

CURRICULUM VITAE

University of Idaho

NAME: Cain, Kenneth D.

DATE: October 22, 2018

RANK OR TITLE: Professor, Department of Fish and Wildlife (Aquaculture and Fish Health)
Associate Director, Aquaculture Research Institute (Campus Facilities)

DEPARTMENT: Fish and Wildlife Resources

OFFICE LOCATION AND CAMPUS ZIP: 105D, 1136

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DATE OF FIRST EMPLOYMENT AT UI: November 29, 1999

DATE OF TENURE: July 1, 2005

DATE OF PRESENT RANK OR TITLE: July 1, 2011

EDUCATION BEYOND HIGH SCHOOL:

Degrees:

Ph.D., Washington State University, Pullman, Washington, 1997, Animal Sciences (Fish Immunology)

M.S., Michigan State University, East Lansing, Michigan, 1993, Fish and Wildlife (Fish Nutrition)

B.S., Michigan State University, East Lansing, Michigan, 1990, Fish and Wildlife

EXPERIENCE:

Teaching, Extension and Research Appointments:

2015 - Present, Adjunct Faculty, Center for Reproductive Biology, Washington State University

2011 - Present, Professor (Aquaculture and Fish Health), University of Idaho

2011 Honorary Research Associate, Australian Maritime College, University of Tasmania

2002 - Present, Associate Director, Aquaculture Research Institute, University of Idaho

2005 - 2011, Associate Professor (Aquaculture and Fish Health), University of Idaho

1999-2005, Assistant Professor (Aquaculture and Fish Health), Fish and Wildlife Resources,
University of Idaho

1998-99, Research Scientist (Postdoctoral Research Fellow), University of Technology, Sydney,
Australia

1994-97, Graduate Research/Teaching Assistant, Animal Sciences Department, Washington State
University

1991-93, Graduate Research Assistant, Department of Fish and Wildlife, Michigan State University

Academic Administrative Appointment:

2002 - Present, Associate Director (Aquaculture Research Institute), Campus facilities, University of
Idaho

Non-Academic Employment including Armed Forces:

1993-94, Fish Health Technician/Fish Culturist, Clear Springs Foods, Inc., Buhl, Idaho

1989-90, Fish Culturist, Bay Port Aquaculture Systems, Inc., West Olive, Michigan

1988, Biologist's Aide, Idaho Department of Fish and Game, McCall, Idaho

Areas of Specialization:

Aquaculture Vaccine Development

Fish Health/Diseases

Fish Immunology/Pathology

Molecular Diagnostics

Proteomics
Aquaculture Development (new species)

TEACHING ACCOMPLISHMENTS:

Courses Taught (UI courses in bold):

Fish Health Management Workshop, August 2018 (Industry focused, Hagerman, ID)
Fish 498 – Aquaculture Internship, Fall/Spring
Hatchery/Wild Fish Interactions, Fish 504, (now Fish 525), Fall Alt yrs (Co-teach with Dr. Dennis Scarnecchia)
Coldwater Aquaculture Workshop, Fish 503, Summer 2017 (Co-taught with Dr. Brian Small)
 Fish Nutrition/Disease Workshop (Mt. Lassen trout farms) 2017
 Coldwater Fish Culture Workshop (UI and Hagerman), 2011
 Fish Immunology Workshop, (New Zealand), 2011
 Biosecurity workshop, shortcourse/workshop presented to Idaho trout industry, Hagerman, Idaho, Summer 2009
 Salmon Disease Workshop, Corvallis, OR, July, 2009; July 2013 (Participating instructor): Intensive 2 wk disease course for fish health professionals
 Current and Emerging Pathogens of Fishes in the Pacific Northwest (Workshop presented at annual Idaho Chapter AFS meeting), Boise, ID. Feb. 2007
 Coldwater Disease Workshop, Annual extension shortcourse/workshop presented to Idaho trout industry, Hagerman, Idaho, Summer 2004, 2005
 Fish Disease/Health Management, Annual extension shortcourse presented to Idaho trout industry, Hagerman, Idaho, September 2000, August 2001, August 2002
Fish Health Management, Fish 424, Spring semesters (alt/yrs as of 2015)
Concepts in Aquaculture, Fish 422, Fall semesters through 2007; Spring semesters 2007-2014; Spring alt/yrs as of 2016
Current Topics in Fish Health, Fish 494, Fall alt/yrs (no longer taught)
Fish Disease Diagnostics and Control, Fish 524, Fall alt/yrs (no longer taught)
Sustainable Aquaculture, Fish 504, Fall 2004 (Co-taught with Dr. Christine Moffitt)
Directed studies, Fish 499, Spring/Fall semesters as appropriate
Fish 398 Aquaculture Internship, every semester as arranged
 Guest presentations annually in **Fish 102**
 Served as poster judge and participate in course projects annually for the CNR college capstone course “NR 470”
Aquaculture and Fish Health, Fish 419, Spring 2000

Students Advised:

Undergraduate Students:

Approximately 45 to completion

Advised during the 2018-2019 academic year: 12 major/program advisees, interacted with 10-25 on-campus students, interacted with 10 or more former students
 Advised during the 2017-2018 academic year: 12 major/program advisees, interacted with 10-25 on-campus students, interacted with 10 or more former students
 Advised during the 2016-2017 academic year: 12 major/program advisees, interacted with 10-25 on-campus students, interacted with 10 or more former students
 Advised during the 2015-2016 academic year: 15 major/program advisees, interacted with 10-25 on-campus students, interacted with 10 or more former students.
 Advised during the 2014-2015 academic year: 15 major/program advisees, interacted with 10-25 on-campus students, interacted with 10 or more former students.
 Advised during the 2012-2013 academic year: 13 major/program advisees, interacted with 10-25 on-campus students, interacted with 10 or more former students.
 Advised during the 2011-2012 academic year: 11 major/program advisees, interacted with 10-25 on-campus students, interacted with 10 or more former students.
 Advised during the 2010-2011 academic year: 12 major/program advisees, interacted with 10-25

on-campus students, interacted with 10 or more former students.
 Advised during the 2009-2010 academic year: 12 major/program advisees, interacted with 10-25 on-campus students, interacted with 10 or more former students.
 Advised during the 2008-2009 academic year: 12 major/program advisees, interacted with 10-25 on-campus students, interacted with 10 or more former students.
 Advised during the 2007-2008 academic year: 15 major/program advisees, interacted with 10-25 on-campus students, interacted with 10 or more former students.
 Advised during the 2006-2007 academic year: 20 major/program advisees, interacted with 10-25 on-campus students, interacted with 10-25 off-campus students.
 Advised during the 2005-2006 academic year: 10 major/program advisees, interacted with 10-25 on-campus students, interacted with 10-25 off-campus students.
 Aquaculture Club. (2000-2013) – Faculty advisor
 Numerous directed study (DS: 299 or 499) students advised

Undergraduate Research Mentor:

Anthony Cianciotto, REU student, 2012
 Marcy Swain, REU student, 2011
 David Burbank, McNair Scholarship, 2008

Graduate Students advised to completion of degree-major professor:

Neil Ashton, PhD., in progress
 Moureen Matuha, PhD., in progress
 Sinem Gulen, M.S., in progress
 Marc Terrazas, M.S., 2016
 Bikram Ghosh, PhD (University of Tasmania co-advisor), 2015
 Tyson Fehring, M.S., 2013
 Neil Ashton, M.S., 2013
 Amy Long, Ph.D., 2012
 James Barron, M.S., 2011
 David Burbank, M.S., 2011
 Tarah Johnson, M.S., 2010
 Mark Polinski, M.S., 2009
 Ben LaFrentz, Ph.D., 2007
 Nicole Lindstrom, M.S., 2007
 John Drennan, Ph.D., 2006
 Christine Swan, M.S., 2006
 Nathan Jensen, M.S., 2006
 Leslie Grabowski, M.S., 2004
 Wade Cavender, M.S., 2003
 Ben LaFrentz, M.S., 2002

Served on graduate committee:

Kristen Meiler, (AVS), MS, in progress
 Tracy Kennedy, (FWS), PhD, in progress
 Tucker A. Brauer, (FWS), M.S., in progress
 Andreas Brezas, (Animal and Vet Sciences), Ph.D., in progress
 Jake Bledsoe, (FWS), PhD, in progress
 Alf Seljenes Dalum (Norwegian School of Veterinary Sciences), 2017
 Alejandro Villasante, (Animal and Vet Sciences), Ph.D., 2015
 Carla Schubiger, Ph.D., (WSU vet med), 2014
 Guro Løkka (Norwegian School of Veterinary Sciences), 2014
 Carson Watkins, M.S., (Fish and Wildlife), 2014
 Christopher Smith, M.S., (Fish and Wildlife), 2013
 Karol Gliniewicz, Ph.D., (WSU vet med), 2012
 Tom Loch, Ph.D., (Michigan State University), 2012

Scott Snyder (Animal and Vet Sciences), Ph.D., 2011
 Heidi Henuguin (Biology), M.S., 2009
 Derek Fryer, M.S., 2008
 John Cheng (WSU), M.S., 2008
 Shannon Amberg (CSS), Ph.D., 2008
 Shannon Miller, M.S., 2007
 Ryan Mann, M.S., 2007
 Dustene Cummings, M.S., 2007
 Johnathan Stodard (Biology), M.S., 2005
 Luis Mazuera, M.S., 2005
 Peggy Simpson, Ph.D., 2003
 Darin Jones, M.S., 2002
 Joel Green, Ph.D., 2001
 Brian Peterson, Ph.D., 2001
 Bill Johnson, M.S., 2000
 Cameron Heuser, M.S. 2000
 Tim Welker, Ph.D., 2000

Postdoctoral Researchers:

Jia Ma, 2017-present
 Tim Bruce, 2017-present
 Sudheesh Ponnerassey, 2003-2008, 2013-2017
 Karen Plant, 2006-2011
 Tanuja Upadhyaya, 2006

Research Technicians/Lab Managers:

Luke Oliver 2017-present
 Joe Evavold, 2013-present
 Scott Williams, 2006-present
 Dan Korbel, 2017-present
 Pat Blaufuss, 2012-2015
 Neil Ashton, 2011-2012
 Nate Jensen, 2006-2011
 Najeeb Parvez, 2008-2010

Visiting Scholars:

Francis Baleta (Professor and Director, Isabela State University, Philippines) Jan.- June 2017
 Jingfeng Sun (Faculty - Tianjin Agricultural University, China), Jan. 2013 –Jan. 2014
 Bikram Ghosh (PhD student – University of Tasmania, Australia), Jan. 2013 – Sept. 2013)
 Makesh Marappan (Central Inst. of Fisheries Education, India), October 2013-Feb. 2014)

Materials Developed:

Fish Nutrition/Disease Workshop (Mt. Lassen trout farms) 2017
 Salmon disease workshop (adaptive immunity and Flavobacterial diseases), 2009, 2013
 Coldwater Fish Culture Workshop/shortcourse, 2011, 2017
 Fish Immunology Workshop/shortcourse, 2011
 Biosecurity workshop (notebook/manual and CD), 2009
 Current and Emerging Pathogens of Fishes in the Pacific Northwest (notebook/manual and CD), 2007
 Manual for Coldwater disease workshop, 2004
 Manual for Fish Health shortcourse, 2000, 2001
 Website development for Fish 422 and 424, Fall 2003 (www.cnr.uidaho.edu/fish422and424/)
 Website development for Fish 422 and 424 (Blackboard)

Courses Developed:

Coldwater Aquaculture Workshop, Fish 503, Summer 2017 (Co-taught with Dr. Brian Small)
 Aquaculture in relation to wild fishes, Fish 525, Fall 2012 (Co-taught with Dr. Dennis Scarnecchia)
 Hatchery/Wild Fish Interactions, Fish 504, Fall 2010 (Co-taught with Dr. Dennis Scarnecchia)
 Concepts in Aquaculture, Fish 422, Fall 2001 (now taught every Spring)
 Fish Health Management, Fish 424, Spring 2001 (now taught every Spring)
 Current Topics in Fish Health, Fish 404/504 (now 494), Fall 2001, 2003, 2005
 Sustainable Aquaculture, Fish 504, Fall 2004 (Co-taught with Dr. Chris Moffitt)
 Fish Disease Diagnostics and Control, Fish 524, Fall 2002
 Developed and implemented an Aquaculture Minor for undergraduate students, 2006
 Aquaculture and Fish Health Management, Fish 419, Spring 2000

Non-credit Classes, Workshops, Seminars, Invited Lectures, etc.:

Fish Health Management Workshop, (Hagerman, ID) Aug. 2018
 Coldwater Aquaculture Workshop, (Hagerman, ID) 2017
 Fish Nutrition/Disease Workshop (Mt. Lassen trout farms) 2017
 Governor Butch Otter's IGEM promotional tour - University of Idaho. (Invitation to highlight fish health products developed in my lab). Jan. 2012.
 Fish diseases caused by select *Flavobacterium spp.* (Invited Lecture). Online Fish Health Course offered to USFWS professionals. Aug. 2012.
 Coldwater Fish Culture Workshop (Participating instructor), 2 week shortcourse for aquaculture professionals, attended by fish culturists from IDFG and Nez Perce tribe, Moscow and Hagerman, ID. June/July, 2011
 Fish Immunology Workshop (Participating/Invited instructor), 1 week course with laboratory, National Institute of Water and Atmosphere, Wellington, New Zealand, March 2011
JFA304 Aquatic Animal Physiology and Behavior, Guest speaker, University of Tasmania, March 2011
Fish 102, Guest speaker, November 2011, March 2017
 Animal and Veterinary Sciences (AVS 471 – Domestic animal diseases), Guest Lecture, Oct 2010
 University Core course **CORS 224**, Guest lecture, May 2010
 Salmon Disease Workshop, Corvallis, OR, July, 2009, 2013 (Participating instructor): Intensive 2 wk disease course for fish health professionals
 Biosecurity workshop, (instructor), August 14, 2009, Hagerman, ID
 Nucleospora Workshop, (participant), August 19, 2009, Boise, ID
 Current and Emerging Pathogens of Fishes in the Pacific Northwest, (instructor) February 20, 2007, Idaho Chapter AFS, continuing education (one day workshop)
 CNR Outreach Workshop (invited participant/contributor), July 12, 2007
 Northwest Reproductive Sciences Symposium (Invited speaker) Reproductive aspects associated with the development of a conservation aquaculture program for burbot (*Lota lota maculosa*), March 23, 2007
 Lower Snake River Compensation Plan Office Annual Meeting (Invited Presenter), March 12-16, 2007
 Palouse Unit AFS meeting (Invited Seminar) Research overview, November 28, 2007
Flavobacterium 2007 workshop (Invited participant/organizer), International meeting bringing over 80 researchers together from all over the world, May 2-4, 2007
 Fish Immunology Workshop, (invited workshop/seminar), Oct 5, 2006, Benchmark Biolabs, Lincoln, NE
 Coldwater Disease Workshop, Annual extension shortcourse presented to Idaho trout industry, Hagerman, Idaho, June 10, 2004, June 2005, August 2005
 Aquaculture short course for Native Americans, (invited instructor) June 15-July 23, 2004, Hagerman, Idaho
 WSU Vancouver (invited seminar), WSU Seminar Series, October 4, 2004
 46th Western Fish Disease Workshop, (organizer, speaker and session chair) AFS/Fish Health Section, June 27-29, Boise, ID. 2005.
 Coldwater disease workgroup meeting, (invited participation with Federal, State, and Tribal agencies to address coldwater disease problems), Seattle, Washington, February 5, 2004
 Workshop for the Center for Reproductive Biology, (invited seminar) Stimulating protective immunity in rainbow trout to the fish pathogen *Flavobacterium psychrophilum*, Washington State

