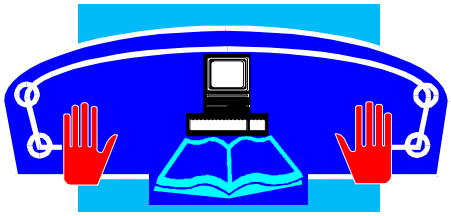

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ASSOCIATION AQUICOLE DU CANADA
QUATRIÈME ASSEMBLÉE ANNUELLE

AQUACULTURE ASSOCIATION OF CANADA
FOURTH ANNUAL MEETING

SESSIONS TECHNIQUES
TECHNICAL SESSIONS

Les 29-30 avril et 1er mai 1987
April 29-30 and May 1st 1987

Hôtel Loews Le Concorde

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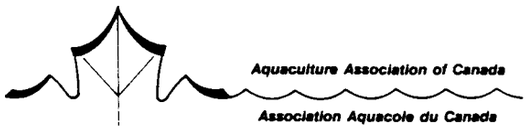

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Session technique 1:
Perspectives en aquiculture

Technical Session 1:
Perspectives in Aquiculture

Moderateur:
Dr Neil Bourne

Chairperson:
Department of Fisheries and Oceans, Nanaimo, B.C.

AQUACULTURE IN EASTERN CANADA AND THE FISHERIES.

RIDLER*, N., KABIR, M.,
Department of Economics, University of New Brunswick, Saint-John, N.B.

Using cost data from New Brunswick Atlantic salmon farms, simulation indicates optimum size to be approximately 100t a year. This corresponds with survey results in Norway. The paper presents the data and the financial/economic implications.

In addition demand estimates for lobster culture are made, including both price and income elasticity of demand.

Finally, the paper analyzes the relationship between aquiculture and the fisheries, which in the short-run may be complementary (because of over-fishing in the captive fisheries) or substitutes. Important implications for the management of the fisheries ensue.

AQUACULTURE IN NORWAY, DENMARK, ENGLAND and SCOTLAND — HIGHLIGHTS OF A RECENT TOUR.

EN RIGHT*, Catherine T., Atlantic Research Laboratory, National Research Council of Canada, Halifax, N.S.

Key commercial and government salmon, trout and oyster aquiculture facilities in Norway, Denmark, England and Scotland were viewed by a North American Aquiculture Delegation for a three week period during the summer of 1986. The highlights of this trip are presented.

PERSPECTIVES ON AQUACULTURE DEVELOPMENT IN ONTARIO.

MOCCIA, R.D. and A.J. CASTLEDINE, Aquatic Pathology Services and Ontario Ministry of Natural Resources, Ontario.

Aquiculture in Ontario has been a viable, commercial industry for over two decades. The production and sale of trout for human consumption was first permitted by law in 1962, and since that time the number of fish farms has increased steadily to its current level of about 175. Rainbow and brook trout are the only species currently allowed to be cultured for sale as food and over 99% of the production is in rainbow trout. Legislative changes expected to occur this year, will expand the number of species which can be propagated to 22, and will include groups that have high commercial potential such as Atlantic, Chinook and Coho Salmon, American Eel, Arctic Char, Yellow Perch, Suckers and others.

Current yearly production of rainbow trout is nearing 2.5 million pounds with an annual revenue value of approximately $5-5.5 million. The Ontario industry is firmly established, with a well-developed Producers' Association, Processing and Marketing Cooperative, and a Provincial Co-ordinating Committee with representatives from both the government and private sector. Many of the production facilities are technologically advanced and are constantly adapting to new developments in gamete production, cage culture, recirculation techniques, ultra-intensive water utilization and large-scale temperature manipulation using thermal energy waste from alternate industrial processes. The present and future development of aquiculture in Ontario will be discussed and highlighted with case examples. In addition, we will demonstrate a successful organizational approach to government/private sector interaction which may be used as a model system for other provinces in Canada.

Session technique II:
Génétique, reproduction et physiologic des poissons.

Technical Session 11:
Finfish Genetics, Reproduction and Physiology.

Moderateur:
Dr Ian McMillan

Chairperson:
Animal and Poultry Science
University of Guelph
Guelph, Ontario.

EXTENDER FORMULA AND EGG TREATMENT.
HAMOR ● , Thomas, Livingston Fish Hatchery, Fish and Wildlife Service, Government of Alberta, Calgary, Alberta

Extender formula with pre-fertilization egg treatments was found to increase hatching success with about 20% compared to the controls.

The treatments are clearing out impurities effecting sperm activities and extending sperm movement 5-40 times, compared to the motility in natural water on similar temperatures.

EARLY SURVIVAL OF THREE STRAINS OF HATCHERY-REARED ARCTIC CHARR (*Salvelinus alpinus*).
KRIEGER*, K. G., Rockwood Experimental Fish Hatchery, Department of Fisheries and Oceans, Gunton, Manitoba.

The spawning performance of three strains of hatchery-reared brood stock are compared. There were significant differences between the survival to hatching between strains. No significant differences were observed between anadromous and landlocked forms. The overall survival of Arctic charr eggs and fry was similar to that observed for rainbow trout. Significant differences in survival at first feeding and year one were observed between the strains. More time was required for charr to hatch and swim-up than rainbow trout. Management recommendations for the development of cultured Arctic charr brood stocks are discussed.

GROWTH AND BIOCHEMICAL PHENOTYPES OF CULTURED ARCTIC CHARR (SALVELINUS *ALPINUS*).
TOMPKINS*, J., PAPST, M., DICK, T. Department of Zoology, University of Manitoba; Department of Fisheries and Oceans, Freshwater Institute, Winnipeg, Manitoba. (S/E)

Growth of progeny from eight families of Arctic charr, *Salveninus alpinus*, was studied for a period of seven months. The initial weight of ail fish varied between *0.5* and 1.5 grams. Replicates of each family were reared at 6° and 10°C to detect family x temperature interactions on growth. Growth rates, based on an increase in weight overtime, were used to detect differences among families and strains. Growth differences among families were found. Growth was characterized by wide variation in weight among siblings within replicates. At termination fish raised at 10°C ranged in size from under 2 grams to 160 grams. Fish reared at 6°C varied from less than 1 gram to greater than 20 grams. Using starch gel electrophoresis, a survey of a number of enzyme systems in the charr was completed to estimate the degree of genetic homogeneity and to determine if significant genetic differences existed among strains. This information combined with the data from growth trials provided an opportunity for attempting to correlate desirable growth traits with the presence of specific biochemical characters which serve as markers for brood stock assessment and selection.

COMPARATIVE SALINITY TOLERANCE OF ARCTIC CHAR *(SALVELINUS ALPINUS)* AND ATLANTIC SALMON (*SALMO SALAR*).
DELABBIO, J. L." , AND GLEBE, B. D., Aquiculture Section Huntsman Marine Laboratory, St. Andrews, N.B. (S/E)

Arctic char and char — Atlantic salmon hybrids are being evaluated for mariculture potential. Two stocks of char have been grown from egg to post-smolt stage and are being maintained as breeding units. During the normal smoltification period for Atlantic salmon, fish (15 cm fork length) from each stock were challenged in 35 ppt/seawater for 96 hr. Challenges were repeated at approximately 4 wk intervals thereafter until December. Na^+, K^+ gill ATPase activity, blood osmolality and ion concentration were monitored in char and salmon maintained in both fresh and salt water environments. Maturation and growth rates of the char stocks are being compared to those of Atlantic salmon in both sea cages and in shore-based seawater tanks.

ATLANTIC SALMON MATURATIONS 1: LINKS WITH GROWTH PATTERNS AND POSSIBILITIES OF ENVIRONMENTAL MANIPULATIONS.
HARBINGER*, C. M., NEWKIRK. G. F., Dept of Biology. Dalhousie University. Halifax, N.S. (S/E)

Two groups of Atlantic salmon smelts (1 year and 2 year old), belonging to several different families, were reared in seawater in the Dalhousie University Aquatron facilities for 18 months after smoltification. Each fish was identified, individually and by family, using a marking code consisting of cold brands and jet-injected dyes. Length, weight and maturation status were collected for each fish, every 6 months or so. During the winter, the fish were split between one ambient temperature regime and

one warmed regime. This paper will present the relationships between growth patterns and maturation patterns, the relationships between the different maturation episodes, and the influence of overwintering temperature. Modification of maturation patterns through manipulation of growth patterns will be discussed.

ATLANTIC SALMON MATURATIONS Ii: GENETIC BASES AND POSSIBILITIES OF SELECTION.
HERBINGER, C. M., NEWKIRK*, G. F.,
Dept of Biology. Dalhousie University.
Halifax, N.S.

This paper will present family differences observed for precocious maturation rates, post-smelt precocious maturation rates and grilse maturation rates. The genetic structure underlying the links between maturation patterns and growth patterns will be presented. Selection for late age at maturity and for high growth rate will be discussed.

RESULTATS PRÉLIMINAIRES SUR LA CROISSANCE DE TRUITES ARC-EN-CIEL STERILES (TRIPLOÏDIE INDUITE PAR UN CHOC DE PRESSION) EN PISCICULTURE.
BOULANGER* Yves,
Pisciculture des Alléghanys Inc.,
St-Philemon, Que.

Nous avons produit en 1986 un lot de truites arc-en-ciel stériles suite a un choc de pression applique aux oeufs, tôt après la fécondation. Leurs croissance et performance en élevage commercial, sur une période de 12 mois (pré-puberté) ont été évaluées.

La croissance et la performance de ces truites triploïdes durant cette période ont été equivalences a celles des diploïdes. Ces résultats different de ceux obtenus par plusieurs groupes travaillant sur ce sujet.

