PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 204

Section: Population Biology

Project Title: Offshore Clams Assessment and Research

Project Leader: Roddick, D.

Other Researchers: Kenchington, E.

Work Activity: W.A.1.1.1.3

Key Words: clams; assessments; assessment research; resource surveys

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1. Project Description:

This project will be incorporated into project 2521 for 1993.

Conduct annual Scotian Shelf offshore clam assessments (Mactromeris polynyma and Arctica islandica) as required for management of the fishery. Research into the biology of the species and assessment methodology is conducted to improve the accuracy and precision of biological advice. Participate in industry/management meetings as required to explain or elaborate assessments and advice on alternate management strategies.

2. Long-Term Objectives:

To provide biological advice on Scotian Shelf clam stocks (Mactromeris polynyma and Arctica islandica), and improve the quality of advice as new information and/or methodologies become available through research and additional commercial data. To further develop the scientific information base for future management of currently underexploited and unexploited species.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Provide stock assessment for Scotian Shelf offshore clams. (Roddick)

A CAFSAC stock summary sheet was prepared and presented on the status of the 1991-92 offshore clam resource.

2. Present biological advice to Offshore Clam Advisory Committee and the Inshore Quahaug Working Group. Prepare biologically-based briefing documents when required, and participate in other DFO-sponsored activities pertaining to the resource management of clams. (Roddick)

One meeting of the Offshore Clam Advisory Committee was convened and attended (another in St. John's, Newfoundland was not attended for financial reasons).

3. Write up report on exploratory surf clam survey. (Roddick)

An Industry Report on the results of an exploratory survey for small Arctic surfclams on the eastern Scotian Shelf was prepared and published.

4. In cooperation with Dr. F. Tan of Physical and Chemical Sciences Branch, used the oxygen isotope technique to verify the use of chondrophore rings for ageing offshore clams. (Roddick)

This goal was dropped due to financial constraints.

5. Complete sampling program for inshore stock to determine the reproductive cycle. (Roddick)

Fifteen months of data have been collected from a sampling programme to determine aspects of the reproductive cycle of Mactromeris polynyma. Histological and shell sections are completed.

6. Finish analyzing samples and start writing up study on age-at-maturity of Mactromeris polynyma. (Roddick)

This goal was delayed due to a change in priorities.

7. Continue the collection and ageing of Mactromeris polynyma to increase the accuracy of growth data. (Roddick)

This goal has been dropped due to sampling and financial constraints.

8. Investigate cost of joint Scotia-Fundy/Newfoundland charter of the Delaware II from Woods Hole for a four-to-six week clam survey. (Roddick)

Inquiries were made into the possibility of chartering the Delaware II from Woods Hole for a four-to-

six week clam survey. Vessel use was confirmed, but costs have not been finalized

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

Amalgamated with project 2521 for 1993.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

Ageing of Mactromeris polynyma: T. Landry, DFO Gulf Region, M. Giguere, DFO Quebec Region, Biological Sciences Branch.

Exploratory Survey of Arctic Surfclams: D. Lemon, DFO Scotia-Fundy Region, Industry Services and Native Fisheries Branch.

Live storage of Mactromeris polynyma and Arctica islandica: S. Flynn, Nova Scotia Ocean Products.

ii. University Liaison -

iii. Communications -

Seminar on the Arctic surfclam fishery given to the Department of Oceanography, Dalhousie University.

iv. Contracts Administered -

One-month contract to Gayle Hartland for processing of historical samples.

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

Roddick, D.L., and D. Lemon. 1992. Exploratory Survey for Small Arctic Surfclams on the Eastern Scotian Shelf. Can. Ind. Rep. Fish. Aquat. Sci. 215: 33pp.

Roddick, D.L. 1992. Banquereau Bank Arctic surfclam Mactromeris polynyma, 1992. CAFSAC Invertebrate Committee Summary Sheet, November 1992.

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 205

Section: Population Biology

Project Title: Scallop Research

Project Leader: Kenchington, E. (nee Rice)

Other Researchers: Lundy, M. ; Roddick, D.

Work Activity: W.A.1.1.1.3

Key Words: scallop assessment ; morphometric analyses; scallop genetics ; ecology

1. Project Description:

This project will change from 205 to 2521 Scallop Assessment and Research - Inshore for 1993 and will incorporate project 204.

Conduct annual assessments of the Bay of Fundy scallop fishery. Research the population dynamics and ecology of Placopecten magellanicus.

2. Long-Term Objectives:

To improve the quality of advice on the Bay of Fundy scallop stock. To enhance the understanding of the biology of commercial scallop species.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Provide a stock assessment of the Bay of Fundy (Digby) scallop resource. (Kenchington)

A stock assessment of the 1991 Bay of Fundy (Digby) scallop fishery (see Res. Doc. 92/41) and the 1992 research survey along with preliminary information (see stock summary sheet) were reviewed by CAFSAC.

2. Present biological advice to Inshore Scallop Advisory Committee. Prepare biologically based briefing documents when required and participate in other DFO sponsored activities pertaining to the resource management of scallops. (Kenchington)

Two meetings of the Inshore Scallop Advisory Committee (ISAC) were attended and advice was presented at each of them.

3. Provide a stock assessment of Brier Island and Lurcher Shoal scallop resource. (Lundy)

A stock assessment of the 1991 Bay of Fundy (Brier Island) scallop fishery (see Res.Doc. 92/42) and the 1992 stock survey along with preliminary information (see stock summery sheet) were reviewed by CAFSAC I&MP Subcommittee.

4. Participate in Exploratory Fishing Program and evaluate data from the fishing logs. (Lundy)

Exploratory Fishing Licences were not renewed in 1992. No fishing activity took place prior to the end of the permit period. In response to requests from management and industry, a scallop biomass survey was completed in the exploratory area, and in adjacent offshore grounds. Results of the surveys were presented to ISAC. Few scallops were found inside the exploratory area, with the greatest concentrations lying along the line with the offshore. Scallops were abundant offshore on German Bank.

5. Conclude 18S rRNA gene sequencing of the scallop and clam species, including data analysis and publication. (Roddick, Kenchington)

All data has been collected and analyzed and reported on in both the Weekly Briefing, and as a poster at OPEN conference. A paper has been accepted (1993 Can. J. Fish. Aquatic Sci.), and a second one was submitted. Genetic markers were identified which differentiate the sea scallop from the Iceland scallop. An inability to detect mixed species catches has hindered development of the latter fishery in Newfoundland.

6. Complete morphometric study of scallop shells. (Kenchington)

All data has been analyzed and a manuscript prepared for internal review.

7. Continue RNA/DNA monitoring program. (Kenchington)

All 1990, 1991 and most of the 1992 samples have been processed and partially analyzed. The monitoring of the health status of the commercial beds off Digby has continued.

4. Additional Accomplishments:

1. Coordinated and produced a display booth for the Digby Scallop Days Festival in August, 1992.

2. Continued second year of seasonal collections of scallop meats and tissue on the Digby beds for meat weight and RNA/DNA analyses, through co-operation with a Digby scallop captain.

5. Goals/Expected Outputs for 1993:

1. Provide a stock assessment of the Bay of Fundy (Digby) scallop resource, and produce a technical report on the Bay of Fundy scallop fishery over the past decade. (Kenchington)

2. Present biological advice to Inshore Scallop Advisory Committee. Prepare biologically based briefing documents when required and participate in other DFO sponsored activities pertaining to the resource management of scallops. (Kenchington)

3. Provide a stock assessment of the Brier Island and Lurcher Shoals scallop resource using research survey data and fishery information. (Lundy)

4. Continue RNA/DNA monitoring programme and prepare data for publication. (Roddick)

5. Complete study of seasonal variation in somatic and reproductive tissue weight in the sea scallop; present results to industry, and prepare manuscript for publication. (Kenchington)

6. Monitor the offshore clam fishery and prepare biological advice as required. Attend meetings of the Offshore Clam Advisory Committee which are held locally. (Roddick)

7. Participate in a scallop assessment/resource science workshop. (Kenchington)

8. Begin analyzing the prepared histological and shell sections of Mactromeris polynyma for a study of the reproductive cycle in this species. (Roddick)

6. Background:

Highlights:

DNA sequences from the Iceland and sea scallops have provided a diagnostic tool to distinguish meats from catches where the species have been mixed. Both species co-occur in commercial quantities in Newfoundland. Previously, small sea scallop meats could not be distinguished from the Iceland scallop meats, and there was a potential danger of large quantities of the undersized sea scallops being illegally landed. With diagnostic DNA sequences available the development of the Iceland scallop fishery can proceed.

Selected Involvements:

i. Collaborative Research -

Image Analysis of Scallop Shells: Assoc. Prof. W.E. Full, Geology Dept., Wichita State University, Wichita, Kansas.

ii. University Liaison -

Image Analysis of Scallop Shells: Assoc. Prof. W.E. Full, Geology Dept., Wichita State University, Wichita, Kansas.

DNA Sequencing and Allozyme Electrophoresis in Scallops: Prof. E. Zouros, Biology Dept., Dalhousie University, Halifax, N.S.

iii. Communications -

Digby Scallop Days Booth. Digby, N.S., August 1992.

Television Interview (Alan Muise, Sou' Wester) on Inshore Scallop Fishery for 'Sea and Shore' programme, excerpts for Sou' Wester, and DFO videos to be issued to regional offices. March 1992.

Weekly Briefing article, Vol. 11, No. 29, July 24, 1992.

iv. Contracts Administered -

Commercial port sampling activities for the Bay of Fundy fleet (3 contracts).

AFAP contract for the development of computerized logs onboard a scallop fishing vessel.

Contracts for technical services for processing of histological samples and DNA sequencing (2 contracts).

v. Other -

7. Publications:

i. Primary -

Kenchington, E., K.S. Naidu, D.L. Roddick, D.I. Cook, and E. Zouros. 1992. The Use of Biochemical Genetic Markers to Discriminate Between Adductor Muscles of the Sea Scallop (Placopecten magellanicus) and the Iceland Scallop (Chlamys islandica). Canadian Journal of Fisheries and Aquatic Sciences. (accepted)

ii. Interpretive Scientific -

iii. Scientific and Technical -

Kenchington, E., and M.J. Lundy. 1992. 1991 Digby (Bay of Fundy) Scallop Stock Assessment. CAFSAC Res. Doc. 92/41, 27pp.

Kenchington, E. and M.J. Lundy. 1992. 1992 Brier Island and Lurcher Shoal (Bay of Fundy) Scallop Stock Status. CAFSAC Invertebrate Committee Summary Sheet, November 1992.

Kenchington, E., and M.J. Lundy. 1992. 1992 Digby (Bay of Fundy) Scallop Stock Status.CAFSAC Invertebrate Committee Summary Sheet, November 1992.

Lundy, M.J., and E. Kenchington. 1992. Brier Island Revisited: A 1991 Scallop Stock Status Report. CAFSAC Res. Doc. 92/42, 15pp.

iv. Popular and Miscellaneous -

Kenchington, E. (Poster) The use of RNA/DNA in Monitoring Scallops Stock Health. Digby Scallop Days, Digby, N.S.

Kenchington, E. and M.J. Lundy. (Poster) Scallop Abundance in the Bay of Fundy. Digby Scallop Days, Digby, N.S.

Kenchington, E. and M.J. Lundy. (Poster) Fishing Logbooks: The Value of Logbooks in Scallop Management. Digby Scallop Days, Digby, N.S.

Kenchington, E., K.S. Naidu, D.L. Roddick, D.I. Cook, and E. Zouros. 1992. (Poster) The Use of Biochemical Genetic Markers to Discriminate Between Adductor Muscles of the Sea Scallop (Placopecten magellanicus) and the Iceland Scallop (Chlamys islandica). Ocean Production Enhancement Network 3rd Annual Scientific Meeting, Halifax, N.S.

Lundy, M.J. (Poster) The Scallop Life Cycle. Digby Scallop Days, Digby, N.S.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 206

Section: Population Biology

Project Title: Cape Breton Crustacean Assessment and Research

Project Leader: Tremblay, J.

Other Researchers: Eagles, M.

Work Activity: W.A.1.1.1.3

Key Words: crabs; lobster; assessments; resource science

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1. Project Description:

This project will change from 206 to 2515 for 1993.

This project conducts research, stock monitoring, and fisheries assessment of snow crab and lobster stocks on the Atlantic side of Cape Breton Island. Advice is also provided on other crab species as requested. The research commitment applies to all aspects of the biology and population dynamics of crabs and lobster ecology that will support crustacean assessment and management.

2. Long-Term Objectives:

Assess present and potential production of commercial crabs in the Scotia-Fundy Region and the possible effects of various management strategies; conduct research on all aspects of the life history, ecology, and environment of commercial crabs and lobsters relevant to understanding natural and man-induced fluctuations in stock size; develop methods of analysis and theoretical models for the above; and communicate results to industry, management, and science.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Continue biological monitoring of commercial snow crab in the Scotia-Fundy Region during 1992. Provide analysis of the effects of the experimental claw gauge to fishermen; table summary sheets of the snow crab fishery to CAFSAC. (Tremblay, Eagles)

Goal met. Port and sea sampling of the snow crab fishery completed. Presentation to Snow Crab Advisory Committee meetings (April 1 and 25). Analysis of experimental claw gauge in Area 23 reviewed at CAFSAC in March (see Publications) and discussed at advisory meeting; fishers voted against continued use due to market conditions. Input of 1992 catch and effort data from fishing logs received to date is complete. Summary sheets of the snow crab fishery in Areas 20-24 were tabled at the Nov. CAFSAC subcommittee meeting.

2. Monitor the lobster fishery in LFA's 27-30, summarize the results and present to clients. (Tremblay, Eagles)

Goal met. Port and sea sampling of the lobster fishery reduced due to limited resources. Active solicitation of fishers resulted in increased number of voluntary logbooks (40 compared to 16 last year). These data have been input to LOBDATA. Summary sheets of the lobster fishery in LFA's 27-30 were tabled at the Nov. CAFSAC meeting. Advisory committees for LFA's 27-30 have not met in 1992.

3. Complete manuscript report describing the lobster fishery database. (Tremblay, Hunter)

Goal met. The database (LOBDATA) was documented in a manuscript report (See Publications).

4. Produce report on the effect of logbook number on the precision of lobster CPUE estimates, and the ability to detect annual changes in CPUE. (Tremblay)

Goal met. Working paper presented during 'The Year of the Lobster' at the Nov. CAFSAC meeting; Tremblay, M.J., Rodger and Pezzack. 'Evaluating trends in catch rate from voluntary fishing logs in the Nova Scotia lobster fishery.'

5. Produce preliminary report of seasonal and area differences in snow crab fecundity. (Tremblay)

Goal not met. Other priorities overriding. Honours student is now undertaking some of the laboratory analysis and her thesis will examine fecundity differences.

6. Produce preliminary report of changes in the geographic distribution of snow crab effort since 1978. (Tremblay, Eagles)

Goal partially met. Data have been plotted and have proved very useful in assessing changes in crab fishery. This work is now viewed as a component of a future manuscript looking at various aspects of the E. Cape Breton snow crab fishery.

7. Examine feasibility of obtaining estimates of growth and recruitment from juvenile surveys of snow crabs. (Tremblay, Eagles)

Goal partially met. An initial short survey to assess sampling gear on the 'Navicula' was partially successful. The ineffective beam trawl was replaced with a more effective flounder trawl.

8. Assess the potential of an initiative to increase CL in LFA 27 stocks. (Tremblay)

Goal met. Working paper presented during 'The Year of the Lobster' at the Nov. CAFSAC meeting; Tremblay, M.J. 'Potential increase in minimum legal size in LFA 27: Biological issues'. CAFSAC Working Paper.

9. To submit a long-term research proposal based on monies provided in workplan. (Tremblay)

Goal met. Initial draft of research proposal was submitted to Section Head in October.

4. Additional Accomplishments:

Provided scientific advice on a study of the lobster population in Bras D'Or Lakes. Met with representatives of the Aboriginal Fisheries Service and the Nova Scotia Dept. of Fisheries on several occasions.

Provided information by phone, mail, or in person to several fishers interested in harvesting underutilized crab species (stone crab, red crab, jonah crab, rock crab).

Provided biological input to GLOBEC project to model dispersal of scallop larvae on Georges Bank. Presented scallop overview at meeting at Dartmouth College (Apr. 92).

5. Goals/Expected Outputs for 1993:

1. Continue biological monitoring of the snow crab fishery in E. Cape Breton and conduct port and sea samples. Communicate status of resource to clients. Provide advice on other crab species as required. (Tremblay, Eagles)

2. Continue biological monitoring of the lobster fishery in LFA's 27-30 (E. Cape Breton). Maintain limited port and sea sampling of catch and collect log book data. Communicate status of and advice on resource to clients. (Tremblay, Eagles)

3. Submit a revised long-term research proposal in view of changing research milieu. (Tremblay)

4. Continue to provide scientific advice on an Aboriginal Fisheries Service (AFS) study of the lobster population of Bras D'Or Lakes and direct a study of the lobster molting cycle there. (Tremblay, Eagles)

5. Study the lobster molt cycle in a selected area of N. Cape Breton in conjunction with the joint project to develop an index of lobster pre-recruit abundance (project no.2160). (Tremblay, Eagles)

6. Upgrade working paper on evaluating CPUE changes from logbook number to a CAFSAC Research Document Explore further analyses with expanded data set (additional years in Port Maitland, additional ports) with goal of producing manuscript for primary publication. (Tremblay, Rodger, Pezzack)

7. Examine feasibility of obtaining estimates of growth and recruitment from juvenile surveys of snow crabs. Two aspects: (i) review sea sample data set and evaluate whether CPUE of small-clawed pre-recruits is correlated with next years CPUE within the fishery and; (ii) sample selected areas with trawls and small mesh traps (dependent upon availability of 'Navicula'). (Tremblay, Eagles)

8. Produce manuscript evaluating biological and economic aspects of carapace increase in LFA 27 stocks (Tremblay, Barbara) and do groundwork for the development of a regional proposal for carapace increase. (Tremblay)

9. Collaborate with GLOBEC team in authoring a paper that evaluates the dispersal of Georges Bank scallop larvae using a circulation model. Present paper at GLOBEC meeting in March, travel expenses funded by GLOBEC. (Tremblay)

10. Collaborate in drafting a manuscript reviewing snow crab regulations for primary publication (Reviews in Fisheries Science). (Elner, Tremblay, Taylor)

11. Produce preliminary report of seasonal and area differences in snow crab fecundity based on S. Roy's Honours Thesis. (Roy, Tremblay)

6. Background:

Highlights:

This project is addressing a number of issues important to the lobster and crab fisheries in Cape Breton, and to the assessment of these species within the Scotia-Fundy Region. Collaborations within DFO have resulted in documentation of a lobster fishery database, an evaluation of voluntary logbook CPUE estimates, and an assessment of the effects of increasing the gauge size in LFA 27. There was positive interaction with Cape Breton native groups on issues related to lobster biology and management. In addition to his work in crustacean fisheries science, the project leader continues to play a small but important role in research related to larval scallop ecology.

Selected Involvements:

i. Collaborative Research -

GLOBEC project to model the dispersal of Georges Bank planktonic larvae : J. Loder and D. Greenberg (Physical and Chemical Sciences Branch); M. Sinclair and F. Page (BSB); D. Lynch (Dartmouth College, NH, USA); F. Werner (Skidaway Institute GA, USA); I. Perry (PBS); G. Lough (NMFS, USA).

Effects of increasing carapace size in LFA 27: R. Barbara and R. Shotton.

ii. University Liaison -

Dalhousie University, Dept. of Biology: External examiner of D. Jackson M.Sc. thesis. Title: Physiological ecology of Placopecten magellanicus: food availability & larval growth response (Jan., 1992).

External supervisor of Honours thesis (Sophie Roy; snow crab fecundity).

University of Guelph, Dept. of Zoology, Dr. J.C. Roff. Methods for measuring instantaneous growth in crustacea. Proposal to develop methods for application to decapod crustacea has been submitted.

iii. Communications -

Crab advisory meetings (Apr. 1, 25)
Talk for Native Guardian Course: 'Biology and Management of Lobsters and Crabs' (Apr)
Contribution to Digby Scallop Days (poster on larvae and recruitment) (Apr.)
Prepared media release on the snow crab fishery off Eastern Cape Breton (Aug.)
Weekly briefing: 'Exploratory trawling for snow crabs off Eastern Cape Breton' (Nov.)

Science in the Schools:

Talk on Fisheries Science as a career (Career Days, Holland Road School, Feb. 1992);
Science Fair judge (Halifax, Dartmouth, Bedford Regional Science Fair, Apr. 92);
Participant in Learning Connections Project (Computer network for high school students).
Talk to high-school students visiting the Halifax Lab (Nov. 92).

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Beninger, P.G., C. Lanteigne, and R.W. Elner. 1992. Reproductive processes revealed by spermatophore dehiscence experiments and by histology, ultrastructure and histology of the female reproductive system in the snow crab Chionoecetes opilio (O. Fabricius). Journal of Crustacean Biology. (in press)

Elner, R.W. and P.G. Beninger. 1992. The reproductive biology of Snow Crab, Chionoecetes opilio: a synthesis of recent contributions. Amer. Zool. 32: 524-533.

Govind, C.K., Read, A.T., Claxton, W.T., and Elner, R.W. 1992. Neuromuscular analysis of the chela-closer muscle associated with precopulatory grasping in male snow crabs, Chionoecetes opilio. Can. J. Zool. 70:

Perry, I. A., G. C. Harding, J. W. Loder, M. J. Tremblay, M. M. Sinclair, and K. F. Drinkwater. 1992. Zooplankton distributions at the Georges Bank frontal system: retention or dispersion? Continental Shelf Res. (in press)

Tremblay, M. J. and M. Sinclair. 1992. Planktonic sea scallop larvae (Placopecten magellanicus) in the Georges Bank region: broadscale distribution in relation to physical oceanography. Can. J. Fish. Aquat. Sci. 49: 1597-1615.

ii. Interpretive Scientific -

iii. Scientific and Technical -

Hunter, C. M. and M. J. Tremblay. 1992. A database for catch and length composition related to the Scotia-Fundy lobster fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. 2149: 27p.

Pezzack, D. S., M. J. Tremblay, C. Hudon, and R. J. Miller. 1992. The inshore-offshore lobster issue in southwestern Nova Scotia. Can. Manuscr. Rep. Fish. Aquat. Sci. 2165: 23p.

Tremblay, M. J., M. Eagles, and R. W. Elner. 1992. Trial use of a claw gauge as an alternate measure of minimum legal size in the snow crab fishery of eastern Cape Breton (Area 23). CAFSAC Res. Doc. 92/24. 11p.

iv. Popular and Miscellaneous -

Loder, J.W., R.I. Perry, K.F. Drinkwater, J. Grant, G.C. Harding, W.G. Harrison, E.P.W. Horne, N.S. Oakey, C.T. Taggart, M.J. Tremblay, D. Brickman, and M.M. Sinclair. 1992. Physics and biology of the Georges Bank frontal system. Science Review 1990 & 91: 57-61. Published by Scotia-Fundy Region of DFO.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 207

Section: Population Biology

Project Title: Marine Plants Assessment and Research

Project Leader: Sharp, G.

Other Researchers: Semple, R. ; Pringle, J.

Work Activity: W.A.1.1.1.5

Key Words: marine plants; Irish moss; Chondrus; Ascophyllum; Laminaria; assessments; assessment research

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1. Project Description:

This project will change from 207 to 2530 for 1993.

This project is an ongoing function dealing with research, monitoring and stock assessment of Maritime marine plant fisheries. Advice is given to a wide range of clients.

2. Long-Term Objectives:

To understand the relationship between marine macroalgal productivity and major abiotic and biotic variables; to determine the biological effects of long-term harvesting on marine plant productivity; to develop management models and harvesting strategies for the commercially important marine plant species in the Region; and to give sound stock assessment and biological advice to clients.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Assessment of Ascophyllum resources in Southwestern Nova Scotia. (Sharp)

Goal met. Landing data are as not yet available.

2. Update the information on the abundance and distribution of New Brunswick Ascophyllum resources. (Sharp)

Goal met. This information was presented to the combined meeting of the CAFSAC Invertebrate and Marine Plants and the Habitat Science sub-committees.

3. Evaluation of linear and non linear models for Chondrus population dynamics. (Sharp)

Goal not met. This project was postponed because of other commitments.

4. Develop an assessment and monitoring program for the Ascophyllum management plan in Southern New Brunswick. (Sharp)

Goal met. The draft N.B. Ascophyllum management strategy and monitoring plan was the foundation for the development of Southern N.B. resources and was presented at a series of public meetings, federal/provincial meetings and finally to CAFSAC.

5. Continue sampling Chondrus populations in SWNS for phase and condition indices. (Sharp)

Goal not met. This project was postponed to permit emphasis on assessment and research needs in Ascophyllum.

6. Publish manuscript report on standing crop of Ascophyllum in N.B. (Sharp)

CAFSAC working paper 92/218 recommended for upgrading to Res. Doc.

7. To co-chair a mini symposium on problems in the resource management of seaweeds, at the ISS., Brest, France. (Pringle)

Goal met. Mini Symposium, 'Factors limiting the attainment of optimal yield from natural stocks' was organized and held. Papers were presented covering Spain, Portugal, Moracco, Canada, Chile and France.

8. To supervise Ph.D. student R. Santos. (Pringle)

Ph.D. student Rui Santos passed his oral exam and is currently analyzing data. A paper from his thesis was awarded 'Best Student Paper' at the XIV ISS in Brest, France.

9. To continue providing consultancy to IDRC on seaweed projects. (Pringle)

Report submitted on November 1991 site visit of research projects at University of Philippines' Marine Science Institute at Quezon City, Manila.

4. Additional Accomplishments:

1. Provided resource assessment advice to IDRC on the project 'Red seaweed development in Senegal'.
2. Assessed the abundance and distribution of Ascophyllum in Lunenburg Co. N.S.
3. Monitored the recovery of Ascophyllum populations after a controlled harvest. This work was carried out with Dr. Put Ang, PDF at the Halifax Fisheries Research Laboratory.
4. Initiated recruitment studies on Ascophyllum to determine the relative contributions of sexual and asexual recruitment with Rui Santos, doctoral student ate the Halifax Fisheries Research Laboratory.
5. Attended the 14th ISS, Brest France; co-authored three presentations. (Sharp & Pringle)
6. Provided advice and assessed a research proposal for CARTIS Co. Ltd. on Gracilaria harvesting in Sri Lanka.

5. Goals/Expected Outputs for 1993:

1. Assess the status of Ascophyllum stocks in Nova Scotia and provide advice to clients. Serve on joint federal/provincial management committee providing advice on management and development of the harvest.
2. Continue to monitor the recovery of harvested Ascophyllum populations at Pubnico for the second year of a three year program.
3. Continue Ascophyllum recruitment studies, Kiely Cove, Halifax Co.
4. Initiate a harvest monitoring program and serve on joint Federal/N.B. Management committees if resource is exploited.
5. Establish three permanent study sites in Lunenburg Co. to monitor recovery of harvested Ascophyllum beds. Only possible if N.S. provides resources.
6. Develop a matrix model for harvested Chondrus populations in conjunction with PDF, Put Ang.
7. If a fishery is directed at Mytilus edulis, monitor effort.
8. Initiate a resource assessment program in Senegal for Hypnea spp., assess abundance levels and provide biological advice.

6. Background:

Highlights:

The marine plants unit has responded to the continued expansion of the Ascophyllum harvest in Scotia-Fundy. It has acquired resources from two provincial governments and industry to.

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

Dalhousie University; on the committee of M. Lazo, Ph.D., project on Ascophyllum. (Sharp)

St. Francis Xavier. with Dr. Garbary on taxonomy of Senegal seaweeds for IDRC project. (Sharp)

iii. Communications -

Attend numerous public meetings on the development of the Ascophyllum fishery in Southern New Brunswick.

Interviewed for the national resource program Land and Sea on Ascophyllum resources.

Co-Chair of the session on Algal Ecology at the XIV ISS, Brest, France.

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Ang, P., G. Sharp and R. Semple. 1993. Experimental assessment of changes in the population structure of Ascophyllum nodosum(L.) Le Jolis due to Mechanical Harvesting. Hydrobiologica (in press)

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

A draft management strategy and monitoring program for the harvest of Ascophyllum in Southern New Brunswick presented to the industry and stakeholders as a joint proposal of DFO and the provincial government.

Ang, P.O., G.J. Sharp and R.J. Semple. 1992. Experimental assessment of changes in the population structure of Ascophyllum nodosum due to mechanical harvesting (P55). Abstracts and Programmes. XIV ISS, Universite de Bretagne Occidental Brest, France: 186pp

Pringle, J.D., G.J. Sharp and T. Chopin. 1992. When science does not limit optimal yield: Canadian seaweed resource management (P117). Abstracts and programme, XIV ISS., Universite de Bretagne Occidental Brest, France: 186pp

Sharp, G.J. C. Tetu, R. Semple and D. Jones. 1992. Recent changes in the marine plant community of western PEI: implications for the industry (P.124). Abstracts and programme, XIV ISS., Universite de Bretagne Occidental Brest, France: 186pp

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 208

Section: Population Biology

Project Title: Marine Plants Assessment and Research - Gulf Region

Project Leader: Sharp, G.

Other Researchers: Semple, R.; Jones, D.; Pringle, J.

Work Activity: W.A.1.1.1.5

Key Words: marine plants; Irish moss; Chondrus; wireweed Furcellaria; assessments; assessment research

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1. Project Description:

This project will change from 208 to 2531 for 1993.

This project is an ongoing function dealing with research, monitoring and stock assessment of marine plant fisheries in the Gulf of St. Lawrence. Advice is given to a wide range of clients.

2. Long-Term Objectives:

To understand the relationship between marine macroalgal productivity and major abiotic and biotic variables; to determine the biological effects of long-term harvesting on marine plant productivity; to develop management models and harvesting strategies for the commercially important marine plant species in the Region; and to give sound stock assessment and biological advice to clients.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Provide biological advise to the resource managers and the industry. (Sharp)

Goal met. Provided advice to the Marine Plants Advisory Committee for P.E.I. (MPAC-P.E.I.) on the status of the resource and harvesting effort. Provided advice to the province on the development of underutilized species, their distribution, abundance, and productivity.

2. Provide an analysis of the long-term changes in marine plant communities in District 1. (Sharp)

Goal met. Presented the paper, "Changes in the seaweed community of western P.E.I. and implications for the industry, at the XIV International Seaweed Symposium (XIV ISS) Brest, France.

3. Examine the marine plant beds of District 6 and determine if any significant changes have occurred in the last ten years. (Sharp)

Goal not met. This project was postponed due to lack of resources; effort placed in District's 1 and 2.

4. Integrate information on nutrient status of Chondrus and Furcellaria with growth studies. (Sharp, Chopin)

Goal met. Interim data from this study were presented in a paper at the XIV ISS and has been accepted for publication.

5. Initiate competition experiments based on manipulation of density of Furcellaria and Chondrus. (Sharp, Têtu)

Goal met. Competition experiments were initiated in Miminegash and monitored three times.

6. Evaluate effort and landing trends in the harvesting industry. (Jones)

Goal met. A report was presented to P.E.I. Fisheries on changes in community structure of commercial beds and recommendations for research and management.

7. Publish primary publication on the distribution of Furcellaria in District 1, P.E.I. (Sharp)

Goal met. See publications.

4. Additional Accomplishments:

1. Initiated experiment to determine the effect of harvesting on the reproductive capacity of Furcellaria.

2. Discovered and delineated extensive Laminaria beds in Marine Plants District 2.

3. Presented a poster at the XIV ISS on 'Commercial Seaweeds of P.E.I.' with D. Judson, P.E.I. Department of Fisheries.

4. Participated in the development of terms of reference for a multi-agency supported market study on Chondrus crispus.

5. Goals/Expected Outputs for 1993:

1. Provide biological advice to resource managers and industry based on stock assessments and resource science.

2. Provide advice to the industry on the degree and rate of change in dominant species in commercial Chondrus beds of Western P.E.I.

3. Submit for a manuscript on the comparative growth and nutrient strategies of Chondrus and Furcellaria.

4. Determine the strategies available for manipulating species composition in commercial Chondrus beds based on recent competition experiments.

5. Initiate a Laminaria harvest experiment to determine impact on recruitment and growth.

6. Background:

Highlights:

The provision of a research program to the Gulf Region focused on immediate commercial resource problems at a scale well beyond the human and fiscal resources of DFO. This additional effort was made possible due to the assistance of the P.E.I. government. This is the half-way year mark of a five-year program. The extent of resource problems has been defined and experiments are underway to find solutions.

Selected Involvements:

i. Collaborative Research -

Dr. T. Chopin, Department of Biology, University of New Brunswick: Nutrient status of Chondrus and Furcellaria and in relation to growth.

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Chopin, T., J. Pringle and R. Semple. 1992. Impact of harvesting on frond density and biomass of Irish moss (Chondrus crispus stackhouse) beds in the southern Gulf of St. Lawrence. Can. J. Fish. Aquat. Sci. 49:349-357.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Judson, G., R. Semple, and G. Sharp. 1992. Seaweed resources of Prince Edward Island. Canada. Abstracts and Programme, XIV International Seaweed Symposium.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 210

Section: Population Biology

Project Title: Lobster Stock Assessment (LFA 40-41) and Related Research

Project Leader: Pezzack, D.

Other Researchers: Duggan, D.

Work Activity: W.A.1.1.1.3

Key Words: lobster biology ; assessments ; assessment research ; LFA 40-41 ; stock structure ; offshore lobster

1. Project Description:

This project will be combined with 214 to form 2513 Lobster Assessment and Research (LFA's 34, 40-41) for 1993.

This project is an ongoing function dealing with: (i) monitoring and assessment of offshore lobsters on the Scotian Shelf, Gulf of Maine and Georges Bank (LFA 41); (ii) determination of the relationship between offshore and inshore lobster and the impact of offshore fishing activity on other areas; and (iii) research into the life history, ecology, and environment of lobsters relevant to understanding the natural and man-induced fluctuations in lobster stock size.

2. Long-Term Objectives:

To provide relevant biological advice to resource managers and clients. To improve our comprehension of the biology and ecology of offshore lobsters.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Assess the offshore lobster fishery through log books, sales slips and at-sea sampling programs. (Pezzack, Duggan)

Goal met. Offshore lobster fishery (LFA 41) logbooks and sales slips (100% coverage) coded and catch, effort, and C/E calculated. A report on the status of the fishery was prepared for the Offshore Lobster Advisory Committee (OLAC; meeting planned for Jan. 1993), and summary sheets for the 1991 and 1992 fishing seasons were prepared for the CAFSAC Invertebrate and Marine Plants Subcommittee meeting in March 1992 and November 1992 respectively. At sea sampling not planned for in 1992.

2. To communicate assessment and research results to the fishing industry. (Pezzack, Duggan)

Goal met. Information on the offshore fishery and assessment methods were presented to industry. Discussions continue on making fishery information public, after a failure to reach a final agreement during the past winter.

3. Publication of: a) Inshore/offshore lobster workshop report (early 1992); b) Lobster distribution paper (early 1992); c) Offshore lobster growth paper. (Pezzack, Duggan)

Goals partially met. "The inshore-offshore issue in SW Nova Scotia" published. Additional papers on the distribution and growth of offshore lobsters are in final stages of preparation.

4. Analyze offshore lobster tagging data base and prepare a publication on offshore lobster distribution and movements in the Browns Bank Area. (Pezzack, Duggan)

Goal not met. The analysis of the offshore tagging database is in progress. A paper on lobster movements in the Browns Bank Closed Area is in progress.

5. Compare NMFS trawl data biomass estimates and actual fishery catch rates. (Pezzack)

Project not undertaken due to changes in priorities.

4. Additional Accomplishments:

1. Invited speaker at Canadian Conference for Fisheries Research (Halifax, Jan. 3-4, 1992). Presented a paper "Lobster migration: Stock structure on movement and migration in lobsters." (Pezzack)

2. Presented "The inshore offshore issue in SW Nova Scotia" report to CAFSAC I&MP Subcommittee (March 1992). (Pezzack)

5. Goals/Expected Outputs for 1993:

This project will be combined with 214 to form 2513 Lobster Assessment and Research (LFA's 34, 40-41) for 1993.

6. Background:

Highlights:

Cooperation from the offshore fishermen has remained high. Tags are still being returned from offshore releases conducted in the mid 1980's. The return rate is high and it is felt that there are few unreported tags from the offshore fishery. Log book compliance is 100%, allowing determination of daily fishing patterns.

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

Responded to numerous questions on the fishery and lobster biology from fishermen, DFO staff and the general public. (Pezzack, Duggan)

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

Pezzack, D.S., M.J. Tremblay, C. Hudon, and R.J. Miller. 1992. The inshore - offshore lobster issue in southwestern Nova Scotia. Can. Manuscr. Rep. Fish. Aquat. Sci. 2165: 23p.

Pezzack, D.S. and D. R. Duggan. 1992. LFA 41. 1991 Lobster Summary Sheet.

Pezzack, D.S. and D. R. Duggan. 1992. LFA 41. 1992 CAFSAC Lobster Summary Sheet.

iv. Popular and Miscellaneous -

D.S. Pezzack. 1992. Lobster migration: Stock structure. Unpublished Abstract. Canadian Conference for Fisheries Research, Halifax, N.S. Jan. 3-4, 1992

D.S. Pezzack. 1992. Lobster Migrations: the long and short of it. Weekly Scientific Briefings 11(3)

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 211

Section: Population Biology

Project Title: Lobster Habitat Research and Assessment Methodology

Project Leader: Miller, R.J.

Other Researchers: Nolan, S.

Work Activity: W.A.1.1.1.3

Key Words: lobster; assessment research; habitat research

1. Project Description:

This project will change from 211 to 2510, Lobster Assessment and Research (LFA 33), for 1993.

The interdependence of near-shore marine communities and exploited species are investigated. Methods for stock assessment and increasing fisheries yields are developed.

2. Long-Term Objectives:

To assess the impacts of macrophyte removal on exploited species, the selectivity of crab and lobster traps, and factors affecting lobster recruitment to the fishery. To advise diverse industry and government clients.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Make editorial changes required on manuscripts mentioned in 3.1 and 3.3 above.

Goal met. Manuscript on the Leslie method is with co-author who is assessing changes. Manuscript on lobster catchability co-efficients is in press.

2. Finish and submit manuscript mentioned in 3.4.

Goal not met. A manuscript on variation of lobster size at sexual maturity was not completed due to other commitments.

3. Review results of lobster larval sampling and collect a second year's data on fishermen's catches of egg-bearing females.

Results from larval sampling were reviewed, in part, which may identify a production bottleneck. Location and number of ovigerous female lobsters captured were obtained in 1992 from 60 log books issued for this purpose.

4. Continue advising on management of a new N.S. sea urchin fishery.

Our log book records were the only reliable source of sea urchin fishery statistics for Nova Scotia. Advised management on the type and amount of effort, harvesting times, locations, methods, and holding and shipping methods.

5. Continue as lobster research coordinator at the HFRL.

A pilot program on lobster was developed with J. Tremblay, C. Hudon, and D. Pezzack. Lobster depth distribution was determined by trapping, a preseason trapping survey was conducted in Shad Bay, and area fishermen were interviewed regarding their fishing locations and their interest in participating in the study.

6. Assume responsibility for monitoring and advising on the LFA 33 lobster fishery.

The fishery was monitored throughout the season by log books and length frequency samples, and assessed. Summaries were presented to meeting of CAFSAC-IMP and the LFA 33 advisory committee. The impact on the Navy firing range on lobster catches was updated. Fisheries and Habitat Management Branch was advised on season extensions.

7. Regional representative on DFO Science Subvention Committee.

One hundred and twenty reviews of research proposals were solicited and presented.

4. Additional Accomplishments:

1. Supervised the touch tank on the Halifax waterfront with increased hours and staff over last year. One hundred and twenty thousand people visited the tank from June through September.

