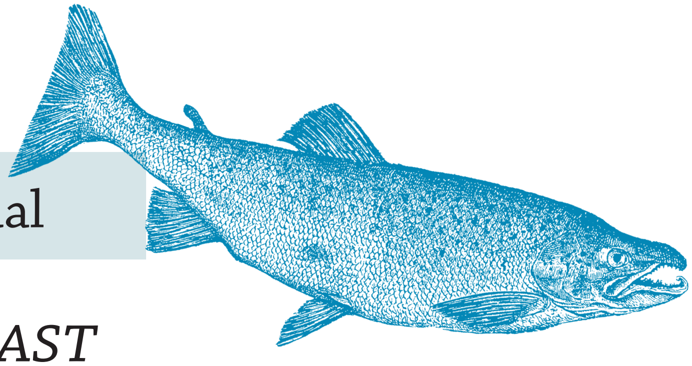
15th Annual



Northeast

Farmed Fish Health Management Workshop

March 27, 2007

Washington County Community College
Calais, Maine

Program Guide & Abstracts

SUPPORTERS

Cooke Aquaculture Inc.

Sea Grant Maine

Maine Aquaculture Association

The Maine Aquaculture Innovation Center

micro technologies, inc.

NBSGA
New Brunswick Salmon Growers Association

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15th Annual

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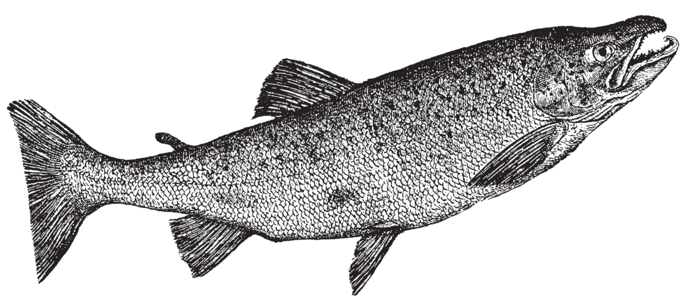


Program Guide & Abstracts

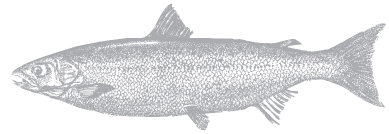
AGENDA

Monday, March 26

5:00 – 7:00	**Reception** *Downeast Heritage Museum*

Tuesday, March 27

8:00 – 8:45	**Registration and Coffee**
8:45 – 9:00	**Welcome** Sebastian Belle, Maine Aquaculture Association Jamey Smith, New Brunswick Salmon Growers Association
9:00 – 10:15	**Session 1** Moderator: Samantha Horn-Olsen, Maine Department of Marine Resources *Industry Perspectives on Control and Management of ISA in New Brunswick* Mike Szemerda, Cooke Aquaculture, Inc. *Stock Mortality Insurers: Disease Coverage: How Can They Assist?* Ernest Marcoux, Marsh Canada, Limited *ISA Management Program Updates from Maine and New Brunswick* Michael Beattie, New Brunswick Department of Agriculture and Aquaculture Stephen Ellis, USDA APHIS Veterinary Services ISA Program
10:15 – 10:35	**Morning Break**
10:35 – 11:45	**Session 2** Moderator: Greg Lambert, Cooke Aquaculture, Inc. *Recent Trends in Vaccine Development for Aquaculture* Kim Thompson, Institute of Aquaculture, University of Stirling *From Carboy to Bioprocessor: 30 Years of Commercial Fish Vaccines* Hugh Mitchell, Novartis Animal Health *The Necessity of Vaccination Standards Throughout the Production Cycle* Randy Peach, Novartis Animal Health Canada



11:45 – 1:00 **Poster Session and Lunch**

1:00 – 2:20 **Session 3**

Moderator: Caroline Graham, New Brunswick Salmon Growers Association

Net Pen Rearing of Atlantic Cod in New Brunswick
Frank Powell, Cooke Aquaculture, Inc.

Shining the Light on Salmon and Cod Farming: Current Knowledge and New Development
Herve Migaud, Institute of Aquaculture, University of Stirling

Phytoplankton Blooms and Their Lethality to Atlantic Salmon in Southwest New Brunswick
Jennifer Martin, Les Burridge, Fisheries and Oceans Canada, St. Andrews Biological Station

2:20 – 2:40 **Afternoon Break**

2:40 – 4:05 **Session 4**

Moderator: Mike Pietrak, Maine Aquaculture Association

Biosecurity on the Farm: Practical Measures Towards Limiting Disease
Michele Walsh, Micro Technologies, Inc.

Depletion of Emamectin Benzoate (SLICE) from Skeletal Muscle of Atlantic Salmon (Salmo salar) being Maintained in Commercial Seawater Cages, Under Ambient Temperature Regimes (0.5°C – 14° C)
Michael Beattie, New Brunswick Department of Agriculture and Aquaculture

Slice™ – Maximising Efficacy
John McHenery, Schering-Plough Animal Health

4:05 **Adjourn**

Welcome

Sebastian Belle, Maine Aquaculture Association
Jamey Smith, New Brunswick Salmon Growers Association

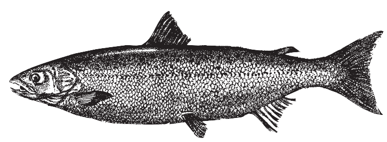
Sebastian Belle is the Executive Director of the Maine Aquaculture Association, a private trade association representing the Maine aquaculture industry. He began his career as a commercial fisherman working his way through the university as a mate on an offshore lobster boat. After taking degrees in fisheries biology and agricultural economics, he managed salmon farms in Norway, managed a commercial salmon farming facility in Eastport, managed a research and development project on the development of captive rearing techniques for bluefin tuna at the New England Aquarium, developed commercial tuna farms in Spain and Mexico, and served as a senior policy analyst to the Maine Department of Marine Resources.

Sebastian is an advocate for producer interests in a number of jurisdictions including state federal and international venues. He has developed producer codes of practice designed to establish minimum operational standards and address public concerns about producer operations. Sebastian has also developed cooperative bay management agreements designed to coordinate local producer activities and minimize risks of disease and environmental impacts. Sebastian also is the president of EconAqua, a consulting firm providing technical services to investors and nonprofit educational institutions. Since 1989, EconAqua has served 32 clients in 12 countries. Sample projects have included marine cage farms, freshwater and marine hatcheries, large scale recirculation and flow-through land-based production farms, broodstock facilities and programs, fish processing plants, live fish transport systems, and large pelagic fish exhibit facilities in public aquariums.