Nous tenterons done de dormer une explication a ces résultats.

ADAPTATION DE L'OMBLE DE FONTAINE A L'EAU DE MER.
BESNER* , M., PELLETIER, D. ET L. BERNIER,
INRS-Océanologie, Rimouski, Que.

Nous avons introduit en eau de mer des ombles de fontaine soit directement, soit graduellement sur une période de deux jours (1 a 8 PPM, 1 a 15 PPM et 5 sem. a 28 PPM) ou cinq jours (1 a 8 PPM, 3 a 15 PPM, 1 a 20 PPM et 5 sem. a 28 PPM). Les ombles introduits directement éprouvent des le mois de juillet des difficulties d'osmoregulation se traduisant au tours de la premiere semaine par des augmentations de pression osmotique et de concentration des ions plasmatiques Cl- et Na^+ à des niveaux moyens de 400 mOSm/1, 190 et 220 meq/1 respectivement alors qu'en juin ils n'étaient que de 375 mOSm/1, 160 et 175 meq/1. Le degré d'activation de l'enzyme branchial Na^- -K+ ATPase décroît de moitié et du quart en juillet et août successivement comparativement a un maximum de 30 µmoles Pi/mg prot./h en juin. L'importance du choc osmotique n'est pas atténuée par une introduction graduelle de deux jours alors que sur cinq jours il y a augmentation significative du taux de survie. On pourrait done affiner le produit par un séjour en eau de mer.

USE OF LHRH ANALOGUE TO IMPROVE EGG QUALITY IN SEACAGED ATLANTIC SALMON.
DAVIES, B.*, GLEBE, B. D., CRIM, L. W.,
Huntsman Marine Laboratory, St. Andrews, N.B. Marine Sciences Research Lab.,
Memorial University of Newfoundland,
St. John's, Nfld.

In recent years, egg quality obtained from seacaged Atlantic salmon broodstock has been very poor compared to freshwater fish. Studies on Pacific salmon have suggested that osmotic stress during egg maturation and ovulation is an important factor. Early induced ovulation of these fish would reduce this stress factor and perhaps improve egg quality. LH-RH analogues have been shown to be powerful inducers of ovulation. D-Ala^4, des-Gly^{-10}-LHRH ethylamide was incorporated into cholesterol pellets giving a total dose of 100 µg. This pellet was inserted, via the egg pore, into the ovary. Samples of spawned eggs were measured for percent fertilization. Preliminary results show similar fertilization rates for treated (79.3%, N = 14) and untreated (77.30/0, N = 13) fish, Untreated freshwater fish showed higher fertilization (84.1 %, N = 5). Changes in feeding prior to spawning may be a major factor in increasing egg quality. LH-RH analogue implanting of grilse in fresh and saltwater will give more data on egg quality and gonadotropin levels during induced spawning.

ANTiFREEZE PROTEIN GENE TRANSFER TO ATLANTIC SALMON BY MICROINJECTION.
M. SHEARS*, M. KING, G. FLETCHER, C. HEW AND P.L. DAVIES.
Mere. Univ. Nfld, St. Johns, Nfld, Res. Inst.,
Hosp. Sick Children, Toronto, Ont. and
Queen's University, Kingston, Ontario.

Atlantic salmon and other salmonids freeze to death when the water temperature declines below -0.7 C. Consequently, the aquiculture of these species in cold water is severely limited. However,

other species such as the winter flounder and ocean pout survive in ice laden sea water by producing a set of antifreeze polypeptides (AFP). With a view to improving the freezing resistance of atlantic salmon through gene transfer, a winter flounder AFP gene in a pUC plasmid was selected for microinjection. This gene codes for the most abundant flounder AFP and is present as a tandemly amplified locus. Mature salmon eggs were individually microinjected with linearized DNA after fertilization. Up to 80% of the eggs hatched. Individual progeny (1-2 gm) and pooled pin-heads were analyzed for the incorporation of the flounder AFP gene by genomic Southern blotting. Two out of thirty fish from the 1985 injection series and several preparations of the pooled pinhead DNA showed hybridization to the flounder DNA probe. The hybridization bands in the Sst I and Barn HI lanes are identical to those obtained from the linearized plasmid where the gene is flanked by these sites. With Hind III the band of hybridization indicates linkage to the salmon genome. The hybridization signal was absent from control fish. Based on the intensity of hybridization at least one copy of the gene was present per ceil. (Supported by NSERC and MRC Canada)

EXTENDED DAYLENGTH DURING AUTUMN ENHANCES GROWTH OF JUVENILE ATLANTIC SALMON.

SAUNDERS*, R. L., HARMON, P. R., and HENDERSON, E. B., DFO, Biological Station, St. Andrews, N.B.

Extended daylength during various times of year may stimulate presmolt growth of Atlantic salmon. However, such artificial photoperiods may not be compatible with completion of the parr-smelt transformation which prepares salmonids for life in the marine environment. During a series of experiments at St. Andrews, N. B., we developed a photoperiod regime that promotes rapid growth during fall and early winter and which allows successful smelt development the following spring. Constant light at 16 hr/day from August or September until late November enhanced growth during this period when ambient temperature was suitable for feeding and growth. Simulated natural photoperiod was restored in late November. The photoperiod regime resulted in a greater proportion of 1 + smelts and fish of larger size than in a control population reared under simulated natural photoperiod. The smelts produced through this photoperiod manipulation developed salinity tolerance in the spring and showed normal survival and growth during the first summer-autumn in a sea cage.

RECYCLAGE DES SAUMONS ATLANTIQUES (SALMO SALAR) GÉNITEURS. TRAVAUX À DATE ET PROBLÉMATIQUE.

TURGEON, Yvan. Service de l'aquiculture, Direction de la faune aquatique, M. L. C. P., Quebec

Les travaux effectués de 1982 a 1986 par le ministère du Loisir, de la Chasse et de la Pêche sur le recyclage du Saumon atlantique (*Salmo salar*) après la fraye artificielle, ont permis de cerner la problématique particulière de cette operation. S'il a été possible d'obtenir des frayes multiples de certains individus, les taux de survie et de maturation sexuelle affichent de grandes variations selon les groupes testes. Les taux de survie sent fonction des conditions de stabulation et de la disponibilité des moyens prophylactiques et thérapeutiques tandis que les taux de maturation sexuelle dependent d'une part des dates du debut d'alimentation et des quantités d'aliments ingérés mais aussi de la capacite physiologique de chacun des individus d'atteindre la maturation sexuelle a chaque annee.

Session technique III: Sante et nutrition

Technical Session III: Health and Nutrition

Modérateur:
Dr Joel de la Noue

Chairperson:
Centre de recherches en nutrition
University Laval
Sainte-Fey, Quebec

DEVELOPMENT OF A COMMERCIAL VACCINE TO PREVENT GAFFKEMIA IN LOBSTERS.

W.D. PATERSON •, 1. KEITH , D. AIRDRIE, L. BOSTON, Aqua Health Ltd., Charlottetown, PEI

Following harvest of lobsters from the sea, fishermen and lobster pound operators suffer a significant economic loss due to animal death on the way to market. A considerable portion of this loss is due to the disease Gaffkemia, caused by *Aerococcus viridans*.

Toward a solution to this dilemma, Aqua Health has been developing a vaccine to prevent Gaffkemia, and this product should be commercially available in the near future.

Following injection delivery of an inactivated *Aerococcus viridans* bacterin to both juvenile and adult lobsters, significant protection against an injected challenge of virulent Gaffkemia bacterin was conferred. At 15°C the protection was observed 10 days after vaccine administration and could be detected for at least 138 days following vaccination. Production lots were manufactured, successfully potency tested, and now data is being assembled prior to submission for license.

THE ATLANTIC VETERINARY COLLEGE'S AQUATIC HOLDING FACILITY: DESIGN AND FUNCTION.

LYON*, P. R., JOHNSON, G., Atlantic Veterinary College, Charlottetown, PEI.

The Atlantic Veterinary College's aquatic holding facility consists of 12 modular units. Each of the 5 marine recirculation modules, possess a sand filter, trickling tower biofilter, ultraviolet sterilizer, hot and cold heat exchangers, header tanks, a variety of holding tanks and a reservoir. There are 7 fresh water flow through modules. Prior to release, effluent from ail modules pass through chlorination contact chambers. Room allocation includes 5 isolation laboratories, a demonstration workroom and a large general holding area. Additional facilities include food perparation for fin fish, crustaceans and molluscs, and an associated post-mortem room. Support services, such as microbiology, toxicology, histopathology and electron microscopy are shared with all species and available for aquatic organisms upon request. The facility, located in the clinical areas of the college, is designed to accommodate teaching, research and diagnostics.

PROPHYLAXIS OF INFECTIOUS PANCREATIC NECROSIS VIRUS EPIDEMY IN BROOK TROUT FINGERLING BY TEMPERATURE MODULATION OF WATER.

BERTHIAUME, L. •, LARRIVÉE, D., FALGUEYRET, J. P., LAPIERRE, J. Centre de recherche en virologie, Institut Armand-Frappier, Univ. du Quebec, Laval, Que.

