Waterlines

WESTERN REGIONAL AQUACULTURE CENTER

2017
ANNUAL REPORT

Alaska · Arizona · California · Colorado · Idaho · Montana · Nevada · New Mexico · Oregon · Utah · Washington · Wyoming

We are pleased to present this issue of *Waterlines*, our 2017 newsletter and report of accomplishments to USDA/NIFA.

IN THIS ISSUE

USDA

United States Department of Agriculture
National Institute of Food and Agriculture

WRAC Extension Impacts

SERVING THE WESTERN REGION

The Western Regional Aquaculture Center (WRAC) serves the aquaculture industry through its research and outreach efforts by focusing resources on areas of high priority. The 12-state region is large and diverse with many marine and freshwater aquaculture species. The main commercial species produced in the region are rainbow trout, white sturgeon, tilapia, catfish, Pacific oysters, and several other finfish and shellfish species as well.

WRAC strives to involve all 12 states in project work. Currently, the research topics address a number of industry priority issues such as developing new aquaculture species, growing aquaculture, innovations in diet nutrition, aquaculture opportunities through genetics, and production of high quality water for shellfish culture.

The Board of Directors, with members from industry, research, and extension, oversees the program. Priorities for new and continuing research and outreach are based on recommendations made by an Industry Advisory Council, representing all industry sectors and geographic zones, together with a Technical Committee consisting of researchers and extension specialists who meet annually to review ongoing and proposed projects.

Critical Role of WRAC Extension—Connecting Industry and Research

Extension efforts help strengthen the applicability and relevance of research results to the industry and document the impacts of WRAC-funded projects on commercial aquaculture throughout the western region. All WRAC-funded projects must include an extension component. Target audiences, outreach goals, activities, outputs, and outcomes must be clearly identified, as well as a funded investigator responsible for outreach. Extension efforts include publications, web-based materials, presentations, videos, and workshops.

WRAC-FUNDED PROJECTS

Based on priority areas, WRAC funds 2 to 3 projects each funding cycle.

- 2013–2016: Determination and practical application of egg. quality measures toward reliable culture of high-value marine finfish species
- 2013–2016: If you feed them, will they grow? A dietary approach to improving the growth of juvenile cutthroat trout.
- 2016–2018: Triploids, tetraploids, and successful metamorphosis in Purple hinge rock scallop (*Crassadoma gigantean*).
- 2013–2016: Efficient, rapid assay for predicting the growth rate of aquaculture species based on metabolic rate of the fertilized egg.
- 2015–2018: The economic impact of regulations on shellfish and trout aquaculture growth in the western United States.
- 2015–2019: Determining causes, costs, and benefits of triploidization to improve sturgeon caviar production.
- 2015–2019: Adapting aquaculture to changing water chemistry in the Pacific Northwest.

WRAC IMPACTS

Finfish

- Developed low phosphorous feeds, which has allowed the Idaho trout industry to maintain production while meeting stringent effluent limits.
- Played a major role in the development of the approximately $35 million retail per year farmed sturgeon caviar industry in California and Idaho.
- Developed fish diets that reduce dependence on fishmeal from wild fish.
- Developed diagnostic tools and vaccines for fish diseases of major economic importance.

Shellfish

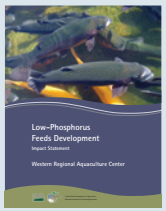
- Developed high-yield oyster lines for the $110 million per year farmed shellfish industry.
- Developed by WRAC Extension Specialists, three sanitation simulation and analytic models (*Aquarius*, *Pearl* & *Mermaid*) for the shellfish industry and state regulators to increase safety of harvested oysters for the consumer. First applied in California, model development led to a $1/2-million/per year revenue increase for growers since 2005. Models are now being applied in other Pacific, Gulf and Atlantic states of the U.S. for potential application.
- Supported industry growth that leads to jobs in rural communities (in Washington, shellfish farming is the first and second largest employer in Pacific & Mason counties, respectively with an annual payroll of $27 million). ■

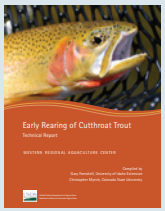
WRAC EXTENSION BY THE NUMBERS 2012–2016

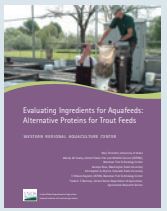
46 Published Research Papers & Journal Articles

22 Online/In the Media

3 WRAC Extension Publications

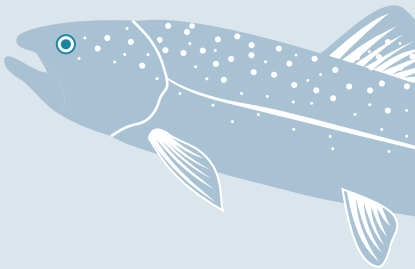






26 Web/Video Workshops/Podcasts

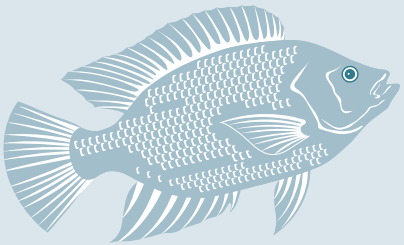
119 Presentations at Professional and Industry Conferences



11 Master's Theses

48 Regional Research and Outreach Preproposals Submitted to WRAC

>50 Students Supported



Photo, front cover: Mark Drawbridge;Illustrations: shorenated, omunkulus28, anton_novik, and MSmmitt777/iStock/Thinkstock, Cathy Schwartz

2017 National Aquaculture Extension Conference

—Excerpted and adapted from National Aquaculture Extension Conference (NAEC) committee reports submitted after the conference.

