

## **PETITION TO RENEW WESTERN CO-ORDINATING COMMITTEE (WCC-099)**

**NUMBER: WCC-099**

**DURATION:** October 1<sup>st</sup> 2001 –September 30<sup>th</sup> 2006

**TITLE:** Broodstock Management, Genetics and Breeding Programs for Molluscan Shellfish

### **STATEMENT OF ISSUE AND JUSTIFICATION:**

Molluscan aquaculture in the U.S. includes a wide range of aquaculture techniques and species. Presently, the Eastern oyster *Crassostrea virginica*, European oyster *Ostrea edulis*, hard shell clam *Mercenaria mercenaria*, blue mussel *Mytilus edulis* and the Atlantic scallop *Argopecten irradians irradians* are cultured on the Atlantic coast. On the West coast, commercially cultured molluscan species include the European oyster, the Pacific oyster *Crassostrea gigas*, the Manila clam *Tapes japonica*, the geoduck *Panopea abrupta* and the red abalone *Haliotis rufescens*.

Oysters are the most economically important group of mollusks in the U.S. with landings of naturally-occurring oysters at 15,213 metric tons in 1998, valued at \$88.6 million (U.S. Dept Commerce, Fisheries Statistics 1998). Although present annual harvests of wild oysters in the U.S. are significant, they represent less than 50% of annual harvests a decade ago. The impact of diseases (*Haplosporidium nelsoni* [MSX] and *Perkinsus marinus* [Dermo]) on Atlantic and Gulf of Mexico Coasts, together with the effects of pollution, habitat destruction and over fishing have contributed to the decline. The adverse impact has been especially evident in the Chesapeake Bay where annual harvests of Eastern oysters are now less than 10% of harvests during the early 1980s.

In contrast to declines in Eastern oyster production on the Atlantic Coast, aquaculture of Pacific oysters on the West Coast has not been impacted by catastrophic disease outbreaks and has benefited from the adoption of modern hatchery techniques. Production was estimated to equal about 92 million pounds of meat in 2000, worth about \$69 million (Toba and Chew 1999; Pacific Coast Shellfish Growers Association).

Broodstock management and breeding programs for the West Coast oyster industry have not been developed and the industry is essentially farming wild oysters. Unlike many agricultural industries in the US, the shellfish industry has not benefited from a coordinated, long-term, funded breeding program; therefore, the industry has not profited from the enhanced economic returns associated with domestication. Recently, this situation has started to change and several regional research projects on the development of breeding programs for oysters have been funded. These include two projects funded by USDA to develop broodstock improvement and management programs for Pacific oysters on the West Coast. One program funded by the USDA - Western Regional Aquaculture Center (WRAC) adopts a cross-breeding approach and involves researchers from California, Oregon and Washington. The USDA-Special Project, the Molluscan Broodstock Program at Oregon State University, is the other West-coast oyster genetics program that focuses on genetic selection of Pacific oysters. In addition, USDA and other Federal and State agencies support several projects in the mid-Atlantic States (New Jersey, Delaware, Maryland and Virginia) on the development of disease-resistant Eastern oysters for the revitalization of the oyster industry of the Chesapeake and Delaware Bays. Among these, the ABC program at the Virginia Institute of Marine Science, is implementing breeding strategies to genetically enhance farmed hard clams. Researchers in the Northeast are also developing a broodstock improvement program for the aquaculture of the Eastern oysters. Lastly, a large, multi-state USDA project is planned to compare the genomics of Eastern and Pacific oysters.

The renewal of WCC-099 will facilitate interaction among researchers working on multi-state genetics projects. In addition, WCC-099 will provide a forum for industry members to work with researchers to develop optimal commercial breeding programs. Appendices 1 and 2 provide descriptions of the accomplishments of the past WCC-099.