In previous experiments, infectious pancreatic necrosis in brook trout was noted as temperature and age dependent. Brook trout from hatching up to 31 weeks of age were tested for susceptibility to infectious pancreatic necrosis virus (IPNV) at experimental temperatures of 5, 10 and 15°C. At 10 and 15°C similarly, between 6 and 21 weeks of age, fingerling died at high percentage level following virus infection. Before and after these ages or at water temperature of 5"C, they appeared insensitive to the disease. Following these observations, an experimental infection with IPNV was performed in brook trout fingerling of about 13 weeks of age at 10"C in two aquariums, both subdivided in two parts with a metallic screen. One day after manifestation of the disease, it was 12 days post-infection, temperature of one aquarium was lowered to 5°C and the other maintained at 10°C. Infected fingerling were left on one side of the screen and uninfected fingerling were placed on the other side, with water circulating from the infected part to the uninfected one. While mortality decimated fingerling IPNV-infected populations both at 10 and 5°C, disease appeared to propagate to uninfected fingerling only in the 10°C aquarium. At 5"C, uninfected fingerling remained in good health while all those infected progressively died up to 6 weeks post-infection. At this time, 5°C uninfected fingerling were placed at 10°C during an additional 4 weeks without any clinical signs of infection. It thus seems that a lower temperature could be used as a prophylactic means to control IPNV.

LESIONS BRANCHIALES OBSERVÉES CHEZ DES TRUITES ÉLEVÉES EN ÉTANG.

PELOQUIN*, R., Sante animale, Laboratoire de Rock Forest MAPAQ, Quebec.

De nombreux pisciculteurs du Quebec gèrent des étangs de pêche et/ou se servent de ce type de bassin pour pratiquer l'élevage intensif de la truite. La dimension et la conception de ces bassins d'élevage sent souvent mal adaptees au volume d'eau de replacement disponible. Il s'en suit done une

degradation graduelle de la qualité de l'eau durant la saison de croissance, des problèmes majeurs se preparent sournoisement et en quelques jours des pies de mortalité peuvent atteindre 15 a 20 %.

Les lesions principals se retrouvent au niveau des branchies où l'on observe une dilatation des capillaires des lamelles, une stase sanguine suivie d'une nécrose des globules rouges et d'une transformation des lamelles.

Un nettoyage du fond de l'étang et/ou une augmentation du taux d'echange d'eau corrige souvent la situation.

EFFECT OF DIETARY LIPIDS ON THE IMMUNE RESPONSE OF BROOK TROUT *(SA VELINUS FONTINALIS)*.

J. CROOK*, J.D. CASTELL and G. OLIVIER, Biology Department, Dalhousie University, Halifax, N. S., Department of Fisheries and Oceans, Halifax, N.S. (S/E)

There is increasing incidence for important interactions between nutrition and immune responses in fish. The following experiment was designed to investigate the role of essential fatty acids on the immune response of juvenile brook trout to *Aeromonas salmonicida* the causative agent of furunculosis in fish. Fish were fed a diet supplemented with herring, corn or olive oil. After four weeks groups of fish from each diet were vaccinated with a commercial anti-furunculosis vaccine[1]. Several nutritional parameters will be evaluated, growth, feed conversion, survival and signs of essential fatty acid deficiency. Four weeks after vaccination the following immunological responses will be investigated, agglutination, complement activity and resistance to furunculosis following challenges with live pathogens. Results will be discussed as to the effect of dietary lipids on the immune response of brook trout.

SPAWNING RASH IN RAINBOW TROUT: AN ATYPICAL FORM OF BACTERIAL KIDNEY DISEASE.

MOCCIA, R. D.' and A.J. SIPPEL, Aquatic Pathology Services and Ontario Ministry of Natural Resources, Ontario

Two year and older rainbow trout (*Salmo gairdneri*) from three separate commercial aquiculture facilities exhibited an atypical form of Bacterial Kidney Disease. Affected fish showed numerous small, ulcerative, blister-like skin lesions from which the bacteria *Renibacterium salmoninarum* could be cultured. In no case did the fish possess kidney or other visceral lesions, and it was difficult to culture the causative organism from any of the visceral organs.

The lesions were observed to be markedly cyclical in nature, developing around spawning time, and undergoing nearly complete remission in the months following this period. In the hatcheries inspected, fish younger than 2 years of age were unaffected, in spite of the fact that they were raised in effluent water from the brood stock holding tanks. This suggests that the clinical expression of the disease is mediated by unidentified endocrine or stress-mediated factors associated with spawning.

Histologically, the skin lesions were comprised of chronic, granulomatous tissue which did not penetrate below the dermis. Using special staining, bacteria resembling *R. salmoninarum* could be seen within microphage-like cells, as well as free within the intercellular spaces. After remission began, bacteria were no longer visible within the lesion, nor could they be cultured from the fish, suggesting successful immune responsiveness.

These cases appear to represent an atypical clinical expression of BKD; and have implications to the procedures used in Fish Health inspections. Awareness of this clinical form may aid in the recognition and identification of this often serious bacterial fish disease.

DISEASES COMMON TO BOTH SALMONIDS AND NONSALMONIDS.

OSTLAND * , V., FERGUSON, H. W., Fish Pathology Laboratory, Department of Pathology, Ontario Veterinary College, University of Guelph, Guelph, Ontario (S/E)

Several bacterial and parasitic conditions of fish can cause disease in both cultured salmonids and nonsalmonids. Bacterial gill disease, nodular gill disease, bacterial kidney disease, furunculosis, epitheliocystis and costiasis have been diagnosed in several species of wild and cultured nonsalmonids including cyprinids, catostomids and clupeids. These diseases present clinical signs and pathological changes similar to those displayed by affected salmonids with diagnosis, control and treatment essentially parallel to those methods employed for salmonids. These diseases were traditionally considered of most importance to salmonids but as nonsalmonid aquiculture grows in Canada their significance to nonsalmonid species should not be underestimated.

1 Compliments of Aqua Health Inc.

THE REFRACTORY PROPERTIES OF THE TOXIC COMPOUNDS IN CANOLA MEAL FED TO RAINBOW TROUT.

HILTON*, J.W. and LEATHERLAND, J. F., Depts of Nutritional Sciences and Zoology, University of Guelph, Guelph, Ontario.

Previous studies in this laboratory have determined that canola meal (CM) contains toxic compounds (TC, glucosinolates) which when fed to rainbow trout depressed growth, feed efficiency, plasma thyroid hormone levels and caused thyroid hypertrophy in this fish. The purpose of this study was to determine if the effects of the TC in CM when fed to rainbow trout are refractory in this fish. Six replicates of trout (70 fish/replicate) were reared on two isonitrogenous practical-type diets with either soybean meal (SM) or CM supplementation. After 12 weeks on the test diets, the growth parameters, carcass composition, plasma thyroid hormone levels, plasma cortisol levels and thyroid and interrenal histology were assayed. The trout reared on the SM and CM diets were then divided into three replicates of fed or fasted fish and maintained under these conditions for a further 8 weeks. In addition, three groups of fish previously fed the CM diet were switched over to the SM diet. After *4* and 8 weeks on these feeding regimens the growth parameters, carcass composition, plasma thyroid hormone levels, plasma cortisol levels and thyroid hormone levels, plasma cortisol levels and thyroid and interrenal histology of the trout were assayed. The preliminary results indicate that the effects of the TC in CM fed to trout are apparently not refactory. Furthermore, it appeared that fish transferred from the CM to SM based diet underwent some compensatory growth response. However, it was observed in the fasting study that trout fed the CM diet prior to fasting lost more weight (o/o body weight basis) and appeared to be somewhat weaker than the trout fed the SM diet prior to fasting. (Supported by NSERC, OMAF and Martin Feed Mills Ltd.)

A PRELIMINARY STUDY ON CATARACTS CAUSED BY DIET-INDUCED ZINC DEFICIENCY IN RAINBOW TROUT (*SALMO GAIRDNERI*) REARED ON VEGETABLE MEAL BASED DIET.

XU*, Z. M., BETTGER, W.J. and HILTON, J. W., Dept. of Nutritional Sciences, University of Guelph, Ontario (S/E)

A study was conducted to determine the incidence and time development of cataracts in rainbow trout caused by soybean meal-induced dietary zinc deficiency. Juvenile rainbow trout (68 fish/tank) were reared on either a fish meal-based diet (FM, Zn = 59 ppm) or a vegetable protein meal-based diet (VM, Zn = 51 ppm) containing soybean meal and corn gluten meal for varying lengths of time from 4 to 36 weeks, and labelled as VM (36 weeks), VMA (32 weeks), VMB (28 weeks), VMC (20 weeks) and VMD (4 weeks) respectively. Trout reared on VM had a significantly lower weight gain, feed intake and feed efficiency compared to the trout reared on FM. Plasma Zn content in trout fed on FM was 12.7 ppm while trout fed on VM diets ranged from 1.7 to 7.0 ppm and decreased with the increase of time the fish were fed the VM diets. Similarly, whole eye Zn content of the trout decreased with the amount of time the trout were fed the VM based diets and were approximately from 20 to 70% of that in fish fed the FM based diet (295 ppm). The incidence and severity of cataracts in trout also increased in relation to the length of time the fish were fed the VM based diets. This study shows that the VM diets had a low bioavailability of dietary Zn. Whole eye Zn and plasma Zn content are directly related to incidence and severity of cataracts in trout. However, plasma Zn content would appear to be the most sensitive parameter to assess the bioavailability of dietary Zn and zinc status in rainbow trout. (Supported by NSERC, OMAF and Martin Feed Mills Ltd.)

NEUROTRANSMETTEURS, HYPOXIE ET FORMULATION DES RÉGIMES ALIMENTAIRES POUR LA TRUITE ARC-EN-CIEL.

POULIOT*, T., DE LA NOUE, J., ROBERGE, A. G., Groupe de recherche en recyclage biologique et aquiculture, University Laval, Ste-Fey, Que. (S/E)

La sérotonine (5-HT) et les catécholamines (CA) sent des neurotransmetteurs dent la concentration clans le cerveau depend de la disponibilité plasmatique de leur précurseur respectif, soit le tryptophane (trp) et la tyrosine (tyr), qui peut être modifiée par l'apport alimentaire et le profil en amino acides des proteines ingérées, les protéines animales et végétales montrant des qualités differences a cet égard.

