

Waterlines

WESTERN REGIONAL AQUACULTURE CENTER

2019
ANNUAL REPORT

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

This issue of *Waterlines* contains our newsletter and report to USDA-NIFA of our accomplishments for 2019.

IN THIS ISSUE

- 2 WRAC Spotlights
- 4 Fred Conte—Champion for WRAC
- 5 Highlights of Research and Outreach Projects
- 10 In the Press & At the Podium



United States Department of Agriculture
National Institute of Food and Agriculture

Photo: Fred Conte



UPDATES TO THE ROSTER

WRAC welcomes new and continuing members of the Board, IAC, and Research and Extension Subcommittees and thanks all who have served this past year. The Board strives to consider a mix of geographic representation and diverse areas of expertise when considering new appointments to WRAC committees. Changes to the roster are provided here and in the July 2019 WRAC Directory (depts.washington.edu/wracuw/about/organization.html).

Board of Directors

- **Fred Conte steps down**
Long-time WRAC champion, Fred Conte (University of California, Davis, Aquaculture Extension Specialist), said his farewells to the Board and the many committees he represents. See story on page 4.
- **Jackson Gross appointed**
We are pleased to announce the quick turnaround at University of California, Davis to appoint of Jackson Gross (Aquaculture Extension Specialist) to the WRAC Board *while* he remains an Extension Subcommittee representative. Notably, Jackson was a Research Subcommittee member prior to joining Extension. With his experience on multiple fronts at WRAC and in aquaculture, Jackson will be a valuable asset on the WRAC Board.

Industry Advisory Council (IAC)

Continuing through 2022

Mark Francis (Aquaneering, Inc, CA), Jeremy Liley (Liley Fisheries, Inc., CO), and Jackie Zimmerman (now with Merck Animal Health, Aquaculture Division) were approved by the Board to continue their terms through June 30, 2022. Thank you all!

New appointment to the IAC

The Board was pleased to see six qualified candidates nominated and went on to approve Beau Perry to the position. Located in California, Beau brings experience as a business entrepreneur and currently works in food systems and mariculture in both CA and AK. Plan to welcome Beau this fall.

Technical Committee/Research Subcommittee

Continuing through 2022

Mark Drawbridge (Hubbs-Seaworld Research Institute, CA), Ken Overturf (ARS, Hagerman Fish Culture Experiment Station, ID), and Wendy Sealey (Bozeman Fish Technology Center, USFWS, MT) will continue to serve through 2020. Thank you all!

New member appointed by Board in May

Please welcome Brent Vadopalas, Washington Sea Grant, Shellfish Aquaculture Specialist, as the newest member of the Research Subcommittee. Brent is also a Sustainable Aquaculture Specialist at the University of Washington.

Moving on from the Research Subcommittee

Barbara Rasco stepped down from the Research Subcommittee this summer as she has taken a position at the University of Wyoming as Dean at the College of Agriculture and Natural Resources. Congratulations Barbara!



Fred Conte



Jackson Gross



Beau Perry



Brent Vadopalas



Barbara Rasco



Paul Olin



Kim Patten



Bill Hanshumaker



Luke Gardner

Technical Committee/Extension Subcommittee

2019, the year of three well-deserved retirements

- Paul Olin (UCSD, CA Sea Grant Aquaculture Specialist) gave years of service to WRAC and brought expertise in marine aquaculture as both a scientist and outreach specialist for California and the broader aquaculture community.
- Kim Patten (WSU, Pacific County Extension Director) shared his expertise built from a long-standing commitment to coastal management issues, affecting oyster and cranberry industries regionally.
- Bill Hanshumaker (OSU, OR Sea Grant) brought his research and outreach expertise to benefit a variety of WRAC-funded projects.

Their combined decades of contributions to WRAC will surely be missed. Best wishes on your next adventures!

New Extension appointment from UC San Diego

We are very fortunate that Luke Gardner (CA Sea Grant Extension Specialist) has been appointed to the Extension Subcommittee in time to participate at the IAC/TC meeting this fall. His marine aquaculture qualifications and experience make him an excellent addition to the Subcommittee.

THREE NEW PROJECTS FUNDED

Thanks to all the members of the IAC, TC, and Board for your input throughout the selection process. With the IAC/TC summary and Executive Committee notes in hand, the Board voted to fund three new projects, selected from eight competitive full proposals:

1. Detection and control of mud blister worm (*Polydora* spp.) infestation on commercial oyster farms throughout the Pacific Northwest. Lead PI, Chelsea Wood (University of Washington), 3-year project, total request \$359,065
2. Emerging and re-emerging Flavobacterial pathogens in aquaculture. Lead PI, Ken Cain (University of Idaho), 3-year project, total request \$326,125
3. Development of oral vaccine delivery methods for prevention of disease in finfish culture. Lead PI, Matt Hawkyard (Oregon State University), 4-year project, total request \$479,900

Photos, 1 to 3, Courtesy of: Washington State University; NOAA/Vents, Korea Polar Research Institute; California Sea Grant, Scripps Institution of Oceanography, UC San Diego

WHAT'S UP NEXT?

