Aquacultural Engineering Society News

AES News, Summer 2001, Vol. 4, No. 3

Letter From Your President

Dear AES Members,

As we enter the last quarter of the year 2001, member activities within AES are accelerating. Committee chairs are working hard to achieve objectives established during our annual meeting in Orlando. This includes preparing for the *2001 AES Issues Forum* scheduled for the period November 11-14 in Shepherdstown, West Virginia. This event, held every two years, is designed as an outlet for engineering research conducted by our members in support of the aquaculture industry. Here researchers representing many countries of the world will be presenting findings in six important topic areas. Shulin Chin, for example, is chairing a timely session that addresses management of production system effluents. This session includes a presentation by the US EPA on "National Aquaculture Effluent Guidelines" and will, no doubt, stimulate a needed debate on this issue. Additional session topics include pond production methods (Chair, David Brune), net pen systems (Chair, John Riley), ozone and UV light treatment (Chair, Steven Summerfelt), aquaculture engineering research needs (Chair, Joseph Hankins), and finally bacterial systems for aquaculture (Chair, Sean Wilton). A complete description of the *AES Issues Forum* Program is included in this newsletter along with instructions for registration. Please plan now to participate in the program and help make this "the" aquacultural engineering meeting to attend in the future.

Best Regards,

Barnaby

Barnaby Watten, President
Aquacultural Engineering Society

Inside:

Developing Vision-Based Systems For Aquaculture

By Dr. Royann J. Petrell, Associate Professor, Chemical and Biological Engineering, University of British Columbia, 2357 Main Mall, Vancouver, B.C. V6T 1Z4, Canada

For many years aquaculture was like a black box. Organisms were placed into a tank, net or open sea (if ranched), and over time they were harvested. What the organisms did throughout the period was of little concern for the grower unless the fish did not eat or grow. The black box approach started to disappear when video surveillance cameras became widely available and economical in the early 1990's, and since then, the knowledge obtained by the use of the cameras within an enclosure of fish has increased fish growth, set the way for the development of better management tools and decreased costs. In this article, the uses of underwater video cameras in aquaculture for fish sizing, fish counting and feed control will be described. The focus of this article will be on caged salmonids. Cameras may, however, be used in tanks and to monitor other types of fishes.

I started to use cameras for studying fish feeding activities after my arrival at the University of British Columbia from the University of Florida in 1990. As any engineer I was keen to conduct research on relevant problems so there, for the first while, I resolved to identify engineering-

type problems by speaking with Industry, Government, and researchers in other fields in aquaculture in B.C. Salmon farming was the largest aquacultural industry. Dr. B. March, a senior scientist in nutrition, spoke of the importance of quantifying food wastage or the amount of food offered but not consumed by fish, while the industry needed a way to count and size fish underwater (so as not to stress them by lifting them out of the water). These were not trivial problems. Salmon are usually grown in the ocean in net cages that can measure over 1000 square m's by 30 m deep. Cage populations extend to over 30,000 fish. A waste-food detection device would have to be placed below the feeding fish or near the cage bottom. As well, effects on its functionality due to current, net movement and other types of debris had to be taken into consideration. A fish counting and sizing system had to be able to function for all species of farmed salmonid (trout, Atlantic salmon, Coho salmon and Chinook salmon) and under different environmental and fish stocking conditions. The fish farming industry required strong evidence that such devices could be both economically and technically feasible, and they were actually needed before they would purchase one.

In my first research project on food-waste detection, I examined the potential of using underwater cameras. Cameras were chosen as the sensors, because (1) There would be direct evidence of workability, (2) Low-light surveillance cameras were economical and readily available, and (3) Images could be directly sent to a computer for analysis, and possible automatic detection and control of fish feeding. In 1993, Mike Foster, as a graduate student, presented the first software program for automatic detection of uneaten pellets at an aquacultural engineering conference. For this application the lens of the camera faced downward in the water, because in this configuration, the pellets were quite easy to detect (they appeared to be white against a dark background). The detection algorithm was, however, slow (partly due to the speed of the personal computer available at that time), and other objects such as parts of fish were occasionally mistaken as pellets.

