

# Waterlines

WESTERN REGIONAL AQUACULTURE CENTER

2015  
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 2015 newsletter and report of accomplishments to USDA/NIFA.

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United States Department of Agriculture  
National Institute of Food and Agriculture

Cover photo: Gary Fornshell



# A Decade at the Helm of the Good Ship WRAC

—Graham Young, Executive Director



Greetings all,

It is a little more than ten years since I took over from Dr. Ken Chew as Executive Director of WRAC. In *Waterlines*, I usually prefer to keep quiet and let the achievements of our research and outreach projects speak for themselves. For this issue, though, I've emerged to briefly highlight some of the significant changes in the past decade that collectively have strengthened the already strong integration of industry-research-extension that is a unique and defining characteristic of the WRAC program.

*Complete revision of the Manual of Operations:* Fred Conte, Chair of the Strategic Planning Committee, members of that Committee, and then Program Manager Deb Granger deserve a sincere thank you for their persistence and good humor over several years in undertaking a (sometimes tedious and painful!) complete revision of the Manual so that it reflects current policies and procedures.

*Outreach as a critical component of a successful proposal:* Responding to the initiative of Extension Subcommittee members—especially Fred Conte (CA), Steve Harbell (WA), and Gary Fornshell (ID)—to strengthen the translation of research findings into impactful outreach products for industry, the Board adopted several policies to improve the integration of outreach with research. These policy changes have already led to an increase in quantity and quality of outreach products, such as publications and workshops, which are especially important for conveying the economic impacts of WRAC's investment to federal agencies and congressional appropriations committees.

*Increasing the quality and quantity of pre-proposals and full proposals:* To increase the competitiveness of the proposal process, the Industry Advisory Council/Technical Committee (IAC/TC) moved to provide more detailed problem statements, increase the number of statements in the RFP, and recommend full proposal development from any

potential Work Group that adequately addressed a problem statement. WRAC now receives an average of 12–14 high-quality pre-proposals each funding cycle and usually requests development of at least 8 full proposals. A welcome consequence of these changes is the number of pre-proposals submitted by teams that have not applied for WRAC funding previously.

*Documenting the long-term impacts of WRAC projects:* Our ability to document long-term impacts of projects, especially in areas where WRAC has made multi-funding cycle investments, is critical in order to demonstrate the effectiveness of the program to federal agencies and to Congress. Members of the Extension Subcommittee have led efforts to more effectively capture long-term impacts, initially in two areas: low phosphorus feeds (Gary Fornshell) and sturgeon caviar production (Steve Harbell). A key feature of these efforts is to seek feedback from industry end-users.

Behind the success of all WRAC projects are an engaged IAC, TC, and Board who have worked with me and our Administrative Office staff to enhance WRAC's mission.

Although the current research funding environment continues to be challenging, and on occasion, discouraging, WRAC continues to provide critical research and outreach in support of our regional industry. And, I encourage you to take whatever opportunity you have to educate decision-makers on the essential role of the five Centers that comprise the National RAC program in supporting the growth of the domestic aquaculture industry. Best wishes and thanks to all in the WRAC community for your support.



Graham Young

Graham

# Spotlights on People and Programs



Wynne and Ray RaLonde

## TECHNOLOGY UPDATES

### Shellfish and Water Quality

#### *Pearl*

Conte FS, Ahmadi A. 2013. Pearl: A New Model for Evaluating and Managing Shellfish Growing Water Closures. *Applied Engineering In Agriculture* ISSN: 0883-8542.

#### *Aquarius, Version 3.0*

Conte FS, Ahmadi A. 2009. Simulation software for rainfall and water quality closure rules designed for agencies and the shellfish industry, Copyright 2009–2010, Regents of University of California. Software and manual, p. 114.