Trois regimes alimentaires sent utilises, soit un regime commercial (protéines mixtes), soit deux autres regimes qui ont, respectivement, un apport protéique majoritairement d'origine animale ou végétale.

Après 149 jours d'adaptation aux regimes (eau saturée en oxygène), les variations clans la concentration de la 5-HT, de la dopamine (DA), de la noradrénaline (NA) et de l'acide 5-hydroxyindolacétique (acide 5-HIA) dependent de la structure cérébrale (hypothalamus, mésencéphale et télencéphale) et du regime alimentaire distribué. La réponse neurochimique a l'hypoxie (eau a 60 o/o de saturation) varie selon la structure cérébrale analysée et est spécifique a chacun des regimes alimentaires. Sous hypoxie, les truites adaptees au regime animal maintiennent l'équilibre, qui existait avant le stress, entre les voies serotoninergique et catécholaminergique. De plus, il n'y a pas de modification de la concentration de la 5-HT, de la DA, de la NA et de l'acide 5-HIA ($P > 0.05$) clans l'hypothalamus.

Les presents résultats indiquent que l'origine de la protéine alimentaire influence la concentration cérébrale de la 5-HT et des CA. Comme l'intégration des information clans le système nerveux central s'effectue a l'aide des neurotransmetteurs, il est done théoriquement possible d'influencer le métabolisme ou le comportment de l'animal par une formulation alimentaire adequate. (Subventionné par le CRSAQ)

EFFECTS OF LEVEL OF FEEDING ON INDIVIDUAL FOOD CONSUMPTION AND STOMACH FILL IN RAINBOW TROUT.

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Previous studies from this laboratory have indicated that some fish within a tank consume a larger proportion of food relative to their body weight than others. This may complicate the assessment of nutritional impact in studies in which individual fish within a tank are sampled. This may especially be a problem when fish are fed at levels at which fish cease vigorous feeding and begin to leave food on the bottom of the tank. Consequently, it appears crucial to delineate relative levels of food ingestion by individual fish, particularly following underfeeding, and to determine whether overfeeding can correct disparate feeding levels. To this end, fish were reared at 15 C for 4 months on a practical trout diet. Eighteen tanks of fish (38 fish/tank) were then fed a practical diet to which had been added either 1% chromic oxide (green diet), 0.85% mucicarmine (red diet) or no dye (control diet). Tanks of fish were fed at levels of either 50%, 75% or 100% of satiety. To determine the effect of overfeeding, some fish were fed red or green diets to 100% satiety and then fed a supplementary 33% of the alternate coloured diet. Following feeding, fish were anaesthetized with tricaine methane sulfonate prior to severing of the spinal cord. Fish were then weighed and stomach were ligated at the oesophagus and pyloric sphincter before removal. Stomach contents were then separated by colour and weighed. Finally, empty stomachs were weighed. Using these techniques, the relative distribution of food amongst individual fish in each tank was determined. The intake data obtained from this study have implications for the feeding and sampling of fish in experimental studies. (Supported by NSERC, OMAF and Martin Feed Mills Ltd.)

DEVELOPMENT OF A FISH METABOLISM CHAMBER-INDICATOR OXIDATION TECHNIQUE FOR NUTRITIONAL STUDIES IN FISH.

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A fish metabolism chamber has been developed for the collection of $^{14}CO_2$ produced by fish fed test diets containing a radiolabelled substrate. The $^{14}CO_2$ collected is used as an index of the level of oxidation of the radiolabelled substrate fed. The concept for the development of this technique for nutritional studies on fish is taken from the amino acid oxidation technique used to determine protein and amino acid requirements of pigs and rats. The basic design features of the experimental system will be explained along with a presentation of the theoretical basis for the application of this technique to determine protein and amino acid requirements and the optimum dietary protein: energy ratio in diets for fish. In addition, this technique maybe used to determine the suitability of alternate dietary energy substrates in fish diets. (Supported by NSERC, OMAF and DFO)

Session technique IV:
Culture des invertébrés et des plantes

Technical Session IV:
Invertebrate and Plant Culture

Modérateur:
Dr John D. Castell

Chairperson:
Department of Fisheries and Oceans
Halifax, Nova Scotia.

TRACE ELEMENT REQUIREMENTS FOR IRISH MOSS.

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Intensive cultivation of Irish moss (*Chondrus cripsus*) in tanks requires the timely addition of appropriate plant nutrients. The effects of chelated supplemental Cu, Fe, Mn, and Zn were tested on stocks of *Chondrus* (1 O kg) in culture tanks (1 .46 m^2; 900 L) maintained with a biweekly batch-wise replacement of seawater. Protocol involved 6 or 7 weeks "depletion" followed by reintroduction of the specific trace element. At the end of the depletion period no significant difference in growth or visible physiological changes could be discerned whether or not *Chondrus* had received Cu, Mn, or Zn supplements. However, within 4-5 weeks of Fe depletion, the growth of *Chondrus* fell below and remained inferior to that in all other treatments. The *Chondrus* also developed a characteristic chlorosis at the apices. On reintroducing Fe, *Chondrus* regained normal chlorophyll levels and production within one week. Tissue analysis revealed that healthy *Chondrus* receiving Fe supplements contained 132-192 ppm of Fe on a dry weight basis; plants depleted of Fe for 6-7 weeks contained only 56-68 ppm.

We conclude that: (i) Fe supplements are necessary for maximum sustained production of Irish moss in systems in which fresh seawater exchange has been minimized, and (ii) tissue analysis for microelements can be a useful management tool in algal aquiculture.

ACCELERATED GROWTH OF JUVENILE AMERICAN LOBSTERS INDUCED BY UNILATERAL EYESTALK ABLATION.

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Bilateral eyestalk ablation is known to increase growth and molting rates in American lobsters, but long-term survival is poor. However, preliminary experiments have indicated that unlateral eyestalk ablation enhances growth rate without a corresponding decrease in survival. To determine the potential of unilateral eyestalk ablation as a technique for accelerating growth rates of juvenile lobsters, 300 siblings that reached fourth stage on the same day were randomly assigned to one of three groups: intact control, right eyestalk ablated, and left eyestalk ablated. Eyestalks were ablated when the lobsters were in the sixth stage. Animals were housed individually and fed daily on frozen adult brine shrimp. After 90 days, the two ablated groups (left and right eye) were statistically similar in carapace length (CL) and weight, but the ablated lobsters were significantly heavier (1440 vs 1050 mg, $p < 0.01$) and larger (12.9 vs 11.6 mm CL, $p < 0.01$), than the intact controls. After 125 days, the unilaterally ablated lobsters were 10% larger (14.7 vs 13.4 mm CL) and 39% heavier (2300 vs 1660 mg) than the controls. All groups had similar survival (80, 74 and 77%). These results suggest that unilaterally eyestalk ablated lobsters will survive as well as intact lobsters but will reach market size significantly sooner.

DIETS FOR THE JUVENILE OYSTER. *OSTREA EDULIS*.

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The growth response of *Ostrea edulis* juveniles when fed over 70 diets were examined. The diets were used both with and without the control diet of *Chaetoceros gracilis*. Diets included various grains, vegetables, dairy products, microencapsulated fatty acid complexes, yeasts and commercially available larval diets. Growth results are described and the advantages of the various diets are discussed.

LA REPARTITION SPATIO-TEMPORELLE DU PHYTOPLANCTON AUTOUR DES STRUCTURES D'ELEVAGE DE LA MOULE BLEUE: RÉSULTATS PRELIMINAIRES.

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On observe généralement une depletion du phytoplancton a proximité des banes de moules, qui résulte en une diminution significative du rendement en chair des moules. En situation d'élevage, la forte densite de moules pourrait vraisemblablement résulter en une situation analogue, où it y aurait depletion de phytoplancton et reduction de la croissance en aval des structures d'élevage. La connaissance du champ de concentration du phytoplancton autour des structures d'élevage serait donc un prérequis a l'optimisation de la disposition spatiale des structures d'élevage. *Nous* poursuivons un double objectif: 1) determiner les échelles spatio-temporelles pertinentes a l'échantillonnage du phytoplancton; 2) étudier l'ampleur, l'étendue et la persistence d'éventuelles zones de depletion, Les travaux ont

été menés clans la lagune de Grande-Entree, aux Îles-de-la-Madeleine. Les quelques résultats dent nous disposons n'indiquent pas d' heterogeneity spatiale du phytoplancton (fluorescence *in vivo*) (< 10 m). Par contre, nous observons des variations marquees (de plus de 25% du maximum) a une échelle de l'ordre de la centaine de mètres. Ces observations ont été faites par temps venteux. Des observations couvrant un plus grand spectre de conditions meteorologiques permettront de savoir si la variance a petite échelle peut êtreignorée de façon systematique. Les concentrations de phytoplancton les plus élevées ont été observées au nerd de la zone d'élevage. Cette structure a persisté au long des quelque deux heures qu'on dure les prélèvements.

ÉVALUATION PRÉLIMINAIRE DE LA CAPACITÉ DE SUPPORT DES LAGUNES DES ÎLES-DE-LA-MADELEINE POUR LA MYTILICULTURE COMMERCIALE.

HEBERT, Serge et MYRAND ●, Bruno, MAPAQ, Cap-aux-Meuies, Que.