University, Pullman, Washington, June 11, 2003
 Fish Disease/Health Management workshop/shortcourse, Annual extension shortcourse presented to Idaho trout industry, Hagerman, Idaho, September 2000, August 2001, August 2002
 Fish Immunology Workshop, Annual American Fisheries Society/Fish Health Section meeting, Gig Harbor, Washington, June 2000
 Oregon State University, Fish Disease Laboratory (invited seminar), March 2001
FISH 102 (invited presentation), September 2000, 2008, 2009, 2011
 8th Congress of the International Society of Developmental and Comparative Immunology (invited presentation) Cairns, Australia, July 2000
 Idaho Aquaculture Association, annual meeting (invited presentation) June 2000
FISH 501 (invited presentation) April 2000

SCHOLARSHIP ACCOMPLISHMENTS:

Publications:

Refereed:

- Ma, J., Bruce, T.J., Sudheesh, P.S., Knupp, C., Loch, T.P., Faisal, M. and Cain, K.D. 2018. Assessment of cross-protection to heterologous strains of *Flavobacterium psychrophilum* following vaccination with a live-attenuated coldwater disease immersion vaccine. *Journal of Fish Diseases* (In Press)
- Nguyen P, Sudheesh, P.S. Sinnesael, M., Thomas, A. Haman, K. and Cain, K.D. 2018. Rapid Detection and Monitoring of *Flavobacterium psychrophilum* in Water by Using a Handheld Field-Portable qPCR System. *North American Journal of Aquatic Animal Health* (In Press)
- Terrazas, M.M., Anderson, C.L. Jacobs, S.J. and Cain, K.D. 2018. Identification of Two Pathogenic Aeromonas Species Isolated during Production Related Epizootics from Juvenile Burbot *Lota lota maculosa*. *North American Journal of Aquatic Animal Health* 30 (3) doi: 10.1002/aah.10023
- Jaing, M.N, Fan, Yuding, Cain, K., Zeng, L. 2018. Development of cross-priming amplification coupled with vertical flow visualization for rapid detection of infectious spleen and kidney necrosis virus (ISKNV) in mandarin fish, *Siniperca chuatsi*. *Journal of Virological Methods* 253, 38-42
- Terrazas, M.M., Adams, J.R., Sudheesh, P. and Cain, K.D. 2018. Effects of Diel Temperature Fluctuation on Growth, Stress Response, and Immune Function of Burbot. *Transactions of the American Fisheries Society*, Volume 146, 996 – 1007
- Hutson, K.S. and Cain, K.D. Pathogens and Parasites, In: *Aquaculture: Farming Aquatic Animals and Plants*. Volume 3, (ed) Southgate, P.C.) Wiley-Blackwell publishing. (In Press)
- Sudheesh, P.S. and Cain, K.D. 2017. Prospects and challenges of developing and commercializing immersion vaccines for aquaculture. *International Biology Review* 1(1): 1-20
- Villasantea, A., Powell, M.S., Murdoch, G.K., Overturf, K., Cain, K., Wacyke, J., Hardy, R.W. 2016. Effect of anthocyanidins on myogenic differentiation 1 in induced and non-induced primary myoblasts from rainbow trout (*Oncorhynchus mykiss*). *Comparative Biochemistry and Physiology Part B* 196–197: 102–108
- Sudheesh, P.S. and Cain, K.D. 2016. Optimization of efficacy of a live attenuated *Flavobacterium psychrophilum* immersion vaccine. *Fish & Shellfish Immunology* 56: 169-180
- Ashton, N.K., Campbell, M.R., Anders, P.J., Powell, M.S. and Cain, K.D. 2016. Evaluating Microsatellite Markers for Parentage-Based Tagging of Hatchery Burbot. *Northwest Science*, 90(3):249-259

- Sudheesh, P.S., Zimmerman, J.K. and Cain, K.D. 2016. Dietary effects on immunity, stress, and efficacy of two live attenuated *Flavobacterium psychrophilum* vaccine formulations. *Aquaculture* 454 35-43
- Ghosh, B., Cain, K.D., Nowak, B.F. and Bridle, A.R. 2016. Microencapsulation of a putative probiotic Enterobacter species, C6-6, to protect rainbow trout, *Oncorhynchus mykiss* (Walbaum), against bacterial coldwater disease. *Journal of Fish Diseases* 39(1):1-11
- Karol Gliniewicz, Mark Wildung, Lisa H. Orfe, Gregory D. Wiens, Kenneth D. Cain, Kevin K. Lahmers, Kevin R. Snekvik and Douglas R. Call. 2015. Potential mechanisms of attenuation for rifampicin-passaged strains of *Flavobacterium psychrophilum*. *BMC Microbiology* 15:179
- Long, A., Call, D.R. and Cain, K.D. 2015. Comparison of quantitative PCR and ELISA for detection and quantification of *Flavobacterium psychrophilum* in salmonid broodstock. *Diseases of Aquatic Organism* 115: 139–146
- Ghosh, B., Bridle, A.R., Nowak, B.F. and Cain, K.D. 2015. Assessment of immune response and protection against bacterial coldwater disease induced by a live-attenuated vaccine delivered orally or intraperitoneally to rainbow trout, *Oncorhynchus mykiss* (Walbaum). *Aquaculture* 446: 242–249
- Makesh, M., Sudheesh, S.S. and Cain, K.D. 2015. Systemic and mucosal immune response of rainbow trout to immunization with an attenuated *Flavobacterium psychrophilum* vaccine strain by different routes. *Fish and Shellfish Immunology* 44: 156-163
- Schubiger, C.B., Orfe, L.H., Ponnerassery, S.P., Cain, K.D., Shah, D.H. and Call, D.R. 2015. Entericidin is requisite for a probiotic treatment (Enterobacter C6-6) to protect trout from coldwater disease challenge. *Applied and Environmental Microbiology* 81:658 –665
- Egan, J.P., Johnson, R.D., Anders, P.J. and Cain, K.D. 2014. Initial Characterization of Embryonic Development in North American Burbot *Lota lota maculosa*. *North American Journal of Aquaculture* 77:1, 37-42
- Wiens, G.D., LaPatra, S.E., Welch, J.J., Rexroad 3rd, C., Call, D.R., Cain, K.D., LaFrentz, B.R., Vaisvil, B., Schmitt, D.P. and Kapatral, V. 2014. Complete genome of *Flavobacterium psychrophilum* strain CSF259-93 used to select rainbow trout for increased genetic resistance against bacterial cold water disease. *Genome Announcements* 2(5):e00889-14. doi:10.1128/genomeA.00889-14
- Plant, K. P., LaPatra, S.E., Call, D.R., and Cain, K.D. 2014. Attempts at validating a recombinant *Flavobacterium psychrophilum* gliding motility protein N as a vaccine candidate in rainbow trout, *Oncorhynchus mykiss* (Walbaum) against bacterial cold water disease. *FEMS Microbiology Letters* 358, 14–20
- Long, A., Fehring, T.R., LaFrentz, B.R., Call, D.R. and Cain, K.D. 2014. Development of a waterborne challenge model for *Flavobacterium psychrophilum*. *FEMS Microbiology Letters*, 359, 154–160
- LaPatra, S.E., Fehring, T.R. and Cain, K.D. 2014. A probiotic Enterobacter sp. provides significant protection against *Flavobacterium psychrophilum* in rainbow trout (*Oncorhynchus mykiss*) after injection by two different routes. *Aquaculture*, 433, 361–366
- Fehring, T.R., Hardy, R.W. and Cain, K.D. 2014. Dietary inclusion of salmon testes meal from Alaskan seafood processing byproducts: Effects on growth and immune function of rainbow trout, *Oncorhynchus mykiss* (Walbaum). *Aquaculture*, 433, 34-39
- LaFrentz, B.R., LaPatra, S.E., Call, D.R., and Cain, K.D. 2014. Immunization of rainbow trout

Oncorhynchus mykiss (Walbaum) with a crude lipopolysaccharide extract from *Flavobacterium psychrophilum*. *Journal of Fish Diseases*, 45, 476–483

- Ashton, N.K., Anders, P.J., Young, S.P. and Cain, K.D.. 2014. Coded Wire and Passive Integrated Transponder Implantations in Juvenile Burbot. *North American Journal of Fisheries Management*, 34:2, 391-400
- Long, A., Call, D.R. and Cain, K.D. 2014. Investigation of the link between broodstock infection, vertical transmission, and prevalence of *Flavobacterium psychrophilum* in eggs and progeny of rainbow trout and coho salmon. *Journal of Aquatic Animal Health*, 26(2):66-77.
- Cain, K.D. and Polinski, M.P. 2014. Infectious Diseases of Coldwater Fish in Fresh Water. Chapter 3. In: *Diseases and Disorders of Finfish in Cage Culture*. Volume 2, (eds) Woo, P.T.K., and Bruno, D.W. CABI publishing, New York, NY. pp.60-113
- Ashton, N.K., Ireland, S.C. and Cain K.D. 2013. Artificial Marker Selection and Subsequent Tagging Evaluations with Juvenile Burbot. *Transactions of the American Fisheries Society*, 142:6, 1688-1698
- Barren, J.M. Jensen, N.R., Anders, P.J., Egan, J.P Ireland, S.C. and Cain K.D. 2013. Effects of stocking density on survival and yield of North American burbot reared under semi-intensive conditions. *Transactions of the American Fisheries Society*, 142:6, 1680-1687
- Holt, R.A., Bertolini, J., Cain, K. and Long, A. 2013. Coldwater Disease. In: *Fish Health Section Blue Book; Suggested procedures for the detection and identification of certain finfish and shellfish pathogens*. Chapter 2.2, American Fisheries Society (Invited book chapter)
- Woo, P.T.K. and Cain K.D. 2013. *Editors*. Current and Emerging Diseases/Disorders of Fish in Aquaculture. Special Issue: *Journal of Aquaculture Research and Development*, (International Open Access) ISSN:2155-9546
- Barren, J.M., Jensen, N.R., Anders, P.J., Egan, J.P., Ireland, S.C. and Cain, K.D. 2013. Suppression of cannibalism during larviculture of burbot (*Lota lota maculosa*) through size grading. *North American Journal of Aquaculture* 75:4, 556-561
- Valdenegro-Vega, V.A., Crosbie, P., Vincent, B., Cain, K.D., and Nowak B.F. 2013. Effect of immunization route on mucosal and systemic immune response in Atlantic salmon (*Salmo salar*). *Veterinary Immunology and Immunopathology* 151(1-2):113-23
- Long, A., Fehring, T.R, Swain, M.A., LaFrentz, B.R., Call, D.R. and Cain K.D. 2013. Enhanced efficacy of an attenuated *Flavobacterium psychrophilum* strain cultured under iron- limited conditions. *Fish and Shellfish Immunology*, 35: 1477-1482
- Polinski, M., Jensen, N., Foltz, J., Ireland, S. and Cain, K.D. 2013. Hydrogen peroxide treatments administered to hatchery reared burbot (*Lota lota*): assessing treatment regimes from embryonic development through juvenile rearing. *North American Journal of Aquaculture*, 75:1 50-56
- Burbank, D.R., LaPatra, S.E., Fornshell, G. and Cain, K.D. 2012. Isolation of bacterial probiotics candidates from the gastrointestinal (GI) tract of rainbow trout and screening for *in vitro* inhibitory activity to *Flavobacterium psychrophilum*. *Journal of Fish Diseases*, 35:11 809-816
- Gliniewicz, K, KP Plant, SE LaPatra, BR LaFrentz, K Cain, KR Snekvik and DR Call. 2012. Comparative proteomic analysis of virulent and rifampicin attenuated *Flavobacterium psychrophilum*. *Journal of Fish Diseases*, 35(7):529-39
- Snyder, S, Barrows, R., Hill, R., Gaylord, G., Overturf, K. Cain, K.D., and Hardy, R. 2012. Effects of carnosine supplementation to an all-plant protein diet for rainbow trout (*Oncorhynchus mykiss*). *Aquaculture*, 338-341, 72-81

- Foltz, J.R., Jensen, N.R., Polinski, M.P., Ireland, S.C. and Cain, K.D. 2012. Characterization of egg development by catheterization and consequences for delaying egg fertilization in hatchery reared burbot (*Lota lota*) *North American Journal of Aquaculture*, 74:3 408-412
- Long, A., Polinski, M.P., Call, D.R., and Cain, K.D. 2012. Validation of Diagnostic Assays to Screen Broodstock for *Flavobacterium psychrophilum* infections. *Journal of Fish Diseases*, 35, 407-419
- Barren, J.M., Jensen, M.R., Anders, P.J., Egan, J.P., Ireland, S.C. and Cain, K.D. 2012. Effects of temperature on the intensive culture performance of larval and juvenile North American burbot (*Lota lota maculosa*). *Aquaculture*, 364-365, 67-73
- Burbank, D.R., Shah, D.H., LaPatra, S.E., Fornshell, G. and Cain, K.D. 2011. Enhanced resistance to coldwater disease following feeding of probiotic bacterial strains to rainbow trout (*Oncorhynchus mykiss*). *Aquaculture*, 321, 185-190
- LaFrentz, B.R., LaPatra, S.E., Call, D.R., Wiens, G.D., and Cain, K.D. 2011. Identification of Immunogenic proteins within distinct molecular mass fractions of *Flavobacterium psychrophilum*. *Journal of Fish Diseases*, 34, 823-830
- Lloyd, S.J., LaPatra, S.E., Snekvik, K.R., Cain, K.D., and Call, D.R. 2011. Quantitative PCR demonstrates a positive correlation between a *Rickettsia*-like organism and severity of strawberry disease lesions in rainbow trout (*Oncorhynchus mykiss*). *Journal of Fish Diseases*, 34, 701-709
- Jensen, N.R., Anders, P.J., Hoffman, C.A., Porter, L.S., Ireland, S.C., and Cain, K.D. 2011. Performance and macronutrient composition of Age-0 burbot fed four diet treatments. *North American Journal of Aquaculture*, 73:3, 360-368
- Paragamian, V.L., Laude, C., Cain, K.D., Barron, J.M., and Jensen, N. 2011. A novel experiment of rearing burbot larvae in cages. *Journal of Applied Ichthyology*. 27 (1), 16-21
- Neufeld, M.D., Cain, K., Jensen, N., Ireland, S.C., and Paragamian, V.L. 2011. Movement of Lake Origin Burbot Reared in a Hatchery Environment and Released into a Large River. *North American Journal of Fisheries Management* 31, 56-62
- Plant, K.P., LaPatra, S.E., Call, D.R., and Cain, K.D. 2011. Immunization of rainbow trout (*Oncorhynchus mykiss*) with *Flavobacterium psychrophilum* proteins elongation factor-Tu, SufB Fe-S assembly protein and ATP synthase β . *Journal of Fish Diseases* 34, 247-250
- Cain, K.D and Swan, C.M. 2010. Barrier Function and Immunology. "The Multifunctional Gut of Fish" Elsevier Inc., (Invited book chapter), *Fish physiology* vol: 30, 112-134.
- Polinski, M.P., Drennan, J.D., Batts, W.N., Ireland, S.C., Cain, K.D. 2010. Establishment of a cell line from burbot *Lota lota* with characterization of susceptibility to IHNV, IPNV and VHSV. *Diseases of Aquatic Organisms* 90, 15-23
- Polinski, M.P., Fehringer, T.R., Johnson, K.A., Snekvik, K.R., LaPatra, S.E., LaFrentz, B.R., Ireland, S.C., Cain, K.D. 2010. Characterization of susceptibility and carrier status of burbot to IHNV, IPNV, *Flavobacterium psychrophilum*, *Aeromonas salmonicida*, and *Renibacterium salmoninarum*. *Journal of Fish diseases* 33, 559-570
- Polinski, M.P., Johnson, K.A., Ireland, S.C., Jensen, N.R., and Cain, K.D. 2010. Assessment of formalin and hydrogen peroxide use during egg incubation of burbot (*Lota lota maculosa*). *North American Journal of Aquaculture* 72, 111-117

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Peer Reviewed/Evaluated (currently scheduled or submitted):

Presentations and Other Creative Activities:

Community presentation:

Cain, K.D. (Clearwater Flycasters presentation). Burbot conservation aquaculture and species recovery, December, 11th 2013.