#### *Rainfall Processing Program, Aquarius, Version 1.0*

Conte FS, Ahmadi A. 2009. Software designed to convert any rainfall database into a format usable for inclusion in the *Aquarius* software. Copyright 2009–2010, Regents of University of California. Software and manual. p. 17.

## NEW TO WRAC—WELCOME!

### Board of Directors

Alaska Representative: Gary Freitag, *Associate Faculty, University of Alaska, Fairbanks; Marine Advisory Program Agent, Alaska Sea Grant, Roberson/Hamilton Technical Center, Ketchikan, AK*

Western Association of Agriculture Experiment Station Directors, WRAC Representative: Dan Edge, *Associate Dean and Professor, Department of Fisheries and Wildlife, College of Agricultural Sciences, Oregon State University*

### Technical Committee, Extension Subcommittee—*Representing Alaska*

Quentin Fong, *Alaska Marine Advisory Program, Kodiak Seafood and Marine Science Center; Seafood Marketing Specialist, Alaska Sea Grant; Professor, University of Alaska, Fairbanks.*

### Research Subcommittee

Jackson Gross, *Research Scientist and Conservation and Aquatic Nuisance Species Program Manager, Smith-Root, Inc.*

Gil Sylvia, *Director, Coastal Oregon Marine Experiment Station; Professor, Department of Agriculture and Resource Economics, Oregon State University*

## A BIG WRAC FAREWELL

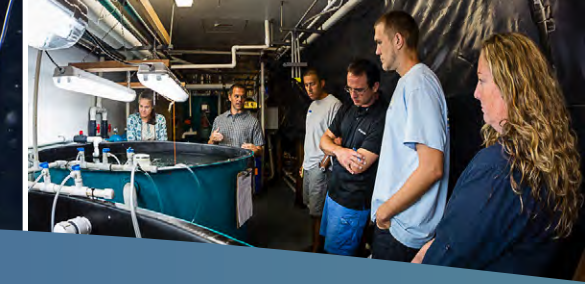
### Ray RaLonde Retires

After more than 24 years in aquaculture development and steadfast support of WRAC, Ray RaLonde celebrated his retirement from the WRAC Board of Directors this fall. Over the years, Ray has been an active Alaska aquaculture researcher, extension professional, and dedicated WRAC Board representative. During his tenure, he provided leadership and guidance to many WRAC-funded projects.

Through his work at Alaska Sea Grant, Ray founded the Alaska Future Farmers of America program in marine technology (*Waterlines*, Winter 2004). This program provides future generations the opportunity to train in aquaculture careers. Also, Ray worked tirelessly to support shellfish farming to diversify Alaska's economy. He built bridges between the industry and the Alaska State Legislature that eased the permitting and site selection process. He also educated hundreds of Alaskans about PSP risks and harmful algal blooms.

Ray's career represents a lifetime of aquaculture achievements. "Congratulations on your retirement," from everyone at WRAC.





# WRAC Project Highlights

September 1, 2014–August 31, 2015

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

## 1 Optimizing the Larval Nutrition of Marine Finfish Aquaculture Species Along the West Coast Termination Report

**Principal Investigators:** Mark Drawbridge, *Hubbs-SeaWorld Research Institute*; Michael Rust and Ron Johnson, *NOAA Fisheries, Northwest Fisheries Science Center*; Chris Langdon, *Oregon State Univ.*; Rick Barrows, *USDA/ARS-Hagerman Fish Culture Experiment Station*

**Outreach Representative:** Fred Conte, *Univ. of California Davis*

**Industry Advisor:** Jim Parsons, *TroutLodge*; Jackie Zimmerman, *Skretting USA*

**Project Monitor:** Ken Cain, *University of Idaho*

**ISSUE:** In the USA, hatchery technologies for marine finfish have been developed on a small scale; however, to be successful, commercial companies will need mass production of high quality juvenile fish to start the growout process. The purpose of this project was to employ nutritional approaches to maximize larval survival and quality.