Aux Îles-de-la-Madeleine, la mytiliculture commerciale s'est developpee clans les grandes lagunes. Deja 8 producteurs y sent installés et de nombreux autres aimeraient en faire autant. Cependant, le faible échange entre la masse d'eau lagunaire et la mer au tours des cycles de marée (16-22 o/o du volume d'eau lagunaire) de même que les courants moyens relativement faibles en été (7,7 crn/see), une concentration estivale en seston total variant entre 2,04 et 7,38 mg/1, et une concentration moyenne en chlorophylle-a de 1,14 µg/L au tours de la même période nous incitent a être très prudents quant au developpement futur de cette nouvelle activité. Le développement rationnel de la mytiliculture clans ces lagunes passe done par la connaissance de leur capacité de support. Ce concept écologique est toutefois difficile d'application car il requiert une foule d'informations difficiles a obtenir «in situ». Pour pallier a ces difficulties, deux modèles simplifies sent généralement utilises soit (1) l'évaluation de la production secondaire a partir de la production primaire disponible et (2) le modèle développé par Incze et Lutz pour determiner la densite optimale des structures d'élevage. Nous avons employé ces deux approches afin d'obtenir une estimation préliminaire de la capacité de support des lagunes en attendant d'y mener des etudes plus approfondies orientées spécifiquement sur ce sujet. Outre les evaluations obtenues a l'aide de ces modèles, nous nous attardons a discuter de leurs difficulties d'application et de leurs limitations.

DEUX REGIONS MYTILICOLES QUÉBÉCOISES AUX CARACTÉRISTIQUES DIFFERENCES: UNE POSSIBILITY D'APPROVISIONNER LE MARCHE A L'ANNEE LONGUE?

MYRAND, B., MAPAQ, CAP-AUX-MEULES, BERGERON*, P., M. A. P. A. Q., Gaspé, Que.

L'élevage de la moule bleue au Quebec se développe presentiment clans deux regions aux caractéristiques environnementales differences. Les lagunes des Îles-de-la-Madeleine constituent un milieu fermé où le renouvellement de la masse d'eau est restreint et les conditions hydrologiques de la colonne d'eau relativement uniformes. La zone côtière de la Baie des Chaleurs (Carleton), quant a elle, constitue un milieu ouvert caractérisé par des variations environnementales plus importances. Le cycle d'élevage aux Îles est comparable a celui des provinces maritimes où les moules atteignent généralement la taille commercial vers l'âge de 18 mois et sent récoltées surtout d'octobre a mai. Par contre a Carleton, la croissance est telle qu'une faible proportion de moules seulement atteignent la taille commercial après une année de mise en boudins. De plus, la récolte hivernale sous la glace serait problématique car la glace y est trop instable et imprévisible pour permettre une operation commercial d'envergure. Heureusement, le rendement en chair observe a Carleton depuis 1984 est relativement élevé tout au tours de l'été (> 30 %) allant même jusqu'à se maintenir a plus de 45 o/o de juin ala mi-août 1986. Il ne montre pas la forte diminution notee pour la même période aux Îles (jusqu'à 20 o/o en 1986). L'évolution de la croissance et du rendement en chair clans chacune de ces regions est examinee en rapport avec les données environnementales disponibles. Ces résultats préliminaires permettent d'envisager un cycle de production base sur une récolte estivale (mai a septembre) a Carleton. Jumelé a une récolte hivernale aux lies, ceci pourrait conduire a un approvisionnement a l'année longue en moules d'élevage de qualité au Quebec. Les données recueillies a Carleton suscitent plusieurs interrogations concernant entre autres les causes du rendement en chair estival élevé, son lien avec une croissance relativement lente et son effet sur d'autres parametres de la qualité du produit.

INTENSIVE LONGLINE CULTURE FOR MUSSELS *MYTILUS EDULIS* ON PRINCE EDWARD ISLAND.

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Water acreage with optimal physical and biological conditions for lonline mussel culture is becoming scarce on Prince Edward Island. This limiting factor could constrict the growth of the cultured mussel industry, both limiting production and eliminating new entrants.

Several producers have developed intensive culture systems based on the use of railway rails as anchorage. These systems have resulted in increased yield and improved lease management. This paper describes these systems and discusses the

implication for intensive mussel culture in Prince Edward Island rivers.

POTENTIEL AQUICOLE DU PÉTONCLE GEANT DE LA BASSE-COTE-NORD DU QUEBEC.

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Le Pétoncle géant constitue une espèce de choix pour l'aquiculture clans les eaux québécoises. Les premiers essais d'élevage realises entre 1980 et 1984 ont permis d'identifier sa faisabilité biologique clans les eaux abritées de la Basse-C6te-Nerd. À la suite des résultats obtenus, des travaux de recherche furent entrepris en 1984 en vue de determiner la biologic de l'espèce clans cet habitat côtier. Ainsi, deux aspects biologiques retiennent particulièrement Inattention soient la période de ponte et la croissance.

La ponte se produit en juillet ce qui constitue la période de ponte complete la plus hâtive clans l'sire de distribution de l'espèce. De plus, la croissance apparait être parmi les plus rapides, certains specimens de la population naturelle atteignant la taille de 100 mm en 3 1/2 ans.

Cependant, le captage de naissain demeure problématique présumément en raison de la faible densite de géniteurs ayant survécu a la période de pêche intensive du debut des années 1970. Deux avenues de recherche sent suggérées pour contrer ce problème, soit la production de naissain en écloserie-nurserie et la creation de sites naturels a haute densite en géniteurs.

ASPECTS DE LA REPRODUCTION ET DE LA PRODUCTION LARVAIRE CHEZ *PLACOPECTEN MAGELLANICUS* MAINTENU EN MILIEU SEMI-NATUREL.

COUTURIER*, C. Dept. of Biology, Dalhousie Univ., Halifax, N.S. (S/E)

Une etude du cycle sexuel et de l'évolution des reserves biochimiques a été réalisée chez *Placopecten magellanicus* maintenu en milieu semi-naturel (lanternes japonaises) pendant presqu'un an. L'examen des gonades par histologic quantitative a démontré que les phénomènes de gamétogènese se déroulent différemment chez les mâles et les femelles. Les reserves de protéines du muscle adducteur semblent être la principal source d'énergie durant la période de croissance des gonades. Après le frai, en Sept-Ott, la gamétogènese est réinitiée aux depens des reserves glucidiques du muscle adducteur. Les patrons d'acquisition et de depenses énergétiques reportés ici, sent different de ceux observes ailleurs, pour cette espèce. Ceci demontre l'influence de l'environnement local sur les phénomènes de la gamétogènese.

La viabilité des gametes, en relation avec la condition reproductrice des géniteurs, a été examinee en laboratoire. Les meilleures larves ont été obtenues quand les parents étaient clans un etat gamètogénique optimal, qui ne correspondait pas au pic de maturité en milieu naturel. Les teneurs en lipides, protides et glucides des ovocytes ont chacune eu un effet sur le developpement embryonnaire, mais ne semblaient pas trop influencer les stades larvaires. Les résultats suggèrent que la «condition» gamètogénique des deux parents doit être prise en consideration si l'on veut developper un plan de production en écloserie, et que la période de conditionnement des adultes pourrait être raccourcie, pourvu que de bons regimes alimentaires pour les géniteurs soient disponibles.

OPTIMISATION DE LA COLLECTE DE NAISSAIN DE PECTINIDES.

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La collecte de naissain sur des collecteurs artificiels serait la premiere étape clans une pectiniculture en milieu naturel. Nous avons determine la période de fixation a Gascons en 1986. Des series de collecteurs ont été placées a des intervalles de 2 sem pour des périodes d'immersion de 2, 4 et 8 sem. Un pic clans le recrutement s'est produit entre le 28 octobre et le 18 novembre. En outre, pour des périodes d'immersion de 4 a 8 sem., l'intensité de fixation dépasse de plusieurs fois celle d'une période d'immersion de 2 sem. Une série de collecteurs a été placée le long d'un gradient de profondeur (de la surface jusqu'au fond a 25.5 m). Il y avait un faible recrutement pres de la surface; un maximum de recrutement entre 9 et 22.5 m, et une chute soudaine a 24 m, pres du fond.

LA PRODUCTION ARTIFICIELLE DU PETONCLE GEANT (*PLACOPECTEN MAGELLANICUS*) AU QUEBEC: L'ÉTAT DE LA RECHERCHE ET LES PERSPECTIVES.

Real FOURNIER et Pierre MARSOT, INRS-OCÉANOLOGIE, Rimouski, Quebec.

La production artificielle du pétoncle géant doit se faire selon deux grandes phases: 10 l'écloserie-nurserie en milieu artificial, 2° le pre-grossissement et l'engraissement en milieu naturel. La premiere etape de ce cycle de production est maintenant contrôlée. Les travaux entrepris en 1984 a l'écloserie experimental de l'INRS-Océanologie ont mene au développement d'une technique de base pour la production de post-larves de taille permettant le transfert «in situ». Les travaux realises en 1985-86 ont permis entre autre de verifier la reproductibilité de la méthode et d'évaluer l'eventuality d'une production

a plus grande échelle. Les essais préliminaires concernant la deuxieme phase de la production artificielle, soit le pré-grossissement «in situ», ont été entrepris en 1986. Quelques 10,000 post-larves de 0.7 a 1.0 mm issues de la production de l'été 86 ont été immergées en casiers d'elevage clans la region de la Tabatière sur la Basse C6te-Nerd. Les différentes recherches menées depuis les trois dernières années, d'une part en milieu artificial sur la production des post-larves (INRS) et d'autre part en milieu naturel sur l'engraissement en structures de fond (MAPAQ), nous permettent de définir un procede d'aquiculture dent les principaux elements sent deja en place. Les connaissances acquises nous laissent envisager, a breve échéance, l'expérimentation semi-industrielle d' une production artificielle du pétoncle géant, de l'oeuf a l'adulte de taille commercial.

RECENT DEVELOPMENTS IN SCALLOP CULTURE IN BRITISH COLUMBIA.

