U.S. Fish & Wildlife Service

The Aquatic Animal Drug Approval Partnership Program

"Working with our partners to conserve, protect and enhance the Nation's fishery resources by coordinating activities to obtain U.S. Food and Drug Administration approval for drugs, chemicals and therapeutants needed in aquaculture"

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AADAP NEWSLETTER

April 2013

Yellowstone River, Paradise Valley, Montana USA

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WHAT'S SHAKIN'

Upcoming FDA CVM Data Quality Webinar

The U.S. Food and Drug Administration (FDA) Center for Veterinary Medicine (CVM) will be hosting a *Data Quality Webinar* spread out over two mornings, June 4 and June 6, 2013; both sessions will run from 9:00 am to 12:00 noon EDT. This webinar will provide training and stimulate discussion on critical factors that can impact the quality of target animal safety and effectiveness data submitted to CVM. The presentation and discussion will cover the lifespan of data—from the conceptualization of the need for data, through the collection and analysis of the data, to the submission of those data to CVM. Submissions containing high quality data contribute to a substantive decrease in the time to approval for many drugs.

The webinar will be available publicly via Adobe Connect software through the web browser on the participant's computer. There is no formal registration for this webinar. Information regarding the webinar URL, the webinar agenda, and other related topics, and instructions on how to access the webinar will be available at least 1 week before the webinar (make sure to test your computer's ability to use Adobe Connect before the day of the webinar!)

The presentation materials, audio transcripts of the presentations, and a written transcript of questions and answers will also be made available on CVM's website within 30 days after the webinar.

Please click *here* for more information.

Text provided by Dr. Jennifer Matysczak (Jennifer.Matysczak@fda.hhs.gov), Leader; Aquaculture Drugs Team; Office of New Animal Drug Evaluation; Center for Veterinary Medicine, Food and Drug Administration; Rockville, Maryland USA.

Aquaflor® Update

In April 2012, Merck Animal Health announced that FDA had approved two new indications for Aquaflor® (50%

florfenicol) Type A Medicated Article. These new indications are:

(1) Aquaflor® can now be used in freshwater-reared warmwater finfish (e.g., catfish, tilapia, and striped bass) at dose rates of 10-15 mg florfenciol/kg body weight/day and in all other freshwater-reared finfish (e.g., trout) at a dose rate of 10 mg florfenicol/kg body weight/day for the control of mortality due to columnaris disease associated with *Flavobacterium columnare*.

(2) Aquaflor® is approved for use in all freshwater-reared warmwater finfish (e.g., tilapia and largemouth bass) at a dose rate of 15 mg florfenicol/kg body weight/day for the control of mortality due to streptococcal septicemia associated with *Streptococcus iniae.*

As before, Aquaflor® is approved for the control of mortality due to enteric septicemia (ESC) associated with *Edwardsiella ictaluri* in catfish, but now a dose rate of up to 15 mg florfenicol/kg body weight/day is allowed for the treatement of ESC. Also, Aquaflor® remains approved for the control of mortality due to furunculosis associated with *Aeromonas salmonicida* and coldwater disease associated with *Flavobacterium psychrophilum* in freshwater-reared salmonids at a dose rate of 10 mg florfenicol/kg body weight/day.

The new "all freshwater-reared finfish" claim for columnaris disease is expected to benefit several public and commercial segments of U.S. aquaculture. However, it will be particularly helpful to catfish producers and feed mills serving the catfish industry because, now, one product can be used for both columnaris and ESC, the two leading bacterial diseases of farmed catfish. (Note: Merck Animal Health has discontinued AQUAFLOR-CA1).

Merck Animal Health also announced that the withdrawal time is now 15 days before slaughter for all species and indications. Previously, the withdrawal time for fish that received 10 mg florfenicol/kg body weight/ day was 12 days for catfish and 15 days for freshwater-reared salmonids. The company emphasized that the new withdrawal time was established to facilitate compliance across all species and dose rates without any change in the high safety profile of Aquaflor®.

Aquaflor®, which can be top-coated on or incorporated in both floating and sinking feeds, has been shown to be highly stable following high-temperature extrusion at feed mills. It is also highly palatable, which helps to optimize antibiotic intake. Aquaflor®-medicated feed should be administered as the sole ration for 10 consecutive days. Aquaflor® is not approved for use in breeding stock or for use in recirculating aquaculture systems.

Aquaflor® is classified by FDA as a Veterinary Feed Directive (VFD) drug, a category established in 1999 to help FDA more closely control new in-feed therapeutic products, primarily antimicrobials, and their use in food animals. Producers may obtain VFD drugs through normal feed distribution channels, but they do require a signed VFD from a licensed veterinarian.

The two recent approvals for Aquaflor® are the result of cooperation between the pharmaceutical company and U.S. public-sector researchers. The following groups generated and contributed data:

- U.S. Fish and Wildlife Service, Aquatic Animal Drug Approval Partnership Program, Bozeman, Montana
- U.S. Department of Agriculture, Agricultural Research Service, Stuttgart National Aquaculture Research Center, Stuttgart, Arkansas
- U.S. Geologic Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin
- Florida Fish and Wildlife Conservation Commission, Florida Bass Conservation Center, Webster, Florida
- Mississippi State University, Thad Cochran National Warmwater Aquaculture Center, Stoneville, Mississippi
- Washington Department of Fish and Wildlife, Bellingham State Fish Hatchery, Bellingham, Washington.

For more information, please go to *www.merck-animal-health.com* or *www.aquaflor-usa.com*.

Remembering Joe Townsend, QAO

Joseph Boatman Townsend, 84, died March 15, 2013, in Bozeman, Montana USA. Joe was AADAP's independent Quality Assurance Officer (QAO) from the late 1990s through the mid-2000s.

Joe was born in 1929 in Minot, North Dakota, but spent many of his childhood years in Montana. He attended the University of Maryland but left school early to serve in the U.S. Marine Corps during the Korean Conflict. After the war, Joe worked for 26 years in the pharmaceutical industry—often advising laboratories in the U.S. and other countries about how to comply with U.S. laws on proper laboratory practices. Joe was a founding member and Past-President of the Society of Quality Assurance for the United States, which is now an international organization. He retired in 1992 and settled in Bozeman in 1997.

In Bozeman, Joe tended his gardens, was active in local nonprofit groups, and served for several years as AADAP's QAO. Joe helped AADAP establish a Good Laboratory Practice (GLP) program and inspected several of AADAP's target animal safety (TAS) studies. We had some spirited debates with Joe about how the

GLP guidelines could be or should be interpreted; however, I can't remember ever winning one of those debates. Perhaps one small testament to Joe's QAO expertise is that none of the TAS studies that we conducted under his "watchful eye" was ever criticized by FDA on the basis of GLP compliance or quality assurance. Thank you, Joe, for all your help.

Joe was buried in Bozeman in a private military funeral. He is survived by his wife of 58 years, Suzanne; his daughter Linda and sons Joseph III, Thomas, and James; many grandchildren; one great-grandchild; and his brother Robert.

Text adapted from the Bozeman Daily Chronicle and provided by Dan Carty (dan_carty@fws.gov), Fish Biologist, USFWS AADAP, Bozeman, Montana USA.

AADAP's Jim Bowker and USGS's Dr. Joe Margraf Nominated for American Fisheries Society Office

The American Fisheries Society (AFS), founded in 1870, is the oldest and largest professional society representing fisheries scientists. Among its many functions, AFS publishes five peer-reviewed journals, a monthly magazine, and many fish- and fisheries-related books.

This year, AADAP's Jim Bowker and the U.S. Geological Survey's Dr. Joe Margraf were the two AFS members nominated for the office of AFS Second Vice President. Being nominated is very much a professional honor because the individual elected will serve on the AFS Governing Board for 5 years, including 1 year as President. Dr. Margraf was elected this year and will undoubtedly serve AFS well. Our congratulations to both Jim and Joe for being willing to run.

AADAP DRUG UPDATES

It's that time of year when we're winding down *and* gearing up. We're wrapping up several Target Animal Safety (TAS) Final Study Reports (FSRs), and we're coordinating some field effectiveness trials. Here's what we've been up to:

AQUI-S®20E and BENZOAK®

Effectiveness—We submitted a letter to FDA on November 20, 2012, requesting that the effectiveness technical section be considered complete for the use of AQUI-S®20E to sedate all freshwater finfish—including ornamental fish—to handleable. In mid-May, we anticipate hearing from FDA that the efficacy technical section is "complete." In the interim, we've been writing in-house Drug Research Information Bulletins (DRIBs) to summarize these studies and working with Drs. Jesse Trushenski and David Glover (Southern Illinois University, Carbondale, Illinois USA) on a sedative-compilation manuscript for submission to a peer-reviewed journal.

Target animal safety—In the December 2012 issue of the AADAP Newsletter, we recapped TAS studies conducted on rainbow trout, yellow perch, and channel catfish for the use of AQUI-S®20E to sedate fish to handleable. Based on mortality data, margins of safety were established for the highest proposed efficacious dose and an overdose dose that we think will be acceptable to FDA. Our histopathologist (Beth MacConnell) has provided us with her findings from the rainbow trout study, and nothing remarkable was observed to make us reconsider the margins of safety based on mortality data alone. We're wrapping up the TAS FSR for rainbow trout; we'll have it inspected by our Quality Assurance Officer and then submit it to FDA for review. The yellow perch and channel catfish TAS studies were similar in design to the rainbow trout study; hence, it should be a breeze to write those two FSRs. Acceptance of all three studies by FDA will put us one big step closer to an approval for use of AQUI-S®20E as an immediate-release fish sedative.

Channel Catfish Pituitary

Environmental assessment—On February 22, 2013, we received a letter from FDA stating that the Environmental Impact technical section is complete for Channel Catfish Pituitary (CP) for female channel catfish. The letter states that the Environmental Assessment adequately supports that both the direct discharge of CP in hatchery effluent and the indirect escapement of hybrid catfish (channel catfish × blue catfish) produced via CP are not expected to have a significant impact on the human environment; thus, a Finding of No Significant Impact (FONSI) has been prepared for the approval of a New Animal Drug Application for CP. Now that's cool! We thank FDA's Dr. Holly Zahner for her help and guidance; we couldn't have done this without her.

Target animal safety—On March 26, 2013, FDA informed us that they have accepted our CP TAS protocol. We thank FDA's Dr. Susan Storey for her help. Susan's past experience with common carp pituitary provided her with some keen insight into issues related to developing protocols with crude products such as fish pituitary, and this insight allowed us to address those "tough-to-address" issues. We've sent a copy of the protocol to Dr. Patricia Gaunt (Mississippi State University, Stoneville, Mississippi USA), who will conduct the CP TAS study next year.

Effectiveness—Next up is developing the CP effectiveness protocol. We've got a good start on it but will likely need as much help from Dr. Storey on this one as we did on the last. Stay tuned.