The 2017 National Aquaculture Extension Coference (NAEC) was held in Boise, Idaho, in June. The USDA National Institute of Food and Agriculture's five Regional Aquaculture Centers and the NOAA National Sea Grant Program co-sponsored the conference. Held approximately every five years since 1992, this unique conference has provided a forum for professional development and growth for participants with all levels of experience and years of service in aquaculture extension education.

Seventy participants came from across the United States and there were even some international attendees. Forrest Wynne (Kentucky State University) and Gary Fornshell (University of Idaho) served as co-chairs. The organizing committee consisted of Jimmy Avery, Samuel Chan, David Cline, Anita Kelly, Gene Kim, Ron Kinnunen, Andy Lazur, Shivaun Leonard, Max Mayeaux, Matt Parker, Caird Rexroad, Mike Rust, and Rossana Sallenave.

The presentations (41 talks and 9 posters) and the conference proceedings are available on the WRAC's website: *http://depts.washington.edu/wracuw/front%20page/Extension_conf/Extension_conf2.html*. Videos of the presentations are on YouTube: *https://www.youtube.com/channel/UCevU6JxOsIM6j0jFaBl3cyg/videos*.

The morning session on the first day comprised interesting, thought-provoking talks on a wide range of topics, including marine aquaculture outreach and education at the Aquarium of the Pacific; history, collaborations, and challenges of the Idaho trout industry; and public perceptions and attitudes toward aquaculture. The afternoon session was divided into two parts: Communications and Extension Program Updates, focusing on social media, technology, webinars, educational videos, hands-on applications, and research and extension in the Pacific Islands, the Republic of Palau, and North Carolina. During the second half of the afternoon, a general session featured speakers from federal agencies, academic institutions, and private companies. The afternoon culminated with nine poster presentations. (Information contained on WRAC's Extension poster is on pages 2–3.)

Day two was devoted to a four-stop tour of Idaho Aquatics, Fish Breeders of Idaho, University of Idaho Hagerman Fish Culture Experiment Station, and Evaqua Farms (Magic Springs). Despite temperatures topping out at 97°F, the tour was a favorite activity. The meals that day—locally sourced sturgeon and trout, served for lunch and for dinner—were big hits.

On day three, participants were back indoors, hearing about and discussing commercial aquaculture health program standards, aquaponics, fish losses, and toxicity, pertaining to freshwater and Great Lakes aquaculture. The afternoon talks centered around marine aquaculture, with topics as diverse as Connecticut's seaweed industry, Alaskan mariculture diversification, oyster aquaculture in Georgia, and sugar kelp in the northeast. The day wrapped up with a lively panel discussion on advocacy in in extension and public outreach. Panel participants included Caird Rexroad, ARS; Sam Chan, Sea Grant; Mike Rust, NOAA; Gene Kim, USDA-NIFA; Larry Dorman, UAPB Extension; and Fred Conte, UC Davis Extension.

At the conclusion of the conference, the committee collected 52 evaluation surveys (a 79% response rate). From more than 120 suggestions collected on the surveys, six themes emerged as key areas for potential focus over the next five years. Collectively, these areas can serve as strategies for enhancing Extension programming:

1. Understanding public perception of aquaculture.
2. Training the next generation of Extension personnel and enhancing competency in Extension tools.
3. Marketing the roles of Extension.

Photo: David Cline

NAEC farm-tour participants take a break from the heat, enjoy the spray from the waterfalls behind them.

4. Defining and implementing best practices, in which Extension can be most effective on regulatory matters.
5. Improving coordination and collaboration through the National Aquaculture Extension Steering Committee (NAESC).
6. Enhancing communication and knowledge sharing among aquaculture Extension professionals.

These focus areas are not the traditional technical, science, engineering, and environmental gaps that aquaculture Extension professionals address on a daily basis, but rather, they center around the need to further address the social and human dimensions of aquaculture in our programming. The NAEC planning team believes that as Extension professionals, we should focus on objectives that are ideally suited to NAESC—foremost as educators, as outreach and engagement specialists, and as trusted brokers of science-based knowledge to address education and applied research needs that inform stakeholders to make wise decisions on aquaculture.

The NAEC planning team produced the following list of potential actions, aimed at stimulating discussion before the next NAESC conference, which probably will be held in 2021.

- Consider ways to include and enhance consideration of the six human dimension focus areas (perception, workforce development, marketing, regulations, coordination/collaboration, and communications in aquaculture Extension programming).
- Continue encouraging youth-to-adult awareness/educational programs that explain the benefits and limitations of aquaculture.
- Enhance Extension's reputation and "understanding" within our universities and allied agencies (aka marketing).
- Enhance collaboration between USDA Land Grant and NOAA's Sea Grant Extensions.
- Build tools to streamline regulatory processes and reduce confusion.