Dr. Jamey Smith presently serves as the Executive Director of the New Brunswick Salmon Growers Association. He assumed this role in September 2006 after working with the NBSGA for over 10 years in various capacities, including Research and Environmental Management Coordinator. His experience with the NBSGA includes establishment and implementation of the Offshore Project designed to support development of high energy marine sites for the NBSGA membership and the sector as a whole.

Jamey has over 20 years of experience with aquatic and coastal ecology, resource use, and planning. Environmental planning and impact assessment has been a major part of his career. He has worked on local, regional, and international projects including land-based and marine aquaculture, fishing activities, food processing, pulp mills, port operations, municipal activities, and nuclear power plants. Jamey has conducted projects for clients as diverse as small companies, international corporations, universities, municipal, provincial and federal governments, and international development agencies.

ABSTRACTS



Industry Perspectives on Control and Management of ISA in New Brunswick

Michael Szemerda, Director of Saltwater Operations, Cooke Aquaculture Inc.

This session presents one fish farmer's view on how ISA affects the New Brunswick salmon farming industry and what needs to happen to control and eliminate it.

For the last six years, **Michael Szemerda** has been the Director of Saltwater Operations for Cooke Aquaculture Inc. He is responsible for the raising of over 20 million salmon on 100 plus sites, including sites in New Brunswick, Nova Scotia, Maine, and Newfoundland.

Stock Mortality Insurers: Disease Coverage – How Can They Assist?

Ernest Marcoux, Vice President, Marsh Canada Ltd.

Ernest Marcoux will discuss the scope of the insurance market for aquaculture stock insurance and what diseases are covered under the usual insurance clause. He will then cover what insurers are looking for regarding disease when reviewing applications. He will also look at what insurers can offer besides claim remediation to assist industry with regards to disease.

Ernest (Ernie) Marcoux is the Vice President of Marsh Canada Ltd., which is parent company to Marsh McLennan, the world's largest insurance brokerage and risk management firm.

In 1979, after 12 years with the Royal Canadian Navy, Ernest Marcoux started his career in insurance when he joined the Department of Fisheries and Oceans Canada as loss adjuster with the Fishing Vessel Insurance Program. He held various positions with FVIP until becoming the manager of the program. At its peak, this program insured over 13,000 vessels throughout Canada. This program was wound down in 1995 when it became evident that private insurers could fill the gap.

In 1995, Ernest Marcoux joined Sedgwick Ltd. as Marine Manager for the Halifax Office. In this position, he developed marine related accounts and focused on expanding the aquaculture insurance section of the business. In 1992, Sedgwick was purchased by Marsh, where he continues to work as client executive specializing in marine and aquaculture accounts.

ISA Management Program Updates from Maine and New Brunswick

Michael Beattie, New Brunswick Dept. of Agriculture and Aquaculture
Stephen Ellis, USDA APHIS Veterinary Services ISA Program

Dr. Michael Beattie received a BSc. (hon.) and MSc. in marine biology from the University of New Brunswick, a DVM degree from the Atlantic Veterinary College, and a Marketing certification from the Norwegian School of Business. In 1997, he became a member of the Royal College of Veterinary Surgeons. Since 2003, he has served as the Chief Veterinarian for Aquaculture in the Dept. of Agriculture and Aquaculture, Province of New Brunswick.

Prior to joining the provincial government, Mike was the North American Product Manager for the world's largest integrated aquaculture company, Nutreco. He was involved in uncovering new research, carrying out field trials, and marketing new products.

Mike continues to work closely with the private sector, and is involved in numerous research and development projects. Areas of interest include bio-security initiatives, vaccine development, and pharmaceutical research.

Dr. Stephen Ellis is an assistant AVIC, New England Area, in charge of the Infectious Salmon Anemia Program with the USDA, APHIS, Veterinary Services (VS), in Eastport, Maine. He received his DVM from Cornell University in 1970. In his current position, Dr. Ellis serves as the program veterinarian for the ISA program, which he has done since the program's inception in Dec. 2001. He and his co-workers have published numerous papers and made frequent scientific presentations on advances in the epidemiology and management of ISA during the course of the program. Prior to this assignment, Dr. Ellis was a field VMO in Maine for 21 years, with special interests in FADD training, embryo transfer certification, and aquaculture.

Before joining the USDA, Dr.Ellis completed a two-year project with fish and vascular plants with the Research Foundation of the State University of New York. Prior to that, he worked in a predominately dairy veterinary practice and a mixed animal practice, both located in upstate New York. Dr. Ellis is a Maine native, and did his undergraduate work at the University of Maine in Orono.

Recent Trends in Vaccine Development for Aquaculture

Dr. Kim Thompson, Aquatic Vaccine Unit, Institute of Aquaculture, University of Stirling

Research and development of vaccines for aquaculture is increasing as the industry grows and new vaccine technologies become available. As a result, the list of commercial vaccines is steadily increasing and these are very successful in reducing mortalities and, in turn, the use of antibiotics used in aquaculture. Primary considerations in the development of vaccines for aquaculture include cost-effectiveness and safety. They must provide long-term protection in the intensive rearing systems of commercial fish farms. Consideration must also be given to the serotypic variants of the disease agent, the time/age when the animal is most susceptible to disease, the route of administration and the method of vaccine preparation. Most commercial vaccines are presently comprised of inactivated (killed) pathogens. However, when this approach has failed to produce an efficacious vaccine, live attenuated vaccines have been tried. There is always a concern with live vaccines, however, that the attenuated strain (usually as a result of gene deletion) may back mutate and revert to the virulent wild type. Thus, licensing these types of vaccines may prove difficult for aquaculture.

The development of fish vaccines has become much more sophisticated in recent years with a trend for the development of sub-unit recombinant vaccines, in preference to the original killed whole cell preparations. An alternative approach is to prepare sub-unit vaccines, where specific components of the disease-causing agent are isolated and then used in the vaccines. In order to increase the amount of available antigen, the recent trend has been to clone the genes encoding for specific antigens and then incorporate these into bacterial DNA where they are expressed, i.e. recombinant vaccines.

A recent major development in fish vaccinology is DNA vaccination. This technology, in conjunction with proteomics and epitope mapping has the potential to revolutionise fish vaccine development. Novel approaches in vaccine adjuvants and vaccine delivery systems are also being pursued, including the development of an antigen protection vehicle for oral vaccines.