**RESPONSE:** The goal of researchers was to increase growth, fitness, and survival of two species of marine finfish—white seabass and California yellowtail—that have excellent potential for commercial aquaculture.

**RESULTS:** By partitioning the project into discreet areas of focus through the larval stage, researchers were able to quantify stage-specific benefits. They improved the consistency of larval survival and quality through nutritional manipulations, including the adoption of new commercially available enrichments and the development of novel microparticulate delivery systems. They discovered and/or validated several new techniques for packaging micronutrients into larval feeds, developed several processing techniques for formulated feeds, and developed and validated an open formula microdiet that will allow the US industry to customize and manufacture diets for individual species.

**IMPACTS:** The research results are already being applied to hatchery protocols for California yellowtail and white seabass, especially with regard to live feeds and enrichments. This has resulted in greater operational efficiency, more consistent larval survival quality, a more streamlined and cost-effective regime for live feeds production, and reduced malformations. Investigators presented their research results to stakeholders at the Marine Larval Nutrition Workshop at Hubbs-SeaWorld Research Institute in August 2015.



## 2 Environmental and Endogenous Factors Affecting Egg Quality and Caviar Yield in Farmed Sturgeon

### Termination Report

**Principal Investigators:** Serge Doroshov, Bernard May, Ermias Kebreab, *University of California Davis*; Barbara Rasco, *Washington State University*; Molly Webb and Chris Guy, *USFWS, Montana State University*; Terry Patterson, *College of Southern Idaho*

**Outreach Representative:** Fred Conte, *University of California Davis*

**Industry Advisors:** Ken Beer, *The Fishery*; Linda Lemmon, *Blind Canyon Aqua Ranch*; Leo Ray, *Fish Breeders of Idaho*; Shaoching Bishop, *Sterling Caviar, LLC*

**Project Monitor:** Jason Mann, *EWOS Canada Ltd*

**ISSUE:** Sturgeon farming in the western region is a thriving and growing industry. Because both the quality and yield of caviar are key factors in the continued economic viability of this industry, it is important to evaluate the elements that impact these factors.

**RESPONSE:** Feeding trials were conducted using current high energy (HE) diets and experimental low energy (LE) diets. Females were sampled after being fed the diets to test the hypothesis that diet energy affects ovarian adiposity, roe yield, and caviar sensory attributes. Researchers also tested the hypothesis that diet and genotype affect ovarian adipocyte size and accumulation in prepubertal sturgeon.

**RESULTS:** Reducing adipocyte size in prepubertal females and adipose accumulation in adult females through diet was successful; however, given the length and complexity of the reproduction cycle for white sturgeon, experimentation with LE diets is still necessary for the age period 3 to 5.5 years to determine if long-term growth rates and sexual maturation rates are acceptable for the industry. Lowering the dietary fat levels to 8–9% at age 5.5 years improved the yield of caviar; however, a cost-benefit analysis is needed to determine if a finishing diet makes economic sense for individual farms. Although overall caviar quality, based on the sensory panels and processing plant grading, was not improved, it was important to determine that LE diets did not lower the quality.

**IMPACTS:** Investigators will conduct a post-research industry survey to determine: to what extent sturgeon feed manufacturers and caviar producers have accepted the dietary regime modifications suggested by the study, at what level the industry has incorporated low-fat diets, and what cost savings have been realized with the new formulated diets. A second survey will be conducted within three years to determine if the low-fat diets adopted by the industry have significantly improved overall caviar yield and quality, how many caviar producers have adopted low-fat diets, and what increased level of profits have been realized.



## WRAC Project Highlights *continued*

# 3

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

### Annual Progress 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, Inc.*

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

**ISSUE:** As capture fisheries on the West Coast are under pressure and the need for sustainable alternative sources of marine finfish increases, it is critical to develop best management practices for marine finfish producers. In addition, the success rate for rearing high-value marine finfish species, such as California halibut (CH), California yellowtail (CYT), and sablefish, is highly variable.