SLICE (0.2% emamectin benzoate)

Target animal safety—On February 19, 2013, we submitted a letter to FDA requesting a formal review of the TAS FSR titled "The Safety of SLICE® (0.2% Emamectin Benzoate Premix) Administered in Feed to Rainbow Trout *Oncorhynchus mykiss*." As stated in the December 2012 issue of the Newsletter, results from our study indicated that the proposed efficacious dose of 50 µg emamectin benzoate (EB)/kg fish/day, when administered in feed for 7 days is safe to fingerling rainbow trout, and the margin of safety extends to 150 µg EB/kg fish/day when administered in feed for 14 days. The review time for a TAS FSR is 6 months, so we should hear back from FDA in August 2013. We hope they agree with our conclusions.

Recent DRIBs

AADAP's *Drug Research Information Bulletins* (DRIBs) are in-house publications that briefly (1-4 pages) summarize work we and our partners have done to evaluate the efficacy and target animal safety of aquaculture drugs being considered for approval by FDA. The DRIBs published since January 1, 2013 are:

- DRIB No. 30—Use of AQUI-S®20E and BENZOAK® to sedate rainbow trout, brown trout, and cutthroat trout to handleable. (J. Bowker, D. Carty, and N. Wandelear).
- DRIB No. 31—Use of AQUI-S®20Eand BENZOAK® to sedate walleye, yellow perch, common carp, and fathead minnow to handleable. (J. Bowker, D. Carty, and N. Wandelear).
- DRIB No. 32—Use of AQUI-S®20E and BENZOAK® to sedate sunshine bass, blue catfish, and Nile tilapia to handleable. (J. Bowker, D. Carty, and N. Wandelear).
- DRIB No. 33—The safety of Aquaflor® (50% florfenicol; Type A Medicated Article) administered in feed to yellow perch. (J. Bowker, D. Carty, and M. P. Bowman).
- DRIB No. 34—Influence of life stage, water temperature, and eugenol concentration on the sedation of rainbow trout with AQUI-S®20E (10% eugenol). (D. Carty, J. Bowker, M. P. Bowman, and N. Wandelear).
- DRIB No. 35—Efficacy of AQUI-S®20E (10% eugenol) and BENZOAK® (20% bnzocaine) to sedate fish to handleable: individual sedation versus group sedation. (D. Carty, J. Bowker, N. Wandelear, and M. P. Bowman).

Recent Peer-Reviewed Publications

In previous newsletters, we've reported on trials conducted to evaluate the safety or effectiveness of various drugs. Since then, we've worked with a number of collaborators to publish the following articles:

Bowker, J. D., D. Carty, J. T. Trushenski, M. P. Bowman, N. Wandelear, and M. D. Matthews. *In press*. Controlling mortality caused by external columnaris in largemouth bass and bluegill with chloramine-T or hydrogen peroxide. *North American Journal of Aquaculture*.

Carty, D., and J. Bowker. 2013. A Terramycin 200 for Fish (44.09% oxytetracycline dihydrate) treatment regimen proposed for the fluorescent marking of rainbow trout vertebrae. *North American Journal of Aquaculture* **75:34-38**.

Matthews, M. D., J. D. Bowker, D. G. Carty, N. Wandelear, M. P. Bowman, J. C. Sakmar, and K. Childress. *In press*. Efficacy of Aquaflor (50% florfenicol) to control mortality associated with *Flavobacterium columnare* infection in largemouth bass and bluegill. *North American Journal of Aquaculture*.

Straus, D. L., J. D. Bowker, M. P. Bowman, D. Carty, A. J. Mitchell, B. D. Farmer, and C. K. Ledbetter. 2013. Safety of feed treated with 17α-methyltestosterone (17MT) to larval Nile tilapia. *North American Journal of Aquaculture* **75:212-219**.

Trushenski, J. T., J. D. Bowker, S. J. Cooke, D. Erdahl, T. Bell, J. R. MacMillan, R. P. Yanong, J. E. Hill, M. C. Fabrizio, J. E. Garvey, and S. Sharon. 2013. Issues regarding the use of sedatives in fisheries and the need for immediate-release options. *Transactions of the American Fisheries Society* **142:156-170**.

Text provided by Jim Bowker (jim_bowker@fws.gov), Research Program Manager; USFWS AADAP; Bozeman, Montana USA.

FINS & TAILS, BITS & BOBBERS

Timeline for Reporting INAD Data

Just a friendly reminder of when Investigational New Animal Drug (INAD) data need to be entered *and* submitted into the INAD Program Management System (IPMS) on-line database.

- **New Study Request—Form W Study Worksheet:** This form is completed by the Investigator before the study is conducted. This form will then be submitted to Stage 2 for the Study Monitor to review. If it is accepted by the Study Monitor, it will be advanced to Stage 3 for AADAP to review and assign a study number to the study. This form is located on the New Study Request tab.
- **Drug Receipt—Form 1:** This form is completed by the Investigator and must be completed within 10 days of receipt of drug. This form is located on the Manage/View Inventory page.
- **Chemical Use Log—Form 2:** This form is completed by the Investigator, and data are entered in the **Results Report—Form 3** table for the amount of drug used in the treatment. Record the transfer or discard of drug in the Manage/View Inventory section within 10 days of the action.
- **Results Report—Form 3:** The study is in Stage 4 and ready for the treatment to be administered. This form is filled out by the Investigator either during or after the treatment has occurred and data have been collected to document the actual drug

use, efficacy, and disposition of the fish. Please note that the **Study Request** converts to the **Results Report Form**, so please review and edit (if necessary) all data to reflect actual treatment data. This form must be completed within 10 days of completing the posttreatment period. This form is accessed from the Investigator's homepage.

- **Study completed:** After completing the **Results Report—Form 3**, the Investigator will advance the study to Stage 5 for the Study Monitor to review. If it is accepted by the Study Monitor, it will be advanced to Stage 6 for AADAP's review. The study is considered complete when it has been accepted by AADAP and advanced to Stage 7.

Forms available at the AADAP Website can be used as templates for filling out the on-line forms. Please see http://www.fws.gov/fisheries/aadap/signup.htm.

A link to the time line is also available on-line at http://www.fws.gov/fisheries/aadap/PDF/Timeline%20of%20when%20paperwork%204%20October%202012.pdf.

Text provided by Bonnie Johnson (bonnie_johnson@fws.gov), National INAD Program Administer, USFWS AADAP; Bozeman, Montana USA

EDITORIAL

Roles and Responsibilities of the U.S. Fish and Wildlife Service AADAP Program

by

Dan Carty
U.S. Fish & Wildlife Service
Aquatic Animal Drug Approval Partnership Program
4050 Bridger Canyon Road
Bozeman, Montana 59715 USA

dan_carty@fws.gov

Note: The views expressed in this editorial are not necessarily those of the U.S. Fish and Wildlife Service or the Aquatic Animal Drug Approval Partnership Program.

The U.S. Fish and Wildlife Service (FWS) Aquatic Animal Drug Approval Partnership (AADAP) program was established in 1994 to ensure FWS compliance with the Federal Food, Drug and Cosmetic Act (FFDCA). The AADAP program works with the U.S. Food and Drug Administration (FDA) and other Federal agencies, state agencies, universities, Native American tribes, and private-sector partners to obtain FDA approval of new and/or expanded uses of drugs for use in fish culture and fisheries management.

To help fisheries professionals across the U.S. maintain FFDCA compliance while efforts are made to obtain new and/or expanded aquaculture drug approvals, AADAP developed (1) an Investigational New Animal Drug (INAD) program, (2) a research program, and (3) a professional outreach program. The INAD program provides fisheries professionals with legal access to a broad variety of experimental drugs (e.g., therapeutants, spawning hormones, fluorescent marking agents, and sedatives) that are in the approval pipeline. The research program uses sound science to evaluate the safety and efficacy of these experimental drugs. The professional outreach program provides fisheries professionals with up-to-date information about existing and pending drug approvals, as well as extensive drug-use guidance information. However, do these current roles and responsibilities of the AADAP program contribute substantively to the FWS mission and its fisheries programs, to other public-sector fisheries programs, and even to commercial fish-production operations? Well, in this editorial, I hope to answer this question with a "yes."

The FWS mission is "working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people." The AADAP mission is "working with our partners to conserve, protect, and enhance the Nation's fishery resources by coordinating activities to obtain FDA approval for drugs, chemicals, and therapeutants needed in aquaculture." Thus, I think AADAP's mission is consistent with and fits nicely within the overall mission of the FWS.

In the U.S., recreational fishing is not only popular but also has high economic value. The FWS National Fish Hatchery (NFH) system's stocking programs help to create recreational fishing opportunities for all Americans, are integral to many fish restoration and recovery programs, and have tremendous economic value. In 2006, NFH efforts resulted in stocking 123 million fish, which in turn generated over 13 million angling days, $554 million in retail sales, $903 million in industrial output, $256 million in job income, and 8,000 jobs (FWS 2010). In addition, over $37 million in Federal tax income and nearly $35 million in state and local tax revenue were generated (FWS 2010). Nationwide, statistics for 2011 recently published by the American Sportfishing Association (ASA 2013) indicate that there are approximately 60 million recreational anglers and that these anglers generate $48 billion annually in retail sales. Recreational fishing also supports more than 828,000 jobs, has a $115 billion impact on the Nation's economy, and generates $15 billion in state and Federal taxes (ASA 2013).

The FWS assists other Federal agencies, states, and Native American tribes with managing the fisheries within their respective jurisdictions. Primary activities include the restoration and recovery of imperiled species, as well as providing recreational fishing opportunities. Many fisheries management programs in the U.S. rely on the use of FDA-approved drugs to help meet their fish production and restoration and recovery goals. Unfortunately, the number of FDA-approved fish drugs is small compared with the large number of fish

pathogens that can cause significant losses of hatchery-reared fish. Moreover, fish culturists and fishery management (field) biologists across the U.S. need access to new spawning hormones for inducing gamete maturation in captive-reared and wild-captured fishes, new fluorescent marking agents for use in fish population-assessment programs, and new sedatives for safely handling and transporting fish.

During the past 15 years, AADAP's INAD, research, and professional outreach efforts have helped the FWS and other public-sector fishery management agencies and commercial fish producers gain access to drugs that are vitally important to the success of their respective programs. During that same time, AADAP has contributed to virtually every new fish drug approved by the FDA. Thus, the scientific data generated by AADAP and submitted to FDA have helped enable hundreds of public-sector fish hatcheries and commercial fish-production facilities to produce various species of fish for fishery management purposes or direct human consumption. Therefore, in my view, AADAP's current roles and responsibilities are consistent with the FWS mission and contribute substantively to ensuring the continued well-being of public and private aquaculture, as well as helping to ensure that the fish produced by public and private aquaculture are healthy and safe for human consumption—all for the continuing benefit of the American people.

References

ASA (American Sportfishing Association). 2013. Sportfishing in America: an economic force for conservation. American Sportfishing Association, Alexandria, Virginia USA. (*http://asafishing.org/uploads/2011_ASASportfishing_in_America_Report_January_2013.pdf*).