Industry (four salmon farming companies and an equipment manufacturer) responded to the pellet detection invention by funding another project in 1993. The aim of the project was to examine the effectiveness of cameras for manually detecting food wastage and controlling feed dispensation rate. Industry Science and Technology Canada and the National Research Council (IRAP program) provided matching funds. At that time, most salmon farming companies in North American and abroad fed fish by hand and used the level of surface feeding activity as a way to set feed dispensation rate. Keng Pee Ang worked on the project as part of his Ph.D. research. Experiments repeated on three salmon farming sites indicated that growth and feed conversion of camera monitored fish were superior to the growth and feed conversion of fish that had been conventionally fed). Unlike Foster's earlier work, cameras in this experiment were positioned facing upward near the bottom of cages. This positioning permitted observations of both fish behaviour and pellet loss while feeding fish.

The use of several key observations permitted a more efficient control of feed dispensation rate during the course of the study. For instance, we observed that when the feed discharge rate was higher than the consumption rate, fish tended to follow pellets downward into the water column instead of remaining on the surface to consume the pellets as they entered the water. This downward movement of the fish was easy to detect at long range due to the size and number of the fish. We learned to use that downward movement to control the discharge rate and anticipate pellet loss (see Figures 1 and 2). With careful observation, pellet wastage was eliminated. Furthermore we observed (independent of species of salmonid) different forms of feeding formations or aggregations. One type can be described as concentric rings of swimming fish. In another form, fish appeared to be spiraling together toward a point in the cage (usually the place where feed enters the water). As a feeding event proceeded, the formations would slowly disappear as the numbers of feeding fish declined.

As a result of the industrial study, low-light surveillance cameras have become common feeding tools on salmon farms in Canada, United Kingdom, Chile and Norway. They are also being used to monitor feed loss in Tuna fish cages in Japan. Usually one camera is placed within a cage. The newer industrial versions of camera and connecters are small as compared to my experimental cameras. Different dealers sell different models. On the farm while feeding, fish farmers use a video monitor to look for evidence of satiation and pellet wastage. Wide-angle lenses are preferred so as to maximize the viewing area adjacent to the cameras. Gain control is an important feature so that image contrast can be optimal under different lighting conditions

Figure 1. A video camera is positioned at 9 m of depth near the bottom of a cage of salmon. It is pointing up toward the water surface. Feeding fish are moving downward toward the camera.

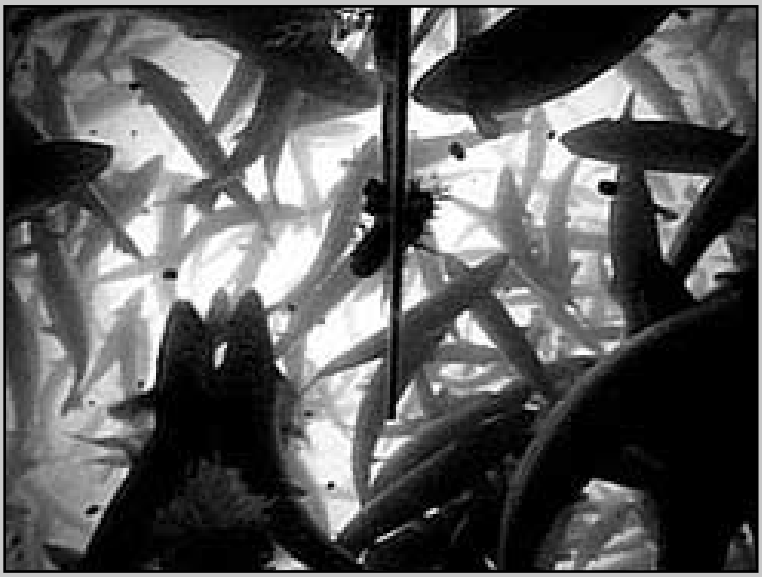

Figure 2. The feeding fish have reached the camera level. The fish farmer will see the pellets and adjust the feed discharge rate so that pellets will not leave the cage uneaten.

(early evening, high turbidity, bright light). Cameras can be moved up and down during a feeding event to ensure pellets are not leaving a cage due to high current.

I have reexamined the automatic pellet detection software of 1993 after reviewing today's faster computer systems. Kevin Parsonage worked on this project for his Master's thesis. The computer code can now distinguish between pellet and non-pellet objects during a feeding event while a camera faces upward (like in Ang's Ph.D. project). The program sends a signal when pellets are detected. The system was shown in a trade show at Campbell River British Columbia. in November of 2000 (The Aquaculture Pacific Exchange), and is currently being considered for commercialization by IAS Products Ltd. of Vancouver, British Columbia. We have tested the system under different stocking densities and environmental conditions.