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Scallop resources in British Columbia are too sparse to support a large fishery. Annual landings from the harvest of two small species, pink, *Chlamys rubida*, and spiny, C. *hastata*, are under 50 t. If a large scallop industry is to develop it will have to rely on culture or enhancement.

In 1981 a joint Federal-Provincial project was begun to investigate the feasibility of scallop culture in British Columbia. Work has focused on two species, the native rock scallop, *Crassadoma gigantea*, and the exotic Japanese scallop, *Patinopecten yessoensis*.

Attempts were made to collect juvenile scallops from natural populations but these proved unsuccessful. The project has now focused on developing hatchery technology to produce large quantities of juveniles that can be used in grow-out trials along the coast, Most of the work has been with the Japanese scallop. Hatchery methology is described and results of limited grow-out work is discussed.

Session technique V:
Technologies d'élevage

Technical Session V:
Rearing Technologies

Moderateur:
Dr Richard L. Saunders

Chairperson:
Department of Fisheries and Oceans
Saint-Andrews Biological Station,
Saint-Andrews, New Brunswick

BIOAUGMENTATION: LA BIOTECHNOLOGIE POUR AMÉLIORER LA PRODUCTION AQUACOLE ET PROTÉGER L'ENVIRONNEMENT.

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L'aquiculture par sa nature est la concentration d'organismes aquatiques clans peu d'eau comparativement au milieu naturel et résulte en la deterioration de la qualité d'eau en termes d'oxygene, d'ammoniac, de nitrites, de la DBO et des solides etc. Cette degradation diminue la productivity aquacole tout en polluant.

La bioaugmentation est l'ensemencement de batteries épuratrices clans des systèmes aquacoles et/ou des plans d'eau. Cette forme de biotechnologie est en phase d'implantation a travers le monde. Eiie permet de: •réduire ies teneurs en ammoniac et phosphore de 90 % et 85 % respectivement clans l'effluent d'une station d'élevage de truites arc-en-ciel,• augmenter la production de barbottes en même temps que la qualité d'eau, • éliminer ± 10 *cm* de boues de truites en étang d'élevage en dedans de 5 semaines, . réduire ies algues, • augmenter la facilité a oxygéner l'eau,• amorcer rapidement et maintenir facilement des filtres biologiques, . augmenter la rentabilité, et • réduire la pollution.

ACTIVATION D'UN LIT NITRIFIANT POUR ÉLEVAGE DE LA TRUITE EN CIRCUIT FERMÉ.

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Une unite experimentaie de traitement de l'eau pour l'élevage intensif de la Truite en circuit fermé a été tongue et opérée. Le système comporte un lit bactérien a ruissellement de 0,44 m^3 avec 100 m^2 de support en polyethylene (267 m^2/m^3) pour l'oxydation de l'azote dissous et un filtre a double couche (anthracite/siiice) pour la retention des particuies colloïdales et sédimentables. La charge finale des bassins a été de 41.5 kg/m^3 (truites arc-en-ciel de 369 ± 69 g). Pendant ies cinq mois d'opération, le taux moyen de croissance a été de 29 %/mois.

Pour établir une activité nitrifiante optimale des l'introduction des poissons, une méthode deactivation du biofiltre a été mise au point. Pour simuler la presence de 200 truites de 150 g, de l'ammoniaque a été ajouté en continu a raison de 6.6 mg N-N H_4^+/min. Par recours a un inoculum de boues enrichies en *Nitrosomonas* et en maintenant le pH a ≥ 8 par injection en continu de tampon (6.4 mg d'alcalinité en $CaCO_3$/mg N-NH_4^+ ajouté), le temps deactivation a été abrégé. Ainsi, une concentration en azote a 1 mg/L environ a été maintenue après quatre jours pour le N-NH_4^+ et 12 jours pour le N-NO_2^-; cette performance se compare avantageusement aux 30 et 37 jours requis respectivement avec des boues non enrichies et un pH non ajusté en continu. (Subventionné par le CRSAQ).

MODULAR WATER RE-USE TECHNOLOGY.

VAN TOEVER* , J. W., 'IAS' Ltd., North Wiltshire, P.E.I.

A high efficiency modular water re-use system has been deveioped which incorporates solid waste removal, biological filtration and re-aeration. The simply retrofitted to existing tanks or incorporated into new tanks and can be scaled to accommodate tanks of any size. A description of the system design and performance capabilities will be presented.

CROISSANCE ET PRODUCTION DE GÉNITEURS MASQUINONGES (*Esox masquinongy*) ÉLEVÉS SUR DIÈTE ARTIFICIELLE EN SYSTÈME DE RECIRCULATION D'EAU.

MOTNIKAR*, S., EHRLICH, K. F., CANTIN, M. C., Aquaresearch Ltd., North Hatley, Que.

Les masquinongés (*Esox masquinongy*) ont été élevés clans un système de recirculation d'eau a des temperatures entre 20 °-25°C. Ils ont été nourris exciusivement sur diète artificielle. La distribution du poids et de la longueur totale d'apres ies mesures effectuées a intervalles de six mois, démontre un taux de croissance pius élevé que chez ies masquinongés sauvages et une separation en deux groupes. Ces deux groupes correspondent aux mâles et femelles dent les taux de croissance different, ces dernières ayant un taux de croissance pius élevé que celui des mâles. L'utilisation de graphes de distribution s'avère être une technique simpie pour la selection de géniteurs masquinongés. Le facteur de condition est examine pour different stades de croissance et l'atteinte de la maturité sexuelle est comparee avec celle de poissons sauvages.

EFFETS DE CYCLES PHOTOPÉRIODIQUES/ THERMIQUES SUR LA PÉRIODE DE FRAIE DE L'ACHIGAN A PETITE BOUCHE (*Micropterus dolomieui*).

CANTIN ●, M. C., College de Sherbrooke, Sherbrooke, Que.

Des achigans a petite bouche (*Micropterus dolomieui*) adultes maintenus clans un système recycle ont été exposes a deux modèles different de cycles photoperiode/temperature pour modifier leur rythme de développement ovarien et leur période de fraie. Cette technique a permis d'avancer la fraie de deux mois sous le régime hivernal comprimé et de la retarder jusqu'à deux mois sous le regime hivernal allongé. La période de fraie est passée de 15 jours en nature a quatre mois sous contrôle photopériodique/thermique. Le developpement ovarien a été suivi en termes de dimension et de stades de maturation des ovocytes et compare au facteur de condition.

ACCELERATION DE LA CROISSANCE DES ALEVINS D'OMBLES DE FONTAINE (*Salvelinus fontinalis*) PAR L'EXPLOITATION D'UNE DIVERSITE THERMIQUE.

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La rapidité de la croissance d'une espèce pour élevage commercial a une influence directe sur les coûts de production. La temperature de l'eau est un facteur clé pour la croissance des poissons. L'influence d'une diversite thermique sur la croissance de l'omble de fontaine fut determine expérimentalement. Un groupe d'alevins fut élevé clans un bassin avec un gradient de temperature et un autre groupe clans un bassin a la temperature constante préférée par l'espèce. A la fin de Inexperience, on a mesuré et compare la croissance des 2 groupes d'alevins. La taille des alevins d'omble de fontaine élevés clans un bassin avec gradient thermique est supérieure a celle du groupe élevé a temperature constante. Ces résultats suggèrent que la presence d'une diversite thermique accélère la croissance des alevins d'omble de fontaine.

USE OF GEOTHERMAL SEAWATER IN SALMON CULTURE.

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Along most of Atlantic Canada's coastline, and the Gulf of Maine, it is not possible to culture Atlantic salmon year-round in conventional sea cages because winter sea-surface temperatures fall below the salmon's lethal level of - 0.7°C. The Bay of Fundy is a notable exception. The usual minimum winter temperature is about 1.5°C in the Fundy Isles Region. Little or no growth occurs in sea cages during the winter, An experiment was conducted in which salmon post-smelts were taken at the beginning of January from a conventional sea-cage site and grown until early May in shore-based tanks supplied with brackish seawater pumped from a well. The fish had been introduced into seacages the previous May as 1 + smelt. They were from a gene pool derived from Saint John River fish. The purpose of using seawater from a groundwater source was to utilize the geothermal properties characteristic of groundwater in general, although there are other benefits in the use of such water for salmon aquaculture. Water temperature remained constant at 8°C. Water at this temperature has the potential for allowing growth well above that of 1.5°C water. The experiment provided empirical data on such a growth potential. During the 115 days of the experiment, the fish increased in weight and length by 940/o and 21 %, respectively. The condition factor increased. The specific weight growth rate averaged 0.54. From the results of the experiment, it is estimated that the return on the operating power costs could be 324% from January to April. But there are capital costs involved which are not required for conventional sea-cage operations. Since land-based salmon farms supplied with pumped seawater are apparently in themselves economically viable (based on Scottish experience), another way to express profitability is to say that the increase in growth observed in the experiment is all bonus for a culture strategy using pumped, ground seawater since no growth would occur if straight seawater is used. While the use of ground seawater holds promise as an innovative bioengineering approach to salmon farming, there are uncertainties. These include the ability to find sources of ground seawater in the large quantities required for commercial operations, and whether or not an elevated growing temperature during the winter months would promote early sexual maturation, although an offsetting advantage might be the larger size of grilse.

L'ÉLEVAGE COMMERCIAL DU SAUMON ATLANTIQUE (*Salmo salar*) A CAPLETON QUÉBEC. UNE NOUVELLE TECHNOLOGIES APPLIQUÉE A LA PROBLÉMATIQUE DE L'ENGRAISSEMENT DE CETTE ESPÈCE EN REGION MARITIME ATLANTIQUE.