The commercial availability of anti-fish IgM antibodies for emerging species for aquaculture will assist in the identification of potential protective antigens, efficacy testing and determining the rate and duration of the immune response which, without doubt, will assist in the development of vaccines to protect fish against significant and emerging diseases.

An update of vaccination strategies used for Atlantic salmon and their application for cod and halibut will be discussed.

Dr. Kim Thompson has been based in the Aquatic Vaccine Unit, Institute of Aquaculture, University of Stirling, for the past 15 years. Her main areas of interest include fish immunology and the development of fish vaccines, and she has considerable experience in identifying and characterising antigens from different fish pathogens, and preparation of monoclonal antibodies to fish pathogens and fish IgM, used for monitoring fish health. Dr. Thompson has also been involved in the organisation of several international workshops on vaccination and antibody based-rapid diagnostics and teaches immunology at the Institute of Aquaculture. She is the Technical Director for Aquatic Diagnostics Limited.

From Carboy to Bioprocessor: 30 Years of Commercial Fish Vaccines

Hugh Mitchell, DVM, Manager, Aqua Business, Novartis Animal Health (Washington)

In the 1970s, Wildlife Vaccines Inc. in Colorado licensed the first vaccine for fish: an immersible *Yersinia ruckeri* preparation against Enteric Remouth disease in trout. In the early eighties, an injectable "multivalent" product was licensed containing *Aeromonas salmonicida* and *Yersinia ruckeri* or *Vibrio* spp. Unfortunately, this did not turn out to be commercially acceptable. In the mid-1980s, the rapidly expanding salmon farming industries in Scotland and Norway provided a large potential market. This drove a number of European and North American companies to put substantial time and resources into fish vaccine development. After several iterations of various injectable, immersion, and oral formulations, the standard "oil-adjuvanted injectable" emerged to be the dominant type of vaccine, still used today in the salmon farming. Differences between products centered on differences in protection provided by the various components, and by differences in risk of side effects – an ever-increasing concern to salmon farmers.

Over the years, other types of vaccines were introduced, for example: adding killed whole cell bacterial or viral components, recombinant (*Piscirickettsiae* sp. in Chile), attenuated live (catfish), and various low-key oral derivatives of some basic immersion formulations. The most significant leap in technology has been a nucleic acid plasmid vaccine against IHN. Throughout this time, like the salmon farming industry, the fish vaccine industry went through several changes. Companies amalgamated or were purchased by mainstream pharmaceutical companies, were sold off, or restructured. Much of this was driven by the waxing and waning health of aquaculture. As it fundamentally influenced its genesis and growth, the future of fish vaccinology, including technological developments and products available, will largely be determined by the fish farming community itself. In order for farmers to help get access to the most effective formulations and technology available, the business model may have to change, especially in smaller markets like North America. What this might look like will be discussed.

Hugh Mitchell "worked" as a veterinarian in the Maine and New Brunswick industry in the late 1980s and early 1990s, learning most everything he knows from Chris Bartlett, the real brains behind his fish lab. When Chris took off to Alaska, Hugh realized that he had better bolt out of the area, before he was discovered. He got a job in the Seattle area as Clinical Trial Manager for Biomed, one of the original fish vaccine companies. Through a convoluted path of amalgamations, closures, layoffs and purchases, familiar to the salmon farming industry, he somehow wound up as a Professional Services Veterinarian with Novartis Animal Health's newly formed Aqua Business. Currently, he is in charge of the Novartis' Aqua Business for North America. In his spare time, he likes to write letters/ articles and give lectures around the country, harassing the aquaculture antagonists, and explaining why salmon farming rocks.

The Necessity of Vaccination Standards throughout the Production Cycle

Randy Peach, Novartis Animal Health Canada

We often assume that vaccines will perform the same under a variety of conditions, using a variety of methods, equipment, and methods of administration. Sometimes we take liberties with label instructions, assuming that minor violations will not have serious consequences. After several years and billions of vaccinated salmon around the world, we are learning that to insure the benefits of maximum protection with minimal risk of side effects, the quality of application, pre-check and follow-up can be almost as important as the vaccine itself. Although we understand a great deal more about some of the risk factors involved in affecting vaccine performance, we are a long way from recognizing and quantifying all of the risk factors involved in the vaccination process. This information is critical so that farmers can make the best decisions in maximizing the benefits of vaccines for their businesses. With this in mind, Novartis developed their SECURE program in order to monitor vaccine use under a variety of conditions around the world, and set a baseline of standards for the vaccination process. The intent is to: 1) adopt a universal set of recommended standards for vaccine application and monitoring; 2) build a comprehensive database of vaccine use under a wide variety of conditions around the world; 3) continually analyze this data and report back to farmers on the best and most effective method of use for their operation.

Randy Peach first started in aquaculture in 1997, working part time on a rainbow trout farm, while completing a BSc. in agriculture at the Nova Scotia Agricultural College. He spent some time working with alternate marine fish species at Shur Gain Feeds and Scotian Halibut Ltd., while completing his MS in aquaculture nutrition at Dalhousie University in Halifax, Nova Scotia. Randy is now the Customer Support Manager for Novartis Animal Health Canada Aqua Health Business Unit.

Net Pen Rearing of Atlantic Cod in New Brunswick

Frank Powell, Cooke Aquaculture Inc.

This presentation is a summary of the various aspects of Cooke Aquaculture Inc.'s Cod Program including: current sites and scale of operation, grow-out strategy, husbandry issues, maturation issues, fish health aspects, broodstock development, and potential marketing plans.

During 1996, Frank Powell began work with Maritime Mariculture Inc. on transfer of halibut aquaculture technology from Norway. He continued work from 1996-2003 on halibut hatchery production and cage grow-out techniques. In 2004, he joined Cooke Aquaculture Inc. as alternate species manager, involved mostly with Atlantic cod and more recently Integrated Multitrophic Aquaculture (IMTA) (mussels and kelp).

Shining the Light on Salmon and Cod Farming: Current Knowledge and New Development

Herve Migaud (Davie, A.), Institute of Aquaculture,
University of Stirling

It is commonly accepted that photoperiod manipulation, especially in salmon farming, is an indispensable tool in modern farm practice. Through the application of adjusted photoperiods it is now possible to reproducibly control spawning times ensuring year round supply of eggs; to produce out-of-season-smolts; to suppress maturation during on-growing; or to enhance growth, thus providing a product of uniform size and quality all-year round (Fig 1). This has been a vital step in removing the seasonality from the salmon production cycle and hence leading to the industries rapid expansion in the last 10 years. Such manipulation of physiology is only possible due to an internal "clock" mechanism which is synchronised by external environmental cues of which light is thought to act as the principle *zeitgeber* (*zeit=time, geber=giver*). Through this mechanism the application of artificial light is perceived as the advancement or delay of the controlling season, which in turn entrains the physiological processes.