I have received funding to examine the potential of using underwater cameras to count and size fish within a cage. The research project involved both videotaping sessions on salmon farms and developing image-processing techniques to automatically count and size the fish images. For his undergraduate and graduate theses, Colin Savage worked on developing image techniques that could separate fish images from background images, and he set up the image capturing and analysis system. Andrew Naiberg for his Master's thesis wrote a stereovision program to size fish underwater. Anthony Shieh, Rachael Jones and Eric Boucher worked on separate research projects; all focused on testing the sizing program in the field and developing methodology for its use.

We found out rather quickly that subsampling (or viewing fish in different cage positions) was necessary to count the fish because the volume of a cage was large relative to the volume that can be viewed by underwater camera. We then attempted to equate the number of fish within the camera view volume to the total number within a cage. Accurate counts were difficult to achieve, as it was not easy to measure fish distribution or cage volume. For example, it was difficult to find fish when the stocking density was low (typical of the early stage of the growth cycle). During later stages of growth, fish would start to swim in a way that left large empty spaces near the center of the cage. The cage volume was not fixed, but rather changed throughout the day as currents moved the nets.

We were much more successful in developing a way to size fish using underwater images. The resulting system is currently being commercialized through Sigma Technologies of Victoria British Columbia.

Currently I am investigating with National Science and Engineering Research of Canada funds the explanation for the large open in the center of the cage, because the size of the hole directly affects how many fish can be contained in a cage.

My future research work will focus on why fish do not remain on the surface to feed, and how and why fish form the aggregations they do while feeding. The answers to these questions will provide for better feeding systems, and to answer them, mostly likely will require the continual use of video cameras in aquaculture.

REFERENCES

1. Foster, M., R. Petrell, M. Ito and R. Ward. 1995. Detection and counting of uneaten food pellets in a sea cage using image analysis. Aquacultural Engineering 14:251-269.
2. Ang, K. and R. Petrell. 1997. Control of feed dispensation in sea cages using underwater video monitoring: effects on growth and food conversion. Aquacultural Engineering 16: 45-62.
3. Ang , K. and R. Petrell. 1998. Pellet wastage, and subsurface and surface feeding behaviours associated with different feeding systems in sea cage farming of salmonids. Aquacultural Engineering 18: 95-115.

Newsletter

The *AES News* is printed quarterly by the Aquacultural Engineering Society. You can receive the *AES News* by joining the Aquacultural Engineering Society. If you would like to discuss the contents of the *AES News*, or, if you would like to contribute information to the *AES News*, please contact either of the two Co-Editors:

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UPCOMING MEETINGS

AES Issues Forum 2001

The next *AES Issues Forum* will be held November 11-14, 2001, in Shepherdstown, West Virginia, USA, at the Clarion Hotel and Conference Center. President Barnaby Watten and First Vice President Steven Summerfelt are hosting this "Members Only" *Issues Forum*. The *AES Issues Forum* is intended for members of the AES to gather and reflect upon the advances that have been made in the field of aquacultural engineering and discuss the important issues we now face. Invited speakers will be discussing AES issues in five special topic sessions arranged over 2.5 days. The major topic areas covered will include: Engineering Challenges for Aquaculture Effluent Treatment, Pond Production Methods, Net Pen Systems, Ozone & UV Treatment, Aquacultural Engineering Research Needs and Bacterial Systems. As in the first *AES Issues Forum*, this *Forum* has been organized to allow 10-20 minutes of audience discussion following each presentation. In addition, attendees will tour the Freshwater Institute's new research facility during a social event on the evening of November 13. And, an optional tour of the new USDA-ARS National Center for Cool and Coldwater Aquaculture will be provided on November 14, after the conclusion of the *AES Issues Forum*. Registration for the AES Issues Forum will be $210 for AES Members ($285 for non-members that are joining the AES with their registration). Registration also includes the AES published conference proceedings[1], two lunches and two dinners (November 12-13), the tour of the Freshwater Institute on the evening of November 13, and break refreshments during the five sessions. Register early! Also, accommodations at the Clarion Hotel (304-876-7000 or www.clarion-shep.com) must be **reserved by October 11, 2001**, in order to receive the special *AES Issues Forum* $84/night room rate. Please contact Steven Summerfelt (ph: 304-876-2815; email: s.summerfelt@freshwaterinstitute.org) if you have questions or if you want more information on the *AES Issues Forum*.