**RESPONSE:** The goals are to: 1) develop simple predictive egg quality measures, 2) mitigate or eliminate potential causes of poor quality eggs in multiple finfish species, and 3) determine how various

culture-related factors affect those egg characteristics. Researchers will use this information to develop effective management practices.

**RESULTS:** Researchers determined that wild broodstock eggs have slightly less lipid than first generation cultured CYT broodstock eggs. Fatty acid analysis showed that linoleic acid tends to be higher in eggs from good spawn events than from poor spawn events. With hormone manipulation, the use of a pre-injection improved egg quality in sablefish. Parentage results showed that spawning events for CYT typically involve a single female and multiple males. Researchers found that CYT will spawn in smaller tanks. Egg quality was recorded for both CH and CYT, showing similar trends for both species.

**IMPACTS:** The information collected has made a significant impact on HSWRI broodstock management protocols and selection. The hormonal manipulation being done with sablefish is a good foundation for looking at different spawning techniques and resulting egg quality that can be used with other marine finfish species. Demonstrating that CYT will spawn in smaller tanks will allow for replication in other broodstock nutrition studies. The findings and approaches applied in this project should translate meaningfully to other species in commercial development in the United States. Information will be presented in multiple sessions at Aquaculture 2016.



# 4 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, *U of Idaho Extension*

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

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

**ISSUE:** While there are commercially available feeds for rearing trout, none are 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 an additional set of studies evaluating the performance of different diet formulations that have the same behavior. 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:** A feeding trial was conducted on Snake River cutthroat trout using six diets—two commercial controls, three commercial-type diets with different protein:lipid ratios, and one experimental diet. Fish were hand fed to satiation for the first month; subsequent feedings were carried out with automatic feeders. Survival was high and not affected by diet type; final fish size was affected by diet.

Two lysine requirement trials for Yellowstone cutthroat trout were terminated prematurely because of issues with diet palatability and disease outbreak. Preliminary data showed that as the lysine level in the diet increased, the fish grew better, with lower feed conversion ratios. A regression analysis suggests the lysine requirement is similar to that for rainbow trout. Because of the disease outbreak, a follow-up lysine requirement trial using highly palatable diets was started in Sept. 2015.

**IMPACT:** Research findings clearly demonstrated that flake feeds are not ideal for cutthroat trout. Overall, the results continue to support the findings of earlier studies that using premium diets or diets with high protein:lipid ratios provides the greatest growth in juvenile Snake River cutthroat trout. This information should be of interest to the aquaculture and feed industries. Based on research findings to date, two manuscripts have been published in the *Journal of Fish and Wildlife Management* and the *North American Journal of Aquaculture*.



## WRAC Project Highlights *continued*

# 5 Profitable and Biosecure Rock Scallop Culture for the West Coast

## Annual Progress Report

**PRINCIPAL INVESTIGATORS:** Paul G. Olin, *University of California Sea Grant Extension Program, UCSD/Scripps Institute of Oceanography*; Carolyn Culver, *UC Sea Grant Extension Program*; Jonathan P. Davis, *Puget Sound Restoration Foundation*

**Collaborating Scientist:** Brent Vadopalas, *University of Washington*

**Outreach Representative:** Ray RaLonde, *Alaska Sea Grant*

**Industry Advisor:** Jeff Hetrick, *Alutiiq Pride Shellfish Hatchery*

**Project Monitor:** Fred S. Conte, *University of California Davis*

**ISSUE:** A viable shellfish industry in the United States is critical to maintain rural economies that are dependent on marine resource development and working waterfronts. Shellfish aquaculture is a low trophic level means of seafood production that provides many benefits to coastal communities and the environment, while at the same time increasing the supply of locally produced safe and nutritious seafood.