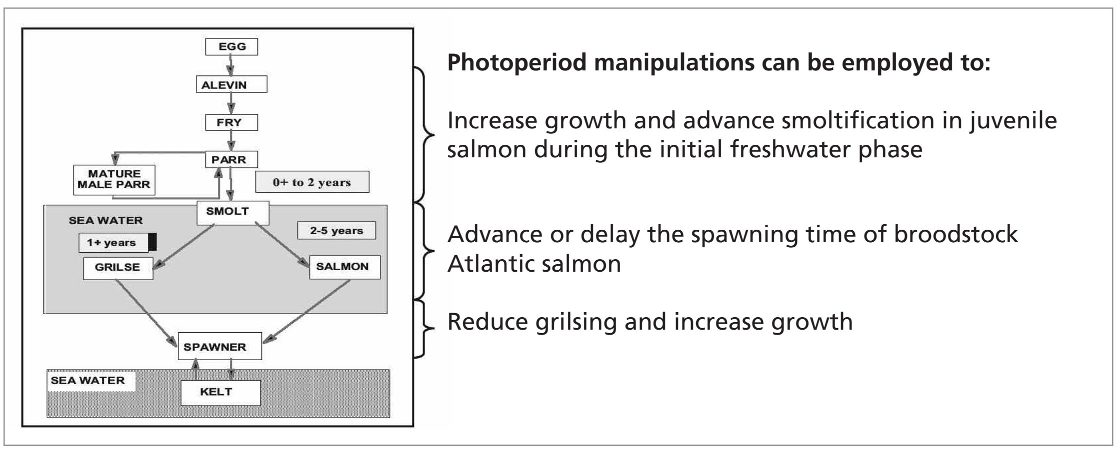


Fig. 1: Summary of the use of photoperiod during the salmon production cycle.

In Atlantic salmon (*Salmo salar*) a simple model for both maturation and smoltification explains the stimulatory effects of the natural photoperiod cycles (Fig. 2A). Smoltification is initiated during the decreasing phase of the natural photoperiod, with its completion occurring during the increasing phase, whereas the initiation of maturation occurs on the increasing photoperiod, with final gonadal recrudescence completed on the decreasing phase. For the aquaculture industry this means that such natural processes can be recreated using simple transitions between constant long and short daylength photoperiod regimes ensuring a more accurately timed production of smolts for example (Fig. 2B) or suppression of early maturation during the on-growing .

In the brief time that artificial photoperiod manipulations have been applied in commercial aquaculture, production systems have rapidly developed and radically expanded. However, little concurrent development in the lighting systems has been forthcoming. In today's financial climate the lighting system efficiency and efficacy are both of paramount importance in the aquaculture industry which is why it is now time to optimise and standardise these lighting systems based on the identified specificities of the species to be farmed, the stage of development, the system used and local environmental conditions. This is now a focus for much concerted research due to various recent technological and academic innovations.

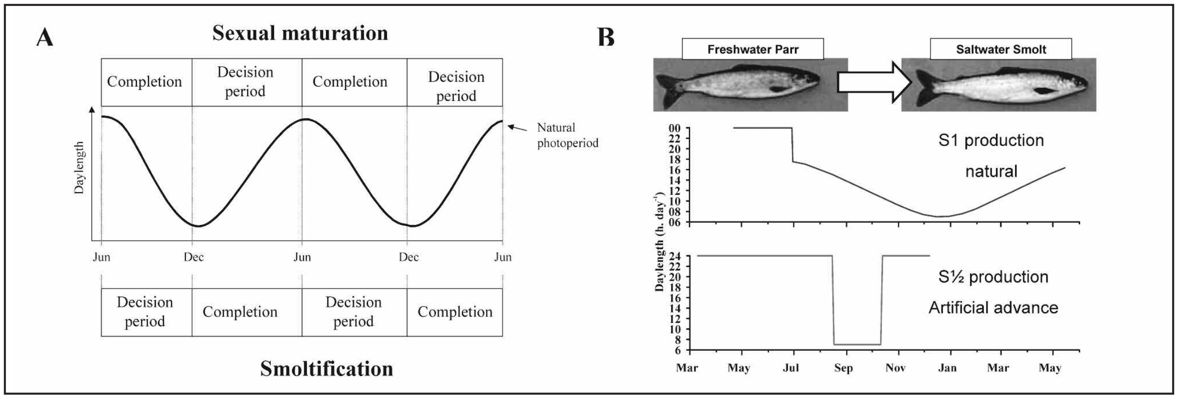


Fig. 2: *A.* Developmental model detailing the proposed stimulatory effects of photoperiod on maturation and smoltification (Duston and Saunders 1992) and **B.** photoperiodic regimes routinely used within the salmon farming industry (Provided by Dr. Iain Berrill).

With the emergence of new aquaculture species such as Atlantic cod (Gadus morhua) it has become apparent that radical remodelling of both the techniques used and the technology deployed, are required. This is being achieved through a better understanding of light perception and seasonal regulation in the species, in conjunction with considerable technological innovations. Common to all gadoids, a major bottleneck in the commercial culture is that of maturation prior to the attainment of the preferred harvest weight (cod ≥ 3kg; haddock ≥ 2kg). This "early" maturation, similar to "grilsing" problems in Atlantic salmon culture leads to reduced growth potential, changes in flesh quality and an extended culture cycle. Photoperiod regimes have been shown to successfully regulate maturation in a number of tank-based studies in Atlantic cod and haddock in which a complete cessation of maturation and upto a subsequent 60% improvement in growth has been observed. It has now been demonstrated that it is in fact the reduction in daylength from summer to winter which initiates reproduction in Atlantic cod (Fig. 3), the opposite of the signal which recruits salmon. As such, the application of continuous artificial light from the summer solstice prior to maturation masks the naturally reducing daylength which ensures all assimilated energy is directed towards somatic (muscular) growth.