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Au Quebec comme pour la majeure partie de la côte atlantique canadienne et du golfe du Maine, la mariculture du saumon atlantique et d'autres espèces de salmonidés ne peut se pratiquer de façon conventionnelle, en pares d'engraissement mouillés en mer a l'année. En hiver, la temperature de surface de l'eau de mer peut descendre sous le niveau létal de - 0.7°C pour le saumon. Certains sites clans

la region des Îles de Fundy subissent suffisamment l'influence des grandes marées propres a la Baie de Fundy pour permettre le developpement d'une industrie. Neanmoins, les temperatures hivernales de l'eau de mer peuvent y atteindre des valeurs aussi basses que 0.5°C. A l'hiver 1986, certains nouveaux sites en exploitation ont connus des pertes en raison de l'atteinte du point de létalité.

Un nouveau concept pour pallier a cette problématique consiste a engraisser les saumons en bassins côtiers. Avec un approvisionnement mixte (eau de mer et eau deuce), il est possible de proceder au melange des eaux d'élevage afin de se rapprocher de l'optimum de croissance de l'espèce. Pour le saumon, ces valeurs correspondent a une temperature de l'ordre de 10 a 12°C et une salinité de 11%. Avec l'utilisation de l'eau deuce, la temperature peut être maintenue a une valeur supérieure a O°C durant l'hiver.

Ces prémisses ont permi l'établissement au Quebec d'un premier centre piscicole voue a l'engraissement du saumon atlantique. Ce centre, localise a St-Omer pres de Carleton (Baie des Chaleurs) opère depuis novembre 1986. Une des caractéristiques intéressante du site de St-Omer est la decouverte d'une importance nappe d'eau souterraine. D'après une etude hydrogeologique, un debit de plus de 59 m^3/min. est disponible en pompant de puits d'une profondeur de 23 mètres. Ce debit appreciable pourrait être augmenté avec des puits plus profonds, certains puits d'essai ayant révélé une profondeur de plus de 35 mètres de gravier a forte permeability. Cette découverte ainsi que la technique d'élevage développée sent discutées en regard avec les perspectives de developpement de l'industrie au Quebec.

OVERWINTERING STRATEGIES FOR CULTURING ATLANTIC SALMON (*Salmo salar*) IN ICEBOUND ESTUARINE CONDITIONS.

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Survey's of insular Newfoundland's coastal environment conducted between 1984-86 indicated that potential areas for marine farming of salmonids are limited due to sub-leathal winter water temperatures induced by the cold southerly flow of the Labrador current and its accompanying drift arctic ice pack. There is, however, one area of the Province, Bay D'Espoir, which, while annually experiencing landfast ice cover, possesses unique oceanographic conditions that create a suitable microclimate for the culture of salmonids. The development of a commercial salmon farming industry in this region is contingent on the development of technology to provide daily feeding of caged fish as well as provision of an air-water interface to allow the physostomous salmonids to replenish their swimbladders during these ice bound periods. In addition, structural changes to cages and systems to prevent drift-ice collisions with floating structures are required during spring breakup. Experiments conducted in the winters of 1985-86 and 1986-87 utilized a variety of techniques to provide feeding and air access during these periods. Systems evaluated include; passive solar feeding boxes, gas-bubbling systems, mechanical flow generator systems, onshore pumped water culture techniques and submerged cages as possible strategies for improving overwinter survival. Results indicate that the provision of an open water area within cages provides adequate opportunity to allow fish to feed and replenish their swim bladders thus enabling minimal winter mortality and a nominal growth rates during winter periods in this region.

ACTIVITY PERFORMANCE OF ATLANTIC SALMON (*SALMO SALAR*) UNDER CHRONIC SUBSURFACE RETENTION IN COLD TEMPERATURE CONDITIONS-DR.

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Subsurface retention of Atlantic salmon (*Salmon salar* L.) leads to negative buoyancy effects due to the denial of surface access necessary for maintenance of swim bladder volume. Behavioral observations were used to quantify the swimming activity of salmon under chronic subsurface retention in the presence and absence of air-dome facilities. Denial of surface access resulted in increased swimming activity and a tendency to congregate in the upper portion of the cage. The effects of negative buoyancy were noted to develop more rapidly for 1 SW salmon than for O SW salmon, while introduction of a submerged "air cushion" alleviated the symptoms of negative buoyancy by allowance for "air gulping" activity. With access to an air-water interface salmon were retained at 10 m depth for up to 40 days. Subsequent resurfacing, with consideration of decompression requirements, was performed without mortalities.

REARING SALMONIDS WITH POWER PLANT ENERGY.

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Power plant condenser cooling water (12°C) and condensate water (52° F) has been utilized in combination with surface lake water and ground water to incubate, hatch and rear five salmonid species since 1980. Fish growth has been advanced to produce market or stocking sized fish in 18 months or six to twelve months earlier than conventional fish

culture facilities. Moreover, capital and operational costs were substantially reduced as the requirement of few year classes of fish increases the turnover rate. This technology, including a comprehensive bio-engineering planning and a formal technology transfer plan, could provide Canada's fledging aquaculture industry with the competitive advantage necessary to develop quickly and competitively into a primary industry.

ADVANCES IN AERATION USING THE «AQUATECTOR» SIDESTREAM.

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The Aquatector is a new invention used to drive gas into solution and has many potential applications in the field of aquiculture. The sidestream method of aeration, using the Aquatector system, involves pumping a small amount of water through the Aquatector where it is mixed under pressure with pure oxygen. Microbubbles (less than 50 microns), in suspension with super saturated water, are released from the unit and reintroduced into the existing flow. These small bubbles have a very slow climbing speed, provide and extremely large gas to water contact area, and are readily absorbed by the receiving water. Test results have shown that the Aquatector is capable of achieving absorption efficiencies as high as 93% when pure oxygen is used. Very few conventional aeration systems have been able to obtain absorption efficiencies over 60%. In addition to extremely high absorption efficiencies, the Aquatector is dependable, contains no moving parts, and is capable of handling ozone.

Session technique VI:
Génétique, reproduction et physiologic des poissons

Technical Session VI:
Finfish Genetics, Reproduction and Physiology

Modérateur:
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GROWTH OF TIGER TROUT (*Salvelinus fontinalis* x *Salmo trutta*).

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Growth rates of brook trout, brown trout and both reciprocal hybrids were determined for a 5-wk period at approximately one year after swimup and for a 4-wk period at 2 years of age. Growth from 6 to 10 months of brown trout families and their hybrid half-sibs was also compared. Growth before, during and after the spawning season was assessed and correlated with information on the maturation status of 2 and 3 year old brook trout, brown trout and reciprocal hybrids. External appearance and dressing percentage were also assessed for these fish to ascertain whether hybrids maintain a better appearance during and after the spawning season. Growth of 1 + year old brown trout was not significantly different from their Bn x Bk hybrid maternal half-sibs during a five week growth period. Growth of the 2 + yr old hybrids was approximately equivalent for the two reciprocal hybrids. The initial weight of the crosses was the same but the Bk x Bn fish were shorter and had a higher condition factor than the Bn x Bk fish. Additional data on growth of both reciprocal hybrids during the first year of life is also being collected.

EARLY SURVIVAL OF TIGER TROUT (*Salvelinus fontinalis* x *Salmo trutta*)

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Early mortality was monitored for hybrid brook x brown trout families produced using a factorial mating system and for pairs of maternal half-sib families, with a pure species brook or brown trout family and hybrid family sharing the same mother. Types of mortality identified and quantified were: 1) uneyed egg 2) eyed egg 3) hatched alevin 4) bluesac disease 5) cripples and twins. Total mortality was greater in the brook female x brown male (Bk x Bn) cross than in the reciprocal cross (Bn x Bk) due primarily to higher mortality at the egg stages. Mortality due to bluesac disease was a major source of mortality for both crosses. Because of higher mortality from bluesac in both crosses and higher mortality at the egg stages in the Bk x Bn cross, overall mortality was much higher in crosses compared with pure species mortality. In the Bk x Bn cross, most of the variation in total mortality was attributable to variation among the Bk dams while in the reciprocal cross, the Bk sires were the most important source of variation. The sire x dam interaction contributed a moderate amount of variability in mortality for both crosses. Brown trout dam performance, as measured by total early mortality of their pure species offspring, was not significantly correlated with their performance as hybrid dams. However, eyed egg mortality and mortality due to bluesac disease were correlated in brown trout and hybrid half-sib families. Performance of brook trout dams was not significantly correlated between pure and crossbred families. Correlations of early mortality in brook trout matings repeated in two years are rather low, suggesting that maternal performance is not highly repeatable across years in pure species matings.

EFFET DE L'ACTIVITÉ LOCOMOTRICE SUR LA CROISSANCE DE L'OMBLE DE FONTAINE SALVELINUS *FONTINALIS* MITCHILL.

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Une souche domestique d'ombles de fontaine a été entraînée pendant 20 jours a differences vitesses de courant: O, 0.85, 1.72 et 2.50 longueurs du corps par seconde (Us). La croissance ainsi que certains comportements agressifs ont été étudiés pour chaque niveau de traitement. La meilleure croissance a été obtenue clans le courant lent. Comparativement a l'eau calme (O Us), le courant lent (0.85 Us) favorise un meilleur taux de conversion alimentaire. De plus, la diminution des interactions agressives, occasionnée par la presence d' un courant, permettrait aux individus d'investir plus d'énergie clans la production de tissus musculaires. La diminution de croissance observée de 0.85 a 2.50 Us serait attributable a la trop grande quantité d'énergie investie clans la nage aces vélocités. L'implication de ces résultats sera discutée.