Workshop/manual development (since 1999):

Salinas, I., Nowak, B., and Cain, K.D., Fish Immunology Workshop (Notebook/manual), 2011

Hardy, R., Cain, K.D., Powell, M., Fornshell, G., and Patterson, T. Coldwater Fish Culture Workshop (notebook/manual and materials), 2011

Fornshell, G., and Cain, K.D. Biosecurity workshop (notebook/manual and CD), 2009

Cain, K.D., Johnson, K., Heindel, J., Emerging Pathogens of Fishes in the Pacific Northwest, Workshop manual and CD, February 20, 2007

Cain, K.D. and LaFrentz, B.R. Coldwater Disease Workshop and Shortcourse. UI Cooperative Extension System. June 10, 2004.

Cain, K. Overview of the Fish Immune System. Fish Immunology Workshop Manual. AFS/FHS continuing education, June 27, 2000.

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Cain, K. Bacterial and Viral Diseases in Aquaculture. Trout Disease/Health Management Short Course Manual. UI Cooperative Extension System and Hagerman Fish Culture Experiment Station. September 12-13, 2000, August 2001.

Professional Meeting Papers, Workshops, Showings, Recitals:

Presentations and Posters (since 1999)

Ma, J., Bruce, T.J., Sudheesh, P.S., Loch, T.P. and Cain, K.D. Cross-protective Ability of a Live Attenuated Coldwater Disease Vaccine in Juvenile Rainbow Trout. International Symposium on Aquatic Animal Health, Prince Edward Island, Canada, September 6-8, 2018

Ma, J., Bruce, T.J., Sudheesh, P.S., Loch, T.P. and Cain, K.D. Cross-protective ability of a live attenuated coldwater disease vaccine against heterologous strains of *Flavobacterium psychrophilum* in juvenile rainbow trout. Western Fish Disease Workshop, Bozeman, MT. June 2018.

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Cain, K.D. Development and Optimization of a Bacterial Coldwater Disease Vaccine. Western Division AFS Annual Meeting, Anchorage, AK. (Invited talk) May, 2018

Cain, K.D. Challenges to the development of new disease management tools/products for aquaculture. Aquaculture America Conference, Las Vegas, NV. (Invited talk) February 19-22, 2018

Ashton, N., Ross, T.J., Hardy, R., Young, S., Nemeth, D. and Cain, K. Identification of thermal bottlenecks affecting burbot embryo development: Implications for restoring the lower Kootenai River population. Idaho Chapter American Fisheries Society. March 2018

- Cain, K.D. 2017. Challenges to the development of new disease management tools/products for a growing aquaculture industry. 8th International Conference on Fisheries & Aquaculture. Toronto, Canada, October 2017 (**Keynote Speech**)
- Cain, K.D. and P.S. Sudheesh. Cross-protection to emerging flavobacterial pathogens following vaccination with a live attenuated *Flavobacterium psychrophilum* vaccine (Fp-B.17-ILM). World Aquaculture Society Conference. Cape Town, South Africa. June 2017
- Baleta, F.N., Sudheesh, P.S. and Cain, K.D. Utilization of *Sargassum* extracts as immunostimulant for rainbow trout: effects of route administration on growth and immune response. 58th Western Fish Disease Workshop, Suquamish, WA June 20-22, 2017
- Burbank, D.R. and Cain, K.D. Probiotics in aquaculture; development of a probiotic to reduce coldwater disease associated mortality. 58th Western Fish Disease Workshop, Suquamish, WA June 20-22, 2017
- Cain, K.D. and P.S. Sudheesh. Cross-Protection To Emerging Flavobacterial Pathogens and Divergent *Flavobacterium psychrophilum* strains following Vaccination with a Live Attenuated Vaccine (Fp-B.17-ILM). Eastern Fish Health Workshop. (Invited talk) East Lansing, MI. April 3rd – 6th, 2017
- Cain, K.D., Schubiger, C.B., Burbank, D.R., Ghosh, B. and D.R. Call. Characterization of a putative probiotic enterobacter strain (C6-6) and potential mechanisms associated with protection of rainbow trout challenged with *Flavobacterium psychrophilum*. Aquaculture America Conference, San Antonio, Texas. February 20-23, 2017.
- Cain, K.D. Emerging and Re-emerging Flavobacterial diseases. Special session of the US Trout Farmers Association (Invited talk), Aquaculture America Conference, San Antonio, Texas. February 20-23, 2017.
- Cain, K.D. Overview of Aquaculture and Fish Health Research at the University of Idaho. Norwegian School of Veterinary Medicine. (Invited Seminar) Oslo, Norway. February 9th, 2017.
- Cain, K.D., Schubiger, C.B., Burbank, D.R., Ghosh, B. and D.R. Call. Characterization of a putative probiotic Enterobacter strain (c6-6) and potential mechanisms associated with protection of rainbow trout challenged with *Flavobacterium psychrophilum*, the causative agent of coldwater disease/rainbow trout fry syndrome. 17th International Symposium on Fish Nutrition and Feeding (ISFNF), (Invited) Sun Valley, Idaho. June 5-10, 2016.
- Cain, K.D. and Terazzas, M. Stress and disease susceptibility of burbot. Kootenai Tribe of Idaho Annual Planning Meeting. (Invited) July 2016.
- Cain, K.D. and Wilson, M. Can “freshwater cod” be produced in Southern Idaho: overview of pilot trials at the University of Idaho (UI) and the College of Southern Idaho (CSI). Idaho Aquaculture Association annual meeting. (Invited) Twin Falls, ID June 11th, 2016.
- Cain, K.D. 2016. Developing “freshwater cod” or burbot (*Lota lota*) into a viable commercial aquaculture species in the United States. Western Regional Aquaculture Center Annual meeting. Proposal presentation. Oct. 12th.
- Cain, K.D. 2016. Emerging and Re-emerging Flavobacterial Pathogens of Salmonids. Proposal presentation. Oct. 12th.
- P.S. Sudheesh, and KD Cain. Efficacy of an improved live attenuated *Flavobacterium psychrophilum* immersion vaccine. FLAVOBACTERIUM 2015. 4th International

Conference on Flavobacterium, October 27-29, 2015, Auburn University, Auburn, AL, USA

- P.S. Sudheesh, Katherine H., and KD Cain. A Novel *Flavobacterium sp.* Causes Bacterial Cold Water Disease-like Symptoms in Steelhead and Rainbow Trout. American Fisheries Society, 145th Annual Meeting, Portland, August 16 - 20, 2015
- Cain, K.D. and Sudheesh, P. 2015. Optimizing the efficacy of a live attenuated *Flavobacterium psychrophilum* vaccine for coldwater disease. World Aquaculture Society (Aquaculture America conference). New Orleans, LA. February 19-22nd.
- Cain, K.D. 2015. Idaho Department of Commerce (IGEM council). Licensing and Commercialization of a Live Attenuated Aquaculture Vaccine (proposal finalist – invited presentation). Boise, ID. September 30th.
- Cain, K.D. 2015. Lower Snake River Compensation Program (Annual Meeting). Coldwater Disease – Working toward a Vaccine (Invited). Clarkston, WA. March 10th.
- Cain, K.D. 2014. Research overview presentation (Invited). Skretting ARC – Stavanger, Norway October, 29th.
- Cain, K.D. 2014. Conservation aquaculture as a critical tool for recovery of native fish Populations. (Invited seminar) Iowa State University. October 10th.
- Cain, K.D. 2014. Developing “freshwater cod” or burbot (*Lota lota*) into a viable commercial aquaculture species in the United States. Western Regional Aquaculture Center Annual meeting. Oct. 8th.
- Cain, K.D. 2014. Defining the relationship between stress, immune function and disease resistance in rainbow trout fed immunostimulants and functional feed additives. Western Regional Aquaculture Center Annual meeting. Oct. 8th.
- Terazzas, M. and Cain, K.D. 2014. Determining Juvenile Burbot Susceptibility to Stress Mediated Pathogens. 65th Annual Northwest Fish Culture Conference. Pendleton, OR. Dec 2-4.
- Blaufuss, P. and Cain, K.D. 2014. Aquaculture developments for Burbot *Lota lota* intended for population restoration in the Kootenai River. 65th Annual Northwest Fish Culture Conference. Pendleton, OR. Dec 2-4.
- Cain, K.D. 2014. Coldwater Disease (CWD) Vaccine. Pacific Northwest Fish Health Protection Committee Meeting. (Invited) Lewiston, ID. September 27th.
- Cain, K.D. Sudheesh, P. and Zinn, J. 2014. Coldwater Disease (CWD) Vaccine: Myth or Reality? (Invited) US Trout Farmers Annual Meeting Twin Falls, ID. September 22nd-23rd.
- Sudheesh, P. and Cain, K.D. 2014. Optimizing the efficacy of a live attenuated *Flavobacterium psychrophilum* vaccine for coldwater disease. International Symposium of Aquatic Animal Health. Portland OR. August 31st – September 4th.
- LaPatra, S., Feringer, T. and Cain, K.D. 2014. Probiotic Provides Significant Protection Against *Flavobacterium psychrophilum* in Rainbow Trout After Injection by Two Different Routes. International Symposium of Aquatic Animal Health. Portland OR. August 31st – September 4th.

- Cain, K.D. and Sudheesh, P. 2014. Dietary Effects on Immunity, Stress, and Efficacy of a Live Attenuated *Flavobacterium Psychrophilum* Vaccine. International Symposium of Aquatic Animal Health. Portland OR. August 31st – September 4th.
- Ghosh, B., Cain, K.D., Nowak, B.F. and Bridle, A.R. 2014. Oral immunoprophylaxis of finfish using alginate microencapsulation. International Symposium of Aquatic Animal Health. Portland OR. August 31st – September 4th.
- Blaufuss, P.C., Cain, K.D., Evavold, J. and Young, S. 2014. Aquaculture development for burbot *Lota lota*. Aquaculture America. February 9th-12th.
- Cain, K.D., Call, D.R., Long, A. and LaFrentz. 2013. New Tools And Potential Management Strategies For Coldwater Disease. (Invited special session talk) 38th Annual Eastern Fish Health Workshop, Gettysburg, PA. April 29th – May 3rd.
- Long, A., Call, D.R. and Cain, K.D. 2013. Use Of Diagnostic Assays For Identification Of *Flavobacterium psychrophilum* Isolates. (Invited special session talk) 38th Annual Eastern Fish Health Workshop, Gettysburg, PA. April 29th – May 3rd.
- Ashton, N. Young, S., Anders, P., Campbell, M., Powell, M. and Cain, K.D. 2013. Evaluations of Artificial and Natural Markers for Monitoring Hatchery Releases of Juvenile Burbot (*Lota lota*). Idaho Chapter/Western Division American Fisheries Society Annual Meeting, April 15-18.
- Ashton, N. Young, S. and Cain, K.D. 2013. Advancements in Aquaculture and Supplementation of Imperiled Burbot in the Kootenai River. Idaho Chapter/Western Division American Fisheries Society Annual Meeting, April 15-18.
- Cain, K.D. 2013. Commercializing specific naturally occurring probiotic bacterial strains to aid in fish disease management for aquaculture. Idaho State Board of Education, Legislative lunch (Invited presentation to Idaho legislature), Feb. 4th.
- Cain, K.D. 2013. Burbot production and research update. Kootenai Tribe of Idaho annual program review and planning meeting. Bonner's Ferry. Jan. 17th.
- Cain, K.D., Long, A., Ownbey, R., and Zinn, J. 2012. Coldwater Disease Research: Update on Vaccine Licensing and Commercialization Status. (Invited) Northwest Fish Culture Conference, Portland, OR. December 10-13.
- Ashton, N., Young, S. and Cain, K.D. 2012. Advancements in Aquaculture and Supplementation of Imperiled Burbot in the Kootenai River. Northwest Fish Culture Conference, Portland, OR. December 10-13.
- LaFrentz, B.R., Cain, K.D., Shoemaker, C. and Klesius, P.H. 2012. Vaccination of fish against *Flavobacterium columnare* and *F. psychrophilum*. Joint meeting with USGS Western Fisheries Center and Russian Fisheries Scientists. Seattle. WA. Nov.
- Cain, K.D. 2012. Update on coldwater disease vaccine development. (Invited) Western Regional Aquaculture Center annual meeting, Oct. 10-12.
- Long, A., Fehringer, T.R., Swain, M.A., LaFrentz, B.R., Call, D.R. Zinn, J. and Cain, K.D. 2012. Culturing a Live Attenuated *Flavobacterium psychrophilum* Vaccine in Iron Limited Media Enhances Efficacy. Annual AFS/Fish Health Section meeting. Lacross, WI. Aug.
- Barron, J.M., Jensen, N.R., Anders, P.J., Egan, J.P., Ireland, S.C., and Cain, K.D. 2012.

Effects of Stocking Density on Survival and Yield of North American Burbot Reared Under Semi-intensive Conditions. International Congress on Fish Biology (Burbot Symposium). Madison, WI. July.

Fehringer, T.R., Hardy, R.W. and Cain, K.D. 2012. Assessing the ability of gonad meal to act as a nucleotide immunostimulant in rainbow trout (*Oncorhynchus mykiss*). 53rd Annual Western Fish Disease Workshop. Boise, ID. June.

Long, A., Fehringer, T.R., Swain, M.A., LaFrentz, B.R., Call, D.R. and Cain, K.D. 2012. Culturing of a live attenuated *Flavobacterium psychrophilum* strain vaccine by culturing in iron limited media enhances efficacy. 53rd Annual Western Fish Disease Workshop. Boise, ID. June.

Cain, K.D. 2012. Conservation aquaculture as a critical tool for recovery of native fish populations. (Invited) James Cook University. Queensland, Australia. March 27th.

Cain, K.D. 2012. Thinking outside the box: new and innovative ways to prevent or control disease in aquaculture. (Invited) James Cook University. Queensland, Australia. March 28th.

Gliniewicz, K., Plant, K., LaPatra, S.E., Cain, K.D., Snekvik, K.R., LaFrentz, B.R. and Call, D.R. 2012. Comparative Proteomic Analysis of Virulent and Rifampicin Attenuated Strains of *Flavobacterium psychrophilum*. Idaho Chapter of American Fisheries Society Meeting. Coeur d Alene, ID. Feb.

Long, A., Fehringer, T.R., Swain, M.A., LaFrentz, B.R., Call, D.R. and Cain, K.D. 2012. Culturing of a live attenuated *Flavobacterium psychrophilum* strain vaccine by culturing in iron limited media enhances efficacy. Idaho Chapter of American Fisheries Society Meeting. Coeur d Alene, ID. Feb.

Cain, K.D. 2012. Identification of specific probiotics capable of enhancing resistance to bacterial coldwater disease (CWD) in rainbow trout. (Invited) Rocky Plains Fish Pathology Meeting. Boise, ID. Jan. 25-26.

Cain, K.D. 2012. A potential vaccine to control bacterial coldwater disease (CWD). (Invited) Rocky Plains Fish Pathology Meeting. Boise, ID. Jan. 25-26.

