, K.D. Emerging and Re-emerging *Flavobacterial Pathogens* in Aquaculture. Western Regional Aquaculture Center (Termination report). Spokane, WA. (2023).
7. Carrillo-Longoria, J.A. Effect of temperature in growth, survival, and chronic stress responses of juveniles of Arctic grayling (*Thymallus arcticus*). Western Division of the American Fisheries Society, Annual Meeting, Boise, ID. (2023).
8. Caudill, C.C. & Keefer, M. Linking concepts of adaptive capacity to ESA-listed salmon and steelhead populations in tributaries of the Upper Willamette River with high-head dams. Oregon Lakes Association Annual Meeting, Corvallis, OR. (2023).
9. Caudill, C.C. et al. Toward empirical assessment of adaptive capacity in aquatic populations across scales: from genomes to landscapes in native rainbow trout populations in Idaho. Western Division/Idaho Chapter American Fisheries Society Meeting, Boise, ID. (2023).

10. Caudill, C.C. et al. Toward empirical assessment of adaptive capacity in aquatic populations across scales: from genomes to landscapes in native rainbow trout populations in Idaho. Freshwater Sciences, Brisbane, Australia. (2023).
11. Chen, Z. et al. Plasticity and genetic basis of thermal tolerance and performance traits in redband trout. Western Division/Idaho Chapter American Fisheries Society Meeting, Boise, ID. (2023).
12. Dunkle, M.R. et al. Seasonal variation in physiochemical conditions and impact on stream food webs in complex Alaskan riverscapes. Freshwater Sciences, Brisbane, Australia. (2023).
13. Evans, P. & Kumar, V. Enhancing the soybean utilization in Atlantic salmon diet via using insect meal as a complementary ingredient. AQUACULTURE America 2023. New Orleans, Louisiana. (2023).
14. Gaylord, T.G. et al. Phytase can reduce the need for phosphorus supplementation in rainbow trout Oncorhynchus mykiss feeds. Aquaculture America, New Orleans, LA. (2023).
15. Gaylord, T.G. et al. The use of organic acids and essential oils in rainbow trout feeds. Fish Feeds and Nutrition Workshop, Orono, ME. (2023).
16. Hamidoghli, A. Functional feed additives in aquaculture: A general overview. 39th Meeting of Fish Feed and Nutrition Workshop, University of Maine, Maine, USA. (2023).
17. Hess, J. Invited Seminar. University of Idaho. (2023).
18. Kumar, V. (2023). Optimizing and enhancing the soybean meal utilization in Atlantic salmon, *Salmo salar* diet. 39th Meeting of Fish Feed & Nutrition Workshop. (2023).
19. Kumar, V. Enhancing the soybean meal utilization in Atlantic salmon and Rainbow trout feed. Soy Aquaculture Alliance: Aquaculture Research Spotlight. (2023).
20. Kumar, V. et al. Dietary inclusion of insect meal enhances the soy protein utilization in rainbow trout via mitigating the gut entertitis and modulating the gut microbiome. AQUACULTURE America 2023. New Orleans, Louisiana. (2023).
21. Kumar, V. Optimizing and enhancing the soybean meal utilization in Atlantic salmon, *Salmo salar* diet. 39thMeeting of Fish Feed & Nutrition Workshop. (2023).
22. Kumar, V. Plant based diets supplemented with additive mixture improves growth and fillet quality of rainbow trout during a 30 week long-term feeding trial. The 2022 US Trout Farmers Association Fall Conference, Annual Fall Conference, Hershey, Pennsylvania. (2023).
23. Ma, J. Determining host safety, antimicrobial activity, antiviral activity, and duration of activity of Armatrex against fish pathogens. 62nd western fish disease workshop, Parksville, British Columbia. (2023).
24. Ma, J. et al. Armatrex effects on host safety, antimicrobial and antiviral efficacy, and activity duration against fish pathogens. 2023 USTFA Fall Conference, Hershey, PA. (2023).
25. Ma, J. Jesse T. Trushenski, Evan M. Jones, Timothy J. Bruce, Doug G. McKenney, Gael Kurath, and Kenneth D. Cain. Characterization of maternal immunity following vaccination of broodstock against ihnv or *Flavobacterium psychrophilum* in rainbow trout (*Oncorhynchus mykiss*). Aquaculture America, New Orleans, Louisiana. (2023).
26. Masingale, J. et al. The heart of the issue: what drives interpopulation differences in behavioral plasticity? Western Division/Idaho Chapter American Fisheries Society Meeting, Boise, ID. (2023)