**RESPONSE:** The goal is to demonstrate production techniques for a new, competitive, and biosecure product—the native purple-hinge rock scallop. Researchers aim to greatly expand the geographic range of scallop culture, reduce genetic interactions between farmed and wild populations, and compare culture techniques to determine the most efficient and profitable way to culture rock scallops. There is also the

desire to develop native species for aquaculture to diversify the shellfish industry and to avoid concerns about the use of non-native species.

**RESULTS:** Diploid production was emphasized to help remove and mitigate production bottlenecks while increasing knowledge and development of husbandry techniques. Scallop production increased slightly between 2014 and 2015. Almost all of these resulted from a single larval rearing cycle using a Kalwall tube with air diffusion. This is a promising indication that water motion and turbulence may seriously impact larval survival and that survival can be increased significantly by manipulations of aeration and water circulation.

**IMPACTS:** Researchers have identified diets that support larval development, survival, and settlement of purple-hinge rock scallops. They have evaluated larval rearing tank designs and water circulation techniques and identified some that seem promising. Determination of optimal protocols for consistent, reliable production of seed with higher survival requires further evaluation and replication. Protocols for producing triploid seed have been established; future work on production of tetraploids and haploid sperm is planned. These are all requisite steps towards the goal of developing protocols for production of scallop seed in sufficient quantities to involve all our commercial partners and establish a scallop sector in the shellfish industry.





# 6 Efficient, Rapid Assay for Predicting the Growth Rate of Aquaculture Species Based on Metabolic Rate of the Fertilized Egg

## Annual Progress Report

**PRINCIPAL INVESTIGATORS:** Benjamin Renquist, *University of Arizona*; Kenneth Overturf, *USDA/ARS-Hagerman Fish Culture Experiment Station*; Christopher Langdon, *Oregon State University*  
**Outreach Representative:** Gary Freitag, *University of Alaska*  
**Industry Advisor:** Leo Ray, *Fish Breeders of Idaho*  
**Project Monitor:** Matt Powell, *University of Idaho*

**ISSUE:** Growth of fish depends on many conditions, including dominance, feed availability, water quality, and water temperature. The AlamarBlue® assay can be used to identify broodstock that pass along the highest genetic potential for growth to their offspring and evaluate treatments that may modify the epigenetic potential for growth (e.g., nutrition, water temperature, salinity).

**RESPONSE:** Confirm that the AlamarBlue® assay, developed in zebrafish, can be applied to tilapia and test its applicability in predicting growth rate of oysters.

**RESULTS:** Using the AlamarBlue® assay, researchers established that embryos with a high metabolic rate grow more quickly than embryos with a low metabolic rate. This growth advantage remained until harvest. In subsequent studies, researchers showed that selection of yolked embryos with a high metabolic rate improves feed efficiency.

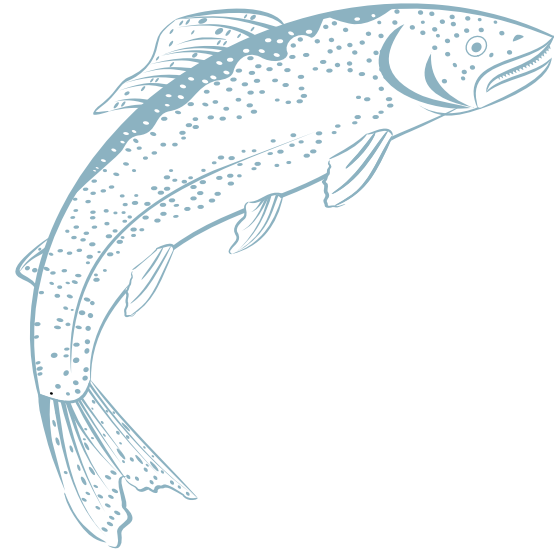
This same assay can be applied to measure metabolic rate of skeletal muscle or fin biopsies. When biopsies are collected from mature fish, a low skeletal muscle metabolic rate will be indicative of decreased skeletal muscle maintenance requirements. Accordingly, selection of fish whose skeletal muscle has a low metabolic rate should allow for improved feed efficiency.