Cain et al. 2011. Identification of specific Autochthonous probiotics capable of enhancing resistance to bacterial coldwater disease. (Invited) Northwest Fish Culture Conference, Victoria, BC Canada. December 6-8.

Cain et al. 2011 A potential vaccine for coldwater disease. (Invited) Northwest Fish Culture Conference, Victoria, BC Canada. December 6-8.

Cain et al. 2011 Conservation aquaculture as a critical tool to recover burbot populations in Idaho's Kootenai River. (Invited) Northwest Fish Culture Conference, Victoria, BC Canada, December 6-8

Cain et al. 2011. Identification of specific Autochthonous probiotics capable of enhancing resistance to bacterial coldwater disease. AADAP meeting Bozeman, MT August 1-4.

Cain et al. 2011. Identification of specific Autochthonous probiotics capable of enhancing resistance to bacterial coldwater disease. (Invited) Pacific Northwest Fish Health Protection Committee (PNFHPC) meeting, Portland OR. September 21-22.

Cain et al. 2011 A potential vaccine for coldwater disease. (Invited) Pacific Northwest Fish Health Protection Committee (PNFHPC) meeting, Portland OR. September 21-22.

- Cain et al. 2011. Identification of specific Autochthonous probiotics capable of enhancing resistance to bacterial coldwater disease. (Invited) US Trout Farmers and Idaho Aquaculture Association annual conference, Twin Falls, ID September 29-Oct 1.
- Cain et al. 2011 A potential vaccine for coldwater disease. (Invited) US Trout Farmers and Idaho Aquaculture Association annual conference, Twin Falls, ID September 29-Oct 1.
- Cain, K.D. 2011. Research overview and update. (Invited) University of Tasmania. February 10th, Launceston, Tas, Australia
- Cain, K.D. 2011. Fish Health Research and Development. CSIRO laboratories. March, Hobart, Tas, Australia (invited presentation to Salmon industry)
- Cain, K.D., 2011. Aquaculture in Idaho and the Pacific Northwest of the US: Research at the University of Idaho. (Invited) Department of Primary Industries, Mount Pleasant Laboratories, May 7th, Launceston, Tas, Australia
- Cain et al. 2011 Conservation aquaculture as a critical tool to recover native fish species. May 18th, University of Tasmania, Launceston, Tas, Australia (invited seminar speaker)
- Gliniewicz, K, KP Plant, SE LaPatra, KD Cain, KR Snekvik, BR LaFrentz, and DR Call. Comparative proteomic analysis of virulent and rifampicin attenuated strains of *Flavobacterium psychrophilum*. *American Fisheries Society Annual Meeting*, Seattle, WA, 5-7 September 2011.
- Swain, MA, A Long, TR Fehringer, BR LaFrentz, DR Call, and KD Cain. Vaccine efficiency in Coho salmon against *Flavobacterium psychrophilum*. Talk presented at the Center for Research on Invasive Species and Small Populations end of summer presentations. Moscow, Idaho, August 4, 2011.
- Cain et al., 2011. Assessing probiotic use for the control of *Flavobacterium psychrophilum* in rainbow trout (*Oncorhynchus mykiss*). 1st Australasian Scientific conference on Aquatic Animal Health. (Invited talk), July 5-8
- Burbank, D.R., LaPatra, S.E., Fornshell, G. and Cain, K.D., 2011. Assessing probiotic use for the control of *Flavobacterium psychrophilum* in rainbow trout (*Oncorhynchus mykiss*). Eastern Fish Health Workshop. (Invited talk) March.
- Long, A, MP Polinski, DR Call, and KD Cain. Validation of Diagnostic Assays to Screen Broodstock for *Flavobacterium psychrophilum* Infection. Talk presented at the *Idaho Chapter of the American Fisheries Society Annual Meeting*. Boise, Idaho, March 2-4, 2011.
- Long, A, J Bertolini, C Olson, DR Call, and KD Cain. 2011. Use of Diagnostic Assays to Evaluate Transmission of Bacterial Coldwater Disease. Presented at American Fisheries Society 141st Annual Meeting. Seattle, Washington.
- Gliniewicz, K., Plant, K., LaPatra, S.E., Cain, K.D., Snekvik, K.R., LaFrentz, B.R., and Call, D.R. 2011. Comparative Proteomic Analysis of Virulent and Rifampicin Attenuated Strains of *Flavobacterium psychrophilum*. *American Fisheries Society Annual meeting*, Seattle, WA September.
- Burbank, D.R, S.E. Lapatra, G. Fornshell, and K.D. Cain. 2010. Assessing Candidate Probiotic Use for the Possible Control of *Flavobacterium psychrophilum* in Rainbow Trout *Oncorhynchus mykiss*. *Aquaculture America 2010*, San Diego, CA, Book of Abstracts, p. 150.

- Johnson, T.J., Parvez, N., Call, D.R., LaFrentz, B.R., Miura, T., and Cain, K.D. (2010) Confirmation of Safety and Efficacy for a Live Attenuated *Flavobacterium psychrophila* Vaccine. Sixth International Symposium of Aquatic Animal Health, September 5-9th, Tampa, FL
- Long, A., Call, D.R., and Cain, K.D. (2010) Use of Diagnostic Assays to Screen Rainbow Trout (*Oncorhynchus mykiss*) Broodstock for *Flavobacterium psychrophilum*. Sixth International Symposium of Aquatic Animal Health, September 5-9th, Tampa, FL
- Cain, K.D., Burbank, D.R., Cavender, W.P., Swan, C.M., Wilson, C. and LaPatra, S.E. (2010) Assessing candidate probiotic use for the possible control of *Flavobacterium psychrophilum* in rainbow trout. American Fisheries Society (Fish Health Section) 51st Annual Western Fish Disease Workshop, Corvallis, OR June 22-24
- Plant, K.P., LaPatra, S.E., Call, D.R. and Cain, K.D. (2010) Is vaccination with *Flavobacterium psychrophilum* gliding motility protein N (GldN) effective? American Fisheries Society (Fish Health Section) 51st Annual Western Fish Disease Workshop, Corvallis, OR June 22-24
- Cain, K.D., Burbank, D.R., Wilson, C. and LaPatra, S.E. (2010) Assessing candidate probiotic use for the possible control of *Flavobacterium psychrophilum* in rainbow trout. Idaho Aquaculture Association annual meeting, Twin Falls, ID June
- Johnson, TJ, BR. LaFrentz, DR. Call, and KD Cain (2010). Characterization of an attenuated *Flavobacterium psychrophilum* vaccine. Idaho Chapter of the American Fisheries Society Annual Meeting, Pocatello, ID March 2-5
- Gliniewicz, Snekvik, Cain, LaPatra and Call, "Assessing the immune-protective potential of FP1493 against coldwater disease in rainbow trout Washington State University Showcase, March 2010.
- Lanier, Shah, Kumar, LaPatra, Gliniewicz, Snekvik, Cain, and Call, "Production of recombinant *in vivo* induced proteins of *Flavobacterium psychrophilum* for development of a coldwater disease vaccine in rainbow trout. Washington State University Showcase, March 2010.
- Gliniewicz, Snekvik, Cain, LaPatra, and Call, "Assessing the immune-protective potential of FP1493 against coldwater disease in rainbow trout. American Society for Microbiology, San Diego, CA, 23-27 May 2010.
- Gliniewicz, Cain, Snekvik, and Call. "The role of *rpoB* gene in rifampicin attenuation of *Flavobacterium psychrophilum*. 11th Annual College of Veterinary Medicine Research Symposium, October 27, 2010.
- Cain, K.D. (2010) Conservation aquaculture as a critical tool to recover burbot populations in Idaho's Kootenai River. Idaho Chapter of the American Fisheries Society Annual Meeting, Pocatello, ID March 2-5
- Cain, K.D. (2010) Conservation aquaculture as a critical tool for recovery of burbot populations in the Kootenai River. Kootenai Valley Resource Initiative annual Burbot subcommittee meeting. May 25th, Bonner's Ferry, ID.
- Lloyd, S.J., LaPatra, S.E., Snekvik, K.R., Cain, K.D., and Call, D.R. (2010) Quantitative PCR demonstrates a positive correlation between a *Rickettsia*-like organism and severity of strawberry disease lesions in rainbow trout (*Oncorhynchus mykiss*). American Society of Microbiology annual meeting, Mach, San Diego, CA.
- LaFrentz BR, Peterson MP, Jensen NR, Cain KD (2010) Conservation aquaculture: a tool for

recovering declining fish populations. 2010 USDA-ARS Auburn Location Earth Day Celebration and Annual Environmental Management System Awareness Training, April 22, Auburn, AL, USA

- Gliniewicz, KS, KD Cain, KR Snekvik, and DR Call. The role of *rpoB* in the attenuation of *Flavobacterium psychrophilum* after passage with rifampicin. Poster presented at the 10th Annual College of Veterinary Medicine Research Symposium, Pullman, WA, October 14, 2009.
- Cain, K.D. (2009) Coldwater disease research update. Idaho Aquaculture Association annual meeting, Twin Falls, ID June
- Cain, K.D., Jensen, N., Ireland, S., Siple, J. and Neufeld, M. (2009) Development of aquaculture methods for burbot *lota lota*. Idaho Chapter of the American Fisheries Society Annual Meeting, Boise, ID March 4-6
- Cain, K.D., LaFrentz, B.R., LaPatra, S.E. and Call, D.R. (2009) Development and characterization of rifampicin resistant *Flavobacterium psychrophilum* strains and their potential as live attenuated vaccine candidates. Aquaculture America, Seattle, WA Feb.15-18
- Cain, K.D., Jensen, N., Ireland, S., Siple, J. and Neufeld, M. (2009) Development of intensive culture methods for burbot *lota lota*. Aquaculture America, Seattle, WA Feb.15-18
- Barron JM, Jensen NJ, Jones RN, Ireland SC, Siple JT, Neufeld MD, Paragamian VL, Cain KD (2009). Development and Optimization of Culture Techniques for the North American Burbot (*Lota lota maculosa*) US Fish and Wildlife Service Pacific Region Hatchery Management Workshop, November 3-5, Richland, WA
- Johnson, TJ., BR. LaFrentz, and KD Cain (2009). Development and optimization of a potential vaccine for *Flavobacterium psychrophilum*, the bacterial agent of cold water disease. Fish Health Section of the American Fisheries Society annual meeting, June 8-10th, Park City, Utah
- Johnson, TJ, BR. LaFrentz, DR. Call, and KD Cain (2009). Characterization of an attenuated *Flavobacterium psychrophilum* vaccine. American Fisheries Society annual meeting, Aug 30th-Sept 3rd, Nashville, Tennessee
- Burbank DR, LaPatra SE, Fornshell G, Cain KD (2009) Assessing Candidate Probiotic use for the Possible Control of *Flavobacterium psychrophilum* in Rainbow Trout (*Oncorhynchus mykiss*) Joint Meeting of the Fish Health Section and Western Fish Disease Workshop, June 7-10th, Park City, Utah, USA
- Long A, Call DR, Cain KD (2009) Comparison of Diagnostic Techniques for Detection of *Flavobacterium psychrophilum* in Ovarian Fluid. Joint Meeting of the Western Fish Disease Workshop and Fish Health Section of the American Fisheries Society Annual Meeting, June 7-10, Park City, Utah.
- Plant KP, LaPatra SL, Call D, Cain KD (2009) recombinant protein vaccination with *Flavobacterium psychrophilum* elongation factor Tu and iron-sulphur assembly protein SufB. Western Fish Disease Workshop and AFS Fish Health Section Annual Meeting, June 7-10th, Park City, Utah.
- Polinski MP, Johnson KA, Snekvik KR, LaFrentz BR, Cain KD (2009) Investigation into the susceptibility of burbot *Lota lota maculosa* to select aquatic pathogens. Fish Health Section annual meeting and 50th annual Western Fish Disease Workshop of the American Fisheries Society, June 8-11, Park City, UT, USA

- Polinski MP, Johnson KA, Snekvik KR, Drennan JD, Batts WN, Cain KD (2009) The development of a cell line from burbot *Lota lota maculosa* with characterization of susceptibility to IHNV, IPNV, and VHSV. Fish Health Section annual meeting and 50th annual Western Fish Disease Workshop of the American Fisheries Society, June 8-11, Park City, UT, USA
- Polinski MP, Johnson KA, Ireland SC, Jensnen NR, Cain KD (2009) Evaluation of formalin and hydrogen peroxide used during egg incubation of burbot *Lota lota maculosa*. Annual Fish Health Section meeting and 50th annual Western Fish Disease Workshop of the American Fisheries Society, June 8-11, Park City, UT, USA
- Jensen, N., Ireland, S., Siple, J., Neufeld, M., and Cain, K. (2008) Burbot hatchery design, development and renovations at the University of Idaho. 59th NWFC, Spokane, WA December 2-4 2008.
- Jensen, N., Williams, S., Ireland, S., Siple, J., Neufeld, M., and Cain, K. (2008) Development of intensive culture methods for burbot *Lota lota maculosa*. 59th NWFC, Spokane, WA December 2-4 2008.
- Polinski MP, Johnson KA, Snekvik KR, Ireland SC, Drennan JD, Cain KD (2008) Evaluation of formalin and hydrogen peroxide use during egg incubation. 59th NWFC, Spokane, WA December 2-4 2008.
- Cain, KD, and LaFrentz, BR (2008) Defining acquired immunity to *Flavobacterium psychrophilum*: implications for developing a coldwater disease (CWD) vaccine. 8th International Congress on the Biology of Fish, July 28-August 1, Portland, OR, USA
- Cain, KD. (2008) Coldwater Disease Research Update: Vaccine Development. Idaho Aquaculture Association Annual Meeting, June 21, Twin Falls, ID
- Polinski MP, Johnson KA, Snekvik KR, Ireland SC, Drennan JD, Cain KD (2008) Investigations into Disease Susceptibility and Diagnostic Tools for Burbot (*Lota lota maculosa*) Fish Health Section of the American Fisheries Society annual meeting, July 15-18th, Prince Edward Island, Canada
- Plant, KP, LaPatra, SE, and Cain, KD (2008) Recombinant Protein Vaccination with *Flavobacterium psychrophilum* Heat Shock Proteins 60 and 70 Induces a Strong Antibody Response. 49th Annual Western Fish Disease Workshop of the American Fisheries Society, June 23-25, Seattle, WA, USA
- Polinski MP*, Johnson KA, Snekvik KR, Ireland SC, Cain KD (2008) Evaluation of formalin and hydrogen peroxide use during egg incubation and preliminary investigations into disease susceptibility of burbot (*Lota lota maculosa*) 49th Annual Western Fish Disease Workshop of the American Fisheries Society, June 23-25, Seattle, WA, USA
- Polinski MP*, Johnson KA, Snekvik KR, Ireland SC, Drennan JD, Cain KD (2008) Preliminary investigations into disease susceptibility of burbot (*Lota lota maculosa*) Annual Meeting of the Idaho Chapter of the American Fisheries Society, February 6-8, Post Falls, ID, USA
- LaFrentz BR, LaPatra SE, Call DR, Cain, KD (2007) Characterization of attenuated strains of *Flavobacterium psychrophilum* generated by selection for rifampicin resistance. 48th Western Fish Disease Workshop and AFS Fish Health Section Annual Meeting, June 4-6, Jackson Lake Lodge, Grand Teton National Park, WY, USA
- Plant, K., LaPatra, S., and Cain, K (2007) Heat shock proteins as DNA vaccine candidates against *Flavobacterium psychrophilum*. 48th Western Fish Disease Workshop and AFS

Fish Health Section Annual Meeting, June 4-6, Jackson Lake Lodge, Grand Teton National Park, WY, USA