FWS (U.S. Fish and Wildlife Service). 2010. Conserving America's fisheries: an assessment of economic contributions from Fisheries and Aquatic Resource Conservation. U.S. Fish and Wildlife Service, Arlington, Virginia USA. (*http://www.fws.gov/home/feature/2011/pdf/FisheriesEconomicReport.pdf*)

USGS's UMESC CORNER

Eugenol

The U.S. Geological Survey's (USGS) Upper Midwest Environmental Sciences Center (UMESC) completed a study to determine the exposure parameters (concentration and duration) that will maximize eugenol residues in the fillet tissue from rainbow trout exposed to AQUI-S®20E (active ingredient, 10% eugenol) and determine the sample times that will adequately characterize the depletion of eugenol residues from the fillet tissue of exposed fish. Data from the study were submitted to FDA in late August 2012. In November 2012, we received notification from FDA that maximum eugenol residue concentrations are generated after exposing fish to 100 mg AQUI-S®20E/L for 1 hour and that the dosing conditions are appropriate for use in future depletion studies. Contact Jeff Meinertz, *jmeinertz@usgs.gov*, for more information.

UMESC completed a definitive study to characterize the depletion, distribution, and identification of eugenol residues in the fillet tissue from exposed fish (a total residue depletion study). Rainbow trout were exposed to 100 mg ^{14}C labeled AQUI-S®20E/L for 1 hour. Data indicated that (1) maximum eugenol and ^{14}C-eugenol equivalent residue concentrations in the fillet tissue were measured immediately after the exposure (44.5 and 38.8 µg/g, respectively); (2) eugenol was the primary ^{14}C-residue (>90% of all ^{14}C-residues) in extracts from fillet tissue taken from fish sampled immediately after the exposure (0 minutes) and from fish sampled at 30 and 60 minutes after the exposure; and (3) the depletion of ^{14}C-eugenol residues from the fillet tissue was rapid ($t_{1/2}$ = 26.25 minutes) after transferring the exposed fish to fresh, flowing water. The final report is progressing through the final stages of the USGS review process. The report is expected to be submitted to FDA by April 2013. Contact Jeff Meinertz, *jmeinertz@usgs.gov*, for more information.

UMESC is conducting a series of studies to assess the utility of using AQUI-S®20E as a sedative to reduce the activity of yellow perch and tilapia during live transport. A portion of the research being conducted is to assess exposure parameters (concentration and duration) that would safely sedate fish while maximizing fish loading density during transport. Both species were exposed to 0, 10, 20, and 30 mg/L eugenol at three loading densities: yellow perch, 120, 240, and 360 g/L; tilapia, 240, 360, and 480 g/L. There was greater than 95% survival with yellow perch and greater than 90% survival with tilapia at all exposure concentrations and loading densities after exposures as long as 10 hours. Field research will continue based on results from these studies in summer 2013. Data are currently being analyzed, and a final report is expected to be submitted to FDA by July 2013. Contact Aaron Cupp, *acupp@usgs.gov*, for more information.

UMESC, in collaboration with the University of Wisconsin – Stevens Point, completed additional work to assess the use AQUI-S®20E to reduce the activity of yellow perch and tilapia during live transport. This research focused on the metabolic rate changes of yellow perch and tilapia exposed to AQUI-S®20E at various loading densities. Both species were exposed to 0, 10, 20, and 30 mg/L eugenol at three loading densities: yellow perch, 60, 120, and 240 g/L; tilapia, 120, 240, and 360 g/L. Data showed a significant (P < 0.05) decrease in the specific metabolic rate (mg O_2/kg/hour) for yellow perch exposed to 30 mg/L eugenol at all loading densities relative to 0 mg/L and 10 mg/L eugenol treatments. Yellow perch exposed to 0, 10,

and 20 mg/L eugenol showed no statistical ($P > 0.05$) differences in metabolic rates among all loading densities. Tilapia showed no statistical differences in metabolic rates among all concentrations and densities, with exception to fish exposed at 30 mg/L and a density of 120 g/L. Results will provide additional information for evaluating the effects of AQUI-S®20E as a sedative for fish transport. Contact Aaron Cupp, acupp@usgs.gov, for more information.

Florfenicol

UMESC conducted a study that fulfilled the following objectives: (1) determine the FFA concentrations in fillet tissue of rainbow trout offered FFC-medicated feed in a recirculating aquaculture system at 20 mg/kg body weight/day for 10 days; (2) determine the FFA concentrations in fillet tissue of rainbow trout offered FFC-medicated feed in a flow-through system at 20 mg/kg body weight/day for 10 days; (3) determine the FFA concentrations in the fillet tissue of nontreated rainbow trout sharing a recirculating aquaculture system with rainbow trout offered FFC-medicated feed at 20 mg/kg body weight/day for 10 days; (4) determine the FFC residue concentrations in water during and after offering FFC-medicated feed to rainbow trout in a recirculating aquaculture system at 20 mg/kg body weight/day for 10 days; and (5) determine unionized ammonia and nitrite concentrations in the water of a recirculating aquaculture system with rainbow trout offered FFC-medicated feed at 20 mg/kg body weight/day for 10 days to assess the impact of treatment on the system's biofilter.

Because of the proprietary nature of the fillet tissue data, conclusions for objectives (1), (2), and (3) cannot be presented at this time. The conclusions for objectives (4) and (5) follow: (4) The FFC concentrations in the recirculating system holding rainbow trout offered FFC-medicated feed at 20 mg/kg body weight/day for 10 days increased from below quantitation on day 1 to 445 µg/L on day 10 of the treatment phase and decreased from 453 µg/L 10 hours posttreatment to 9 µg/L 480 hours posttreatment; and (5) The recirculating aquaculture system biofilter nitrogen oxidation efficiency was not impacted by the treatment of rainbow trout offered FFC-medicated feed at a rate of 20 mg/kg body weight/day for 10 days. A final report was submitted to FDA in December 2012. Contact Jeff Meinertz, jmeinertz@usgs.gov, for more information.

Hydrogen Peroxide

UMESC is conducting research to expand the label for 35% PEROX-AID® to include the reduction of *Gyrodactylus* sp. infestation density on cool- and warmwater fish species. One trial was completed in fathead minnows with a natural infestation of *G. hoffmani*, and a second trial is underway with yellow perch with a natural infestation of *G. freemani*. The study objective is to assess the efficacy of 35% PEROX-AID® to reduce *Gyrodactylus* sp. infestation density and includes the evaluation of parasite density on fish following assignment to one of three treatment regimens: (1) a nontreated control group; (2) a group treated at 50 mg/L for 60 minutes; and (3) a group treated at 75 mg/L for 60 minutes. The 35% PEROX-AID® treatments were applied once daily on alternate days for a total of three treatments. Following treatment of fathead minnows, parasite density on fish in the treated groups decreased relative to parasite density on fish in the nontreated group. Data from the fathead minnow study are currently being analyzed, and a final report is expected to be submitted to FDA by July 2013. The yellow perch study will be completed on April 30, 2013, with report preparation complete by July 2013. Contact Sue Schleis, sschleis@usgs.gov, for more information.

Gyrodactylus Speciation – Send us your parasites!

The U.S. Fish and Wildlife Service's La Crosse Fish Health Center (LFHC) is once again looking for a few good parasites. During discussions among LFHC, UMESC, and FDA, the FDA requested that information be developed to describe the *Gyrodactylus* species infesting nonsalmonid, freshwater-reared fishes—similar to data developed previously for *Gyrodactylus* infestations of freshwater-reared salmonids. These data are needed to determine the diversity of *Gyrodactylus* species infesting fish in aquaculture in order to inform future label decisions. The LFHC is looking for samples of nonsalmonid, freshwater-reared fishes presently in hatchery rearing that are infested with *Gyrodactylus*. The LFHC will identify those parasites to species and, in collaboration with UMESC, provide information on the identified parasite species and fish host species to FDA. Samples can be submitted to Eric Leis at the La Crosse Fish Health Center (555 Lester Ave, Onalaska, Wisconsin USA 54650) either as whole fish on ice (ship overnight for morning delivery) or skin scrapes/fin clips in 70% ethanol. Contact Eric Leis at eric_leis@fws.gov or (608) 783-8440 for more information.

Text provided by Jeff Meinertz (jmeinertz@usgs.gov), Research Physiologist; USGS UMESC; La Crosse, Wisconsin USA.

USDA's ARS CORNER

Aquaculture 2013 Conference

The Aquaculture Drug Research and Drug Approval Status special session had seven presentations, with ***good*** attendance at each. The session was organized and moderated by AADAP's Jim Bowker and the U.S. Department of Agriculture's (USDA) Agricultural Research Service's (ARS) Dave Straus. This was the

11th year for this session, which is focused on research in aquaculture therapeutants. We plan to continue this next year, so we'll be calling to see about presenters!

Copper Sulfate ($CuSO_4$)

Saprolegniasis—Two separate Final Study Reports (lab and field) for the effectiveness dose-confirmation study of $CuSO_4$ on fungus of channel catfish eggs have been submitted by the sponsor (Freeport-McMoRan) to FDA. We are awaiting the outcome and anticipate providing any information needed by FDA. This should complete all major technical sections, except for Environmental Safety under a hatchery scenario.

Ichthyophthiriasis—The Environmental Safety technical section for the indication "… to control mortality associated with ichthyophthiriasis on channel catfish cultured in earthen ponds" will be submitted soon. A draft label has been prepared, and "all other information" is being compiled.

Text provided by Dr. Dave Straus, (dave.straus@ars.usda.gov) Research Toxicologist; U.S. Department of Agriculture, Agricultural Research Service; Harry K. Dupree – Stuttgart National Aquaculture Research Center, Stuttgart, Arakansas USA.

AFS's WGADCB CORNER

The American Fisheries Society's (AFS) Working Group on Aquaculture Drugs, Chemicals, and Biologics (WGADCB) met February 23, 2013, in Nashville, Tennessee USA, and discussed a number of ongoing projects and emerging issues:

Efficacy Study "Wish List"

During the previous WGADCB meeting, several attendees expressed an interest in helping to generate data needed for drug approvals and wanted to know more about claims in development and what efficacy data were needed. It was decided that a spreadsheet or "wish list" of efficacy data would be developed. Jim Bowker (AADAP) prepared a draft wish list and distributed it to the meeting attendees. After incorporating the suggestions received, the final wish list was published on the AFS Fish Culture Section website: https://docs.google.com/file/d/0B43dblZIJqD3SjdoSkFsbHNyZ2M/edit). Reminders to check the list will be sent periodically to partners and stakeholders to encourage their participation in drug approval research.