2. Met twice with the Armour Group to discuss a public aquarium to be located at Historic Properties.

3. Advised government (in addition to 3.4, 3.6 and 3.7): B.C. Parks - sea urchin predators; N.S. Government and Gulf Region DFO - lobster research priorities; Gulf Region DFO - snow crab catch in gillnets; DOT - lobster abundance survey design; DFO, Scotia-Fundy - fishing effort in Halifax Harbour; DFO, Scotia-Fundy - urchin abundance survey design; Russia - ctenophore predation on fish larvae.

4. An experimental trapping study on the south shore investigated lobster catch rates versus time of day and number of hours fished.

5. An experimental laboratory study investigated artificial habitats chosen by juvenile lobsters.

6. Wave surge and light was recorded in four types of seaweed habitat.

5. Goals/Expected Outputs for 1993:

1. Finish manuscript on lobster sexual maturity with F. Watson; and submit manuscripts with J. Addison (experimental study on crab and lobster interactions), R. Elner (a fishery licensing strategy), and R. Mohn (Leslie method).

2. Investigate field methods of capturing juvenile lobsters, eg., small trawls, small mesh traps, and diver deployed artificial habitats.

3. Continue monitoring and advising on management of the LFA 33 lobster fishery.

4. Continue advising on the sea urchin fishery.

5. Continue as lobster research coordinator at HFRL.

6. Continue as regional representative on Science Subvention Committee.

7. Work with Historic Properties in developing a public aquarium.

6. Background:

Highlights:

A positive response from lobster fishermen to our research initiatives. A second successful year of the touch tank.

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

Presentation to Benthic Ecology Workshop, St. Andrews: Gaps in our knowledge of lobster life history.

Assisted Communications Branch in writing three articles for the popular press. One of these, on trap design resulted in 14 letters and more phone calls requesting additional information.

Two submissions for the Weekly Science Briefing.

Two radio interviews taped for Broadcast News

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

Miller, R., A. Campbell, G. Sharp, and C. Hudon. 1992. Are juvenile lobsters habitat limited? *In* Y. de LaFontaine, G. Lilly, and R. Miller eds., Tech. Rep. Fish and Aquat. Sci.

Pezzack, D., M. Tremblay, C. Hudon, and R. Miller. 1992. The inshore-offshore lobster issue in southwestern Nova Scotia. Can. Ms. Rep. Fish. Aquat. Sci. 2165: 19p.

iv. Popular and Miscellaneous -

Miller, R. (abstract). Strengths of lobster fishery management in Scotia-Fundy. CAFSAC - The Year of the Lobster.

Nolan, S. and R. Miller (abstract). Lobster assessment methodology. CAFSAC - The Year of the Lobster.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 212

Section: Population Biology

Project Title: Lobster Resource Science - Larval Biology

Project Leader: Harding, G.C.; Pringle, J.

Other Researchers: Vass, W.P.; Duggan, R.; Miller, R.J.

Work Activity: W.A.1.1.1.3

Key Words: lobster; assessment research; larvae; recruitment

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1. Project Description:

This project will be included with 213 to form 2512 for 1993.

Studies designed to further understanding of lobster larval ecology and thereby the recruitment process of the American lobster through field studies and laboratory experiments.

2. Long-Term Objectives:

Provide scientific advice required to improve management of the lobster fisheries in the near-shore and offshore regions of Atlantic Canada based on results of research on larval lobster ecology, production, and recruitment.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Write and submit for primary publication manuscripts on: a) the vertical migration of lobster planktonic stages (Harding) and, b) the temporal and spatial distribution of lobster larvae in St. Margarets Bay, N.S. (Pringle)

Goals not met. a) data analyzed on larval vertical migration; b) the 1983 data analyzed and report in draft form.

2. Submit for internal review, a manuscript on the spatial distribution of the planktonic lobster life history stages in relation to Georges Bank. (Harding)

Goal not met. Effort placed on lobster larval size manuscript (see publications).

3. Prepare a manuscript on the evidence for lobster larval dispersal from Georges Bank. (Harding)

Goal not met. Effort placed on a review of lobster larval biology and ecology (see communications).

4. Conduct a study to track the dispersal of lobster larval patches from NW Browns Bank using Loran-C drifters and Vass-Tucker trawl. (Harding)

Goal not met. Cruise cancelled due to lack of resources.

4. Additional Accomplishments:

An extensive review of lobster larval biology and ecology was written and presented.

5. Goals/Expected Outputs for 1993:

No Goals; project will be included with 213 to form 2512 for 1993.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

Paper presented at the CAFSAC subcommittee's lobster workshop.

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

DiBacco, Claudio, and John D. Pringle. 1992. Larval lobster (*Homarus americanus*, H. Milne Edwards, 1837) distribution in a protected Scotian Shelf Bay. J. Shellfish Res. 11: 81-84.

Harding, G., E. Kenchington, and Z. Zheng. 1992. Morphometrics of lobster larvae, *Homarus americanus* Milne Edwards, in relation to stock determinations in the Maritimes, Canada. Can. J. Fish. Aqua. Sci. 49: _____.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Harding, G. 1992. An overview of lobster larval ecology. Abstract. CAFSAC I&MP Subcommittee, The Year of the Lobster, Workshop.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 213

Section: Population Biology

Project Title: Lobster Resource Science and Assessment (LFA 31 and 32)

Project Leader: Pringle, J.

Other Researchers: Duggan, R.; Harding, G.C.

Work Activity: W.A.1.1.1.3

Key Words: lobster; assessments; LFA 31-32; assessment research

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1. Project Description:

This project will change from 213 to 2512 Lobster Assessment and Research (LFA 31 and 32) and will include project 212 for 1993.

Ongoing assessment of the lobster fishery along Nova Scotia's eastern shore, developing assessment techniques, carrying out resource science, providing biological advice to industry and the resource manager.

2. Long-Term Objectives:

To provide the best possible advice on which to base sound lobster management by employing the most efficient methods for gathering and analyzing stock assessment data and by carrying out pertinent research.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Assess the lobster stocks in LFA 31-32 and provide biological advice to the resource manager and industry. (Duggan)

Goal met. Lobster port sampling carried out as planned, data analyzed and Summary Sheet developed and presented to CAFSAC. LFA 31/32 yet to meet this fiscal year.

2. Write and submit a manuscript on aspects of lobster reproductive ecology. (Pringle)

Goal not met. Emphasis placed elsewhere.

3. Provide biological advice, via CAFSAC, on lobster growth and dispersion in the southern portion of LFA 32. (Pringle)

Goal partially met. Growth data analyzed but not written up. Lobster movement data used in Can. Manscr. Rept. Fish. Aqua. Sci. No.1716.

4. Give advice on the influence of tagging data on tag retention. (Duggan)

Goal partially met. Data analyzed and a report written, but transferred to M. Moryasu, Gulf Region for development of a joint publication.

5. Assist and supervise graduate student R. Ugarte and Honours B.Sc. student T. Lee. (Pringle)

Goal met. R. Ugarte developed a proposal for 1992 field work incorporating suggestions from Stan Cobb and Dave Aiken's laboratories respectively, following presentations at each. A successful field season was completed. About 200 reproductively mature (non-berried) female lobsters were tagged in early spring and followed through to July, with the aid of Canso area fishers. Additionally, twenty animals were caged at two depths along with egg-bearing females; the respective pleopods and eggs were removed weekly to assess maturation rates in relation to water temperatures. A paper on this work was presented at the First European Crustacean Conference in Paris.

T. Lee successfully defended his B.Sc. Honours thesis, presented a poster at the Cameron Conference, Dalhousie University, and has drafted a manuscript ready for internal review.

6. Co-edit The Lobster Newsletter. (Pringle)

Goal met. Two issues of Volume 5 were edited and published.

4. Additional Accomplishments:

Meeting held with principals of Canso area schools in preparation for lobster science day in spring, 1993.

5. Goals/Expected Outputs for 1993:

1. Assess the lobster stocks in LFA 31-32 and provide biological advice to the resource manager and industry. (Duggan)

2. Write and submit a manuscript on aspects of lobster reproductive ecology. (Pringle)

3. Provide biological advice, via CAFSAC, on lobster growth and dispersion in the southern portion of LFA 32. (Pringle)

4. Assist and supervise graduate student R. Ugarte. (Pringle)

5. Co-edit The Lobster Newsletter. (Pringle)

6. Write and submit for primary publication manuscripts on: a) the vertical migration of lobster planktonic stages (Harding) and, b) the temporal and spatial distribution of lobster larvae in St. Margarets Bay, N.S. (Pringle)

7. Submit for internal review, a manuscript on the spatial distribution of the planktonic lobster life history stages in relation to Georges Bank. (Harding)

8. Prepare a manuscript on the evidence for lobster larval dispersal from Georges Bank. (Harding)

6. Background:

Highlights:

The discovery of a shoreward movement of reproductively mature female lobsters in relation to ovarian maturation and water temperature.

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

Dr. R O'Dor, Dalhousie University.

iii. Communications -

- Paper presented at First European Crustacean Conference, Paris, August 1992.
- Paper presented at the lobster workshop of the CAFSAC, I&MP subcommittee.
- Seminar given in the Zoology Dept., University of Rhode Island.

iv. Contracts Administered -

Dalhousie University

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Ugarte, R.A. A field study of embryo development and mature female *Homarus americanus* behaviour in relation to temperature; a proposal for the 1992 season. Submitted to and approved by Dalhousie Univ. thesis committee: 11pp.

Ugarte, R.A., J. Pringle and R. Duggan. 1992. A field study of embryo development and ovigerous female *Homarus americanus* behaviour in relation to temperature. Abstract. First European Crustacean Conference, Paris, August 1992.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 214

Section: Population Biology

Project Title: Lobster Assessment and Research (LFA 34)

Project Leader: Pezzack, D.

Other Researchers: Duggan, D.; Hudon, C.

Work Activity: W.A.1.1.1.3

Key Words: lobster biology; assessments; assessment research; LFA 34; stock structure; inshore lobster; Gulf of Maine; Southwest Nova Scotia

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1. Project Description:

This project will be combined with 210 to form 2513," Lobster Assessment and Research (LFA's 34, 40-41)" for 1993.

The project has the ongoing functions of: 1) monitoring the lobster fishery in LFA 34; 2) providing advice to resource manager, and 3) carrying out that research deemed most important to improving the biological advice.

2. Long-Term Objectives:

1. To provide the best possible advice given.
2. To gain the confidence of both the fisheries and other clients.
3. To improve an understanding of the biology and ecology of lobsters in relation to the local fishery.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Monitor the LFA 34 lobster fishery by sampling the catch at sea, and using a voluntary logbook program in designated ports in LFA 34, and summarize results for management and industry. (Duggan, Pezzack)

Goals met. Annual sampling and collection of logbooks completed and data coded. Update on fishery presented to LFA 34 Advisory Committee. Summary Sheets (1991,1992) presented to CAFSAC.

2. Provide biological advise on lobster management and related issues at the LFA, Regional and Zonal levels, and coordinate production of CAFSAC summary sheets into document for public. (Pezzack)

Goal met. Information on recent and longer term landing trends presented to management and LFA 34 Advisory Committee during a special May meeting in an attempt to discern cause of low winter and spring landings and the issue of a season extension. Involved in planning the Scotia-Fundy Regional Lobster Advisory Committee meeting, now planned for Jan., 1993. Provided information to Communications Branch and managers on overall status of lobster stocks and fisheries, and reviewed press releases on lobster fishery. Compiled and edited Lobster Summary sheets and expanded them to include a glossary of technical terms, and a section dealing with commonly asked questions. Copies mailed to all senior managers in Scotia-Fundy Region and distributed by Communications Branch in media packages.

3. Coordinate a review of - 1) purpose and expectations of voluntary logbook information; and 2) logistic requirements (quantity, deployment within and between LFA) of voluntary logbook data collection. (Pezzack)

Goal met. Review incorporated into the CAFSAC Invertebrate and Marine Plants Subcommittee, November. Co-authored a paper presented at the meeting examining the number of log books required to detect changes in C/E in the lobster fishery.

4. Estimate recent changes in midshore effort, using flights of opportunity on DFO helicopter and interviews with fishermen. (Duggan, Pezzack)

Goal not met. DFO over flights discontinued due to the unavailability of helicopter time. Interview program not undertaken due to budget and PY restraints.

5. Oversee the monitoring lobster molting period(s) at two sites in LFA 34 using pleopod and blood protein methods. Sampling and analysis to be done by Clearwater Lobsters, under a scientific permit. (Pezzack)

Goal not met. Project not undertaken by Clearwater Lobsters.

6. Tag berried females during late May, in Barrington Bay to determine over wintering grounds.

Goal not met. Tagging not undertaken due to changes in priorities. (Duggan, Pezzack)

4. Additional Accomplishments:

1. Co-organizer of the CAFSAC I&MP Subcommittee workshop 'The year of the lobster' Nov. 19-22, 1992; developed programme, invited outside participants and made local arrangements. Chaired the session on 'Effort controls, and exploitation rate', compiled session summaries and abstracts, and prepared the final subcommittee report for steering committee. (Pezzack)

2. Presented four papers to CAFSAC's workshop 'The year of the lobster': an overview of lobster landings and resource; an examination of the role groundfish species, that prey on lobsters, could play in the recent increases in lobster landings; movement of tagged lobsters on south shore of Nova Scotia; and a critique on the potential effect of variations in recruitment on the estimates of exploitation rates. (Pezzack, Duggan)

3. Involved in planning and execution of the pilot pre-recruit trapping survey in Shad Bay, N.S. Conducted a tagging program to determine the discreteness of the lobsters in the study area. (Pezzack, Duggan)

4. Paper titled 'A review of lobster (Homarus americanus) landing trends in the Northwest Atlantic 1947-1986' finalized for publication in J. Northwest Atlantic Fisheries Science. (Pezzack)

5. Goals/Expected Outputs for 1993:

1. Provide biological advice on lobster management and related issues at the LFA, Regional and Zonal levels, and coordinate the production of the lobster summary sheets. (Pezzack)

2. Monitor the SW Nova Scotian (LFA 34) inshore lobster fishery through at sea sampling and a voluntary logbook program in designated ports, and summarize the results for management and industry. (Duggan, Pezzack)

3. Monitor and assess the offshore lobster fishery through log books, and sales slips and summarize results of assessment and research for management and industry. Increase at-sea sampling in response to increased fishing effort and landings in the Georges Basin and SW Browns Bank areas. (Pezzack, Duggan)

4. Design and carry out a study employing fishermen interviews to determine the distribution and amount of fishing effort in the 'middle grounds' area (40-90 km from the coast) and the history of expansion into the these grounds. (Pezzack, Duggan)

5. Organize a CAFSAC working group to review lobster assessment techniques and report results to the I&MP Subcommittee in 1993. (Pezzack)

6. Coordinate a review of Scotia-Fundy lobster assessment needs and methods through meetings with DFO scientists, managers and industry. (Pezzack)

7. Edit the proceedings from the CAFSAC workshop, 'The year of the lobster'. (Pezzack and Savard (IML, Quebec))

8. Submit manuscripts on a) Lobster distribution on the Scotian Shelf; b) Growth rates of offshore lobster; c) Lobster distribution and movements in the Browns Bank Area. (Pezzack, Duggan)

6. Background:

Highlights:

Lobster summary sheets were expanded and given wider circulation. The summary sheets were well received and proved to be a valuable source of up-to-date information for managers, biologists and the media.

The organization for 'The year of the lobster' consumed a great deal of time. The meeting was successful in bringing biologists and non-biologists together to examine important questions facing the lobster fishery and its management. All the issues could not be answered in a three-day meeting and working groups were established to gather more information and to develop concrete proposals over the next year. These will be presented at the 1993 CAFSAC subcommittee meeting.

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

Invited to discuss the advantages and disadvantages of doing research in government, with senior undergraduates in a special multidisciplinary class offered through the Geology Dept. at Dalhousie University. (Pezzack) (Jan. 1992)

iii. Communications -

Interviewed by press for information/article/broadcast - CBC-TV Country Canada (Jan.); CBC-Radio Sydney (June); CBC-Radio 'Radio Noon' (July); Chronicle-Herald (May). (Pezzack)

Responded to numerous questions on the fishery and lobster biology from fishermen, DFO staff and the general public. (Pezzack, Duggan)

Involved with Communications Branch in preparing and reviewing media information and press releases. (Pezzack)

iv. Contracts Administered -

At sea sampling of the commercial catch in LFA 34 during May and Dec. (Duggan)

Tag recovery contract in the Port Maitland area. (Duggan)

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

D.S. Pezzack. 1992. Overview Scotia Fundy, and LFA 34. 1991 Lobster Summary Sheets.

D.S. Pezzack. 1992. Overview Scotia Fundy, and LFA 34. 1992 CAFSAC Lobster Summary Sheets.

iv. Popular and Miscellaneous -

D.S. Pezzack. 1992. Book Review: Lobsters: Florida, Bahamas, the Caribbean. Lobster Newsletter 5(1).

D.S. Pezzack 1992. (editor) Scotia-Fundy Lobster Summary Sheets. 16p.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 229

Section: Population Biology

Project Title: Wild Mussel Resource Assessment and Research

Project Leader: Sharp, G.

Other Researchers: Semple, R.

Work Activity: W.A.1.1.1.3

Key Words: mussels; assessments; assessment research; Mytilus edulis; lobster

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1. Project Description:

This project will be incorporated with 207 (New #2530) for 1993.

This is an ongoing project concerned with stock assessment, research and the provision of biological advice on the Region's wild mussel harvest.

2. Long-Term Objectives:

Determine the distribution and resource characteristics of wild mussel stocks; describe and assess the developing mussel harvest industry and its impact on the resource and associated species; develop management models and strategies for the resource; and provide clients with resource information.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Unless this fishery becomes active in 1992, assessment will not be carried out.

Goal not met. Fishery not active.

2. Examine samples previously collected for the presence of a 'new' mussel species (Mytilus trossulus) that has been found in aquaculture research.

Goal not met. Other priorities prevented examination of samples.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

No Goals for this project number. Project will be incorporated with 207 (New #2530) for 1993.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 2514

Section: Population Biology

Project Title: Development of Abundance Indices for Pre-recruit Lobsters

Project Leader: Miller, R.J.

Other Researchers: Pezzack, D.; Tremblay, J.; Duggan, D.; Duggan, R.; Eagles, M.; Lawton, P.; Nolan, S.; Robichaud, D.

Work Activity: W.A.1.1.1.3

Key Words: lobster; pre-recruits; recruitment; assessment

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1. Project Description:

Lobster landings in Atlantic Canada reached record highs in many areas in the latter half of the 1980s. Lobster scientists did not predict these increases and were unable to identify the underlying process(es). This new project undertakes annual trapping surveys for pre-recruits in several areas of the Scotia-Fundy Region, and explores other approaches for estimating pre-recruit abundance.

2. Long-Term Objectives:

To develop indices of lobster pre-recruit abundance that predict recruitment to the fishery at least two years in advance, and to identify mechanisms that underlie recruitment variation.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

1. Obtain data on the Shad Bay lobster fishery as follows: size structure, CPUE, spatial distribution of fishing effort and lobster movement. Data will be obtained through a combination of voluntary logbooks, samples of the catch, and tag return information. (Miller, Nolan and others)

2. Review pilot study of Shad Bay pre-recruit lobsters. Evaluate the area as a study site; recommend improvements to survey methodology. (Miller, Pezzack, Tremblay)

3. Survey existing sea samples of the fishing catch in the Scotia-Fundy Region. Although these samples were collected for other purposes, the catch rate of pre-recruit lobsters may be related to some measure of fishing success in subsequent years. (Miller, Lawton, Pezzack, Tremblay)

4. Select an area in Cape Breton suitable for a pre-recruit survey. Conduct interviews of fishers to delineate fishing area (spring). Conduct pilot trapping survey to stratify the sampling area and assess gear saturation (summer). Conduct trapping survey (autumn). (Tremblay, Eagles, and others)

5. Conduct tagging study of selected Cape Breton area to evaluate degree of isolation and growth (summer). (Tremblay, Eagles and others)

6. Conduct the second annual pre-season trapping survey of pre-recruit abundance in Shad Bay. (Miller, Nolan and others)

7. Select an area in southwest Nova Scotia suitable for a pre-recruit survey. Conduct interviews of fishers to delineate fishing area, conduct pre-trapping survey to stratify the sampling area and assess gear saturation. Conduct tagging study to evaluate degree of isolation if necessary. (Pezzack, Duggan and others)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 2540

Section: Population Biology

Project Title: Shrimp Assessment and Research

Project Leader: Butler, M.

Other Researchers: Robert, G.

Work Activity: W.A.1.1.1.3

Key Words: assessment; shrimp; Scotian Shelf

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1. Project Description:

This project was within project 203 for 1992.

Annual stock assessment of the Scotian Shelf shrimp fishery is carried out for management purposes. Advice is prepared for clients.

2. Long-Term Objectives:

Provide biological advice on traditional and exploratory shrimp fisheries in the Scotia-Fundy Region to industry and resource managers.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

1. Assessment of shrimp resources on the Scotian Shelf.
2. Presentation of biological advice to the Regional Shrimp Advisory Committee and preparation of other briefing documents when required.
3. Investigate possible improvements in the estimation of catch-rates (gear and vessel).
4. Establish a port sampling programme if funding is available.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4110

Section: Invertebrate Fisheries

Project Title: Soft-Shell Clam Fishery Research

Project Leader: Robinson, S.

Other Researchers: Chandler, R.; Martin, J.D.

Work Activity: W.A.1.1.1.3

Key Words: clams; assessments; ecology; assessment research

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1. Project Description:

This is a long-term project designed to look at the basic population characteristics of the soft-shell clam, *Mya arenaria*, in the Scotia-Fundy Region. Abundance, population age structure, growth, mortality, condition, and reproductive aspects are being investigated, and how these attributes are affected by the fishery in different habitats.

2. Long-Term Objectives:

Provide a detailed and comprehensive data base on the basic ecology and population structure of the soft-shell clam, *Mya arenaria*, in the Bay of Fundy for support in future management decisions; assess the impact of various fishery practices on the soft-shell clam stocks.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Continue with the study of the Scotia-Fundy soft-shell clam fishery through elements of the former Clam Enhancement Program. Attempt to increase the presence of industry in the development of methods to increase the stocks, harvest, and/or production. (Robinson)

A project was initiated with Canadian Sea Products Ltd. in Lepreau Basin, New Brunswick to look at changes in the productivity of the clam flats due to commercial clam digging. An experiment was set up this past summer and is due to be harvested next summer. This project was undertaken with the assistance of the Canada/New Brunswick Cooperation Agreement on Fisheries and Aquaculture Development.

2. Continue to survey the subtidal area of some local areas to determine the extent of the subtidal population. (Robinson)

Some diving was done to survey the subtidal populations, but the delay in the completion of the invertebrate workboat, *Gemma*, reduced the amount of surveying planned. This will be continued next year.

3. Initiate a program to investigate the recruitment dynamics of the soft-shell clam in a few diverse local habitats to address the topics of growth, mortality, and habitat selection. (Robinson)

A project was successfully initiated with Canadian Sea Products Ltd. in the Lepreau area and the Deer Island area of New Brunswick. Local clam fishermen were assisted in putting up small fences in experimental plots to try to increase the natural spatfall of clam larvae to beaches with low clam densities. Sampling of the plots is to occur in January. This project was undertaken with the assistance of the Canada/New Brunswick Cooperation Agreement on Fisheries and Aquaculture Development.

4. Provide information to the industry and managers on the state of the clam stocks through industry meetings. (Robinson)

Information on the clam fishery was sent to interested parties in the Minas Basin, Nova Scotia. An invited talk on clam beds was prepared for the Gulf of Maine conference on shellfish beds.

4. Additional Accomplishments:

1. Continued a project on the feasibility of rotational digging to increase the productivity of the clam beaches.

2. A trip was made to Prince Edward Island to consult with a commercial fishermen and the Development Branch of the Dept. Fisheries and Oceans on the potential for setting up a clam farm.

5. Goals/Expected Outputs for 1993:

1. Continue the project to follow the settlement of clam larvae on the beaches and the effects of digging on productivity with the local calm industry. Attempt to increase the presence of industry in the development of methods to increase the stocks, harvest, and/or production.(Robinson)

2. Continue to survey the subtidal area of some local clam beds to determine the extent of the subtidal population. (Robinson)

3. Begin development of a new survey technique to assess clam densities (Robinson).

4. Produce a Technical Report describing the soft-shell clam fishery in the Bay of Fundy. (Robinson)

5. Provide information to the industry and managers on the state of the clam stocks through industry meetings. (Robinson)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

A project was done with Dr. Brian Beal from the University of Maine (Machias) and Jennifer Martin (SABS) to study the interannual differences in growth rates of clams.

ii. University Liaison -

1. External thesis advisor to M.Sc. student, Kimberley Liska, at Acadia University, Wolfville, Nova Scotia.
2. Dr. David Black from the University of New Brunswick was consulted regarding pre-history growth in the soft-shell clam.

iii. Communications -

1. Interview with reporter from the Sou'wester on the clam enhancement work we have been doing with fishermen in this area.
2. Co-editor of the Canadian Connection section in the newsletter of the National Shellfisheries Association.

iv. Contracts Administered -

1. Soft-shell clam research support ($2,300).
2. Clam Enhancement project ($15,150).

v. Other -

1. Two manuscripts were reviewed for primary publication.

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Robinson, S. M. C. (Co-editor). The Canadian Connection in the National Shellfisheries Association Newsletter.

Robinson, S. M. C. 1992. Enhancement of natural spat settlement in the soft-shell clam, Mya arenaria. J. Shellfish Res. 11: 206.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4120

Section: Invertebrate Fisheries

Project Title: Scallop Population Dynamics and Assessment

Project Leader: Robinson, S.

Other Researchers: Chandler, R.; Martin, J.D.; Parsons, J.

Work Activity: W.A.1.1.1.3

Key Words: scallops; assessment research; ecology

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1. Project Description:

Fishery related aspects of the population dynamics of the sea scallop, Placopecten magellanicus, are being studied in the New Brunswick area of the Scotia-Fundy Region.

2. Long-Term Objectives:

To understand and assess the stock structure and dynamics of the sea scallops in our mandated study area in order to provide advice for the efficient management of the fishery.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Conduct scallop assessment surveys on the New Brunswick side of the Bay of Fundy concentrating on the upper Bay, Grand Manan and the Fundy Isles. Prepare CAFSAC documents for the annual meeting in March. (Robinson)

The survey of the three areas was completed. Results of the surveys in the two key areas for major scallop fishing (Grand Manan and Cape Spencer) were presented at the annual meeting of the Invertebrate Subcommittee of CAFSAC on November 17 to 24.

2. Continue with scallop spat project. Analyze one more year of settlement patterns over the grid system and choose reference spat stations for subsequent years. Continue with the study on the settlement phase of the larvae and postlarval survival. (Martin)

The spatial patterns of settlement of scallop larvae in Passamaquoddy Bay were consistent with the previous two years, although each year differed in magnitude. Reference sites were selected for monitoring settlement in subsequent years. Preliminary trials on settlement trays were done to try to design a feasible system to look at early mortality of juveniles. The results look encouraging as early juveniles were recovered in late November.

3. Redesign study to investigate selectivity of Digby scallop drags and assess immediate impacts on bottom. (Robinson)

Vessel problems (a crack in the hull) with the J.L. Hart resulted in the cancellation of this project again.

4. Examine the relationship between environmental parameters and the settlement time and success in scallop spat. (Parsons)

J. Parsons has completed all his field work and has been publishing his results. His thesis is scheduled to be completed in the fall of 1993.

5. Maintain effective communication linkages with scallop fishery representatives. (Robinson)

Data on stock structure from Grand Manan and Cape Spencer were presented at the ISAC meeting in Halifax.

4. Additional Accomplishments:

1. The fourth annual report on meat counts was sent out to all the fishery offices in New Brunswick. This information will give the officers advance notice of potential meat count violations they may encounter in the upcoming year.

2. A new digital measuring board for measuring scallops on board ship was given final field tests. A manuscript on its design is being prepared.

5. Goals/Expected Outputs for 1993:

1. Continue the time series of scallop spat settlement in artificial collectors in the Quoddy region. (Martin)

2. Continue with the development of a robust biochemical condition factor in bivalves (Robinson).

3. Conduct population assessments of the scallop populations in the Quoddy, Grand Manan and Cape Spencer areas. (Robinson)

4. Produce a map of chlorophyll a concentrations in Passamaquoddy Bay from the spring to fall for correlation with bivalve population density. (Robinson)

5. Maintain the 14 year GSI time series on scallops from Navy Island. (Robinson)

6. Produce a manuscript report on an automated measuring board for scallops. (Robinson)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

A study on daily growth rings in juvenile scallops was completed with J. Parsons from the University of Guelph. A manuscript has been accepted for publication in the Canadian Journal of Fisheries and Aquatic Sciences.

ii. University Liaison -

1. Dr. John Himmelman from Laval University in Quebec has a Ph.D. graduate student (Kevin Stokesbury) working in our lab on the behaviour of movement in the sea scallop.

2. Dr. Alan Fraser and his Ph.D. student (Eric DeGrace) from the University of Moncton is involved in a study in one of our study areas in Passamaquoddy Bay to study seasonal changes in the mitochondrial DNA complement in the sea scallop.

3. Dr. Kyung S. Chung from the Instituto Oceanográfico de Venezuela at the Universidad de Oriente sponsored my two week trip to give a graduate course on the use of indicators of stress in fish populations with emphasis on the use of RNA/DNA ratios (December 1992).

iii. Communications -

1. Two seminars on 'Some Practical Examples of the Use of Biotechnology in Applied Ecological Research' at the Universidad de Oriente on Isla de Margarita and in Cumana, Venezuela.

iv. Contracts Administered -

1. Scallop spat sorting, measurement and analysis ($1,480)

v. Other -

7. Publications:

i. Primary -

Parsons, G.J., S.M.C. Robinson, R.A. Chandler, L.A. Davidson, M. Lanteigne, M.J. Dadswell. 1992. Intra-annual and long-term patterns in the reproductive cycle of giant scallops *Placopecten magellanicus* (Bivalvia: Pectinidae) from Passamaquoddy Bay, New Brunswick, Canada. Mar. Ecol. Prog. Ser. 80: 203-214.

ii. Interpretive Scientific -

Robinson, S.M.C., J.D. Martin, R.A. Chandler, G.J. Parsons, and C.Y. Couturier. 1992. Larval settlement patterns of the giant scallop (*Placopecten magellanicus*) in Passamaquoddy Bay, New Brunswick. CAFSAC Res. Doc.

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Article on scallops: Scallop Research - It will benefit both fisheries. Saint Croix Courier Nov. 17, 1992.

DFO Backgrounder Nov. 12, 1992. Scallop spat collection research will aid aquaculture and traditional fisheries.

Summary Sheet on scallop fisheries for CAFSAC Invertebrate Subcommittee (November 19920

Report to fishery officers in New Brunswick regarding average meat weights and counts in different areas of the Bay of Fundy for 1992.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4130

Section: Invertebrate Fisheries

Project Title: Lobster Stock Assessment (LFA's 35, 36 and 38)

Project Leader: Lawton, P. (0.4 PY)

Other Researchers: Robichaud, D. (0.5)

Work Activity: W.A.1.1.1.3

Key Words: lobster; assessments

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1. Project Description:

This project is an ongoing function dealing with the monitoring of the lobster fishery in the Bay of Fundy (Lobster Fishing Areas 35, 36 and 38).

2. Long-Term Objectives:

Assess stocks and production of lobsters and make recommendations on the relative merits and potential effects of various management strategies (e.g., size limits, quotas, seasons, fishing effort, gear type); develop methods of analysis and theoretical models for the above; communicate results to the fishing industry, management bodies, and scientists, including primary scientific publications.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Provide resource assessment advice on the lobster fishery in the Bay of Fundy area as a contribution to the fishery management process. (Lawton)

Attained. CAFSAC Working Paper 92/62 presented at Invertebrates and Marine Plants (I&MP) Subcommittee meeting, March 9 - 13, 1992, after receiving a formal request for advice on February 13. Paper upgraded to Res. Doc. status.

2. Monitor the Bay of Fundy area lobster fishery through sampling programs. (Robichaud)

Attained. Lobster Fishing Areas 35, 36, and 38 were monitored through at-sea sampling programs. Spring fishery samples were obtained from Alma (LFA 35), and Dipper Harbour (LFA 36). Fall fishery sampling was undertaken in Alma (LFA 35), Dipper Harbour (LFA 36), and North Head and Seal Cove (LFA 38).

3. To communicate results to the fishing industry through management advisory committee meetings. (Lawton)

Attained. In addition to regular LFA Committee Meetings, P. Lawton and D. Robichaud met with fishermen groups prior to the end of the spring 1992 season to discuss potential tagging studies.

4. Assess the movement patterns of lobsters in LFA 36, particularly in the boundary areas with LFA 35 by focusing on cross boundary movement. (Robichaud)

Attained. Historical data on tagging in this area of the Bay of Fundy was summarised in CAFSAC Res. Doc. 92/20. CAFSAC research recommendation 92/62 acknowledged the need to conduct further tagging studies. In late spring, the group was involved in intense consultation with fishermen, and area F&H Management staff. This resulted in the definition of, and supplemental funding for, a tagging study within a three week time frame. A total of 3000 lobsters were subsequently tagged and released during a 10-day closed season charter using two commercial vessels. By this prompt reaction, a potentially explosive situation in the local fishery was diffused.

5. Prepare for primary publication the joint study (with industry) assessing the enhancement value of releasing pound-generated broodstock to LFA 38 fishing grounds. (Robichaud)

Partially attained. A draft manuscript was completed and sent for internal review. The manuscript was considered to require further revision, but additional workloads under goal 4 precluded action on this requirement.

6. Publish a manuscript report on historical lobster landings for the Atlantic Provinces. (Lawton)

Attained. After final editing by P. Lawton and D.A. Robichaud, a manuscript report by A. Williamson (prepared prior to retirement) was published.

4. Additional Accomplishments:

1. Participation in S.W. New Brunswick Aquaculture Working Group meetings; assessment of over 30 specific aquaculture development proposals (part of DFO review process). (Lawton)

2. Presented paper on Bay of Fundy fisheries monitoring program at November 1992 meeting of CAFSAC I&MP Subcommittee. (Robichaud)

5. Goals/Expected Outputs for 1993:

1. Provide resource assessment advice on the lobster fishery in the Bay of Fundy area as a contribution to the fishery management process. (Lawton)

2. Monitor the Bay of Fundy area lobster fishery through sampling programs. Obtain a more complete seasonal profile of present catch rates in LFA 35 and 36 to compare with historical database (CAFSAC research recommendation 92-62). (Robichaud)

3. To communicate results to the fishing industry through management advisory committee meetings. Provide interim report on 1992 LFA 36 tagging study for distribution to Bay of Fundy LFA Committees. (Lawton)

4. Assess lobster catch rates during July in southwestern portions of LFA 36, and movement patterns of lobsters tagged in the requested extension period. This would continue the tagging study initiated in 1992. The activity is contingent upon supplemental funding above the nominal budget allocation to this project (CAFSAC research recommendation 92-62). (Robichaud)

5. Prepare for primary publication the joint study (with industry) assessing the enhancement value of releasing pound-generated broodstock to LFA 38 fishing grounds. (Robichaud)

6. Review existing y/r and e/r models for Bay of Fundy lobsters and apply revised estimates for size at maturity and reproductive schedules of mature lobsters. (Lawton, Waddy)

6. Background:

Highlights:

During 1992 the group responded to urgent requests for advice and action on season extension issues. Following an area consultation exercise in Fall 91, LFA 36 fishermen lobbied the Minister's office directly, resulting in a call for a formal response from CAFSAC early in 1992. The group provided an update to CAFSAC with approx. 3 weeks notice.

In June 1992, again in response to intense lobbying from area fishermen, the group proposed several alternative biological study approaches, and within 3 weeks set up a tagging study, involving review and selection of boat charters, in upper LFA 36. This study involved 10 fishing days, some requiring overnight accommodation aboard the vessels. With this timely "hands-on" response, the group diffused a very sensitive political issue, and secured a positive profile for the Science Branch among area fishermen.

However, the tagging study required diversion of limited technical support from previously planned work objectives under this and Project 414. Following staff retirement, and continuing restrictions in the availability of term technical support the group is now hard pressed to respond to what has become a very active fisheries mandate.

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

Two mailings distributed to Bay of Fundy lobster fishermen; two press releases, and three telephone interviews concerning lobster tagging study (Lawton).

iv. Contracts Administered -

2 boat charters ($9.6K); 3 tag collection contracts ($.9K); Fall 1992 fishery monitoring in LFA's 36 and 38 ($1.75K).

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

Lawton, P., and D.A. Robichaud. 1992. Update on the fishing season extension issue in Lobster Fishing Area 36. CAFSAC Research Document 92/20, 22pp.

Williamson, A. 1992. Historical lobster landings for Atlantic Canada, 1892 - 1989. Can. MS Rep. Fish. Aquat. Sci. 2164, 110pp.

iv. Popular and Miscellaneous -

Three (single page) summary sheets, presenting a profile of recent fishery performance in each Bay of Fundy LFA (35 - 38) were reviewed and updated for distribution within the department, and to media contacts.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4140

Section: Invertebrate Fisheries

Project Title: Population Dynamics and Ecology of Bay of Fundy Lobsters

Project Leader: Lawton, P. (0.4 PY)

Other Researchers: Robichaud, D. (0.5 PY)

Work Activity: W.A.1.1.1.3

Key Words: lobster; assessment research; recruitment

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1. Project Description:

This project is an ongoing function dealing with research into all aspects of the life history, ecology, and environment of juvenile and adult lobsters relevant in the short- and long-term to an understanding of natural and man-induced fluctuations in lobster stock size.

2. Long-Term Objectives:

Evaluate the impact of natural and man-induced factors on the ecology and productivity of lobster stocks by determining juvenile and adult lobster population parameters, such as growth, size-at-maturity, mortality, recruitment and migration, and how these vary temporally and spatially in relation to biotic and abiotic factors; apply existing population dynamics theory and approaches, and develop new analytical methods for the above studies; communicate the results to fishing industry, management bodies, and scientists.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Continue studies on juvenile lobsters in the Beaver Harbour area. Diving activities in 1992 will expand the sampling coverage for recently settled lobsters, using air-lift samplers, to document spatial distribution patterns. (Lawton)

Attained: Lower numbers of recently-settled lobsters were captured at our main study site in 1992, compared to 1991. However, they were caught at levels comparable to the 1991 censuses in a second, lightly disturbed area. The present spatial resolution of sampling does not permit distinction between the possibility of interannual variability in postlarval supply, and the prospect that our earlier destructive benthic sampling in the main study area has compromised settlement habitat quality. Both effects have implications for the design of future studies on the distributional ecology of early benthic phase lobsters, and the development of recruitment indices.

2. Re-survey juvenile lobster release area at Birch Cove and continue to integrate the use of hatchery-reared juvenile lobsters, where practical, into field population studies on juvenile lobster ecology. (Lawton)

Attained. Of 266 lobsters released in October, 1991, two were recaptured in April, 1992, and one in October 1992. At release the hatchery-raised lobsters could be distinguished from wild stock by their pigmentation, and this was still evident in lobsters recaptured in April. The lobster captured in October had moulted, and assumed normal coloration.

3. Complete construction of a laboratory facility for behavioural studies on juvenile lobsters. (Lawton)

Attained. An existing aquarium system was reconditioned to provide individual holding compartments for juvenile lobsters, and six experimental tanks were fabricated. These tanks are in a light-proof enclosure, within which a computer-controlled light system provides a photoperiod with dawn and dusk crepuscular periods.

4. Prepare publications on: distribution of lobsters in inshore areas of the Fundy Isles Region in relation to salmon aquaculture development (technical report); juvenile lobster distribution in relation to depth and substrate type in the Bay of Fundy (primary publication); seasonal use of inshore habitats on Grand Manan (primary publication). (Lawton, Robichaud)

Partially attained. Lack of continuity in technical support, and need to redirect available personnel resources to Project 413 resulted in partial attainment of this goal. An interim report on the distribution of lobsters in the Fundy Isles region was produced and distributed to the New Brunswick Department of Fisheries and Aquaculture; data analysis was completed for two manuscripts dealing with the use of inshore habitats by lobsters on Grand Manan, and a preliminary draft written. Two extended abstracts were prepared for the special session on lobsters at the November, 1992, CAFSAC I&MP Subcommittee meeting.