- Lindstrom, N.M., LaFrentz, B.R., Hugunin, H., Call, D.R., and Cain, K.D. (2007) Proteomic analysis of a distinct molecular mass fraction of *Flavobacterium psychrophilum*. 48th Western Fish Disease Workshop and AFS Fish Health Section Annual Meeting, June 4-6, Jackson Lake Lodge, Grand Teton National Park, WY, USA
- Cain, K.D., and Call, D.R. (2007) Comparative genomics and proteomics of *Flavobacterium psychrophilum*: Moving toward vaccine development. FY 07 Aquaculture ID and WA Annual Meeting, January 16-17, University Inn, Moscow, ID.
- Cain, K.D. (2007) Reproductive aspects associated with the development of a conservation aquaculture program for burbot (*Lota lota maculosa*), 9th Annual Northwest Reproductive Sciences Symposium, March 23, University Inn, Moscow, ID.
- Chen, J., LaFrentz, S.A., Davis, M.A., LaPatra, S.E., Cain, K., and Call D.R. (2007) Genetic variation of *Flavobacterium psychrophilum* examined by pulse-field gel electrophoresis. *Flavobacterium* 2007 Workshop, May 2-4, Shepherdstown, WV.
- Cain, K., Sudheesh, P.S., LaFrentz, B.R., Call, D.R., Siems, W.F., LaPatra, S.E., and Wiens, G.D. (2007) Identification of potential vaccine target antigens by immunoproteomic analysis of a virulent and non-virulent strain of the fish pathogen *Flavobacterium psychrophilum*. *Flavobacterium* 2007 Workshop, May 2-4, Shepherdstown, WV.
- Shah, D.H., Cain, K.D., and Call, D.R. (2007) Effects of codon usage bias on recombinant expression of *Flavobacterium psychrophilum* proteins in *E. coli*. *Flavobacterium* 2007 Workshop, May 2-4, Shepherdstown, WV.
- Cain, K.D., LaFrentz, B.R., Lindstrom, N.M., LaPatra, S.E., and Call, D.R. (2007) Electrophoretic and western blot analyses of the lipopolysaccharide and glycocalyx of *Flavobacterium psychrophilum*. *Flavobacterium* 2007 Workshop, May 2-4, Shepherdstown, WV.
- Cain, K.D., Lindstrom, N.M., Hamilton, M.J., House, M.L., and Call, D.R. (2007) A quantitative enzyme-linked immunosorbent assay (ELISA) and filtration-based fluorescent antibody test as potential tools for screening *Flavobacterium psychrophilum* in broodstock. *Flavobacterium* 2007 Workshop, May 2-4, Shepherdstown, WV.
- Call, D.R., Soule, M., Shah, D., LaFrentz, S., Cheng, J., Ramsrud, A., Kang, M., LaFrentz, B.R., Cain, K.D., LaPatra, S.E., and Wiens, G.D. (2007) *Flavobacterium psychrophilum* is composed of two distinct genetic lineages. *Flavobacterium* 2007 Workshop, May 2-4, Shepherdstown, WV.
- Lloyd, S., Snekvik, L., St-Hilaire, S., LaPatra, S., Cain, K., and Call, D. (2007) A rickettsia-like organism is associated with strawberry disease lesions in rainbow trout. WSU Research Symposium, Fall 2007.
- Cain, K. D. (Presenter & Author), CRB workshop, "Development of Burbot aquaculture techniques", CRB, Pullman, WA. (December 13, 2006).
- Cain, K. D. (Presenter & Author), Western Regional Aquaculture Center Meeting, "Coldwater disease prevention and control through vaccine development and diagnostic improvements", Reno, NV. (October 5, 2006).
- Cain, K. D. (Author Only), LaFrentz, B. (Presenter & Author), Lindstrom, N. (Author Only), LaPatra, S. (Author Only), Call, D. (Author Only), International Symposium on Aquatic Animal Health, "Analysis of *Flavobacterium psychrophilum* carbohydrate antigens and

- their potential role in protective immunity", San Francisco, CA. (September 4, 2006).
- Cain, K. D. (Author Only), LaFrentz, B. (Presenter & Author), 47th Western Fish Disease Workshop, "An analysis of *Flavobacterium psychrophilum* carbohydrate antigens and their potential role in protective immunity", Victoria, BC. (June 27, 2006).
- Cain, K. D. (Author Only), Maddox, T. (Presenter & Author), 47th Annual Fish Disease Workshop, "Development of autochthonous probiotics to control *Flavobacterium psychrophilum*, *Aeromonas salmonicida*, and *Yersinia ruckeri* in aquaculture", Victoria, BC. (June 26, 2006).
- Cain, K. D. (Presenter & Author), Jensen, N. (Author Only), CRB annual retreat, "Cryopreservation of burbot semen", CRB, Dworshak Dam, Idaho. (June 1, 2006).
- Cain, K. D. (Presenter & Author), Call, D. . (Presenter & Author), Aquaculture Initiative annual review, "CWD vaccine development", WSU/UI, Pullman, WA. (March 8, 2006).
- Cain, K. D. (Presenter & Author), Aquaculture Initiative annual review, "Development of Probiotics for disease control in aquaculture", WSU/UI, Pullman, WA. (March 8, 2006).
- Cain, K. D. (Author Only), LaFrentz, B. (Presenter & Author), Idaho Chapter of the Wildlife Society, Northwest Section of the Wildlife Society, Northwest Scientific Association, and Northwest Lichenologists Annual Meeting, "An analysis of *Flavobacterium psychrophilum* carbohydrate antigens and their potential role in protective immunity", Boise, ID. (March 7, 2006).
- Cain, K. D. (Author Only), LaFrentz, B. (Presenter & Author), Annual meeting of the Idaho chapter of the American Fisheries Society, "SDS-PAGE and western blot analysis of *Flavobacterium psychrophilum* carbohydrate antigens and their potential role in protective immunity", Idaho Falls, ID. (February 16, 2006).
- Cain, K. D. (Presenter & Author), Fish Reproductive Biology monthly meeting, "Understanding transmission factors for WSIV in white sturgeon", WSU, Pullman, WA. (January 2006).
- Cain, K.D., and Drennan, J.D. 2005. Transmission of White Sturgeon Iridovirus in Kootenai River White Sturgeon (*Acipenser transmontanus*). Center for Reproductive Biology, Fish Reproduction Meeting (*Invited presentation*). December 15.
- Jensen, N., Williams, S., Ireland, S., Siple, J., Neufeld, M., and Cain, K.D., 2005. Development of conservation aquaculture strategies for restoration of burbot (*Lota lota maculosa*) in Idaho's Kootenai River. Northwest Fish Culture Conference. Boise, ID. December 2-6.
- Cain, K.D., Jensen, N., Williams, S., Anders, P., and Ireland, S. 2005. Conservation aquaculture strategies for restoration of Burbot (*Lota lota*) in Idaho's Kootenai River. American Fisheries Society National Meeting. Anchorage, AK. (*Invited presentation*) September 11-16.
- Cain, K.D., Sudheesh, P.S., LaPatra, S.E., Wiens, G.D., LaFrentz, B.R., and Call, D.R. 2005. Identification and expression of an immuno-reactive heat shock protein from *Flavobacterium psychrophilum*. AFS Annual Fish Health Section Meeting, Minneapolis, MN July 25-28.
- Drennan, J.D., LaPatra, S.E., Sampson, C. A., Ireland, S., and Cain, K.D. 2005. Evaluation of Lethal and Non-lethal Sampling for the Detection of WSIV Infection in White Sturgeon (*Acipenser transmontanus*). AFS Annual Fish Health Section Meeting, Minneapolis, MN July 25-28.

- Soule, M., LaFrentz, S., Cain, K.D., LaPatra, S.E., and Call, D.R. 2005. Combining suppression subtractive hybridization and microarrays to map the intra-specific phylogeny of *Flavobacterium psychrophilum*. AFS 45th Western Fish Disease Workshop, Boise, ID, June 27-29.
- Lindstrom, N.M., LaFrentz, S.A., Call, D.R., and Cain, K.D. 2005. Development of an enzyme-linked immunosorbent assay (elisa) for detection of *Flavobacterium psychrophilum*. AFS 45th Western Fish Disease Workshop, Boise, ID, June 27-29.
- Drennan, J.D., LaPatra, S.E., Sampson, C. A., Ireland, S., and Cain, K.D. 2005. Evaluation of lethal and non-lethal sampling for the detection of WSIV infection in Kootenai river white sturgeon (*Acipenser transmontanus*). AFS 45th Western Fish Disease Workshop, Boise, ID, June 27-29.
- Cain, K.D., LaPatra, S.E., and Fornshell, G. 2005. Development of autochthonous probiotics to control disease outbreaks in aquaculture. Idaho Aquaculture Association Meeting (Invited presentation). June 18.
- Cain, K.C., Call, D.R., Sudheesh, P.S., LaFrentz, B.R., LaPatra, S.E., and Soule, M. 2005. Comparative genomics and proteomics of *Flavobacterium psychrophilum*. Annual WSU/UI Aquaculture Review. February 2005.
- Cain, K.C., LaPatra, S.E., and Fornshell, G. 2005. Development of autochthonous probiotics to control disease outbreaks in aquaculture. Annual WSU/UI Aquaculture Review. February 2005.
- Sudheesh, P.S., LaFrentz, B.R., LaPatra, S.E., Call, D., and Cain, K.D. 2004. Differential proteomic analysis of virulence associated and immunoreactive antigens of the salmonid pathogen, *Flavobacterium psychrophilum*. AFS Annual Fish Health Section Meeting, Kearneysville, West Virginia, July 25-28.
- Drennan, J.D., LaPatra, S.E., Siple, J.T., Ireland, S., and Cain, K.D. 2004. Transmission of White Sturgeon Iridovirus in Kootenai River White Sturgeon (*Acipenser transmontanus*). AFS Annual Fish Health Section Meeting, Kearneysville, West Virginia, July 25-28.
- Grabowski, L.D., LaPatra, S.E., and Cain, K.D. 2004. Relative Percent Survival and Antibody Response in Tilapia (*Oreochromis niloticus*) Following Immunization and Challenge with *Flavobacterium columnare*. AFS Annual Fish Health Section Meeting, Kearneysville, West Virginia, July 25-28.
- LaFrentz, B.R., LaPatra, S.E., Jones, G.R. and Cain, K.D. 2004. An Investigation Into The protective Nature Of *Flavobacterium psychrophilum* Lipopolysaccharide Against Coldwater Disease. AFS Annual Fish Health Section Meeting, Kearneysville, West Virginia, July 25-28.
- Cain, K.D., LaFrentz, B.R., Williams, S., Jones, G.R., and LaPatra, S.E. 2004. Transfer of maternally derived antibody to eggs and fry following broodstock immunization with *Flavobacterium psychrophilum* AFS 45th Western Fish Disease Workshop, Juneau, Alaska, June 22-24.
- LaFrentz, S.E., Williams, S., Jones, G.R. and Cain, K.D. 2004. Potential for Broodstock Immunization as a Method to Reduce CWD in rainbow trout (*Oncorhynchus mykiss*) Fry. Idaho Aquaculture Association Annual Meeting, June 12-13 (invited presentation)
- Cain, K.D., LaFrentz, B.R., and LaPatra, S.E. 2004. Can maternal transfer of immunity enhance disease resistance in rainbow trout fry? World Aquaculture Society Meetings, Honolulu, Hawaii, March 1-5.

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- Grabowski, L.D., LaPatra, S.E., and Cain, K.D. 2003. Systemic and mucosal antibody response to *Flavobacterium columnare* vaccine preparations in tilapia (*Oreochromis niloticus*). AFS Annual Fish Health Section Meeting and 44th Western Fish Disease Workshop, Seattle, Washington, July 14-17.
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- Cain, K.D., LaFrentz, B.R., Jones, B.R., and LaPatra, S.E. 2003. Identification of vaccine target antigens of *Flavobacterium psychrophilum*, the causative agent of coldwater disease and rainbow trout fry syndrome. World Aquaculture society Annual Meeting, Salvador, Brazil, May 19-23.
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- Cain, K.D. 2002. Broodstock immunization: A potential strategy to reduce disease related mortality in ESA listed stocks. Salmon Recovery Symposium: Issues on Pacific Salmon Recovery in the Northwest: Reproduction and Conservation, Moscow, Idaho, March 28-29 (invited presentation)
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- Cain, K.D. 2002. Pathology and disease dispersal in supplemented systems: Identification of disease-related risks. Tribal supplementation workshop. Moscow, Idaho, January 24-25(invited presentation)
- Cain, K.D. 2001. Broodstock vaccination strategies for enhanced reproductive efficiency through disease resistance, Center for Reproductive Biology (WSU/UI): Salmon Recovery Program & National Marine Fisheries Service Meeting, Spokane, Washington,

November 13 (invited presentation)

Cain, K.D., Grabowski, L., and LaPatra, S.E. 2001. Separation and comparison of proteins from virulent and nonvirulent strains of the fish pathogen *Flavobacterium psychrophilum*, AFS/Fish Health Section meetings, Victoria, B.C. Canada.

LaFrentz, B.R., Grabowski, L., LaPatra, S.E., and Cain, K.D. 2001. Characterization of serum and mucosal antibody responses to *Flavobacterium psychrophilum*: Is antibody important for protection? AFS/Fish Health Section meetings, Victoria, B.C. Canada.

LaPatra, S.E., Shewmaker, W., Jones, G., Cain, K., and Overturf, K. 2001. Understanding aquatic animal virus survival and its role in risk assessment. AFS/Fish Health Section meetings, Victoria, B.C. Canada.

Cain, K.D., Mucosal and Systemic Immunity in Fish. Oregon State University's Fish Disease Laboratory Seminar series, Corvallis, Oregon. March 2001 (invited presentation)

Cain, K.D. 2000. Immune responses in fish: What affects resistance to disease? Idaho Aquaculture Association annual meetings, Twin Falls, Idaho (invited presentation)

Cain, K.D., Jones, D.R. and Raison, R.L., 2000. Antibody-antigen kinetics following immunization of rainbow trout (*Oncorhynchus mykiss*) with a T-cell dependent antigen. 8th Congress of the International Society of Developmental and Comparative Immunology, Cairns, Australia (invited presentation)

Prasad, S.S., Cain, K.D., Jones, D.R. and Raison, R.L. 1999. Identification of cell surface proteins using 2-D gel electrophoresis. *Conference proceedings* Royal North Shore Hospital/ University of Technology, Sydney, Australia.

Patents:

Cain, K.D. and Burbank, D.R. "Probiotic Bacterial Strains For Use to Decrease Mortality In Fish Due to Bacterial Disease". Issued on August 27th, 2013. US Patent No. 8,518,413

Cain, K.D. and Burbank, D.R. Probiotic Bacterial Strains and Method of Use to Decrease Mortality Due to Bacterial Disease. Full patent application filed on April 5th, 2012 (PCT Application PCT/US2012/029896)

Cain, K.D. Enhanced efficacy of an attenuated CWD vaccine following culture in iron limited media. Provisional patent application filed August 25th, 2011, case number 11-019.

Cain, K.D. and Burbank, D.R. Discovery of specific probiotics bacterial strains capable of reducing disease-related mortality in aquaculture. Provisional patent application filed April 7th, 2011.