#### **OBJECTIVES:**

- 1) Provide a forum for geneticists, physiologists, nutritionists, biotechnologists and others interested in the aquaculture of molluscan shellfish to exchange ideas and information on molluscan reproduction, chromosome and genetic manipulation techniques, broodstock management and breeding programs.
- 2) Co-ordinate research efforts among scientists on the Pacific, Atlantic and Gulf coasts.
- 3) Identify research needs for enhancement of commercial molluscan production while maintaining environmental quality.
- 4) Provide industry members with up-to-date research information that will lead to optimal broodstock management and breeding programs to enhance commercial production.
- 5) Publish committee reports and documents.

#### **EXPECTED OUTCOMES AND IMPACTS:**

- 1) WCC-099 will continue to provide a forum for geneticists to exchange ideas and information on molluscan reproduction, chromosome and genetic manipulation techniques, broodstock management and breeding programs. Researchers working on Federally - funded projects on the East and Gulf Coasts will continue to present findings to the Committee and exchange ideas.
- 2) Co-ordination and reporting of research among participants will reduce duplication of research effort and costs. Multi-disciplinary and inter-regional exchanges among participants will reveal new directions of scientific enquiry and facilitate formulation of new research questions. The committee will help overcome problems associated with geographical isolation facing many researchers located at remote marine field stations.
- 3) Input from industry members at committee meetings will enable scientific research to better address industry needs.
- 4) Increased economic returns to the Pacific oyster industry resulting from improved strains of oysters could amount to \$7.2 million annually (10% greater than present returns), assuming a 2% increase in annual production over a five-year period. Re-vitalization and expansion of the shellfish industry will benefit employment in coastal communities that are currently suffering from declines in fisheries and, in the Northwest, from declines in the timber and salmon industries. Planting disease-resistant, fast-growing oysters on the Atlantic and Gulf coasts could revitalize the oyster industry in these regions and result in the re-establishment of historically recorded production levels.
- 5) The WCC-099 committee published a report describing the outcome of a WCC-099 meeting held in 1995 to develop a plan for the Molluscan Broodstock Program (Hedgecock, D., C. Langdon, M. Blouin and S. Allen. 1997. Genetic improvement of cultured Pacific oysters by selection. Ag. Exp. Stn. Sp. Report 968, Oregon State University. 40 pp.). An additional publication will be undertaken in the proposed five-year period to provide industry with a manual on broodstock management and breeding.

## INTERNAL AND EXTERNAL LINKAGES:

See attached Projected Participation forms and Appendix 3 listing participants in WCC-099 meetings. Summary of completed Projected Participation forms:

<u>Name</u>	<u>Affiliation</u>	<u>email address</u>
<b>Academics</b>		
Stan Allen	Virginia Inst. Mar. Sc.(VIMS)	ska@vims.edu
Mike Blouin	Oregon State Univ. (OSU)	blouinm@bcc.orst.edu
John.Brake	OSU	john.brake@hmsc.orst.edu
Mark Camara	VIMS	camara@vims.edu
Dennis Hedgecock	U. CA, Davis	dehedgecock@ucdavis.edu
Ford Evans	OSU	evansiii@mailbox.orst.edu
Ximing Guo	Rutgers Univ.	xguo@hsrl.rutgers.edu
Chris Langdon	OSU	chris.langdon@hmsc.orst.edu
Sean Matson	OSU	sean.matson@hmsc.orst.edu
Paul Oilin	CA Sea Grant	pgolin@ucdavis.edu
Paul Rawson	U. Maine	prawson@maine.edu
Kim Reece	VIMS	kreece@vims.edu
John Scarpa	Harbor Branch. Ocean. Inst.	jscarpa@hboi.edu

## Industry/non-academics

John Agosti	Qutekcak Hatchery	qshatch@artic.net
Bill Dewey	Taylor Shellfish	billd@taylorshellfish.com

## EDUCATIONAL PLAN:

WCC-099 is open to students and several have presented their findings at meetings. WCC-099 has also included increasing numbers of industry representatives over the last five years. This is because research on genetics and broodstock management has resulted in useful information to improve commercial production. WCC-099 meetings provide an ideal opportunity for planning collaborative work between researchers and industry; for example, at the Seattle meeting in 2000, a joint experiment was designed between industry members and researchers to determine performance of progeny from selected broodstock on a commercial scale.