4. Additional Accomplishments:

1. Secured COOP funding ($28.5K) for a third year of benthic surveying at proposed aquaculture sites in the Fundy Isles region. This diving services contract, administered by Lawton, provided information on lobster and scallop distribution in the vicinity of these sites, from which recommendations were made to federal/provincial aquaculture advisory committees responsible for siting decisions. (Lawton)

2. A 5 day survey was undertaken in September, 1992, on the J.L. Hart to explore the summer inshore distribution of lobsters in the upper Bay of Fundy. Six rockhopper trawls conducted in Scott's Bay, in waters of 9 - 36 m depth, yielded only low catches of lobsters (N=6). A diving survey off Cape Split resulted in the collection of 37 lobsters, including early benthic phase lobsters. Twelve tows conducted off Martin Head in 14 - 22 m depth, in the vicinity of an earlier tagging experiment, yielded catches of 24 to 50 lobsters per tow (N=223). The sex ratio was heavily skewed towards female lobsters (85% of total), of which 88% were berried. The rockhopper trawl thus shows promise for documenting inshore distribution of lobsters. (Robichaud, Lawton)

3. Presented two papers on Bay of Fundy lobster research, and one interpretive video, at November CAFSAC meeting in the special session 'Year of the Lobster' (Lawton, Robichaud).

4. Attended two meetings of the I&MP Subcommittee of CAFSAC, as a core participant; Attended inaugural meeting of Habitat Science Subcommittee, Nov. 1992, contributing to a review of the habitat implications of rockweed harvesting in the Bay of Fundy. (Lawton)

5. Completed 10 day residential course on statistics and experimental design, with particular application to ecological field research, given by Dr. A.J. Underwood, at University of Maine at Orono (Lawton).

6. Completed training in oxygen administration for diving accidents (Robichaud, Lawton).

7. Served as Station Diving Officer, responsible for overview of station diving programs including: review of certification, equipment maintenance, diving project appraisal, and annual summary of diving activity. (Robichaud)

5. Goals/Expected Outputs for 1993:

1. Prepare the first draft of an invited chapter on ecology of postlarval, juvenile, and adult lobsters, for a book being published by Academic Press on the biology of the American lobster (Lawton).

2. Prepare and submit for publication a primary manuscript on the seasonal use of inshore habitats off Grand Manan by mature lobsters. (Robichaud).

3. Prepare and submit for publication a primary manuscript on changes in habitat utilization by mature lobsters in relation to salmon aquaculture development on Grand Manan. (Lawton).

4. Prepare technical report on the distribution of lobster and scallops resources in relation to salmon aquaculture development in the Fundy Isles region (Lawton).

5. Prepare the first draft of a manuscript on the distribution of early benthic phase lobsters in relation to depth and substrate type. (Lawton).

6. Continue studies on juvenile lobsters in the Beaver Harbour area. Diving activities in 1993 will include further censuses for recently-settled lobsters using air-lift suction samplers, and will include a preliminary assessment of faunal associations in disturbed and undisturbed benthic habitats. (Lawton)

7. Conduct laboratory experiments on the foraging behaviour of early benthic phase lobsters in relation to predation risk (Lawton). This is a collaborative study with Dr. R. L. Vadas, University of Maine at Orono.

8. Review existing databases on pre-recruit lobster abundance in the Bay of Fundy (from recent diving-based research, and historical fishery monitoring), and determine ways to integrate this program into a regional research initiative on development of a pre-recruit index for lobsters. (Lawton).

9. Conduct research cruise aboard J.L. Hart to further describe the seasonal aggregation of mature lobsters in shallow waters of the upper Bay of Fundy. (Robichaud).

10. Obtain experience with the use of submersibles for studying distributional ecology of mature lobsters in the Bay of Fundy. This activity is contingent on the availability of submersible time on a planned HMS Cormorant cruise (PISCES, SDL tender) in the Scotia-Fundy region. (Lawton).

6. Background:

Highlights:

Our research contributions on the field ecology of early benthic phase, and reproductive phase lobsters were well received at the I&MP CAFSAC 'Year of the Lobster' special session. For the Fundy Isles region we have a good general understanding of the distribution of various benthic life history phases from which we can develop our program in future years. The major task for the coming review year is to complete publication processing of the existing data series.

This project had to rely once again on limited term (4 month), and contract (3 month) support to achieve 1992 work objectives. Staff changeover due to alternative (longer term) job prospects, the

need for retraining on an annual basis, and administrative load reduce the effective contribution of these short term staff positions. As noted in Project 413 there was a need to divert these personnel resources to cover an enhanced lobster fisheries assessment mandate.

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

Further meetings were held with Dr. R. L. Vadas, University of Maine at Orono, resulting in the design and construction of experimental tanks for a series of laboratory predation studies to commence in 1993. A planned collaboration with Dr. S. Lim, Huntsman Marine Science Centre, lapsed due to her relocation to Singapore during 1992; Appointed Adjunct Professor, UNB, St. John, and now supervising PhD thesis work on sea cucumber ecology through joint collaboration with Drs. M. L. H. Thomas, and B. A. MacDonald. Discussed with Dr. R. L. Vadas, and Mr. R.W. Rangeley possible research collaborations on habitat ecology of rockweed beds. (Lawton)

iii. Communications -

Article on lobster habitat ecology prepared for the 1990-91 Science Review; one weekly science briefing; one lecture to students on Marine Biology for Divers course; provided interview on lobster research to Stern magazine. (Lawton)

iv. Contracts Administered -

Statcom Consultants, diving services ($9.0K); Beatons Aqua Dive and Charter, diving services for COOP contract ($28.5K).

v. Other -

Provided peer review of five research proposals: NOAA Undersea Research Program (2 projects; $US45K); NSF (Biological Oceanography; $204K); National Sea Grant Program (California, $20K; Washington, $180K; Maine, $600K) (Lawton); provided input to regional review on molluscan aquaculture research (Lawton); 4 manuscripts were reviewed for primary publications. (Lawton, Robichaud)

7. Publications:

i. Primary -

Lawton, P. and R. K. Zimmer-Faust. 1992. Context-sensitivity in crab foraging studies. Amer. Zool. 32: 396-404.

ii. Interpretive Scientific -

iii. Scientific and Technical -

Lawton, P. 1992. Identification of lobster areas in the vicinity of proposed, current and possible future aquaculture sites in southwestern New Brunswick. Interim Report to the New Brunswick Department of Fisheries and Aquaculture, 77pp.

iv. Popular and Miscellaneous -

Lawton, P. and D.A. Robichaud. 1992. Lobster habitat ecology research in the Bay of Fundy, pp 53-56. In J. Cook [ed] Science Review 1990 and 1991. Bedford Institute of Oceanography, Dartmouth, NS.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4150

Section: Invertebrate Fisheries

Project Title: Lobster Biology

Project Leader: Aiken, D. (0.4 PY)

Other Researchers: Waddy, S. (0.3 PY); Young-Lai, W. (0.4)

Work Activity: W.A.1.1.1.3

Key Words: lobster molting and growth; larval development; storage and shipment

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1. Project Description:

Biological research in support of fisheries management and the traditional storage and shipment industry on mechanisms that influence survival, growth, development and recruitment of the American lobster.

2. Long-Term Objectives:

Provide biological information required for effective management of the lobster fishery; provide biological and technological information required in the lobster storage and shipment industry.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Conduct research on the factors controlling recruitment in juvenile lobsters: (Waddy)

a) conduct a series of studies on the factors and biological mechanisms regulating molt synchrony and vertical migration in larval lobsters;

Attained; seven studies completed in the winter, spring and summer of 1992, data analyses complete

b) develop a stock of juvenile lobsters and determine whether responses to lab-reared juveniles are comparable to field-caught animals for experimental work planned for 92/93 on juvenile behavior and ecology;

Attained; over 500 juvenile lobsters have been grown under temperature and daylength conditions characteristic of nearshore Bay of Fundy waters

c) design and fabricate an experimental holding system for studies on pre-recruit lobsters;

Partially attained; prototype developed and tested but project on hold because expertise was lost with staff turnover related to the assignment program

d) continue studies on the biology of the ciliate *Anophrys* and its interaction with the lobster;

Study was dependent on availability of ciliates. No outbreaks occurred in 1992, so little work could be done. However, we were able to determine that *Anophrys* maintained in culture lose their ability to parasitize lobsters (as sometimes happens with parasitic ciliates in other organisms).

2. Conduct research on biological mechanisms and cycles that influence egg production and maturation of the American lobster:

a) conduct a study to determine the influence of autumn and winter seawater temperatures on the success of egg production (Waddy);

Attained; study completed, data being analysed

b) continue studies to define the complex seasonal temperature requirements for egg production (Waddy);

Attained; study completed and manuscript being prepared

c) continue studies on flexibility in mating strategies that enable lobsters to maximize their reproductive potential (Waddy);

Attained; longterm studies still in progress

d) continue studies on male reproductive cycles and temporal variation in male potency (Waddy);

Attained; studies ongoing; initiated a colloborative project with Dr. Hans Laufer (endocrinologist) to examine the endocrine basis for the results

e) continue work on the Bay of Fundy size at maturity study;

Attained; preliminary results presented at CAFSAC (Nov 92)

3. Communicate scientific and technical information on lobster reproductive biology (Waddy):

a) prepare and deliver an invited plenary review at the Fourth International Symposium on Invertebrate Reproduction: 'Controlling Reproduction in the American Lobster'; prepare invited manuscript for primary publication in the Journal of Invertebrate Reproduction and Development;

Attained; plenary review given and invited manuscript submitted and accepted for publication

b) prepare the first draft of an book chapter on lobster growth and reproduction for a book on the American lobster being edited by Dr. Jan Factor, SUNY;

Partially attained; outline submitted and first draft underway

c) transfer technical information on lobster holding and biology to the industry, private sector and general public by providing information and advice through personal contacts, telephone communications, lectures, etc.;

Attained; responded to 228 personal, telephone and fax requests for assistance, advice and information

d) complete and submit two manuscripts on lobster reproduction to CJFAS;

Attained; one manuscript submitted and accepted for publication, the second manuscript is under review

4. Serve on the regional animal care committee (Waddy);

Attained; served as Chairman, met all requirements.

4. Additional Accomplishments:

1. Presented four papers at CAFSAC in the special session 'Year of the Lobster' (Waddy);

2. Presented two papers at international conferences: the annual meeting of the American Society of Zoologists in Atlanta, and the World Aquaculture Society in Orlando (Waddy);

3. Established cooperative projects with researchers at the Catholic University if Nijmegan (The Netherlands) and the University of Connecticut (Waddy);

4. Conducted a collaborative study with Dr. Brian Tsukimura (Illinois State University) on the endocrine response of American lobsters to a spring increase in seawater temperature (Waddy).

5. Goals/Expected Outputs for 1993:

1. Conduct biological research in support of fisheries management needs and effect the transfer of this information to the private sector:

a) Conduct a series of laboratory experiments on the mechanisms that regulate molt synchrony and recruitment in larval lobsters (Aiken);

b) Conduct a field experiment on the temporal and spatial distribution of larvae hatched from lobster aggregations in the southwestern Bay of Fundy (Aiken);

c) Analyze data from studies on the effect of size, aggression and population density on growth and survival of postlarval and juvenile lobsters (Aiken);

d) Prepare and submit for primary publication a manuscript on larval molting behavior (Aiken).

e) Edit and prepare for publication the Proceedings (74 manuscripts) of the ICES Symposium on Shellfish Life Histories held in Moncton in June, 1990 (Aiken, Waddy).

2. Conduct biological and bioengineering research in support of the traditional lobster storage and shipment industry and effect the transfer of this information to the private sector:

a) Assist private industry in solving biological and bioengineering problems encountered in the storage and shipment of lobsters and communicate scientific and technical information on lobster storage and shipment to the private sector through personal contacts, telephone communications, etc. (Aiken, Waddy, Young-Lai).

b) Conduct a collaborative study in conjunction with Moore-Clark to evaluate the efficacy of various feed additives as attractants in feeds for the lobster storage industry (Waddy, Aiken).

c) Continue work on an updated version of the 'Handbook on Lobster Storage and Shipment' (Aiken, Young-Lai).

6. Background:

Highlights:

The invitation (to S.L. Waddy) to deliver a plenary lecture at the Sixth International Symposium on Invertebrate Reproduction held in Dublin in June was a highlight, as were invitations to participate in three separate collaborative projects (Waddy).

Selected Involvements:

i. Collaborative Research -

Collaborative studies with Drs. David Borst and Brian Tsukimura of Illinois State University, and Dr. Hans Laufer of the University of Connecticut (Waddy).

ii. University Liaison -

Dalhousie PhD student supervised on thesis research (Aiken)

iii. Communications -

One television and two radio interviews on lobster biology, two weekly science briefings, two lectures to university students (UNB and LSU), one talk to a fifth grade class (Salisbury) and tours of the lobster facility to over 100 people. Responded to four calls from the media for background information; supplied photographs (reproducible quality) to several groups for educational and information purposes (eg. Fisheries Museum of the Atlantic, Nelson Publishers, Stern magazine and GEO magazine). Participated in the production of a video on the fishing industry aimed at tourists and the general public. Responded to over 200 requests for technical information from the public, industry, and educators (Waddy).

iv. Contracts Administered -

v. Other -

External review of 9 manuscripts submitted for primary publication (Waddy).

7. Publications:

i. Primary -

Waddy, S.L. and D.E. Aiken. 1992. Seasonal variation in spawning response of preovigerous lobster (*Homarus americanus*) to manipulation of photoperiod and temperature. Can. J. Fish. Aquat. Sci. 49: 1114-1117.

Waddy, S.L. and D.E. Aiken. (in press). Environmental intervention in the reproductive process of the American lobster, *Homarus americanus*. J. Invert. Reprod. Dev.

ii. Interpretive Scientific -

Aiken, D. E. and S. L. Waddy. 1992. The growth process in crayfish. Rev. Aquat. Sci. 63(3): 335-381.

Waddy, S.L. and D.E. Aiken. (in press). Temperature regulation of reproduction in female American lobsters, *Homarus americanus*. Rapp. P.-v. Reun. Cons. int. Explor. Mer.

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Tsukimura, B., S. Waddy, J.M. Vogel and D.W. Borst. 1992. The regulation of vitelogenesis in the lobster, Homarus americanus. Amer. Zool. (in press).

Waddy, S. L. 1992. Watching the clock - the key to survival for young lobsters. Weekly Science Briefing, Vol. 11, No. 12, March 27, 1992.

Waddy, S. L. & D. E. Aiken. 1991. Photoperiod regulation of the metamorphic molt in larval American lobsters, *Homarus americanus*. J. World Aquacul. Soc. 22(3):62A.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4160

Section: Invertebrate Fisheries

Project Title: Resource Potential of Underutilized Invertebrate Species

Project Leader: Robinson, S.; Lawton, P.

Other Researchers: Martin, J.D.; Robichaud, D.; Chandler, R.

Work Activity: W.A.1.1.1.3

Key Words: underutilized invertebrates; assessment research; ecology

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1. Project Description:

Studies on growth, mortality, reproduction, ecology, and population structure of underutilized invertebrate species that have commercial fisheries potential in the Bay of Fundy.

2. Long-Term Objectives:

Obtain a thorough understanding of the biology, natural history, and population characteristics of underutilized Bay of Fundy invertebrates so that advice can be given for the prudent management of emergent fisheries.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Continue with research on the green sea urchin in southwestern New Brunswick pertaining to stock characteristics and fishing impacts. This project is entirely contingent on additional funding being available.

A standing stock survey using SCUBA for local populations of the green sea urchin was initiated in June with the Campobello Fishermen's Association to produce the first estimate of biomass in the Quoddy region since 1972. The project will be completed in March 1993.

2. Analyze logbooks submitted by fishermen for the 1991-92 sea urchin fishing season. (Robinson)

Logbooks were analyzed and the results presented to the fishermen at an industry meeting in May. Results from the logbooks were also provided to the Statistics Branch of DFO who used them to correct their catch estimates.

3. Maintain an overview on underutilized species in the Bay of Fundy area and communicate results to industry through meetings, workshops, and newsletters.

A meeting with the sea urchin fishing industry was held in May. Results of a preliminary survey was presented along with a video on the visual effects of scallop drags on sea urchin populations.

4. Additional Accomplishments:

1. A survey of periwinkle size distribution was done with volunteers from the Deer Island Shoreline Cleanup Program.

2. An aerial survey was done to document some of the fishing locations and effort on intertidal stocks of invertebrates.

3. Contact was made with fishermen in the local periwinkle industry and a proposal was submitted to do a resource survey on the New Brunswick side of the Bay of Fundy.

5. Goals/Expected Outputs for 1993:

1. Continue the survey of sea urchin populations at reference sites and extend the survey towards Maces Bay. This project is entirely contingent on additional funding being available. (Robinson)

2. Begin to examine some of the biological characteristics of sea urchin populations relating to growth, reproduction, and movement. This project is contingent on additional funding for manpower being available. (Robinson)

3. Produce an industry report on the population estimates of sea urchins in the Quoddy region. (Robinson)

4. Begin work to develop a condition factor for sea urchins which will allow a rapid assessment of whether a local population of sea urchins is being food limited. (Robinson)

5. Analyze logbooks submitted by fishermen for the 1992-93 sea urchin fishing season. (Robinson)

6. Initiate research studies on the population dynamics and feeding biology of sea cucumbers in the Quoddy region of the Bay of Fundy. This is a collaborative study with Drs. M.L.H. Thomas and B.A. MacDonald of the Biology Department , UNB at Saint John. A Ph.D. student, R. Singh, will commence field studies int he spring of 1993. The Invertebrate Fisheries Section will provide logistic support for planned diving surveys in Passamaquoddy Bay (Lawton).

7. Maintain an overview on underutilized species in the Bay of Fundy area and communicate results to industry through meetings, workshops, and newsletters. (Robinson)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

1. Weekly Scientific Briefing on an expanding sea urchin fishery.
2. Weekly Scientific Briefing on developments in the periwinkle fishery in the Bay of Fundy areas and new market potential.

iv. Contracts Administered -

Sea urchin survey (March 1992)	$12,000
Sea urchin survey (June 1992-Mar 1993)	$71,600

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Robinson, S. 1992. Periwinkle fishery is growing. Atlantic Fish Farming 5(7):8.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4170

Section: Invertebrate Fisheries

Project Title: Invertebrate Reproductive Biology

Project Leader: Waddy, S. (0.4 PY)

Other Researchers: Aiken, D. (0.1 PY); Young-Lai, W. (0.5 PY); Lawton, P.

Work Activity: W.A.1.1.1.3

Key Words: maturation; reproduction; size at maturity; fecundity; recruitment

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1. Project Description:

Research on the reproductive biology of commercially important invertebrates in support of fisheries management with emphasis on maturation and reproduction and the way in which these are influenced by the environment.

2. Long-Term Objectives:

In support of fisheries management needs, obtain biological information on the reproductive process in commercially important invertebrates and identify how environmental factors influence invertebrate biological cycles and recruitment success.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

(New project; previously reported under 4150)

4. Additional Accomplishments:

(New project; previously reported under 4150)

5. Goals/Expected Outputs for 1993:

1. Conduct research on biological mechanisms and cycles that influence egg production and size at maturity of the American lobster:

   a) Complete research to redefine size at maturity of North Head lobsters (Waddy);

   b) Complete data analysis of studies on size at maturity of lobsters from two locations in the southern Gulf of St. Lawrence (North Rustico and Miminegash) (Aiken, Waddy);

   c) Evaluate and update reproductive data used in Egg- and Yield-Per-Recruit models
   i. Begin studies to determine the variation in size at maturity throughout the Bay of Fundy (Waddy, Lawton);

   d) Continue studies on the role of seasonally changing seawater temperature on spawning control in Bay of Fundy lobsters (Waddy);

   e) Conduct collaborative research projects to identify the endocrine basis for reproductive responses:
   i. Collaborate with Dr. Hans Laufer of the University of Connecticut in a study on reproductive cycles in male lobsters and the cause of temporal variation in male potency (Waddy);
   ii. Continue studies with Drs D. Borst and B. Tsukimura on the control of spawning in lobsters in the Bay of Fundy (Waddy);
   iii. Begin collaborative work with Drs. F. van Herp and D.P.V. de Kleijn of the Catholic University of Nijmegan to reveal the endocrine mechanisms involved in responses to seasonal temperature changes in American lobsters (Waddy).

2. Communicate scientific and technical information on lobster reproductive biology to fisheries managers, enforcement officers, the scientific community and the general public:

   a) Provide advice on lobster reproductive biology and transfer technical information to the industry, private sector, fishery officers, the general public and other researchers through personal contacts, telephone communications, lectures, etc. (Waddy);

   b) Prepare and submit for primary publication (CJFAS) a manuscript on lobster reproduction

(Waddy);

c) Co-author (with Dr. Brian Tsukimura) a paper to be presented at the annual meeting of the American Society of Zoologists in December (Waddy);

d) Prepare an invited chapter on lobster reproduction for a book on The Biology of the American Lobster being published by Academic Press (Waddy, Aiken);

6. Background:

Highlights:

(New project - previously reported under project 4150)

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

(New project - previously reported under project 4150)

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

FRESHWATER AND ANADROMOUS FISHERIES

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Freshwater and Anadromous Project No.: 301

Section: Stock Assessment and Enhancement

Project Title: Salmon Assessment Research

Project Leader: Marshall, T.

Other Researchers: Amiro, P.; Cutting, R.; O'Neil, S.; Ritter, J.; Cameron, J.; Longard, D.; Jefferson, E.

Work Activity: W.A.1.1.1.1

Key Words: salmon; assessments; assessment research

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1. Project Description:

Enumeration and monitoring of adult and juvenile stocks and Atlantic salmon harvest, preparation of required stock assessment documents, research into methodologies for improvement and expansion of salmon stock assessments, and provision of regional input to Canadian input on international matters involving Atlantic salmon.

2. Long-Term Objectives:

The Departmental legislated mandate includes the responsibility for managing anadromous fish resources according to current, sound scientific information. The long-term objectives of the project are to develop required data bases, conduct pertinent studies and analyses, and prepare biological advice and recommendations on a timely basis for internal and external clients having interests in the valuable Atlantic salmon resources.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Prepare required assessments of Atlantic salmon stocks to define stock status, such as Saint John, St. Croix, LaHave, Stewiacke, Liscomb, St. Mary's, Grand, Middle and inner Fundy rivers and, where possible, forecast future returns. (Marshall, Amiro, Cutting, Jessop)

Stock assessment for the upper Saint John River is expected to be vetted at ACFF Subcommittee, CAFSAC, and will be upgraded to Research Document. LaHave, Stewiacke, Grand and Liscomb assessments and Middle, St. Mary's, Big Salmon and inner Fundy stock status reports will be vetted within and upgraded to a Research Document on regional stock status. Investigations on the St. Croix River were discontinued until 1994 because of budgetary constraints, particularly by the Maine Atlantic Sea-Run Salmon Commission and because of the absence of sufficient returning adults for the evaluation of fish passage at Grand Falls. Full-time continuing person resources lost from assessment activities in 1990 were not replaced in 1991 or 1992; O'Neil assumed salmon investigations (SFA 20) formerly conducted by Jessop. Considerable term person-power was redirected in 1992 to "partnership" projects with natives (Item 3.2 below) that should improve future assessments of the Saint John, Stewiacke and inner Fundy rivers. (All)

2. Prepare timely biological advice and recommendations for internal and external clients and service, particularly, the biological information needs of the Zone Management Advisory Committees. Involve external clients where feasible and desirable in the collection of biological data. (Marshall, Amiro, Cutting, Jessop, O'Neil, Ritter)

Prepared stock status report (item 3.1 above) for all SFA's of the Region for vetting at CAFSAC and upgrading to Research Document. Participated in and provided regional CAFSAC and other advice to five zone management committees, area managers and Canada-U.S. boundary water committees and interest groups (St. Croix, the Aroostook and Saint John above Grand Falls), based on counts of salmon by divers, electrofishing of juveniles and adults, counts, age and origin of salmon at fishways and estimates of sport catch. Provided weekly in-season forecasts of end-of-season projected counts at Mactaquac, Saint John River, and advised managers and Indian Bands of stock status and surpluses to target spawning requirements at various information sessions/allocation negotiations. Advised and cooperated with numerous sport fishing associations, corporations/commissions in the execution of various assessment-related projects, e.g., external clients i) operated adult counting facilities in fishways at Beechwood on the main Saint John River (NB Power), the Magaguadavic River at St. George (Atlantic Salmon Federation) and at the Moncton-Riverview causeway on the Petitcodiac River (New Brunswick Wildlife Federation) and ii) were directed in the conducting of biological surveys, the construction and operation of an adult salmon counting fence and physical habitat surveys on the Sackville (Sackville Rivers Association), Tobique River (Fraser Inc.), Big Salmon (NBDNRE) and St. Mary's (see 3.12) rivers. New partnerships in the assessment of salmon stocks were established with the Indian Brook Band of the MicMac Nation which resulted in the funding and installation by October of a fish counting fence on the Stewiacke River and with four Bands of the Maliseet Nation in the Saint John River Valley which resulted in the site preparation and construction (but not installation) of fish counting fences for the Meduxnekeag and Nashwaak rivers, the electrofishing of about 60 sites, surveying about 80 km of stream habitat, preparation of scales for reading, counting of fish at the Tobique Narrows fishway, distributing of juvenile hatchery salmon and in the collection of broodstock for Mactaquac Hatchery. The Eskasoni Band began sea ranching of salmon from

Christmas Brook and the Chapel Island Band began consultations for a similar project at Robinson's Cove Brook. (All)

3. Continue the investigation of pre- and in-season forecast models, as resources permit. (Marshall, Harvie, Amiro, Ritter)

Refined the in-season forecast of season-end counts of adults at Mactaquac through examination of the differences between recent and past cumulative weekly counts in July and August and various groupings of mean daily river discharges. No new initiatives were made on pre-season forecasting. (Marshall)

4. Investigate stock-recruit relationships on acid-impacted rivers (LaHave, Liscomb) and non-acid-impacted rivers (Saint John and Big Salmon) to ascertain optimal spawning requirements. (Marshall, Amiro, Cutting)

Prepared Working Papers for upgrading to Research Documents on LaHave and Saint John river adult stock and recruit relationships at the ACFF Subcommittee workshop examining stock and recruitment relationships background to the establishment of target spawning requirements. Also tabled was the Atlantic Salmon Regional Acidification Model (ASRAM), ref. MS "Development and evaluation of a biological model to assess regional scale effects of acidification on Atlantic salmon" in acid rain research, which was developed under contract to Environmental and Social Systems Analysts Ltd. (ESSA). The number of spawners for stabilized recruits (simulations over a 50-year period) were evaluated for salmon of the LaHave River (acidified) and Grand and Middle rivers, Cape Breton, (non-acidified) using stock-specific life history and habitat information, density-dependent processes and estimates of survival at various life stages. (All)

5. Investigate models that would enable use of recreational catch as an indicator of stock strength. (O'Neil, Jessop, Amiro, Ritter, Marshall)

Reports were begun on i) the effects of the length of the salmon fishing season and river discharge on angler catch and effort and ii) a proposal for a catch/effort card system in New Brunswick. (O'Neil)

6. Participate, as resources permit, in initiatives to examine distant interception of Scotia-Fundy Region stocks; formulate and test hypotheses and propose data collections (e.g., indices of change in marine environment, marine growth, sex ratio of smolts) to explain MSW changes in mainland stocks. (Marshall, Ritter, Cutting)

Continued the external tagging of significant numbers of hatchery-reared smolts from various stocks of the Region. Discontinued tagging of wild smolts on the Saint John because of budgetary constraints and absence of returns to Mactaquac from fish tagged in 1990 and 1991. Sexed internally samples of 1SW fish (Saint John) in a study to determine the utility of previous external sexing as an index of shift in sea-age at maturation. Presented posters at the Fourth International Atlantic Salmon Symposium, St. Andrews, N.B., entitled "Marine migration and survival of inner Bay of Fundy Atlantic salmon" (Amiro) and "Life histories of LaHave and Saint John River 1SW salmon after their maiden return" (Marshall and Cutting). (All)

7. Publish the model for determining salmon production capacity of rivers through use of information derived from remote sensing, and complete, if possible, survey information data bases for New Brunswick rivers. Investigate and advise on utility of ESSA model to assess current and potential capacity of the regions rivers to produce salmon. Conduct study on parr density and age-at-smoltification, as resources permit. (Amiro)

A primary paper titled "Habitat measurement and population estimation of juvenile Atlantic salmon (*Salmo salar*)" was accepted for publication in Spec. Publ. Fish. Aquat Sci. 118, and results are included in the ESSA project (see 3.4). Technical assistance was inadequate to complete the remote-sensed data base for New Brunswick rivers. The continued counting of smolts and estimation of their age on Little River (Stewiacke) will be used to complement ongoing studies of density-dependent growth of parr and subsequent age-at-smoltification. (Amiro)

8. Participate in the modelling exercise to assess the effects of acid rain on the production of N.S. salmon stocks. (See Acid Rain Research project for details). (Amiro, Cutting)

Contributed the data base, juvenile production model and analyses for the ASRAM computer model to assess effects of acidification, reclamation and management options for Atlantic salmon. Advised on and provided data and component models of population distribution, density-dependent size and smolt survival-at-length for the larger ASRA model (earlier developed as an ICES working paper) and applied same to the question of stock size required for equilibrium recruitment in acid and non-acid rivers (see 3.4). Attempted, for the second year, to enumerate smolt output (without success) and measure juvenile densities from the acid-impacted upper LaHave River for model verification. (Both)

9. Initiate, as resources permit, projects utilizing the image processing system for analyzing scale patterns. (Amiro)

Technical assistance remained inadequate to initiate waiting projects.

10. Draft final report, as resources permit, of the two-year cooperative sonic-tagging project for studying adult Atlantic salmon movements and behaviour on the Saint John River. (Marshall)

Analysis and write-up of the two-year study require person resources beyond those committed by DFO or available to co-sponsors. However, summary observations for the 1991 study and recorded daily angling landings of salmon at Hartland (Angus Fraser diaries, 1948-1966) were prepared and presented to interested parties and sponsors at a science review. A commitment was also made to NB Power to prepare a summary report before April 1993 on the two years of observations and conclusions re: the suitability/use of Hartland Pool by salmon. Based on observations and preliminary results from ultrasonic-tagged fish at and in the vicinity of Beechwood Dam in 1990 and 1991, NB Power installed, as a first phase, (at a cost of about $200,000) a pump to double the volume of fishway attraction water and replaced two fixed-depth entrances to the fishway with auto-levelling leaf gates that spill

attraction water at the surface of the tailrace. The resulting rate of fish passage, even under adversely high river discharges of 1992, was one of the best in 20 years. (Marshall)

11. Implement investigations, as resources permit, to determine the cause(s) for recruitment failure common to inner Bay of Fundy stocks in recent years. (Amiro)

Advised a special meeting of SFA 22 and 23 Salmon Management Advisory Committees on the status and continuing research concerning inner Bay of Fundy wild Atlantic salmon stocks. Convened and reported on a DFO Science Sector Workshop on the IBOF salmon situation. Held vaccinated and unvaccinated groups of hatchery smolts from the Stewiacke, Moser and Big Salmon rivers in salt water tanks to ascertain their vulnerability to Vibrio - a saltwater bacteria ubiquitous to the Bay of Fundy - Scotia Shelf and hypothesized as a possible factor impacting survival of inner Fundy salmon stocks. Released tagged vaccinated and unvaccinated smolts to the Big Salmon, Petitcodiac, and Stewiacke rivers; provided background material on the possible 'problems' in inner-Fundy to a Steering Committee comprised of private, DFO science and management personnel for the development of broad-ranging investigative strategies. Published an article in the Nova Scotia Salmon Association Newsletter concerning the IBOF situation. (Amiro)

12. Direct biological investigations carried out under the pilot 'river-specific management' project for the St. Mary's River. (Jessop, Cutting)

The St. Mary's River Association (SMRA) continued to allocate 65% of funds from the river-specific management project (RSMP) to a full-time biologist. Remaining resources limited field research to electrofishing and estimation of juvenile salmonid densities at 22 sites and the collection of stock characteristic data from 180 adult salmon contributed by anglers or captured for broodstock. A complete review and revision of the original RSMP schedule of events and expected outcomes were prepared for consideration by the RSMP steering committee in February, 1993. (O'Neil)

13. Develop and prepare required regional input for special CAFSAC investigations, for Canada's input to ICES, and for Canada's input to NASCO. (Marshall, Ritter)

(The following accomplishments were for Feb-March, 1992, and were unavailable in their entirety for the 1991/92 PREP). Regional delegates to the ICES Study Group on North American Salmon Fisheries and Working Group on North Atlantic Salmon; described events of the 1991 fisheries in Scotia-Fundy Region and Canada, assisted the Canadian delegation in the development of run reconstruction models of Canadian stocks for input to a North Atlantic (global) model, assisted in the evaluation of the effects of the 1991 quotas in the commercial salmon fishery of Newfoundland and Labrador, and provided a Canadian compilation of microtag, finclip and external tag releases. Reviewed U.S. models of Canadian interception of U.S. stocks, Greenland interception of Canadian stocks, new approaches to assessing interception in distant waters, and advised CAFSAC and ICES as appropriate. Contributed a section on 'Target spawning requirements and assessment' and another on 'Return forecasts' to the ICES Report of the Workshop on Salmon Assessment Methodology, Dublin, 2-4 March, 1992. Also provided major input to analyses and text of sections on 'Measures of Abundance, Escapement and Survival Indices' within 'Status of stocks occurring in Commission Areas', i.e., Western North Atlantic and drafted several sections under the heading 'Research' - Progress on data requirements and research needs, progress on recommendations, requirements for future meetings etc., in the Report of the Working Group on North Atlantic Salmon, Dublin, 5-12 March. Accomplishments in March, 1993 are expected to include, in addition to Regional inputs and reviews of items tabled, contributions to the assessment of the effect of management measures on the Canadian fisheries and to further work on trends in stock status. (Marshall, Ritter)

14. Provide consultation and direction on the choice and use of salmon stocks and on the distribution programs for adult and all stages of juvenile salmon. (Marshall, Amiro, Cutting, Jessop, O'Neil)

Provided advice and directions to the fish culture program involving collection of some 23 salmon broodstocks (personnel and equipment directly involved in 12 collections), distribution of 12,000 Saint John adult salmon, and distribution of over two million juvenile salmon, some of which originated in private hatcheries. Summarily identified the magnitude of difference in 1SW return rates between CWT-smolts released above one, two, or three hydroelectric dams on the Saint John River, 1989-1992. Investigated the movement of ultrasonically tagged wild and hatchery adult salmon transported to the Tobique Headpond dumpsite for more effective deployment of hatchery-origin fish. (All, except Jessop)

15. Continue preparation of individual river management plans, to the extent time permits. (Marshall, Cutting, Amiro, Jessop, Ritter)

Provided input to the Saint Mary's River Steering Committee and redeveloped, with public interest groups, U.S. agencies, provincial government representatives and within DFO, an interim strategy for conservation, enhancement (inc. numbers of adults to be trucked from Mactaquac to the Aroostook River and main river above (Grand Falls) for the Saint John River salmon resource above Mactaquac Dam. Advised on closure of inner Fundy rivers to recreational fishing until spawning escapement levels in the Big Salmon River meet conservation requirements. (All, except Jessop but incl. O'Neil)

4. Additional Accomplishments:

1. Dr. Marshall contributed to the Fourth International Atlantic Salmon Symposium (poster with Cutting below), the ICES Workshop on Salmon Assessment Methodology (March, 1992), a two-day DFO-NBDNRE meeting on Management of Recreational Fisheries in New Brunswick (26-27 March, 1992) and numerous 'information' sessions with Indian Bands, Band Councils and the Maliseet Nation Fisheries Management Federation of the Saint John River Valley. He provided background information at various sessions involving clients/government personnel re: the ' Saint John River Colonization Project' under the Recreational Fisheries Agreement for New Brunswick. Biological Technician Cameron, trained about 30 Natives for electrofishing and habitat surveys and with the assistance of three term persons did surveys of juvenile salmon populations and their habitats and prepared fence sites and constructed fences for installation in 1993 (see 3.1 and 3.2). In recognition of his effort and success on the Saint John River projects, 1990-92,

Cameron received a 'Regional Citation for Excellence Award'.

2. Mr. Amiro contributed to the Fourth International Atlantic Salmon Symposium (poster below), and had the paper 'Habitat measurement and population estimation of juvenile Atlantic salmon (*Salmo salar*)' accepted for publication in Spec. Publ. Fish Aquat. Sci. 118. He provided background information and participated in meetings with public and private sector re: strategic planning exercise within the terms of reference of the Recreational Fisheries Agreement for Nova Scotia, assisted the Aboriginal Fisheries Coordinator and the Anadromous Fisheries Advisor at five Native Fisheries Program meetings in Nova Scotia. He is the Chairman of the Local Arrangements Committee for the 1994 Annual Meeting of the American Fisheries Society in Halifax.

3. Mr. O'Neil presented an update on Scotia-Fundy Region activities to the Atlantic International Chapter of the American Fisheries Society and worked with the Millbrook Native Band to initiate a pilot trout culture project at West River Sheet Harbour.

4. Mr. Cutting contributed to the Fourth International Atlantic Salmon Symposium (poster with Marshall) below and co-edited symposium proceedings with R.J. Gibson 'Production of juvenile Atlantic Salmon, *Salmo salar*, in natural waters', Spec. Publ. Fish Aquat. Sci. 118.

5. Dr. Ritter had his paper on the 'Management of the Atlantic Salmon (*Salmo salar*) Resource of Saint John River, New Brunswick' accepted for publication in a symposium issue of the American Fisheries Society. He was instrumental in the establishment of funding for partnership programs with Native Bands. He also was the Scotia-Fundy Science representative on the planning and implementation committees for the DFO Recreational Fisheries Initiative announced this year.

   He presented the lead paper to the session entitled 'Salmon in the Sea' at the Fourth International Atlantic Salmon Symposium, St. Andrews, N.B., June 14-17, 1992; paper entitled 'Changes in Atlantic salmon (Salmo salar) harvests and stock status in the North Atlantic'.

   He is the Science representative on the Canada-U.S. Steering Committee for the development and management of the fish resources of the St. Croix River, New Brunswick-Maine. In this capacity, drafted the 'Five-Year Operational Plan for the Development and Management of the Diadromous Fishes of the St. Croix River' with input from other Committee members as a guide to the development and management of the diadromous fishery resources of the St. Croix River.