Cain, K.D., LaFrentz, B.R., and LaPatra, S.E. "Vaccines for Diseases of Fish," issued on June 22, 2010 as US Patent No. 7,740,864

Cain, K.D. An antibody for screening salmon and trout broodstock for the aquatic pathogen *Flavobacterium psychrophilum*, which causes bacterial coldwater disease and rainbow trout fry syndrome. Technology licensed to ImmunoPrecise Antibodies, Ltd. (2009)

Cain, K.D., Probiotic bacterial strain C6-6 (*Enterobacter sp.*) for use in fish disease control. Invention disclosure (OTT case number 09-002; filed: 2009)

Cain, K.D., LaFrentz, B.R., and LaPatra, S.E. Vaccines for diseases of fish. Non-provisional patent filed 6/2/08; patent application number 12/156,509

Cain, K.D., LaFrentz, B.R., and LaPatra, S.E. Development of a rifampicin resistant strain of *Flavobacterium psychrophilum* for use as a live attenuated vaccine for the prevention of bacterial coldwater disease and

rainbow trout fry syndrome, (Provisional patent application filed on 6/22/2007, application number 60/936,756).

Cain, K.D., Call, D., and Lindstrom, N. Development of a quantitative ELISA to detect *Flavobacterium psychrophilum*, Invention Disclosure, (Filed: February 2007).

Cain, K.D. and Cavender, W. QPCR diagnostic probe for detecting the whirling disease parasite in fish: Real-time quantitative polymerase chain reaction (QPCR) technique composed of a forward and reverse primer and a TazMan® Minor Groove Binding (MGB) probe specific for the genetic sequence that encodes the Heat shock protein 70 (Hsp 70) gene of *Myxobolus cerebralis*. Invention Disclosure, (Filed: October 2003).

Grants and Contracts Awarded:

Funded:

Welker, Tom (PI), Overturf, Ken, Cain, Ken (Co-PI). Underlying Mechanisms For Selected Disease Resistance And Enhanced Non-Specific Resistance In Rainbow Trout. USDA-NIFA Special Aquaculture Grant program. **\$309,489** (Oct. 2018 – Sept. 2020)

Cain, Ken (PI), Hardy, Ron, Bruce, Tim, Small, Brian. Effects of dietary soy replacement on burbot (freshwater cod) growth and immune function: implications for commercial culture of this new and novel species. Soy Aquaculture Alliance. **\$92,998** (Oct. 2018 – Sept. 2019)

Cain, Kenneth (PI), Coldwater vaccine optimization for licensing and commercialization. Private Animal Health Company. **\$207,000** (Sept. 2018 – Aug. 2019)

Small, Brian (PI), Cain, Ken (CO-PI), Hardy, Ron (Co-PI), Overturf, Ken (Co-PI) Developing critical knowledge of intestinal microbiota and mucosal immune system influence on early fish health using a unique trout model. USDA-NIFA **\$149,949.00** (1/1/18 – 12/31/19)

Salinas, Irene (PI), Cain, Ken (Co-PI) Understanding the duration and mechanisms of long-lasting protection of nasal vaccines in rainbow trout. USDA-NIFA \$500,000 (**\$50,000 UI**) (8/1/17-7/31/21)

Cain, K.D. (PI). Temperature effects on early life stages of the North American Burbot: Implications for restoring the lower Kootenai River population. Kootenai Tribe of Idaho, **\$50,884.05** (Jan. 2018 - Feb. 2019)

Cain, Ken (PI), Myrick, Chris (CoPI), Fornshell, Gary (Co-PI). Developing “freshwater cod” or burbot (*Lota lota*) into a viable commercial aquaculture species in the United States. USDA-Western Regional Aquaculture Center (WRAC), (**\$444,783**) (Oct. 2017-Oct. 2021)

Loch, T. (PI), Faisal, M. (PI), Cain, Kenneth (PI), and Call, D. (PI), Flavobacterial diversity and its effect on disease in aquaculture. \$360,428 (**\$79,526 UI**) (Jan. 2016-Jan 2019)

Cain, Kenneth (Principal), Thermal bottlenecks affecting reproductive success of burbot. Sponsored by the Kootenai Tribe of Idaho (BPA), Federal, (**\$106,194**) (Feb. 2017-Jan. 2018)

Cain, Kenneth (Principal), Coldwater vaccine optimization for licensing and commercialization. Private Animal Health Company. (\$93,735 + 34,695+\$36,600 + \$187,298 = **\$352,328**) (Jan. 2015 – March 2018)

Cain, Kenneth (Principal), “Kootenai River Burbot egg/embryo/larval Temperature dependent survival study. USFWS. (**\$45,000+\$55,000 + \$55,000**) (July 2015 – June 2018)

Cain, Kenneth (Principal), “Identification of critical thermal bottlenecks affecting embryo and early life-stage development for Burbot *Lota lota*: Implications for Kootenai River hydro-management” (Idaho Department of Fish and Game. (**\$104,371**) (May 2015-May 2018)

Cain, Kenneth (Principal), “Development of Burbot (*Lota lota*) conservation aquaculture and evaluation of

disease susceptibility”, Sponsored by the Kootenai Tribe of Idaho (BPA), Federal, (**\$170,889**) (January 2014 – January 2016)

Cain, Kenneth (Principal),”Licensing and Commercializing a live attenuated aquaculture vaccine” (Idaho Department of Commerce – Idaho Global Entrepreneurial Mission), State funding, (**\$105,452**) (September 2015 – June 2017)

Cain, Kenneth (Principal),” Commercializing newly developed aquatic animal health products to benefit aquaculture through disease reduction” (Idaho Department of Commerce – Idaho Global Entrepreneurial Mission), State funding, (**\$124,021**) (July 2013 – November 2014)

Cain, Kenneth (Principal), “Performance Analysis of Algae Meal as a Feed Ingredient in Salmonids”, Research and Development Contract, Algal Scientific (Private Company) (**\$13,753**) February 2013 – July 2013)

Cain, Kenneth (Principal), “Development of Burbot (*Lota lota*) conservation aquaculture and evaluation of disease susceptibility”, Sponsored by the Kootenai Tribe of Idaho (BPA), Federal, (**\$170,889**) (January 2013 – January 2014)

Cain, Kenneth (Principal), Ashton, Neil (student), Measuring the effectiveness of coded wire tagging as a potential tool for mass marking juvenile burbot (*Lota lota*) for population recovery efforts in the Kootenai river of Idaho and British Columbia, Northwest Marine Technologies (Private Company), (**\$15,000**) (September 2012-January 2013)

Cain, Kenneth (Principal), Finalizing Critical Needs for Commercialization and Licensing of a Coldwater Disease Vaccine, Research and Development Contract, Aquatic Life Sciences (Private Company), (**\$20,000**) (November 2012-February 2013)

Cain, Kenneth (Principal), “Development of Burbot (*Lota lota*) conservation aquaculture and evaluation of disease susceptibility”, Sponsored by the Kootenai Tribe of Idaho (BPA), Federal, **\$172,295** (January 2012 – January 2013)

Cain, Kenneth (Principal), “Development of Burbot (*Lota lota*) conservation aquaculture and evaluation of disease susceptibility”, Sponsored by the Kootenai Tribe of Idaho (BPA), Federal, **\$167,930** (January 2011 – January 2012)

Cain, Kenneth (Principal), “Development of Burbot (*Lota lota*) conservation aquaculture and evaluation of disease susceptibility”, Sponsored by the Kootenai Tribe of Idaho (BPA), Federal, **\$161,741** (January 2010 – January 2011)

Cain, Kenneth D (Principal), "Commercializing autochthonous probiotics to control fish diseases in aquaculture", Idaho State Board of Education, Incubation fund grant, **\$34,848** (April 2011 – July 2012)

Cain, Kenneth (Principal), “Pilot testing of potential phyto-therapeutics for inhibition of bacterial pathogens important to aquaculture”, Research service agreement, Private company (Liveleaf Biosciences), **\$5,489** (October 2010 – April 2011)

Gilman, Vladimir (Principal) Cain, Kenneth (Co-Principal) Development of a High Sensitivity and Specificity Quantitative Aptamer Assay for Coldwater Disease Management Applications. Sponsored by Infoscitex Corporation as a USDA/SBIR phase I subcontract, Federal, \$100,000 (**\$27,000 UI**), (July 2010 – Jan 2011)

Cain, Kenneth D (Principal), "Comparative genomics and proteomics of *Flavobacterium psychrophilum*: moving toward vaccine development", Sponsored by WSU/UI Aquaculture Initiative (USDA/CSREES), Federal, \$96,000 (**\$43,000 UI**). (October 2010 - October 2011).

Cain, Kenneth D (Principal), "Comparative genomics and proteomics of *Flavobacterium psychrophilum*:

moving toward vaccine development", Sponsored by WSU/UI Aquaculture Initiative (USDA/CSREES), Federal, \$100000 (**\$50,000 UI**). (October 2009 - October 2012).

Cain, Kenneth D (Principal), "Development of autochthonous probiotics to control fish diseases in aquaculture", Sponsored by WSU/UI Aquaculture Initiative (USDA/CSREES), Federal, **\$30,000** (October 2009 - October 2012).

Hardy, McIver, Cain, Murdock, Powell, Rodnick. Transforming environmental and physiological assessments using fish erythrocyte gene expression to measure responses. *National Science Foundation*. **\$600,000** (12/09-12/11).

Hardy, Ron (Principal); Cain, Kenneth (Co-Principal), "Converting Alaska fish byproducts into value added ingredients and products" Sponsored by USDA, ARS (University of Alaska), Federal, **\$234,956** (September 2009 – September 2012)

Cain, Kenneth (Principal); Plant, Karen (Co-Principal), "Understanding innate defense mechanisms to enhance control strategies for infectious hematopoietic necrosis virus in rainbow trout." Sponsored by WSU/UI Aquaculture Initiative (USDA/CSREES), Federal, **28,000** (October 2009 - October 2010)

Cain, Kenneth (Principal), "Development of Burbot (*Lota lota*) conservation aquaculture and evaluation of disease susceptibility", Sponsored by the Kootenai Tribe of Idaho (BPA), Federal, **\$154,151** (November 2008 – January 2010)

Cain, Kenneth D (Principal), "Comparative genomics and proteomics of *Flavobacterium psychrophilum*: moving toward vaccine development", Sponsored by WSU/UI Aquaculture Initiative (USDA/CSREES), Federal, \$100000 (**\$40,000 UI**). (October 2008 - October 2009).

Cain, Kenneth D (Supporting), Douglas Call (Co-Principal - WSU), "Identifying the etiologic agent of Strawberry Disease in rainbow trout", Sponsored by WSU/UI Aquaculture Initiative, Federal, **\$25,000 UI**. (October 2008- October 2009).

Cain, Kenneth D (Principal), Douglas Call (Co-Principal - WSU), Fornshell, Gary CG (Supporting), "Coldwater disease prevention and control through vaccine development and diagnostic improvements", Sponsored by Western Regional Aquaculture Center (USDA/CSREES), Federal, **\$324,874: \$158,230 to UI**. (October 2007 - October 2011).

Cain, Kenneth D (Principal), "Comparative genomics and proteomics of *Flavobacterium psychrophilum*: moving toward vaccine development", Sponsored by WSU/UI Aquaculture Initiative (USDA/CSREES), Federal, **\$100,000: \$50,000 to UI**. (October 2007 - October 2008).

Cain, Kenneth (Principal), "Development and Evaluation of Extensive Larval and Juvenile Rearing Techniques and Systems for Burbot (*Lota Lota maculosa*) to meet Conservation Aquaculture Needs", Sponsored by USFWS, Federal, **\$66,000** (October 2007 – September 2011).

Cain, Kenneth (Principal), "Development of Burbot (*Lota lota*) conservation aquaculture and evaluation of disease susceptibility", Sponsored by the Kootenai Tribe of Idaho (BPA), Federal, **\$143,362** (November 2007 – November 2008)

Cain, Kenneth (Principal), Tim Alefantis (Co-Principal) "Bacterial Ghosts as a Vaccine for the Prevention of Cold Water Disease Affecting the Salmonid Aquaculture Industry", Sponsored by Vital Probes, Inc. as a USDA/SBIR phase I subcontract, Federal, **\$75,000: \$22,624 to UI**, (July 2007 – Jan 2009)

St. Hilaire, Sophie (Principal – ISU), Cain, Kenneth (Co-investigator with many others), "The development of an oral delivery system for DNA vaccines in aquatic species", Idaho State Board of Education (SBOE) One-time grant, **\$550,000: \$24,150 to UI**. (January 2008 – January 2010)

Strom, Mark (Principal-NOAA), Cain, Kenneth (Co-Principal), "Genomic and proteomic expression profiling of *Renibacterium salmoninarum* during the infection of Chinook salmon", NOAA Fisheries, Federal, **\$90,088**

(September 2007 – September 2009)

Cain, Kenneth D (Supporting), "Identifying the etiologic agent of Strawberry Disease in rainbow trout", Sponsored by WSU/UI Aquaculture Initiative, Federal, \$35000. (October 2007 - October 2009).

Cain, Kenneth D (Principal), "Development of Burbot (*Lota lota*) conservation aquaculture and evaluation of disease susceptibility", Sponsored by Kootenai Tribe of Idaho (BPA), Federal, \$126963. (December 2006 - December 2008).

Cain, Kenneth D (Principal), "Comparative genomics and proteomics of *Flavobacterium psychrophilum*: moving toward vaccine development", Sponsored by WSU/UI Aquaculture Initiative (USDA/CSREES), Federal, \$100000. (October 2006 - October 2007).

Cain, Kenneth D (Principal), "Development of autochthonous probiotics to control fish diseases in aquaculture", Sponsored by WSU/UI Aquaculture Initiative (USDA/CSREES), Federal, \$34987. (October 2006 - October 2009).

Cain, Kenneth D (Supporting), "Identifying the etiologic agent of Strawberry Disease in rainbow trout", Sponsored by WSI/UI Aquaculture Initiative, Federal, \$35000. (October 2006 - October 2007).

Cain, Kenneth D (Co-Principal), "Control of BKD by Inactivation of the *Renibacterium salmoninarum* Sortase as an Alternative to Antibiotics", Sponsored by NOAA/NMFS, Federal, \$79720. (September 2006 - September 2007).

Cain, Kenneth D (Principal), "ELISA detection of antibody response in fish", IDFG, \$700. (September 2006 - November 2006).

Cain, Kenneth D (Co-Principal), "Genomic and proteomic expression profiling of *Renibacterium salmoninarum* during the infection of Chinook salmon", Sponsored by NOAA/NMFS, Federal, \$24600. (May 2006 - September 2006).

PI: Dr. Ken Cain, Co-PI: Dr. Keith Johnson (IDFG), Distribution of *Mxyobolus cerebralis* during the Migration Period for Juvenile Anadromous Salmonids in the Snake and Salmon Rivers of Idaho, Whirling Disease Foundation, 9/00-12/01, \$29,954.

PI: Dr. Scott LaPatra Co-PI: Dr. Ken Cain, Immunological Responses of Rainbow Trout to Coldwater Disease, USDA/SBIR phase I proposal with Clear Springs Foods, 5/01-11/01, \$75,000 (subcontract: \$22,212).

PI: Dr. Charles Hatch, Co-investigators: Brannon, Hardy, Powell, Cain, Overturf. Innovative Seafood Production: Customizing Feeds/Fish in Sustainable Aquaculture, NSF, 1/01-12/04, \$564,709.

Support (to date) under this funding:

PI: Dr. Ken Cain, Immune response to *Flavobacterium columnare* in tilapia (*Oreochromis niloticus*): implications for an ornamental fish vaccine, approx.: \$100,000.

PI: Dr. Ken Cain, Effects of Density on Manifestation of WSIV in White Sturgeon, Kootenai Tribe of Idaho, 4/01-12/01, \$10,000.

PI: Dr. Ken Cain, Co-PI: Dr. Keith Johnson (IDFG), Distribution of *Mxyobolus cerebralis* during the Migration Period for Juvenile Anadromous Salmonids in the Snake and Salmon Rivers of Idaho, continued funding through LSRCP and Idaho Power, 1/01-12/01, \$16,092.