FAQ with FDA article planned for *Fisheries*

As an outcome from the AFS/FDA summit following publication of the *AFS Policy Statement on the Need for Immediate-Release Sedatives (*Bowker, J., and J. Trushenski. 2011. *Fisheries* **36(3):132-135**), an *FAQ with FDA* outreach article is being written to explain, in plain terms, the FDA approach to approving fish sedatives and other fish drugs. The article—which is being written by Dr. Melanie McLean (FDA) with assistance from Dr. Jennifer Matysczak (FDA), Jim Bowker (AADAP), and Dr. Jesse Trushenski (SIU)—is undergoing review at FDA. After that review has been completed, the article will be submitted for publication in *Fisheries* magazine.

FDA Guidance Document #61

Dr. Jennifer Matysczak (FDA) provided a brief synopsis of Guidance Document #61 (*Guidance for Industry: FDA Approval of New Animal Drugs for Minor Uses and for Minor Species*) and noted that the draft revision is still being reviewed by legal/policy advisors within FDA. Dr. Matysczak also mentioned that FDA does not yet know the target release date for public comment.

The Federal Budget Crisis: What does it mean, and what can we do?

Dr. Jesse Trushenski led a group discussion on the potentially widespread effects of the ongoing Federal budget crisis (including sequestration) and what it could mean for those involved in the aquaculture drug approval process. The group discussed how reduced funding levels could slow, or even halt, progress towards future drug approvals. Many in attendance expressed concern regarding the consequences of agencies potentially deprioritizing drug approval efforts for the future of public and private aquaculture and asked how they should communicate these concerns to decision-makers. There was some discussion of the general processes by which stakeholders can communicate directly with agency staff regarding these issues. There was also brief discussion of the potential need for stakeholder communication with Congressional staff in order to highlight the national-scope importance of ensuring continuation of ongoing drug approval efforts. Although discussion resulted in no specific decisions or "action items," the group certainly concurred that the current Federal budget crisis poses a serious threat to the future "health" of partnership drug-approval efforts.

For more information on current WGADCB activities, please see past meeting minutes available at the AFS Fish Culture Section website: https://sites.google.com/site/fishculturesection/about-the-fcs/minutes-and-reports), contact one of the co-chairs, or better yet, *come to our next meeting*!

Updates provided by Dr. Jesse Trushenski (saluski@siu.edu); Center for Fisheries, Aquaculture, and Aquatic Sciences; Southern Illinois University at Carbondale; Carbondale, Illinois USA.

FDA's CVM NOTES

FDA Announces Public Meetings with Food-Animal Producers and Veterinarians

Five meetings intended to discuss impacts of antimicrobial resistance strategy in areas of the USA that may lack access to adequate veterinary services

In early March, the U.S. Food and Drug Administration (FDA) Center for Veterinary Medicine (CVM) announced a series of five meetings to provide the public with opportunities to discuss and provide critical feedback on the challenges faced by livestock producers and veterinarians as the agency phases in veterinary oversight of the therapeutic use of certain medically important antimicrobials. The FDA is seeking input as it moves forward to further develop and implement its strategy to promote the judicious use in food-producing animals of antibiotics that are important in treating humans. The meetings are intended to provide a forum to discuss potential challenges faced by animal producers in areas that may lack access to adequate veterinary services and to explore possible options for minimizing adverse impacts. The meetings are jointly sponsored by FDA and U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS).

The FDA has worked with many stakeholder groups and USDA to develop a strategy that it believes will be successful in reducing antimicrobial resistance while minimizing adverse impacts on animal health and disruption to the animal agricultural industry. The agency took the following steps toward implementing this strategy:

- Issuing a guidance for industry, entitled "*Judicious Use of Medically Important Antimicrobials in Food Producing Animals*," which establishes the framework for phasing out production uses (i.e., growth promotion and feed efficiency) of antimicrobials important in treating humans, and phasing in veterinary oversight of the remaining therapeutic uses of such drugs.
- Issuing a *draft guidance* that will assist drug companies seeking to voluntarily revise product labels to remove production uses and to voluntarily change the marketing status of these medically important antimicrobials to include veterinary oversight or supervision.
- Providing *draft text for a proposed regulation* intended to improve the efficiency of existing Veterinary Feed Directive (VFD) requirements. The VFD drugs are new animal drugs intended for use in or on animal feed which are limited to use under the professional supervision of a licensed veterinarian.

The FDA acknowledges that the proposed change in the marketing status of certain antimicrobial drugs to require the involvement of a licensed veterinarian will have practical implications for animal producers and practicing veterinarians. Once the status of the product changes from over-the-counter (OTC) to prescription (Rx) or VFD, producers will no longer be able to purchase the animal drug or medicated feed product directly from suppliers, unless the producer has a valid prescription or order from a licensed veterinarian. The impact of this change on producers may vary depending on the extent to which a given producer already has access to and utilizes veterinary services. This change also has potential impacts on practicing veterinarians depending on their practice (business) model.

The dates and locations for the meetings were/are:

- April 9, 2013, Bowling Green, Kentucky
- April 23, 2013, Olympia, Washington
- May 8, 2013, Fort Collins, Colorado
- May 21, 2013, Pierre, South Dakota
- June 4, 2013, College Station, Texas

The FDA will also seek public input and additional feedback through other forums, such as webinars, as it works collaboratively with USDA, veterinary, and producer organizations to address this important issue. Comments also may be made to the FDA Docket No. FDA-2012-N-1046 at any time.

Additional information on the meetings and agenda can be found at:

Federal Register Notice

Judicious Use Page

Text provided by Dr. Jennifer Matysczak (Jennifer.Matysczak@fda.hhs.gov), Leader; Aquaculture Drugs Team; Office of New Animal Drug Evaluation; Center for Veterinary Medicine, Food and Drug Administration; Rockville, Maryland USA

RELEVANT LITERATURE

Listed below are journal citations with particular relevance to the broad topic of drugs and aquaculture species. With some exceptions, this list includes citations not previously included in our newsletter. Our Relevant Literature Master list, which dates back to 2009, can be viewed or downloaded by *clicking here*.

Inclusion of a citation in our newsletter does not imply (1) acceptance by the U.S. Food and Drug Administration's Center for Veterinary Medicine of a drug's safety or effectiveness, (2) endorsement of a drug or product by the U.S. Fish and Wildlife Service, (3) recommendation of the technique to any particular

situation, or (4) concurrence with a treatment procedure/ drug.

Please send citations of interest to Dan Carty (dan_carty@fws.gov).

Antibiotic and Bacterial

Afizi, MSK, et al. 2013. Herbal and antibiotic resistance of *Aeromonas* bacteria Isolated from cultured fish in Egypt and Malaysia. *Journal of Fisheries and Aquatic Science* **8 (2):425-429**.

Ambili, TR, et al. 2013. Toxicological effects of the antibiotic oxytetracycline to an Indian major carp *Labeo rohita*. *Archives of Environmental Contamination and Toxicology* **64 (3):494-503**.

Barakat, KM, and Gohar, YM, 2012. Antimicrobial agents produced by marine *Aspergillus terreus* var. *africanus* against some virulent fish pathogens. *Indian Journal of Microbiology* **52(3):366-372**.

Barros-Becker, F, et al. 2012. Persistent oxytetracycline exposure induces an inflammatory process that improves regenerative capacity in zebrafish larvae. *PloS One* **7 (5):e36827**.

Bowker, JD, et al. *In press*. Controlling mortality caused by external columnaris in largemouth bass and bluegill with chloramine-T or hydrogen peroxide. *North American Journal of Aquaculture*.

Budiati, T, et al. 2013. Prevalence, antibiotic resistance and plasmid profiling of Salmonella in catfish (*Clarias gariepinus*) and tilapia (*Tilapia mossambica*) obtained from wet markets and ponds in Malaysia. *Aquaculture* **372-375:127-132**.

Casadei, E, et al. 2013. The effect of peptidoglycan enriched diets on antimicrobial peptide gene expression in rainbow trout (*Oncorhynchus mykiss*). *Fish & Shellfish Immunology* **34(2):529-537**.

Cazedey, ECL, and Salgado, HRN. 2013. Orbifloxacin: a review of properties, its antibacterial activities, pharmacokinetic/pharmacodynamic characteristics, therapeutic use, and analytical methods. *Critical Reviews in Analytical Chemistry* **43(2):79-99**.

Chiu, T-H, et al. 2013. Antibiotic resistance and molecular typing of *Photobacterium damselae* subsp. *Damselae* isolated from seafood. *Journal of Applied Microbiology* **114 (4):1184-1192**.

Declercq, AM, et al. 2013. Antimicrobial susceptibility pattern of *Flavobacterium columnare* isolates collected worldwide from 17 fish species. *Journal of Fish Diseases* **36(1):45-55**.

Del Castillo, CS, e al. 2013. Comparative sequence analysis of a multidrug-resistant plasmid from *Aeromonas hydrophila*. *Antimicrobial Agents and Chemotherapy* **57(1):120-129**.

Evaggelopoulou, EN, et al. 2013. Development and validation of an HPLC method for the determination of six penicillin and three amphenicol antibiotics in gilthead seabream (*Sparus aurata*) tissue according to the European Union Decision 2002/657/EC. *Food Chemistry* **136(3-4):1322-1329**.

Fang, W, et al. 2013. Pharmacokinetics and tissue distribution of thiamphenicol and florfenicol in Pacific white shrimp *Litopenaeus vannamei* in freshwater following oral administration. *Journal of Aquatic Animal Health* **25(2):83-89**.

Farmer, BD, et al. 2013. Pretreating channel catfish with copper sulfate affects susceptibility to columnaris disease. *North American Journal of Aquaculture* **75(2):205-211**.

Gaikowski, MP, et al. *In press*. Safety of florfenicol administered in feed to tilapia (*Oreochormis* sp.). *Toxicologic Pathology*.

Geng, Y, et al. 2013. Isolation and characterization of *Edwardsiella ictaluri* from southern catfish, *Silurus soldatovi meridionalis*, (Chen) cultured in China. *Journal of the World Aquaculture Society* **44(2):273-281**.

Granados-Chinchilla, F, et al. 2013. Tetracycline and 4-epitetracycline modified the *in vitro* catabolic activity and structure of a sediment microbial community from a tropical tilapia farm idiosyncratically. *Journal of Environmental Science and Health Part B* **48(4):291-301**.

Granja, RHMM et al. 2013. Development and validation of a liquid chromatography-UV detection method for the determination of sulfonamides in fish muscle and shrimp according to European Union Decision 2002/657/EC. *Journal of AOAC International* **96(1):212-215**.

Guo, JJ, et al. 2012. The effects of garlic-supplemented diets on antibacterial activity against *Streptococcus iniae* and on growth in orange-spotted grouper, Epinephelus coioides. *Aquaculture* 364-365:33-38.

Hayes, J. 2013. Determination of florfenicol in fish feeds at high inclusion rates by HPLC-UV. *Journal of AOAC International* **96(1):7-11**.

Ji, K, et al. 2012. Risk assessment of chlortetracycline, oxytetracycline, sulfamethazine, sulfathiazole, and erythromycin in aquatic environment: are the current environmental concentrations safe? *Ecotoxicology* **21(7): 2031-2050**.