Developing research and outreach priorities (problem statements) for the next Proposal Cycle—Funding Year (FY) 2021

The next Request for Pre-Proposals (RFP) is slated for FY2021 and begins with the development of problem statements by the Industry Advisory Council (IAC) in the fall of 2019.

Here is the timeline for the upcoming WRAC Proposal development cycle:

- This summer, the “Solicitation for Research Priorities for Future Research and Outreach Projects” was distributed throughout the region and closed on August 26, 2019.
- Collected via online survey and email, the submissions are prepared for the IAC members to review at their fall meeting.
- Then, working together, the Industry and Technical committees recommend new priorities and persistent problems in the aquaculture industry for the next RFP.
- Prior to the Board meeting, the Executive Committee will meet to prepare a draft of the RFP FY2021 for Board review.



UPCOMING WRAC MEETINGS

IAC/TC Meetings

IAC Meeting, October 8, 2019, Spokane, WA

TC Meeting and combined IAC/TC Meeting, October 9–10, 2019, Spokane, WA

Board Meeting

November 12, 2019, Portland, OR

Fred Conte— Champion for WRAC

Fred Conte, a founding member and long-time champion of WRAC, said his farewells to the Board and to the many committees he served. Fortunately, Fred will continue his role as Outreach Coordinator on several WRAC projects.

Fred, an Aquaculture Specialist and Lecturer at the University of California Davis, primarily conducts programs that benefit aquaculture producers, state and federal agencies that impact aquaculture, and the general public. His programs cover both marine and freshwater production aquaculture. In recent years, his research has focused on shellfish sanitation, sanitation modeling, software development, and aquatic animal welfare.

During his career, Fred has originated and implemented innovative and sustained programs that have had a positive and lasting impact in advancing the field of aquaculture through knowledge and improved production processes.¹ He has been instrumental in the WRAC outreach efforts since WRAC's inception. He led WRAC's Strategic Planning Committee in a major revision of the Manual of Operations to reflect current practice and to emphasize the importance that WRAC places both on sound, relevant science, and transfer of that information to the industry. He authored numerous WRAC outreach publications and conducted numerous WRAC workshops. His outreach products were also used for conveying the economic impacts of WRAC's investment to federal agencies and congressional appropriations committees.

Through WRAC-funded research projects, Fred and his research partner developed three shellfish sanitation models: "Aquarius," "Pearl," and "Mermaid"; and numerous ancillary shellfish software programs used to evaluate and manage shellfish growing areas. The models provide more sensitive and accurate analyses of sanitation conditions in growing areas, especially when making adjustments in rules for opening and closing areas for harvest. The models rapidly handle massive datasets and associated calculations with precision that provides time-saving advantages to the commercial industry and public health agencies.

Fred served as the California Extension representative from WRAC's inception until 2017, and as the California

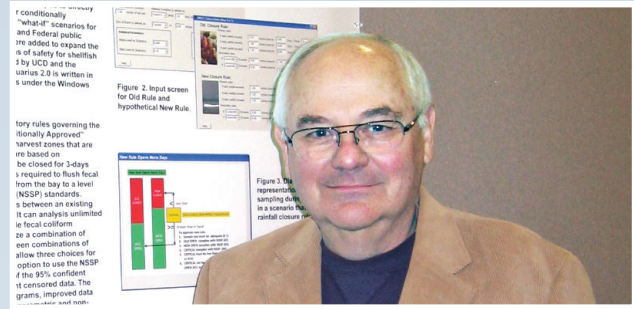


Photo: Debbie Granger

Board representative from 1999 until 2019. Among his career awards, Fred received the 2016 Joseph McCraren Award for outstanding contributions in promoting the growth of aquaculture. The award, named in honor of Joseph P. McCraren, the first chairman and executive director of the National Aquaculture Association (NAA), is the most prestigious honor given by the NAA. Fred also served as the President of the World Aquaculture Society in 1984–1985.

After a 50-year post-graduate academic career in extension and research (Texas A&M University 7; UC Davis 43), Fred has scheduled his retirement from the UC System in November 2020, but plans to continue WRAC projects as Emeritus. We are all grateful to Fred for his dedicated service to WRAC and to the aquaculture industry and wish him all the best in the future!