Researchers collaborated with industry and Christopher Langdon at the Hatfield Marine Science Center to confirm that the assay can also be applied to measure metabolic rate in oyster D-larvae and spat. The signal generated by oysters increased with time of exposure to the assay, and smaller oysters generated a lower signal than their larger siblings. Variability within a family was robust and individual selection may allow for more rapid improvement of oyster stock.

**IMPACT:** Selecting embryos with a high metabolic rate allows researchers to identify tilapia that will grow more quickly. Additionally, a method has been proposed to select fish with improved feed efficiency. This work will be applicable across aquaculture species and is expected to be widely adopted by the industry. Efforts to commercialize the process should allow for industry implementation. A *Journal of Visual Experimentation* article and an eXtension webinar video about this assay are available at [acbs.cals.arizona.edu/people/benjamin-renquist](http://acbs.cals.arizona.edu/people/benjamin-renquist).

# In The Press and At The Podium

WRAC-funded projects from 9/1/14–8/31/15



## PUBLICATIONS

Baker AK, Vixie B, Rasco BA, Ovissipour M, and Ross CF. 2014.

Development of a lexicon for caviar and its usefulness for determining consumer preference. *Journal of Food Science* 79:S2533–S2541.

Conte FS, Ahmadi A. 2014. Application of the Pearl model to analyze fecal coliform data from conditional approved shellfish harvest areas in seven Texas bays. *Journal of Environmental Health*, 77(2):22–29.

Conte FS, Ahmadi A. 2014. Analysis of shellfish growing areas of Alabama, Florida and Georgia, USA—using the Pearl shellfish sanitation model. *International Journal of Food Systems Dynamics*, 5(4):212–229.

Ham BR, Barrows FT, Huttinger Duff AGC, Yeoman CJ, Maskill MG, Sealey WM. 2015. Evaluation of dietary soy sensitivity in Snake River Cutthroat Trout. *North American Journal of Aquaculture* 77(2):195–205.

Ham BR, Myrick CA, Barrows FT, Yeoman CJ, Duff GC, Maskill MG, Sealey WM. 2015. Feed characteristics alter growth efficiency of cutthroat trout. *Journal of Fish and Wildlife Management* 6(1):83–91.

Hawkyard M. 2015. Researchers develop better methods for delivery of water-soluble nutrients to marine fish larvae. *Hatchery International*. May/June 2015. <http://hatcheryinternational.com/husbandry/researchers-develop-better-methods-for-delivery-of-water-sol>

Hawkyard M, Stuart K, Langdon C, Drawbridge M. 2015. The enrichment of rotifers (*Brachionus plicatilis*) and *Artemia franciscana*

with taurine-liposomes and their subsequent effects on the larval development of California yellowtail (*Seriola lalandi*). *Aquaculture Nutrition* 22(4), May 2015, DOI: 10.1111/anu.12317.

Lu X, Talbott MJ, Van Eenennaam JP, Webb MAH, Doroshov SI, Ovissipour M, Rasco B. 2013. Determining ovarian maturity in farmed sturgeon (*Acipenser transmontanus*) for caviar production using Fourier Transform Infrared Spectroscopy (FT-IR). *Aquaculture Research and Development* 5:1–6.

Ovissipour M, Al-Qadiri HM, Lu X, YHu Y, Ross CR, Van Eenennaam JP, Doroshov SI, Rasco B. 2015. The effect of white sturgeon (*Acipenser transmontanus*) ovarian fat deposition on caviar yield and nutritional quality: Introducing image processing method for sturgeon ovary fat determination. *International Aquatic Research* 7: 263–272.