Kokou, F, et al. 2012. Antibacterial activity in microalgae cultures. *Aquaculture Research* **43(10):1520-1527**.

Lajnef, R, et al. 2012. Comparative study on the antibiotic susceptibility and plasmid profiles of *Vibrio alginolyticus* strains isolated from four Tunisian marine biotopes. *World Journal of Microbiology & Biotechnology* **28(12):3345-3363**.

Liu, Y, et al. 2013. High-performance liquid chromatography using pressurized liquid extraction for the determination of seven tetracyclines in egg, fish and shrimp. *Journal of Chromatography B* **917-918:11-17**.

Lu, C, et al. 2013. Assessment of antibacterial properties and the active ingredient of plant extracts and its effect on the performance of crucian carp (*Carassius auratus gibelio* var. E'erqisi, Bloch). *Journal of the Science of Food and Agriculture* **93(4):902-909**.

Marchand, P-A, et al. 2012. Reduction of *in vitro* growth in *Flavobacterium columnare* and *Saprolegnia parasitica* by products containing peracetic acid. *Aquaculture Research* **43(12):1861-1866**. (note: bacteria *and* fungus)

Matthews, MD, et al. 2013. *In press*. Efficacy of Aquaflor (50% florfenicol) to control mortality associated with *Flavobacterium columnare* infection in largemouth bass and bluegill. *North American Journal of Aquaculture*.

Minh, NP, et al. 2013. Accumulation and clearance of orally administered erythromycin in adult Nile tilapia (*Oreochromis niloticus*) and giant freshwater prawn (*Macrobrachium rosenbergii*). *Journal of Applied Aquaculture* **25(1):1-8**.

Monte, MM, et al. 2013. Cloning and characterization of rainbow trout interleukin-17A/F2 (IL-17A/F2) and IL-17 receptor A: expression during infection and bioactivity of recombinant IL-17A/F2. *Infection and Immunity* **81(1):340-353**.

Nayak, SK, et al. 2013. Direct antibacterial activity of CD8+/ CD4+ T-cells in ginbuna crucian carp, *Carassius auratus langsdorfii*. *Fish & Shellfish Immunology* **34(1):136-141**.

Noor Uddin, GM, et al. 2013. Bacterial flora and antimicrobial resistance in raw frozen cultured seafood imported to Denmark. *Journal of Food Protection* **76(3):490-499**.

Ohkawa, K, et al. 2012. Study on the prevention and spread of bacterial coldwater disease in ayu (*Plecoglossus altivelis*). *Aquabiology* **34(1):88-92**. (English abstract)

Oplinger, RW, and Wagner, EJ. 2013. Control of *Flavobacterium psychrophilum*: tests of erythromycin, streptomycin, osmotic and thermal shocks, and rapid pH change. *Journal of Aquatic Animal Health* **25(1):1-8**.

Picchietti, S, et al. 2013. Immune modulatory effects of *Aloe arborescens* extract on the piscine SAF-1 cell line. *Fish & Shellfish Immunology* **34(5):1335-1344**.

Pruden, A, et al. 2012. Correlation between upstream human activities and riverine antibiotic resistance genes. *Environmental Science & Technology* **46(21):11541-11549**.

Schrader, KK, et al. 2013. *In vitro* comparisons of the inhibitory activity of florfenicol, copper sulphate and potassium permanganate towards *Aeromonas hydrophila* and *Flavobacterium columnare*. *Aquaculture Research* **44 (2):212-219**.

Shaowu, L, et al. 2013. Isolation of *Yersinia ruckeri* strain H01 from farm-raised Amur Sturgeon *Acipenser schrencki* in China. *Journal of Aquatic Animal Health* **25(1):9-14**.

Soto, E, et al. 2013. Efficacy of florfenicol for control of mortality associated with *Francisella noatunensis* subsp. *orientalis* in Nile tilapia, *Oreochromis niloticus* (L.). *Journal of Fish Disease***s 36(4):411-418**.

Sundell, K, et al. 2013. Structure of *Flavobacterium psychrophilum* populations infecting farmed rainbow trout *Oncorhynchus mykiss*. *Diseases of Aquatic Organisms* **103 (2):111-119**.

Wagner, EJ, et al. 2012. Penicillin-G: efficacy against *Flavobacterium psychrophilum* and evaluation of lethal dose limits for rainbow trout. *Open Journal of Animal Sciences* **2 (3):150-158**.

Wang, R, et al. 2013. Studies on the isolation of *Photobacterium damselae* subsp. *piscicida* from diseased golden pompano (*Trachinotus ovatus* Linnaeus) and antibacterial agents sensitivity. *Veterinary Microbiology* **162 (2-4):957-963**.

Wang, Y-D, et al. 2013. Oral administration of bovine lactoferrin inhibits bacterial infection in tilapia and elevates survival after bacterial infection: an examination of its immune-modulating properties. *Aquaculture International* **21(1):75-96**.

Yang, F, et al. 2013. A physiologically based pharmacokinetics model for florfenicol in crucian carp and oral-to-intramuscular extrapolation. *Journal of Veterinary Pharmacology and Therapeutics* **36(2):192-200**.

Parasite and Fungus Control

Adams, MB. 2012. Preliminary success using hydrogen peroxide to treat Atlantic salmon, *Salmo salar* L., affected with experimentally induced amoebic gill disease (AGD). *Journal of Fish Diseases* **35(11):839-848**.

Bravo, S, et al. 2013. Efficacy of the treatments used for the control of *Caligus rogercresseyi* infecting Atlantic salmon, *Salmo salar* L., in a new fish-farming location in Region XI, Chile. *Journal of Fish Diseases* **36(3):221-228**.

Helgesen, KO, et al. 2013. Single-dose field bioassay for sensitivity testing in sea lice, *Lepeophtheirus salmonis*: development of a rapid diagnostic tool. *Journal of Fish Diseases* **36(3):261-272**.

Hemaprasanth, KP et al. 2012. Efficacy of two avermectins, doramectin and ivermectin against *Argulus siamensis* infestation in Indian major carp, *Labeo rohita*. *Veterinary Parasitology* **190(1-2):297-304**.

Igboeli, OO, et al. 2013. Immunostimulation of *Salmo salar* L., and its effect on *Lepeophtheirus salmonis* (Kroeyer) P-glycoprotein mRNA expression following subsequent emamectin benzoate exposure. *Journal of Fish Diseases* **36(3):339-351**.

Ikonomou, MG, et al. 2013. Ultra-trace determination of aquaculture chemotherapeutants and degradation products in environmental matrices by LC-MS/MS. *International Journal of Environmental and Analytical Chemistry* **93 (2):183-198**.

Jones, PG, et al. 2013. Detection of emamectin benzoate tolerance emergence in different life stages of sea lice, *Lepeophtheirus salmonis*, on farmed Atlantic salmon, *Salmo salar* L. *Journal of Fish Diseases* **36(3):209-220**.

Kumar, A, et al. 2012. Antiparasitic efficacy of piperine against *Argulus* spp. on *Carassius auratus* (Linn. 1758): *in vitro* and *in vivo* study. *Parasitology Research* **111(5):2071-2076.**

Picón-Camacho, SM, et al. 2012. *In vitro* assessment of the chemotherapeutic action of a specific hydrogen peroxide, peracetic, acetic, and peroctanoic acid-based formulation against the free-living stages of *Ichthyophthirius multifiliis* (Ciliophora). *Parasitology Research* **110(2):1029-1032**.

Poley, J, et al. 2013. Combinatorial effects of administration of immunostimulatory compounds in feed and follow-up administration of triple-dose SLICE (emamectin benzoate) on Atlantic salmon, *Salmo salar* L., infection with *Lepeophtheirus salmonis*. **Journal of Fish Diseases 36 (3):299-309**.

Santos, RFB, 2012. Acute toxicity and histopathology in ornamental fish Amazon bluespotted corydora (*Corydoras melanistius*) exposed to formalin. *Anais da Academia Brasileira de Ciências* **84(4):1001-1007**.

Skilbrei, OT, et al. 2013. Impact of early salmon louse, *Lepeophtheirus salmonis*, infestation and differences in survival and marine growth of sea-ranched Atlantic salmon, *Salmo salar* L., smolts 1997-2009. *Journal of Fish Diseases* **36(3):249-260**.

Straus, DL, et al. 2012. Acute toxicity and histopathology of channel catfish fry exposed to peracetic acid. *Aquaculture* **342-343:134-138**.

Torrissen, O, et al. 2013. Salmon lice--impact on wild salmonids and salmon aquaculture. *Journal of Fish Diseases* **36(3):171-194**.

Whyte, SK, et al. 2013. A fixed-dose approach to conducting emamectin benzoate tolerance assessments on field-collected sea lice, *Lepeophtheirus salmonis*. *Journal of Fish Diseases* **36(3):283-292**.

Sedation or Anesthesia

Afkhami, M, et al. *In press*. Comparative efficacy of two anesthetic agents in the Sobaity sea bream, *Sparidentex hasta* (Valenciennes 1840). *Comparative Clinical Pathology*.

Akbulut, B, et al. 2012. Effect of anaesthesia with clove oil and benzocaine on feed intake in Siberian sturgeon (*Acipenser baerii* Brandt, 1869). *Turkish Journal of Fisheries and Aquatic Sciences* **12(3):667-673**.

Bauquier, SH, et al. 2013. Evaluation of the sedative and anaesthetic effects of five different concentrations of alfaxalone in goldfish, *Carassius auratus*. *Aquaculture* **396-399:119-123**.

Christiansen, HE, et al. 2013. Anesthesia of juvenile Pacific lampreys with MS-222, Benzoak, AQUI-S 20E, and Aquacalm. *North American Journal of Fisheries Management* **33(2):269-276**.

Cruz, S, et al. 2012. Anesthetizing solar-powered sea slugs for photobiological studies. *The Biological Bulletin* **223 (3):328-336**.

Davis, JL, et al. 2013. Effectiveness of three compounds to anesthetize rainbow trout during PIT tag implantation surgery. *North American Journal of Fisheries Management* **33(3):482-487**.

de Souza, RAR, et al. 2012. Comparative effect of benzocaine, menthol, and eugenol as anesthetics for juvenile fat snook. *Boletim do Instituto de Pesca Sao Paulo* **38(3):247-255**. (English abstract)

Delbon, MC, et al. 2012. Eugenol in tilapia juvenile: concentrations and successive administrations. *Boletim do Instituto de Pesca Sao Paulo* **38(1):43-52**. (English abstract)

Ghanawi, J, et al. 2013. Anaesthetic efficacy of clove oil, benzocaine, 2-phenoxyethanol and tricaine methanesulfonate in juvenile marbled spinefoot (*Siganus rivulatus*). *Aquaculture Research* **44(3):359-366**.

Gressler, LT, et al. 2012. Immersion anaesthesia with tricaine methanesulphonate or propofol on different sizes and strains of silver catfish *Rhamdia quelen*. *Journal of Fish Biology* **81(4):1436-1445**.