## GOVERNANCE:

Chair: One year. Elected from committee membership. Duties include organizing annual meeting, chairing the meeting, extending invitations to outside participants, developing special presentations and initiatives.

Secretary: One year. Elected from committee membership. Duties include recording minutes and disseminating them by means of the list server for WCC-099, collecting donations to cover the costs of meetings, maintenance of the mailing list based on the WCC-099 list server.

## AUTHORIZATION:

---

Dr. Lavern Weber, Administrative Advisor WCC-099,  
College of Agriculture, Oregon State University.



---

Dr. H. Michael Harrington, Executive Director, WAAESD

## APPENDIX 1

### **Accomplishments of WCC-099 “Broodstock management, genetics and breeding programs for molluscan shellfish”**

Four Committee meetings have taken place since the renewal of WCC-099 in October 1997 and the extension granted in July 2000. In February 1998, the Committee met in Las Vegas, followed by a March 1999 meeting in Olympia, Washington, and a March 2000 meeting in Seattle, Washington, and finally a meeting in Orlando, Florida, in January 2001. These meetings have involved from 20 to 30 participants and included representatives of the West Coast shellfish industry as well as US and international researchers.

There is presently an unprecedented level of funding for shellfish genetics research in the US. On the West Coast, oyster genetics research is being conducted by the USDA-CSREES Molluscan Broodstock Program, based at Oregon State University, as well as the USDA-WRAC supported Oyster Genetics program based at the Bodega Marine Laboratories, University of California, Davis. Two substantial NOAA-Sea Grant shellfish programs are funded on the East and Gulf coasts and oyster genetics research is a major component of both these programs. Lastly, the State of Virginia has invested in an aquaculture genetics program at the Virginia Institute of Marine Science that has a strong emphasis on oyster genetics and broodstock management. The WCC-99 meetings have played an important role in facilitating the exchange of information among these scientists.

In the last set of meetings, the committee has discussed some of the new molecular genetic techniques that have made detailed genomic mapping of oyster species feasible. Work on genome mapping of *Crassostrea* species is in progress at the Virginia Institute of Marine Sciences, University of Delaware, Rutgers University and the University of California, Davis. The objective is to identify genetic markers and quantitative trait loci that can be used in genetic programs to facilitate broodstock improvement. Close collaboration between East and West Coast researchers has been facilitated by WCC-099, leading to a joint proposal USDA IFAFS to compare the genomes of Eastern and Pacific oyster species.

International oyster genetics and broodstock selection programs have recently been established in France, New Zealand and Australia. The New Zealand and Australian programs are modeled after the USDA-funded Molluscan Broodstock Program. Representatives from these programs participated in the March 2000 meeting in Seattle and later toured commercial hatchery facilities in Washington and at the Hatfield Marine Science Center, Oregon State University. Collaborative projects between US and French researchers have been developed that will yield additional advantages to the US shellfish industry.

As genetic improvement programs have developed and broodstock have become available, the shellfish industry has become increasingly interested in participating in WCC-099. At the meeting in Seattle, March 2000, a special half-day meeting was held with industry to develop methods for evaluating the commercial performance of offspring from genetically selected broodstock. A large-scale experiment was planned and is presently being executed at several commercial facilities. WCC-099 proved to be an excellent forum for this “nuts and bolts” kind of meeting.

WCC-099 has proven to be an excellent means of stimulating interactions among researchers and industry from different parts of the US and abroad. A two-year extension would allow this collaboration to continue, resulting in new scientific research initiatives and improved economic health for the US shellfish industry.