5. Goals/Expected Outputs for 1993:

1. Prepare required assessments of Atlantic salmon stocks to define stock status, such as Saint John, St. Croix, LaHave, Stewiacke, Liscomb, St. Mary's, Grand, Middle and inner Fundy rivers and, where possible, forecast future returns. (Marshall, Amiro, Cutting, O'Neil)

2. Prepare timely biological advice and recommendations for internal and external clients and service, particularly, the biological information needs of the Salmon Fishing Area Management Advisory Committees. Involve external clients where feasible and desirable in the collection of biological data. (Marshall, Amiro, Cutting, O'Neil, Ritter)

3. Implement investigations, as resources permit, to determine the cause(s) for recruitment failure common to inner Bay of Fundy stocks in recent years. (Amiro)

4. Promote and where possible, seed ideas and provide advice to the public sector and consultants on projects which will contribute to long-term objectives of salmon assessment research under the four-year federal-provincial agreements to develop recreational fisheries of Nova Scotia and New Brunswick. (Ritter, Cutting, Marshall, Amiro, O'Neil)

5. Train and supervise Natives, as resources permit, in the installation and operation of adult and smolt counting fences, deployment of live capture methods in food fisheries, conducting of electrofishing, habitat surveys, sea ranching, preparation of scales for reading and in standards of safe working practices in the spirit of the 'partnership' established with Natives to assess/manage salmon stocks. (Marshall, Amiro, Cutting, O'Neil, Ritter)

6. Direct biological investigations carried out under the pilot 'river-specific management' project for the St. Mary's River. (O'Neil, Cutting)

7. Contribute to the publication of the ASRA model for determining salmon production capacity of rivers. Investigate and advise on utility of ASRA model to assess current and potential capacity of the Region's rivers to produce salmon. Conduct study on relationship between parr density and age-at-smoltification, as resources permit. (Amiro, Cutting, Ritter)

8. Participate, as resources permit, in initiatives to examine distant interception of Scotia-Fundy Region stocks; formulate and test hypotheses and propose data collections (e.g., indices of change in marine environment, marine growth, sex ratio of smolts) to explain MSW changes in mainland stocks. (Marshall, Ritter, Cutting)

9. Draft final report, as resources permit, of the two-year cooperative sonic-tagging project for studying adult Atlantic salmon movements and behaviour on the Saint John River. (Marshall)

10. Participate in the ESSA contract to develop sampling strategies for assessing the effects of acid rain on the production of N.S. salmon stocks. (See Acid Rain Research project for details). (Amiro, Cutting)

11. Continue the investigation of pre- and in-season forecast models, as resources permit. (Marshall, Harvie, Amiro, Ritter)

12. Continue to investigate stock-recruit relationships on acid-impacted rivers (LaHave, Liscomb) and non-acid-impacted rivers (Saint John and Big Salmon) to ascertain optimal spawning requirements. (Marshall, Amiro, Cutting)

13. Develop and prepare required regional input for special CAFSAC investigations, for Canada's input to ICES, and for Canada's input to NASCO. (Marshall, Ritter)

14. Investigate models, as resources permit, that would enable use of recreational catch as an indicator of stock strength. (O'Neil, Amiro, Ritter, Marshall).

15. Initiate, as resources permit, projects utilizing the image processing system for analyzing scale patterns. (Amiro)

16. Provide consultation and direction on the choice and use of salmon stocks and on the distribution programs for adult and all stages of juvenile salmon. (Marshall, Amiro, Cutting, O'Neil)

17. Evaluate, as resources permit, the East River Sheet Harbour project and develop a long range plan. (O'Neil)

18. Continue preparation of individual river management plans, to the extent time permits. (Marshall, Cutting, Amiro, O'Neil, Ritter)

6. Background:

Highlights:

Successful launching of significant partnerships between the Division and MicMac and Maliseet Indian Nations in salmon assessment and research activities; submission for publication by ESSA the manuscript 'Development and Evaluation of a Biological Model to Assess Regional Scale Effects of Acidification on Atlantic salmon'; and focused effort in the investigation for CAFSAC of the utility and possible differences between traditional stock-recruit and ASRA models in the definition of target spawning requirements.

Selected Involvements:

i. Collaborative Research -

With project biologist(s) hired by the St. Mary's River Salmon Association for the investigation and implementation of river-specific management; Nova Scotia DOF in the collection of landlocked salmon for broodstock; with NB Power, and to a lesser extent NBDNRE, Atlantic Salmon Federation, Tobique, Woodstock, St. Mary's, and Oromocto Native bands, Fraser Inc., Central Branch of the Saint John River Salmon Assoc., and Tobique Salmon Protective Assoc. in the conduct of assessment related activities in New Brunswick; and with the Indian Brook Band, the Cobequid Salmon Association, Atlantic Salmon Federation in the construction and operation of the Stewiacke River counting fence.

With four Native bands along the Saint John River of the Maliseet Nation in the conduct of various assessment data collection programs, with the NB Wildlife Federation in the enumeration of salmon returns to the Petitcodiac River, with U.S. officials and the Waterway Commission in the development and management of the diadromous fishery resources of the St. Croix River.

ii. University Liaison -

iii. Communications -

Press and radio coverage of various aspects of salmon returns and spawning requirements, usually initiated by a media representative sensitive to the possibility of over-fishing by Native food fisheries and, in the case of the Stewiacke River fence, significant coverage of the partnership between DFO, Natives and anglers.

iv. Contracts Administered -

Silvacare Inc. for the interpretation of ages of approximately 2,000 adult salmon sampled at Mactaquac.

v. Other -

The Cobequid Salmon Assoc. for assistance on the Stewiacke river.

7. Publications:

i. Primary -

Amiro, P.G. 1992. Habitat measurement and population estimation of juvenile Atlantic salmon (*Salmo salar*). *In* R.J. Gibson and R.E. Cutting [ed.]. Production of juvenile Atlantic salmon, *Salmo salar*, in natural waters. Can. Spec. Publ. Fish. Aquat. Sci. 118, p.00-00.

Gibson, R.J., and R.E. Cutting [ed.]. 1992. Production of juvenile Atlantic salmon, *Salmon salar*, in natural waters. Can. Spec. Publ. Fish. Aquat. Sci. 118. 000p.

Ritter, J.A., and T.L. Marshall. 1992. Management of the Atlantic salmon (*Salmo salar*) resource of the Saint John River, New Brunswick. *In* R.H. Stroud [ed.]. Fishery management and watershed development. Am. Fish. Soc. Symp. 13 (1992), p. 205-218.

ii. Interpretive Scientific -

Amiro, P.G. 1992. Marine migration and survival of inner Bay of Fundy Atlantic Salmon. Poster presentation at the Fourth Int. Atl. Salm. Symp., St. Andrews, N.B., 14-17 June, 1992.

Marshall, T.L., and R.E. Cutting. 1992. Life histories of LaHave and Saint John River 1SW salmon after their maiden return. Poster presentation at the Fourth Int. Atl. Salm. Symp., St. Andrews, N.B., 14-17 June, 1992.

Ritter, J.A. 1992. Changes in Atlantic salmon (Salmo salar) harvests and stock status in the North Atlantic. In D. Mills (ed.) Fourth International Atlantic Salmon Symposium, St. Andrews, N.B., Atlantic Salmon Symposium, St. Andrews, N.B., June 14-17, 1992, p. 00-00.

Ritter, J.A., and R.E. Cutting. 1992. Science and salmon management in the 1990s. BIO Science Review, Department of Fisheries and Oceans, p. 97-100.

iii. Scientific and Technical -

Amiro, P.G. 1992. Review of Atlantic salmon stocks of inner Bay of Fundy rivers. CAFSAC Res. Doc. 92/17, 16p.

Amiro, P.G., R.E. Cutting, B.M. Jessop, T.L. Marshall, and S.F. O'Neil. 1992. Status of Atlantic salmon stocks of Scotia-Fundy Region, 1991. CAFSAC Res. Doc. 92/21, 22p.

Marshall, T.L., P.G. Amiro, J.A. Ritter, B.M. Jessop, R.E. Cutting and S.F. O'Neil. 1992. Perfunctory estimates of allowable harvest of Atlantic salmon in 18 rivers of Scotia-Fundy Region. CAFSAC Res. Doc. 92/16, 28p.

Marshall, T.L. 1992. Assessment of Atlantic salmon of the Saint John River, N.B., above Mactaquac, 1991. CAFSAC Res. Doc. 92/74, 22 + v p.

iv. Popular and Miscellaneous -

Amiro, P.G. 1992. Inner Bay of Fundy Salmon -- A Troubled Resource?, *In* K. Rice [ed.]. Nova Scotia Salmon Association Newsletter, Spring 1992.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Freshwater and Anadromous Project No.: 302

Section: Stock Assessment and Enhancement

Project Title: Non-Salmonid Assessment Research

Project Leader: Jessop, B.

Other Researchers: Cutting, R.; Ritter, J.; Stone, H.

Work Activity: W.A.1.1.1.1

Key Words: gaspereau; shad; alewife; striped bass; eels; diadromous fishes; assessments; assessment research

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1. Project Description:

Enumeration and assessment of adult and juvenile stocks and harvests of non-salmonid diadromous species, especially the alewife and blueback herring (gaspereau); preparation of stock assessment documents and advice to managers, and research into improved methodology and expansion of assessments of anadromous (other than salmonids) and catadromous stocks.

2. Long-Term Objectives:

The responsibility for managing anadromous and catadromous fish resources according to current, sound scientific information lies in the Departmental legislated mandate. The long-term objectives of the project are to develop the data base, conduct pertinent analyses, and prepare biological advice on a timely basis for internal and external clients with interests in those diadromous species other than salmonids.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Continue the enumeration and assessment of the return of alewife and blueback herring to the Mactaquac Dam, Saint John River and to the Milltown Dam, St. Croix River. Achieve designated spawning escapements and supervise the commercial fisheries. (Jessop, Stone)

All goals in connection with the enumeration, assessment and control of the return of alewife and blueback herring to the Mactaquac Dam, Saint John River were achieved. A reduction in returns to the Milltown Dam, St. Croix River resulted in a spawning escapement about half of the desired level. No commercial fishery was permitted at the Milltown Dam. (Jessop, Stone)

2. Complete data analysis and summarize results of the assessment of downstream movement of juvenile alewife and blueback herring from the Mactaquac Dam headpond. (Jessop, Stone)

Analysis of the data on the downstream movement of juvenile alewife and blueback herring from the Mactaquac Dam headpond has been partially completed; further work has been deferred in response to other priorities. (Jessop, Stone)

3. Complete data analysis and begin preparation of a report on the run timing and biological characteristics of American eel elvers to the East River, Sheet Harbour. (Jessop)

Analysis of the data on run timing and biological characteristics of American eel elvers in the East River, Sheet Harbour, has been largely completed but report preparation has been deferred. (Jessop)

4. Complete analysis of stomach contents of gaspereau collected in marine fish surveys, analyze data, and draft report. (Stone, Jessop)

Analysis of the stomach contents of gaspereau collected in marine fish surveys has been completed and a publication is in the final stages of preparation. The paper will be presented at a forthcoming symposium. (Stone, Jessop)

5. Begin ageing of American eel otoliths collected in the survey of the commercial fishery in the lower Saint John River. This task may be of extended duration because of its time-consuming nature and the possible higher priority of other tasks. (Jessop)

Ageing of American eel otoliths collected in the commercial fishery of the lower Saint John River has been deferred due to loss of term PY's in resource cut-backs. (Jessop)

6. Resources permitting, continue the American eel age verification study by collecting otoliths from samples of transplanted, known-age eels for age analysis. (Jessop, Stone)

An electrofishing survey of the site of transplanted, known-age eels was conducted with little success. Modified plans are being prepared to reattempt the project. (Jessop, Stone)

7. Complete a report and submit for journal consideration a paper on the relation between spawning stock size and the juvenile abundance index of alewives and blueback herring returning to the Mactaquac Dam headpond. (Jessop)

A paper on the relation between spawning stock size and the juvenile abundance index of alewives and blueback herring returning to the Mactaquac Dam headpond is in the final stages of preparation and will be presented at a forthcoming symposium. (Jessop)

8. Provide biological and technical advice to fishery managers on gaspereau, American shad, rainbow smelt, striped bass, American eel, shortnose sturgeon, and other non-salmonid diadromous fish resources. The output will be timely, sound, scientific information based on the data current at the time of response. (Jessop, Cutting, Ritter)

Increasing requests for biological and technical advice on the non-salmonid diadromous species were effectively handled for internal and public sector clients. Advised FHMB managers on preparation of regional striped bass management plans. Leader participated in advisory committees as required. (Jessop, Ritter, Cutting)

4. Additional Accomplishments:

1. Extended the survey of the commercial catch composition of American eels to the Saint John River upstream of the Mactaquac Dam. (Jessop, Stone)

2. Collected over 100 samples of American shad ovaries from each of the Saint John River at Mactaquac Dam and the Shubenacadie/Stewiacke River for MTDNA analysis in a cooperative project with Dr. B. Brown, University of Virginia and Virginia Marine Resources Commission. (Jessop, Stone)

3. Collected eggs, juvenile and adult (blood, liver, ovary) samples of striped bass as available from the Saint John, Shubenacadie/Stewiacke, and Annapolis rivers for MTDNA analysis in cooperation with Dr. I. Wirgin, N.Y. University Medical School. Conducted extensive surveys in cooperation with local Fishery Officers on the lower Saint John and Annapolis rivers to attempt collection of eggs and juvenile striped bass. Sought assistance from interested fishermen on the Annapolis and Shubenacadie rivers. (Jessop, Stone)

4. Collected various species of anadromous/estuarine fish in several size categories for Dr. S. Campana of Marine Fish Division as a contribution to an otolith atlas. (Jessop, Stone)

5. Developed and installed an elver collection system downstream of the Mactaquac Dam, Saint John River, for the collection of biological data and for mitigation of fish passage obstruction at the dam. (Jessop, Stone)

5. Goals/Expected Outputs for 1993:

1. Continue the enumeration and assessment of the return of alewife and blueback herring to the Mactaquac Dam, Saint John River and to the Milltown Dam, St. Croix River. Achieve designated spawning escapements and supervise the commercial fisheries. (Jessop, Stone)

2. Continue the survey of run timing and abundance of American eel elvers to East River, Sheet Harbour, in order to develop an elver abundance index time series (the only one in North America), resources permitting. (Jessop)

3. Continue the collection and passage upstream of elvers at the Mactaquac Dam, Saint John River, pending final inter-governmental agency approval, resources permitting. (Jessop, Stone)

4. Revitalize the known-age eel otolith project by stocking a new, larger and more suitable lake in the present research area of the Wreck Cove watershed, Cape Breton Island. Eel ageing capability is needed to provide insight to the allegation by Saint John River commercial eel fishermen that their adult eel resource is growing more slowly, so they should be permitted to harvest smaller eels, while, in reality, the smaller size is due to over-fishing. Cross reference with numbers 7 and 8 below. (Jessop, Stone)

5. Conduct a survey of the seasonal density and near-surface distribution of American eel elvers in relation to environmental factors (tide, water temperature, day/night) in the upper estuary of East River, Sheet Harbour, resources permitting. (Jessop, Stone)

6. Complete data analysis and begin preparation of a report on the run timing and biological characteristics of American eel elvers to East River, Sheet Harbour. Information on elver recruitment and migration patterns is needed for advice to managers in the face of greatly increased pressure, including offshore sources, to increase the harvest of elvers in Scotia-Fundy rivers. Cross reference with numbers 3 and 5 above. (Jessop)

7. Complete data analysis and begin preparation of a report on the catch composition of American eels in the commercial fisheries of the Saint John River. (Jessop)

8. Begin ageing of American eel otoliths collected in the survey of the commercial fishery in the lower Saint John River. This task depends on availability of resources and may be assigned lower priority because of its time-consuming nature and requirement for skills development. (Jessop)

9. With implementation of the striped bass management plan, collect stock status information, as available or as can be developed, on the three major striped bass stocks in the Scotia-Fundy Region. (Jessop, Stone)

10. Provide biological and technical advice to fishery managers on gaspereau, American shad, rainbow smelt, striped bass, American eel, shortnose sturgeon, and other non-salmonid diadromous fish resources. The output will be timely, sound, scientific information based on the data current

at the time of response. (Jessop, Cutting, Ritter)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

Leader and a core member of the Statistics sampling and Survey Subcommittee (CAFSAC).

Leader collaborated in research programs by Dr. B. Brown, University of Virginia, and Dr. I. Wirgin, N.Y. State Medical School.

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

The St. Croix International Waterway Commission contracted to operate the Milltown fishway, St. Croix River, during the gaspereau run and to collect the biological and fish count information required for the continuing data base.

v. Other -

7. Publications:

i. Primary -

Had accepted for primary publication (scheduled for 1993) a paper on the fecundity of alewives and blueback herring. (Jessop)

Stone, H.H., and B.M. Jessop. 1992. Seasonal distribution of river herring Alosa pseudoharengus and A. aestivalis off the Atlantic coast of Nova Scotia. Fishery Bulletin, U.S. 90:376-389.

ii. Interpretive Scientific -

iii. Scientific and Technical -

Published a report of gaspereau in five rivers in Nova Scotia in the Manuscript Report Series. (Stone, Jessop, Parker)

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Freshwater and Anadromous Project No.: 303

Section: Stock Assessment and Enhancement

Project Title: Salmon Enhancement Research (Enhancement Biology)

Project Leader: Cutting, R.

Other Researchers: Amiro, P.; Farmer, G.; Jansen, H.; Marshall, L.; O'Neil, S.; Ritter, J.; Cameron, J.; Jefferson, E.; Newbould, K.; Longard, D.

Work Activity: W.A.1.1.2.4

Key Words: salmon enhancement; hatcheries

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1. Project Description:

The project involves the identification, planning, implementation, and assessment of Atlantic salmon enhancement projects. Expertise in biology, engineering, and fish culture are coordinated to increase salmonid production for the commercial, recreational and Native food fisheries. Major activities are: identification of suitable projects, development of enhancement techniques, integration of engineering services and fish culture production output with project needs, monitoring of stocks under development, and provision of senior biological advice to planning and implementation of salmon enhancement programs.

2. Long-Term Objectives:

Increase Atlantic salmon production by using enhancement technology in conjunction with other resource management and habitat protection efforts. The enhanced production can be used to: expand the recreational fishery, increase commercial landings, and satisfy authorized food fishery requirements of Native communities.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Continue to operate the LaHave and Liscomb rivers Atlantic salmon enhancement projects, especially to continue their valuable assessment data bases and, in the case of Morgan Falls, to monitor fish movements in the face of an imminent hydropower development. (Cutting, O'Neil)

Enumeration and field activities were undertaken on the LaHave and Liscomb rivers to continue project evaluations and to collect information useful in salmon assessments. Fishway counts and biological parameters measured in 1992 were inserted into the continuing time series data bases. As usual this information was used (Project 301) in developing regional status reports and stock assessments which appear in CAFSAC documentation. The LaHave data base was used in the ACFF (CAFSAC) Workshop on stock-recruitment of Atlantic salmon. As well, that data base is used to prove the salmon production model (ASRAM) being developed with LRTAP funds (Project 315). Counting fences were installed in the upper LaHave River for the capture of smolt samples needed to verify age, sex and mean size for stock background and, especially, input to the production model for acidified rivers. (Cutting, O'Neil)

2. Undertake and collaborate on the collection of the salmon broodstock for the fish culture program. (Amiro, Farmer, Cutting)

Salmon broodstocks for the Fish Culture program were collected at enumeration facilities at East River (Sheet Harbour), LaHave, Liscomb, Petitcodiac, Sackville, Saint John (Mactaquac) and Tusket rivers, and by seining or electrofishing on the Annapolis, Gaspereau, Gold, Grand, Hammond, Kennebecasis, Musquodoboit, Nashwaak, North, Salmon (Digby), St. Mary's, and Stewiacke rivers in joint operations with staff of the Fish Culture Section. (Amiro, Farmer, O'Neil)

3. Coordinate the biological, engineering, and private sector inputs to the Atlantic salmon development project for the upper Saint John River, i.e., the Aroostook River and the main river above Grand Falls. (Ritter, Marshall)

Coordination was carried out externally through meetings and many phone consultations and written communications with external clients. Funding was available for consultants to study the rock excavation requirements which will influence the detailing of the final design for the Grand Falls fish passage facility. Collaborated with the private sector and U.S. officials in the allocation of salmon juveniles and spawners for above Grand Falls and to the Aroostook River tributary to the upper Saint John River; trucked 340 adults above Grand Falls and 315 adults above Tinker Dam on the Aroostook River. (Ritter, Jansen, Farmer, Marshall)

4. Direct the development of the Atlantic salmon and gaspereau resources of the St. Croix River, N.B., and coordinate activities with U.S.A. officials. (Marshall, Jessop, Ritter)

Participated in the St. Croix River Steering Committee activity to achieve coordination with U.S.A. officials, including some revision of the operational planning document. Funding was not allocated

for Atlantic salmon enumeration in 1992. Collaborated with U.S.A. officials on engineering aspects of upstream and downstream fish passage at the three main stem dams. (Ritter, Jansen, Cutting, Marshall)

5. Coordinate the salmon development for the Sackville River, N.S., and carry out related field activities. (O'Neil)

Collaborated, coordinated, and/or directed salmon restoration and monitoring efforts on the Sackville River as diverse as salmon stocking, adult counting fence operation, fishway operation, enforcement, tallying redd distribution, berm construction, tree planting, habitat surveys, water quality, electrofishing, and habitat improvement. The work was conducted mainly by a third party with self-arranged funding. (O'Neil, Jansen)

4. Additional Accomplishments:

1. On behalf of Science Branch, played a key planning and coordination role in the shaping of the rationalization and design for the recreational fisheries initiatives in New Brunswick and Nova Scotia. (Ritter)

2. Provided input and data for the consultants developing the Nova Scotia recreational fishing plans. (Many staff)

3. Provided technical input and advice on several Native fisheries initiatives. (Amiro, Farmer)

4. Advised the Millbrook Native Band on trout pond culture, West River, Sheet Harbour, N.S. (O'Neil)

5. Goals/Expected Outputs for 1993:

1. Continue to operate the LaHave and Liscomb rivers Atlantic salmon enhancement projects, especially to continue their valuable assessment data bases and, in the case of Morgan Falls, to monitor fish movements in the face of an imminent hydropower development. (Cutting)

2. Undertake and collaborate on the collection of the salmon broodstock for the fish culture program. (Amiro, Farmer, O'Neil)

3. Coordinate the biological, engineering, and private sector inputs to the Atlantic salmon development project for the upper Saint John River, i.e., the Aroostook River and the main river above Grand Falls. (Ritter, Marshall, Jansen)

4. Direct the development of the Atlantic salmon resources of the St. Croix River, N.B., and coordinate activities with U.S.A. officials. (Marshall, Jansen, Ritter)

5. Coordinate the salmon development for the Sackville River, N.S., and carry out related field activities. (O'Neil)

6. Oversee the planning, co-ordination, and implementation of enhancement initiatives in N. B. and N.S. under Recreational Fisheries Initiatives and the Aboriginal Fisheries Strategy. (Ritter, Cutting, Farmer, Amiro, Marshall, O'Neil)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

Information from projects is routinely used for stock assessments, for evaluating fish culture practices, and for apprising external clients interested in current project development. Communications related to the upper Saint John River salmon development involved briefing documents, exchanges with State of Maine officials, upper basin meetings, planning documentation, and seedstock reallocations.

iv. Contracts Administered -

v. Other -

Participated in the Annapolis Valley Rivers Committee interested in redeveloping fisheries resources for the people of the valley. (Cutting)

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Freshwater and Anadromous Project No.: 304

Section: Engineering Services

Project Title: Enhancement and Fish Passage Engineering

Project Leader: Jansen, H.

Other Researchers: Conrad, V.

Work Activity: W.A.1.1.2.4

Key Words: fish passage; mitigation; salmon enhancement; fishways

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1. Project Description:

Provides engineering technology required to operate and maintain existing Department-owned assessment and enhancement facilities ($4.2M replacement value). Involves planning, design, and construction of new enhancement projects consisting of habitat restoration or improvement, and fish passage facilities. Provides engineering services to the Fisheries and Habitat Management Branch.

2. Long-Term Objectives:

Maintain, restore and expand freshwater and anadromous fish production for the commercial, recreational and Indian food fisheries by the use of enhancement technology in conjunction with other resource management and habitat protection efforts.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

(Note that projects with * require funding over and above Division A-base).

1. Complete the engineering aspects of planning future year projects as follows: *(a) Geological-engineering investigation of the Grand Falls fishway route for rock stabilization and complete functional design and costing of the fishway and trapping-trucking alternatives. (b) Site survey of Gorden Falls, Pollet River, N.B. (c) Continue with St. Mary's River flow control study. (d) Additional attraction water and fishway entrance improvements at Tobique fishway. (e) Preliminary investigation of downstream fish passage facilities for Tobique Hydroelectric Station. (f) Investigate fish passage efficiency of alewives at Tusket (3 sites), White Rock and Milltown. (g) Functional design of replacement fishway at NSPC Tusket Diversion Dam.

a. Completed in consultation with Gemtec Ltd. with N.B. Rec. Fish. Funds. b, c, d, and e. Deferred because of new projects with higher priority. f. Fish counts were taken at Tusket and Milltown. g. Functional drawing completed.

2. Design, project administration and/or site supervision of construction projects as follows: *(a) Phase I of Grand Falls, St. John River, fishway construction. (b) Morrison Brook, N.S. culvert modifications. (c) Install two weirs in channel downstream of fishway at Ruth Falls. (d) Minor improvements to Sackville River fishway. (e) Elver trapping at Mactaquac. (f) Smolt trapping facilities LaHave River. (g) Solve problem at highway culvert at Lochaber Lake.

a, b, and c. Rescheduled for 1993 due to lack of funding. d. Completed. e. Completed. f. Completed. g. Investigation revealed insufficient habitat to warrant work.

3. Update the fishway inventory.

There are now 260 structures on inventory. They consist of 219 upstream and downstream fishways and 41 culverts with special features for fish passage.

4. Provide engineering services to Fisheries and Habitat Management Branch consisting of the development of acceptable fish passage designs and negotiations with proponents of water-use projects to meet the requirements of Section 20, 21, 22 and 30 of the Fisheries Act. Also included are negotiations with owners of existing fish passage facilities for improvements. (Conrad, Jansen)

A. Reviewed water use proposals and provided functional designs of fishery protective measures for the following projects: (a) A recreational dam at West Moose River, N.S. (b) Several baffled highway culverts on Grantmire Brook, N.S.; on Big Flat Brook, N.B.; on Meadow Brook, N.B.; on Rand Brook, N.S. (c) Small hydro development at Morgan Falls, N.S. (d) A water supply dam at Sherbrooke, N.S.

B. Ministerial approvals of final construction drawings were given for fish passage facilities proposed at: (a) A water supply dam at Parks Brook, N.B. (b) A culvert at Mill Creek, N.S. (c) A water supply dam at Greenwood Lake, N.S. (d) A culvert at Trainors Cove Brook, N.B. (e) A culvert at Brown's Cove Brook, N.B.

c. Improvements to existing fish passage facilities were implemented at the following locations: (a) Cowie Falls, N.S. (b) Lower Great Brook, N.S. (c) Three locations on Tupper Brook, N.S. (d) Rhodenizer Lake, N.S. (e) Davis Lake, N.S. (f) Brooklyn Clark Meadow, N.B. (g) Piskahegan River, N.B. (h) Hillsborough River, N.B. (i) Bridge Marsh Brook, N.B. (j) Beechwood Hydro Plant, N.B.

5. Applied research on engineering aspects of habitat improvements and restoration techniques in cooperation with the Stock Assessment and Enhancement Section, the Area Managers, Fishery Officers, and the Habitat Management Branch: (a) fish passage at Woolen Mill dams on the North Magaguadavic River, N.B. (b) Typical dam-fishway layouts. (c) Preliminary fish screening tests. (d) Additional items will develop during the year. (Conrad, Jansen)

a, b, and c. Not started due to change in priorities. d. Inspected eight of a list of 23 new highway culverts provided by NBDOT to assess fish passage adequacy.

4. Additional Accomplishments:

1. A steel and aluminum 216' long fish counting fence on a concrete base was designed, fabricated and installed in the Stewiacke River with assistance from a Native crew. Funds for this project were obtained from the N.S. cooperative agreement, CEIC pathways and the N.S. Salmon Association.

2. A new type, portable, steel, counting, fence 132' long was designed, fabricated and installed on the Meduxnekeag River with assistance from Natives. Funding was from the Aboriginal Fisheries Strategy.

3. The components for a 172' long salmon counting fence were fabricated for the former Nashwaak River site. The wood components were fabricated by Natives. Due to delays in fabrication and delivery of material, the installation has been delayed until 1993. Funding was from the Aboriginal Fisheries Strategy.

4. An electrically operated salmon trap was fabricated and installed in the St. George fishway with funding provided by AFAP.

5. Restoration of salmon holding pools downstream of the Tusket River Diversion Dam was completed.

6. Constructed and installed floating trash racks upstream of the Ruth Falls louvers. Funding was mainly from Capital Assets.

7. Advice was provided to consultants for louver installations in the Quebec Region.

8. Inspection of fish passage facilities and information exchange with biologist, Mr. Minoru Mogi, and engineering professor, Mr. Shunroku Nakamura, from Japan.

9. Provided NSPC with a priorized list of fishery protective improvements required at their hydro installations.

5. Goals/Expected Outputs for 1993:

(Note that projects with * require funding over and above A-base.)

1. Complete planning, field surveys, drafting and design for fish passage, enhancement and assessment projects as follows: *(a) Phase II Grand Falls, Saint John River, complete design of fishway and preparation of construction drawings and specifications. (b) Detailed design of water storage dam and fishway for flow augmentation, Gold River, N.S. (c) Design salmon trap for Ruth Falls fishway. (d) Provide engineering input to planning and implementation of N.S. and N.B. Recreational Fisheries programs. (e) Provide engineering input to N.S. and N.B. Native Fisheries projects under the Aboriginal Fisheries Strategy.

2. Proceed with project administration and/or site supervision for several construction projects as follows: *(a) Construct Phase I of Grand Falls fishway. (b) Complete installation of fish counting fences, Nashwaak and Meduxnekeag rivers. This includes modifications for boat passage. *(c) Make additions and improvements to Stewiacke River fish counting fence including boat passage. *(d) Construct two concrete baffles at entrance to Ruth Falls fishway, and install salmon trap. (e) Improve culvert fish passage, Morrison Brook, N.S. (f) Remove deteriorated timber super structure at Morgan Falls and install a new steel structure.

3. Provide engineering services to Habitat Management Branch, habitat coordinators, fishery officers and outside agencies for design and construction of new fish passage facilities, to give Ministerial approval, and to improve existing facilities for water use projects under Section 20, 21, 22 and 30 of the Fisheries Act. Also included is the annual update of the regional fishway inventory.

6. Background:

Highlights:

This project continues to rely on outside sources of funding to undertake maintenance and improvements to existing DFO assessment and enhancement facilities and to undertake new installations. In 1992-93, a total of $327 K was received from the Canada-N.B. Cooperation Agreement on Recreational Fisheries Development, AFAP, Aboriginal Fisheries Agreement, N.S. Salmon Association. For the first time, Native construction crews were utilized exclusively and successfully on two construction projects in N.B. and one in N.S.

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

Approximately 200 contracts for the supply of construction materials, construction equipment, metals fabrication, construct contracts, geological-engineering consultants and land surveying consultants were administered during the year.

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

120 detailed engineering drawings were produced.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Freshwater and Anadromous Project No.: 305

Section: Engineering Services Section

Project Title: Fish Culture Engineering

Project Leader: Jansen, H.

Other Researchers: Hubley, P.

Work Activity: W.A.1.1.2.4

Key Words: hatcheries; salmon enhancement; aquaculture

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1. Project Description:

Provides engineering technology required to operate and maintain existing hatcheries ($20M replacement). Plans, designs and constructs new hatchery facilities or modifies, improves, and expands existing facilities where technically feasible. Provides technical feasibility reviews of private and other government hatchery proposals and ad hoc advisory services to aquaculture operations.

2. Long-Term Objectives:

Expand Atlantic salmon production from the Region's fish culture facilities for the commercial, recreational and Indian food fisheries.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

(Note that projects with * require funding over and above Division A-base).

1. Complete the engineering aspects of planning for future year projects as follows: *(a) Mactaquac FCS - investigate problem of low yield from well #5. (b) Continue with design of refurbished fish rearing facilities for Cobequid FCS. (c) Mersey FCS - construction drawings and cost estimates for installation of a central pH adjustment facility and a 32" main pipeline.

(a) Completed with N.B. Rec. Fish funding. (b) Partially completed; to be continued next year. (c) Completed construction drawings and cost estimate for the pipeline.

2. Update the long-term minor maintenance plan and complete work on several items from the plan as funds permit.

(a) At the Mactaquac Accelerated Rearing Facility replaced two rotten wooden doors with steel-clad doors and levelled several 3 m swede tanks that had settled. (b) At Mactaquac FCS repaired access hatches to aeration tower, repaired several valves, replaced protective screening around oil storage tank, replaced entry doors to two pump houses. (c) At Saint John FCS replaced guardrail at bridge. (d) Repaired the furnace and trench covers at Mersey FCS with Capital Assets funding. (e) Replaced the sewage pump, replaced the furnace, replaced the foot bridge, repaired the hatchery steps and replaced the roof shingles of the garage/feed room at Coldbrook FCS with Capital Assets funding. (f) Repaired the roofs of all the buildings, modified furnace duct work and replaced the furnace in the sub-hatchery and constructed a domestic well at Cobequid FCS with Capital Assets funding.

3. Continue with the planning of a preventative maintenance program for mechanical equipment.

Partially completed; to be continued next year.

4. Proceed with project administration and/or site supervision for several construction projects as follows: *(a) Saint John FCS - complete the 8 - deep 25' swede ponds which were partially completed last year. *(b) Mactaquac FCS - painting of roof and structural steel. *(c) Mactaquac FCS - construction/modification of nine deep 36' swede ponds and associated piping and work to overhead doors. *(d) Cobequid FCS - modify 5 - 25' Ø circular ponds by constructing new deep walls and a new drainage and water supply lines. *(e) Yarmouth FCS - depending on the decision to close or open, proceed with the modification required. *(f) Mersey FCS - construct flood protection dyke and bury 12" Ø pipeline under the spillway channel. *(g) Saint John FCS - construction/modification of eight deep 25' swede ponds and associated piping. *(h) Mactaquac FCS - modify fish sorting facility for removing undesirable species.

(a) Completed with Division A-base funding. (b) Completed painting of roof only with Capital Assets funding. No funding provided for painting of structural steel. (c) Completed with N.B. Rec. Fish funding. (d) Unfunded; deferred to next year. (e) Based on decision to close, many assets were removed for use at other hatcheries. Additional work will be required next year to complete the close out and disposal of this facility. (f) Unfunded; deferred to next year. However, with minimal AFAP funding and Division A-base funding the location for the dyke was cleared and 75% of the dyke was completed. Portion completed still requires riprapping. No work was done on burying the

pipeline. (g) Unfunded; deferred to next year. (h) Completed.

5. Complete additional health and safety improvements as funds permit. The major item is the replacement of fuel storage tanks at several hatcheries to comply with the National Environmental Code of Practice for Underground Storage Tank Systems Containing Petroleum Products 1989.

(a) Replaced two underground storage tanks at Mactaquac FCS, one tank at Mersey FCS, and one tank at Coldbrook FCS with Capital Assets funding. (b) Installed fire escape stairs and modified interior stairway to attic to comply with National Building Code at Saint John FCS. (c) Improved propane supply system to meet all code requirements at Mactaquac FCS with Capital Assets funding. (d) Installed pump in new well at Cobequid FCS providing staff with a source of drinking water for first time in 60 years. (e) Had DPW correct deficiencies with electrical upgrade of facilities and feeders at Saint John FCS and with electrical upgrade of feeders at Mactaquac FCS. Process involved CSA certification of fish feeders at Saint John FCS.

4. Additional Accomplishments:

(1) Replaced deep well pump and redeveloped well (33 k) at Mactaquac FCS with Capital Assets funding.

(2) Carried out structural repairs and lowered ceiling in hatchery building, insulated walls and replaced chimney for furnace at Cobequid FCS.

(3) Designed and installed a system of wires and support cables on eight 36 foot swede ponds for predator (bird) control.

(4) Functional design and cost estimates for a satellite rearing facility to produce 15,000 Atlantic salmon smolts at Eskasoni.

5. Goals/Expected Outputs for 1993:

(Note that projects with * require funding over and above Division A-base).

1. Complete the engineering aspects of planning for future year projects as follows: *(a) Modification of aeration/degassing river and groundwater at Mactaquac FCS. (b) Complete the design of refurbished fish rearing facilities at Cobequid FCS. (c) Upgrading of the migration channel for released smolts and returning adults at Mactaquac FCS. (d) Investigate the cost savings of installing smaller and more efficient pump motors at Mactaquac FCS. (e) Provide engineering input to planning and implementation of N.S. and N.B. Recreational Fisheries programs. (f) Provide engineering input to N.S. and N.B. Native Fisheries projects under the Aboriginal Fisheries Strategy.

2. Update the long-term minor maintenance plan and complete work on several items from the plan as funds permit. Priority projects are as follows: (a) Roof repairs for Mactaquac FCS, Administration Building. *(b) Dam repairs and removal of underground fuel storage tanks at Yarmouth FCS. (c) Roof repairs at Saint John FCS.

3. Complete additional health and safety improvements as funds permit. Priority projects are as follows: *(a) Complete electrical upgrade at Saint John FCS. *(b) Complete flood protection dyke and protection of 12" diameter cold water pipeline, Mersey FCS. *(c) Upgrade ventilation system for garage/workshop at Mactaquac FCS. *(d) Electrical upgrade/retrofit at Mactaquac FCS. *(e) Electrical upgrade/retrofit at Mersey FCS. *(f) Improve chemical storage area at Mactaquac FCS. (g) Service water treatment equipment at Mersey FCS. (h) Repair/replace sewage pump (house #1) at Mersey FCS. (i) Drywall interior of furnace room at Cobequid FCS to comply with National Building Code requirements.

4. Proceed with project administration and/or site supervision for several construction projects as follows: *(a) Saint John FCS - Install automatic fish feeders on the eight deep 25' swede ponds constructed in 1992-93 and install pump recirculation system to conserve water. *(b) Mactaquac FCS - Provide predator protection for smolts. *(c) Mactaquac FCS - Deepen seven - 11 m ponds to increase smolt production and improve smolt quality. *(d) Mactaquac FCS - Refurbish automatic feeder system at ARF. *(e) Mactaquac FCS - Upgrade the Adult Salmon Sorting and Broodstock Holding Facilities. *(f) Mactaquac FCS - Upgrade the water supply system and control valves. *(g) Mactaquac FCS - Upgrade the Incubation and Accelerated Rearing Facility. *(h) Mactaquac FCS - Refinish pond surfaces with epoxy to improve smolt quality. *(i) Mactaquac FCS - Redevelop #5 well. *(j) Mactaquac FCS - Refurbish the Visitor Facility. *(k) Mactaquac FCS - Perform required maintenance on the three shallow wells and pumps.

6. Background:

Highlights:

This project continues to rely on outside sources of funding to undertake maintenance and improvement of the hatchery installations. In 1992-93, a total of $502 k was received from the Canada-N.B. Cooperation Agreement on Recreational Fisheries Development, Capital Assets, CEIC and Corrections Canada.

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

Approximately 300 contracts for the supply of construction materials, construction equipment, operational equipment, metals fabrication and construction contracts were administered during the year.

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Twenty detailed engineering drawings were produced.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Freshwater and Anadromous Project No.: 306

Section: Stock Assessment and Enhancement

Project Title: Finfish and Invertebrate Introductions and Transfers

Project Leader: Cutting, R.

Other Researchers: Ritter, J.

Work Activity: W.A.1.1.1.1

Key Words: introductions; transfers

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1. Project Description:

Provides focus for review and coordination of Regional matters pertaining to the introductions and transfers of finfish and invertebrates and for coordination of the Division's involvement in assessing the impact of aquaculture on wild salmonid populations.

2. Long-Term Objectives:

Coordinate Divisional and Regional (as required) assessments of introductions and transfers of marine organisms.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Provide Regional and Canadian representation for required inputs to Regional, national, ICES, and NASCO groups regarding introductions and transfers of marine organisms, especially salmonids. (Cutting).

Solicited federal and provincial inputs for the Maritimes and contributed to the Canadian national report for the ICES Working Group on Introductions and Transfers of Marine Organisms annual meeting. As chairperson of the Regional Non-Indigenous Species Introductions Committee, coordinated and expedited the preparation of advice, recommendations, or draft written permissions for proposals for the movement of aquatic organisms with possible impact on native fish populations. These organism movements addressed species as varied as Arctic charr, Atlantic salmon, striped bass, bay scallop, brook trout, giant scallop, sea urchins, red alga (Nori), softshell clam, and white shrimp. Updated and maintained the U.S.A. - Canada combined inventory of salmonid introductions and transfers in eastern North America for the Scientific Working Groups on Introductions and Transfers of Salmonids, a bilateral unit of the North American Commission of NASCO. Provided Scotia-Fundy input to draft national policy documents on introductions and transfers of aquatic organisms and on guidelines for research and release of genetically modified (transgenic) aquatic organisms in Canada. Drafted several written permission documents for the Licensing Unit for transfers of organisms within Scotia-Fundy Region after coordination with the Local Fish Health Officer.