See the AES Issues Program on page 5

Aquaculture America 2002

The California Aquaculture Association will be hosting *Aquaculture America 2002*, which will be the next meeting of the US Chapter of the World Aquaculture Society. The *Aquaculture America 2002 Conference and Tradeshow* will be held January 27-30, 2002, at the Town and Country Resort in San Diego, California, USA. Abstracts for presentations (oral or poster) are due by July 31, 2001. For more information on the overall program and tradeshow at *Aquaculture America 2002*, please contact John Cooksey, WAS Director of Conferences (phone: +1 760-432-4270: fax: +1 760-432-4275; e-mail: worldaqua@aol.com), or visit the World Aquaculture Society's website at: http://www.was.org

The AES is organizing a half day workshop on "Designing a 100,000 lb per year coolwater or warm water Recirculating Aquaculture System (RAS)", a half day workshop on "Design of Intensive Shrimp & Shellfish RAS Systems, a half day special session on "Effluent Treatment" and a one-day session of contributed aquacultural engineering papers during *Aquaculture America 2002*. The workshops are intended for fish farmers, biologists, and engineers with some prior fin-fish culture experience. The special session on "Effluent Treatment" will overview a range of treatment methods and water reclamation techniques; this session is applicable to all those involved in fish and shellfish production. The contributed paper session contains a wide range of aquacultural engineering presentations. Dr. Michael Timmons (mbt3@cornell. edu) and Dr. Steven Summerfelt (s.summerfelt@freshwaterinstitute.org) are coordinating the AES involvement.

World Aquaculture 2002

The World Aquaculture Society and the China Society of Fisheries are planning *World Aquaculture 2002 International Conference and Exposition* to be held at the Beijing Convention Center in Beijing, China, from April 23-27, 2002. The AES is an associate sponsor of this international conference and Dr. Shulin Chen (chens@mail.wsu.edu) and Dr. Song-Ming Zhu are coordinating our involvement. For more information on the overall program and tradeshow at *World Aquaculture 2002*, please contact John Cooksey, WAS Director of Conferences (phone: +1 760-432-4270: fax: +1 760-432-4275; e-mail: worldaqua@aol.com), or visit the World Aquaculture Society's website at: http://www.was.org.

[1] All attendees will receive photocopies of each paper during the Forum. the AES published proceedings will be mailed to each Forum attendee after the meeting.

2001 AES ISSUES FORUM PROGRAM

SUNDAY EVENING, NOVEMBER 11

7:30-9:30 Evening Registration and Welcome Social, Rumsey Tavern, Clarion Hotel & Conference Center

MONDAY, NOVEMBER 12

8:00-8:30	*Barnaby Watten*, US Geological Survey, USA	Welcome & Introduction
Engineering Challenges for Aqua. Effluent Treatment		Session Chair: *Shulin Chen*, Washington State University, USA
8:30-9:00	*Shulin Chen*, Washington State University, USA	Current knowledge and research needs for recirc. syst. effl. management
9:00-9:50	*Asbjorn Bergheim*, Rogaland Research, Norway	Effluent treatment for flow through systems and European Environ. Reg.
9:50-10:00	Break	
10:00-10:40	*Craig Tucker*, Mississippi State University, USA	Effluent management for pond systems
10:40-11:20	*Marta Jordan*, US EPA, USA	National Aquaculture Effluent Guidelines: EPA's perspective
11:20-12:00	*Jim Zehringer*, Meiring Poultry & Fish Farm, USA	Aquaculture effluent management in practice: Farmer's perspective
12:00-1:00	Lunch	
Pond Production Methods		Session Chair: *David Brune*, Clemson University, USA
1:00-1:40	*John Hargreaves*, Mississippi State University, USA	Pond catfish production: practices, problems and potentials
1:40-2:20	*Mike Massingill*, Kent SeaTech Corporation, USA	Wetlands for aquaculture nitrogen, alkalinity and temperature control
2:20-2:40	Break	
2:40-3:20	*Yoram Avnimelech*, Israel Inst. of Technology, Israel	Scaling of suspended culture aquaculture ponds
3:20-4:00	*David Brune*, Clemson University, USA	High rate algal systems for aquaculture
4:00-4:40	*Robin McIntosh*, Belize Aquaculture Ltd., Belize	High rate bacterial systems for shrimp prodution
4:40-6:00	Break	
6:00-8:00	Dinner at the Clarion with Keynote Speaker *Jason Clay*, World Wildlife Fund, Washington, D.C., USA	