**APPENDIX 2**  
**SAES-442**

**Project number:** WCC-099

**Project title:** “Broodstock management, genetics and breeding programs for molluscan shellfish”

**Period covered:** 2000-2001

**Date of report:** April 27<sup>th</sup> 2001

**Most recent annual meeting:** 21<sup>st</sup> January 2001, Orlando, Florida

**Participants**

Stan Allen	Virginia Inst. Mar. Sc.(VIMS)	ska@vims.edu
Ford Evans	OSU	ford.evans@hmsc.orst.edu
Ximing Guo	Rutgers Univ.	xguo@hsrl.rutgers.edu
Dennis Hedgecock	U. California, Davis	dehedgecock@ucdavis.edu
Chris Langdon	OSU	chris.langdon@hmsc.orst.edu
Sean Matson	OSU	sean.matson@hmsc.orst.edu
Anja Robinson	OSU	anja.robinson@hmsc.orst.edu
Paul Rawson	U. Maine	prawson@maine.edu
Kim Reece	VIMS	kreece@vims.edu
John Scarpa	Harbor Branch. Ocean. Inst.	jscarpa@hboi.edu
Lavern Weber	OSU	lavern.weber@hmsc.orst.edu

**Academics – Foreign**

Peter Crewe                      CSIRO, Australia

**Industry/non-academics**

John Agosti	Qutekcak Hatchery	qshatch@artic.net
Dan Cheney	Pacific Shellfish Inst.	cheneydp@compuserve.com
Sue Cudd	Taylor Shellfish	suecudd@aol.com
Joth Davis	Taylor Shellfish	jdavis@wolfenet.com
Bill Dewey	Taylor Shellfish	billd@taylorshellfish.com
Dick Pool	Lummi Oyster	none
Paul Taylor	Taylor Shellfish	pault@taylorshellfish.com
Doug Thompson	Coast Oyster	coastdoug@olympus.net

**Minutes of meeting**

The attendees were welcomed by chairperson Chris Langdon @ 8:45 AM, January 21, 2001. Sean Matson was asked to collect \$20.00 from each attendee to cover the meeting costs. Chris discussed the agenda and the question of renewal of WCC. A decision was made later in the meeting to pursue renewal as attendees acknowledged value of program with a caveat to ensure inclusion of East and Gulf Coast shellfish breeding and genetics research.

Lavern Weber was recognized as the long-term committee advisor from Oregon State University (OSU). Lavern will retire at the end of the year. He will be greatly missed as our advocate at OSU in past years.

Stan Allen, VIMS, gave an overview of the ABC program that fosters aquaculture development in Virginia, focusing mainly on shellfish. Stan introduced Mark Camara as a new ABC researcher to work on improving the shellfish breeding capabilities at ABC. Selection for disease resistance, clam breeding, development of non-native species and the commercial potential of polyploidy will be among Mark’s main duties.

Stan then went on to describe the results of a workshop on genetic considerations for hatchery-based restoration of oyster reefs that was held at VIMS on September 21-22, 2000. The meeting focused on restoration of reef function as a primary ecological habitat with self-or auto-recruitment implicit in its overall function. The recommendation was that areas for auto-recruitment should be identified and set aside as preserves. Habitat restoration must continue with the rehabilitation of many thousands of acres; however, the amounts of material needed for substrate restoration are very large. Recurrent stocking of the reef may have to be ongoing if recruitment doesn't work. Hatchery capacity for this effort does not presently exist on the East Coast.

Stan reported that there was concern expressed at the workshop over maintenance of a large effective population size in hatchery production of seed for restocking. Do hatchery-derived oysters affect the genetic make up of wild oyster populations? There is no information on effective sizes of wild oyster populations on the East Coast.

Stan discussed the potential value and pitfalls of using disease-resistant stocks for enhancement. There was a recommendation to use selected disease-resistant oysters, originally from Delaware Bay (DRO), on reefs where auto-recruitment was expected to be high and to monitor genetic introgression using genetic markers that were ideally linked to disease resistant genes.