2. Provided advice on proposed new guidelines for Nova Scotia on the transfers of the smallmouth black bass for recreational fisheries. (Ritter, Cutting)

3. Promote and coordinate studies to identify and evaluate the impacts of the salmon aquaculture industry on local wild salmon stocks. (Cutting, Ritter)

Coordinated and collaborated with the Atlantic Salmon Federation on a project to study possible impacts of salmon aquaculture on wild salmon populations at the Magaguadavic River, N.B. Reviewed and maintained the collection of current publications on aquaculture impacts on native stocks, mostly documents by NASCO or ICES. (Ritter, Cutting)

4. Additional Accomplishments:

Participated in the development of proposals for a national registry of aquaculture stocks and for gene banking for any stock but initially for any one with exceptional value. (Ritter)

5. Goals/Expected Outputs for 1993:

1. Provide Regional and Canadian representation for required inputs to Regional, national, ICES, and NASCO groups regarding introductions and transfers of marine organisms, especially salmonids. (Cutting).

2. Promote and coordinate studies to identify and evaluate the impacts of the salmon aquaculture industry on local wild salmon stocks. (Cutting, Ritter)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

Collaborated with the Atlantic Salmon Federation to study the impacts of salmon aquaculture on the wild population in the Magaguadavic River.

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

Outputs are the documents, such as draft written permissions, required by Regional administration and clients, draft correspondence or advice needed by senior levels in DFO, and input to ICES and NASCO requirements on introductions and transfers.

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Freshwater and Anadromous Project No.: 308

Section: Fish Culture

Project Title: Hatchery Operations and Production

Project Leader: Farmer, G.

Other Researchers: Aitken, D.; Austin, W.; Goff, T.; McAskill, J.; Penney, G.; Dunfield, R.

Work Activity: W.A.1.1.2.4

Key Words: aquaculture; Atlantic salmon enhancement; hatcheries

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1. Project Description:

Juvenile anadromous Atlantic salmon produced at five hatcheries and landlocked salmon at one hatchery are distributed to public waters for enhancement purposes. Atlantic salmon smolts and parr are provided to the aquaculture industries in N.S. and N.B. and are available for private, university and government research. Trapping and trucking operations for gaspereau and adult salmon are carried out on the Saint John River, N.B. Technical advice on salmonid culture methods and facilities are provided to private aquaculturists.

2. Long-Term Objectives:

Support public fisheries and the stocks upon which they depend. Encourage and support the development of the salmonid aquaculture industries in N.S. and N.B.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Meet production targets for juvenile hatchery salmon specified by salmon enhancement biologists. (Farmer)

Twenty-three discrete stocks of anadromous Atlantic salmon were reared at Scotia-Fundy hatcheries for stock enhancement purposes. The 50,000 salmon fry, 2.0 million parr and 741,000 smolts distributed in 30 rivers during 1992 satisfied production targets.

2. Support the salmon aquaculture industries in N.B. and N.S. by providing technical advice and stocks for broodstock development. (Farmer, Goff, Aitken, McAskill)

Twenty-seven thousand 1+ salmon smolts produced at the Mactaquac and Saint John hatcheries were supplied to the Salmon Demonstration and Development Farm operated by the New Brunswick Salmon Growers Association for research purposes. Thirty-one thousand 1+ smolts produced at the Mactaquac Hatchery were provided to the St. Mary's First Nation for their aquaculture project. Twenty-eight thousand LaHave, River Philip and Saint John 1+ smolts produced at the Mersey Hatchery were supplied to two sea cage operators in Nova Scotia as part of a DFO/industry broodstock development program. The performance of smolts supplied to the Nova Scotia industry during 1991 was assessed in the fall of 1992.

3. Modify hatchery facilities to improve smolt quality as measured by an index. (Farmer, Jansen, Hubley)

Modernization and upgrading of the Mactaquac and Saint John hatcheries continued during 1992. Nine swedish-type ponds at Mactaquac were modified to operate with a 1 m depth of water rather than 0.5 m of water. Eight, deep, swedish-type ponds were constructed at the Saint John Hatchery to replace deteriorated raceways which were unsuitable for the culture of salmon. The modernization and upgrading of hatchery facilities which has occurred the past three years has resulted in a marked improvement in smolt quality. Thus, 84% of the 1+ smolts and 88% of the 2+ smolts produced at Scotia-Fundy hatcheries during 1992 were observed to be of good quality. Studies have demonstrated that the survival rate of smolts utilized for enhancement purposes increases with improvements in their quality. Salmon produced at Scotia-Fundy hatcheries were inspected by the Regional Fish Health Unit on a regular basis and found to be free of diseases or disease agents listed in schedule II of the Fish Health Protection Regulations.

4. Carry out trapping and trucking operations for adult salmon and gaspereau returning to the Mactaquac hydro dam on the Saint John River. (McAskill)

A total of 11,867 adult Atlantic salmon were captured at the Mactaquac Dam on the Saint John River and then transported to the Mactaquac Hatchery for sorting and the collection of biological information. Approximately 400 adult salmon were retained for broodstock purposes and the remainder transported to release sites located above the dam to satisfy recreational and Native food fisheries and spawning escapements. Adult salmon were released in the main Saint John River at Woodstock and above Grand Falls as well as in the Tobique and Aroostook tributaries. Two hundred and seventy-seven

tonnes of gaspereau were collected at the Mactaquac Dam for the commercial harvest and 900,000 gaspereau transported to the Mactaquac headpond to satisfy the required spawning escapement.

5. Increase public awareness of ongoing DFO programs and the fishery resources of the Scotia-Fundy Region. (Farmer, McAskill)

Two students were hired under the COSEP and CEIC Challenge programs to provide tours of the Mactaquac Visitor Facility to the public. Tours feature the viewing of juvenile and adult salmon as well as other species of freshwater and anadromous fishes. Displays and pamphlets are available to explain Atlantic salmon biology, salmon enhancement and management programs and fish culture techniques. Funds have been provided under the Canada-New Brunswick Recreational Fisheries Project (fiscal years 1992/93; 1993/94) to develop additional displays, a self-guided tour brochure, highway signs, a children's kiosk with educational panels and a video centre.

Several recreational fisheries and Native groups participated in the incubation of salmon eggs and/or the distribution of fry or hatchery parr within rivers of specific interest (e.g., Gold, Sackville, St. Mary's rivers, N.S.; Upper Saint John, Salmon, Tobique, Meduxnekeag rivers, N.B.)

4. Additional Accomplishments:

Supplied Atlantic salmon eggs to: (a) Ontario Ministry of Natural Resources for their Lake Ontario restoration program; (b) Aqua Health Ltd., P.E.I., for the development of vaccines; (c) three recreational fishing groups to conduct egg incubation studies on the Saint John River, N.B. and (d) government and university scientists for their research.

Four thousand Atlantic salmon parr and smolts were provided to government and university scientists for their research.

Labour, materials and equipment were provided to carry out construction and repairs at the Mersey Hatchery during the December-March period under the Catch Failure Program. The program was sponsored by the Queens County Fish and Game Association and provided 137 person-weeks of employment.

A considerable number of maintenance and upgrading projects were carried out at the Coldbrook, Cobequid, Saint John and Mactaquac hatcheries under the direction of the Engineering Services Section, Freshwater and Anadromous Division. Details of these projects are listed in the Engineering Services Section PREP document.

5. Goals/Expected Outputs for 1993:

1. Meet production targets for juvenile hatchery salmon specified by salmon enhancement biologists. (Farmer)

2. Support the salmon aquaculture industries in N.B. and N.S. by providing technical advice and stocks for research and broodstock development. (Farmer, Goff, Aitken, McAskill)

3. Modify hatchery facilities to improve smolt quality as measured by an index. (Farmer, Jansen, Hubley)

4. Carry out trapping and trucking operations for adult salmon and gaspereau returning to the Mactaquac hydro dam on the Saint John River. (McAskill)

5. Increase public awareness of ongoing DFO programs and the fishery resources of the Scotia-Fundy Region. (Farmer, Jansen, Hubley)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Freshwater and Anadromous Project No.: 309

Section: Fish Culture

Project Title: Fish Culture Research

Project Leader: Farmer, G.

Other Researchers: McAskill, J.; Aitken, D.; Goff, T.; Austin, W.; Penney, G.; McLean, J.; Ashfield, D.

Work Activity: W.A.1.1.2.4

Key Words: aquaculture; Atlantic salmon enhancement; hatcheries

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1. Project Description:

Devise salmon broodstock, rearing, distribution, marking, evaluation and research programs and coordinate these programs with hatchery staff, stock assessment and enhancement biologists, engineers and fish health and nutrition biologists. Feedback from these programs is used to improve rearing methods, facilities, smolt quality and survival. Private aquaculture proposals are assessed for federal/provincial funding agencies. Chair Salmon Seedstock committees in Nova Scotia and New Brunswick involved in the coordination of seedstock supply to private-sector hatcheries and marine cage sites and in the implementation and assessment of salmon broodstock development programs. Chair Scientific Advisory Committee to the Salmon Genetics Research Program.

2. Long-Term Objectives:

Provide and coordinate biological input to the Division's hatchery programs to ensure their effectiveness and continued improvement. Liaise with provincial fisheries officials and the aquaculture industries in Nova Scotia and New Brunswick in the areas of salmon seedstock supply, broodstock development and the assessment of private aquaculture proposals. Chair Scientific Advisory Committee to the Salmon Genetics Research Program.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Coordinate and provide biological input to the Region's fish culture program. Improvement in the quality of both 1+ and 2+ smolts is possible and of high priority. (Farmer)

Rearing, broodstock, nutrition, fish health, marking and research programs were devised in conjunction with hatchery managers, DFO biologists, engineers and scientists and then implemented. Research has shown that the survival rate of Atlantic salmon smolts utilized for enhancement purposes increases with their size at release and with improvements in quality. Smolt size can be increased and quality improved by modifying and/or replacing existing hatchery ponds. Concrete raceways at the Saint John Hatchery have been removed and replaced with 16, deep, swedish-type ponds. Walls of 31 swedish-type ponds at the Mactaquac Hatchery have been extended so that water depth can be increased to 1 m. Earthen ponds at the Cobequid Hatchery were deepened, reshaped and the deteriorating control structures replaced. These modifications have resulted in an increase in smolt size and an improvement in quality. The 731,000 1+ smolts produced at Scotia-Fundy hatcheries during 1992 had a mean weight of 47 g and 84% were considered to be of good quality. The 88,000 2+ smolts which were produced had a mean weight of 58 g and 88% were of good quality. Further improvements in smolt quality are anticipated in 1993. All stocks of hatchery salmon were inspected by the Regional Fish Health Unit on a regular basis and found to be free of diseases or disease agents listed in Schedule II of the Fish Health Protection Regulations.

2. Work with the salmon aquaculture industry in N.S. to develop and assess their broodstock program. (Farmer)

Twenty-eight thousand LaHave, River Philip and Saint John smolts produced at the Mersey Hatchery were supplied to two sea cage operators in Nova Scotia as part of the DFO/Industry broodstock development program. The performance of smolts supplied to the industry during May 1991 was assessed during October and November of 1992. Performance information collected the past three years indicates that River Philip or Saint John stock is preferable to the LaHave stock because of the lower incidence of maturity of those stocks after 16 months in the sea cages. Economic hardship and changing ownership among the sea-cage operators involved in the N.S. broodstock development program has interfered with program continuity and the supply of seedstock to the local industry. These problems as well as changes to the broodstock development program are to be addressed during upcoming meetings among DFO, NSDOF and industry representatives.

3. Chair the N.B. and N.S. Salmon Seedstock committees. (Farmer)

Present DFO involvement in the N.S. and N.B. aquaculture industries is to provide salmon smolts for broodstock development and for research purposes (88,000 smolts during 1992). Private-sector smolt supply in New Brunswick generally satisfied industry demand during the spring of 1992. The destruction of smolts at private N.B. hatcheries in the past because of disease concerns has required

that DFO supply smolts to alleviate industry shortages. This was not necessary during the spring of 1992. Conversely, the oversupply of private-sector smolts in Nova Scotia during recent years has caused hardship among hatchery operators who were unable to market their smolts. Because of this, some private hatcheries are no longer in operation. Without proper planning, there could be a shortage of private-sector smolts in N.S. because of the recent provincial initiative to stimulate development of the sea cage industry.

4. Identify aquaculture proposals submitted to federal agencies for funding which have potential for success. (Farmer)

Twenty-four proposals to develop salmon and trout hatcheries, salmonid sea cage sites, technology applicable to the salmon aquaculture industry and to design cage systems were reviewed for federal and provincial funding agencies (ACOA, AFAP, NRC-IRAP, ERDA). The number of proposals submitted for review during 1992 was double that submitted during 1991.

5. Report on completed biological investigations. (a) Improvements in salmon egg quality attributable to changes in holding practices. (b) The influence of parentage and smolt size at release on age at maturity of adult Atlantic salmon. (c) Survey of east Shelburne County rivers in preparation for smolt release and liming experiments. (d) Sex ratios of hatchery-reared salmon smolts. (e) Effects of stream liming on invertebrate diversity and abundance. (f) Gull worm incidence among juvenile Atlantic salmon. (g) Magnitude of cormorant predation on salmon smolts. (Farmer)

Report (c) was published as was the report 'Some factors which influence the survival of hatchery Atlantic salmon smolts (Salmo salar) utilized for enhancement purposes'.

6. Chair the Scientific Advisory Committee of the Salmon Genetics Research Program. (Farmer)

The Scientific Advisory Committee (SAC) of the Salmon Genetics Research Program (SGRP) met October 16 and 17, 1991, with SGRP staff to review ongoing programs. A report prepared by the SAC and forwarded to the SGRP Steering Committee during February, 1992, provides an assessment of ongoing SGRP programs and makes recommendations for future research initiatives. The report was tabled and discussed at the November 24, 1992, SGRP Steering Committee meeting.

7. Modify existing 11 m swedish-type rearing ponds at the Mactaquac Hatchery and construct an additional 8 - 7.6 m swedish-type ponds at the Saint John Hatchery (Engineering Services and Fish Culture sections).

An additional eight - 7.6 m swedish-type ponds were constructed at the Saint John Hatchery utilizing DFO and CEIC funds. The modernization and upgrading of this hatchery has been completed and a salmon smolt production of 120,000 is targeted rather than 55,000 as in the past. Nine - 11 m swedish-type ponds at the Mactaquac Hatchery were modified using funds from the Canada-New Brunswick Recreational Fisheries Agreement so that water depth in the ponds is 1 m rather than 0.5 m. This type of modification has resulted in an increase in mean smolt weight and an improvement in quality.

4. Additional Accomplishments:

Maintenance and upgrading of facilities at all five Scotia-Fundy Region hatcheries were carried out during 1992 under direction of Engineering Services and Fish Culture Section staff. Funds will be available during 1992/93 and 1993/94 under the Canada-New Brunswick Recreational Fisheries Agreement and the Atlantic Salmon Federation's EPAP program to complete the Visitor Facility located at the Mactaquac Hatchery. It is estimated that 10,000 visitors tour the facility each year.

Both the Yarmouth and Florenceville hatcheries were declared surplus to DFO requirements and will be disposed of during 1993.

Considerable time and effort was expended by staff during 1992 to collect 22 discrete stocks of adult Atlantic salmon for broodstock purposes.

5. Goals/Expected Outputs for 1993:

1. Coordinate and provide biological input to the Region's fish culture program. Continued improvement in the quality of both 1+ and 2+ smolts is possible and of high priority. (Farmer)

2. Work with the salmon aquaculture industry in N.S., provincial and federal representatives to develop and assess a salmon broodstock program. (Farmer)

3. Chair the N.B. and N.S. Salmon Seedstock committees. (Farmer)

4. Identify aquaculture proposals submitted to federal/provincial agencies for funding which have potential for success. (Farmer)

5. Report on completed biological investigations. (a) Improvements in salmon egg quality attributable to changes in holding practices. (b) The influence of parentage and smolt size at release on age at maturity of adult Atlantic salmon. (c) Sex ratios of hatchery-reared salmon smolts. (d) Effects of stream liming on invertebrate diversity and abundance. (e) Gull worm incidence among juvenile Atlantic salmon. (f) Magnitude of cormorant predation on salmon smolts. (g) The influence of incubation substrates on the size and proximate composition of salmon fry. (Farmer)

6. Chair the Scientific Advisory Committee of the Salmon Genetics Research Program. (Farmer)

7. Modify seven, shallow 11 m swedish-type rearing ponds at the Mactaquac Hatchery. Develop educational displays, brochures, a children's kiosk, videos on Atlantic salmon biology and conservation and a video display centre at the Mactaquac Visitor Facility using funds from the Canada-New Brunswick Recreational Fisheries Agreement and the Atlantic Salmon Federation's EPAP program. A number of other projects designed to improve smolt quality and increase smolt

production at the Mactaquac Hatchery are planned and will utilize funds from the Recreational Fisheries Agreement (detailed list provided in Engineering Services Section PREP document). (Hubley, Farmer)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

Farmer, G.J. 1992. Some factors which influence the survival of hatchery Atlantic salmon (Salmo salar) smolts utilized for enhancement purposes. Can. Tech. Rep. Aquat. Sci. No. 1855. 19 p.

Farmer, G.J., D. Ashfield and D.K. MacPhail. 1992. Chemical characteristics of selected rivers in Shelburne County, Nova Scotia, 1988-1991. Can. MS Rep. Fish. Aquat. Sci. No. 2155. 35 p.

MacPhail, D.K. 1992. Ages of the salmon broodstock collected in the Scotia-Fundy Region during 1991. Internal Document 92-04, 36 p.

McLean, E.J. 1992. Quality evaluation of hatchery-reared 1+ Atlantic salmon smolts. Internal Document 92-03, 129 p.

McLean, E.J. 1992. Quality evaluation of hatchery-reared 2+ Atlantic salmon smolts. Internal Document 92-04, 36 p.

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Freshwater and Anadromous Project No.: 310

Section: Stock Assessment and Enhancement

Project Title: Anadromous Species Statistical Consulting and Data Collection and Analysis

Project Leader: O'Neil, S.

Other Researchers: Cutting, R.; Marshall, L.; Harvie, C.; Jessop, B.; Newbould, K.; Stewart, D.

Work Activity: W.A.1.1.1.1

Key Words: data processing; salmon; assessments; biostatistics

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1. Project Description:

Provision of timely and accurate catch/effort statistics (both commercial and sport) for diadromous fish species to scientific staff, fishery managers, provincial resource agencies, and the public. Responsibility for the collection of diadromous statistics was delegated to the Freshwater and Anadromous Division, and procedures for salmon are coordinated with some provincial resource agencies. Preliminary analyses are carried out on data, and the systems developed are verified for accuracy and timeliness. The Tag Clearing House is administered by this project, supplying biologists and scientists with a computerized system for entry and retrieval of release and recapture data on wild and hatchery stocks of Atlantic salmon. Biostatistical consulting services are also provided under this project.

2. Long-Term Objectives:

(i) To provide catch/effort statistics for the diadromous fish species in the Region as required by DFO. (ii) To maintain an information retrieval system for Division tagging and tag recapture data. (iii) To provide editing services to the Division; and (iv) To provide biostatistical consulting services to Division members.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Ensure that catch and effort data for anadromous sport and commercial fisheries are provided in a timely and accurate fashion for stock assessment purposes, for planning and assessment of enhancement projects, and for habitat management. (O'Neil, Harvie)

Catch and effort data on various species were collected, analyzed and summarized for distribution to assessment staff and other agencies, as required. (O'Neil, Stewart)

2. Maintain Tag Clearing House for: (a) Regional salmon tagging programs; and (b) Canadian salmon tagging programs. (Newbould, O'Neil)

Maintained and summarized as required by clients. Fifty-two thousand tags were deployed for application in 1992 and almost 200 tags were returned from previous taggings for processing. (Newbould)

3. Provide editorial services to Division staff. (Newbould)

Five manuscripts were edited and printed by this office during the review period. (Newbould)

4. Design creel surveys and analyze the resulting data, as required. (O'Neil)

A creel survey designed for the St. Mary's River was not carried out in 1992 due to inadequate resources. A survey was designed to monitor the native fisheries catch in the Saint John River near Fredericton. DFO officers carried out parts of the survey but discontinued it before adequate data were obtained. (O'Neil)

5. Prepare documentation of catch/effort system. (O'Neil)

The catch/effort data collection system was further documented to permit users in the Special Projects Unit to operate the system in 1992. Publication of the system development and operation is some time from completion. About 60-70 person-days are required to complete the preparations to make this report ready for release. (O'Neil)

6. Provide required biostatistical consulting. (Harvie)

A biostatistical consulting service was provided as required. Substantial other projects included completion of a CAFSAC research report entitled 'Forecasts of MSW salmon returns to the Saint John River using non-parametric and parametric models', and assistance in two 'in-prep' papers entitled 'Atlantic salmon sport fishery season length as a factor influencing catch and effort' and 'Proposal for a catch and effort data collection system for the Atlantic salmon sport fishery in New

Brunswick'. (Harvie, O'Neil)

7. Complete publication of 1989 and 1990 angling statistics in Data Report Series and work towards finalizing seasons/discharge report. (O'Neil)

Publication of the 1989 and 1990 'Redbooks' was postponed due to alteration of program priorities after the preparation of the 1991 PREP document. Some progress was made on the 1989 and 1990 reports. (O'Neil)

The seasons/discharge project accomplishments: (a) Discharge data were added to the seasons data base which was cleaned up. (b) The seasons data were edited and several new rivers were added. (c) Regressions were run to note the impact of discharge on catch and effort and its relationship to season length. (O'Neil)

4. Additional Accomplishments:

Assisted salmon assessment in underwater work doing censusing. (O'Neil)

5. Goals/Expected Outputs for 1993:

1. Ensure that catch and effort data for anadromous sport and commercial fisheries are provided in an accurate and timely fashion for stock assessment purposes, for planning and assessment of enhancement projects, and for habitat management. (O'Neil, Newbould)

2. Maintain Tag Clearing House for: (a) Regional salmon tagging programs; and (b) Canadian salmon tagging programs. (Newbould, O'Neil)

3. Provide biostatistical consulting services to division staff as required and participate in CAFSAC planning and meetings to develop advances in stock assessment science methodology. ( )

4. Distribute Atlantic salmon angler diaries on the Liscomb, LaHave, St. Mary's, and Musquodoboit rivers and summarize results. Review diary system and prepare an evaluation report. (O'Neil, Newbould)

5. Publish Atlantic salmon sport catch data reports for 1989, 1990, 1991, and 1992 as time and resources permit. (O'Neil, Newbould, Stewart)

6. Provide an editing service for the division and oversee publication of reports, if resources permit. ( )

7. Complete report on a proposal for a license stub system for N.B. (O'Neil)

8. Prepare the report on the Nova Scotia license stub system. (O'Neil)

9. Continue to work towards completion of the report on salmon season length and discharge, as resources permit. (O'Neil)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Clayton, R.R. and S.F. O'Neil. 1991. Using small creel surveys and mark-recapture experiments to interpret angling statistics. American Fisheries Society Symposium 12: 195-205.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

AQUACULTURE

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 242

Section: Aquaculture

Project Title: Invertebrate Nutrition

Project Leader: Castell, J.

Other Researchers: Boston, L.

Work Activity: W.A.1.1.2.3

Key Words: marine fish; nutrition; scallops; aquaculture; algae; lipids; essential fatty acids; metabolism

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1. Project Description:

This project will change from 242 to 2420 Nutrition - Lipid Research for 1993.

The nutritional requirements of commercially important, non salmonid marine species will be studied by: analyzing the nutrient composition of natural, live and formulated feeds; conducting feeding trials using live or formulated diets varying in specific nutrients such as vitamins, lipids, amino acids or mineral elements; using radio tracers and short-term physiological experiments in which the growth, survival, metabolism, feed conversion, and other indices of nutrition are monitored.

2. Long-Term Objectives:

1. Establish the nutritional requirements of marine species with emphasis on non salmonid finfish species;
2. Analyze the nutrient composition of natural food sources for aquaculturally important species;
3. Develop feeds; and
4. Acquire a basic understanding of the role of essential nutrients (particularly lipids) in the metabolism and physiology of aquaculturally important species.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

Specific Objectives:

1. Scientific Publications:

Completion of outstanding manuscripts on crustacean nutrition research will continue to be a priority. (Castell and Boston)

a) Effects of feed attractants in diet of lobster;

Goal not met. Though the experimental work was completed for this project in the spring of 1992, data analysis and manuscript preparation were delayed as a result of John Castell's developmental leave.

b) Design and techniques for crustacean nutrition research;

Goal met. After extensive revisions, this manuscript was completed and has been submitted to Aquaculture.

c) Standard experimental diets for lobsters;

Goal not met. Data analyses and figures and tables for this manuscript have been completed but still only in a rough draft.

d) Vitamin B and Manganese, in lobster molt death syndrome;

Goals partially met. These manuscripts appeared in the Crustacean Nutrition Newsletter Vol. 7, and will be redrafted and submitted for primary publication.

e) molt death syndrome in lobster; and

Goal not met. First drafts of three manuscripts on this topic have been prepared and require further work before they will be submitted.

f) fatty acid patterns of lobster eggs and larvae.

Goal not met. This manuscript has been completed and internally reviewed. It will be submitted in

Note form to the Can. J. Fish. Aquat. Sci. by February 1993.

- The work on crustacean nutrition will be phased out during the review year and be replaced with the Non-Salmonid Nutrition Project.

Goal met. All projects on crustacean nutrition have been completed, except for publication, during the last review year and several non-salmonid nutrition projects initiated as described below.

- In cooperation with other members of the marine fish culture task force, it is anticipated that a complete bibliography of marine fish culture and nutrition will be prepared and published. (Castell, Waiwood, et.al.)

Goal partially met. Although input has not been received from DFO personnel, input from researchers in Scotland, Norway and Sweden were placed in a relatively comprehensive marine fish bibliography and is available from the authors.

- First draft manuscripts on lipid composition of halibut eggs, larvae and food organisms. (Castell) should also be completed in the next review period and on the possibility of using fatty acid markers in distinguishing geographic origin of lobster larvae. (Boston)

Goal partially met. The halibut manuscript is pending completion of lipid analyses. The lobster manuscript is completed and has been submitted for internal review.

2. Laboratory Studies:

This year will principally involve lipid analyses, including analysis of 30 lobster egg samples supplied by Dr. Robert Miller and numerous halibut egg, larvae and food organisms from the marine fish culture project at St. John's, Newfoundland. If time permits, samples of algae cultured in the Halifax laboratory will be analyzed to determine effects of culture conditions on their lipid content and quality.

Goal partially met. Analyses of lobster egg lipids completed. Analyses of halibut eggs, larvae and food organisms were not completed due to work on molluscan nutrition and a lobster toxicology feeding trial (see below). Note: Objectives for Linda Boston were reevaluated in July (see attached memo). The algal lipid analysis were postponed due to lack of time.

3. Education and Training:

Linda Boston will learn new techniques in lipid analysis by hands-on experience in the laboratory, and possibly by taking a University Course on lipid chemistry. John Castell will gain experience in lipid research techniques during a 10 month developmental leave at the University of Stirling, Scotland, February to December, 1992.

Goal partially met. Numerous technical problems with the new Varian Gas Chromatograph resulted in Linda Boston learning to repair and service it. Linda also gained experience in lipid analysis while working with Dr. Robert Ackman at the Technical University of Nova Scotia. The considerable unforseen work load prevented her from having time to take any university courses this year.

John Castell completed 10 months development leave at the University of Stirling where he gained experience in lipid class analyses; fish cell culture; marine fish hatchery operation; turbot, algae, copepod and other marine species culture; and other aspects of lipid analysis and metabolism.

4. Additional Accomplishments:

1. In response to critical problems in the SFT Ventures molluscan hatchery, Linda Boston provided 2 weeks technical assistance in lipid analyses of oyster samples at the Technical University of Nova Scotia.

2. Linda Boston assisted Dr. Chou (for one month) in initiating a study of the effects on cadmium and iron on juvenile lobsters. This included interviewing, hiring and training a technical assistant, diet formulation and manufacture and assistance in operating the lobster hatchery and juvenile culture system.

3. Linda Boston collaborated with Bob Keith in the preparation of a vitamin supplement for use in the Halibut culture research project at Memorial University, St. John's Newfoundland.

4. A study of the effect of osmolality on fatty acid composition of lipids of cultured turbot fin, and Atlantic salmon embryo cells in serum-free and fetal calf-supplemented media was completed in collaboration with Dr. D. R. Tocher, University of Stirling.

5. A study of lipid and individual fatty acid digestibilities in juvenile turbot (Scophthalmus maximus) was completed while on developmental leave at the University of Stirling.

6. In collaboration with Gordon Bell, Univ. Stirling, a 2.5 month feeding trial on essential fatty acid requirements of juvenile turbot was completed.

5. Goals/Expected Outputs for 1993:

1. Support to halibut culture projects:

a) completion of egg and feed analyses from DFO, St. John's Nfld.

b) assist Mike Kacergis, (MSc student of Dr. Ken Waiwood, St. Andrews, N.B.) with chemical analyses of natural zooplankton organisms that might be food for halibut larval cultures.

c) provision of vitamin supplements and other feed related products as required by either of the two

halibut culture projects.

2. Scientific Publications:

Much of the early part of the next review period will be spent exclusively on completion of several outstanding publications.

a) Lobster molt death; effects of dietary vitamins and minerals;
b) Protein/energy ratio (standard experimental diets) in lobster diets;
c) Lobster feed attractants;
d) Lipid and fatty acid digestibility in juvenile turbot;
e) Effects of media salinity on fatty acid composition and metabolism in cultured fish cells;
f) Submit manuscript on design and techniques for publication.
g) Submit manuscript on lobster egg fatty acids for publication.

3. Laboratory studies:

a) Analysis of tissue, organ and intact fish carcasses from turbot EFA feeding trial conducted at the University of Stirling.

b) The results of the turbot EFA study are contrary to current hypotheses on dietary lipid requirements of marine fish. The feeding trial should be repeated in Halifax, but permission will be required to import juvenile turbot and hold them in quarantine.

c) If the NSERC proposal is funded, a PhD student (Luc Commeau) will begin a project on lipid metabolism of available cultured marine fish cells and primary cultured cells of cod and/or halibut at Dalhousie University under the supervision of Dr. Castell.

6. Background:

Highlights:

This has been a transition year with the termination of invertebrate work and the initiation of lipid metabolism studies. Development leave at Stirling University was most profitable and has provided the required training and orientation for redirection of the project.

Selected Involvements:

i. Collaborative Research -

Joint studies with Dr. Joe Brown, Memorial University of Newfoundland on halibut aquaculture.

Analyses of oyster samples from SFT Ventures project.

Lobster toxicology project with Dr. Chou, Physical and Chemical Sciences, DFO.

Turbot nutrition at University of Stirling.

Lipid metabolism of cultured fish cells, University of Stirling.

ii. University Liaison -

Supervision of PhD student Xu Xueliang, Biology Dept, Dalhousie University.

Dr. Castell gave lectures and supervised laboratory practical in 10 day course on larval fish culture and nutrition (ERASMAS Waganenen University and University of Ghent).

Dr. Castell served as liaison officer for Science Subvention project of Dr. Tom MacRae.

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Koshio, S., Castell, J.D. and O'Dor, R.K. 1992. The effect of different dietary energy levels in crab-protein-based diets on digestibility, oxygen consumption, and ammonia excretion of bilaterally eyestalk-ablated and intact juvenile lobsters, Homarus americanus. Aquaculture 108:285-297.

ii. Interpretive Scientific -

iii. Scientific and Technical -

Three papers on EFA requirements of Penaeus chinensis have been published in Chinese. Proper citations are not available.

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 243

Section: Aquaculture

Project Title: Fish Nutrition

Project Leader: Lall, S.

Other Researchers: Keith, R.

Work Activity: W.A.1.1.2.3

Key Words: salmon; aquaculture; fish food; nutrition

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1. Project Description:

This project will change from 243 to 2430 Nutrition - Salmonids and Disease for 1993.

Investigate the nutritional requirements of salmonids and marine fish in relation to growth, development, general health, reproduction, and other physiological functions. Present research is concerned with nutrition of salmonids to provide essential information for government and private culture operations, the feed industry, universities, fisheries management, and assessments.

2. Long-Term Objectives:

Determine the nutrient requirements of salmonids and marine fish for commercial operations; develop analytical and biological techniques to characterize the nutritional deficiencies in cultured and wild fish; provide information on nutritional requirements of salmonids, feed formulations, micronutrient losses in feed, and feed manufacturing techniques to other segments of government, universities, and the private sector; and develop a biological basis for determining salmonid culture potential for economic projections.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Continue research on the nutrient requirements of Atlantic salmon specifically emphasizing the role of polyunsaturated fatty acids in immune response and disease resistance specifically of salmon to Vibrio anguillarum. (Lall, Keith, Olivier)

Goal partially met. Delay resulting from the lack of funds and a severe outbreak of Enteric Redmouth Disease six weeks after the commencement of study. The experiment has been restarted with anticipated completion by May 1993.

2. Develop and test experimental protocols for determining amino acid requirement of Atlantic salmon in sea water, with emphasis on the role of dietary arginine. (Lall, Keith, Kaushik)

Goal met. The arginine requirement of 1.5 % of the dry diet was obtained from growth assay and arginine oxidation studies. Several biochemical indices including liver arginase activity, plasma arginine, insulin and growth hormone levels were measured in collaboration with Drs. Kaushik and LeBail of I.N.R.A., France. Results have direct application on improving the feed formulations for Atlantic salmon. A manuscript submitted for internal review.

3. Co-ordinate fish hatchery nutrition programs. Continue to provide advice to private aquaculture operations, feed industry, and universities and maintain a suitable communication link with these agencies. (Lall)

Goal met. Demand for services related to the fish hatchery nutrition program increased due to feed quality related problems of new supplier. Diagnosis of several nutritional deficiencies from hatcheries and fish farms were conducted; numerous written and telephone inquiries originating from fish culturists, feed industry and aquaculture personnel were answered. Evaluation of commercial fish meals and several fishery by-products were completed. Active participation in aquaculture industry sponsored seminars.

4. Submit manuscripts on research completed or nearing completion on (a) phosphorus utilization by Atlantic salmon and (b) folic acid requirement of Atlantic salmon. (Lall, Keith)

Goals partially met. a) manuscript drafted for internal review for submission to Aquaculture; b) incomplete due to problems associated with the folic acid kits supplied by BioRad for radioimmunoassay. Analytical problems under review and part of the study is likely to be repeated. Emphasis placed on other manuscripts, see additional accomplishments #1.

4. Additional Accomplishments:

1. Completed four manuscripts which are in press (Section 7).

2. Completed two projects in co-operation with Dr. R. G. Ackman (and visiting scientist Dr. S. Kang and Ph. D. student M. Parazo) on absorption and metabolism of vitamin E and diacyl glyceryl ethers by Atlantic salmon.

3. Continued involvement with Dr. Rainie, Atlantic Veterinary College and Aqua-Health Ltd., on development of suitable diets for incorporation of antibiotics and oral vaccines in Atlantic salmon and other finfish diets.

4. Successfully developed eel diets for South Shore Trading Ltd., Port Elgin, N. B. in collaboration with Corey Feed Mills Ltd.

5. Goals/Expected Outputs for 1993:

1. Continue research on the nutrient requirements of Atlantic salmon with emphasis on the role of dietary lipid and vitamin C (polyphosphate form) on the immune response and disease resistance to *Vibrio anguillarum* and *Aeromonas salmonicida*. (Lall, Olivier, Keith and Chin)

2. Start preliminary work on development of nutritional strategies to reduce feed costs of Maritime salmonid aquaculture industry. Emphasis will be placed on the biological and chemical evaluation of existing Atlantic salmon feed formulas and development of feeding guides. (Lall)

3. Co-ordinate fish hatchery nutrition programs. Continue to provide advice to private aquaculture operations, feed industry, and universities and maintain a suitable communication link with these agencies. (Lall)

4. Report findings of Arginine, vitamin E and vitamin B_6 requirements of Atlantic salmon. Complete two chapters in books entitled 'Noninfectious Disorders' (J. Leatherland, Ed.) and Fish and Fishery Products (A. Ruiter, Ed.). (Lall)

5. Publish outstanding papers on (a) Organic requirements, (b) folic acid requirements and (c) phosphorous utilization of Atlantic salmon. (Lall)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

1. Dr. R. L. Saunders, DFO, Biol. Station, St. Andrews, N. B. - Feeding rate and sexual maturation in Atlantic salmon.

2. Dr. W. D. Paterson - Incorporation of oral vaccines in fish feeds.

3. Dr. S. J. Kaushik and Dr. P. LeBail, I. N. R. A., France - Arginine metabolism.

ii. University Liaison -

1. Dr. R. G. Ackman, Technical University of Nova Scotia - Digestibility of wax esters; absorption and deposition of tocopherol.

2. Dr. D. Anderson, Truro Agriculture College - Protein quality of fish meals produced in Atlantic Canada.

3. Dr. D. Rainie, Atlantic Veterinary College - Medicated feeds for Atlantic salmon.

4. Dr. C. B. Cowey and Dr. W. Woodward, University of Guelph.

5. Dr. B. MacKinnon, University of New Brunswick, Fredericton.

iii. Communications -

iv. Contracts Administered -

v. Other -

Reported progress on fish nutrition research at the following scientific meetings and workshops:

1. V Int'l. Symposium on Nutrition and Feeding of Fish, Santiago, Chile.
2. Annual Meeting of the Expert Committee on Animal Nutrition, Truro, N. S.
3. Weston Fish Nutrition Workshop, Toronto.

7. Publications:

i. Primary -

Sigurgisladottir, S. M., S. P. Lall, C. C. Parrish and R. G. Ackman. 1992. Cholestane as a digestibility marker in the absorption of polyunsaturated fatty acid ethyl esters in Atlantic salmon. Lipids. 27:418-424.

Anderson, S. A., S. P. Lall and D. M. Anderson. 1992. Apparent and true availabilities of amino

acids from common feed ingredients for Atlantic salmon (*Salmo salar*) reared in sea water. Aquaculture 108:111-124.

Anderson, S. A., S. P. Lall and D. M. Anderson. 1993. Quantitative lysine requirement of Atlantic salmon (Salmo salar). Can J. Fish Aquat. Sci. (In Press).

ii. Interpretive Scientific -

iii. Scientific and Technical -

Lall, S. P. 1991. Digestibility, metabolism and excretion of dietary phosphorus in fish. p. 21-36. *In* C. B. Cowey and C.Y. Cho (ed.) Proc. Int'l Symp. Nutritional Strategies in management of Aquaculture Waste. University of Guelph.

Lall, S. P. and O. J. Torrissen. 1991. Nutrition and feeding of marine cold water fish. p. 688-696. *In* M. K. Stopskopf (ed.) Fish Medicine, Saunders Press, N.Y.

Lall, S. P. and G. Olivier. 1993. Role of micronutients in immune response and disease resistance in fish. Proc. V Int'l Symp. Fish Nutrition and Feeding. Biarritz, France (In Press).

Ackman, R. G., S. M. Polvi, S. Sigurgisladottir , C. C. Parrish and S. P. Lall. 1993. Absorption and deposition of Omega-3-fatty acids in Atlantic salmon (*Salmo salar*). Proc. Third Int'l Cong. on Essential Fatty Acids and eicosanoids. Adelaide, Australia (In Press).

Ackman, R. G., S. Sigurgisladottir, S. M. Polvi and S. P. Lall. 1993. Fatty acid absorption and transformation in Atlantic salmon (*Salmo salar*). Proc. Int'l Sym. on Cultivation of Atlantic salmon. Bergen, Norway (In Press).

iv. Popular and Miscellaneous -

Lall, S. P., S. J. Kaushik and R. A. Keith. 1992. Quantitative arginine requirement of Atlantic salmon (*Salmo salar*) reared in seawater. IV Int'l Symp. Fish Nutrition and Feeding. Santiago, Chile, September 7-10, 1992, p.6 (Abs.).