PERFORMANCES APRÈS ENSEMENCEMENT DE TROIS LIGNEES D'OMBLES DE FONTAINE (*SAI VELINUS FONTINALIS* MITCHILL).

Stephanie LACHANCE* et Pierre MAGNAN,
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Nous avons étudié les performances après ensemencement d'une lignée domestique, d'une lignée indigene et d'une lignée hybride (domestique x indigene) d'ombles de fontaine. Les parametres examines étaient le retour par la pêche sportive, la

croissance en longueur et en poids, le potentiel reproducteur et la reaction face a une espece compétitrice, le meunier noir (*Catostomus commersoni*). Les résultats préliminaires indiquent, qu'apres un an, les retours par la pêche sportive et la croissance sent meilleurs pour les lignées domestique et hybride, clans les lacs où ii n'y a pas de compétiteurs. Par contre, lorsque celle-ci se fait sentir, soit par les meuniers ou par les ombles residents, le retour et la croissance sent faibles clans tous les cas et aucune des lignées ne semble se demarquer de façon claire. Au moment de la période de reproduction, les femelles de la lignée indigene n 'étaient pas matures sexuellement alors que celles des lignées domestique et hybride presentient des indices gonado-somatiques (1. G. S.) caractéristiques d'individus matures. Chez les mâles, les individus de toutes les lignées étaient matures, mais l'I.G.S. moyen des mâles indigenes était le plus faible.

INFLUENCE DU CARBONATE DE LITHIUM (Li_2CO_3) SUR LA CROISSANCE DE L'OMBLE DE FONTAINE (*SALVENIUS FONTINALIS*).

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Les sels de lithium sent reconnus pour leur effet tranquilisant et antiagressif; de plus, ils favorisent une augmentation du poids chez les sujets traités. C'est pourquoi, du 10 juillet au 18 septembre 1985, des Ombles de fontaine ont été élevées en pisciculture et soumises a differences concentrations de lithium en vue d'accélérer [cur croissance. La méthode utilisée consistait a incorporer du carbonate de lithium a la nourriture. Dans l'ensemble, les résultats furent négatifs; plus la concentration en lithium était élevée, plus la croissance des poissons etait faible. La condition et l'indite de transformation ont également été plus faibles par rapport au groupe témoin. Malgré son effet tranquilisant, le lithium ne doit done pas être utilise pour favoriser la croissance de l'Omble de fontaine.

PROGRESS OF CIDA'S AQUACULTURE RESEARCH TECHNICAL COOPERATION PROJECT ON *COLOSSOMA* SPECIES AT THE BRAZILIAN AQUACULTURE RESEARCH AND TRAINING INSTITUTE IN PIRASSUNUNGA.

A. STERSKY* , CIDA, HULL, QUE.

Two Canadian aquiculture specialists, one in fish nutrition the other in induced fish reproduction have started their research on *Colossoma* species in April 1986.

Objectives in nutrition: compile/estimate probable nutrient requirements of *Colossoma* based on: existing literature, unpublished research resuls from Pirassununga and other Brazilian research centers. Characteristics of optimum values of temperature, water quality, dissolved oxygen for the *Colossoma* species: pacu and tambaqui, formulation of standard rations based on digestibility, protein/energy and growth studies of pacu and tambaqui, development of least cost rations from locally available ingredients are investigated.

Induced spawning in pacu has been obtained by using pituitary extract and LHRH in pellet form. Metomidate hydrochloride, Stersnil (azaperone) and 2-phenoxyethanoi have been used as anesthetics with juvenile and adult pacu; practical technique is developed for oral anesthesia to reduce excitation. Experimentation with biodegradable (of plant origin) insecticides is planned in order to replace organophosphate insecticide. The institute is planning to install under CIDA's guidance large scale plancton culture for larval rearing.

Session technique VII:
Economic, gestion, environnement et education

Technical Session VII:
Economics, Management, Environment and Education

Modérateur:
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Montreal, Quebec

NORTHERN EUROPEAN AQUACULTURE: IMPLICATIONS FOR THE CANADIAN INDUSTRY

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Although fish culture maybe site specific, we, in Canada, do not have to "Reinvent the wheel". European aquaculturists have had decades of experience culturing salmonids. The industry is expanding from these successes with salmonids into the culture of other species including cod, eel and turbot (*Scophthalmus maximus*). The National Research Council of Canada through its Industrial Research Assistance Program funded the presenters on a field study of aquacultural enterprises in Denmark, West Germany, Sweden, Norway and Scotland. European developments in the areas of fish food production, pollution control, cage technology and marketing of significance to the Canadian Aquiculture Industry will be discussed.

LA GESTION DE PROJETS AQUICOLES: UN MODÈLE GENERAL.

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Pour initier, developper et opérer un projet clans le secteur de la bio-industrie de l'aquiculture, plusieurs activités differences sent requises (e.g. la planification stratégique, la selection d'especes, l'analyse économique, la construction). Dans le but de coordonner ces activites, un modèle general de gestion est propose aux professionnels et aux producteurs. Ce modèle utilise une structure modulaire afin d'aider a l'acquisition, la repartition et l'utilisation des resources. Le modèle ne garantit pas le succès du projet ou de l'entreprise, mais il cherche a favoriser la prise de decision.

AN INVENTORY AND ENVIRONMENTAL EVALUATION OF 26 TROUT FARMS IN WEST CENTRAL ONTARIO.

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Rapid growth in the aquiculture industry in recent years coupled with instances of downstream degradation or conflicts in water use has prompted the Ontario Ministry of the Environment to conduct a study in 1986 of the trout farms located in the West Central Region. Seventy-two operations were identified from permit records held by the Ministry of the Environment and the Ministry of Natural Resources. Forty six had either ceased operations outright or were not operating on a commercial scale. The remaining twenty-six were fishing-for-fee and/or commercial rearing operations with the majority of sales direct to resturants, retail outlets or the Ontario Trout Producers' Co-operative. For ten farms from which accurate figures were available for both feed utilization and fish producing, feed utilization averaged 9.7 tons/y r., while producing 7.7 tons of fish/yr. Only two farms processed their fish on site, either fresh on ice or quick frozen, for direct sales through grocery stores, restaurants, etc.. Five of the twenty-six had some form of waste water treatment generally consisting of a settling pond with continuous discharge to the stream.

An evaluation has been conducted of the relative water quality contributions of different types of rearing facilities (ponds, circular tanks or raceways) and of the effectiveness of the treatment systems in place. Based on environmental considerations a "preferred" rearing and treatment design will be recommended.

ESTIMATING PRODUCTION FUNCTIONS IN AQUACULTURE.

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The empirical estimation of production and cost functions is an important aspect of the economics of aquiculture. Production functions, which are purely technological in nature, provide the maximum level of output for any given combination of inputs. When the production function is combined with input prices, duality theory allows direct calculation of the cost function; the inverse is also possible. Results of such empirical research may serve several purposes, including: (1) structural analysis, such as the evaluation of the marginal production of each input as well as elasticities of production; and (2) policy analysis such as the impact of a subsidization program for inputs on input usage and costs. A number of previous studies have been conducted in the area of production and cost functions for aquaculture. A model is proposed for the estimation of cross-sectional production functions for trout farms in Quebec. Possible research and policy applications of the results are discussed.

AQUICULTURE EN EAU DOUCE AU QUEBEC: QUELQUES RÉSULTATS ÉCONOMIQUES.

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Le but de cet article est de determiner les principales caractéristiques des entreprises aquicoles au Quebec. L'étude se concentre sur la production en eau deuce puisque les activités en milieu marin sent encore aux stades embryonnaires. La recherche a permis, en particulier, de mettre en evidence quelques facteurs socio-économiques pour expliquer le plafonnement de la production depuis 5 ans.

A PROJECT APPROACH TO TEACHING AQUACULTURE AND BUSINESS MANAGEMENT SKILLS IN THE CAGE CULTURE OF SALMONIDS PROGRAM AT THE MARINE INSTITUTE.

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The Salmon hatchery at Bay D'Espoir, Newfoundland, has 60000 —70 000 S-1 smelt ready to be turned over to private salmon farmers in the spring of 1987. A producers cooperative has been formed to coordinate production and marketing for ten small salmon farms which will receive 6000 smelt each. The Marine Institute held a Cage Culture of Salmonids program from September to December, 1986, to train 12 workers for these new salmon farms. For the first time in Canada, a "project approach" was used as the method of teaching in an aquiculture program. The "project approach" combined the teaching of the technical aquiculture skills necessary to operate a salmon farm and the business skills necessary to set-up and manage a farm successfully. Each student prepared a business plan for his own salmon farm. The business plan included a description of the business, a marketing strategy, a management plan, and complete financial projections for the first three years of operation. Other topics covered in the program included Assessing Your Potential as an Entrepreneur, Arranging Financing, and Marketing. A sample business plan will be presented for discussion.

STEADY-STATE MASS TRANSFER MODELLING: APPLICATIONS FOR AQUACULTURE.

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Steady-state mass transfer modelling, particularly of metabolizes, can be used to demonstrate and evaluate many aspects of aquatic culturing. Basic models can describe feed intake, growth, production of ammonia, oxygen consumption and other factors. More complex models can expand these relations, describe their interactions and offer a powerful tool to understand and to design aquatic holding systems; especially recirculated systems. Models constructed with correctly identified interfaces, describing fluxes across those interfaces, may permit identification of previously unsuspected relations. A complex model developed at Guelph has been used in the development of several recirculated systems and has been used to evaluate the performance of simple flow-through systems. The model is computer based to effectively manipulate the large number of variables involved. A natural extension of this work is to describe the simple relations in the model in terms of phenomenological equations permitting estimations of stability and coupling of related processes.