PI: Dr. Ken Cain, Beneficial Use Reconnaissance Program (BURP), Idaho DEQ, 8/01- 11/01, \$164,080.

Co-PI: Dr. Ken Cain, USDA/CSREES: Aquaculture Idaho and Washington: Congressional initiative in support of aquaculture research at UI and WSU: FY02 \$600,000: FY03 \$750,000: FY04 \$650,000.

Funding supports small individual and larger WSU/UI collaborative projects.

Support (to date) under this funding:

PI: Dr. Ken Cain, Mucosal Immunity in Fish: Triggering the First Line of Defense, 9/02- 9/05, FY02 \$30,000: FY03 \$35,000: FY04 \$35,000.

PI: Dr. Ken Cain, Co-PI: Dr. Doug Call, Collaborators: Scott LaPatra, Gary Thorgaard, Ken Overturf. Comparative genomics and proteomics of *Flavobacterium psychrophilum* and regulation of host genes during a protective immune response, 9/02-9/04, FY02 \$100,000{\$50,000 (UI)}: FY03 \$100,000 {\$50,000 (UI)}: FY04 \$100,000 {\$50,000 (UI)}.

PI: Dr. Ken Cain, Separation and comparison of proteins from virulent and nonvirulent strains of the fish pathogen *Flavobacterium psychrophilum*, using a 2-D electrophoretic approach, Bio-Rad company, 3/01, \$500.

PI: Dr. Ken Cain, (Service contract), Histology and data analysis, Clear Springs Foods, Inc., 9/00-1/01, \$7,000.

PI: Dr. Ken Cain, (Service contract), Data analysis for Tilapia diet study, Hartz Mountain Corporation, 1/01-5/01, \$4,500.

PI: Dr. Ken Cain, (Service contract), Analysis of fish T-cell antibodies, Immuno-Precise Antibodies Ltd., 1/02- 10/02, \$3,800.

PI's: Dr. Ken Cain, Dr. Douglas R. Call, Dr. Rollin Hotchkiss, Dr. Frank J. Loge, Development of a Comprehensive Monitoring Protocol to Characterize the Concentration and Associated Health Risks of Salmonid Pathogens Suspended in Water, Washington Water Resources, December 2001, \$19,997.

PI's: Cain, Cloud, Nagler, Thorgaard, Ingermann, Byrne, McElwain, Passavant, Phillips, WSU/UI Center for Reproductive Biology, WSU and UI Salmon Restoration Program – “Broodstock Vaccination Strategies for Enhanced Reproductive Efficiency Through Disease Resistance” and 8 other projects, USFWS (\$500,000 FY02; \$375,000 FY03)

Support (to date) under this funding:

PI: Dr. Ken Cain, Reduction of disease-related impacts on important salmonid stocks through broodstock immunization against key pathogens, 7/02-10/05, \$101,947.

PI: Dr. Ken Cain, Identifying and evaluating immunogenic components of the fish pathogen *Flavobacterium psychrophilum*. UI seed grant program, 7/02-10/03, \$10,000.

PI: Dr. Ken Cain, A Quantitative PCR (QPCR) Approach to Rapidly Distinguish Between *Myxobolus* Species and Assess Infection Severity in Fish. Whirling Disease Foundation, 7/02-12/03, \$35,167.

PI: Dr. Scott LaPatra Co-PI: Dr. Ken Cain, Immunity to *Flavobacterium psychrophilum* antigens and development of a coldwater disease (CWD) vaccine. USDA/SBIR 9/03-9/05, \$299,907 (Subcontract \$148,000 to UI).

PI: Dr. Ken Cain, Feasibility assessment and development of Burbot (*Lota lota*) conservation aquaculture. Kootenai Tribe of Idaho, 9/03-9/04, \$46,545.

PI: Dr. Ken Cain, Primitive mechanisms of immunity in white sturgeon (*Acipenser transmontanus*) to the viral pathogen, white sturgeon iridovirus (WSIV). UI seed grant program, 7/03-7/04, \$9,909.

PI: Dr. Ken Cain, Gary Fornshell, Bacterial disease workshop, UI/WSU Aquaculture Initiative Extension Products, Support for hosting annual disease workshop in Hagerman, Idaho, 04-05, \$4,142.

PI: Dr. Fran Wagner, Dr. Ken Cain, Dr. George Newcombe, Dr. Armando MacDonnell, Under the microscope. USDA Equipment grant for teaching microscope, 03 \$25,000.

PI: Dr. Ken Cain and John Drennan, Direct DNA amplification of the *ribonucleotide reductase* gene from white sturgeon *iridovirus*. Laboratory for Ecological and Conservation genetics – DeVlieg Small Grants Project, \$683.

PIs: Dr. Lisette Waits, Dr. Steve Brunsfeld, Dr. Cort Anderson Co-PIs: Cain and others. Research Center Grant submitted to establish the Center for Research on Invasive Species and Small Populations Cain, Ken (PI), Sato, Esteban (Co-PI), Fornshell, Gary (Co-PI). Emerging and Re-emerging Flavobacterial Pathogens of Salmonids. USDA-Western Regional Aquaculture Center (WRAC), (\$328,775)

Langdon, Chris (PI), Hawkward, Matt (Co-PI), Cain, Ken (Co-PI), Sudheesh, Ponnerassery (Co-PI). Development of more effective delivery methods for vaccines for prevention of disease in finfish culture. USDA-Western Regional Aquaculture Center (WRAC), (\$471,335)

Cain, Ken (PI), Linley, Tim (Co-PI). Lake Roosevelt Burbot Maturation Study. Colville Tribe, (\$341,177) (CRISSP). State Board of Education (SBOE), 04-07 \$1,000,000.

PI: Dr. Ken Cain, Burbot (*Lota lota*) Development of Conservation Aquaculture Techniques for Burbot (*Lota lota*). Kootenai Tribe of Idaho, 9/04-9/06, \$97,357: funding tentatively agreed on (start date 9/04)

PI: Dr. Ken Cain, Improved Methods to Limit Vertical Transmission of WSIV in Progeny of White Sturgeon, Kootenai Tribe of Idaho, 3/02-12/05, \$126,373: (\$53,209 – yr 1, \$35,068 – yr 2, \$38,096 – yr 3)

Submitted:

2018 (total grant dollar for submitted proposals = \$6,397,396):

Welker, Tom (PI), Overturf, Ken, Cain, Ken (Co-PI). Underlying Mechanisms For Selected Disease Resistance And Enhanced Non-Specific Resistance In Rainbow Trout. USDA-NIFA Special Aquaculture Grant program. **\$309,489** (Oct. 2018 – Sept. 2020)

Cain, Ken (PI), Hardy, Ron, Bruce, Tim, Small, Brian. Effects of dietary soy replacement on burbot (freshwater cod) growth and immune function: implications for commercial culture of this new and novel species. Soy Aquaculture Alliance. **\$92,998** (Oct. 2018 – Sept. 2019)

Cain, Kenneth (Principal), Coldwater vaccine optimization for licensing and commercialization. Private Animal Health Company. **\$207,000** (Sept. 2018 – Aug. 2019)

Cain, Ken (PI), Call, Doug (Co-PI) Determining the mechanism by which entericidin B, from the probiotic *Enterobacter* C6-6, protects trout from coldwater disease. USDA-NIFA, **\$499,999** (Oct. 2019 – Sept. 2022)

Bruce, T.J. (PI), Cain, K.D. (Co-PI). Investigation of gut microbiota, physiological stress response, and immune parameters in cultured burbot (*Lota lota*). USDA-NIFA EWD postdoctoral training grant, **\$159,829** (March 2019 – Sept. 2020)

Small, B.C. (PI), Hardy, R.W. (Co-PI), Cain, K.D. (Co-PI). RII Track-2 FEC: Establishing Core Approaches for Genome to Phenome Associations in Teleost Fish Immune Function. NSF Epscor, **\$3,663,467.48** (Aug. 2018 – July 2022)

Cain, K.D. (PI). Temperature effects on early life stages of the North American Burbot: Implications for restoring the lower Kootenai River population. Kootenai Tribe of Idaho, **\$50,884.05** (Jan. 2018 - Feb. 2019)

Kumar, V. (PI), Small, B.C. (Co-PI), Smith, B.M. (Co-PI), Cain, K.D. (Co-PI), Fornshell, G. (Co-PI). An Integrated Approach to Reducing Downgrading Losses Due to Soft Fillet and Gaping in the Trout Industry. Western Regional Aquaculture Center (WRAC), **\$478,937.00** (Sept. 2019 – Aug. 2022)

Cain, K.D. (PI), Soto, E. (Co-PI), Fornshell, G. (Co-PI), Bruce T.J. (Co-PI), Ma, J. (Co-PI) Emerging and

Re-emerging Flavobacterial Pathogens in Aquaculture, Western Regional Aquaculture Center (WRAC), **\$417,000** (Sept. 2019 – Aug. 2021)

Cain, K.D. (PI), Hawkard, M. (Co-PI OSU), Bruce, T.J. (Co-PI), Ma, J. (Co-PI). Development of oral vaccine delivery methods for prevention of disease in finfish culture, Western Regional Aquaculture Center (WRAC), **\$479,000** (Sept. 2019 – Aug. 2022)

Cain, K.D. (PI). ORED FY19 EIS - CNR Aquatic Animal Laboratory (AAL) ORED FY19 EIS Infrastructure Support Request, UI Office of Research and Economic Development, **\$38,791** (Jan. 2019-April 2019)

2017:

Small, Brian (PI), Cain, Ken (CO-PI), Hardy, Ron (Co-PI), Overturf, Ken (Co-PI) Developing critical knowledge of intestinal microbiota and mucosal immune system influence on early fish health using a unique trout model. USDA-NIFA **\$149,949.00** (1/1/18 – 12/31/19)

Salinas, Irene (PI), Cain, Ken (Co-PI) Understanding the duration and mechanisms of long-lasting protection of nasal vaccines in rainbow trout. USDA-NIFA **\$50,000 (UI)** (8/1/17-7/31/21)

Cain, Kenneth (Principal), Coldwater vaccine optimization for licensing and commercialization. Private Animal Health Company. **\$187,298** (Feb. 2017 – March 2018)

2016:

Small, Brian (PI), Cain, Ken (CO-PI), Hardy, Ron (Co-PI), Overturf, Ken (Co-PI). Using a Model Trout Strain to Explore the Roles of Genotype and/or Gut Microbiota in Non-Specific Disease Resistance for Farmed Fish. USDA-NIFA, (**\$499,958**)

Call, Doug (PI), Cain, Ken (Co-PI). Determining the mechanism by which entericidin B, from the probiotic Enterobacter C6-6, protects trout from coldwater disease. USDA-NIFA, Animal Health and Production, (**\$500,000**)

Cain, Ken (PI), Myrick, Chris (CoPI), Fornshell, Gary (Co-PI). Developing “freshwater cod” or burbot (*Lota lota*) into a viable commercial aquaculture species in the United States. USDA-Western Regional Aquaculture Center (WRAC), (**\$444,783**)

Cain, Ken (PI), Sato, Esteban (Co-PI), Fornshell, Gary (Co-PI). Emerging and Re-emerging Flavobacterial Pathogens of Salmonids. USDA-Western Regional Aquaculture Center (WRAC), (**\$328,775**)

Langdon, Chris (PI), Hawkward, Matt (Co-PI), Cain, Ken (Co-PI), Sudheesh, Ponnerassery (Co-PI). Development of more effective delivery methods for vaccines for prevention of disease in finfish culture. USDA-Western Regional Aquaculture Center (WRAC), (**\$471,335**)

Cain, Ken (PI), Linley, Tim (Co-PI). Lake Roosevelt Burbot Maturation Study. Colville Tribe, (**\$341,177**)

Cain, Kenneth (Principal), “Identification of critical thermal bottlenecks affecting embryo and early life-stage development for Burbot *Lota lota*: Implications for Kootenai River hydro-management” (Idaho Department of Fish and Game. (**\$104,371 – yr 2 portion**))

Cain, Kenneth (Principal), “Kootenai River Burbot egg/embryo/larval Temperature dependent survival study. USFWS. FONs project: (**\$45,000 year 2 portion**)

Cain, Kenneth (Principal), Thermal bottlenecks affecting reproductive success of burbot. Sponsored by the Kootenai Tribe of Idaho (BPA), Federal, (**\$106,194**)

Cain, Kenneth (Principal), Coldwater vaccine optimization for licensing and commercialization. Private

Animal Health Company. (**\$34,695**)

Unfunded:

Small, B.C. (PI), Hardy, R.W. (Co-PI), Cain, K.D. (Co-PI). RII Track-2 FEC: Establishing Core Approaches for Genome to Phenome Associations in Teleost Fish Immune Function. NSF Epscor, \$3,663,467.48 (Aug. 2018 – July 2022)

Small, Brian (PI), Cain, Ken (CO-PI), Hardy, Ron (Co-PI), Overturf, Ken (Co-PI). Using a Model Trout Strain to Explore the Roles of Genotype and/or Gut Microbiota in Non-Specific Disease Resistance for Farmed Fish. USDA-NIFA, (\$499,958)

Call, Doug (PI), Cain, Ken (Co-PI). Determining the mechanism by which entericidin B, from the probiotic Enterobacter C6-6, protects trout from coldwater disease. USDA-NIFA, Animal Health and Production, (\$500,000)

Cain, Ken (PI), Sato, Esteban (Co-PI), Fornshell, Gary (Co-PI). Emerging and Re-emerging Flavobacterial Pathogens of Salmonids. USDA-Western Regional Aquaculture Center (WRAC), (\$328,775)

Langdon, Chris (PI), Hawkward, Matt (Co-PI), Cain, Ken (Co-PI), Sudheesh, Ponnerassery (Co-PI). Development of more effective delivery methods for vaccines for prevention of disease in finfish culture. USDA-Western Regional Aquaculture Center (WRAC), (\$471,335)

Cain, Ken (PI), Linley, Tim (Co-PI). Lake Roosevelt Burbot Maturation Study. Colville Tribe, (\$341,177)

Loch, Tom (Co-PI), Faisal, Mohammed (Co-PI), Cain, Ken (Co-PI), Evolution and emergence of fish-pathogenic flavobacteria as a consequence of Chinook salmon introductions into the Great Lakes. NSF - **\$441,361**

Hardy, Ron (Principal), Rodnick, Ken (Co-principal - ISU), Schreck, Carl (Co-principal OSU), Cain, Ken (Co-principal) Genomic identity of thermal adaptation: evolutionary and ecological trade-offs. NSF – preproposal

Cain, Kenneth (Principal), Call, Doug (Co-principal - WSU), 2014. US-UK Collaborative: Novel strategies to control coldwater disease and rainbow trout fry syndrome (CWD/RTFS) in rainbow trout and Atlantic salmon aquaculture. USDA AFRI program (**\$499,980**)

Loch, Tom (Principal – MSU); Cain, Kenneth (Co-Principal). 2014. Flavobacterial diversity and its effect on disease in aquaculture. USDA AFRI program (**\$109,414 – UI portion**)

Cain, Kenneth (Principal) 2014. Develop practical strategies for controlling coldwater disease in salmonids at all life stages. NIFA (USDA Special Grants Program) (**\$300,000**)

Hardy, Ron (Principal); Cain, Kenneth (Co-principal) 2014. Exploring the genetic mechanisms and the gut microbiota of a selected trout strains resistant to diseases as a model to develop preventive tools for disease resistance in farmed fish. USDA AFRI program (**\$500,000**)

Cain, Kenneth (Principal) 2014. Developing “freshwater cod” or burbot (*Lota lota*) into a viable commercial aquaculture species in the United States. Western Regional Aquaculture Center (USDA) (**\$460,235**)

Cain, Kenneth (Principal) 2014. Defining the relationship between stress, immune function and disease resistance in rainbow trout fed immunostimulants and functional feed additives. Western Regional Aquaculture Center (USDA) (**\$480,000**)

Loch, Tom (Principal); Cain, Kenneth (Co-Principal). 2013. Evolution and emergence of fish-pathogenic flavobacteria as a consequence of Chinook salmon introductions into the Great Lakes. NSF (**\$500,000**)

Cain, Kenneth (Principal), Call, Doug (Co-principal - WSU), LaFrentz, Ben (Co-principal - USDA), 2013.