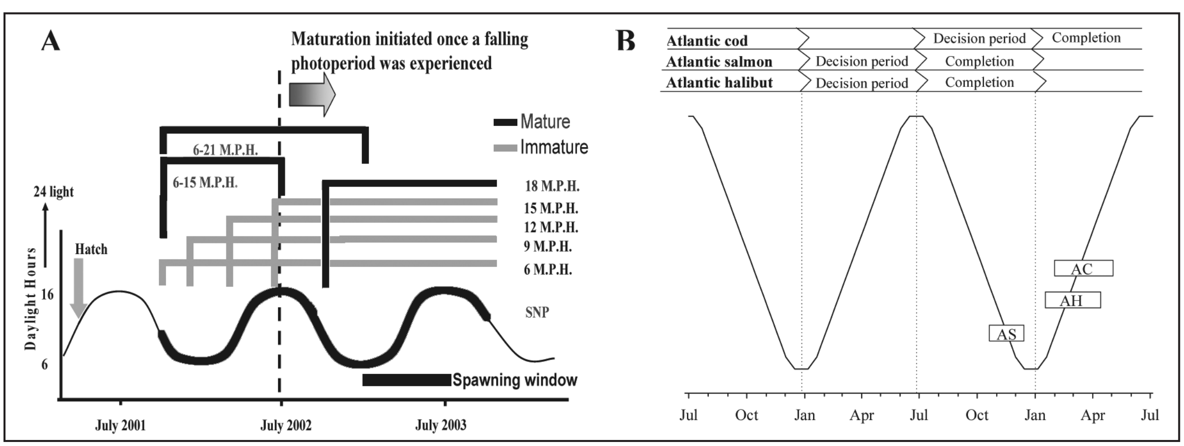


Fig 3: Photoperiod regulation of maturation in Atlantic cod, **A.** photoperiod treatments tested in cod and effects on sexual recruitment (black : maturing groups, grey : immature groups) and **B.** a model of the proposed role of seasonally changing daylength in recruiting individuals into sexual maturation (decision period) and subsequently regulating the final stages of the process (completion) in relation to natural spawning seasons (open boxes) in Atlantic cod (AC), Atlantic salmon (AS) and Atlantic halibut (AH). Figures from Davie et al., 2007a, b.

Unfortunately, when such test photoperiods are applied at a commercial scale in open cage systems during on-growing, ambient light can still provide an entraining signal if the lighting is inappropriate and as such the results reported have not been consistently reproducible. Therefore, it is necessary to radically redesign the lighting systems and their method of application to ensure continued profitable development of the industry.

A cornerstone to the development of effective photoperiod management in salmon and cod is a clear understanding of how light is perceived by these target species. In order for photoperiod to entrain reproduction and growth, fish must be able to perceive the seasonally altering change in daylength or more fundamentally the transition from light to dark. In fish, it is currently believed that the retina of the lateral eyes and the pineal gland, a photoreceptive organ located on the dorsal surface of the brain are the principal organs which perceive and integrate the photoperiodic information into hormonal and neural signals that synchronise rhythmic functions, behaviours and physiological events to daily and annual cycles. *In vitro* studies of the pineal gland, have established light intensity threshold in a number of species including salmon, sea bass and cod (i.e. the difference between day and night perception). Taken together, these data suggest that salmon can detect levels as low as 0.02 Watts/m^2 which is interpreted as a continuation of ambient daylight with cod being the most sensitive fish species studied so far (Fig. 4).

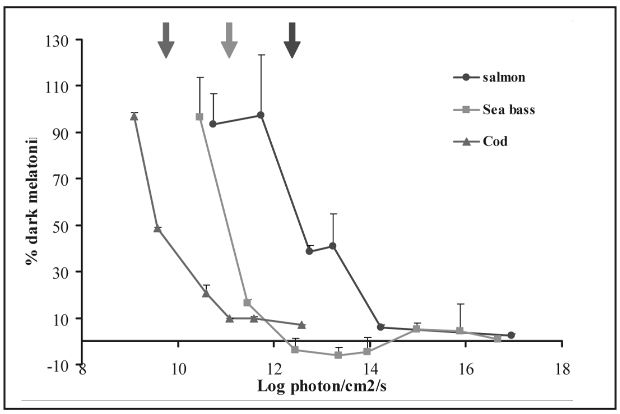


Fig 4: Light intensity thresholds in salmon, sea bass and cod (unpublished, Migaud and Davie). Arrows indicate theoretical *ex-vivo* thresholds for pineal glands light intensity. Data are expressed as the percentage of melatonin produced by the pineal glands in comparison to dark levels.

Consequently, it is currently believed that lighting unit intensity *per se* would not be the main key issue but rather the generation of an even, diffuse lighting field throughout the cage allowing the fish to perceive the artificial light independently of their position as cod behaviour appears to be very different in the cage environment than salmon which display a strong attraction to light. At present, there is a tendency towards the use of more numerous and greater powered underwater lighting units as cage systems increase in size. However, most current aquaculture lighting systems are high intensity point sources which make such light management awkward and with resulting energy consumption, expensive and hence not an acceptable solution for the profitable farming of the species. Therefore, lighting systems to be applied to cod farming as for other species require remodelling in a species-specific manner with the biological sensitivities of the species being the focal point for system design.

The present communication will therefore aim to present a review on the current knowledge regarding the control of physiology (mainly reproduction, smoltification and growth) in two of the most commercially important fish species and bring new concepts that have been investigated and developed by the Reproduction Group at the Institute of Aquaculture (UK).

Acknowledgements

The authors would like to thank the Reproduction Group and IoA staff. This work has been funded by a variety of funding bodies including the British Marine Finfish Association (BMFA), Natural Environment Research Council (NERC), EU (PUBERTIMING, Q5RS-2002-01801), Norwegian Research Council and numerous commercial partners.

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Phytoplankton Blooms and their Lethality to Atlantic Salmon in Southwest New Brunswick

Jennifer Martin and Les Burridge, Fisheries and Oceans Canada, St. Andrews Biological Station

Within the past decade, harmful algal blooms (HABs) have compromised the health of fish at a number of salmon farms in southwest New Brunswick. A project was undertaken to investigate the usefulness of several potential early warning approaches for predicting HABs at salmon farms in the region. The components of the project included: training of farm personnel on the sampling, identification, and counting of harmful phytoplankton species; implementation of daily phytoplankton monitoring by workers at selected salmon farms; retrospective analyses of existing phytoplankton monitoring data; laboratory experiments to determine threshold concentrations of selected harmful phytoplankton species which can cause problems for farmed salmon; use of a tidal circulation model to predict movements of phytoplankton blooms in the vicinity of salmon farms; evaluation of the effectiveness of a light sensor array for bloom detection; and evaluation of the usefulness of satellite imagery for bloom detection.