Kim Reece, VIMS, discussed the development of microsatellites for construction of a genetic linkage map of the Eastern oyster and for genetic monitoring of restoration efforts. She has focused on identifying microsatellite regions from a shotgun library. She described the design and testing of primers for microsatellites and reported that of 13 primers investigated, five had problems with null alleles. Her lab is currently working on 69 primer sets for the Eastern oyster with 16 of them working and 46 more in progress. She reported that the primers do not work with Pacific oysters.

Kim reported that three stocks (DEBY-VIMS, CROSBreeds and VIMS stocks) are being assessed for use in restocking efforts. Both DEBY-VIMS and CROSBreeds are amenable for restoration; however, both have problems due to inbreeding. DEBY's are probably the best choice because they are selected for both MSX and Dermo disease resistance while CROSBreeds are mainly selected for MSX resistance. The biochemical basis for disease resistance is also being investigated at VIMS.

Ximing Guo, Rutgers University, next gave an update on projects ongoing at the Haskins lab, Rutgers University. He discussed possible causes of the reported superior performance of triploids compared with diploid clams and oysters. PB-1 triploids usually do better than PB-2 triploids suggesting that genetic heterozygosity plays a part. Ximing also proposed that higher growth rates and larger sizes of triploids could be due to "triploid gigantism" – the occurrence of large cells.

Ximing also presented an update on aneuploidy research in oysters. The goal of this research is to produce aneuploid families and the production of trisomic ( $2n+1$ ) families. About 55 families of have been produced to date and 20 have been confirmed for Pacific oysters. Tetrasomic ( $2n+2$ ) families were also produced. Ximing observed a decline in trisomic frequency with age. He then discussed the potential use of trisomics in developing genetic linkage maps.

Paul Rawson, University of Maine, discussed the Eastern oyster breeding program in Maine. Poor cold-water growth is the principle impediment to higher commercial profits and was the principle target of Maine's selection program. Bob Hawes started the program in 1986. It was then passed onto Bruce Barber and finally to Paul. Paul reported that the program was initially based on four stocks. The current status of these stocks is that the Haskins line was discarded after 1989-90 due to high mortality; the Milford lines were dropped due to poor shell characters; the local lines were dropped due to poor growth; leaving the Flowers lines that have been maintained for 4 generations of truncation selection. The Flowers line is used extensively in the industry and is reported to be significantly larger @ 18 months of age

compared to control and wild stocks. It also appears resistant to Juvenile Oyster Disease (JOD); however resistance may be due to a size refuge in that selected oysters are growing faster.

Dennis Hedgecock, University of California, Davis, discussed the WRAC project and interest in applying a functional genomics in identifying superior broodstock and seed. There was a general discussion of heterosis and the rationale in using inbred Pacific oysters in the WRAC cross-breeding program. Large-scale testing is key for rapid hybrid development. The corn industry is able to analyze 1000's of stocks. In oysters, the dominance hypothesis for heterosis appears most likely explanation as oysters appear to carry a high load of recessive lethal genes. Dennis discussed recent work on the transmission of lethal genes in Pacific oysters and the development of new microsatellites - 53 developed to date. Dennis pointed out that 11-day-old larvae can be used for genetic mapping as no segregation distortion occurs up to this developmental stage.

Dennis then proceeded to describe the WRAC project and the use of inbred oysters for hybrid stock development. He reported on the current status of the WRAC research effort including cooperation with LYNX and use of its megaclone and MPSS technology. This cooperative effort should lead to the use of functional genomics to screen broodstock and seed for desired genetic characteristics.

Joth Davis, Taylor Shellfish, discussed the development of a commercial-based hybrid breeding effort as part of the WRAC project at Taylor Shellfish Inc. He discussed year 2000 breeding results and presented data on early hybrid growth in a commercial nursery system.