Hekimoğlu, MA, and Ergun, M. 2012. Evaluation of clove oil as anaesthetic agent in fresh water angelfish, *Pterophyllum scalare*. *Pakistan Journal of Zoology* **44(5):1297-1300**.

Javahery, S, et al. 2012. Efficacy of clove oil as an anaesthetic for two sizes of *Rutilus frisii kutum*. *Global Veterinaria* **9(3):319-322**.

Kanani, HG, et al. 2013. Effect of tricaine methanesulfonate (MS222), clove oil and electro-anaesthesia on respiratory burst activity in whole blood and serum alternative complement response in rainbow trout (*Oncorhynchus mykiss*), during the narcosis stage. *Fish & Shellfish Immunology* **34(2):692-696**.

Kristan, J, et al. 2012. Comparison of the effects of four anaesthetics on haematological and blood biochemical profiles in pikeperch (*Sander lucioperca* L.). *Neuroendocrinology Letters* **33(3):66-71**.

Sajan, S. 2012. Use of an eco-friendly anaesthetic in the handling of *Puntius denisonii* (Day, 1865) - an endemic ornamental barb of the Western Ghats of India. *Indian Journal of Fisheries* **59(3):131-13**5.

Shaluei, F, et al. 2012. Physiological responses of great sturgeon (*Huso huso*) to different concentrations of 2-phenoxyethanol as an anesthetic. *Fish Physiology and Biochemistry* **38(6):1627-1634**.

Simose, LN, et al. 2012. The use of clove oil as an anesthetic for advanced juvenile tilapia (*Oreochromis niloticus*). *Acta Scientiarum* **34(2):175-181**.

Stockman, J, et al. 2013. Physiologic and biochemical measurements and response to noxious stimulation at various concentrations of MS-222 in Koi (*Cyprinus carpio*). *Veterinary Anaesthesia and Analgesia* **40(1):35-47**.

Trushenski, JT, et al. 2013. Issues regarding the use of sedatives in fisheries and the need for immediate-release options. *Transactions of the American Fisheries Society* **142(1):156-170**.

Veeck, APL, et al. 2013. Lipid stability during the frozen storage of fillets from silver catfish exposed *in vivo* to the essential oil of *Lippia alba* (Mill.) NE Brown. *Journal of the Science of Food and Agriculture* **93(4):955-960**.

Vera, LM, et al. 2013. Effectiveness of the anaesthetic MS-222 in gilthead seabream, *Sparus aurata*: effect of feeding time and day-night variations in plasma MS-222 concentration and GST activity. *Physiology & Behavior* **110-111:51-57**.

Skeletal (Fluorescent) Marking

Cameron, LM, et al. 2012. Optimising chemical marking techniques for Australian bass, *Macquaria novemaculeata*, fry and fingerlings prior to restocking. *Australian Journal of Zoology* **59(4):242-248**.

Crumpton, RL, et al. 2012. Marking otoliths and fin spines of juvenile shortnose sturgeon with oxytetracycline and the effects of water temperature during treatment. *North American Journal of Fisheries Management* **32(3):523-527**.

Eckmann, R. 2012. Massive stocking with hatchery larvae may constrain natural recruitment of whitefish stocks and induce unwanted evolutionary changes. *Advances in Limnology* **63:325-336**.

Lederoun, D, et al. 2012. Postembryonic development of the cephalic skeleton in relation to external morphological changes in *Labeo parvus* (Ostariophysi, Cyprinidae). *Cybium* **36(2):383-396**.

Meyer, S, et al. 2012. Sublethal effects of alizarin complexone marking on Baltic cod (*Gadus morhua*) eggs and larvae. *Aquaculture* **324-325:158-164**.

Parkinson, KL, et al. 2012. Validation of otolith daily increment formation for two temperate syngnathid fishes: the pipefishes *Stigmatopora argus* and *Stigmatopora nigra*. *Journal of Fish Biology* **80(3):698-704**.

Russell, DJ, et al. 2013. Age and growth of two newly established invasive populations of *Tilapia mariae* in northern Australia. *Journal of Fish Biology* **82(4):1211-1225**.

Spawning Hormones and Sex Manipulation

Baumann, L, et al. 2013. The maturity index as a tool to facilitate the interpretation of changes in vitellogenin production and sex ratio in the fish sexual development test. *Aquatic Toxicology* **128-129:34-42**.

Legendre, M, et al. 2012. Biology and culture of the clown loach *Chromobotia macracanthus* (Cypriniformes, Cobitidae): 1-hormonal induced breeding, unusual latency response and egg production in two populations from Sumatra and Borneo Islands. *Aquatic Living Resources* 25**(2):95-108**.

Nyuji, M, et al. 2013. GnRHa-induced spawning of wild-caught jack mackerel *Trachurus japonicas*. Fisheries Science **79 (2):251-258**.

Rolland, AD, et al. 2013. Profiling of androgen response in rainbow trout pubertal testis: relevance to male gonad development and spermatogenesis. *PLoS ONE* **8(1):e53302**.

Farmer, JL, and Orlando, EF. 2012. Creating females? Developmental effects of 17α-ethynylestradiol on the *Mangrove rivulus'* ovotestis. *Integrative and Comparative Biology* **52(6):769-780**.

Martyniuk, CJ, and Denslow, ND. 2012. Exploring androgen-regulated pathways in teleost fish using transcriptomics and proteomics. *Integrative and Comparative Biology* **52(5):695-704**.

Saoshiro, S, e al. 2013. Sexual bipotentiality of behavior in male and female goldfish. *General and Comparative Endocrinology* **181:265-270**.

Senior, AM, et al. 2012. The fitness consequences of environmental sex reversal in fish: a quantitative review. *Biological Reviews* **87(4):900-911.**

Senior, AM, et al. 2013. A comparative analysis of chemically induced sex reversal in teleosts: challenging conventional suppositions. *Fish and Fisheries* **14(1):60-76**.

Straus, DL, et al. 2013. Safety of feed treated with 17α-methyltestosterone (17MT) to larval Nile tilapia. *North American Journal of Aquaculture* **75(2):212-219**.

Su, B., and 24 coauthors. 2013. Relative effectiveness of carp pituitary extract, luteinizing hormone releasing hormone analog (LHRHa) injections and LHRHa implants for producing hybrid catfish fry. *Aquaculture* **372-375:133-136**.

Targonska, K, et al. 2012. Controlled reproduction of the crucian carp *Carassius carassius* (L.) combining temperature and hormonal treatment in spawners. *Journal of Applied Ichthyology* **28(6):894-899**.

Vinas, J, et al. 2013. Gonadal sex differentiation in the Senegalese sole (*Solea senegalensis*) and first data on the experimental manipulation of its sex ratios. *Aquaculture* **384-387:74-81.**

Vaccines/Biologics—Salmonids

Fredriksen, BN, et al. 2013. Efficacy of a divalent and a multivalent water-in-oil formulated vaccine against a highly virulent strain of *Flavobacterium psychrophilum* after intramuscular challenge of rainbow trout (*Oncorhynchus mykiss*). *Vaccine* **31(15):1994-1998**.

Julin, K, et al. 2013. Study of virulence in field isolates of infectious pancreatic necrosis virus obtained from the northern part of Norway. *Journal of Fish Diseases* **36(2):89-102**.

Karlsen, M, et al. 2012. Efficacy and safety of an inactivated vaccine against *Salmonid alphavirus* (family Togaviridae). *Vaccine* **30(38):5688-5694**.

Kvamme, BO, et al. 2013. Modulation of innate immune responses in Atlantic salmon by chronic hypoxia-induced stress. *Fish & Shellfish Immunology* **34(1):55-65**.

Munang'andu, HM, et al. 2013. The kinetics of CD4+ and CD8+ T-cell gene expression correlate with protection in Atlantic salmon (*Salmo salar* L) vaccinated against infectious pancreatic necrosis. *Vaccine* **31(15):1956-1963**.

Munang'andu, HM, et al. 2013. Immunogenicity and cross protective ability of the central VP2 amino acids of infectious pancreatic necrosis virus in Atlantic salmon (*Salmo salar* L.). *PloS One* **8(1):e54263**.

Romstad, AB, et al. 2013. Antibody responses correlate with antigen dose and *in vivo* protection for oil-adjuvanted, experimental furunculosis (*Aeromonas salmonicida* subsp. *salmonicida*) vaccines in Atlantic salmon (*Salmo salar* L.) and can be used for batch potency testing of vaccines. *Vaccine* **31(5):791-796**.

Schwenteit, J, et al. 2013. Toxoid construction of AsaP1, a lethal toxic aspzincin metalloendopeptidase of *Aeromonas salmonicida* subsp. achromogenes, and studies of its activity and processing. *Veterinary Microbiology* **162(2-4):687-694**.

Welch, TJ, et al. 2013. Mortality associated with Weissellosis (*Weissella* sp.) in USA farmed rainbow trout: potential for control by vaccination. *Aquaculture* **388-391:122-127**.

Wiik-Nielsen, J. 2013. Genetic variation in Norwegian piscine myocarditis virus in Atlantic salmon, *Salmo salar* L. *Journal of Fish Diseases* **36(2):129-139**.

Wolf, A, et al. 2013. A hemagglutinin-esterase-expressing salmonid alphavirus replicon protects Atlantic salmon (*Salmo salar*) against infectious salmon anemia (ISA). *Vaccine* **31 (4):661-669**.

Vaccines/Biologics—Catfish

None

Vaccines/Biologics—Tilapia

Chen, M, et al. 2012. Effects of recombinant tHsp70 on immune function of tilapia peritoneal macrophages. *Journal of Fishery Sciences of China* **19(1):145-153**. (English abstract)

Vaccines/Biologics—Shrimp

Kulkarni, A, et al. 2013. Truncated VP28 as oral vaccine candidate against WSSV infection in shrimp: an uptake and processing study in the midgut of *Penaeus monodon*. *Fish & Shellfish Immunology* **34(1):159-166**.

Pathan, M, et al. 2013. *In vivo* therapeutic efficacy of recombinant *Penaeus monodon* antiviral protein (rPmAV) administered in three different forms to WSSV infected *Penaeus monodon*. *Aquaculture* **376-379:64-67**.

Satoh, J. 2012. Studies on prevention measure of white spot disease of kuruma shrimp Marsupenaeus japonicas. *Bulletin of Fisheries Research Agency (Japan)* **36:57-106**. (English abstract)

Sun, R, et al. 2013. Hemocytic immune responses triggered by CpG ODNs in shrimp *Litopenaeus vannamei*. *Fish & Shellfish Immunology* **34(1):38-45**.

Zhang, J, et al. 2012. Protection efficacy of vp28 DNA vaccine and immune responses in *Litopenaeus vannamei* against white spot syndrome virus. *Progress in Fishery Science* **33 (3):77-82**. (English abstract)

Vaccines/Biologics—Miscellaneous

Alonso, M, et al. 2013. Licensed DNA vaccines against infectious hematopoietic necrosis virus (IHNV). *Recent Patents on DNA & Gene Sequences* **7(1):62-65**.