In 2003 and 2004, a number of salmon farms were affected when *Alexandrium fundyense*, the organism responsible for producing paralytic shellfish poisoning (PSP) toxins, bloomed at densities exceeding 3 million cells•L^{-1}. Through participation in the project the industry was able to analyse additional samples providing an opportunity to mitigate some of the bloom effects and reduce the number of mortalities.

To establish whether elevated concentrations of algae can cause mortality, monocultures of microalgae, *Alexandrium fundyense*, *Ditylum brightwellii* and *Chaetoceros socialis* were grown in large quantities. Atlantic salmon smolts were exposed to a range of concentrations of these cultures for 24 hours and an LC50 was determined according to the concentration of cells present (cells•L^{-1}). Cultures of *Ditylum brightwellii* at concentrations as high as 10^6 cells•L^{-1} had no deleterious effect on the salmon. This concentration is well above the concentration zobserved in the field. While behavioural responses were noted in salmon exposed to 4 x 10^6 chains•L^{-1} of *Chaetoceros socialis*, only one fish died during the experiments. Some concentrations of *A. fundyense* were lethal to salmon. The LC50 was estimated to be 614,000 cells•L^{-1}, a concentration that has been observed in the field. Samples of the cultures used in our exposures were analysed by HPLC. These data, together with information on the size of fish used in the experiments, were used to calculate an LD50 for A. fundyense and salmon of 1.8 mg (PSP equivalents)•Kg^{-1} (fish).

Jennifer Martin has worked for DFO for 30 years in the field of phytoplankton, with particular emphasis on harmful algal blooms (HABs). She was involved with the research on the herring kills in the Bay of Fundy in the late 1970s, domoic acid in the 1980s, and in the past 15 years with problems associated with the salmon industry.

Les Burridge is a reseach scientist with DFO working in the field of ecotoxicology. He has a PhD in fish physiology from UNB. He has been with DFO for 29 years and has worked on aquaculture-related issues for approximately 15 years mainly in the area of potential hazards of anti-louse compounds on nontarget organisms. His recent work has focused on the lethality of individual algae on Atlantic salmon.

Biosecurity on the Farm: Practical Measures Towards Limiting Disease

Michele Walsh, Micro Technologies, Inc.

In an era of myriad advances in aquaculture production and aquatic health diagnostics, practical preventative measures to protect fish health are often undervalued. This talk is intended to serve as an introduction to, or refresher for, biosecurity basics, with an emphasis on cost-effective ways to minimize pathogen introduction and minimize disease transmission at the individual farm level.

Michele Walsh is the staff veterinarian for Micro Technologies, Inc., an aquatic animal health laboratory in Richmond, ME. A New England native, she spent formative post-college years coast-hopping and cultivating her interests in animal health and disease ecology. The road to aquatic animal veterinarian has included stints as wildlife disease surveillance co-coordinator at Banff National Park, research coordinator at a lobster research nonprofit in Maine, and marine programs director for an NGO based in Montreal, QC, CAN and Ipswich, MA.

Depletion of Emamectin Benzoate (SLICE) from Skeletal Muscle of Atlantic Salmon (Salmo salar) being Maintained in Commercial Seawater Cages, Under Ambient Temperature Regimes (0.5° C – 14° C)

NBDAA, NBSGA, & DFO (ACRDP Grant)
Michael Beattie, New Brunswick Dept. of Agriculture and Aquaculture

To assist industry with monitoring the depuration of emamectin benzoate in treated salmon, under natural conditions, a pre-arranged sampling regimen was conducted at selected seawater cage sites (differing yr. classes and size of fish). Samples were collected in a prescribed protocol given to NBDAA from Health Canada (VDD) and CFIA. Sample sizes will alternate between 5 and 25 fish collected at specific time intervals (as close to day 1,3,7,11,15, 21 days following the last day of treatment and or until a level of 2 ppb is reached). Samples were collected throughout the year from 8-10 commercial sites (one cage per site). Analysis of the samples and medicated feed fed the cages were carried out utilizing HPLC methodology.

The object of the study is to provide additional evidence to Health Canada (VDD) in support of creating a withdrawl time directly linked to a degree-day elimination curve. A graduate student at AVC is analyzing the preliminary database in order to generate a degree-day elimination curve based on commonly used and recognized pharmaceutical statistical packages.

The duration of the project has been extended until August 31, 2007, and only half of the farms have been sampled. Therefore, any data presented at this time will be both inconclusive in nature and furthermore, must be verified at the end of the study.

Dr. Michael Beattie received a BSc. (hon.) and MSc. in marine biology from the University of New Brunswick, a DVM degree from the Atlantic Veterinary College, and a Marketing certification from the Norwegian School of Business. In 1997, he became a member of the Royal College of Veterinary Surgeons. Since 2003, he has served as the Chief Veterinarian for Aquaculture in the Dept. of Agriculture and Aquaculture, Province of New Brunswick.

Prior to joining the provincial government, Mike was the North American Product Manager for the world's largest integrated aquaculture company, Nutreco. He was involved in uncovering new research, carrying out field trials, and marketing new products.

Mike continues to work closely with the private sector, and is involved in numerous research and development projects. Areas of interest include bio-security initiatives, vaccine development, and pharmaceutical research.

Slice™ – Maximising Efficacy

John G McHenery, Schering-Plough Animal Health

The control of sea lice, *Lepeophtheirus salmonis* and *Caligus spp.*, on farmed Atlantic salmon was traditionally reliant on the use of immersion baths. More recently, in-feed medicines have been authorized and are used worldwide, enabling aquaculture industry health professionals, and production managers, to achieve degrees of control which have enabled the farmed and wild-fish interests to resolve a number of their differences and work more closely.

The efficacy of any medicine is dependent on the uptake and distribution of the active ingredient in the patient and the parasite. In-feed delivery of medicines enables the active ingredients, emamectin benzoate in the case of SLICE®, to be targeted reducing inputs into the environment. However, this also creates a potential difficulty in ensuring that the correct dose is delivered throughout the population being treated. This also highlights the difficulties which can be encountered where fish are exhibiting inappetence due to intercurrent disease or environmental factors.

Investigations have been undertaken on farms under commercial use conditions to investigate the impact of husbandry procedures on achieving the correct dose and these will be presented together with consideration of the potential impacts of failure to achieve the correct dose.

John McHenery obtained his Degree and Doctorate from the University of Glasgow and has been involved in the assessment of sea lice medicines for over 25 years, working as an environmental consultant to a number of companies in human and veterinary medicines. He joined Schering-Plough Animal Health in 2000, having previously been part of the Slice development team for 5 years. John is currently Aquaculture Business Manager in the UK and provides technical support to other territories.