“Fred was one of the crucial long-term participants in our highly successful development of white sturgeon aquaculture projects, which spanned over 28 years of WRAC support; quite the impressive achievement.”

—Joel Van Eenennaam and Serge Doroshov

“In the mid-1980s, Fred was the driver of expanding WRAC to include all the western states. He was the person who recruited representatives from other states beyond the original founding member states.”

—Kevin Fitzsimmons

“As a new faculty member, I've benefited from Fred's extensive knowledge of the sturgeon industry and California aquaculture more generally.”

—Andrea Schreier

¹ Adapted from: CAA Staff. (2016, February 29) Notable News: Fred S. Conte, PhD Receives National Award for Contributions in Aquaculture. <http://caaquaculture.org/2016/02/29/fred-s-conte-phd-receives-national-award-for-contributions-in-aquaculture/>



WRAC Project Highlights

September 1, 2018–August 31, 2019

Full annual reports available at:
[depts.washington.edu/wracuw/
research/current_research.html](https://depts.washington.edu/wracuw/research/current_research.html)

1 Determining Causes, Costs, and Benefits of Triploidization to Improve Sturgeon Caviar Production Termination Report

PRINCIPAL INVESTIGATORS: Andrea Schreier, Joel Van Eenennaam, Anne Todgham, and Fred Conte, *University of California 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 autopolyploidy (unintentional induction of genetic triploidy) has been detected in white sturgeon production facilities. Possible benefits of triploidization include larger eggs and a female-biased sex ratio; possible negative impacts include the production of reproductively impaired 10N progeny in crosses between spontaneous autopolyploid (12N) and normal (8N) broodstock. Thus far, no studies have evaluated the relative costs and benefits of triploidization on the caviar industry.

RESPONSE: We completed experiments to determine how/why spontaneous autopolyploids are produced in white sturgeon culture and compare metabolic performance, stress response, and immune function among 8N, 10N, and 12N fish. We studied the relationship between ploidy and female reproductive development and compared methods of ploidy detection. We tested the hypothesis that 12Ns exhibit a female-biased sex ratio. We provided producers with recommendations about how best to identify 10N and 12N fish and prevent spontaneous autopolyploidy.

RESULTS: We confirmed that mechanical shock from vigorous treatment during egg de-adhesion is the main cause of spontaneous autopolyploidy in white sturgeon culture. Egg ageing and mechanical shock during de-adhesion can cumulatively increase the number of 12N progeny produced. High quality eggs are more resilient to spontaneous autopolyploidy, although some females seem prone to producing 12Ns. Coulter counter analysis is the best method for detecting sturgeon with abnormal ploidy. Although 10N females experience delayed reproductive development and have fatty ovaries, they can reach sexual maturity; some 8N and 12N females exhibit a similar phenotype. This suggests that factors other than ploidy also contribute to late sexual maturation. Physiological data show that 8N, 10N, and 12N white sturgeon exhibit similar responses to warming and acute stress, but individuals with abnormal ploidy (10N, 12N) are different metabolically from 8N sturgeon. The 12N individuals sampled had a female-biased sex ratio.

IMPACTS: New egg handling practices at collaborating farms have greatly reduced the production of spontaneous autopolyploids. Although 12Ns seem to have a female-biased sex ratio, metabolic and developmental differences in 12N white sturgeon, and especially their 10N progeny, may negatively affect their performance in culture. We recommend further investigation of the factors causing delayed maturity in white sturgeon females and suggest that producers reconsider keeping late-maturing females, regardless of ploidy, because they tend to have fatty ovaries with low caviar yield.

**NATION-WIDE
REGULATORY COSTS PER YEAR:**

National
(total)

\$ 16.1 Million

On-farm
(average)

\$ 150,506

LOST REVENUE PER YEAR:

Thwarted
expansion
attempts

\$ 40.1 Million

Lost
market
sales

\$ 7.1 Million

Reduced
production

\$ 5.3 Million

\$1.23

Average regulatory
costs per pound
of production

FISH HEALTH
Considered the most
problematic regulation
by the farmers

12%

Regulatory
costs of total
farm costs

28%

Lost revenue due
to regulatory
costs

\$140,218,834

2018 trout import
trade deficit

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

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

Outreach Coordinator: Gary Fornshell, *University of Idaho*

Industry Advisor: Bill Dewey, *Taylor Shellfish Farms*

Project Monitor: Gunnar Knapp, *University of Alaska*

ISSUE: While regulations are developed to improve quality of life of US citizens, the suite of regulations that affect US 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 in the US has contributed to declines in several sectors of US aquaculture in addition to preventing growth of others. Yet there has been no attempt to measure the economic effects of the total regulatory regime on West Coast shellfish and US trout farms.