Andreoni, F, et al. 2013. Isolation of a novel gene from *Photobacterium damselae* subsp. *piscicida* and analysis of the recombinant antigen as promising vaccine candidate. *Vaccine* **31(5):820-826**.

Aviles, F, et al. 2013. The conserved surface M-protein SiMA of *Streptococcus iniae* is not effective as a cross-protective vaccine against differing capsular serotypes in farmed fish. *Veterinary Microbiology* **162(1):151-159**.

Cai, S-Hu. 2013. Expression and immunogenicity analysis of accessory colonization factor A from *Vibrio alginolyticus* strain HY9901. *Fish & Shellfish Immunology* **34(2):454-462**.

Cen, J, et al. 2013. Identification and immunogenicity of immunodominant mimotopes of outer membrane protein U (OmpU) of *Vibrio mimicus* from phage display peptide library. *Fish & Shellfish Immunology* **34(1):291-295**.

Chen, CL, et al. 2013. Antigenic analysis of grass carp reovirus using single-chain variable fragment antibody against IgM from *Ctenopharyngodon idella*. *Science China: Life sciences* **56(1):59-65**.

Dan, X-M, et al. 2013. Immune responses and immune-related gene expression profile in orange-spotted grouper after immunization with *Cryptocaryon irritans* vaccine. Fish *& Shellfish Immunology* **34(3):885-891**.

Dong, C, et al. 2013. Efficacy of a formalin-killed cell vaccine against infectious spleen and kidney necrosis virus (ISKNV) and immunoproteomic analysis of its major immunogenic proteins. *Veterinary Microbiology* **1(2-462):419-428**.

Jia, P-P, et al. 2013. Comparative study of four flagellins of *Vibrio anguillarum*: vaccine potential and adjuvanticity. *Fish & Shellfish Immunology* **34(2):514-520**.

Kim, J-W, et al. 2013. Molecular characterisation and biological activity of a novel CXC chemokine gene in rock bream (*Oplegnathus fasciatus*). *Fish & Shellfish Immunology* **34(5):1103-1111**.

Kim, W-S, et al. 2012. Disease control efficacy of synthetic double-stranded RNA Poly (I:C) administration for viral nervous necrosis (VNN) in sevenband grouper (*Epinephelus septemfasciatus*). *Aquaculture* **364-365:259-262**.

León-Rodríguez, L, et al. 2013. Biodegradable microparticles covalently linked to surface antigens of the scuticociliate parasite *P. dicentrarchi* promote innate immune responses *in vitro*. *Fish & Shellfish Immunology* **34(1):236-243**.

Liu, L, et al. 2012. Evaluation of immune efficacy of GCRV vp6 DNA vaccine. *Journal of Fishery Sciences of China* **19 (5):841-847**. (English abstract)

Martinez-Lopez, A, et al. 2013. Improving the safety of viral DNA vaccines: development of vectors containing both 5' and 3' homologous regulatory sequences from non-viral origin. *Applied Microbiology and Biotechnology* **97(7):3007-3016**.

Mori, K, and Fukuda, Y. 2012. Protective efficacy of formalin-killed Serotype I and II vaccines for *Streptococcus parauberis* infection in Japanese flounder *Paralichthys olivaceus*. *Fish Pathology* **47(3):107-110**.

Mu, Y, et al. 2012. A vector that expresses VP28 of WSSV can protect red swamp crayfish from white spot disease. *Developmental & Comparative Immunology* **36(2):442-449**.

Oh, M-J, et al. 2013. Assessment of the sevenband grouper *Epinephelus septemfasciatus* with a live nervous necrosis virus (NNV) vaccine at natural seawater temperature. *Vaccine* **31(16):2025-2027**.

Pang, H-Y, et al. 2013. Identification of novel immunogenic proteins of *Vibrio alginolyticus* by immunoproteomic methodologies. *Aquaculture Research* **44(3):472-484**.

Wang, C, et al. 2013. Environmental isolates P1SW and V3SW as a bivalent vaccine induce effective cross-protection against *Edwardsiella tarda* and *Vibrio anguillarum*. *Diseases of Aquatic Organisms* **103(1):45-53**.

Wang, N, et al. 2013. Identification of Omp38 by immunoproteomic analysis and evaluation as a potential vaccine antigen against *Aeromonas hydrophila* in Chinese breams. *Fish & Shellfish immunology* **34(1):74-81**.

Wang, Y, et al. 2013. Functional characterization of *Edwardsiella tarda* twin-arginine translocation system and its potential use as biological containment in live attenuated vaccine of marine fish. *Applied Microbiology and Biotechnology* **97(8):3545-3557**.

Xue, R, et al. 2013. Oral vaccination of BacFish-vp6 against grass carp reovirus evoking antibody response in grass carp. *Fish & shellfish immunology* **34(1):348-355**.

Yan, Y, et al. 2013. Asd-based balanced-lethal system in attenuated *Edwardsiella tarda* to express a heterologous antigen for a multivalent bacterial vaccine. *Fish & Shellfish Immunology* **34(5):1188-1194**.

Yu, JE, et al. 2013. Identification of antigenic *Edwardsiella tarda* surface proteins and their role in pathogenesis. *Fish & Shellfish Immunology* **34(2):673-682**.

Probiotics

Angélica Garrido-Pereira, M, et al. 2013. Effect of ultraviolet (UV) radiation on the abundance and respiration rates of probiotic bacteria. *Aquaculture Research* **44(2):261-267**.

Biswas, G, et al. 2013. Cytokine responses in the Japanese pufferfish (*Takifugu rubripes*) head kidney cells induced with heat-killed probiotics isolated from the Mongolian dairy products. *Fish & Shellfish Immunology* **34(5):1170-1177**.

Cerezuela, R, et al. 2013. Changes in intestinal morphology and microbiota caused by dietary administration of inulin and *Bacillus subtilis* in gilthead sea bream (*Sparus aurata* L.) specimens. *Fish & Shellfish Immunology* **34(5):1063-1070**.

Daga, P, et al. 2013. Bioencapsulated probiotics increased survival, growth and improved gut flora of turbot (*Psetta maxima*) larvae. *Aquaculture International* **21(2):337-345**.

D'Alvise, PW, et al. 2013. Protection of cod larvae from vibriosis by *Phaeobacter* spp.: a comparison of strains and introduction times. *Aquaculture* **384-387:82-86**.

Del'Duca, A, et al. 2013. Evaluation of the presence and efficiency of potential probiotic bacteria in the gut of tilapia (*Oreochromis niloticus*) using the fluorescent *in situ* hybridization technique. *Aquaculture* **388-391:115-121**.

Fontana, L, et al. 2013. Sources, isolation, characterisation and evaluation of probiotics. *The British Journal of Nutrition* **109(S2):S35-50**.

Heo, W-S, et al. 2013. Effects of dietary probiotic, *Lactococcus lactis* subsp. *lactis* I2, supplementation on the growth and immune response of olive flounder (*Paralichthys olivaceus*). *Aquaculture* **376-379:20-24**.

Lamari, F, et al. 2013. Comparison of the effects of the dietary addition of two lactic acid bacteria on the development and conformation of sea bass larvae, *Dicentrarchus labrax*, and the influence on associated microbiota. *Aquaculture* **376-379:137-145**.

Lee, J-S, et al. 2013. Effects of dietary supplementation of *Lactobacillus pentosus* PL11 on the growth performance, immune and antioxidant systems of Japanese eel *Anguilla japonica* challenged with *Edwardsiella tarda*. *Fish & Shellfish Immunology* **34(3):756-761**.

Muñoz-Atienza, E, et al. 2013. Antimicrobial activity, antibiotic susceptibility and virulence factors of lactic acid bacteria of aquatic origin intended for use as probiotics in aquaculture. *BMC Microbiology* **13:e15 (22 pages)**.

Nwachi, OF. 2013. An overview of the importance of probiotics in aquaculture. *Journal of Fisheries and Aquatic Science* **8 (1):30-32**.

Ranjit Kumar, N, et al. 2013. Effect of dietary supplementation of *Bacillus licheniformis* on gut microbiota, growth and immune response in giant freshwater prawn, *Macrobrachium rosenbergii* (de Man, 1879). *Aquaculture International* **21 (2):387-403**.

Sharma, P, et al. 2013. Relative efficacy of two probiotics in controlling the epizootic ulcerative syndrome disease in mrigal (*Cirrhinus mrigala* Ham.). *Journal of Fisheries and Aquatic Science* **8(2):305-322**.

Silva, EF, et al. 2012. Effect of probiotic (*Bacillus* spp.) addition during larvae and postlarvae culture of the white shrimp *Litopenaeus vannamei*. *Aquaculture Research* **44 (1):13-21**.

Sun, Y-Z, et al. 2013. Application of autochthonous *Bacillus* bioencapsulated in copepod to grouper *Epinephelus coioides* larvae. *Aquaculture* **392-395:44-50**.

Tapia-Paniagua, ST, et al. 2012. Use of the probiotic *Shewanella putrefaciens* Pdp11 on the culture of Senegalese sole (*Solea senegalensis*, Kaup 1858) and gilthead seabream (*Sparus aurata* L). *Aquaculture International* **20(6):1025-1039**.

Yee, LC, et al. 2013. Antibacterial ability and molecular characterization of probionts Isolated from gut microflora of cultured red tilapia. *Asian Journal of Animal and Veterinary Advances* **8(1):116-123**.

Zink, IC, et al. 2013. Improvement of rotifer *Brachionus plicatilis* population growth dynamics with inclusion of *Bacillus* spp. probiotics. *Aquaculture Research* **44(2):200-211**.

Prebiotics (new)

Anguiano, M, et al. 2013. The effects of prebiotics on the digestive enzymes and gut histomorphology of red drum (*Sciaenops ocellatus*) and hybrid striped bass (*Morone chrysops* × *M. saxatilis*). *The British Journal of Nutrition* **109 (4):623-629**.

Ebrahimi, G, et al. 2012. Effects of a prebiotic, Immunogen, on feed utilization, body composition, immunity and resistance to *Aeromonas hydrophila* infection in the common carp *Cyprinus carpio* (Linnaeus) fingerlings. *Journal of Animal Physiology and Animal Nutrition* **96(4):591-599**.

Geraylou, Z, et al. 2012. Effects of arabinoxylan-oligosaccharides (AXOS) on juvenile Siberian sturgeon (*Acipenser baerii*) performance, immune responses and gastrointestinal microbial community. *Fish & Shellfish Immunology* **33(4):718-724**.

Ghorbani, A, et al. 2012. The effect of different levels of prebiotic on the length of fingerling rainbow trout. *African Journal of Biotechnology* **11(36):8928-8931**.

Luna-Gonzalez, A, et al. The prebiotic inulin increases the phenoloxidase activity and reduces the prevalence of WSSV in whiteleg shrimp (*Litopenaeus vannamei*) cultured under laboratory conditions. *Aquaculture* **362-363:28-32**.