Lall, S. P. 1992. Nutritional and chemical characteristics of Canadian fish meal and oil. Expert Committee on Animal Nutrition Meeting. Truro, N. S., May 31-June 2, 1992 (Abs.).

Lall, S. P. 1992. Report from the Canadian Working Group on Finfish Nutrition. Expert Committee on Animal Nutrition Meeting. Truro, N. S., May 31-June 2, 1992 (Abs.).

Ackman, R. G., S. M. Polvi, S. Sigurgisladottir, C. C. Parrish and S. P. Lall. 1992. Absorption and deposition of Omega-3-fatty acids in Atlantic salmon (*Salmo salar*). Third Int'l Cong. on Essential Fatty Acids and eicosanoids. Adelaide, Australia, February 29 - March 4, 1992, p.19 (Abs.).

Ackman, R. G., S. Sigurgisladottir, S. M. Polvi and S. P. Lall. 1992. Fatty acid absorption and transformation in Atlantic salmon (*Salmo salar*). Int'l Sym. on Cultivation of Atlantic salmon. Bergen, Norway, August 17-20, 1992, p.23 (Abs.).

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 244

Section: Aquaculture

Project Title: Fish Disease Research

Project Leader: Olivier, G.

Other Researchers: Moore, A.; Kew, A.; Daly, J.

Work Activity: W.A.1.1.2.1

Key Words: fish disease; diagnostics; immunology; aquaculture; salmon; BKD; furunculosis

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1. Project Description:

This project will change from 244 to 2440 Fish Disease and Immunology Research for 1993.

Using in-vitro and in-vivo techniques and the study of wild and cultivated stocks, investigate the bacteriological diseases of fish to determine their epidemiology and etiology, and conduct research leading to the development of eradication techniques and the development of vaccines.

2. Long-Term Objectives:

Develop a full understanding of the common and rare diseases of fish and methods of control to protect both wild and cultivated stocks.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Using brook trout, determine the survival in vivo of cytotoxic and non-cytotoxic strains of the three phenotypes of A. salmonicida. (Fildes, Olivier)

Goal met. Only the cytotoxic A-layer positive strain is virulent for fish. For avirulent strains, the presence of an A-layer increases survival in vivo compared to strains devoid of an A-layer. A manuscript in preparation.

2. Using live vaccines, we will investigate if protection against furunculosis in brook trout is correlated with survival of the vaccine strain in vivo. We will also determine antibody titers in immune fish to verify the role of humoral immunity in protection. (Fildes, Olivier)

Goal met. Using a live A-layer positive strain which is avirulent we were able to protect fish against furunculosis. Injection of a live vaccine did not give rise to antibodies indicating that protection was not humoral but likely cellular. Manuscript in preparation.

3. Investigate the bactericidal activity of brook trout peritoneal macrophages against the various phenotypes of A. salmonicida by adapting the MTT bactericidal assay described by Graham et al. (1988) who were using rainbow trout kidney leukocytes. This assay will be used to investigate the role of cellular immunity in fish vaccinated with live vaccines. (Daly, Moore)

Goals partially met. Normal fish study completed but work to be continued in immune fish. The virulent cytotoxic A-layer positive strain is partially killed by normal brook trout macrophages whereas all other phenotypes tested are efficiently killed. Although the colorimetric killing assay (MTT) detected killing, we have developed a superior killing assay using plate counts,which gives reproducible results and is rapid. The completed portion of this work will be incorporated into the above noted publications.

4. Continue and complete our experiments on the role of antibodies and complement on the phagocytosis of A. salmonicida by brook trout and Atlantic salmon peritoneal macrophages. (Moore, Olivier)

Goals met. Complement can opsonize avirulent bacteria but not virulent ones, furthermore complement has a better opsonic effect than antibodies. A manuscript is in preparation.

5. Investigate the BKD resistance of Atlantic salmon from Margaree. If time and tank space are available, we will repeat the experimental infection of these fish with BKD. (Olivier, Fildes, Daly)

Goal not met. Experiment is scheduled for January 1993.

6. Using the MTT assay described earlier, the killing capacity of Peritoneal and Kidney macrophages towards A. salmonicida phenotypes will be compared. (Moore, Daly)

Goal partially met. Killing of avirulent A. salmonicida by kidney macrophages was demonstrated but a

better yield of kidney macrophages is needed before project can be completed.

4. Additional Accomplishments:

Strains of A. salmonicida are still being typed using antibiotic resistance profiles and phage sensitivity. (Over 100 strains received in 1992 from various countries)

Atlantic salmon post-smolts fed various levels of vitamin C were challenged against vibriosis and furunculosis. Bactericidal assays with peritoneal macrophages have also been completed. (Collaborative project with Dr. S. Lall) as part of a joint venture agreement with Hoffmann La-Roche Ltd.

5. Goals/Expected Outputs for 1993:

1. Complete publication of 3 manuscripts for projects completed in 1991-93. (Olivier, Moore, Daly)

2. Isolate and culture lymphocytes from the blood, spleen and kidney of Atlantic salmon and brook trout. (Moore and Daly)

3. Adapt a lymphocyte proliferation assay for fish, based on the reduction of the dye, MTT to replace an assay requiring radioactive material. (Daly, Moore)

4. Compare live (cellular) and dead (humoral) vaccines in the protection of fish against furunculosis. Using our assays (macrophage bactericidal and lymphocyte proliferation assays) we are now in a position to fully assess the role of both branches of the immune system in the protection against furunculosis. (Daly, Moore)

5. Complete BKD challenge of F1 generation crosses between Margaree (resistant) and Saint-John (susceptible) stocks. (Kew, Daly and Olivier). This work is part of a collaborative project with Dr. C. Herbinger (Dalhousie University) to investigate genetic resistance.

6. Complete the study on the role of vitamin C in the immune response of Atlantic salmon post-smolts, including disease challenges, phagocytosis, and complement experiments. A report will be prepared for Hoffmann La-Roche. (Moore, Kew, Olivier)

7. Investigate the role of three lipid sources on the immune response of Atlantic salmon. (Collaboration with S. P. Lall) (Kew, Olivier)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

Dr. C. Herbinger (Dalhousie University); BKD resistance in Atlantic salmon.

Dr. B. Pohodjak (Dalhousie University); detection of fish lymphokines and cytokines.

Dr. D. Groman (Atlantic Veterinary College); diagnostic of atypical furunculosis in salmonids from Newfoundland.

iii. Communications -

iv. Contracts Administered -

Scientific advisor on three DFO subventions.

v. Other -

7. Publications:

i. Primary -

Olivier, G., S. G. Griffiths, J. Fildes and W. H. Lynch. 1992. The use of Western blot and electroimmunotransfer blot assays to monitor bacterial kidney disease in experimentally challenged Atlantic salmon, Salmo salar L. J. Fish Dis. 15; 229-241.

Olivier, G., A. R. Moore and J. Fildes. 1992. Toxicity of Aeromonas salmonicida cells to Atlantic salmon, Salmo salar, peritoneal macrophages. Dev. Comp. Immunol. 16; 49-61.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Olivier, G. The use of a stress test for detection of latent infection. British Columbia Ministry of Aquaculture Fisheries and Food Furunculosis Workshop. Vancouver B.C. January 30-31, 1992.

Olivier, G. Antibiotic resistance in strains of Aeromonas salmonicida. British Columbia Ministry of Aquaculture Fisheries and Food Furunculosis Workshop. Vancouver B.C. January 30-31, 1992.

Olivier, G. A comparison of typical and atypical furunculosis in salmonids. British Columbia Ministry of Aquaculture Fisheries and Food Furunculosis Workshop. Vancouver B.C. January 30-31, 1992.

Olivier, G. History of furunculosis on the East coast and Aeromonas salmonicida strain differences. British Columbia Ministry of Aquaculture Fisheries and Food Furunculosis Workshop. Vancouver B.C. January 30-31, 1992.

Olivier, G. Aspects bactériologiques et immunologiques d'Aeromonas salmonicida, l'agent causal de la furonculose chez les salmonidés. Micro-hebdo, Institut Armand-Frappier, Montreal, P.Q., 30 Mars, 1992.

Olivier, G and J. Daly (Abstract) Research progress in fish disease detection, diagnosis and control. Aquatech 92 'Progress and profits from research' Halifax, Nova Scotia, March 2-3, 1992.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 245

Section: Aquaculture

Project Title: Parasitology

Project Leader: Morrison, C.M.

Other Researchers: Morrison, C.A.

Work Activity: W.A.1.1.2.1

Key Words: fish disease; diagnostics; parasitology; aquaculture

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1. Project Description:

This project will change from 245 to 2450 Histology and Parasitology for 1993.

Histology, histopathology and parasitology of finfish and shellfish.

2. Long-Term Objectives:

Describe the histology of normal cod and molluscan tissues as a baseline for disease investigations; investigate the pathology of disease conditions of economically important wild and cultured finfish and shellfish species; conduct taxonomic studies of protozoan parasites of marine fish; provide diagnostic support to the Fish Health Service Unit.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Start Cod Atlas, Part 5 - Supportive Tissues (Cartilage, bone, notochord, and muscle), and skin and scales. (Morrison)

Project not undertaken because of reduced technical support and anticipation of funding problems for publication, given similar difficulties with Cod Atlas Part 4.

2. Complete work on Goussia gadi in cod and haddock. (Morrison)

Project delayed because of lack of qualified technical support until July. Ultrastructural studies and preparation of manuscript almost completed.

3. Process cases from Diagnostic Unit and Dr. McClelland as required. (Morrison)

Three cases processed for pathology and report submitted.

4. Start survey and study of ultrastructure of prokaryote organisms in bivalves. (McGladdery and Morrison)

S. McGladdery did not find samples with levels of rickettsias high enough for ultrastructural work. Work on hold pending samples.

5. Start study of life-cycle of Pleistophora hippoglossoideos in American plaice. (McClelland and Morrison)

Work to date has concentrated on prevalence and distribution of the parasites; project is not yet at a stage requiring histological work.

6. Start collaborative SEM study with Mark Powell, Research associate at AVC, on defense mechanisms of trout gill. (Powell, Burka, Morrison)

Project not started because Powell's funding was denied; a new application has been submitted.

4. Additional Accomplishments:

1. Cod Atlas, Part 4, brought to galley stage. Ready for printing when funds available. (Morrison)

2. Study of neoplasia in clams prepared and accepted for publication. (Morrison)

3. Manuscript prepared on studies of schwannomas in smelt. (Morrison, and Harshbarger, Smithsonian Institute)

4. Manuscripts on the adductor muscle and mantle of eastern oysters accepted for publication. (Morrison)

5. Assisted in the SFT Project by checking algal cultures for contamination using scanning electron microscopy. (Morrison and Morrison)

6. Electron microscope suite established and brought into full functional capability. (Morrison and Morrison)

5. Goals/Expected Outputs for 1993:

1. Initiate a study of bivalve histology, to include publications on pathological conditions in Eastern and European oysters, including the ultrastructure of Malpeque Disease induced in susceptible oysters, as part of a broader collaborative program, with S. McGladdery of Gulf of Region, to determine the potential impact of the disease on Cape Breton oyster populations. (Morrison, McGladdery and Morrison)

2. Initiate Cod Atlas, Part 5, Studies (cartilage, bone notocord and muscle). (Morrison and Morrison)

3. Begin a study on the classification and prevalence of smelt tumors using ultrastructure, with a view to assessing impact on the stock. (Morrison and Morrison)

6. Background:

Highlights:

1. The submission of Cod Atlas, Part 4, to the publisher.
2. Completion of Electron Microscope suite.

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

On committees for two PhD graduate students, Patrick Wells at Dalhousie University, and S. Zhou at Technical University of Nova Scotia. Collaborative research planned with Mark Powell, Atlantic Veterinary College.

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Renaud, C.B. and C.M. Morrison. 1992. Histological evidence from nuptial tubercles for the respective monophyly of the genera Gadus and Boreogadus (Gadidae). Copeia. 4:

ii. Interpretive Scientific -

Cold-water commercial marine fish anatomy and physiology. C.M. Morrison and R.E. Zurbrigg. pp. 672-684, In Fish Medicine, M.K. Stopskoff (ed.). W.B. Saunders Co. Toronto, Montreal.

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Morrison, C.M. The digestive tract of the cod eleutheroembryo ('yolk-sac larva') and larva. Abstract. Bulletin of the Canadian Society of Zoologists. 23g

Morrison, C.M. and G.M. McClelland. Book Review of J. Grabda (1991): Marine Fish Parasitology: and outline. Europ. J. Protistol. 28: 249-250.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 246

Section: Aquaculture

Project Title: Molluscan Culture and Phytotoxin Research

Project Leader: Scarratt, D.; Cornick, J.

Other Researchers: Freeman, K.; Kean-Howie, J.; Bradford, B.

Work Activity: W.A.1.1.1.7; W.A.1.1.2.2

Key Words: domoic acid; aquaculture; mussels; oysters; scallops; phytotoxins; nutrition; molluscan culture

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1. Project Description:

This project will change from 246 to 2460 for 1993.

Research into the physiology and ecology of invertebrates in support of the development of the aquaculture industry in the Scotia-Fundy Region. In collaboration with Inspection Branch, Habitat Ecology Division, and Physical and Chemical Oceanography, determine rates of uptake and depuration of marine toxins by commercial molluscs.

2. Long-Term Objectives:

Apply scientific knowledge and information to the development of an economically viable invertebrate culture industry in Scotia-Fundy. Describe the dynamics of toxin uptake and depuration by molluscs and develop protocols for depuration.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

Reassignment of K. Freemen and B. Bradford in August to assist J. Kean-Howie (on maternity leave Dec/92) on SFT special project as well as a requirement for K. Freeman to work off excess vacation carry over on a planned schedule has interrupted all tasks. Project leader (D. Scarratt) retired in September.

1. Complete and publish manuscript on Mytilus edulis and trossulus morphs. (Freeman, et al)

Goal partially met. Draft of a Technical Report is under internal review.

2. Reevaluate and publish data on fecundity, egg size and larval viability of Mussels. (Freeman)

Goal partially met. Reevaluation is incomplete pending completion of SFT work. A draft paper is in progress.

3. Evaluate fertility of M. edulis x trossulus hybrids, including gametogenic index and publish results. (Freeman, Perry)

Goals not met. Spawning occurred but no larvae survived of any crosses. Reassessment ongoing. The GI index work is on temporary hold. New work will be carried out with a different type of digitizer requiring assessment and conversion of previous data to conform with new system.

4. Evaluate settling times of larvae of M. edulis and M. trossulus on a commercial lease where both species exist. (Freeman, Bradford) (Requires contract with S. Hancock for Mpi analysis)

Goal not met. Spat for 1992 have not grown to a stage suitable for isoenzyme analysis.

5. Test protocols for depuration of domoic acid from naturally and artificially contaminated mussels, bay scallops and american oysters. (Scarratt)

Goals met. Two draft manuscripts in preparation. (1) A primary publication on depuration of Domoic acid from cultured mussels and the implications for aquaculture management; (2) A Technical Report on uptake and elimination of Domoic acid from mussels and Bay scallops.

6. Breed F3 generation of introduced bay scallops, Argopecten irradians, and continue performance trials of existing strains. (Scarratt, Bradford) Continue attempts to develop a Perkinsus-free strain.

Goals met. Attempts to breed a Perkinsus-free strain of bay scallop completed and a paper co-authored with S. McGladdery has been submitted for publication. F3 generation of introduced bay scallops successfully bred, but performance has been disappointing. Animals have been distributed to and are doing well at several culture facilities in Nova Scotia. Consideration being given to discontinuing breeding program because of high labour requirements.

4. Additional Accomplishments:

1. Collaboration continued with Working Group on Introductions and Transfers of Fish and Shellfish to Prince Edward Island. Redrafting of part of the P.E.I Introductions Policy is on hold due to retirement of D. Scarratt. (Scarratt)

2. Continued collaboration on National Working Group on Development of a Manual of Compliance for Shellfish Health Protection Regulations. First draft of a section on Crustacean diagnostics completed. (Scarratt)

3. Completed production of domoic acid-contaminated mussels at different concentrations to be used in a collaborative project with DFO Inspection Branch, Ottawa, to evaluate a new assay procedure. (Scarratt and Bradford)

4. As of August mostly contributed to SFT project with J. Kean-Howie. (Freeman and Bradford)

5. Goals/Expected Outputs for 1993:

1. Complete and publish data on mussel (Mytilus edulis and Mytilus trossulus) morphs as a Technical Report Technical Report. (Freeman, et al)

2. Complete, and submit for publication, manuscript on fecundity, egg size and larval viability of mussels. (Freeman)

3. Complete publication of depuration of Domoic acid from naturally and artificially contaminated mussels, bay scallops and oysters. (Scarratt, Freeman)

4. Evaluate fertility of M. edulis and M. trossulus hybrids including gametogenic index. (Freeman)

5. Evaluate settling times of M. edulis and M. trossulus larvae on a commercial lease. (Freeman, Bradford)

6. Assist, as necessary, in carrying out the DFO component of the SFT project for J. Kean-Howie during her maternity leave. This project, involving a number of different agencies, is investigating the reasons for significantly poor hatchery performance of European oysters at a commercial hatchery. Coordinate project, summarize and report data (Freeman), determine glycogen values (Freeman and Bradford) and do proximate and protein analysis (Bradford) on algal and oyster samples.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

Collaborated with SFT Ventures, Mallet Research Associates, TUNS and NRC on a project dealing with hatchery performance problems of European oysters at SFT.

ii. University Liaison -

Drs Zouros, Pogson and Ball, Dalhousie U., Assessment of mitochondrial DNA in, with and between matings of Mytilus edulis and Mytilus trossulus; work completed and published. (Freeman)

Committee member and supervisor for Katherine Perry, Honours student, Mount Allison University, Sackville, N.B. on peak spawning times of co-occurring mussel species on a Nova Scotia mussel farm. Thesis accepted and Honours degree granted. (Freeman)

Committee member and supervisor for Renata Outerbridge, Masters student at Dalhousie University, on uptake and elimination of domoic acid. Thesis accepted and degree granted. Draft of manuscript for publication in internal review. (Scarratt)

iii. Communications -

'Depuration of cultured mussels with domoic acid from a toxic diatom: Implications for aquaculture management', by R.A.M. Outerbridge and D.J. Scarratt. Presented by D.J. Scarratt at the Canadian Workshop on Harmful Algae. Mont Joli, Quebec, May 1992.

'Morphology, condition and reproduction of two co-occurring species of Mytilus at a Nova Scotia mussel farm', by K. Freeman, K. Perry and T. DiBiacco. Presented by K. Freeman at Aquaculture Association of Canada Meeting, Vancouver, B.C. June 1-5, 1992.

iv. Contracts Administered -

With R. M. Outerbridge: Report on Depuration of Cultured Mussels Contaminated with Domoic Acid. (Scarratt)

With Katherine Perry: Routine maintenance of batch phytoplankton cultures and care of experimental bivalve molluscs. (Scarratt)

v. Other -

7. Publications:

i. Primary -

Zouros, E., K. R. Freeman, A. O. Ball and G.R. Pogson. 1992. Direct evidence for extensive paternal mitochondrial DNA inheritance in the marine mussel Mytilus. Nature. 359(6394): 412-414.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

D.J. Scarratt contributed monthly articles to the Atlantic Fish farmer for a column series, 'From the Lab'.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 247

Section: Aquaculture

Project Title: Molluscan Nutrition

Project Leader: Kean-Howie, J.

Other Researchers: Bradford, B.

Work Activity: W.A.1.1.2.2

Key Words: bivalve; shellfish; microparticle; synthetic diets; nutrition; ecophysiology

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1. Project Description:

This project will change from 247 to 2470 for 1993.

Investigate the nutritional requirements of bivalve molluscs in relation to their ecophysiology and life history with a view to development of a successful nutrition protocol for bivalve hatcheries.

2. Long-Term Objectives:

Plan and implement a molluscan nutrition research program; determine specific nutrient requirements of bivalve molluscs; monitor and evaluate the information needs of shellfish producers with respect to nutrition physiology; develop and test new research tools, especially synthetic diets and measure indices of response to these tools; determine suitable protocol for experiments with synthetic diets; evaluate existing and develop new analytical techniques for biochemical analyses.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Completion and successful defence of dissertation by March 31. (Kean-Howie)

Goal not met. Incumbent now reassigned to a pressing project to contribute to a multiagency thrust to resolve a serious problem with European oyster culture at a commercial hatchery in Nova Scotia (SFT Project). (Kean-Howie)

2. Complete the preparation of manuscripts based on PhD thesis. (Kean-Howie)

a) Feeding trials with juvenile bay scallops and sea scallops using microparticulate diets.
b) Changes in proximate composition of juvenile sea scallops over their first two years.

Goals not met. The pressures of work to develop a proposal and work plans for the SFT project, sick leave and then maternity leave precluded completion of these two manuscripts. Drafts of both manuscripts are in preparation and are given top priority. (Kean-Howie)

3. Review and evaluate the requirements of bivalve culture operation with respect to nutrition management and practises. (Kean-Howie)

Goal not met. Completion of a selected Ostrea edulis bibliography initiated as background for the SFT project is considered a start to this review and evaluation. (Kean-Howie)

4. Plan and conduct experiments on food presentation protocol for larval studies, specifically the use of shakers to retain diets in suspension. (Kean-Howie)

Goals not met. Experiments were not initiated due to temporary redirection and current reassessment of the direction for this project. (Kean-Howie)

4. Additional Accomplishments:

1. Completed development of a proposal, work plans, background bibliography, microencapsulated diets (Kean-Howie) and some analyses (Bradford, and Freemen [on assignment from molluscan culture]) for the SFT project.

5. Goals/Expected Outputs for 1993:

The direction of this project is currently under review and development of specific long term goals awaits a final decision on priorities which should be completed by the end of this fiscal year. In the meantime the following activities are given priority:

1. Completion of the SFT Project and development and submission of a final report. (Kean-Howie, Bradford, Freeman (on assignment)

2. Complete the preparation of manuscripts. (Kean-Howie)

   a) Feeding trials with juvenile bay scallops and sea scallops using microparticulate diets.

   b) Changes in proximate composition of juvenile sea scallops over their first two years.

6. Background:

Highlights:

DFO's decision to develop an expert in the field of molluscan nutrition has been justified, given the industries' requirements for assistance.

Selected Involvements:

i. Collaborative Research -

1. Dr. Horatio Hervas, TUNS. Development of microparticulate diet for European oysters. SFT Project.
2. Dr. R. G. Ackman, TUNS, Analyses for SFT Project.
3. Dr. Andre Mallet, Mallet Research Services, Sampling for SFT Project.
4. Dr. James Craigie, NRC, Glycogen analyses for SFT Project.
5. Dr. R. Pocklington, Marine Chemistry, BIO, Protein analysis for SFT Project.

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 248

Section: Aquaculture

Project Title: Fish Health Services Unit

Project Leader: Cornick, J.

Other Researchers: MacKinnon, A.M.; McMenemy, M.; Williams, D. (contract); Keiser, K. (contract)

Work Activity: W.A.1.1.2.1

Key Words: diagnostics; fish health; fish disease; furunculosis; BKD; aquaculture; salmon

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1. Project Description:

This project will change from 248 to 2480 for 1993.

This project 1) provides diagnostic service, formulates and administers quarantines, and regulates movements of salmonoids and their products under FHPR; 2) provides diagnostics and implements Regional Fish Health Guidelines for intra-provincial salmonoid movements; 3) is responsible for fish health matters related to federal fish culture systems; 4) investigates disease aspects of fish kills in the wild; 5) provides diagnostic and counselling service to government agencies and the aquaculture industry with respect to both finfish and shellfish; 6) assists in the transfer of technology in fish disease diagnosis by providing informal training as well as workshops and seminars with the industry; and 7) develops, in cooperation with industry, disease control programs to eliminate specific health problems.

2. Long-Term Objectives:

To: 1) prevent introduction of foreign disease agents into the Maritime provinces; 2) control the spread of the diseases such as Furunculosis, ERM and BKD between watersheds within provinces; 3) prevent or minimize the impact of disease on hatchery-reared fish and provide counselling service; 4) pinpoint the effects of disease agents in fish kills in the wild; 5) minimize the effects of disease and provide counselling on fish health matters to the aquaculture industry; 6) strengthen private sector disease control capability through technology transfer; 7) reduce economic losses related to specific health problems; and 8) study the distribution of fish diseases throughout the Maritime provinces.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Administer FHPR, in N.S. and N.B. in order to prevent introduction and transfer of disease agents into and between provinces. Provide advice on revisions to the FHPR including Manual of Compliance. (Cornick)

Goals met. Twenty-eight FHPR Import Permits under Local Fish Health Officer authority issued and 38 inspections and 7 certifications issued (authority as Fish Health Official). M. I. Campbell (Gulf Region) collected samples and assisted in the lab for Gulf Region cases. No certifiable disease agents were detected despite considerable movement of both salmonoid eggs and fish between provinces Input to review of the FHPR continued this year with two meetings with the local representative (MI. I. Campbell) of the Technical Review Committee.

2. Administer Regional Fish Health Policy to control intra-provincial movement of furunculosis, ERM and BKD and continue the revision of existing guidelines toward making the Policy a Regulation. (Cornick)

Goal met. Completed diagnostics at 25 facilities (108 lots) for intraprovincial, interwatershed transfers under this program with no disease outbreaks recorded. Existing guidelines continue under review for delayed promulgation as a regulation now slated for early 1993.

3. As appointed U.S. Title 50 Certifying Official, provide permits for fish transfers into the U.S.A. (Cornick)

Goal met. In April 1992, FHPR requirement for the certification of eviscerated cultured salmonoids was rescinded, eliminating our need to test fish at approximately 50 cage sites for export to the U.S. under U.S. Title 50. We nevertheless carried out inspections under a Joint Venture Agreement at 15 sites, which also permitted issuance of 15 U.S. Title 50 permits as well as a summary report of disease status of the farms.

4. Review proposals and make recommendations based on disease considerations for finfish/shellfish introductions and/or transfers under authority of Introduction and Transfer Committee and supervise associated quarantines. (Cornick)

Carried out 11 disease inspections and reviewed nine proposals for the interprovincial transfer of indigenous shellfish and non-salmonoid finfish. Provided evaluation and disease control recommendations for a proposed introduction of Tiger shrimp from China to Nova Scotia. Supervised the installation and operation of two quarantine units for introduction of Atlantic salmon eggs under Section 4.

5. Provide diagnostic and counselling service to federal hatcheries in the S-F Region. (Cornick, MacKinnon, McMenemy)

Goal met. No major disease problems were encountered. Furunculosis monitoring continued at Mactaquac FCS, but the disease was not diagnosed, although the swim bladder fungus reappeared periodically with low mortalities. Stocks at all hatcheries were tested and passed under the Regional Fish Health Policy for intraprovincial stocking.

6. Investigate disease as a cause of wild fish kills. (Cornick, MacKinnon, McMenemy)

Goal met. Thirteen lots of various species were examined and reports filed . Infectious disease was not the prime cause of any of the kills.

7. Provide diagnostic and counselling service to other government agencies and private aquaculturists, as resources permit. Encourage and strengthen private sector capability to detect and control disease by providing advice and counsel and referring appropriate cases to private diagnosticians. (Cornick, MacKinnon, McMenemy)

Goal met. Demand for services essentially unchanged from the previous year. Expected decrease in workload, resulting from the dropping of FHPR III, did not occur. A disease surveillance program in support of proposed changes to FHPR, increased demand from Quebec and Newfoundland for certification services, an increase in the number of inspections for interprovincial salmonoid movements, and a new cooperative BKD brood monitor program with the Province of Nova Scotia offset the loss. All cases were effectively handled. BKD, Furunculosis, Vibrio anguillarum, IPN (carrier state), ERM, and Gaffkemia were identified, and reports filed and recommendations made. The withdrawal of all DFO services available from private sector, continues; but services not as readily available as anticipated.

8. Conduct surveys on private fish culture facilities and in the wild, in order to establish a disease profile for the Maritime Provinces. Reallocate resources formerly assigned to FHPR III certifications to this function. (Cornick, MacKinnon, McMenemy)

Goal met. See 3.3 above.

9. Cooperate with N.B. Department of Fisheries and Aquaculture and N.S. Dept. of Fisheries in the control of vertical transmission of BKD in N.B., by advising on the conduct of the brood stock screening programs. Continue the Carrier testing program for Furunculosis for both private and government sector facilities in N.B., but gradually phase out involvement as NBFA capability comes on line. (Cornick, MacKinnon, McMenemy)

Goal met. Discussions held with N.B. fisheries on protocols for and interpretation of FAT tests for BKD in broodstock. A new cooperative BKD broodstock screening program was initiated with N.S. fisheries. Involvement with furunculosis carrier testing program for New Brunswick is now phased out.

10. Develop protocols for examination of shellfish to minimize transfer of disease in native and introduced species. (Cornick, MacKinnon, McMenemy)

Continued collaboration with S. McGladdery of Gulf Region in examining six lots of shellfish. Continued contribution to ongoing review of shellfish disease and diagnostics for new proposed regulations.

11. Provide Diagnostic services as required for DFO, Gulf Region. (Cornick, MacKinnon, McMenemy)

Goal met. Under a memorandum of understanding, 170 cases were referred to the FHSU and satisfactorily completed. An annual report for work conducted in 1991-92 was submitted. Number of submissions increased by 37 percent.

12. Provide other services as required. (Cornick, MacKinnon, McMenemy)

Other services included FHPR certification of five facilities, 24 lots in Quebec and one lot in Newfoundland.

4. Additional Accomplishments:

Diagnostic surveys on wild stocks were carried out (outside memorandum of agreement) in Little S.W. Miramichi R. and Catamaran Brook, N.B. (9 lots), and for Newfoundland Department of Fisheries (Gulf Region client) on stocks from Spirity Pond and Portland Creek, Newfoundland (5 lots).

J. Cornick carried out duties of Section Head from April 1, 1992 onward.

5. Goals/Expected Outputs for 1993:

1. Administration of FHPR regulations and diagnostics for FHPR certifications in N.S. and N.B. in order to prevent introduction and transfer of disease agents into and between provinces. Provide advice on revisions to the FHPR including the Manual of Compliance. (Cornick)

2. Administer the Regional Fish Health Policy to control intraprovincial movement of furunculosis, ERM and BKD, and continue the revision of existing guidelines toward making the policy a regulation. (Cornick)

3. Provide FHPR certification inspections for DFO, Quebec, and Newfoundland Regions as requested, and as resources permit. Cornick, MacKinnon, McMenemy)

4. Review proposals and make recommendations based on disease considerations for finfish/shellfish introductions and/or transfers under authority of Introductions and Transfers' Committee and supervise associated quarantines. (Cornick)

5. Provide diagnostic and counselling service to federal hatcheries in the Scotia-Fundy Region. (Cornick, MacKinnon, McMenemy)

6. Investigate disease as a cause of wild fish kills. (Cornick, MacKinnon, McMenemy)

7. Provide diagnostic and counselling service to other government agencies and private aquaculturists as resources permit. Encourage the development of private sector diagnostic capability through advice, counsel and referring appropriate cases. (Cornick, MacKinnon, McMenemy)

8. Cooperate with the New Brunswick Department of Fisheries and Aquaculture and the Nova Scotia Department of Fisheries to control vertical transmission of BKD by advising on the conduct of BKD screening programs in New Brunswick and undertaking a cooperative program to provide advice and diagnostic service in Nova Scotia. (Cornick, MacKinnon, McMenemy)

9. Provide diagnostic service as required for DFO Gulf Region. (Cornick, MacKinnon, McMenemy)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

New Brunswick Fisheries and Aquaculture Staff: consultation and diagnostics for (1) BKD and furunculosis control programs in New Brunswick, and (2) vibriosis outbreaks in marine cages in N.B. (Cornick and MacKinnon)

Gulf Region: Provision of diagnostic service and collaboration on health inspections with Gulf Region staff (S. McGladdery). (Cornick, MacKinnon, McMenemy)

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

Administered a joint-venture agreement with New Brunswick Salmon Growers Association to carry out a disease surveillance program at 15 marine cage sites.

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4010

Section: Finfish Aquaculture

Project Title: Salmonid Growth, Smolting and Reproduction

Project Leader: Saunders, R.

Other Researchers: Harmon, P.; Knox, J.D.

Work Activity: W.A.1.1.2.2

Key Words: salmon; aquaculture; salmonid culture; physiology

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1. Project Description:

Conduct physiological research on salmonid growth and smolting to elucidate effects of environmental manipulation on metabolism, growth and behaviour; evaluate smolting on the basis of endocrinological, metabolic and osmoregulatory activity; investigate environmental and genetic bases for age-at-maturity of Atlantic salmon; conduct field tests on sea farms to scale-up promising lab results; transfer salmonid culture technology to private sector through contact with commercial marine and freshwater salmon producers.

2. Long-Term Objectives:

Provide solutions to biological problems encountered or anticipated in salmonid aquaculture; improve the quality and cost-effectiveness of producing salmon smolts for aquaculture and enhancement of wild populations; improve the productivity and cost-effectiveness of salmonid aquaculture through a better understanding of the environmental and genetic control of age-at-maturity; develop and perfect methods of controlling maturity; participate in an effective extension service for the salmonid aquaculture industry by cooperative research and technology transfer with salmonid aquaculture companies and by receiving feedback from new R&D initiatives.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Hatch and rear transgenic (growth hormone) salmon and evaluate effects of extra copies of GH on growth and smolting. (Saunders, Fletcher)

Some exceptionally large fish are being examined for presence of introduced GH genes, i.e. evidence of transgenic status.

2. Continue study of underyearling smolt production with follow-up evaluation of long-term survival and growth in seawater. (Saunders, Duston)

Smolt-like salmon produced in autumn have been transferred to sea cages for evaluation of survival and growth performance.

3. Evaluate smolt production from previously mature male parr. (Saunders)

Large mature males are capable of completing smolting the following spring. Paper presented in Salmon Culture Symposium, Bergen.

4. Conduct study in cooperation with Connors Bros., re effectiveness of food deprivation in winter-spring on grilse maturation. (Saunders, Frantsi)

Food deprivation resulted in sharp reduction in incidence of male and female grilse.

5. Report findings of cooperative study with SGRP, re smolt production in concrete vs fibreglass rearing tanks. (Saunders, Friars)

Fish grow more slowly in concrete tanks and fewer reach smolt size. Published results in Ann. Rep. S.G.R.P. 1991/92.

6. Evaluate influence of photoperiod and temperature on development of bimodality in length frequency as an indication of incipient smolt status. (Saunders, Duston)

Elevated temperature during winter promotes growth of salmon parr otherwise too small to complete smolting the following spring, but some resulting smolt-sized fish are not functional smolts.

4. Additional Accomplishments:

1. Organized and chaired 4th International Salmonid Smolt Workshop in St. Andrews. Editing Proceedings.

2. Hosted visiting scientists from Norway; conducted joint study of effects of starvation on post-smolts in fresh water and sexual maturation.

3. Responded to request from Atlantic Salmon Federation to evaluate smolt status of previously mature male parr. Conducting ongoing evaluation of such smolts in sea cages.

5. Goals/Expected Outputs for 1993:

1. Complete analysis of biological material and data from cooperative AFAP project with Connors Bros. Ltd. re effectiveness of food deprivation in winter-spring on prevention of maturation as grilse. AFAP with Bill Robertson of Connors Bros. Ltd.

2. Conduct experiment on effects of elevated winter temperature on growth and smolt development. In cooperation with Jim Duston (Connors) and Sigurd Stefansson (Bergen, Norway).

3. Hatch and rear transgenic (growth hormone) salmon and evaluate effects of extra copies of GH genes on growth and smolting. In cooperation with Garth Fletcher (Memorial University) and Choy Hew (University of Toronto) with strategic grant funding from NSERC.

4. Continue research on environmental conditions necessary to produce underyearling smolts with emphasis on survival and growth in seawater. In cooperation with Jim Duston with funding to Connors through new IRAP-ACOA contract.

5. Study growth dynamics using enzymatic assessment of growth rate during short periods in the early stages of smolting. Joint experiment with Tillmann Benfey of U.N.B.

6. Investigate use of photoperiod to reduce precocious maturation during production of fall (1.5-year) smolts. In cooperation with Jim Duston.

7. Revise salmon culture chapter in book, Coldwater Aquaculture in Atlantic Canada.

8. Edit papers from 4th International Smolt Workshop for publication of proceedings in the journal, Aquaculture.

6. Background:

Highlights:

1. Presented scientific papers at: Aquaculture 92 in Vancouver; International Symposium on Culture of Atlantic Salmon; and 4th International Salmonid Smolt Workshop.

2. Participated in Workshop re transgenic salmon involving researchers in NSERC Strategic Grant study.

Selected Involvements:

i. Collaborative Research -

With Dr. James Duston of Connors Bros. Ltd., Aquaculture Div. on research leading to underyearling smolt production under terms of IRAP-P project; with SGRP personnel to evaluate smolt status of previously mature male parr; with Dr. Sigurd Stefansson, Univ. of Bergen, re environmental manipulation of growth, smolting and sexual maturity; with Bill Robertson of Connors Bros. Ltd. and SGRP re food deprivation in winter to reduce incidence of grilse.

ii. University Liaison -

1. Conducting joint research with Dr. Tillmann Benfey, U.N.B., on analysis of salmon growth during short periods, using an enzyme bioassay.

2. Conducting research on transgenic (growth hormone) salmon in cooperation with Dr. Choy Hew of Univ. of Toronto and Dr. Garth Fletcher, Memorial Univ. of Newfoundland, with support through an NSERC Strategic Grant.

iii. Communications -

1. With ATV re alternate species for aquaculture in response to the Northern cod crisis.

2. With Astroff Corkum Ross Assoc. re article on winter feed deprivation to reduce grilse maturation - for Supply and Services R & D Bulletin.

3. Weekly briefings - Report on 4th International Smolt Workshop

iv. Contracts Administered -

AFAP contract with Connors Bros. Ltd. re winter feed deprivation to reduce incidence of grilse maturation.

v. Other -

7. Publications:

i. Primary -

Duston, J., and J. D. E. Knox. 1992. Acclimation of Atlantic salmon (*Salmo salar*) parr to seawater in autumn: stimulatory effect of a long photoperiod. Aquaculture 103: 341-358.

Bjerknes, V., J. Duston, D. Knox, and P. R. Harmon. 1992. Importance of body size for

acclimation of underyearling Atlantic salmon parr (*Salmo salar* L.) to seawater. Aquaculture 104: 357-366.

Duston, J., R. L. Saunders. 1992. Effect of 6, 12, 18 month photoperiod cycles on smolting and sexual maturation in juvenile Atlantic salmon (*Salmo salar*). Can. J. Fish. Aquat. Sci. 49: (in press).

Komourdjian, M. K., and R. L. Saunders. 1992. Cells with affinity for periodic acid-Schiff are present in the pars intermedia of Atlantic salmon. Can. J. Zool. 69: 3105-3108.

Saunders, R. L., A. P. Farrell, and D. E. Knox. 1992. Progression of coronary arterial lesions in Atlantic salmon (*Salmo salar*) as a function of growth rate. Can. J. Fish. Aquat. Sci. 49: 878-884.

ii. Interpretive Scientific -

Stefansson, S. O., A. E. Berg, T. Hansen, and R. L. Saunders. 1992. The potential for development of salinity tolerance in underyearling Atlantic salmon (*Salmo salar*). World Aquacult. 23: 52-55.

iii. Scientific and Technical -

O'Flynn, F. M., R. L. Saunders, J. D. Martin, G. W. Friars, J. K. Bailey, and J. M. Terhune. 1992. The effect of extended daylength on early sexual maturation and growth in Atlantic salmon (*Salmo salar*) reared in sea cages. Salmon Genetics Res. Prog. Tech. Rep. Ser. 151: 14 p.

Duston, J., D. Knox, and T. Maynard. 1991. On producing 1.5+ year old Atlantic salmon smolts in autumn by photoperiod manipulation. Bull. Aquacult. Assoc. Can. 91-3: 41-43.

Sanders, R. L., and F. M. O'Flynn. 1992. Physiological indications of smolt development in fibreglass and concrete tanks. Ann. Rep. Salmon Genetics Res. Prog. 1991/1992: 18-19.