RESPONSE: West Coast shellfish and US trout farms were surveyed to collect farm record data on the actions taken by farms to comply with the total sets of regulations with which they must comply and the associated costs.

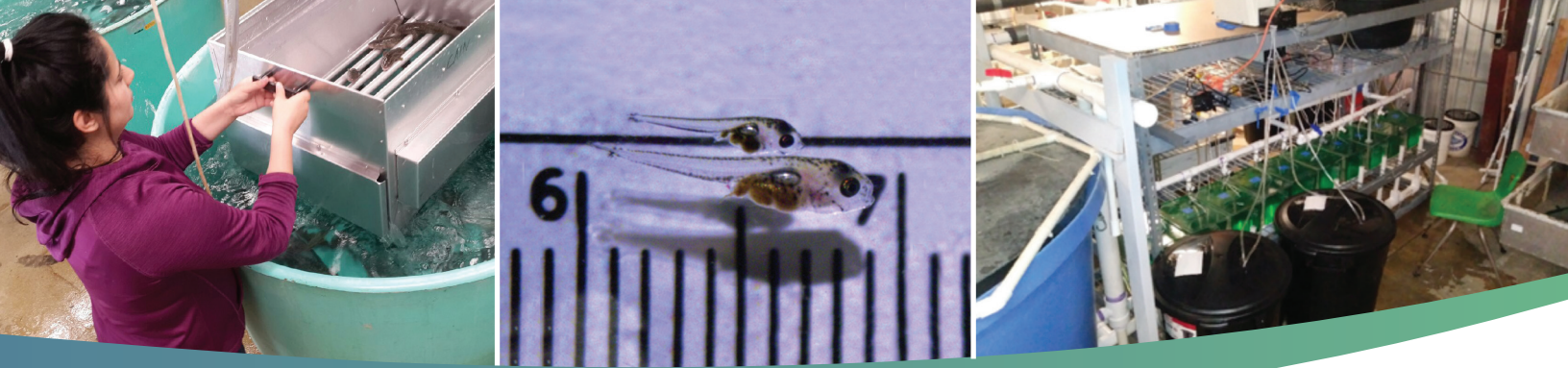
RESULTS: Quantitative estimates of increased costs due to local, state, federal, and federally mandated state regulations demonstrated the types of regulations and the corresponding reporting, monitoring, and compliance requirements that have created the greatest adverse

economic effects on US trout/salmon and West Coast shellfish farms. Quantifying these impacts provides a basis for changes that would streamline regulatory processes to reduce the on-farm regulatory burden and promote growth and development of sustainable US aquaculture in accordance with the goals of the 1980 National Aquaculture Act.

The value of the original proposal (limited to Western region trout farms) was such a high priority that US Trout Farmers Association and USDA-APHIS contributed funding to expand the project nationally for trout and salmon farms. Consequently, this has and will continue to increase the impact from this study.

IMPACTS: Project results have increased awareness of the magnitude of the regulatory cost burden on US aquaculture farms and have stimulated discussions and meetings concerning ways to reduce on-farm regulatory costs. These results are being used by various aquaculture associations in discussions with policy makers related to the types of reforms necessary to reduce the on-farm cost burden while maintaining adequate oversight.

Results have been presented to state aquaculture councils and the USDA-ERS; distributed to members of Congress by the Pacific Coast Shellfish Growers Association; submitted, by request, to the National Oceanic and Atmospheric Administration, Department of Commerce; and used by the National Aquaculture Association to ask the Environmental Protection Agency to reduce frequency of testing for discharge. PI Engle has been asked to deliver a workshop to FDA-CVM about ways that FDA can potentially reduce on-farm regulatory costs of aquaculture producers.



3 Developing “Freshwater Cod” or Burbot (*Lota lota*) into a Viable Commercial Aquaculture Species in the United States

Annual Progress Report

PRINCIPAL INVESTIGATORS: Kenneth Cain, *University of Idaho*; Christopher Myrick, *Colorado State University*; Shawn Young, *Kootenai Tribe of Idaho*; Rick Barrows, *Emeritus USDA/ARS*,

Outreach Representative: Gary Fornshell, *University of Idaho*

Industry Advisors: Linda Lemmon, *Blind Canyon Aqua Ranch*

Project Monitor: Mark Drawbridge, *Hubbs-Seaworld Research Institute*

ISSUE: The integration of burbot (freshwater cod) production into existing trout farms presents a novel, low-risk strategy to develop this species for commercial aquaculture. By expanding production, this project addresses the USDA-NIFA challenge areas of food security, water, childhood obesity, and food safety. The goal and challenge is to provide US fish growers with applied knowledge of burbot farming, thereby encouraging diversification of crops and enabling competition in potentially lucrative food and other niche markets.