Mourino, JLP, et al. 2012. Effect of dietary supplementation of inulin and *W. cibaria* on haemato-immunological parameters of hybrid surubim (*Pseudoplatystoma* sp). *Aquaculture Nutrition* **18(1):73-80**.

Peso-Echarri, P, et al. 2012. Sodium alginate as feed additive in cultured sea bream (*Sparus aurata*): does it modify the quality of the flesh? *Food Chemistry* **135(2):699-705**.

Raggi, T, and Gatlin, DM. 2012. Prebiotics have limited effects on nutrient digestibility of a diet based on fish meal and soybean meal in goldfish. *North American Journal of Aquaculture* **74(3):400-407**.

Razeghi Mansour, M, et al. 2012. Effect of dietary mannan oligosaccharide (MOS) on growth performance, survival, body composition, and some hematological parameters in giant sturgeon juvenile (*Huso huso* Linnaeus, 1754). *Fish Physiology and Biochemistry* **38(3):829-835**.

Seychelles, LH, et al. 2013. Impact of arachidonic acid enrichment of live rotifer prey on bacterial communities in rotifer and larval fish cultures. *Canadian Journal of Microbiology* **59(3):189-196**.

Soleimani, N, et al. 2012. Dietary supplementation of fructooligosaccharide (FOS) improves the innate immune response, stress resistance, digestive enzyme activities and growth performance of Caspian roach (*Rutilus rutilus*) fry. *Fish & Shellfish Immunology* **32(2):316-321**.

Wu, S-C, et al. 2012. Antivirus and prebiotic properties of seaweed-oligosaccharide-lysates derived from Agarase AS-II. *Journal of the Fisheries Society of Taiwan* **39(1):11-21**.

Miscellaneous Articles

Altinterim, B, et al. 2012. Determination of safety dose of *Eucalyptus camaldulensis* hydrosol on mirror carp (*Cyprinus carpio*). *Fresenius Environmental Bulletin* **21(5a):1219-1222**.

Canistro, D, et al. 2012. Modulation of cytochrome P450 and induction of DNA damage in *Cyprinus carpio* exposed in situ to surface water treated with chlorine or alternative disinfectants in different seasons. *Mutation Research* **729(1-2):81-89**.

Edun, OM. 2013. Safety and quality concerns associated with fish production. *Journal of Fisheries and Aquatic Science* **8 (1):21-25**.

Konradsdottir, F. 2009. Fish skin as a model membrane: structure and characteristics. Journal of Pharmacy and Pharmacology 61(1):121-124.

Landeira-Dabarca, A, et al. 2013. Change in food ingestion induces rapid shifts in the diversity of microbiota associated with cutaneous mucus of Atlantic salmon *Salmo salar*. *Journal of Fish Biology* **82(3):893-906**.

Mitchell, SO et al. 2012. Development of a novel histopathological gill scoring protocol for assessment of gill health during a longitudinal study in marine-farmed Atlantic salmon (*Salmo salar*). *Aquaculture International* **20(5):813-825**.

Peng, X-X. 2013. Proteomics and its applications to aquaculture in China: infection, immunity, and interaction of aquaculture hosts with pathogens. *Developmental & Comparative Immunology* **39(1-2):63-71**.

Pridgeon, JW, et al. 2013. Identification and virulence of *Chryseobacterium indologenes* isolated from diseased yellow perch (*Perca flavescens*). *Journal of Applied Microbiology* **114(3):636-643**.

Wyatt, TA, et al. 2013. Refining ammonia treatments for control of *Prymnesium parvum* in striped bass fingerling ponds. *North American Journal of Aquaculture* **75(2):170-177**.

Xu, D-H, et al. 2012. Enhanced susceptibility of channel catfish to the bacterium *Edwardsiella ictal*uri after parasitism by *Ichthyophthirius multifiliis*. *Veterinary Microbiology* **158(1-2):216-219**.

Zhu, L-Y, et al. 2013. Advances in research of fish immune-relevant genes: a comparative overview of innate and adaptive immunity in teleosts. *Developmental & Comparative Immunology* **39(1-2):39-62**.

UPCOMING MEETINGS (2013)

International Conference on Marine Science and Aquaculture (May 15-16, Amsterdam, The Netherlands)

The 2013 International Conference on Marine Science and Aquaculture will be held May 15-16 in Amsterdam, The Netherlands. The conference will bring together leading academic scientists, researchers, and scholars to exchange and share their experiences and research about all aspects of marine science and aquaculture. Conference details can be found at (*https://www.waset.org/conferences/2013/amsterdam/icmsa/*).

Kentucky State University Aquaculture Field Day and Workshop (May 16, Frankfort, Kentucky USA)

The Kentucky State University (KSU) Cooperative Extension Program will be hosting an Aquaculture Field Day and Workshop on May 16 (10 am-3 pm) at the KSU Center for Sustainability of Farms and Families, 1525 Mills Lane, Frankfort, Kentucky USA. The agenda includes presentations on the commercial production of a variety of aquatic animals, including fish, crayfish, and prawns. To sign up for the field day and workshop, contact Carol Faulkner at 502-597-6830 (phone) or carol.faulkner@kysu.edu. (*http://news.ca.uky.edu/article/ksu-host-aquaculture-field-day-may-16*).

American Academy of Veterinary Pharmacology and Therapeutics Biennial Symposium (May 20-22) and Drugs for Use in Animal Feeds Workshop (May 22-23) in Potomac, Maryland USA

The American Academy of Veterinary Pharmacology and Therapeutics will hold its 18th Biennial Symposium on May 20-22 in Potomac, Maryland USA (*https://m360.aavpt.org/event.aspx?eventID=58865*).

The symposium's themes are (1) Latest requirements for bioanalytical method validation, (2) Cutting edge use of pharmacokinetics, and (3) Improving veterinary drug labels. The symposium will be held May 20-21, and there will be a 1-day workshop on *Understanding Drug Labels* on May 22.

In conjunction with the symposium, a ***Drugs for Use in Animal Feeds*** *w*orkshop will be held May 22-23. Details of this 2-day workshop can be found in FDA CVM's Notes on page 8 of this newsletter, and the workshop brochure can be downloaded from AADAP's website (*http://www.fws.gov/fisheries/aadap/PDF/CVM_Draft%20brochure%20dec2012.pdf*).

Canadian Aquaculture Institute Workshops (May 27-28 and May 29-30, Charlottetown, Prince Edward Island, Canada)

The Canadian Aquaculture Institute is pleased to announce two workshops: (1) Health and Husbandry of Aquatic

Laboratory Animals (May 27-28) and (2) Advanced Aquatic Animal Care and Husbandry (May 29-30). Both workshops will be held at the Atlantic Veterinary College, University of Prince Edward Island, Charlottetown, Prince Edward Island, Canada, under the leadership of Dr. Jonathan Spears, Clinical Laboratory Animal Veterinarian.

The target audience includes Attending, Clinical or Consulting Veterinarians, Facility Managers, Aquatic Facility Technicians, and Animal Care Committee Members working with academic or research institutions that house laboratory aquatic animals or review animal care protocols involving manipulating fish in the wild. The workshops will provide hands-on experience in procedures for aquatic laboratory animals and are designed to fulfill the requirements of Continuing Education for Attending, Clinical or Consulting Veterinarians, Facility Managers and Facility Technicians as required by the Canadian Council on Animal Care. For more details, please see *http://lifelonglearning.upei.ca/cai*.

Aquaculture Canada 2013 (June 2-5, Guelph, Ontario, Canada)

Aquaculture Canada 2013 will be held June 2-5 in Guelph, Ontario, Canada, in association with the University of Guelph (*http://www.aquacultureassociation.ca*).

Aquaculture Canada largely focuses on the science of aquaculture; however, the meeting also provides a diversity of technical sessions and unique social and networking opportunities for all those working in or interested in aquaculture.

Aquaculture Europe 2013 (August 9-12, Trondheim, Norway)

Aquaculture Europe 2013 will be held August 9-12 in Trondheim, Norway. This year's theme is *Making Sense of Science*; consequently, the conference will focus on knowledge management to support technological development and innovation. Making sense of science implies setting priorities for knowledge generation; using the best people and infrastructure to create the knowledge, and using the most suitable communication channels to ensure maximum impact of the results for all the different players in the value chain as well as for the end-users. All conference details can be found at *http://www.easonline.org/component/content/article/226*.

U.S. Trout Farmers Association Fall 2013 Conference (September 12-14, Pittsburg-Green Tree, Pennsylvania USA)

The U.S. Trout Farmers Association (USTFA, *http://www.ustfa.org/*) has scheduled its 2013 Fall Conference for September 12-14 at the DoubleTree Hotel in Pittsburgh-Green Tree, Pennsylvania USA.

With the theme of Partners in Progress, the USTFA Fall 2013 Conference will focus on how producers and stakeholders working together play such an integral role in the growth, successes and sustainability of the domestic trout industry. Speakers will address a variety of topics, including advances in fish health management, redesigning the Lacey Act, emerging trout pathogens, research achievements, allied industry partnerships, and improvements in waste management. A featured presentation will be Dr. Gary Jensen's *Lessons Learned about Aquaculture in the United States*, a reflection on realities, considerations for future development and experiences during his 23 years at the U.S. Department of Agriculture. Dr. Jensen serves as National Program Leader for Aquaculture and Chair of Joint Subcommittee on Aquaculture.

The conference agenda has been set, with the USTFA Board of Directors Meeting being held Thursday morning (Sep 12). The conference and trade show will open Sep 12 at 2 pm, followed by a President's Reception that evening. Friday (Sep 13) will feature a full day of presentations and exhibits, along with lunch, social hour and dinner. An optional tour is scheduled for Saturday (Sep 14).

Those interested in exhibiting or sponsoring an event at the conference are asked to contact the USTFA office at ustfa@thenaa.net or 870-850-7900.

34th Fish Feed and Nutrition Workshop (September 22-24, Carbondale, Illinois USA)

The 34th Fish Feed and Nutrition Workshop will be hosted by the Southern Illinois University (SIU) Center for Fisheries, Aquaculture, and Aquatic Sciences in Carbondale, Illinois USA on September 22-24. The preliminary agenda includes a welcome social (Sep 22); technical presentations, a tour of the SIU aquaculture facilities, and a catfish dinner (Sep 23); and tours of local fish farms (Sep 24). If you would like to attend or present a paper, please see the workshop brochure at http://fishdata.siu.edu/ffnw13.pdf.

Cover Photo

Paradise Valley, Montana USA is a major river valley of the Yellowstone River in southwestern Montana just north of Yellowstone National Park. The valley is flanked by the Absaroka Mountain range to the east and the Gallatin Mountain Range to the west. The section of the Yellowstone River that flows through the valley is noted for its rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), and Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*) fishing. Paradise Valley also hosts other natural wonders, such as several hot springs, including Chico Hot Springs near Emigrant, La Duke Hot Springs near Gardiner, and Hunter's Hot Springs near Livingston.