Based on evaluation comments and practical planning purposes, the planning committee recommended that NAEC occur every three-to-our years, rather than waiting five-or-so years to reconvene. ■

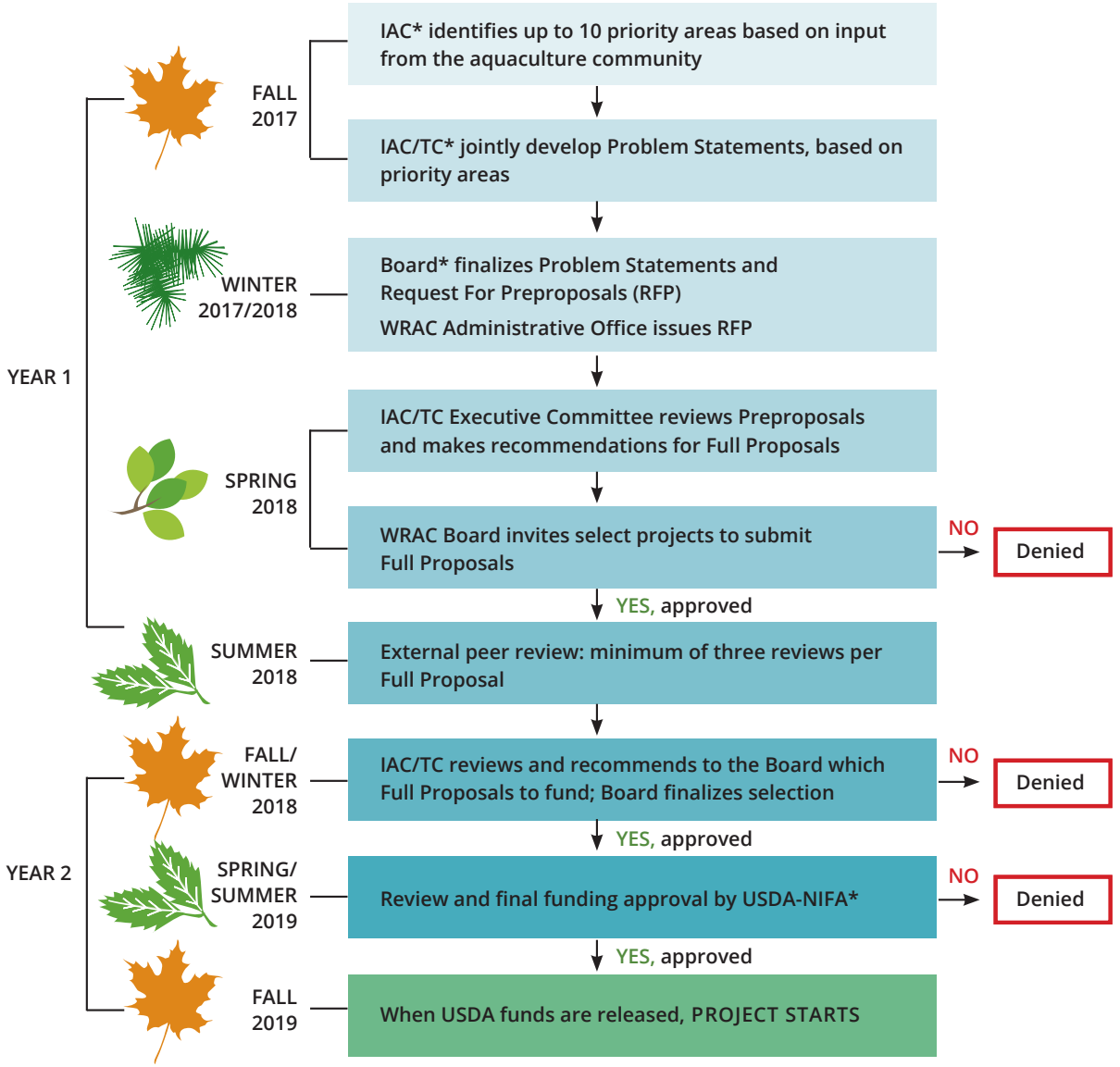
WRAC Project Funding Schedule

Meeting stakeholders needs with a thoughtful project selection process

We are pleased to report that the national Regional Aquaculture Center program was fully funded in 2017, which continued the support of ongoing WRAC projects. WRAC is once again grateful for the strong support letters that led to the appropriation from Congress. WRAC's Board of Directors subsequently agreed to move forward with the Request for Proposals (RFP) for 2018.

WRAC funds research and extension projects based on available federal funding. The selection process begins in the fall of every odd year. Working with the input from regional aquaculture industry representatives, WRAC determines priority areas to address in upcoming projects. The entire process—from stakeholder discussion to funding the selected projects—takes nearly two years. This diagram outlines the WRAC selection and funding process.

The RFP is scheduled for dispersal in early 2018; projects selected in 2018 will receive funding beginning in 2019. ■



IAC = Industry Advisory Committee TC = Technical Committee composed of Extension and Research
Board = Board of Directors USDA-NIFA = US Department of Agriculture—National Institute of Food and Agriculture

Spotlights *on the* West

RETIREMENTS & CHANGES

Board of Directors

Congratulations to **John Sherwood** on his retirement from Montana State University and the WRAC Board in June 2017. John has been involved with WRAC as a Board representative for more than 15 years and participated on several standing and ad hoc committees throughout his time at WRAC.

Photo: University of Montana

John Sherwood

Industry Advisory Council (IAC)

- After several years as an active representative, **Jim Parsons** has chosen to take a break from the IAC while promising to participate in future WRAC endeavors.
- The WRAC Board approved the IAC nomination for **Sean Nepper**, who will begin his three-year tenure on the IAC in July 2017. Please welcome Sean in his new role.