POSTER SESSION

Poster Session

Bacterial Profiling Leads to the Development of a Treatment for Improving Haddock Larval Survival

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Fabrice Pernet, Coastal Zone Research Institute Inc.

Rachael Ritchie, The New Brunswick Research & Productivity Council (RPC),

Abstract

Analysis of the bacterial microflora associated with aquaculture rearing systems can yield important information about the health of the particular species being cultivated and the suitability of the existing culture conditions to maintaining good health. Bacterial profiling of haddock larval (*Melanogrammus aeglefinus*) rearing systems has lead to the discovery of important information about the succession of bacterial species associated with healthy developing larvae and permitted the isolation of several species of bacteria with properties that suggest they may be useful when applied as a probiotic treatment to culture systems. Haddock larvae treated during the early stages of development with one of these isolates, L68, has shown a 76% and 139% increase in survival over controls in duplicate trials. Interestingly, larvae treated with L68 also showed an altered microbial succession profile compared to controls, such that species associated with healthy larvae appeared earlier in development. Together, these results suggest that L68 is capable of increasing larval survival by influencing the natural succession and development of bacterial microflora in haddock larvae.

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Poster Session

The Histopathological Effects of Low Make-up Water Exchange Rate on Rainbow Trout (*Oncorhynchus mykiss*) in Recirculating Aquaculture Systems

Christopher M. Good*, John W. Davidson, Carla Welsh, and Steven T. Summerfelt

The Conservation Fund's Freshwater Institute

Abstract

Unpublished research at The Conservation Fund's Freshwater Institute (TCFFI) has suggested that as make-up water exchange rate drops below a feed loading of 1.3-2.0 kg/d per m^3/d of make-up water flow (i.e. 1-2% make-up water exchange rate), salmonid mortality increases and overall fish health decreases within recirculating aquaculture systems (RAS). When this decline in fish health occurs, however, all typical water quality parameters are within safe limits, and no infectious diseases or opportunistic infections are suspected. Because this decline represents an important barrier to operating RAS with high feeding rates, a better understanding of the reasons for the observed fish health changes would be very beneficial.

Direct acute or chronic effects of low water make-up exchange rates at the cellular level could result in impaired organ function, and histopathological examination of specific tissues is a useful tool to qualify and quantify this tissue damage. This presentation describes an investigation currently being conducted at TCFFI to identify specific histopathological lesions associated with low make-up water exchange. A total of 6300 rainbow trout (*Oncorhynchus mykiss*) are presently divided among six RAS and three small flow-through tanks, and are being reared to a maximum density of 80 kg/m^3 (i.e. as fish grow over time, tanks are periodically thinned to achieve comparable densities). Three RAS tanks are receiving a normal make-up water exchange rate (approximately 2.6%), while three systems are receiving only a 0.26% exchange rate. Within 24 hours of initial stocking, five fish per tank were euthanized, and portions of skin, skeletal muscle, gill, heart, liver, spleen, pyloric ceca-pancreas, swim bladder, and anterior and posterior kidney were sampled and processed for baseline histological examination. At the two-month point, and at the termination of the study (approximately four-to-six months from initiation), the above sampling will be repeated. Histopathological lesions observed from each sampling will be summarized descriptively, and will be quantified for statistical association with make-up water exchange rates.

We anticipate that specific histopathological lesions will be associated with the low make-up water exchange rate, and will increase in number and severity over time relative to fish exposed to the normal make-up exchange rate. Results of a pilot study conducted at TCFFI prior to the above investigation indicated that low make-up water exchange rates were associated with multiple organs (and in particular, the swim bladder) demonstrating histopathological lesions. The results of the present study will be summarized and published later this year.

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A Prospective Case-Control Study of Bacterial Gill Disease Outbreaks in Ontario, Canada Government Salmonid Hatcheries

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Abstract

Bacterial gill disease (BGD) is an important concern in freshwater aquaculture, and affects many species of farmed fish worldwide. This disease has been a persistent problem at Ontario Ministry of Natural Resources (OMNR) salmonid hatcheries and the Alma Aquaculture Research Station (AARS); BGD outbreaks at these locations have, on occasion, been associated with rapid and very high morbidity and mortality levels. The causative agent of BGD, Flavobacterium branchiophilum, is considered ubiquitous in fresh water, and therefore outbreaks of BGD are thought to be precipitated by environmental conditions and host factors favoring opportunistic infections. Despite the importance of BGD, very little epidemiological research has been conducted to examine factors associated with episodes of this disease.

This presentation summarizes a 14-month (July, 2002 – September, 2003) rearing unit-level prospective nested matched case-control investigation at five OMNR hatcheries and the AARS, with the objective of identifying, and quantifying the effects of, important risk factors for BGD outbreaks. Daily data were collected on putative BGD risk factors for all early-rearing (<9 months of age) fish tanks at participating hatcheries, and all outbreaks of BGD were confirmed by light microscopy at the Fish Health Laboratory (University of Guelph) during the study period. Control tanks were selected at the end of the study and matched to individual case tanks based on time, hatchery, and species. The case-control data were then analyzed using multivariable logistic regression modeling, controlling for fish age. The results of the final model indicated that tanks with confirmed BGD outbreaks were significantly more likely to have lower fish numbers, lower individual fish weights, higher mortality levels, and higher feeding rates during the week preceding observed BGD outbreaks than were asymptomatic control tanks. Refinements in the observation and manipulation of these factors will therefore aid in the prevention of fish losses associated with BGD outbreak mortality spikes. The predictive (as opposed to causal) nature of the identified risk factors indicates the need for further research to understand the relationships between these factors and BGD.