27. Matuha, M. et al. Consumer Acceptance and Sensory Properties of Burbot, *Lota lota* maculosa, Compared to Other Aquaculture Products. Paper presented at Aquaculture America Conference, New Orleans, Louisiana. (2023).
28. Maxwell R. et al. Probiotics as an Alternative Treatment and their Application to Address CWD and Columnaris in Rainbow Trout (*Oncorhynchus mykiss*). 2023 USTFA Fall Conference, Hershey, PA. (2023).
29. Myrsell, V. et al. Development of a live-attenuated vaccine to prevent furunculosis in rainbow trout (Oncorhynchus mykiss). 62nd western fish disease workshop, Parksville, British Columbia. (2023).
30. Nance, N. & Kumar, V. Optimizing the soybean meal inclusion level in different life stages of Atlantic salmon (*Salmo salar*) diet. AQUACULTURE America 2023. New Orleans, Louisiana. (2023).
31. Narum, S. Genome Canada GenARCC program (November 2023).
32. Narum, S. Invited Seminars. Michigan State University (2023).
33. Oliver L.P. et al. Development of a monoclonal antibody specific to burbot (*Lota lota*) IgM and optimization of an ELISA to measure anti-Aeromonas sp. antibody titers following pathogen challenge. Northwest Fish Culture Concepts Annual Conference. (2023).
34. Oliver L.P. et al. Triploid burbot: Optimization of triploid induction parameters and analysis of sterility. Western Division American Fisheries Society. (2023).
35. Powell, M. et al. Effects of dietary soybean meal inclusion on calcium -binding protein expression and inflammatory gene markers in liver and intestine of Atlantic salmon (*Salmo salar* L.). Aquaculture America, New Orleans, LA. (2023).
36. Powell, M.S. Supporting our partners and industry through applied research. Annual forum on Rainbow Trout Production in Mexico. (2023).
37. Richardson, R. et al. Idaho Conference on Undergraduate Research. (2023).
38. Seaborn, T. et al. Linking concepts of adaptive capacity to salmonid fishes in the Pacific Northwest. USGS workshop on adaptive capacity concepts for fisheries, Madison, WI. (2023).
39. Singha, K.P. & Kumar, V. Dietary interaction of l-alanine and lipid on growth and physiology of rainbow trout (*Oncorhynchus mykiss*). AQUACULTURE America 2023. New Orleans, Louisiana. (2023).
40. Singha, K.P. & Kumar, V. Precision nutrition: Long-term feeding plant-based diets supplemented with additive mixture improves growth and fillet quality of rainbow trout Oncorhynchus mykiss. 39thMeeting of Fish Feed & Nutrition Workshop. (2023).
41. Singha, K.P. et al. A 30 week feeding trial shows supplementation of additive mixtures in plant-based diets improves growth, myogenic gene expression and fillet quality of rainbow trout (*Oncorhynchus mykiss*). Aquaculture Europe 2023. (2023).
42. Singha, K.P. et al. Long-term feeding soy-based diets supplemented with additive mixture improves growth and fillet quality of rainbow trout (*Oncorhynchus mykiss*). AQUACULTURE EUROPE 2023. Vienna, Austria. (2023).
43. Singha, K.P. et al. Long-term feeding soy-based diets supplemented with additive mixture improves growth and fillet quality of rainbow trout (*Oncorhynchus mykiss*). AQUACULTURE America 2023. New Orleans, Louisiana. (2023).
44. Story, C. & Caudill, C.C. Does Invertebrate Drift Vary Spatially within a Stream and Affect Food Availability for Salmonid Fishes? Idaho Conference on Undergraduate Research. (2023).

Extension and Outreach Activities

1. Bledsoe, J. Aquaculture in the Classroom – Hagerman High School.
2. Bledsoe, J. Aquaculture in the Classroom – Murtaugh High School.
3. Bledsoe, J. Assisted local trout farm in establishing and conducting scientific on-farm feeding trial in collaboration with industry collaborators.
4. Bledsoe, J. Book revision steering committee and co-author, Fish Hatchery Management Piper Manual Redux – Water Quality Management chapter.
5. Bledsoe, J. Cochair, Idaho Aquaculture Association Annual Meeting.
6. Bledsoe, J. Gooding County Science Fair.
7. Bledsoe, J. Gooding Elementary Science.
8. Bledsoe, J. Hagerman High School Ag and FFA Science Sessions.
9. Bledsoe, J. Magic Valley High School Career Development Day.
10. Bledsoe, J. Meridian High School Ag Expo.
11. Bledsoe, J. Monterrey Bay Aquarium-Seafood Watch Program, Expert Consultant and Reviewer of the 2023 Update on Sustainability of U.S. Raised Rainbow Trout as a Human Food-Choice.
12. Bledsoe, J. Twin Falls County Fair Aquaculture Booth.
13. Bledsoe, J. UI Youth Natural Resources Camp.
14. Narum, S. Co-hosted Coastwide Salmonid Genetics Meeting and edited special issue of proceedings.
15. Powell, M. Fish production on small farms in Africa (Sierra Leone), oral presentation (3-day workshop) and handouts.



University of Idaho

Aquaculture Research Institute

Advancing sustainable aquaculture and the conservation of aquatic resources