Research Subcommittee

- Congratulations to **Jim Bowker** on his recent retirement from USFWS and the Aquatic Animal Drug Partnership Program in Bozeman, MT at the end of 2017. We wish him well in his new endeavors.

Photo: AADAP Program/USFWS

Jim Bowker

AWARD & HONORS

Ron Hardy Awarded Highest World Aquaculture Honor

Photo: University of Idaho

Ron Hardy

Current WRAC Board of Directors Chair, Ron Hardy, received the "Honorary Lifetime Membership" award from the World Aquaculture Society. The award is the highest honor given by the Society and "… is awarded to one person in the world each year as recognition for lifetime achievement in service to the Society and for scientific achievement contributions that advance the global aquaculture industry."* The President of the Society, Dr. Juan-Pablo Lazo, presented the award at the annual meeting held in Cape Town, South Africa, in June 2017.

Hardy has been an active member of the Society and was elected to many leadership positions. His scientific contributions include authoring and co-authoring over 300 papers, chapters, and books related to fish nutrition. Well earned, the award recognizes his "longstanding and significant contributions to the field of aquaculture."

The WRAC Board is well served having Ron Hardy as Chair and congratulates him on this well-deserved award.

* *"World Aquaculture Society Awards Ron Hardy Highest Honor," Aquaculture Research Institute, University of Idaho. Winter 2017.*




WRAC Project Highlights

September 1, 2016–August 31, 2017

Full annual reports available at:
depts.washington.edu/wracuw/research/current_research.html

1 Determination and Practical Application of Egg Quality Measures Toward Reliable Culture of High-Value Marine Finfish Species

Termination Report

Principal Investigators: Kevin Stuart, *Hubbs-SeaWorld Research Institute (HSWRI)*; Ronald B. Johnson, *NOAA NMFS Northwest Fisheries Science Center (NWFSC)*; Frederick Goetz, *NOAA NMFS NWFSC, Reut Division, Manchester Research Station;* John Hyde, *NOAA NMFS Southwest Fisheries Science Center;* Gordon Murdock, *Animal and Veterinary Science, University of Idaho*

Outreach Representative: Paul Olin, *California Sea Grant, Extension Program, University of California San Diego*

Industry Advisor: Jim Parsons, *TroutLodge*

Project Monitor: James Nagler, *University of Idaho, Department of Biological Sciences, and Washington State University/University of Idaho Center for Reproductive Biology*

ISSUE: In the USA, marine finfish farming is a fledgling industry with great promise given the available ocean waters and highly marketable native species. A key limiting factor in the development of consistent juvenile production is the optimization of egg and larval quality. Unfortunately, identifying simple indicators of egg quality has been difficult as no individual metric is universally applicable within and among species.

RESPONSE: An expert team of scientists with experience in broodstock husbandry, physiology, and nutrition was assembled to identify easy-to-use indicators and document pre- and post-spawning factors that affect egg quality.

RESULTS: Egg diameters are an indicator for improved quality in California yellowtail (CYT), and larger diameter eggs are correlated to improved larval survival. The addition of arachidonic acid to the broodstock diet improved egg quality metrics and production. CYT will spawn successfully in small breeding tanks. Researchers showed a hormone treatment for sablefish will improve egg quality and give growers the ability to synchronize spawn events between females. Parental analysis through genetic testing confirmed that a small number of females contributes to a large proportion of the eggs produced. Removal of dominant females will impact overall egg quality and production.

IMPACTS: Research results were applied directly into broodstock management protocols for CYT, California halibut, and sablefish and will lead to more efficient egg and larval production and more consistent larval survival and quality. The results are expected to have applicability to other fishes (e.g., freshwater) that are reared intensively.

Photos: Kevin Stuart, Mike Rust

2 If You Feed Them, Will They Grow? A Dietary Approach to Improving the Growth of Juvenile Cutthroat Trout

Annual Progress Report

PRINCIPAL INVESTIGATORS: Christopher A. Myrick, *Fish, Wildlife, and Conservation Biology, Colorado State University;* Biswamitra Patro and Madison Powell, *Aquaculture Research Institute, University of Idaho;* Wendy Sealey, *USFWS, Bozeman Fish Technology Center*

Outreach Representative: Gary Fornshell, *University of Idaho Extension*

Industry Advisors: Jeremy Liley, *Liley Fisheries,* David Brock, *Rangen, Inc.,* Jackie Zimmerman, *Skretting USA*

Project Monitor: Rick Barrows, *USDA, Hagerman, ID*

ISSUE: While there are commercially available feeds for rearing trout, none is formulated specifically for cutthroat trout. The goal is to build upon the WRAC-funded work of Myrick et. al. 2010 to identify suitable feeds for the production of market-sized cutthroat trout.

RESPONSE: Researchers conducted trials to evaluate the performance of cutthroat trout fed existing commercial salmonid diets that have the desired pellet behavior and the performance of diets that have the same behavior, either floating or sinking. Nutritional requirements of juvenile cutthroat trout will be determined in three phases: 1) lysine requirement, 2) optimal digestible protein to digestible energy ratio, and 3) optimal vitamin and mineral mixture concentration.