Talbott, MJ, Servid SA, Cavinato AG, Van Eenennaam JP, Doroshov SI, Struffenegger P, Webb MAH. 2014. Confirmation of ovarian homogeneity in post-vitellogenic cultured white sturgeon, *Acipenser transmontanus*. *Fish Physiology and Biochemistry* 40:1–7.



## FEATURED IN THE MEDIA/ON THE WEB

- Elliott S. (2015, July 7) Nothing fishy about probiotics. USDA/NIFA blog post. Retrieved from: <https://nifa.usda.gov/blog/nothing-fishy-about-probiotics>
- Hawkyard M, Langdon C, Stuart K, Drawbridge M. Liposomes open new doors in larval fish nutrition. Global Aquaculture Alliance: Advocate. May/June 2015.
- Stuart K. Hubbs Sea World Research Institute (HSWRI) Aquaculture Program Report September 2014, [http://hswri.org/wp-content/uploads/2014/06/070\\_HSWRI\\_News\\_July142.pdf](http://hswri.org/wp-content/uploads/2014/06/070_HSWRI_News_July142.pdf).

## MASTER'S THESIS

- Simon MR. 2015. The effects of dietary composition on energy deposition in juvenile white sturgeon. MS Thesis, University of California, Davis. 74p.

## PRESENTATIONS AND POSTERS

- Baker AK, Vixie B, Rasco B, Ovissipour M, Van Eenennaam JP, Ross CF. Lexicon development and validation for caviar characterization and relationship to consumer preference. Institute of Food Technology, Chicago, IL. July 10–15, 2015.
- Conte FS, Ahmadi A. Pearl: A New Model for Evaluating Bay Sanitation Conditions and Managing Shellfish Growing Water Closures. World Conference on Computers in Agriculture and Natural Resources, presenter. University of Costa Rica, San Jose Costa Rica, July 28, 2014.
- Davis J. Recent developments in purple-hinge rock scallop culture on the US West Coast. Northeast Aquaculture Conference and Exposition and the Milford Aquaculture Seminar, Portland, ME, January 14–16, 2015.

- Hawkyard M, Laurel B, Hamre K, Barr Y, Stuart K, Drawbridge M, Langdon C. Challenges and solutions associated with the provision of water-soluble nutrients to marine fish larvae. Aquaculture America 2015, New Orleans, LA, February 19–22, 2015.
- Jackson M, Wykoff S, Davis J, Vadopalas B. Advances in rock scallop *Crassadoma gigantea* culture: Seed production and induction of triploidy. 68th Joint Annual Meeting of the National Shellfisheries Association Pacific Coast Section and the Pacific Coast Shellfish Growers Association, Vancouver, WA, September 22–25, 2014.
- Owens CE, Sealey WM, Myrick CA. Evaluation of subadult Snake River cutthroat trout exposed to a novel environment and a novel predator. Do size or diet influence behavior? Presentation to the 2015 US FWS Directorate Fellow Program, Denver, CO.
- Stuart K, Barrows FT, Rust MB, Johnson RB, Hawkyard M, Langdon C, Drawbridge M. Evaluation of experimental microdiets with larvae of two marine finfish species. Aquaculture America 2015, New Orleans, LA, February 19–22, 2015.
- Vadopalas B, Jackson M, Davis JP. Induction of triploidy in the purple-hinge rock scallop *Crassadoma gigantea* (Gray, 1825). 10th Annual Meeting of the National Shellfisheries Association, Monterey, CA, March 22–26, 2015.
- Van Eenennaam JP, Doroshov SI, Beer K. Caviar yield of farm raised white sturgeon fed a lower fat content diet for twenty-nine months prior to harvest. Aquaculture America 2015, New Orleans, LA. February 20–22, 2015.
- Vishwasrao RS, Gille D, May B, Schreier A. Genetic parentage analysis of White Sturgeon. University of California Davis Undergraduate Research Symposium, Davis, CA, May 1, 2015.

# Waterlines

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*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:

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