Saunders, R. L. 1992. Enhancing smolt production. World Aquacult. 23: 37-39.

iv. Popular and Miscellaneous -

Saunders, R. L. 1991. Book review of 'Ecology and Management of Atlantic Salmon' by Derek Mills. Trans. Am. Fish. Soc. 120: 828.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4020

Section: Finfish Aquaculture

Project Title: Marine Finfish Aquaculture

Project Leader: Waiwood, K.

Other Researchers: Howes, K.; Reid, J.

Work Activity: W.A.1.1.2.2

Key Words: halibut; haddock; marine fish culture

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1. Project Description:

This project is focused on halibut (*Hippoglossus hippoglossus*) and haddock (*Melanogrammus aeglefinus*) and consists of four thrusts: developing and maintaining a facility for studying all stages in the life cycle of halibut and haddock, conducting research on the culture of halibut and haddock, providing advice to non-industry clients, and providing assistance to industry in support of the commercial culture of halibut and haddock.

2. Long-Term Objectives:

To develop technologies for the culture of marine finfish in support of the aquaculture industry in the Scotia-Fundy Region; to determine the feasibility of introducing new marine fish species and culture techniques for aquaculture purposes; to transfer technologies related to marine fish culture to industry, and to provide advice/assistance on physiological and behavioural problems related to the culture of marine finfish in the Scotia-Fundy Region.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Continue on-growing studies on halibut and haddock with Harbour DeLoutre Products Ltd., Campobello.

Ongrowing studies were continued. New data indicates that halibut males mature after reaching market size. Growth was better with frozen fish than with moist pellets.

2. Continue study on the on-growing of halibut in bottom cage with Maine Aquaculture Innovation Center (MAIC) and Marine Trade Center, Eastport.

This study was delayed due to problems with construction of the cage. The cage was deployed in July and preliminary results suggest that fish grew well but not as well as in salmon cages.

3. Continue work on mass collection of zooplankton in conjunction with the MAIC and the University of Maine.

Collection of field data and sample analysis were completed and the student is in the process of analysing data and preparing a thesis.

4. Complete experiments on effect of salinity on incubation of halibut eggs; analyze data.

Experiments were completed and data analysis was initiated. Preliminary results indicate that the addition of NaCl can not be used to increase buoyancy in halibut eggs.

5. Initiate studies on incubation methods for halibut yolk sac larvae including an evaluation of incubator type and effect of salinity on survival and development; analyze data.

Studies were initiated. Preliminary analysis of the results suggest that there are major problems with yolksac incubation in ambient salinities starting at about 3 weeks post-hatching. Over 4000 first feeding larvae were produced but these were generally of poor quality. The lack of resources prohibited the construction of additional incubators and effort was curtailed. Lack of funds also prevented the construction of plankton nets and zooplankton was collected in insufficient quantities to maintain cultures. Due to a lack of capital funding a data acquisition/ control/alarm system was not acquired and there were 2 major failures in the antiquated temperature control system. This resulted in the loss of 60,000 yolk sac larvae at 40 days post-hatching.

6. Submit for publication Technical Report on halibut on-growing in weirs.

Data were analysed and a decision was made to submit this as a primary publication. This will be done in the next year (see below).

7. Present paper at 16th Annual Larval Fish Conference, Kingston, RI, June 17-19, 1991.

Dr. Anders Mangor-Jensen (co-author) was unable to contribute to the preparation of the proposed paper on halibut research.

8. Present paper at conference on Broodstock Management and Egg and Larval, Quality, Stirling, Scotland June 23-27, 1991.

Participation in this conference was cancelled due to insufficient funding.

9. Conduct collaborative studies with Anders Mangor-Jensen (Austevoll, Norway) on water transport in fish eggs.

A project on water balance in fish eggs was successfully completed and a paper has been accepted for publication in Fish Biology.

4. Additional Accomplishments:

1. A paper on variation in egg size was accepted for publication (see below).

2. A manuscript on halibut survival an size regulation was accepted for publication as a chapter in a book (see below).

3. Presentations on halibut culture were made at the Fishermen's Forum in Rockport, Maine and at the APIC meeting in Sidney N.S.

4. A technology transfer project with Harbour DeLoutre Products was initiated.

5. A review of non-salmonid Aquaculture in Scotia Fundy was undertaken and a report prepared.

5. Goals/Expected Outputs for 1993:

1. Continue operation of broodstock and hatchery facility for halibut. Expand facility for the culture of yolksac and first feeding stages including the setting up of twenty 1,100-L yolksac incubators. Install data acquisition/control/alarm system in hatchery. Determine optimum lighting, salinity and flow manipulations for yolksac stage in ambient salinities. Set up facility for artemia culture and attempt to reproduce successful feeding strategy used in Austevoll, Norway. Send J. Reid to Austevoll to learn recent techniques in yolksac and first feeding culture. Apply knowledge gained to current spawning season.

2. Determine the contribution of batch and maternal effects on variation in halibut egg quality using buoyancy measurements. Conduct a study in Austevoll with A. Mangor-Jensen on the effect of light intensity and wave length on water balance and buoyancy in halibut eggs. Analyse data and initiate preparation of manuscript.

3. Attend ICES Symposium on Mass Rearing of Juvenile fish. Present two papers on variation in egg quality and buoyancy in halibut eggs. Participate in the establishment of Halibut sub-working group.

4. Initiate first attempt to culture haddock juveniles from the egg stage. Set up rotifer culture/enrichment system for early feeding haddock. Obtain experience on the culture of haddock (egg to first feeding) while in Norway.

5. Conduct experiments on determining optimum salinity and temperature conditions for haddock yolksac larvae (leader R. Peterson).

6. Continue growth studies in salmon cages and bottom cages. Submit paper on ongrowing of halibut in herring weirs.

7. Continue Masters project (M. Kacergis) with the University of Maine, Orono. Review first draft of thesis. Initiate preparation of primary papers on thesis work.

8. Initiate Ph.D. or Masters project with Memorial University. Thesis subject will be factors determining yolksac quality in halibut.

9. Initiate study on vitellogenen production dynamics in halibut by a visiting scientist (F. Luizi).

10. Continue technology transfer project with Harbour DeLoutre Products.

11. Initiate Ph.D. project on first feeding halibut (Ed Baker, URI).

6. Background:

Highlights:

Progress was affected by cutbacks in A-Base funding (see Accomplishments 5, 8). We did manage to grow halibut to 3 weeks post first feeding on our first attempt. Although funding for the basic hatchery facility continues to be threatened, we have managed to secure outside support for numerous projects for next year (see below).

Selected Involvements:

i. Collaborative Research -

With the Maine Aquaculture Innovation Center, University of Maine and North Atlantic Aquaculture Inc., on a grow out study using bottom cages and a Masters student project on the collection of wild zooplankton for feeding larval fish.

With Harbour De Loutre Ltd. - halibut growout study using modified salmon cages and on a technology transfer project funded by AFAP.

With A. Mangor-Jensen and R. Peterson - study of water balance in striped bass.

With S. Smith on the successful submission of a manuscript for publication as a chapter in a book.

With C. Chambers on successful submission of a paper on variation in egg quality of fish.

ii. University Liaison -

University of Maine, Orono, Maine, co-supervisor of a MSc student.
University of New Brunswick presenting lectures and tours for students.
N.B. Community College supervision of 2 summer students.
Washington County Community College, cooperation on bottom cage study.
Huntsman Marine Science Laboratory on the preparation of a 5-year project to establish a facility for mass production of micro-organisms for feeding marine fish larvae.
Memorial University on the successful submission of an NSERC strategic grant for studying halibut larval quality and the provision of 3 broodstock for Logy Bay Lab.

iii. Communications -

Presentations: paper on halibut aquaculture opportunities for Maine presented to Fishermen's Forum, Lockporte ME. March 1992, and a paper on halibut aquaculture (Kacergis first author) to APICS in March, 92.

Interviews: S. Morgan on halibut research (published Sept 7 in Atlantic Fish Farming), C. Freeman (Oct. 92) on halibut research (to be published in Seafood Business), C. Smith on halibut aquaculture (aired ATV July 7), and A. Viola on halibut aquaculture (to be aired on Fish'n Canada)

Conduction of 25 tours/lectures of halibut facility to students, industry representatives, politicians and scientists.

iv. Contracts Administered -

1) Halibut on-growing in salmon cages (with Harbour DeLoutre Products), funded by Can.- N.B. Coop. Agreement (15.0K)

2) Technology transfer (withHarbour DeLoutre Products), funded by AFAP (30.3K)

3) Halibut bottom cage (with Treat's Island Inc.), funded by Maine Aquaculture Innovation Center (15.0K)

4) Zooplankton study (M.Sc. student) (with University of Maine, Orono), funded by Maine Aquaculture Innovation Center (18.0K)

v. Other -

Collaboration and participation in discussions leading to a major industry proposal to build a pilot hatchery for halibut.

7. Publications:

i. Primary -

Mangor-Jensen, A. , K.G. Waiwood, R.H. Peterson (in press). Water Balance in Striped bass *(Morone saxatilis* W.) eggs. J. Fish. Biol.

Chambers, R.C. and K.G. Waiwood. (in press) Egg size variation in cod: relative contribution of batch, within batch and maternal effects. Can. J. Fish. Aquat. Sci.

ii. Interpretive Scientific -

Smith, S.J. , Waiwood, K.G. and Neilson, J.D. (in press). Evaluating minimum size regulation for Atlantic halibut *(Hippoglossus hippoglossus)*: Analysis of survival data. In Case Studies in Biometry Ed. N. Lange.

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Waiwood, K.G. 1992. Continuing studies on Atlantic halibut. The Water Column. (Winter, 1992).

Waiwood, K.G. 1992. On-growing studies with Atlantic halibut. Weekly Scientific Briefing (January 10, 1992).

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4030

Section: Finfish Aquaculture

Project Title: Environmental Requirements for Early Fish Development

Project Leader: Peterson, R.

Other Researchers: Martin-Robichaud, D.

Work Activity: W.A.1.1.2.2

Key Words: salmon; striped bass culture; marine fish culture

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1. Project Description:

Investigate the ways in which environmental perturbation and culture conditions can affect the physiology and early development of fish.

2. Long-Term Objectives:

Determination of optimal environments for culture of early stages of fish. Prediction of how environmental changes can affect fish populations through effects on early life stages.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Continue to study the influence of environmental variables on the dynamics of yolk utilization and water and ion movements in larval fish. Experiments in 1992 will focus on comparisons of an estuarine spawner (striped bass), and a marine spawner (cod and/or haddock); and on developing techniques for estimating yolk and embryo wet and dry weights for the small larvae. We also hope to develop a predictive model of water change in salmon alevins, as influenced by substrate and ambient temperature. The cod/haddock experiments are joint projects with Marine Fish Division (E. Trippel), and are contingent upon acquisition of a post-doctoral researcher, with 1992 a set-up year.

Much of the project's research efforts this year were directed toward determination of optimal temperature-salinity conditions for growth and yolk utilization of larval striped bass. Newly hatched striped bass were reared in 15 combinations of temperature and salinity (in running water systems), with samples taken daily from each treatment. Samples are still being analyzed for larval lengths, larval and yolk weights.

Three additional experiments were performed with striped bass in collaboration with three Norwegian researchers. The temperature-salinity optimum for the first few weeks of larval striped bass feeding was investigated in a manner analagous to that described above for yolk-sac larvae. The physiological responses (mortality, blood osmolality, gill ATPase) of older striped bass juveniles to temperature and salinity change were examined, and the results will be compared to salmonid responses during parr-smolt transformation. Such responses should yield valuable information on the best times to transfer striped bass to sea cages.

Attempts to acquire funding for a post-doctoral researcher for cod and haddock larval development were unsuccessful. Some preliminary trials at rearing cod and haddock larvae through to first feeding were successful.

The experiments with salmon alevins (influence of substrate on growth and water content) are complete and the data analyzed. A manuscript will be written in the next year.

2. Investigate the influence of the physical characteristics of shelter on growth, feeding and stress in elvers. This project will probably involve a Ph.D. candidate (Collaboration with T. Benfey, UNB).

The Ph.D. candidate is now completing her course work, and will begin the experimental program in April 1993.

3. Complete the lumpfish sex reversal experiments.

This project formed the basis of D. Martin-Robichaud's M.Sc. program in a cooperative project with U.N.B. The experimental work is completed and the thesis is partly written. I anticipate the degree to awarded in the fall of 1993.

4. Begin to examine the electrical properties of vitelline membranes in relation to water and ion permeability.

A manuscript on ion exchange and electrical properties of salmon egg chorions has been submitted.

5. Continue exploratory experiments on the neurophysiology of triploid fish.

These experiments were not performed. The Norwegian visitor, who was to work on this project, opted to work on striped bass osmoregulation and salinity-temperature tolerance instead.

4. Additional Accomplishments:

1. A series of experiments was performed on newly fertilized halibut eggs to determine the influence of light intensity and salinity on water-hardening. These data will be analyzed and a manuscript written in the next year.

2. The striped bass broodstock were spawned successfully for the second consecutive year, and the eggs were successfully reared to the juvenile stage. In addition to providing organisms for culture experiments, juveniles were provided to HMSC and the aquaculture industry for growth trials.

3. Some preliminary trials investigating the influence of overhead cover on first feeding and early growth of salmon fry were performed at a private hatchery. Uncontrolled factors rendered the results somewhat inconclusive. The company has constructed a controlled-environment room and has applied for AFAP funding to continue the experiments.

5. Goals/Expected Outputs for 1993:

1. Earlier induction of spawning by striped bass broodstock. Our striped bass normally spawn the first week in June. By photoperiod and temperature manipulation, we hope to advance spawning time by 2-3 weeks. Expected output: longer growing period for larvae and juveniles.

2. Investigate the influence of tank morphometry, water turbulence, and overhead light intensity on swimbladder-inflation success of striped bass larvae. Expected output: approximately 1/3 of our reared larvae failed to inflate their swimbladders this year. We expect to improve on this, as well as learn something of early behavior at first feeding.

3. Influence of incubation salinities and temperatures on hatching success, size at hatch, and efficiency of yolk utilization of cod larvae (collaboration with E. Trippel). Expected output: determination of optimal conditions for cod early development. We plan to use 15 treatments - 5 temperatures (2, 4, 6, 8, 10°C) at 3 salinities (10, 20, 30 o/oo).

4. We plan a set of experiments similar to No. 3, but with haddock rather than cod. Haddock spawn somewhat later than cod, so there should be no temporal conflicts with Goal No. 3. Some aspects of this goal will eventually be collaborative with L. Van Eeckhaute, who will supply haddock eggs from the Browns and Georges bank stocks to see if natural differences in growth rates are also expressed under controlled laboratory conditions. This aspect will probably receive greater effort in 1994. These experiments will also be collaborative with K. Waiwood who has captive haddock broodstock.

5. Provide facilities for initiation of studies on the influence of environmental variables (temperature, stocking density) on eel culture and sex determination (collaborative with U.N.B.), possibly also with an eel pilot culture facility receiving ACOA funding in 1993. Possible external funding through the science subvention program or AFAP.

6. Complete data analysis for lumpfish sex-reversal experiments - as required for completion of D. Martin-Robichaud's thesis requirements.

7. Continue study of the influence of overhead cover on early feeding and growth of Atlantic salmon fry (collaborative with Connors Bros. Ltd., who have applied for AFAP funding - but will finance the experiments at their Lake Utopia hatchery, regardless).

8. Determine optimum salinity-temperature conditions for growth of striped bass juveniles (10-20 g) (collaborative with R. L. Saunders). This experiment will complete the study of temperature-salinity optima for striped bass growth up to the point of release into cages.

6. Background:

Highlights:

The striped bass program had several highlights in 1992. The broodstock were again spawned successfully, resulting in eggs and larvae for experiments. The optimal conditions for early larval development were determined, and preliminary analysis of the samples indicate maximum larval size is attained near 1 o/oo salinity and 16-18°C. Striped bass juveniels were provided to several people in the private sector.

The influence of substrate on salmon alevin development was elucidated at 5 temperatures. Prior to these experiments, it was thought that the primary effect of substrate would be to reduce locomotor activity and increase yolk utilization efficiency. Alevins without substrate would presumably be more active and use their yolk more quickly; however, in actuality, alevins without substrate not only used yolk less efficiently, but less rapidly as well - a response possibly mediated through some sort of stress pathway.

Sex reversal of lumpfish was successfully accomplished by incorporating estrogen into living artemia - a novel technique which promises general application to any species of fish can be fed artemia during the critical stage of sex determination. We have received enquiries from as far as Hawaii and Japan on the technique.

Selected Involvements:

i. Collaborative Research -

Water hardening of halibut eggs (K. Waiwood, SABS)
Influence of shelter on first feeding of salmon (W. Robertson, Connors Bros. Ltd.)
Osmoregulation of striped bass juveniles (A. Berge, S. Stephanson, R. Saunders)
Water movement through the striped bass chorion (A. Mangor-Jensen, K. Waiwood)
Early rearing of striped bass (Maritime Culture Systems, HMSC)
Induction of maturation in striped bass (Y. Zohar, Univ. of Maryland)

ii. University Liaison -

University of New Brunswick - co-supervision of 2 graduate student programs.

iii. Communications -

Lectured NBCC aquaculture students twice (on striped bass culture and early salmon development).
Lectured U.N.B. aquaculture students (on striped bass culture).
Presented seminar to Biology Dept., U.N.B. on the influence of stream acidity on fish community structure.
Poster presentation on feminization of lumpfish (presented by D. Martin-Robichaud, Int. Symp. Fish Endocrinology, Saint-Malo, France, June 1-4/92).

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Freedman, B., O. Maessen, S. Beauchamp, J. J. Kerekes, R. H. Peterson, and K. Fisher. 1989. Trace elements in water, sediment, and biota of three oligotrophic lakes in Queens and Annapolis counties, Nova Scotia. Proc. N.S. Inst. Sci. 39: 123-132.

Peterson, R. H., and L. Van Eeckhaute. 1992. Distributions of Ephemeroptera, Plecoptera, and Trichoptera of three maritime catchments differing in pH. Freshw. Biol. 27: 65-78.

Peterson, R. H., and A. Sreedharan. 1992. Water content of Atlantic salmon fry at first feeding in southern New Brunswick hatcheries. Prog. Fish Cult. 54: 181-183.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4100

Section: Invertebrate Fisheries

Project Title: Invertebrate Aquaculture Research and Fisheries Coordination

Project Leader: Aiken, D. (0.5 PY)

Other Researchers: Waddy, S. (0.3 PY); Young-Lai, W. (0.1 PY); Robinson, S. (0.1 PY); Martin, J.D. (0.1 PY); Lawton, P. (0.1 PY)

Work Activity: W.A.1.1.2.1

Key Words: aquaculture; administration

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1. Project Description:

Biological and bioengineering research on invertebrate species with commercial aquaculture potential; administration and coordination of invertebrate aquaculture and fisheries research in southwestern Bay of Fundy.

2. Long-Term Objectives:

Conduct biological and bioengineering research on invertebrate species with commercial aquaculture potential, effect the transfer of aquaculture science and technology to the private sector and general public, and coordinate a multidisciplinary program on invertebrate stock assessments, research and aquaculture.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Conduct a study to evaluate the effect of body size and aggressive capability on survival and growth of small juvenile lobsters under communal conditions. (Aiken)

Study completed as planned.

2. Conduct a study to evaluate the effect of stocking density on survival, growth and social interaction of small juvenile lobsters under communal conditions. (Aiken)

Study completed as planned.

3. Edit, coordinate and publish 'World Aquaculture,' the aquaculture science and technology journal of the World Aquaculture Society. (Aiken)

Attained; edited and published three editions comprised of 58 scientific, technical and general articles on aquaculture.

4. Organize, coordinate and preside over 'Aquaculture Canada 92,' the ninth Annual Meeting of the Aquaculture Association of Canada, to be held at the University of British Columbia, Vancouver BC, June 1992. (Waddy)

Attained; served as Chairman of the Conference Steering Committee. This meeting was the largest and most successful of any the Association has sponsored. Over 320 registrants from 10 countries presented over 90 scientific and technical presentations.

5. Edit, coordinate and publish the 'Proceedings of the Ninth Annual Meeting of the Aquaculture Association of Canada. (Waddy)

Attained; edited, coordinated and published the Proceedings consisting of 34 technical papers on aquaculture science and technology.

4. Additional Accomplishments:

1. Administered (as Acting Director) the St. Andrews Biological Station for three months (Aiken);

2. Served as Section Head of the Invertebrate Fisheries Section and coordinated fisheries assessments and aquaculture research activities in the Bay of Fundy; served as a member of the Station Management Committee; served as a core member of the Invertebrate Subcommittee of the Canadian Atlantic Fisheries Scientific Advisory Committee (Aiken);

3. Organized and co-chaired the Bivalve Culture Workshop, an international workshop held in Orlando in May (Aiken);

4. Served as chairman of the Computer Services Working Group at the Biological Station (Aiken);

5. Promoted aquaculture development on a national and international level by serving as President of the Aquaculture Association of Canada and Vice President of the World Aquaculture Society (Waddy);

6. Promoted the transfer of aquaculture technology to industry and the private sector by serving as Managing Editor of the Bulletin of the Aquaculture Association of Canada; edited, coordinated and published three Bulletin issues, one of which was the Proceedings of the BCMAFF Furunculosis Workshop (Waddy);

7. Communicated scientific and technical information on a wide variety of aquaculture topics by providing information and advice through telephone and fax communication; responded to over 100 requests for technical and general aquaculture information (Aiken, Waddy);

8. Coordinated and directed a cooperative effort between industry and federal and provincial governments to organize, fund and host satellite industry workshops at Aquaculture Canada 92, including a workshop on sockeye salmon enhancement and two workshops on water quality issues and new candidate species. Funding (in excess of $15,000) was raised from several sources to bring in experts from throughout North America for these sessions. The groups involved included CAPC, DFO, NSERC, BCMAFF, and the BC Shellfish Growers Association (Waddy).

9. Invited speaker at workshop for lobster pound operators hosted by the Atlantic Veterinary College, Charlottetown PEI (Waddy).

5. Goals/Expected Outputs for 1993:

1. Conduct biological and bioengineering research to develop systems and strategies for the culture of invertebrate species.

   a) Participate in the development of a multidisciplinary program to assess the biological feasibility of commercial cultivation of bivalve molluscs in Passamaquoddy Bay and the southwestern Bay of Fundy (Aiken);

   b) Conduct a field study to determine spatial and temporal abundance, availability and growth of sea scallop spat as seedstock for a potential scallop culture industry (Robinson);

   c) Conduct a field study to assess the role that environment plays in the timing and success of settlement of scallop spat (Robinson);

   d) Begin development of benthic collectors for use in obtaining scallop seedstock (Martin);

   e) Evaluate RNA/DNA ratios and other biochemical indices as methods for determining the condition of scallops and other bivalves used in aquaculture (Robinson).

2. Facilitate the transfer of aquaculture science and technology to the private sector and general public:

   a) Prepare the first draft of an invited chapter on lobster culture for a book on aquaculture in Atlantic Canada (Aiken);

   b) Prepare the first draft of a chapter on multiuse conflicts in aquaculture for a reference book on aquaculture in Atlantic Canada (Aiken);

   c) Edit, coordinate and publish "World Aquaculture"; the aquaculture science and technology journal of the World Aquaculture Society (Aiken);

   d) Prepare the first draft of a chapter on lobster culture for a reference book being published by Academic Press on the biology of the American lobster (Aiken);

   e) Edit and publish the Proceedings of the Tenth Annual Meeting of the Aquaculture Association of Canada (Waddy);

   f) Communicate scientific and technical information on a variety of aquaculture topics by providing information and advice through personal contacts and telephone and fax communication (Aiken, Waddy).

   g) Coordinate, edit and publish the proceedings of five special sessions and workshops held in conjunction with Aquaculture canada 92: smolt quality, water quality issues in mollusc culture, new invertebrate species for aquaculture, intensive salmonid systems and Arctic char culture (Waddy).

3. Participate in administration, management, and research coordination in support of fisheries and aquaculture activities at the local, national and international level:

   a) Serve as Section head of the Invertebrate Fisheries Section and coordinate fisheries assessments and aquaculture research activities in the Bay of Fundy (Aiken);

   b) Serve on the Management Committee of the St. Andrews Biological Station (Aiken);

   c) Serve as Chairman of the Scotia-Fundy Regional Animal Care Committee (Waddy);

   d) Serve as President of the World Aquaculture Society and chair the 25th Annual Meeting of the World Aquaculture Society in New Orleans Louisiana in January 1994 (Waddy);

   e) Serve as a member of the Library Committee at the St. Andrews Biological Station (Waddy);

   f) Serve as a member of the Aquatic Systems Advisory Committee at the St. Andrews Biological Station (Waddy);

g) Serve as Association Manager for the Aquaculture Association of Canada (Waddy);

h) Serve as a member of the Computer Advisory Committee at the St. Andrews Biological Station (Robinson);

i) Serve as a member of the Scotia Fundy Softshell Clam Advisory Committee (Robinson);

j) Serve as a member of the Southwest New Brunswick Clam Advisory Committee (Robinson);

k) Serve as a member of the Southwestern Nova Scotia Clam Advisory Committee (Robinson);

l) Serve as a member of the Inshore Scallop Advisory Committee (Robinson);

m) Serve as a member of the Invertebrate Subcommittee of CAFSAC (Robinson, Lawton);

n) Serve as member of the Southwest New Brunswick Aquaculture Working Group (Lawton);

6. Background:

Highlights:

The editing and publication of World Aquaculture has brought international recognition regarding Canada's successful development of a viable commercial aquaculture industry. The editing and publication of the Bulletin of the Aquaculture Association of Canada has kept industry aware of the latest research in aquaculture. The organization of Aquaculture Canada 92 brought scientists, government and industry together. All of these activities contributed to DFO'S mandate to communicate with its clients and transfer science and technology to the private sector.

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

Adjunct Professor, Dalhousie University, and supervisor of PhD Thesis work

iii. Communications -

Effected communication of scientific and technical information to researchers and interpretive information to entrepreneurs, growers and the general public through multilevel editorial involvements in World Aquaculture and the Bulletin of the Aquaculture Association of Canada. Responded to over 100 industry requests for aquaculture information.

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

Aiken, D.E. (editor) 1991. World Aquaculture 22(4):80 p.

Aiken, D. E. (editor) 1992. World Aquaculture 23(1):80 p.

Aiken, D.E. (editor) 1992. World Aquaculture 23(2):80 p.

Aiken, D.E. (editor) 1992. World Aquaculture 23(3):72 p

iii. Scientific and Technical -

Waddy, S.L. (editor). 1992. Bulletin, Aquaculture Association of Canada 92-3 (In press).

Waddy, S. L. (editor). 1992. Bulletin, Aquaculture Association of Canada 92-2: 24 pp.

Waddy, S. L. (editor). 1992. Proceedings of BCMAFF Furunculosis Workshop. Bulletin, Aquaculture Association of Canada 92-1, 72 pp.

Waddy, S.L. (Editor). 1991. Bulletin, Aquaculture Association of Canada 91-4, 36 pp.

iv. Popular and Miscellaneous -

Aiken, D.E. 1991. Book review. A plethora of dictionaries - how to get scrod in a dozen different languages. World Aquaculture 22 (4): 62-63.

Aiken, D.E. 1992. The perils of accountability in science. World Aquaculture 23(3):3.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4600

Section:

Project Title: Salmon Genetics Research Program

Project Leader: Watson-Wright, W.

Other Researchers: Saunders, R.; Ritter, J.; Farmer, G.; Peterson, R.; Olivier, G.; Claytor, R.

Work Activity: W.A.1.1.2.2

Key Words: salmon; aquaculture; salmonid culture; genetics

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1. Project Description:

This is a cooperative project, initiated by the Department of Fisheries and Oceans and the Atlantic Salmon Federation (ASF) in 1973. Additional support has been received in recent years from the New Brunswick Salmon Growers Association (NBSGA), the New Brunswick Department of Fisheries and Aquaculture, the National Research Council/Atlantic Canada Opportunities Agency and the University of New Brunswick (UNB) administered cooperative project on disease prevention involving UNB, NBSGA, ASF and the Research Productivity Council. The research is centred on the genetics of stocks of Atlantic salmon for both enhancement and sea-cage culture.

2. Long-Term Objectives:

Design, develop and test models, protocols and procedures for breeding which have practical application both in the management of wild Atlantic salmon stocks and in aquaculture; chair the Salmon Genetics Research Program Steering Committee to coordinate the development of improved strains of Atlantic salmon so that the strategies of salmon enhancement and cage rearing can be realized; implement the selection of four year classes of Saint John River stock and a high grilse strain for aquaculture, develop three year classes of fish for sea ranching, encourage collabrative research with governments, universities and private organizations to complement the breeding program at ASF.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Evaluate seawater performance in control and select lines of the Biotechnology strain.

Data procured on this strain at the Huntsman Marine Science Centre of July 22 and 23, 1992, indicates approximately one standard deviation of genetic gain in both length and weights.

2. Evaluate freshwater performance of control and select lines of the 87JC strain.

The control and select line have been reared through hatchery-and parr-tank stages. Family identification has been maintained to allow assessment of smoltification in early 1993 and seawater performance thereafter. Additionally, data on survival of families following challenges with bacterial kidney disease (BKD), at the Research Productivity Council, have been obtained for incorporation in a selection index in the next reproduction of the line.

3. Integrate disease resistance into the selection index to be used in the 84JC strain.

Family survival data on challenges with BKD were incorporated into the index for the selected line of this strain, reproduced in November, 1992.

4. Evaluate smoltification in strain 90JC.

Percentage presumptive smolt in each family was estimated and this strain was transferred to sea cages at ASDDF.

5. Evaluate the return rates of control and vaccinated (vibrio and furunculosis) groups of released smolts.

The 1992 two-sea-winter salmon returns allowed the assessment of vaccination on return rates. This data confirms the results of the two previous years, where vaccination decreased return rate.

6. Establish cooperative research projects in sperm cryogenics, disease resistance, allozyme and DNA markers, sea lice resistance and evaluation of the behavior of cage escapees, where funds can be obtained.

Sperm cryogenics - In cooperation with the SGRP, Adam Harrington in developing a M.Sc. thesis in this area at the University of Guelph.

Disease Resistance - Data on the survival of families challenged with bacterial kidney disease,

collected in cooperation with the Research Productivity Council and the University of New Brunswick, has been used in the selection of cage -cultured broodstock used in the 1992 spawning. Data collected on a second strain will allow similar selection for the 1994 spawning. Families identified for high versus low resistance to furunculosis by G. Olivier of DFO, have been set aside in a cage at Connors's Bros'. Deer Island site.

Allozyme and DNA Markers - Work on allozymes with T.Cross of Cork, Ireland was completed. This work showed that the sampling and selection techniques have not changed gene frequencies in the Saint John River strains used for aquaculture, presumably due to the wide genetic basis maintained. However, the degree of genetic diversity in the Biotechnology strain appears to be much narrower than expected, where release-return studies with this strain may have caused "bottlenecking" in the late 1970's and early 1980's. Blood samples have been collected on two year classes of released smolts and the 1992 returned grilse. Funds for DNA fingerprinting on the samples are being sought for cooperative work with R.Doyle of Dalhousie University.

Sea Lice - Observations by B. MacKinnon (UNB) have revealed variation between families with respect to the incidence of sea lice carried.

Cage Escapees - A graduate student, Jonathan Carr (UNB) under the co-supervision of J.M. Anderson (ASF) is assessing the frequency of cage escapees in the Magaguadavic River. The cooperative work with T. Benfey (UNB) on sterility through triploidy represents a fundamental contribution to this area.

4. Additional Accomplishments:

1. Smolts, derived from a wide genetic base in the Saint John River in 1990, were supplied to multiplier growers in the aquaculture industry in 1992.

2. Input to meetings of: The Northeast U.S. Fish and Wildlife meetings at Rockport, Me. and Norfolk Va., International Symposium on Atlantic salmon at St. Andrews, International Smolt Symposium at St. Andrews.

3. Publication of primary, scientific, technical and popular press releases of information.

4. Supply of surplus SGRP to DFO for river stocking an research.

5. Goals/Expected Outputs for 1993:

1. Reproduce the Biotechnology strain control and select lines.

2. Evaluate smoltification in control and select lines of strain 87JC.

3. Establish control and select lines of strain 89JC.

4. Evaluate selection response in strain 84JC.

5. To participate in cooperative work on triploidy, disease resistance, smolt mortality, DNA fingerprinting, Y probe for sex determination and sea-cage escapees where funds can be obtained.

6. Background:

Highlights:

The SGRP has conducted research on the genetics of wild stocks of Atlantic salmon since 1974. With the initiation of the cage-culture industry in the Bay of Fundy in the late 1970's, research and development has been extended into stocks suited to the purposes of this new industry.

Selected Involvements:

i. Collaborative Research -

Assessment of ovarian development in grilse, salmon and grilse x salmon crosses in collaboration with R. Claytor, DFO, Moncton.
The entry of data from high and low resistance families into a computer system in cooperation with G. Olivier, DFO, Halifax.
Supply of stock from the Biotechnology strain to R. Saunders, DFO, St. Andrews for research on restricted feeding. Closely allied to this work, is the initiation of cooperative work with Connors Bros. Ltd. on the marketing of this strain at a pre-grilse stage.
Collaboration with R. Peterson, DFO, St. Andrews on optimum times for first feeding.
Collaboration with L. Burridge, DFO, St. Andrews on the reduction of stress in the handling of parr.
Collaboration with E. Donaldson and R. Devlin, DFO, Vancouver on the development of a Y probe to identify the sex of Atlantic salmon.
Collaboration with V. Zitko and G. Lacroix, DFO, St. Andrews on the detection of sea-cage escapees.

ii. University Liaison -

G. Friars is an Honorary Research Associate of the University of New Brunswick (UNB), where he acts as co-supervisor for Alex Hanke who has completed a Ph.D. and with A. McGeachy who has started a M.Sc. program.

J. Anderson has been appointed as an Honorary Research Associate at UNB and is a co-supervisor of J. Carr, doing research for a M.Sc. thesis on sea-cage escapees.

G. Friars has been appointed to the supervisory committee of Adam Harrington, a graduate student at the University of Guelph, doing cooperative research with the SGRP on sperm cryogenics.

Work on the role of methyltestosterone, in cooperation with L. Crim of Memorial University, on the reconditioning of kelts has produced results, enabling the development of strains for enhancement studies.

Pedigreed families have been reared for DNA fingerprinting research in conjunction with C. Herbinger and R. Doyle, of Dalhousie University. Additionally, blood samples have been procured to evaluate DNA heterozygosity in released smolts contrasted to returning adults.

Collaborative work on disease, with M. Burt, W. Lynch and T. Benfey, of the University of New Brunswick, G. Bacon, of the Research and Productivity Council, and N.B. Salmon Growers' Association, has produced information on triploidy and bacterial kidney disease resistance. This work has been extended to examine family variation in resistance to sea lice in cooperation with Dr. B. MacKinnon, of the University of New Brunswick.

Collaborative work with J.A Ritter, DFO, and R.W. Doyle, Dalhousie University, is being planned in connection with cage escapees.

Preliminary development of a technical bulletin on Sea Ranching will be supplemented by input from G. Farmer, DFO.

Cooperative work with C. Exley, University of Stirling, Scotland, is being conducted on aluminum and silicon content of water from concrete and fibreglass tanks.

iii. Communications -

1. Primary publications
2. Lectures to visiting public and university groups.
3. Participation in aquaculture and school fairs.
4. Workshops with industry and conservation groups.
5. Popular press.
6. Participation in scientific meetings.
7. Development of a Breeding Primer technical bulletin, now ready for printers.

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Herbinger C.M. and G.W. Friars, 1992. Effects of winter temperature and feeding regime on the rate of early maturation in Atlantic salmon (Salmon salar) male parr. Aquacult., 101:147-162.

Herbinger C.M. and G.W. Friars, 1991. Correlation between condition factor and total lipid content in Atlantic salmon, Salmon salar L., parr. Aquacult. Fish. Mngmnt., 22:527-529.

O'Flynn F.M., G.W. Friars, J.K. Bailey and J.M. Terhune, 1991. Development of selection index to improve market value of cultured Atlantic salmon (salmon salar). Genome 35:304-310.

ii. Interpretive Scientific -

iii. Scientific and Technical -

Bailey, J.K. and F.M. O'Flynn, 1992. Abst. Genetic and phenotypic correlations and growth patterns in a pedigreed, individually-marked population of Atlantic salmon (Salmo salar). 4th International Smolt Workshop, St. Andrews, New Brunswick, October 10-13, 1992.

Friars, G.W., J.K. Bailey and F.M. O'Flynn, 1992. Merging conventional mating and selection practices with transgenic technology. Progress and Profits from Research. Dept. of Fisheries and Oceans Can., Aquaculture and Resource Development Branch. P.39-42. Aquatech '92, Halifax, Nova Scotia, March 1-3,1992.

Friars, G.W., J.K. Bailey and K.A. Coombs. 1991. Some aspects of selection in salmonid aquaculture. Presented at the Proceeding of the Special session on Salmonid Aquaculture, World Aquaculture Society, February 16, 1989, Los angeles, USA. Published in the Canadian Technical Report of Fisheries and Aquatic Sciences No. 1831, November 1991. P.85-92.(Not previously reported)

Hanke, A.R., 1992. The effects of hatch time and family competition on the growth of a grilse and a two-seawinter stock of Atlantic salmon parr (Salmo salar). Ph.D. thesis, University of New Brunswick, Fredericton, N.B., E3B 5A3.

O'Flynn, F.M., R.L. Saunders, J.D. Martin, G.W. Friars, J.K. Bailey, and J.M. Terhune, 1992. The effect of extended day length on early sexual maturation and growth in Atlantic salmon (salmo salar) reared in sea cages. Salmon Genetics Research Program, Report Series, Technical Report No.151.

Anonymous. 1992. Salmon Genetics Research Program Annual Report 91/92.

iv. Popular and Miscellaneous -

Anonymous. 1992. Newsletter on Salmon Genetics Research Program, January 1992.

Anonymous. 1992. Newsletter on Salmon Genetics Research Program, August 1992.

Friars, G.W., 1991. A report on the 4th International Symposium on Genetics in Aquaculture. Aquaculture Sept. 1991, World Aquaculture, Vol.22(3);71&72.

Silverstone, M., 1992. Chamcook Salmon Saga. Salar Vol. 11, No. 4, November 1992.

HABITAT STUDIES

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 2490

Section: Aquaculture

Project Title: Investigations on the Source of 'Redness' and Toxicity in Cultivated Mussels in Ship Harbour

Project Leader: Pringle, J.

Other Researchers: Freeman, K.; Bradford, B.

Work Activity: W.A.1.1.2.1; W.A.1.1.3.2

Key Words: PSP, DSP, phytoplankton, domoic acid, mussels, *Mesodinium*

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1. Project Description:

The identification and ecology of phytoplankton species known to contaminate shellfish with human toxins.

2. Long-Term Objectives:

To provide advice to clients on the ecology and distribution of toxic phytoplankton in relation to physical and chemical oceanographic state variables at shellfish farming sites, and to describe the conditions responsible for the production of toxic blooms.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. To identify the source/cause of the 'redness' in mussels occurring in farms along Nova Scotia's eastern shore.

Goal met. In early April, 1992, as in 1991, cultivated mussels in Ship Harbour developed russet-colored digestive glands. Phytoplankton contained 30 µm particles which fluoresced, as did the mussel digestive glands, in the phycoerythrin band. The plankton samples consisted of large numbers of the photosynthetic ciliate *Mesodinium rubrum*, containing phycoerythrin. 'Control' mussels developed redness when transferred to Ship Harbour and 'red' mussels lost redness when transferred to non-Ship Harbour waters.

2. To investigate the rate of depuration for mussel 'redness'.

Goal met. Depuration trials were carried out using highly contaminated mussels. They were placed in two temperatures in the Halifax Laboratory along with controls. Redness was visually assessed periodically, and histological sections made. Degree of redness changed rapidly with time; in fact within 20 hours it was nearly gone. Temperature did not affect the rate of depuration.