RESULTS: In 2016, Black Canyon Trout Farms (BCTF), an industry partner in Idaho, set aside rearing space and received a batch of Snake River cutthroat eggs to be incubated and reared. Unfortunately, the facility lost most of the cutthroat trout. The workgroup secured another batch of cutthroat from Crystal River Hatchery in Colorado in November 2016. Permission to raise these fish in Idaho was obtained from Idaho Department of Fish and Game. An experimental diet formulated by the workgroup reflecting the DPDE, lysine requirement, and vitamin/mineral data obtained in Objective 3 was extruded at the BTCF in May 2017. Fish were raised to approximately 33g on a commercial diet prior to stocking out randomly in six 12-ft tanks at the end of June 2017. The cutthroat are being fed either a commercial diet or the experimental 5 diet in triplicate tanks. Thus far, fish have been sampled monthly and the trial is scheduled to continue until April 2018.

IMPACT: The poor performance of flake feed diets clearly demonstrated that flake feeds are not ideal for cutthroat trout. Information on the suitability of existing feed types for use in cutthroat trout culture and on lysine and DP to DE levels, along with optimal vitamin and mineral premix supplementation, should help aquaculture producers and the feed industry select appropriate feeds for cutthroat trout culture.

Photos: Matt Powell

3 Triploids, Tetraploids, and Successful Metamorphosis in Purple Hinge Rock Scallop (*Crassadoma gigantean*)

Annual Progress Report

PRINCIPAL INVESTIGATORS: Jonathan P. Davis, *Puget Sound Restoration Foundation*; Brent Vadopalas, *School of Aquatic and Fishery Sciences, University of Washington*; Benoit Eudeline, *Taylor Shellfish Co.*

Outreach Coordinators: Paul G. Olin, *UC Sea Grant Extension Program, UC San Diego/Scripps Inst. of Oceanography*; Carolynn Culver, *UC Sea Grant Extension Program, Scripps Inst. of Oceanography, UC San Diego and Marine Science Institute, UC Santa Barbara*

Industry Advisor: Sue Cudd, *Whiskey Creek Shellfish Hatchery*

Suggested Project Monitor: Gary Freitag, *University of Alaska Fairbanks*

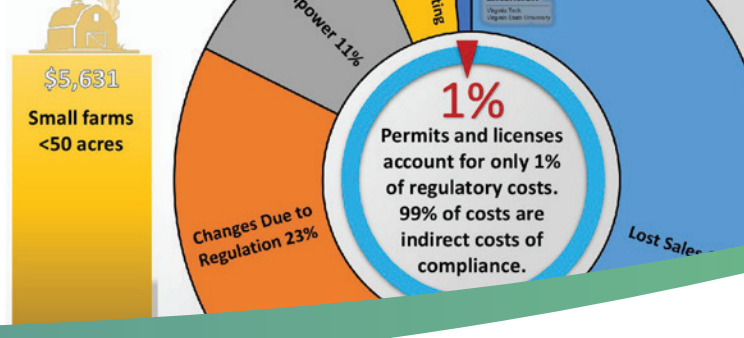
ISSUE: Rock scallop aquaculture production on the West Coast has market potential and substantial interest and investment from the shellfish industry. Barriers to sustainable culture include husbandry during settlement and metamorphosis to the juvenile stage and regulatory impediments due to genetic stock structure, population size, and distribution. Knowledge of optimal conditions for culture will inform coastal marine spatial planning efforts.

RESPONSE: Continue the WRAC-funded work of Olin et al. to advance sustainable rock scallop aquaculture, including production of triploids and refining grow out techniques.

RESULTS: None of the spawn attempts in 2017 was successful; visual inspections of broodstock gonads revealed gametogenesis generally failed to progress well. Because rock scallop broodstock failed to condition and spawn, all 4N induction trials were conducted using both chemicals and pressure using Pacific oyster as proxy. All trials were curtailed in May 2017 due to ongoing serious problems with larval mortality at the Taylor hatchery. The pressure technique is a promising method to try for rock scallop 4Ns once gametes are available. Results of the growout study demonstrated the potential for rock scallop aquaculture, once culture challenges can be overcome.

IMPACTS: The project has yielded important data on rock scallop growout performance. First, survival was good across all sites. Second, growth was excellent at three sites. Third, the shift to different growout gear and regular, albeit infrequent, handling effectively prevented cementation of the vast majority of juvenile rock scallops; it thus appears possible to minimize the cementation behavior by a combination of gear and handling during a critical developmental stage/size. The resulting product is attractive and can be marketed as live product. The relative ease of production coupled with yield (growth + survivorship) of rock scallops in seven disparate locales within Washington illustrates the high potential profitability of rock scallop aquaculture.