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Remotely Operated Vehicle Use in Environmental Monitoring of Aquaculture

Rebecca Milne, Huntsman Marine Science Centre, St Andrews, NB

Gerhard Pohle, Huntsman Marine Science Centre, St Andrews, NB

Abstract

Environmental monitoring is an important tool in allowing aquaculture to be a sustainable industry. This service is traditionally provided by divers. However, it has become more difficult as aquaculture sites are moving offshore to deeper waters due to site limitation in the inshore areas. The Huntsman Marine Science Centre is currently researching the potential of a remotely operated vehicle (ROV) in environmental monitoring of deep- water aquaculture sites. As divers are limited by depth, the ROV should prove safer and more efficient at deeper sites. Acquired with the help of the Environmental Trust Fund, the Gulf of Maine Council on the Marine Environment, the Industrial Research Assistance Program of the National research Council, Business New Brunswick, and Ocean Horizons Ltd., the Huntsman ROV is equipped to operate at depths of up to 1000 feet. Colour and low light, black and white cameras are used for the capture of high resolution video feed and still images, as well as for navigation. Scanning sonar and a tracking/positioning system also aid in piloting the ROV. In association with Shark Marine Technologies Inc., a one-of-a-kind pneumatic sampler has been developed specifically for the collection of sediment cores. These are used for geochemical or biological analysis of the substrate to help detect possible environmental impacts. The ROV is also equipped with a manipulator arm and clamshell device for other modes of sample collection. In addition to being used in environmental monitoring, the ROV has the capacity to expand into other areas of marine research, including aquaculture.

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Poster Session

Composting Fish Wastes from Fish Hatcheries

Mike Pietrak*, Maine Aquaculture Association

Will Brinton, Woods End Research Laboratories

Abstract

Disposal of fish wastes from hatcheries is becoming more and more of an expense and issue for freshwater hatcheries. In Maine, the allowable discharge limits on pollutants such as phosphorous have recently been in all hatchery permits. This has forced state and federal hatcheries to construct new effluent treatment systems, while industry hatcheries have to modify some existing treatment systems. Overall, more solids are being separated and removed from discharge streams sooner, in an effort to reduce the level of nutrients discharged. In addition to now dealing with the added expense of new treatment systems, hatcheries must also safely dispose of large amounts of fish wastes, which also add further expense to the operation of any hatchery. This project was undertaken to develop new economical methods for disposing of fish wastes by employing a commercial small-scale in-vessel compost reactor.

Based on past experience with fish waste, Woods End developed four different compost recipes that used various amounts of fish sludge, peat, and sawdust. The goal was to start composting at approximately a 30/40: 1 C:N (carbon: nitrogen) ratio, based on elemental analysis, using two different carbon sources (wood, peat) expected to have differing behavioral traits during composting. The best-performing recipe in terms of heat, ammonia capture, and stabilization was selected for trial in a demonstration scale compost vessel.

Two demonstration trials were conducted. The first was performed at Woods Ends Laboratory in order to monitor the in-vessel unit for key composting parameters, such as temperature and oxygen levels. In addition, protocols for monitoring and completing the process were developed. This first demonstration run yielded a final compost product with a total nitrogen level of 3.31% after active composting for 35 days and curing for 120 days. The staff at the Bingham Hatchery conducted the second demonstration project. Results similar to those of the first demonstration trial were seen in this second run, indicating that an end-product rich in stable nitrogen could be produced.

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<u>*POSTER SESSION*</u>

Ozonation and Ultraviolet Irradiation Provide Synergy for Inactivating Bacteria in a Recirculating System

Mark J. Sharrer and **Steven T. Summerfelt**, The Conservation Fund's Freshwater Institute

Abstract

Recirculating aquaculture systems may require an internal disinfection process to control population growth of pathogens and heterotrophic bacteria. Ozonation and ultraviolet (UV) irradiation are two technologies that have been used to treat relatively large aquaculture flows, including flows within systems that recirculate water. Previous research has shown that adding low levels of ozone to a water recirculating system will improve the quality of water in the system, as the dissolved ozone oxidizes dissolved organic matter and nitrite and improves microscreen filtration of particulate matter, as well as aiding settling, and foam fractionation. UV irradiation has also been shown to achieve both dissolved ozone destruction and bacterial inactivation in water recirculating systems.

The objective of the present study was to evaluate the effectiveness of ozone application alone or ozone application followed by UV irradiation to reduce abundance of heterotrophic and total coliform bacteria in a water reuse system. Results indicate that when only ozone was applied at dosages – defined by the product of the ozone concentration times the mean hydraulic residence time (C*t) – that ranged from 0.10 to 3.65 min*mg/L, the total heterotrophic bacteria counts and total coliform bacteria counts in the water exiting the contact basin were reduced to, respectively, 3-12 cfu/ml (1.1-1.6 LOG_{10} reduction) and 2-18 cfu/100 ml (1.9-3.1 LOG_{10} reduction). Bacteria inactivation appeared to be just as effective at the lowest ozone c*t dosage (i.e., 0.1 mg/L ozone after a 1 min contact time) as at the highest ozone c*t dosage (i.e., 0.2 mg/L ozone after a 16.6 min contact time).

As with our previous research on UV inactivation of bacteria, we hypothesize that the recirculating system provided a selection process that favors bacteria that embed within particulate matter or that form bacterial aggregates that provides shielding from oxidation. However, when ozonation was followed by UV irradiation, the total heterotrophic bacteria counts and total coliform bacteria counts in the water exiting the UV irradiation unit were reduced to, respectively, 0-4 cfu/ml (1.6-2.7 LOG_{10} reduction) and 0-3 cfu/100 ml (2.5-4.3 LOG_{10} reduction). Thus, combining ozone dosages of only 0.1-0.2 min-mg/L with a UV irradiation dosage of approximately 50 mJ/cm2 would consistently reduce bacteria counts to near zero. These findings were orders of magnitude lower than the bacteria counts measured in the system when it was operated without disinfection or with UV irradiation alone. These findings indicate that by combining ozonation and UV irradiation, it may be possible to effectively disinfect recirculating water before it returns to the fish culture tank(s).

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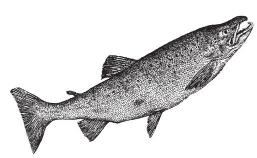

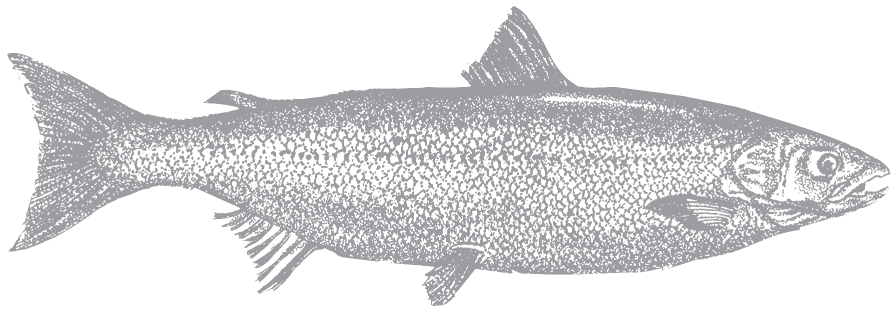

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