RESPONSE: We hypothesize that growth and performance at all life stages can be optimized to make culture of burbot efficient and economically attractive. Our objectives are to: optimize spawning, early rearing, and grow out; conduct commercial pilot scale trials and gather data relevant to production; determine water quality limits; determine if triploid induction is possible and if it may be feasible to produce sterile burbot; conduct a basic economic analysis of production costs; and disseminate results broadly to the aquaculture industry.

RESULTS: Results have shown that pressure treatments on eggs can result in 100% triploid induction and demonstrate the potential to produce burbot that may be sterile. Egg incubation temperatures above 4°C resulted in high deformity and low survival rates, and temperatures of 6°C during early incubation were lethal to embryos. Diet studies have shown that young burbot grow best on a higher protein marine type diet; yet, during the grow out stage, they grow equally on a trout or marine type diet, which has large implications for production costs. Water quality limits are being investigated and, so far, indicate that ammonia tolerance for burbot is similar to trout. Weaning trials indicate that the period of feeding live prey to burbot larvae may be reduced by using various artemia replacements. Burbot from this program have been distributed to three commercial producers in Southern Idaho, processed, and sold at a local restaurant, where customer surveys indicate high consumer acceptance. Further sensory evaluation of burbot fillets showed that burbot were preferred overall to tilapia (87%) or trout (81%).

IMPACTS: We have demonstrated that burbot triploids can be produced (still need to confirm sterility) and that this species can grow well on trout diets, has favorable taste compared to other farmed species, has water quality limits comparable to trout, and can be successfully produced at trout facilities. The indication that the time for weaning burbot from live diets to a dry diet can be reduced has economic implications for early rearing. At this point, it appears that burbot would be well received as a new aquaculture species in the market, can be produced under similar conditions as salmonids, and have high potential as a new freshwater aquaculture species in the US.



4 Adapting Aquaculture to Changing Water Chemistry in the Pacific Northwest

Annual Progress Report

PRINCIPAL INVESTIGATORS: George G. Waldbusser, Brian Haley, and 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: Kenneth Cain, *University of Idaho*

ISSUE: Water quality issues continue to affect the ability of major commercial oyster hatcheries in Oregon and Washington, despite the significant improvements in production associated with buffering seawater to mitigate ocean acidification impacts. Industry personnel estimate that, on average, production is still 20% or so below historic values. The decreases in production appear to manifest in later-state larvae and generally occur in the late summer. One of the current limitations on expansion of oyster aquaculture has been seed supply; thus, increasing production will help the market expand and meet demand.

RESPONSE: The project team is focusing on identifying water quality issues associated with production decreases through various monitoring and measurement approaches. We have installed additional monitoring equipment in one hatchery to add to the high frequency data collection underway, and have carried out two field campaigns of targeted measurements (nutrients, metals, inorganic carbon, oxygen, oxygen demand, and sulfide) of water as it moves through the hatchery setting and within static culture tanks

over time. Our results are being used to develop a best management practices guide for water quality and ocean acidification for oyster hatcheries and growers.

RESULTS: Our results are beginning to point towards a couple of related causes that we will continue to explore. First, oxygen demand (and associated redox potential) appears to be impacting specific cohorts. When we record spikes in oxygen demand in the monitoring data, they are showing some alignment with tidal and light phasing. Second, metabolism within tanks appears to be exacerbating water quality issues, with possible indirect effects on metals toxicity through speciation. However, to date, metals measurements are all below lethal levels—yet, the metals concentrations appear to be elevated sporadically in some culture tanks and higher in buffering agents at times. So far, we have measured no detectable sulfide in either of the two hatcheries, except in the soda lime slurry. Finally, we are exploring the link between the oxygen demand spikes and tidal phasing. While season and phasing appear to drive elevated CO₂ in late summer/fall, the oxygen demand spikes nearly always appear during extreme low-tide series.

IMPACTS: Globally, the demand for shellfish is increasing. Providing tools and approaches for oyster hatcheries to adapt to changing water chemistry will help to keep the United States strong in this market and also provide opportunities for the sector to grow. Hatcheries are quickly moving to increase water quality monitoring and treatment equipment. Identifying the key mechanisms for failures will ensure the most efficient use of resources and provide opportunities for targeted treatment.