 Photos: Joth Davis



4 The Economic Impact of Regulations on Shellfish and Trout Aquaculture Growth in the Western United States

Annual Progress Report

PRINCIPAL INVESTIGATORS: Carole R. Engle, *Engle-Stone Aquatic LLC, Virginia Polytechnic Institute and State University*; Fred Conte, *UC Davis*; William Hanshumaker, *Oregon State University*; Bobbi Hudson, *Pacific Shellfish Institute,* Michael H. Schwartz and Jonathan van Senten, *Virginia Polytechnic Institute and State University*

Outreach Coordinator: Gary Fornshell, *University of Idaho*

Industry Advisor: Bill Dewey, *Taylor Shellfish Farms*

Project Monitor: Gunnar Knapp, *University of Alaska*

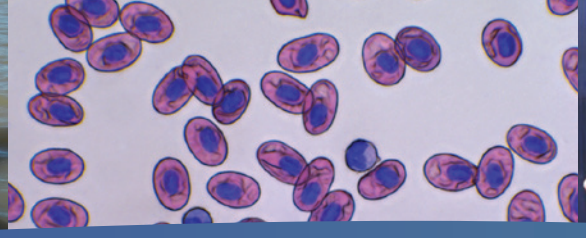
ISSUE: The regulations that affect U.S. aquaculture often overlap, trigger other permitting requirements, and frequently result in a lengthy and convoluted chain of approvals. There is growing concern that the regulatory framework has contributed to declines in several aquaculture sectors and prevented growth of others. Only one study—focused on U.S. baitfish and sportfish farms—quantified the regulatory cost burden and economic impact of the total set of regulations. No attempts have been made to assess the effects on shellfish and trout aquaculture growth in the Western U.S.

RESPONSE: Direct, in-person surveys were designed to systematically measure the regulatory cost burden on shellfish farms in the Western region and on trout farms nationally (additional funding from USDA-APHIS and the U.S. Trout Farmers Association covered survey costs outside the Western region). This project will develop detailed information on the complete set of regulations and compliance requirements as well as the costs incurred to obtain the necessary permits and comply with all monitoring, compliance, and reporting requirements.

RESULTS: Preliminary results of the shellfish survey indicate that frequent and extended delays associated with acquiring permits have been costly to farms, prevented entry of new shellfish farms in spite of increased demand, and prevented farms from adopting improved technologies that are more environmentally sustainable and more efficient, particularly on small-scale farms. Preliminary results from the trout survey indicate that a number of trout farms have gone out of business due to the regulatory environment. Some of the most problematic regulatory issues include the cost of the widely different fish health testing requirements for interstate shipping and the costs of water testing, particularly when there is a long history of test data that demonstrate no adverse effects on the environment.

IMPACT: There has been intense interest in the survey results, demonstrated by the number of invited talks on the project's progress. Study data are expected to provide insight into the types of reporting, monitoring, and compliance requirements that have created the greatest adverse effects on West Coast shellfish and U.S. trout farms.

Photos: Courtesy of Carole Engle

5 Determining Causes, Costs, and Benefits of Triploidization to Improve Sturgeon Caviar Production.

Annual Progress Report

PRINCIPAL INVESTIGATORS: Andrea Schreier, Joel Van Eenennaam, Anne Todgham, and Fred Conte, *UC Davis*, Molly Webb, *Bozeman Fish Technology Center*, Shawn Young (*Kootenai Tribe of Idaho*

Outreach Representative: Fred Conte, *UC Davis*

Industry Advisors: Peter Struffenegger, *Stellar Biotech*; Linda Lemmon, *Blind Canyon Aqua Ranch*

Project Monitor: Kevin Fitzsimmons, *University of Arizona*

ISSUE: Spontaneous triploidy, or unintentional induction of genetic triploidy, has been detected in white sturgeon production facilities. There are some possible benefits of triploidization, including larger eggs and a female-biased sex ratio, but possible negative impacts include the production of reproductively impaired 10N progeny in crosses between spontaneous triploid (12N) and normal (8N) broodstock. Thus far, no studies have evaluated the relative costs and benefits of triploidization on the caviar industry.

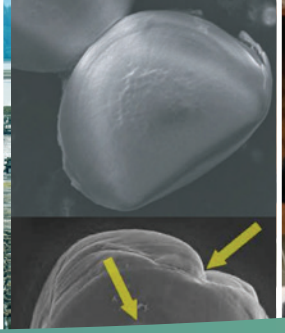
RESPONSE: 1) Determine how and why spontaneous triploids are produced in white sturgeon culture and compare metabolic performance, stress response, and immune function between 8N, 10N, and 12N individuals. 2) Evaluate the relationship between ploidy and female reproductive development and compare methods of ploidy.

RESULTS: Post-ovulatory ageing and mechanical shock during egg siltation can increase rates of spontaneous triploidy, and some females appear to be genetically predisposed to produce triploids. Both 10N and 12N white sturgeon have different blood chemistries and appear to use different metabolic pathways to handle chronic stress than normal 8N fish. 10N females exhibit delayed or arrested reproductive development and possess fatty ovaries, although some 8N females show similar abnormalities. Flow cytometry and Coulter counter analysis can distinguish between 8N, 10N, and 12N sturgeon with high accuracy, but blood smears analysis cannot identify 10N fish and can't always distinguish between 8N and 12N individuals.

IMPACTS: Minimizing post-ovulatory ageing and handling eggs very gently during siltation are likely to reduce spontaneous triploidy, although some females will likely produce some 12N progeny regardless of treatment. It is recommended that producers 1) avoid crosses between 8N and 12N broodstock because 10N females may not reach sexual maturity and those that do will require several more years and exhibit relatively low caviar yield due to ovarian fattiness, and 2) use a Coulter counter for ploidy screening due to high accuracy and throughput.