TUESDAY, NOVEMBER 13

Net Pen Systems		Session Chair: *John Riley*, University of Maine, USA
8:30-9:00	*John Riley*, University of Maine, USA	Introduction to marine net pen culture in North America
9:00-9:40	*Chris Bartlett*, University of Maine, USA	Recent developments and challenges in feeding systems for salmon ind.
9:40-10:00	Break	
10:00-10:40	*Royann Petrell*, Univ. of British Columbia, Cananda	New fish tags for cage culture: Where are the fish and what do they eat?
10:40-11:20	*Sebastian Bell*, Maine Aquaculture Assoc., USA	Containment of net pen cultured fish, a growing problem
11:20-12:00	*Cliff Goudey*, Massachusetts Inst. of Technol., USA	Future directions in net pen culture
12:00-1:00	Lunch	
Ozone & UV Treatment		Session Chair: *Steven Summerfelt*, Freshwater Institute, USA
1:00-1:20	*Steven Summerfelt*, Freshwater Institute, USA	Introduction and current knowledge of ozone and UV treatment
1:20-2:00	*Phillip Lee*, Univ. of TX Marine Biomed. Inst., USA	Engineering issues of ozonation within recirc. marine aquaculture syst.
2:20-2:40	*Anthonie Schuur*, Harbor Branch Oceanic Inst., USA	Engineering vs ozone systems at large-scale shrimp farms
2:40-3:00	Break	
3:00-3:40	*Edward Cryer*, Montgomery-Watson, USA	Engineering experiences with ozonation and UV Disinfection
Aquacultural Engineering Research Needs		Session Chair: *Joseph Hankins*, Freshwater Institute, USA
3:40-4:20	*Joseph Hankins*, Freshwater Institute, USA	Aquacultural engineering research needs
4:20-5:00	Panel Discussion	Aquacultural engineering research needs
5:00-7:30	Tour & Social at Freshwater Institute	
7:30-10:00	Dinner at Bavarian Inn	

WEDNESDAY, NOVEMBER 14

Bacterial Systems for Aquaculture Water Treatment		Session Chair: *Sean Wilton*, PRAqua Technologies Ltd., Canada
8:00-8:40	*Sean Wilton*, PRAqua Technologies Ltd., Canada	Biofilter applications at large commercial coldwater fish farms
8:40-9:20	*Jean-Paul Blancheton*, IFREMER, France	Biofiltration of intensive marine fish culture effluents
9:20-10:00	*Ronald Malone*, Louisiana State University, USA	Floating bead bioclarifier treatment of southern greenhouse tilapia syst.
10:00-10:20	Break	
10:20-11:00	*Jaw-Kai Wang*, University of Hawaii, USA	Algae based recirculating oyster and shrimp systems
11:00-11:40	*Brian Brazil*, Virginia Tech, USA	Denitrification of recirculating system effluent
AES Issues Forum Ends		
1:00-4:00	Optional Tour of USDA-ARS National Cold & Coolwater Aquaculture Center	

Backup presentations will be available if needed to fill in for one or more no shows.

AES Sponsors

The AES is looking for sponsors within the aquaculture industry to support the cost of producing the AES News. The sponsors listed below have donated generously to support the AES in 2001. For this donation, the AES will be inserting a one-page product literature sheet in one of the newsletter mailings, and list the vendor as an AES supporter in four consecutive newsletters. Please contact one of the AES News Co-Editors if you would like to be a sponsor.

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For more information on the AES, visit the AES web page at: http://www.aesweb.org

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To join the AES, please fill out the following information and send with payment to: Brian Vinci, c/o Freshwater Institute, P. O. Box 1889, Shepherdstown, WV, 25443, USA (fax: 304-870-2208). Make cheques payable to the Aquacultural Engineering Society. You do not have to provide education information to become a member.

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