5

Identification of Genetic Markers for Disease Resistance to Infectious Hematopoietic Necrosis Virus (IHNV) in Commercial Populations of Rainbow Trout through Genome-wide Association Analysis

Annual Progress Report

PRINCIPAL INVESTIGATORS: Kerry Naish, *University of Washington*; Maureen Purcell, *Western Fisheries Research Center, US Geological Survey*; Kyle Martin, *Hendrix Genetics/Troutlodge Inc.*; Yniv Palti, *National Center for Cool and Coldwater Aquaculture*

Outreach Representative: Luke Gardner, *CA Sea Grant Extension*; Jackson Gross, *UCSD Aquaculture Extension*

Industry Advisor: Stephen Reichley, *Clear Spring Foods, Inc.*

Project Monitor: Kathleen O'Malley, *Oregon State University*

ISSUE: Disease is the single largest cause of production related mortality in the rainbow trout (*Oncorhynchus mykiss*) industry, accounting for 90% of the total losses (25.4 million fish) in 2015 (NASS 2016). Efficacious control methods are not available for all diseases, or if available, may add significantly to production costs. Thus, there is a need and an opportunity to develop additional approaches to mitigate disease losses in aquaculture.

RESPONSE: This project was initiated in November 2018 when Hendrix Genetics created progeny representing 100 families from the “November Even Year” line. A total of 2,055 fish were distributed among three challenge tanks and challenged for 21 days with IHNV. In May 2019,

Hendrix personnel created 120 “May Odd Year” line families. These progeny fish were transferred to the WFRC in August 2019, and we are currently conducting pilot virus challenge experiments to determine the optimal dose for the main challenge. We anticipate starting the main challenge the week of September 16, 2019.

RESULTS: To date, results showed a high degree of consistency in host response among the three tanks. We experienced higher mortality (81% CPM) than anticipated based on the pilot dose challenges. However, we do not anticipate this result will be a major impediment to our analysis because we will rank fish phenotypes as highly susceptible (early mortality), moderate susceptibility (later mortality), and resistant (no mortality). Fin tissues were excised from all virus challenged November 2018 progeny individuals and preserved for DNA analysis.

IMPACTS: So far, this project has provided information on the best way to achieve repeatability among challenge tests for large scale IHNV studies by using “common garden” tanks. Such standardization is relevant to informing future studies that disentangle genetic versus environmental effects in host disease responses. We have also trained one undergraduate student in fish husbandry, disease challenges, and biological sampling.

In The Press & At The Podium

WRAC-funded projects
Sept. 1, 2018–Aug. 31, 2019

JOURNAL PUBLICATIONS & MANUSCRIPTS

- Allan CP, Waldbusser GG, Hales B. (in prep) 2018. Empirical prediction of estuarine carbonate weather. To be submitted to *Limnology and Oceanography: Methods*.
- Ashton NK, Jensen NR, Ross RJ, Young SP, Hardy RS, Cain KD. 2019. Temperature and maternal age effects on burbot reproduction. *North American Journal of Fish Management* 39:1192–1206, American Fisheries Society ISSN: 0275-5947 print / 1548-8675 online
- Engle CR, van Senten J, Fornshell G. 2019. Regulatory costs on U.S. salmonid farms. *Journal of the World Aquaculture Society* 50(3):522-549. doi.org/10.1111/jwas.12604.
- Engle CR, van Senten J. 2018. Measuring the costs of regulations in aquaculture. *Fish Farming News* Issue 4.
- Fiske JA, Van Eenennaam JP, Todgham AE, Young SP, Holembell C, Goodbla A, Schreier AD. 2019. A comparison of methods for determining ploidy in white sturgeon (*Acipenser transmontanus*). *Aquaculture* 507: 435–442.
- Leal MJ, Van Eenennaam JP, Schreier AD, Todgham AE. 2019. Triploidy in white sturgeon (*Acipenser transmontanus*): effects of acute stress and warm acclimation on physiological performance. *Comparative Biochemistry and Physiology A: Molecular and Integrative Physiology* 229:10–7.
- Leal MJ, Van Eenennaam JP, Schreier AD, Todgham AE. 2019. Diploid and triploid white sturgeon differ in magnitude of physiological responses to exhaustive exercise at ambient and elevated temperature. Submitted to *Journal of Experimental Biology*.
- Oliver LP, Ma J, Bruce TJ, Evavold JT, Korbel DB, Cain KD. Triploid induction in cultured burbot (*Lota lota*) using thermal and hydrostatic shock. *Aquaculture* (submitted/ in review).
- Van Eenennaam JP, Fiske A, Leal M, Cooley-Rieders C, Todgham AE, Conte FS, Schreier A. Mechanical shock during egg de-adhesion and post-ovulatory ageing cause spontaneous autopolyploidy in cultured white sturgeon (*Acipenser transmontanus*). Submitted to *Aquaculture*.