 Photos: Courtesy of Andrea Schreier






6 Adapting Aquaculture to Changing Water Chemistry in the Pacific Northwest

Annual Progress Report

PRINCIPAL INVESTIGATORS: George G. Waldbusser, Brian Haley, Burke Hales, *Oregon State University*; Alan Barton, *Whiskey Creek Shellfish Hatchery*; Benoit Eudeline, *Taylor Shellfish, Inc.*; Chris Langdon, *Oregon State University*

Outreach Representative: Brad Warren, *National Fisheries Conservation Center*

Industry Advisor: Sue Cudd, *Whiskey Creek Shellfish Hatchery*

Project Monitor: Ken Cain, *University of Idaho*

ISSUE: In the Pacific Northwest, hatcheries play a key role in supplying oyster seed to growers. In the normal production cycle, hatcheries spawn oysters, grow them in optimal temperature and food conditions, and sell the ready-to-settle seed to growers. The sensitivity of developing bivalve embryos to environmental stressors is well documented, and the role of hatcheries has always been to minimize these stressors and maximize growth. Previous work has documented the sensitivity of developing Pacific oyster embryos to ocean acidification and the mechanism for this sensitivity. It is in the late-stage of the bivalve larval period that the hatcheries are still experiencing some problems.

RESPONSE: Provide adaptation tools and information for shellfish hatcheries and settings to address changing water quality conditions associated with local and global change. Research focus will be at two hatcheries (OR and WA) where researchers have established relationships and water quality monitoring programs. The outreach and extension plan will extend the lessons from these locations to other settings and hatcheries along the US west coast (CA and AK).

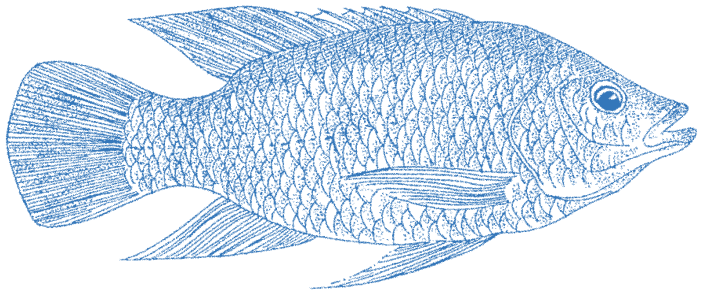
RESULTS: A chemistry forecasting product has been developed that shows fairly good success at predicting carbonate chemistry by using meteorological data and machine learning techniques. In addition, an instrument providing real-time data on several water quality parameters has been installed. Preliminary data indicate that oxygen levels appear to stay mostly in the low 90% saturation in tanks, while the treated and processed water is usually up near 200%.

IMPACTS: To date, the most valuable and directly applicably outcome is the forecasting of chemical conditions. The functionality of a statistically driven chemical forecasting is very promising to provide user-level data and forecasts to aquaculture stakeholders, who may not be able to afford and support long-term chemistry monitoring.

Photos, left to right: iStock/AwakenedEye; iStock/PhilAugustavo, George Waldbusser, George Waldbusser

In The Press & At The Podium

WRAC-funded projects from 9/1/16–8/31/17



JOURNAL PUBLICATIONS & MANUSCRIPTS

Conte FS, Ahmadi A. Mermaid: A Shellfish Sanitation Model Providing Additional Metrics for the Classification of Shellfish Growing Areas of Virginia (USA), Managed by the Direct Rule Method. Applied Engineering in Agriculture. Vol. 33(6): 825–839 © 2017 American Society of Agricultural and Biological Engineers ISSN 0883-8542 *https://doi.org/10.13031/aea.12355*

Gille DA, Van Eenennaam JP, Famula TR, Schreier AD, Beer K, Struffenegger P, Renschler B, Bishop S, Doroshov SI. 2017. Finishing diet, genetics, and other culture conditions affect ovarian adiposity and caviar yield in cultured white sturgeon (*Acipenser transmontanus*). Aquaculture 474: 121–129.

Owens CE, Sealey WM, Conley ZB, Fornshell G, and Myrick CA. In press. Evaluating dietary impacts of commercial-type diets on the growth of Snake River cutthroat trout (*Oncorhynchus clarkii behnkei*). Aquaculture.

Stuart K, Hawkyard M, Barrows F, Rust M, Drawbridge M. 2017. Evaluation of dietary taurine concentrations in microparticulate diets provided to larval California yellowtail (*Seriola dorsalis*) post larvae. Aquaculture DOI: 10.1111/anu.12527

Stuart K, Johnson RB, Armbruster L, Drawbridge M. In Review. Arachidonic acid in the diet of adult California yellowtail *Seriola dorsalis* and its effect on egg quality. North American Journal of Aquaculture.

PRESENTATIONS/POSTERS

Armbruster L, Stuart K, Drawbridge M, Johnson RB. California yellowtail *Seriola dorsalis* egg quality and chemical composition. Aquaculture America, Las Vegas, NV. February 22-26, 2016.

Armbruster L, Stuart K, Drawbridge M, Johnson RB. California yellowtail *Seriola dorsalis* egg quality and chemical composition. US-Korea Joint Coordination Panel for Aquaculture Meeting, Seattle, WA. March 23, 2016.

Armbruster L, Stuart K, Drawbridge M, Johnson RB. Egg chemical composition and quality are affected by feeding California Yellowtail (*Seriola dorsalis*) broodstock supplemental arachidonic acid. NOAA Northwest Fisheries Science Center Symposium. Seattle, WA. April 5, 2016.