Peter Grewe, CSIRO Australia, discussed transgenic research to develop fish and shellfish possessing a deleterious gene that only switches off when synthetic chemicals are added in hatchery production. Without addition of these chemicals, development of embryos is blocked under natural conditions. Work at CSIRO has focused on oysters, zebra fish and mice. The objective is to achieve aquaculture production of non-native species with zero risk of uncontrolled reproduction in the wild.

Chris Langdon, OSU, discussed the response to selection in Cohort 5 MPB oyster families maintained at Totten Inlet and Yaquina Bay sites. Multiple trait selection of generalists (with performance at the two sites being different traits) was achieved by selecting six families common to the top ten families at both sites.

Availability of MBP broodstock was discussed. MBP has culled the largest third of the oysters within each family for MBP broodstock. The remainder was given to industry to use for hatchery production. There is no knowledge of the effects of within family selection compared to among family selection on the breeding value of Pacific oyster broodstock.

A better understanding is also needed of MBP broodstock numbers needed by each of the primary commercial hatcheries. Chris then discussed the need for industry to establish an industry broodstock repository in which large broodstock families can be maintained for commercial production.

Sean Matson, OSU, discussed outreach efforts by MBP to disseminate broodstock information to the industry including results and summaries, WRAC and MBP broodstock availability, host company and email addresses. Sean then demonstrated the MBP website and its use to locate broodstock families for commercial production.

Bill Dewey, Taylor Shellfish, discussed the ARS West Coast shellfish initiative and the state of progress with this initiative. The ARS Aquaculture program has about \$20 million in its annual budget but ARS has very little West Coast exposure. Bill described the history of the initiative including the initial ARS workshop at Warm Springs, Oregon, in September 2000. Facilities needs are the focus of interest as the research needs have been identified through the 2010 goals document. Three research areas of current

interest to the West Coast shellfish industry include shellfish genetics, ecology and food safety. Bill ended with a discussion of West Coast shellfish policy on genetically modified organisms (GMO).

Peter Grewe, CSIRO, Australia, gave an update of the Pacific oyster breeding program in Australia. The Tasmanian oyster industry, with annual production valued at \$Aus 25 million (\$US 12 million) is participating in an oyster breeding program. The entire industry is hatchery-based. The first Pacific oysters were introduced to Australia in 1947. CSIRO carries out studies on genetic diversity, genetics and physiology, molecular genetics and selective breeding of Pacific oysters. A selective breeding program has been initiated and a second selected generation was produced in 2000. The Australian oyster industry rated desired traits for the selection program. Meat yield and growth rate were identified as the most important traits for selection.

#### Industry Outreach and Integration

There was a general discussion on how best to transfer information and broodstock from research breeding programs to industry. There is a need to have a meeting of hatchery operators and others interested in using MBP and WRAC broodstock in spring 2001. A workshop was proposed to be held in conjunction with the Washington Sea Grant Shellfish Growers workshop in March 2001 that would gather all commercial entities together to go over the operational details of using broodstock in the coming season. The workshop would include a performance overview of selected lines, availability and location of stocks, timing of procurement and management of oysters in the hatchery (number of oysters to use from each line, strip spawning vs natural spawning).

Discussion also focused on the potential for MBP to cryopreserve sperm from each MPB broodstock family to ensure sufficient males for commercial production. Training would be provided by MPB on how to use the cryopreserved materials, store and ship sperm, etc.

Meeting adjourned at approximately 4:30 pm.

Respectfully submitted,

Joth Davis, Secretary WCC-099

#### **Outcomes:**

- 1) A joint proposal was submitted by Committee members Guo, Gaffney, Allen, Reece, and others to the USDA-IFAFS program titled "Comparative mapping of expressed genes in Pacific and Eastern oysters".
- 2) A workshop was held at the Sea Grant-supported Shellfish Growers conference held in Olympia, WA. The workshop was designed to inform the shellfish industry of available broodstock from the Molluscan Broodstock Program and its correct use in commercial hatcheries. About 20 industry members attended the workshop.