FACT SHEETS & INFOGRAPHICS

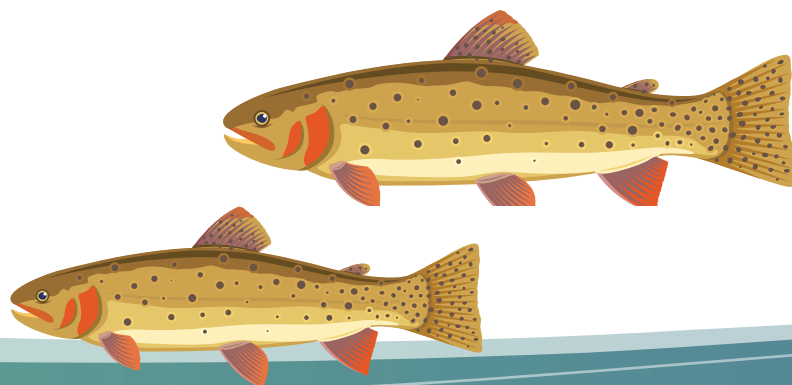
This wide-ranging project, “The Effects of Regulations on the U.S. Salmonid Industry,” co-authored by Carol Engle, Jonathan van Senten, and Gary Fornshell, produced 15 fact sheets and 15 matching infographics as well as a video.

Included in the study were 1 national survey, 3 regional surveys (midwest states, coastal states, western region) and 11 state surveys (Colorado, Idaho, Michigan, New York, North Carolina, Ohio, Pennsylvania, Utah, Virginia, West Virginia, Wisconsin).

Links to the fact sheets, infographics and video are available on the WRAC website at: http://depts.washington.edu/wracuw/front%20page/Effects-of-Regulations_Engle.html

PRESENTATIONS & POSTERS

- Bruce TJ, Ma J, Oliver LP, Cain KD. Immunological parameters in cultured burbot (*Lota lota*) following long-term feeding of soy protein variants and exposed to pathogenic *Aeromonas* spp. Western Fish Disease Workshop/AFS FHS Annual Meeting. Ogden, UT. June 17–20, 2019.
- Bruce TJ, Oliver LP, Small BC, Hardy RW, Brown ML, Craig SR, Cain KD. Evaluation of fishmeal replacement with soy protein sources on the growth response and health of cultured burbot (*Lota lota*). *Aquaculture America* 2019. New Orleans, LA. March 7–11, 2019. Poster presentation.
- Bruce TJ, Ma J, Oliver LP, Gulen S, Lafrentz BR, Cain KD. Disease diagnostics and evaluation of immunological parameters in cultured burbot (*Lota lota*). Platform presentation. *Aquaculture America* 2019. New Orleans, LA. March 7–11, 2019.
- Engle C, van Senten J. Cost of trout regulation update. *Aquaculture America* 2019. New Orleans, LA. March 9, 2019.



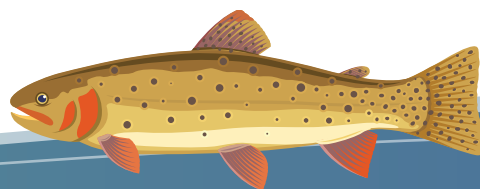
- Fiske A, Van Eenennaam JP, Todgham AE, Holem-Bell C, Young S, Schreier AD. A comparison of methods for determining ploidy of cultured white sturgeon. North American Sturgeon and Paddlefish Society Meeting, Columbia, MO, October 21–24, 2018.
- Fornshell G, Mollison J. Regulatory Costs on U. S. Trout Farms: Fact Sheets, Infographics and World Premiere Video—Let’s Start the Conversation about Regulations! U.S. Trout Farmers Association Fall Conference. Seattle, WA. September 5, 2019.
- Fornshell G, Engle CR, van Senten J. Regulatory costs on U.S. trout farms. Middle Snake Regional Water Resource Commission. Twin Falls, ID. June 19, 2019.
- Leal MJ, Van Eenennaam JP, Schreier AD, Todgham AE. Physiological differences of stress and metabolic responses in white sturgeon of different ploidies. North American Sturgeon and Paddlefish Society Meeting, Columbia, MO, October 21–24, 2018.
- Ma J, Bruce TJ, Oliver LP, Lafrentz BR, Cain KD. Disease diagnostics in cultured burbot (*Lota lota*) and experimental challenge with novel *Flavobacterium columnare* and *Aeromonas* spp. isolates. Western Fish Disease Workshop/AFS FHS Annual Meeting. Ogden, UT. June 17–20, 2019.
- Oliver LP, Ma J, Bruce TJ, Evavold JT, Korbel DB, Cain KD. Triploid induction in cultured burbot (*Lota lota*) using thermal and hydrostatic shock. Aquaculture America 2019. New Orleans, LA. March 7–11, 2019.
- Oliver LP, Ma J, Bruce TJ, Evavold JT, Korbel DB, Cain KD. Triploid induction in cultured burbot (*Lota lota*) using thermal and hydrostatic shock. Idaho Aquaculture Association Annual Meeting 2019. Twin Falls, ID. March 6–8, 2019.
- Van Eenennaam JP, VTodgham A, Conte F, Schreier A. Reducing 12N production in hatchery white sturgeon. North American Sturgeon and Paddlefish Society Meeting, Columbia, MO, October 21–24, 2018.
- Van Eenennaam JP, Schreier A, Conte F, Fiske A, Leal M, Todgham AE. Ploidy analysis using non-lethal sampling and a Coulter counter. North American Sturgeon and Paddlefish Society Meeting, Winnipeg, Manitoba, Canada, September 8–12, 2019.
- van Senten J, Engle CR. Regulatory effects on the value of shellfish aquaculture. East Coast Commercial Fisherman’s & Aquaculture Trade Exposition. Ocean City, MD. January 19, 2019.
- van Senten J, Engle CR. Final version of the trout economic study. Colorado Aquaculture Association Annual Meeting, CO. February 1, 2019.
- van Senten J, Engle CR. Regulatory compliance costs on West Coast shellfish farms. Abstract. Aquaculture America 2019. New Orleans, LA. March 11, 2019.
- van Senten J, Engle CR. U.S. interstate trade regulation for aquaculture: what is the cost to U.S. producers? Abstract. Aquaculture America 2019. New Orleans, LA. March 11, 2019.
- Waldbusser, GG, SR Smith, B Hales. Effects of seagrass and tides on carbonate chemistry exposure in juvenile oysters. ASLO Aquatic Sciences Meeting, **San Juan, Puerto Rico. February 23–March 2, 2019.**
- Warren B, Feely R. Accelerating ocean change in the PNW: New research, and new policy tools to protect healthy waters. Pacific Coast Shellfish Growers Association Meeting, Blaine, WA, September 18–20, 2018.