Armbruster L, Stuart K, Drawbridge M, Johnson RB. Egg chemical composition and quality are affected by feeding California Yellowtail (*Seriola dorsalis*) broodstock supplemental arachidonic acid. Poster presentation. NOAA Aquaculture Science Review. Seattle, WA. July 26, 2016.

Davis J. Developments in aquaculture for purple hinge rock scallop. 70th Annual Joint Meeting of the National Shellfisheries Association - Pacific Coast Section and the Pacific Coast Shellfish Growers Association. Chelan, Washington. October 12–14, 2016.

Engle CR, van Senten J. Fish farming costs: how much is due to regulations? Fall Meeting of the United States Trout Farmers Association and Penn Aqua. Bethlehem, PA. September 7, 2016.

Engle CR, van Senten, J. Fish farming costs: how much is due to r egulations? Idaho Aquaculture Association Annual Meeting. Twin Falls, ID. June 11, 2016.

Engle CR. Regulatory costs of U.S. aquaculture businesses. National Webinar Sponsored by National Aquaculture Association, U.S. Aquaculture Association, and North Central Regional Aquaculture Center. September 27, 2016.

Engle CR, van Senten J. The economic impact of regulations on the US trout aquaculture growth. U.S. Trout Farmers Association. San Antonio, TX. February 22, 2017.

Engle CR, van Senten J. Update on regulatory cost studies. Requested by National Aquaculture Association Board. San Antonio, TX. February 19, 2017.

Engle CR, van Senten, J. Update on trout survey. Pennsylvania Aquaculture Advisory Council, Harrisburg, PA. June 15, 2017.

Fiske A, Van Eenennaam JP, Todgham AE, Holem-Bell C, Young S, Schreier AD. A comparison of methods for determining ploidy of cultured white sturgeon. Abstract submitted to 8th International Symposium on Sturgeon, Vienna, Austria, September 2017.

Leal MJ, Van Eenennaam JP, Clark BE, Schreier AD, Todgham AE. The effects of warm temperature acclimation on the generalized stress response and immune function in 8N and 10N white sturgeon. Poster presentation. American Fisheries Society California–Nevada Chapter Annual Meeting, Eureka, CA, April 2017.

Patro B, Powell MS, Barrows FT. Evaluation of varying levels of digestible protein and digestible energy and their ratios in the diets of juvenile cutthroat trout. Aquaculture America, San Antonio, TX. February 19–22, 2017.

Patro B, Powell MS, Hardy RW. Dietary lysine requirement of juvenile Snake River cutthroat trout. Aquaculture America, San Antonio TX. February 19-22, 2017.

Powell MS, Patro B. Recent advances in cutthroat trout nutrition. U.S. Trout Farmers Association and Idaho Aquaculture Association. September 2017.

Schreier A, Van Eenennaam J, Todgham A. Determining the causes of spontaneous autopolyploidy in cultured white sturgeon. Abstract submitted to 8th International Symposium on Sturgeon, Vienna, Austria, September 2017.

Stuart K, Johnson RB, Armbruster L, Drawbridge M. Manipulation of arachidonic acid in the diet of adult California yellowtail (*Seriola dorsalis*). Aquaculture America, Las Vegas, NV. February 22–26, 2016.

Todgham A, Leal MJ, Van Eenennaam J, Schreier AD. Impacts of polyploidy on the physiological performance of white sturgeon. Abstract submitted to 8th International Symposium on Sturgeon, Vienna, Austria, September 2017.

Van Eenennaam J, Todgham A, Conte F, Schreier A. Reducing spontaneous autopolyploidy in white sturgeon. Oral presentation. Abstract submitted to 8th International Symposium on Sturgeon, Vienna, Austria, September 2017.

van Senten J, Engle CR The cost of regulations affecting U.S. trout aquaculture. Colorado Aquaculture Association Meeting. Nathrop, CO. February 3, 2017.

van Senten J, Engle CR, Fornshell G, Conte F, Hanshumaker B, Hudson B, Schwarz M. The cost and impact of regulations on shellfish aquaculture. 70th Annual Shellfish Growers Conference and Tradeshow. Lake Chelan, WA. October 12, 2016.

van Senten J, Engle CR. The regulatory burden: Types of economic effects on West Coast shellfish farms. Annual Meeting of the National Shellfish Association, Knoxville, TN. March 22, 2017.

IN THE MEDIA

Davis, J. Interview for article discussing the potential for purple hinge rock scallop aquaculture. "Rock scallop: Viable candidate for aquaculture." [This interview features research funded by WRAC.] Aquaculture North America, June 2016.

Orlowski A. Small fish farms hit harder by paperwork, fees. Study seeks to find out how much of operational costs are due to regulations. Aquaculture North America. Vol. 7, Issue 6. [This article features Engle and van Senten research funded by WRAC.] November/December 2016. *https://www.aquaculturenorthamerica.com/downloads/1224/download/ANAnovdec2016-low.pdf*

Walker, T. Rock scallop: Viable candidate for aquaculture. Research looks at raising purple-hinge rock scallop for commercial production. Aquaculture North America, June 21, 2016. *https://shar.es/anUZ31*

ON THE WEB

Stuart K. HSWRI Aquaculture Research Program Newsletter, bimonthly. Vol. 85–2017. Found at *http://hswri.org/wp-content/uploads/2014/06/085-2017_HSWRI_Aquaculture-News.pdf*

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Vol. 22, No. 1

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