### APPENDIX 3

#### Attendees of meetings of WCC-099 “Broodstock management, genetics and breeding programs for molluscan shellfish” 1997-2001.

Name	Affiliation	email address
<b>Academics - US</b>		
Stan Allen	Virginia Inst. Mar. Sc.(VIMS)	ska@vims.edu
Mike Blouin	Oregon State Univ. (OSU)	blouinm@bcc.orst.edu
Gene Burreson	VIMS	gene@vims.edu
John Buchanan	Louisiana St. Univ.	jbuchanan@agctr.lsu.edu
Joe Cloud	Univ. Idaho	jcloud@uidaho.edu
Fred Conte	U. California, Davis	fsconte@ucdavis.edu
Chris Davis	U. Maine	cdavis41@maine.edu
Ford Evans	OSU	ford.evans@hmsc.orst.edu
Pat Gaffney	Univ. Delaware	pgaffney@bach.udel.edu
Ximing Guo	Rutgers Univ.	xguo@hsrl.rutgers.edu
Steve Harbell	WA Sea Grant	sharbell@u.washington.edu
Dennis Hedgecock	U. California, Davis	dehedgecock@ucdavis.edu
Sophie Hubert	U. California, Davis	shubert@ucdavis.edu
Chris Langdon	OSU	chris.langdon@hmsc.orst.edu
Mark Luckenback	VIMS	luck@vims.edu
Donal Manahan	Univ. S. California	manahan@usc.edu
Sean Matson	OSU	sean.matson@hmsc.orst.edu
Paul Oilin	CA Sea Grant	pgolin@ucdavis.edu
Anja Robinson	OSU	anja.robinson@hmsc.orst.edu
Paul Rawson	U. Maine	prawson@maine.edu
Kim Reece	VIMS	kreece@vims.edu
John Scarpa	Harbor Branch. Ocean. Inst.	jscarpa@hboi.edu
Tom Soniat	Nicholls State U.	biol-tms@mail.nich.edu
Terry Tiersh	Louisiana St. Univ.	ttiersch@agctr.lsu.edu
Brent Valopalas	U. Washington	brent@fish.washington.edu
Lavern Weber	OSU	lavern.weber@hmsc.orst.edu
<b>Academics – Foreign</b>		
Pierre Boudry	IFREMER, France	pboudry@ifremer.fr
Peter Grewe	CSIRO, Australia	
Jean Moal	IFREMER, France	jmoal@ifremer.fr
Jean Francois Samain	IFREMER, France	jfsamain@ifremer.fr
<b>Industry/non-academics</b>		
John Agosti	Qutekcak Hatchery	qshatch@artic.net
Andrea Blackburn	SeaLord Shellfish, NZ	ajb@sf.sealord.co.nz
John Bayes	Seasalter Shellfish, UK	seasalter@compuserve.com
Dan Cheney	Pacific Shellfish Inst.	cheneydp@compuserve.com
Sue Cudd	Taylor Shellfish	suecudd@aol.com
Joth Davis	Taylor Shellfish	jdavis@wolfenet.com
Bill Dewey	Taylor Shellfish	billd@taylorshellfish.com
Jim Donaldson	Olympus Aquaculture	olyaqua@olympus.net
Brett Dumbauld	WA Fish/Wildlife	dumbabrd@dfw.wa.edu
Ralph Elston	Aquatech	aquatech@olypen.com
Benoit Eudeline	Taylor Shellfish	beudeline@aol.com
Brian MacDonald	Pacific Shellfish Inst.	macdonald@telesphere.com

Tim Morris  
Dick Pool  
Paul Taylor  
Doug Thompson

Coast Seafoods  
Lummi Oyster  
Taylor Shellfish  
Coast Oyster

coasttim@techline.com  
none  
pault@taylorshellfish.com  
coastdoug@olympus.net