Controlling warmwater and coldwater aquaculture diseases using probiotics with pathogen specific antimicrobial properties. USDA AFRI program (**\$499,988**)

Cain, Kenneth (Principal) 2012. Algae-Derived Feed Supplements Containing Beta-1,3-Glucan for Reduced Disease Impact and Improved Aquaculture Productivity. Subcontract – USDA/SBIR phase I proposal submission with the company Algal Scientific (\$150,000 - **28,955** to UI)

Cain, Kenneth (Principal), 2012. Development of Techniques to Culture Pacific Lamprey in the Snake River Basin. USFWS, (\$89,630)

Cain, Kenneth (Principal), 2012. Finalizing Critical Needs for Commercialization and Licensing of a Coldwater Disease Vaccine, Research and Development Contract, Aquatic Life Sciences (Private Company), (\$127,764) – partially funded

Cain, Kenneth (Principal) Development of a High Sensitivity and Specificity Quantitative Aptamer Assay for Coldwater Disease Management Applications. Subcontract – USDA/SBIR phase II proposal submission with the company InfoScitech (\$400,000 – **\$177,000** to UI)

Cain, Kenneth (Principal), Understanding *Nucleospora salmonis* infections in wild and hatchery fish to develop strategies to limit transmission and spread, Lower Snake River Compensation Program/USFWS, (\$70,404)

Cain, Kenneth (Principal), Call, Douglas (Co-Principal – WSU), “Characterization and delivery of *Flavobacterium psychrophilum* 259.93B.17, an attenuated vaccine candidate for coldwater disease” USDA/CSREES AFRI program, Federal, **\$374,998** (Submitted – 3/31/09)

Cain, Kenneth (Principal), Call, Douglas (Co-Principal – WSU), “Development of vaccines for *Flavobacterium psychrophilum* through enhanced expression of recombinant protein antigens and improved delivery of an attenuated vaccine strain”, Sponsored by USDA/CSREES NRI program, Federal, **\$372,002** (October 2008 – October 2011)

Walsh (Principal), Cain and 5 others (Co-PIs), “Characterization of a novel fungus infecting burbot in the Pacific Northwest”, Sponsored by Smithsonian Institution, Federal, \$43,500 (March 2008 – March 2009)

Cain, Kenneth D (Supporting), "Identification and characterization of immunodominant antigens in the catfish pathogen *Flavobacterium columnare*", Sponsored by USDA/NRI, Federal, \$60,000. (October 2007 - October 2010).

PI: Dr. Joe Cloud Co-PIs: Cain and others. IGERT for the Impacts of Global Change on Conservation Biology: A Union of Biology and Geography, National Science Foundation (NSF), 2,000,000.

PIs: Dr. Gary Thorgaard, Dr. Chris Bayne, Dr. Ken Cain. “Dissecting a Natural Killer Cell Complex in Trout” National Institute for Health (NIH), 1,702,174.

PI: Dr. Ken Cain, Adaptation of Larval Burbot (*Lota lota*) to Commercially Available Diets. UI seed grant program, February 2004, \$10,000.

PI: Dr. Ken Cain, Dr. Gary Thorgaard, Dr. Chris Bayne, Dissecting a candidate natural killer complex in trout National Institute of Health (NIH), 7/04-7/08, \$1,702,174.

PI: Dr. Cort Anderson, Co-PI: Dr. Ken Cain, Isolation and sequencing of the myxozoan mitochondrial genome, and validation of PCR-based diagnostic tools McIntire-Stennis, 2003, \$67,200.

PI: Dr. Ken Cain; Co-PI: Dr. Doug Call, Identification and characterization of vaccine target antigens for the fish pathogen *Flavobacterium psychrophilum*. USDA/NRI Animal Health and Well-Being program, New Investigator/Standard Strengthening, January 2002, \$247,640.

- PI: Dr. Ken Cain, A quantitative PCR (QPCR) approach to rapidly diagnose *Myxobolus cerebralis* and assess infection severity in fish, Whirling Disease Foundation, February 2001, \$43,136.
- PI: Dr. Ken Cain, Aquaculture Vaccine Development: Eliciting Immunity to *Flavobacterium psychrophilum*, UI seed grant program, February 2001, \$10,000.
- PI: Dr. Ken Cain, Mucosal Immunity in Fish: Triggering the First Line of Defense, USDA/NRIP Animal Health and Well-Being program, New Investigator/Standard Strengthening, January 2001, \$362,166.
- PI: Dr. Ken Cain, Virulence-Associated proteins of *Flavobacterium psychrophilum*, USDA/NRI seed grant program, October 2000, \$75,000.
- PI: Dr. Sandra Ristow, Co-PI's: Dr. Ken Cain and 7 others, Developmental and Comparative Immunobiology of Finfish, Western Regional Aquaculture Consortium (WRAC), May 2000, \$400,000.
- PI: Dr. Ken Cain, Immunological Characterization of White Sturgeon, UI seed grant program, February 2000, \$10,000.
- PI: Dr. Ken Cain, Identification of Unique Cell Surface Markers on Fish Lymphocytes, Washington Sea Grant Program, January 2000, \$160,000.

Honors and Awards:

- Nominated (by Research Office) as Fellow for National Academy of Inventors, 2018
 Mid-Career Presidential Award 2013-2014
 Innovation Award for licensed technology, 2012
 Innovation Award for Issued Patent "Vaccines for Diseases of Fish", 2010
 Innovation Award for Technology Licensed (Cain/ImmunoPrecise Antibodies, Ltd), 2009
 Best Professional Poster presentation (Idaho Chapter AFS meeting), 2009
 UI Alumni Award for Excellence, 2008
 Certificate of Appreciation, UI Tech Transfer, Invention disclosure, coldwater disease vaccine
 Certificate of Appreciation, UI Tech Transfer, Invention disclosure, C6-6 probiotic candidate
 Outstanding Alumni Award (Alumni Hall of Fame), Swartz Creek High School, 2008
 Certificate of Appreciation: As faculty mentor for UI McNair Scholarship program, 2008
 Certificate of Appreciation: for Burbot conservation efforts, Kootenai Valley Resource Initiative, 2005
 UI Award for Excellence in Teaching (Nominated, 2005)
 UI alumni award for excellence in mentoring, 2001
 Outstanding graduate student award, (Department of Animal Sciences), 1997
 Best paper award nomination, (Progressive Fish Culturist), 1995
 Snieszko Student Travel Award, AFS (fish health section), 1995

SERVICE:

- 2011-2013, Co-editor, Special Issue (New and Emerging Diseases in Aquaculture), JARD
 2010-2013, Executive Editor, *The Journal of Aquaculture Research and Development (JARD)*
 2007-present, Co-Director (Aquaculture Core Laboratories), WSU/UI Center for Reproductive Biology
 2005-present, Editorial Board, *Aquaculture Research*
 2005-present, Editor, Aquaculture Research Institute Newsletter

Major Committee Assignments:

- Board of Director, US Aquaculture Society, (Nominated 2017)
 CNR Promotion and Tenure Committee, 2017-present
 CNR Awards Committee, 2017-present
 CNR Wet lab steering committee (Chair), 2017-present
 3rd year review committee, Chris Caudill, 2015.
 ARI new building design and planning committee, 2014-present
 Student Programs Committee (FWS), 2015-present

Search Committee, Fish Physiologist (ARI/FWS), 2014-2015
 CNR committee on committees, 2015-present
 UI Dismissal Hearing Committee, 2015-present
 UI Scientific Misconduct Committee, 2013-present; Chair, 2015-2016
 Promotion and Tenure committee, AVS, 2014
 Search Committee, Department Head (FWS), 2013-2014
 Search Committee, College of Business, 2012
 CNR curriculum committee, served for Dr. Rachlow while she was on sabbatical, Fall 2012
 Chair, Promotion and Tenure committee, Department of Fish and Wildlife Sciences (Quist), 2012
 Promotion and Tenure committee, Department of Animal and Veterinary Sciences, 2011
 UI Intellectual Properties Committee, 2010-2013
 Chair, 2009-2010, Dismissal Hearings Committee, University of Idaho, 2007- 2010
 Ted Bjorn Scholarship Committee, 2009-present
 Idaho Fish Health Policy Committee, 2007-present
 National Science Foundation, Marine Biotechnology and other SBIR Review Panels, 2004-present
 USDA Aquaculture SBIR review panel, 2006-present
 Western Regional Aquaculture Center (WRAC), Technical advisory board – Research subcommittee, 2004-present
 Chair, Rankings committee, USGS, Fish Physiologist Co-op position, 2009
 Promotion and Tenure committee, Department of Animal and Veterinary Sciences, 2007
 Chair, Search Committee, Riparian Ecologist, Department of Fish and Wildlife, 2007-2008
 Chair, 2005 – 2007 Animal Care and Use Committee, University of Idaho, served since 2001
 Search Committee, Department of Fish and Wildlife, Limnologist, 2006-2007
 Search Committee, College of Natural Resources, Developmental Director, 2007
 Chair, Fisheries Curriculum Review Committee, 2005
 Chair, 3rd year review committee, Department of Fish and Wildlife, 2007
 Burbot Recovery Team, Aquaculture Subcommittee, 2004-present
 Burbot Aquaculture Facility Design Team, 2007-present
 Organizing committee, 46th Western Fish Disease Workshop, AFS/Fish Health Section, June 27-29, Boise, ID. 2005.
 Bacteriology Subcommittee, AFS/FHS Technical standards committee, 2003-2005
 EXCOM Secretary/Treasurer, Fish Health Section of AFS, 2002-2005
 CNR Scientific Equipment Committee, 2004-present
 White Sturgeon Recovery Team, 2002-present
 Chair, Graduate student/postdoc selection committee, Center for Research on Invasive Species and Small Populations (CRISSP), 2004
 Search Committee, Department of Fish and Wildlife Resources, Fish Ecologist, 2004
 DeVleig Scholarship Committee, 2002
 Idaho Fish Health Protection Committee, 2001-present
 Promotion and Tenure committee, Biology department, October 2001
 Program review committee, Department of Fish and Wildlife Resources, 2000-01
 Search Committee, Department of Fish and Wildlife Resources, Riparian Ecology, 2000-01
 3rd and 5th year Review Committee, Department of Fish and Wildlife Resources, 2000
 Aquaculture Wet Lab Steering Committee, Department of Fish and Wildlife Resources, 2000-present
 Graduate Selection Committee, Department of Animal Science, Washington State University, 1995-96

Professional and Scholarly Organizations:

European Association of Fish Pathologists
 American Fisheries Society (Fish Health Section)
 International Society of Developmental and Comparative Immunology (former member)
 International Society of Aquatic Animal Epidemiology
 World Aquaculture Society
 US Aquaculture Society
 Idaho Aquaculture Association
 WSU/UI Center for Reproductive Biology
 Member of Center for Fish Disease Research (Oregon State University)
 Center for Research on Invasive Species and Small Populations (CRISSP)

Manuscripts reviewed for following journals: (only partial list)

Journal of Aquaculture Research and Development (former Editor)
Fisheries
Vaccine
Microbiology
Journal of Aquatic Animal Health
North American Journal of Fish Management
Transactions of the American Fisheries Society
Aquaculture Research (Editorial board member)
Archives in Virology
Journal of Veterinary Medicine
Diseases of Aquatic Organisms
Fish and Shellfish Immunology
Journal of Fish Diseases
Journal of the World Aquaculture Society
Journal of Fish Biology

Grant proposals reviewed for the following funding agencies: (only partial list)

Kuwait Foundation for the Advancement of Sciences (KFAS)
Norwegian Research Council
American Academy for the Advancement of Sciences
Polish Foundation for Sciences
Technology grant program (Greece)
Mississippi State University (Center for Veterinary Medicine)
Minnesota Sea Grant
Maryland Sea Grant
National Research Council (Canada)
Canadian Foundation for Innovation (CFI)
National Science Foundation (SBIR)
USDA (SBIR)
Western Regional Aquaculture Center
Great Lakes Trust Foundation

Outreach Service:

Press release, Aquaculture North America, 2016
 SBOE Legislative lunch, 2013
 Moscow/Pullman daily news, 2012
 Spokesman review, 2012
 Columbia Basin Bulletin, 2012
 Argonath interview, 2012
 NPR interview, 2012
 TV highlights, channel 7 Boise, 2012
 Article for *Capital Press*, 2011
 Article for *Trout Talk*, 2011
 Coldwater Fish Culture Workshop, 2011
 Fish Immunology Workshop, 2011
 Invited presentation (5) related to Sabbatical in Australia, 2011
 Editor for Aquaculture Research Institute bi-annual newsletter, 2005-present
 Article for *Hatchery International Magazine*, 2009
 Articles for *Waterlines* (published by the Western Regional Aquaculture Center), 2009
 Biosecurity Workshop (instructor), presented to trout industry
 Salmon Disease Workshop, Corvallis, OR, July, 2009 (Participating instructor): Intensive 2 wk disease course for fish health professionals
 Presented research overview at Idaho Aquaculture Association annual meeting, 2008

Spokesman Review, Article on Coldwater Disease Vaccine development, October, 2006
 Idaho Science and Technology newsletter, October, 2006
 Columbia Basin Bulletin, October, 2006
 Spokesman Review, Article on Burbot Aquaculture, December, 2006
 CNR magazine, research highlights, 2006
 CNR alumni news, research highlights, 2005, 2006, 2007
 UI Research Webpage (Today at UI), Press release describing Burbot aquaculture project, 2004
 Twin Falls Times (Ag weekly), Article on research presentation given by Ben LaFrentz at IAA meeting, 2004
 Coldwater Disease workshop presented to Aquaculture Industry, CSI Hatchery, Twin Falls, Idaho, 2004
 Fish Immunology Workshop, AFS/Fish Health Section, Continuing education, 2000
 Twin Falls Times (Ag Weekly), Highlighted Fish Health Class tour of Aquaculture Industry
 Trout Disease Workshop, Idaho trout industry, provide shortcourse for industry employees
 Totally Wild Television program, Sydney, Australia, segment on Fish Vaccination
 Twin Falls Times (Ag Weekly), article highlighting invited seminar for Idaho Aquaculture Association

Community Service:

Annual contribution (fishing trip), Palouse Unit, American Fisheries Society
 Taught beginning whitewater kayaking course, University of Idaho Outdoor Program, August 2000

PROFESSIONAL DEVELOPMENT:

Teaching:

Participant in McNair Scholar Program, 2004, 2007-2008
 Writing across curriculum (WAC) workshop, January 2000

Scholarship:

Sabbatical – Jan. 2011-June 2011. University of Tasmania, Australia
 Sabbatical application, (accepted 2008) Building international collaborations in aquaculture and fish health through research, teaching, and outreach. (Spring semester 2011)
 Continuing education, AFS/FHS (80+credit hrs – Fish Virology, Histology, Hematology, Immunology, and Neoplasia in Fishes New Molecular Diagnostic Techniques, Early Fish Development, Fish Nutrition, Toxicology, Application of bacterial genomics to fish diagnostics, etc.)
 Grant writing workshop, April 2000

Administration/Management:

Associate Director, Aquaculture Research Institute, July 2002-present