IN THE MEDIA & ON THE WEB

- Cooper, Leigh. The Pipeline: Developing fish vaccines. University of Idaho, College of Natural Resources. [Features WRAC funded research and PI K. Cain] Published in the fall 2018 issue of Here We Have Idaho. Found at: https://www.uidaho.edu/news/here-we-have-idaho-magazine/invention-pipeline?fbclid=IwAR2odXx_E0ykt6j6o67dJ_oeFDIgj976fU_SFdceTjHqXCMJjpllt-vJNAtg.
- Engle CR, van Senten J, and Fornshell G. Regulatory costs on U.S. salmonid farms. Trout Talk Newsletter. United States Trout Farmers Association, Spring, 2019. <https://ustfa.org/?s=regulatory+costs>.
- Engle C, van Senten J, Kumar G, Cassiano E, DiMaggio M, Watson C, Asche F. What do regulations cost your aquaculture farm business? Fish Farming News, August, 2019.

GRADUATE SEMINARS

- Gulen S. Dietary effects on growth performance and health indices for burbot (*Lota lota maculosa*). University of Idaho College of Natural Resources, Department of Fish & Wildlife Sciences Graduate Seminar (Fish 501).
- Matuha M. Sustainable production of burbot: weaning techniques, optimal spawning, sensory analysis and production economics. University of Idaho College of Natural Resources, Department of Fish & Wildlife Sciences Graduate Seminar (Fish 501).



Western Regional Aquaculture Center
School of Aquatic & Fishery Sciences
Box 355020
University of Washington
Seattle, Washington 98195-5020

EXECUTIVE DIRECTOR

Graham Young

PROGRAM MANAGER

Julie Hahn

FISCAL MANAGER

Sarah Merlino

EDITORS

Julia Hahn

Cathy Schwartz

GRAPHIC DESIGNER

Cathy Schwartz

WEB DESIGNERS

Erica Curles

Marcus Duke

Please send us your email address!

You are receiving this newsletter by mail because WRAC does not have an active email address for you. To help us keep in touch with you, please share your email address by contacting us at wrac@uw.edu.

Waterlines is a publication intended to inform the general public and various aquaculture groups about WRAC activities and regional news. These include highlights of USDA/NIFA-funded research and extension projects as well as articles regarding aquaculture appropriate to the western region. Readers are encouraged to submit material for inclusion in *Waterlines*. Publication of material in *Waterlines* does not imply endorsement by WRAC.

To submit materials, make comments, be added or removed from our mailing list, or receive this publication online only, please contact us at:

Editor, WRAC *Waterlines*
School of Aquatic and Fishery Sciences
College of the Environment
University of Washington
Box 355020, Seattle, WA 98195-5020

phone: 206-685-2479
email: wrac@uw.edu
web: depts.washington.edu/wracuw

Visit our website at:
depts.washington.edu/wracuw