3. To study the distribution and abundance of the causative organism.

Goal met. Ship Harbour was systematically sampled using vertical plankton tows and pumped water; CTD profiles were taken as well. Temporal and spacial distributions of *Mesodinium rubrum* were described.

4. To analyze histological sections of affected mussels' digestive glands.

Goal met. Samples were preserved in both Lugol's Iodine and 2% formalin/glacial acetic acid because of *M. rubrum's* fragility. There were marked histological differences between controls and contaminated mussels, eg. red mussels had larger digestive tubules and intertubule space was greatly reduced over non-red mussels.

5. To identify the agent producing the DSP-type toxin in shellfish at Ship Harbour.

Goal partially met. A time series of toxicity levels was produced, but a causative agent has yet to be identified.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

1. To describe the development of a *Mesodinium* bloom; sampling to start in mid-February.

2. In collaboration with NRC, develop methods to assess 'redness' levels using an image analyzer and colorometry.

3. To initiate mussel grazing studies of *Mesodinium*.

4. To identify the source of, and the 'unknown toxin' occurring in, Ship Harbour grown mussels.

5. To submit one manuscript for the primary literature from the 1992 *Mesodinium* study.

6. Background:

Highlights:

The identification of the causative agent of the 'red mussel' phenomenon along Nova Scotia's eastern shore plus the development of the concept of a simple depuration procedure.

Selected Involvements:

i. Collaborative Research -

- Roddy Warnock, P&CS Division.
- Larry Fritz and Don Douglas, Institute of Marine Biotechnology, NRC, Halifax.

ii. University Liaison -

iii. Communications -

Poster presented at DFO Phycotoxin Workshop, M.L.I., Mont Joli, Quebec.

iv. Contracts Administered -

- Mallet Research Services.

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Weekly Briefing Article

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Freshwater and Anadromous Project No.: 315

Section: Freshwater Habitat Research

Project Title: Acid Rain Research

Project Leader: W. Watt

Other Researchers: White, W.; Watson, N.; Ritter, J.; Cutting, R.; Scott, D.; Hamilton, A.; Zamora, P.

Work Activity: W.A.1.1.3.2

Key Words: acid rain; Atlantic salmon; computer model; mitigation; liming; biomonitoring

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1. Project Description:

Chemical and biological monitoring of river and lake acidification and its impact on Atlantic salmon and other freshwater species. Quantification of acidification impact on freshwater fisheries. Investigation of possible mitigation techniques. Model development to assess the impact of acid deposition on salmon production.

2. Long-Term Objectives:

Long-term objectives are to: (1) provide information to aid policy development under international air quality agreements, and under NASCO and ICES; (2) design and test mitigation procedures and apply them to preserve (for a future restocking effort) nuclei of Atlantic salmon stocks presently threatened with extinction; (3) maintain a long-term biomonitoring program to detect biological changes attributable to increases or decreases in acid deposition, and to determine the impact of acidification/deacidification on selected freshwater communities.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Continue long-term biomonitoring protocols for lake benthos and fish, scaling down the benthos portion to one sample per year. (Watson, White)

As a result of regional and national reviews, the invertebrate portion of the lake biomonitoring program was downsized to one sampling trip per year (from 2), the fish community was sampled once (in fall) as usual.

2. Reorganize the acid river biomonitoring program (chemistry, invertebrates and fish), reducing the scale and the number of rivers, and mothballing the caged fish bioassay program. (Watt, White, Watson)

Acid salmon river biomonitoring underwent a major restructuring as a result of the national review. The number of rivers has been reduced to six, several 11 year long data sets being discontinued. Invertebrates are now only done in rivers that still retain salmon, so very low pH rivers in southwest N.S. have been dropped. In addition, the number of annual invertebrate samplings has been reduced from three to two.

3. Commence computerization and transmission of the biomonitoring data to the national data base. (White, Watson)

One year of invertebrate data, ten years of electrofishing data, and three years of in situ bioassay data were computerized and transmitted to Burlington for incorporation into a national data biomonitoring database being developed there.

4. Maintain the limed refuge on East River, N.S. as a study area to measure the juvenile salmon production levels that can be achieved by deacidifying an Atlantic Upland stream. This information is required for development of the computer simulation model of salmon in acid rivers, see #5 below. (White, Watt and staff of Stock Assessment Section)

In Jan-Feb, 1992, 200 tonnes of limestone were spread on two headwater lakes in the refuge. The tonnage has been reduced because natural storage in the refuge has reached the desired capacity. Salmon juvenile numbers continued to increase in 1992 as the species continued to expand into the newly available (detoxified) habitat within the refuge. The new populations downstream of the refuge, in the main river, have maintained themselves and may be increasing there also. There situation is considered precarious because of the extreme pH fluctuations that occur there. The Atlantic salmon is the only fish species, thus far, to show any significant response to the liming operation.

5. Test the preliminary hydrochemistry module of the Atlantic Salmon Regional Acidification Model, identify shortcomings and prepare a revised version. Test the revised versions of the freshwater and marine life stage modules and design studies to collect some of the data required

to fill the information gaps made apparent by the modelling exercise. Program and commence testing the preliminary hydrochemical module. (All Habitat Research staff plus staff from other Sections and Divisions of Biological Sciences Branch and Environment Canada)

The marine and freshwater biological submodels have been extensively tested and revised, and the system is now being fitted to other rivers for further testing and revision. The preliminary hydrochemistry submodel is being revised to relate water quality to deposition chemistry. The chemistry available from LaHave river is inadequate (very few sulphate analyses), so surrogates will be sought in the Medway, Mersey and East River chemistry. The model is already providing new insights into the dynamics of Atlantic salmon productivity in acid impacted rivers.

6. Complete data analysis and publish:

(i) Creation of a limed refuge for genetic preservation of an Atlantic salmon stock threatened by acidification, East River, N.S. (Watt)

A technical manuscript has been published, a more detailed analytical manuscript is in preparation.

(ii) Evidence for lethal and sub-lethal effects of acidification, and their mitigation, in semi-natural caged fish bioassays using juvenile Atlantic salmon. (Watt)

This program has been cancelled and there are no resources within Scotia-Fundy for data analyses or report preparation. Alain Kemp (DFO, Quebec) has undertaken to incorporate Scotia-Fundy's bioassay reports and data into a 1993 final report on the LRTAP Atlantic salmon bioassay program.

(iii) Model of Atlantic salmon production in relation to stream pH. (Ritter, Regional DFO staff and ESSA)

A manuscript is in preparation and will be submitted for publication early next year (1993).

4. Additional Accomplishments:

Preliminary analysis indicates that as expected there are fewer and different taxa present in the more acidic rivers. (Watson, Hamilton)

The eel parasite community has shown a highly significant response to liming. A paper is in press, and the program (a cooperative effort with Professor Cone, of St. Mary's University) will be broadened next year to look at the impact of acidification on fish parasite communities in other N.S. rivers and lakes. (Watt, White)

5. Goals/Expected Outputs for 1993:

1. Continue long-term biomonitoring of benthos and fish in LRTAP impacted rivers and lakes. (Watt, White, Watson, Scott, Hamilton, Zamora)

2. Maintain the limed refuge on East River, N.S. as a study area to measure the juvenile salmon production levels that can be achieved by deacidifying an Atlantic Upland stream. This information is required for development of the computer simulation model of salmon in acid rivers, see #3 below. (Cutting, White, Watt, Scott)

3. Refine the hydrochemical and the overall Atlantic salmon regional simulation model, and prepare a report for publication, describing the hydrochemical submodel and its tie-ins with the biological submodels. (Ritter, Watt and ESSA staff)

4. Complete data analysis and publish:

(i) A detailed analytical report (primary) on the chemical and biological changes that resulted from the establishment of a limed refuge on East River N.S. (Watt, White)

(ii) A primary publication on the development and evaluation of the biological model to assess regional scale effects of acidification on Atlantic salmon (ESSA staff, Lacroix, and F.W.A. staff)

(iii) A primary publication on the effects of acidification on the zoogeographical distribution of freshwater fish in N.S. (White)

6. Background:

Highlights:

Regional taxes and national budget cuts have reduced the budget for this project by $8.8k, thus far, this year. The problem has been made much worse by year-end spending freezes. The reduction has been accommodated by not letting contracts for the entry of new data into the computer database, by reducing the taxonomy contracts, and by not repairing or replacing broken, worn-out and obsolete equipment. These cuts, combined with last year's, have now put the processing of invertebrate samples one year behind, and some of our equipment is non-functional, which forces us to borrow, rent or do without, all of which slows the operation even further.

Invertebrate sorting and electrofishing are quite labour intensive, and this is normally supplied by contracts and students. This year the electrofishing person-power requirement was partially made up by a two week loan of four students from the N.S. Dept. of the Environment.

Selected Involvements:

i. Collaborative Research -

Dr. R. K. Misra (Physical and Chemical Sciences Branch) is developing specialized statistical procedures and computer programs for trend-through-time analysis of the biomonitoring data.

Environment Canada will be using the East River (limed, unlimed and mixed sites) to test their remote sensing (pH, temp, cond. and flow) *in situ* monitors under conditions involving extreme episodic events. DFO owns a flow gauge on this river and will provide regular servicing of the monitors and water samples for corroborative chemistry.

The Environment Canada Water Quality Laboratory, in Moncton, performs major ion analysis on the DFO biomonitoring lakes and one of the rivers. (They also do two of the rivers that were dropped this year.). DFO collects samples from the other five biomonitoring rivers, which are analyzed at the same laboratory on a cost recovery basis.

ii. University Liaison -

Dr. David Cone, St. Mary's University, is collaborating on a study of eel parasite communities as indicators of acid stress in N.S. rivers.

iii. Communications -

Television, radio and newspaper coverage, initiated by a media representative, often after reading a Science Briefing Note and having been referred to Habitat Research by Communications Branch. There are one or two such media contacts each month. The most popular topic is liming. Other common subjects are: the extent of the damage, other mitigation approaches, the timing and extent of the anticipated recovery, and DFO's program of monitoring for "signs of recovery".

iv. Contracts Administered -

Permian Now, Halifax, N.S.: Analyses (within 48 hrs) for water quality parameters that cannot be reliably measured after prolonged storage. ($11k).

Environmental and Social Systems Analysts Ltd., Vancouver, B.C.: Development of models to assess the impacts of acid deposition on Atlantic salmon production in N.S. ($55k).

Dr. K.A. Neil, Acadia University: Identification and enumeration of benthic invertebrates.($10k).

v. Other -

7. Publications:

i. Primary -

Cone, D.K., D. Marcogliese, and W.D. Watt. 1993. Metazoanparasite communities of yellow eels (A. rostrata) in acidic and limed rivers of Nova Scotia. Can. J. Zoo., **71** #2(Feb.).

ii. Interpretive Scientific -

iii. Scientific and Technical -

Shan, M.R., S. Geiling, S. Barbour, I.J. Davies, E.A. Hamilton, A. Kemp, R. Reid, P.M. Ryan, N. Watson and W. White. 1992. The Department of Fisheries and Oceans national LRTAP biomonitoring program; site location, physical and chemical characteristics. DFO Technical Report #1875.

Watt, W.D. and W.J. White. 1992. Creating a de-acidified Atlantic salmon refuge in the East River, Nova Scotia. Atlantic Region LRTAP Monitoring and Effects Report for 1991, Environment Canada, pp 108-147.

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Freshwater and Anadromous

Project No.: 316

Section: Freshwater Habitat Research

Project Title: Freshwater Fish Habitat Assessment and Related Research

Project Leader: Watt, W.

Other Researchers: White, W.; Boudreau, P.R.; Zamora, P.; Scott, D.

Work Activity: W.A.1.1.3.1

Key Words: alewife; Atlantic salmon; habitat research; mitigation; gaspereau; salmon enhancement

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1. Project Description:

Conduct biological investigations as required to protect freshwater fisheries habitat by: (a) reviewing all major development proposals and doing field assessments to determine the potential for impact on freshwater and anadromous fisheries; (b) conducting post-construction assessments of mitigation effectiveness and developing improved mitigation techniques; and (c) investigating habitat problems relating to fish passage, habitat alterations, water diversions, and screening of intakes.

2. Long-Term Objectives:

Provide DFO's freshwater research and assessment requirements arising from the fish passage and habitat protection sections of the Fisheries Act, and the Federal Environmental Assessment and Review Policy (EARP).

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Respond to any freshwater fish habitat related EARP and RSCC environmental impact assessment referrals, and prepare Initial Environmental Assessments and (where necessary) Initial Environmental Evaluations for new projects in the Freshwater and Anadromous Division. (White)

Initial Environmental Assessment documents were prepared for all projects of the Freshwater and Anadromous Division.

An Environmental Assessment report was prepared for fish passage facilities to be constructed in conjunction with the reconstruction of the hydroelectric generating station at St. George, N.B.

An environmental review of the fish passage and fish habitat implications of the proposed restoration of the Shubenacadie Canal, N.S.

Review of consultant's report on the history of fish passage investigations at the Annapolis tidal power station.

Review of proposed fish habitat surveys and improvements in Eskasoni Indian Reserve.

Review of the fish habitat implications of the design and location of a proposed sewage treatment plant on Lake Fletcher.

An Environmental Review of fish passage proposals in the new power plant design for Morgan Falls, LaHave River, N.S.

A review of the consultants report on the Madawaska River fish habitat survey.

A review of the water quality of Upper Thirties ashfill site, N.S.

An Initial Environmental Evaluation was prepared for the proposed new fishway to be constructed at Grand Falls N.B. on the Saint John River.

2. Design, and if flow conditions permit, carry out an assessment of the effectiveness of the downstream bypass at Milltown, St. Croix River, New Brunswick/Maine. The study will use radio tagged Atlantic salmon smolts. (White)

Flow conditions were suitable in May, 1992. Unfortunately, insufficient radio tags were available (dead batteries) for a full assessment of smolt usage of the downstream bypass facility. Receivers were evaluated for effectiveness in the vicinity of the generating station and different antenna configurations were tested. Five captured smolts were fitted with tags, and their radio frequencies monitored for several weeks from sites below the dam. Results were inconclusive due to small number of tagged fish. Twenty new miniature radio tags have been ordered for the next try, and battery replacements for several old tags.

3. Provide scientific advice to the Fisheries and Habitat Management Branch and senior DFO management with regard to non-guidelined and complex fish habitat alteration proposals, and other technical problems affecting the administration of the fish passage and fish habitat protection sections of the Fisheries Act. (White, Watt)

A water sampling and analysis program was conducted and a report prepared, assessing acidification as a potential limiting factor in a proposed DFO salmon enhancement project for the East and West rivers, Sheet Harbour, N.S.

Detailed technical advice was provided for river liming proposals from local environmental and fisheries organizations aimed at salmon restoration of the Pennant River, Nine Mile River, Woodens River, East River (St. Margaret's Bay) and (for N.S. Dept. of Fisheries) Medway River.

At the request of the Biological Sciences Directorate, DFO, Ottawa, a Canadian response was prepared to a request, from the North American Atlantic Salmon Conservation Organization (NASCO), for advice as to the principal sources of SO_2 emissions affecting the Southern Upland area of Nova Scotia, and on the anticipated effectiveness of the United States' and Canada's SO_2 emission control programs at alleviating acid toxicity in the Atlantic salmon rivers of Canada and the United States.

4. Set up a SPANS GIS model of juvenile salmon production in the portion of LaHave river above Morgan Falls. (Boudreau)

Postponed due to Paul Boudreau's absence on an assignment.

5. Publish a Technical Report on relative roles of egg deposition and habitat availability in juvenile salmon densities in Gulquac River, Saint John System, N.B. (Boudreau, Watt)

Not completed due to Boudreau's absence on assignment, however, a manuscript has been prepared.

6. Publish a Technical Report on relation between alewife run density and efficiency in use of a fish ladder on the St. Croix River, N.B. (Watt)

This was postponed due to the low priority presently assigned to alewife studies and to reduced international interest in redevelopment of the St. Croix River.

4. Additional Accomplishments:

A report on Atlantic salmon habitat research in Scotia-Fundy was prepared for the Workshop to Review Atlantic Salmon Research (Oct. 29-30, 1992, Halifax)

Advice and information is also provided to members of the public (1-2 requests per week, many are referred by the Communications Branch) regarding fish habitat protection: eg. DFO role in evaluation of the Mactaquac low flow test, methods of controlling algae in garden ponds and on golf courses, potential for lake and river liming, liming water sources for aquaculture, lake eutrophication problems, predicting the effects of proposed landfill sites on fishery resources, interpretations of water chemistry data, the impact of acid rain on freshwater fisheries resources, etc.

Advice and information was provided to the Nova Scotia Museum to be used in a planned republication of Natural History of Nova Scotia, to the Nova Scotia Dept. of Parks and Recreation on fish populations in the proposed Cape Chignecto Provincial Park, and to the Habitat Ecology Branch on the availability of water quality and effluent data relating to pulp mills.

At the request of the Bowater-Mersey Co., an afternoon presentation was given to their woodlands staff on current recommendations for the protection of fish habitat during the construction of logging roads and during forest harvesting.

A preliminary assessment (electrofishing) was conducted on the channelized (in 1980) portion of Debert River. Habitat Research did a five year study immediately after the channelization, with the idea of following the progress of natural restoration. The 1992 results suggest that the river is still seriously degraded. A more quantitative study is being planned for next year.

5. Goals/Expected Outputs for 1993:

1. Respond to any freshwater fish habitat related EARP and RSCC environmental impact assessment referrals, and prepare Initial Environmental Assessments and (where necessary) Initial Environmental Evaluations for new projects in the Freshwater and Anadromous Division. (White)

2. Provide scientific advice to the Fisheries and Habitat Management Branch and senior DFO management with regard to non-guidelined and complex fish habitat alteration proposals, and other technical problems affecting the administration of the fish passage and fish habitat protection sections of the Fisheries Act. (White, Watt)

3. Provide fish habitat related advice to the general public and environmental organizations as requested. (Watt, White, Boudreau)

4. Carry out an assessment (if flow conditions permit) of the smolt passing efficiency of the downstream bypass at Milltown, St. Croix River, New Brunswick/Maine. The study will use radio tagged Atlantic salmon smolts captured in the river. (White, Zamora, Scott)

5. Reexamine the Debert River, N.S., channelization project. After the 1980 channelization of this river, the distribution of juvenile Atlantic salmon was followed for the next five years (electrofishing) to assess habitat rehabilitation as the river restabilized. It is time now to assess the level of stability achieved after 13 years. This will be a three year project. (White, Zamora, Scott, Habitat Management)

6. Set up OS2 and SPANS, and investigate the practicality of creating a GIS model of juvenile salmon production in the portion of LaHave river above Morgan Falls, and marrying the GIS model

with the Atlantic salmon regional acidification model being produced under project 315. (Boudreau, Watt)

7. In collaboration with the Habitat Management Branch, set up a GIS data base (In Focus) of habitat related information for projects under the Recreational Fisheries Agreement. (Boudreau)

8. In collaboration with the Habitat Management Branch, initiate a program to evaluate the effectiveness of currently employed techniques for instream habitat improvement. (Boudreau)

6. Background:

Highlights:

Funding was exceptionally tight early in the year due to the regional taxes for BSB and Sector 6 being charged against this project's 'A' base funds ($25.5k) for the entire LRTAP budget ($145k) of Project 315. This occurred because the LRTAP funds were late in arriving. The June 15 notional shows $14.9 in this project, whereas the prorated allotment is $22.7k.

Selected Involvements:

i. Collaborative Research -

Mr. Boudreau is collaborating with personnel of the Habitat Ecology Div. to prepare a GIS inventory map of coastal and marine habitat sensitivities.

Near the end of 1992 a new collaboration was started, centered on Mr. Boudreau's GIS skills, to prepare a habitat data base for the Rec. Fish. Program. The program will initially be using Habitat Research's GIS data and digital maps of the LaHave River drainage.

Habitat Management Branch collaborated in a preliminary assessment of a 1980 channelization project on Debert River, N.S. More is planned for 1993.

ii. University Liaison -

iii. Communications -

Information was provided to the N.S. Museum for a new compendium of the Natural History of Nova Scotia.

Information was provided to the Organization of Economic Cooperation and Development on the availability of habitat for declining and endangered species.

Information was provided to Wildlife Habitat Canada on the design and content of a data base of habitat agencies within Canada.

An inventory of freshwater fish species and habitat availability was provided to the N.S. Dept. of Natural Resources for the area of a proposed new Provincial Park at Cape Chignecto.

Occasional (about one every two months) contacts by redia representatives for interviews on the state of freshwater fish habitat in Scotia-Fundy, current threats to the habitat, mitigation approaches, impacts of landfills, etc.

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4210

Section: Applied Ecology

Project Title: Phytotoxin Research

Project Leader: Wildish, D.

Other Researchers: Martin, J.L.; Wilson, A.

Work Activity: W.A.1.1.3.3

Key Words: phytoplankton; eutrophication; toxins; aquaculture; traditional fishery

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1. Project Description:

The aim of the research undertaken is to document phytoplankton autecology of species of microalgae which are harmful to humans, finfish or bivalve molluscs, particularly those of commercial value. Individual projects are selected based on their practical relevance in resolving problems primarily in mariculture in the Bay of Fundy, but also in more traditional fisheries.

2. Long-Term Objectives:

To understand phytoplankton autecology of species harmful (or potentially harmful) to commercially valuable bivalve molluscs or finfish and their human consumers. This will allow remedial or inspection measures to be considered in the mariculture or traditional fisheries industries.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Determine the factors controlling the production of domoic acid in *N. pseudodelicatissima*.

The strain of *Nitzschia pseudodelicatissima* collected during 1988 when domoic acid was detected developed culture problems and both these and backup cultures at Bigelow Lab crashed. This has delayed and complicated culture experiments. Various *Nitzschia* species were isolated from nature from various locations in SW Bay of Fundy during 1992. Cultures are to be analyzed for domoic acid production and optimum growth conditions are being studied. This project will be continued in 1993, concentrating on environmental factors which result in loss of the toxin.

2. Collaborate with K. Haya in a PSP study involving saxitoxin uptake and elimination in American lobsters.

Lobsters have been fed known concentrations of PSP toxins from extracts of scallop tissues collected from the Bay of Fundy by J.L. Martin. Results of this work are expected to be completed by 1993 and will be reported by K. Haya.

3. Provide a phytoplankton monitoring service to the DFO Inspection Labs and salmonid aquaculture industry, whilst maintaining a long time series analysis of phytoplankton of the SW Bay of Fundy.

This study was initiated in 1987 with 18 sampling locations and sampling at three depths. The 18 sites were modified to 12 in 1989 and to 4 sites in 1991 as a result of trends and patterns observed during previous years. Sampling is also now only at the surface and 1 m above bottom. Parameters measured include temperature, salinity, dissolved oxygen, nutrients (nitrates, phosphates and silicates), secchi disc and phytoplankton distribution and abundance. This project is ongoing and results are presented in a publication every other year. This project also acts as an aid to the Inspection Branch of DFO in their monitoring of shellfish toxins, and a rapidly growing salmonid aquaculture industry. With the aid of contracted help, it is possible to have indicator phytoplankton sampling results within 24 h of collection. The extensive database is also being statistically examined to determine annual, recurrent patterns in phytoplankton species and their density. Preliminary work has been undertaken in observing trends in phytoplankton populations. J.L. Martin completed a half credit STATS course from U.N.B. in April, with approval to take another STATS course in the fall. Since this course is only offered in alternate years during the spring session, she will commence this course in January. This will aid in the temporal analysis of the data and may yield predictive patterns of value in the management of toxic microalgae.

4. Complete development and testing of an automated flume, based on the Turner fluorometer as the seston controller.

Through an error in last year's PREP submission, this goal was included in both projects 404 and 406 (now 4210 and 4220). It is dealt with fully under project 4220 rather than here.

5. Conduct salmon smolt bioassays with implanted heart tags to determine the effect of toxic microalgae on physiology and behaviour.

Salmon smolts have been obtained and acclimated in our lab. Due to funding cuts, it was not possible to contract out the construction of a new flow chamber in which this work will be carried out. Instead, the flow chamber is to be made in house (at BIO), with delivery date not expected until June 1993. The project is ongoing and will provide published information on the effect of Bay of Fundy dominant microalgae on salmon of direct interest to the salmon mariculture industry located there.

4. Additional Accomplishments:

1. Gave advice as follows: i) N.B. Salmon Growers on low dissolved oxygen concentrations in the fall (Wildish, Martin); ii) Inspection Branch - high concentrations of *Dinophysis* sp. found in Beaver Harbour which alerted them to collect mussels in the area and measure toxins. This is the first recorded incident of DSP in the Bay of Fundy (Martin); iii) assisted Mont Joli in a DSP-related problem in the Gaspé (Martin); iv) assisted Gulf Region in identification of phytoplankton and methods for collection and cyst identification (Martin); v) assisted Inspection Branch in Halifax re identification of phytoplankton; vi) advice to others at STABS re growing phytoplankton and measuring Chl a (Martin); vii) enquiries from the USA re phytoplankton-ecological conditions in the Bay of Fundy/Gulf of Maine (Martin).

2. Reviewed manuscripts and research proposals (Wildish, Martin).

3. Attended the 3rd Canadian Workshop on Toxic Phytoplankton held at IML, Mont Joli, Quebec (Wildish, Martin). See under Section 7 for presentations given.

5. Goals/Expected Outputs for 1993:

1. Provide phytoplankton monitoring long-term time series analysis of phytoplankton in SW Bay of Fundy.

   It is planned to continue this project at 4 sites in 1993, with weekly summer sampling and the 7 variables used in recent years (see Section 3). This goal is of most direct benefit to the aquaculture industry and DFO Inspection Branch, as well as contributing to a Scotia-Fundy temporal analysis of phytoplankton, potentially with predictive value for determining the timing of blooms.

2. Conduct experiments to determine the effect of toxic microalgae on the physiology and/or behavior of salmon smolts.

   Beginning in June, test locally available dominant microalgae taken by net tows to influence the behavior and physiology of salmon smolts. Further experiments in 1994 will be with cultured microalgae from local sources which have elicited negative response. This proactive method of testing for possible phytotoxin problems in the salmonid culture industry is justified by the knowledge that in every other major salmon growing area in the world, except the Bay of Fundy, toxic microalgae have directly resulted in salmon deaths. It is believed that once methodological problems are solved, this research will yield results of high potential value to the salmonid aquaculture industry.

3. Determine the factors controlling production of domoic acid in *N. pseudodelicatissima*.

   Although this diatom has proved to be difficult to grow in culture, further efforts will be made to investigate environmental conditions which lead to growth and production of domoic acid in culture. The information is important in estimating where toxin problems might occur, since this is often based on phytoplankton densities, and the relationship between species, or strain, and domoic acid content must be known in order to predict hot spots where Inspection Branch sampling of clams, for example, should take place.

4. *Alexandrium* cyst study in the Bay of Fundy.

   This new project involves collecting sediment samples throughout the Bay and analyzing for cyst density and distribution. It may also be possible to analyze for toxin content using HPLC in collaboration with PCS. The project objective is to determine the major seed beds in the Bay over a 5-yr period (4 yr completed). This project is important in determining the focii of summer blooms and therefore indicating where local PSP problems are likely to occur, and it should be continued for one more year.

5. Quoddy region biophysical interactions.

   This collaborative project with others at STABS (W. Watson-Wright, F. Page, S. Robinson) is designed to obtain physical oceanographic and climatic data of the local area of use in correlating with phytoplankton data. A long-term aim is to provide predictive physical models of circulation in this region.

6. Background:

Highlights:

The finding of high concentrations of *Dinophysis* sp. led to the first confirmed occurrence of diarrhetic shellfish poisoning in the Bay of Fundy.

Selected Involvements:

i. Collaborative Research -

Collaboration with PCS group at STABS was mutually beneficial. Also collaborated with the phytoplankton group at the Gulf Fisheries Centre, Moncton.

ii. University Liaison -

With U.N.B. - obtaining EM's of local phytoplankton and providing cultures to Bruce MacDonald (Martin).

iii. Communications -

Gave a TV interview on paralytic shellfish poisoning (Martin).

iv. Contracts Administered -

A personal service contract for phytoplankton identification (Martin).

v. Other -

7. Publications:

i. Primary -

Wildish, D. J., P. D. Keizer, A. J. Wilson, and J. L. Martin. Seasonal changes of dissolved oxygen and plant nutrients in seawater near salmonid net pens in the macrotidal Bay of Fundy. Can. J. Fish. Aquat. Sci. (in press).

ii. Interpretive Scientific -

Wildish, D. J., J. L. Martin, and M. Ringuette. Methods to assess potentially harmful microalgae in the Bay of Fundy salmonid culture industry. Can. Tech. Rep. Fish. Aquat. Sci. (in press).

Martin, J. L., and D. J. Wildish. Integrated water column versus Niskin bottle sampling in the southwest Bay of Fundy. Can. Tech. Rep. Fish. Aquat. Sci. (in press).

Yeats, P., D. Wildish, Subba Rao, D. V., J. Smith, R. Penny, J. Martin, M. Levasseur, P. Keizer, D. Gordon, R. Forbes, and G. Bugden. Overview of Canadian phytoplankton monitoring programs. Can. Tech. Rep. Fish. Aquat. Sci. (in press).

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4220

Section: Applied Ecology

Project Title: Aquaculture Ecology Research

Project Leader: Wildish, D.

Other Researchers: Martin, J.L.; Wilson, A.

Work Activity: W.A.1.1.3.5

Key Words: aquaculture; habitat research; benthos

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1. Project Description:

The aim of this work is to determine the extent and biological implications of habitat changes caused by the intensive culture of finfish or bivalve molluscs, so that remedial measures to minimize self pollution can be taken. The research is multidisciplinary and involves collaboration with chemical, physical and biological oceanographers.

2. Long-Term Objectives:

Fully understand the environmental factors influencing the holding capacity of cultured marine fish and the production of cultured suspension-feeding marine bivalve molluscs.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Continue a study of environmental factors influencing bivalve feeding rates. Emphasis will be on behavioural responses to velocity. Part of the work will involve a collaborative project on bivalve molluscs feeding on toxic microalgae with Dr. P. Lassus, IFREMER, Nantes (see project 404). (Wildish, Wilson)

Flume experiments to determine the effect of velocity on feeding behavior were completed and the results submitted for publication (see 7).

A collaborative project with Dr. P. Lassus of IFREMER, Nantes, was approved as part of the Canada/France agreement. Initial work with a new automated flume suggested electronic/computer problems which are not yet resolved. The project objectives are to determine whether commercially important bivalve molluscs can reject toxic strains of *Alexandrium* when offered both toxic and non-toxic cells. This knowledge is required to estimate toxin uptake in field conditions and should be continued in 1993.

2. Undertake a review of the literature regarding flow as an environmental factor affecting suspension feeding benthic animals. (Wildish)

Over 2000 references have been assembled with many of the important references read. A book proposal, 'Marine Benthic Suspension Feeders and Flow,' by D. J. Wildish and D. D. Kristmanson was accepted for publication by Cambridge University Press. The project will be continued in 1993.

3. Continue the study 'The effects of dissolved oxygen and temperature on salmon smolt growth' with Dr. Brian Glebe, of Huntsman Marine Science Centre. The project is focused on determining potential effects of low dissolved oxygen on feeding and growth by salmon. (Wildish)

Preliminary studies at HMSC by a student partially supported by DFO funds suggested interesting results with supersaturated seawater providing the best growth rates. A further funding proposal to continue this project was submitted to NRC IRAP in collaboration with a local salmon grower, but was unsuccessful. This project will be continued in 1993 only if external funding can be obtained to support it.

4. Organize a fifth benthic workshop at St. Andrews in collaboration with J. Grant and B.T. Hargrave on 'Marine Benthos and Flow'. (Wildish)

A successful workshop was held on 28-29 October at which over 45 people attended from local universities and government labs. The overall theme was hydrodynamics and the benthos, with 15 papers presented and discussed, plus 3 posters and a video of bivalve feeding.

4. Additional Accomplishments:

1. Co-chairman with Dr. B. Jones (N.B. Dept. of Fisheries and Aquaculture) of the Federal/Provincial Aquaculture Environmental Coordinating Committee, which advises governments on environmental matters related to the aquaculture industry.

2. At the request of the N.B. Salmon Growers Association, gave advice on the environmental steps a

local pulp company is taking to improve water quality in the Letang where their industry is centred.

3. Provided advice and information to the N.B. Conservation Council on environmental matters, particularly relating to the aquaculture industry.

4. Editorial advisor for the international journal: Journal of Experimental Marine Biology and Ecology.

5. Reviewed 18 manuscripts submitted for publication in primary journals.

6. Reviewed and recommended whether 6 research proposals should be funded or not.

5. Goals/Expected Outputs for 1993:

1. Effect of toxic microalgae on bivalve feeding.

Two different methods in France and Canada have been used to measure feeding rates in bivalves. They will be compared (? April) and a final decision made as to how the experiments should be set up. The experimental design will compare uptake rates of toxic versus non-toxic species of *Alexandrium* as well as comparisons with natural phytoplankton and unialgal cultures of non-toxic species. Previous published reports of toxic microalgal uptake have ignored the important effect of velocity on uptake rates. It is expected that the work will be completed in 1994 and then published. This is considered to be a priority area for research in both France and Canada because of its importance in predicting bivalve toxic burdens.

2. Prepare a draft of the book 'Marine Benthic Suspension Feeders and Flow' by D. J. Wildish and D. D. Kristmanson, to be delivered to Cambridge University Press by 1 December 1993.

3. Devise and test a cheap method for determining water movement at individual aquaculture sites.

Variables affecting the holding capacity of a site include water depth and degree of water movement. Because current meters are expensive to deploy and difficult to interpret, a method using dental plaster balls and weight loss caused by dissolution due to seawater turbidity is being tested. The work will involve calibration in a flume as well as field trials at local salmonid farm sites. The N.B. Dept. of Environment, who is responsible for monitoring the salmonid industry in the Bay of Fundy, is directly interested in such a method.

4. The effects of dissolved oxygen and temperature on salmon smolt growth.

This project will be continued in 1993 if external funding can be obtained to support it.

5. Physiological and behavioral effects of chemicals used in salmonid aquaculture.

Part of a Green Plan submission (PCS Project No. GPT, 'Effects on ecosystems of medicaments, chemicals and wastes used in mariculture.') This project will only be activated if Green Plan funds are committed.

6. Background:

Highlights:

Cambridge University Press selection of a book proposal submitted by D. J. Wildish and D. D. Kristmanson for expected publication in 1994.

Selected Involvements:

i. Collaborative Research -

Began collaborative research under the Canada/France agreement with Dr. P. Lassus, IFREMER, Nantes, on the effect of toxic microalgae on bivalve feeding.

ii. University Liaison -

1. Examiner for two M.Sc. theses at Dalhousie University and Université du Québec à Rimouski.
2. Co-supervisor of a Ph.D. student at the Université du Québec.
3. Honorary Research Associate at U.N.B.

iii. Communications -

Gave radio interviews concerning the ecology of the local area.

iv. Contracts Administered -

v. Other -

Invited presentation at a NATO Advanced Workshop held in Renesse, Holland, entitled 'Hydrodynamic Control of Bivalve Filter Feeders: a Conceptual View.'

7. Publications:

i. Primary -

Wildish, D. J., and A. M. Saulnier. 1992. The effect of velocity and flow direction on the growth of juvenile and adult giant scallops. J. Exp. Mar. Biol. Ecol. 155: 133-143.

Wildish, D. J., D. D. Kristmanson, and A. M. Saulnier. 1992. Interactive effect of velocity and seston concentration on giant scallop feeding inhibition. J. Exp. Mar. Biol. Ecol. 155: 161-168.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Wildish, D. J. 1992. The effect of flow on the suspension feeding of molluscs. In Scotia-Fundy Science Reviews 1990-91 (in press).

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4230

Section: Applied Ecology

Project Title: Effects of Acid Rain Control Programs on Salmonid Recovery

Project Leader: Lacroix, G.

Other Researchers:

Work Activity: W.A.1.1.3.2

Key Words: acid rain; Atlantic salmon; recovery

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1. Project Description:

Ecological and physiological responses of Atlantic salmon to temporal changes in chemistry in acidic rivers of Scotia-Fundy possibly linked to changes in sulphate deposition as a result of Canada-U.S. sulphur dioxide control programs.

2. Long-Term Objectives:

Determine the effects of the sulphur dioxide control programs and the resultant increase or decrease in environmental acidification on Atlantic salmon and its habitat, the rate and extent of aquatic recovery, and the need for further emissions reductions to protect fish habitat in rivers of Scotia-Fundy.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Investigate the importance of movements (preference/avoidance) by juvenile salmonids in the responses of populations to acid episodes in chronically acidic streams of Nova Scotia using sonic tracking. (Lacroix)

Series of tracking experiments successfully completed on acidic rivers with salmon parr and with wild migrating adult salmon.

2. Collaborate in a study of the sublethal effects of acidity on physiological debt and chemoreception in Atlantic salmon from a developmental perspective. (Lacroix, Morin, Hara, Eales)

Two experiments were completed at the Mersey Hatchery using salmon parr and smolts, neurophysiological testing of the fish was conducted at the Freshwater Institute, and olfactory response was evaluated in an acidic river.

3. Assume duties as coordinator of the Scotia-Fundy LRTAP Program and on the DFO LRTAP Subcommittee. (Lacroix)

Coordinated the regional reorganization of 12 LRTAP research and monitoring projects to meet deliverables under the Green Plan, successfully secured the regional resource requirements, and participated in a national review and reorganization of the LRTAP program and objectives.

4. Assume a leading role and collaborate in the continued development of the Atlantic Salmon Regional Acidification Model (ASRAM) and Hydrochemical Submodel. (Lacroix, DFO scientists from several Divisions, ESSA)

Successfully obtained LRTAP funding for the project, co-managed the project, and contributed to the testing and refinement of the model and in the preparation of a manuscript for primary publication.

5. Prepare and submit a manuscript examining the seasonal responses of salmonids to low pH and the physiological effects of chronic versus acute acid exposures in streams of Nova Scotia. (Lacroix)

No progress was made and goal was put on hold after the sudden and unexpected loss of the LRTAP PY allocated to this project. A potential for several manuscripts exists.

6. Analyze laboratory findings from the completed evaluation of the proposed silica-aluminum model of interaction in relation to toxicity in Atlantic salmon fry and of the importance of organic anions. (Lacroix)

Tissue samples were analyzed for metals, a comprehensive histological examination of gills was completed, and statistical and graphical analysis of data was initiated. Progress was delayed because of the lack of PY support.

7. Evaluate the analysis of spatial and temporal trends in fish populations in acidic streams of Nova Scotia, and continue the sampling of fish populations as required to detect responses to changes in LRTAP in the Medway River. (Lacroix)

Analysis of trends was deferred to 1993/94 and beyond because of reprofiling of Green Plan resources and resulting reductions in LRTAP funding. Responsibility for sampling of fish populations in Medway R. was transferred to the biomonitoring program as part of restructuring.

8. Continue to assess the long-term effectiveness of applying limestone gravel in an acutely acidic stream on water chemistry and the recovery of fish populations. (Lacroix)

Monitoring of water chemistry, fish densities, and salmon spawning in limed and untreated sections of Fifteen Mile Brook was continued and data were summarized for the year.

9. Collaborate in the preparation of a manuscript on the dynamics of aluminum in the gills of Atlantic salmon fry in relation to ambient concentrations of organic anions. (Peterson, Lacroix)

A manuscript intended for primary publication was completed after further analyses, and it was submitted for internal review.

4. Additional Accomplishments:

1. Collaborated in a submission to Environment Canada by New Brunswick Department of Environment for establishing a national ecological monitoring and assessment network (NEMAN) in southern New Brunswick.

2. Provided expertise and training to Atlantic Salmon Federation for study on interactions between aquaculture and wild Atlantic salmon in the Bay of Fundy.

5. Goals/Expected Outputs for 1993:

1. Publish manuscript on aluminum dynamics on gills of Atlantic salmon in the presence of organic anions and effects on integrity of gill structures. (Lacroix, Peterson)

2. Prepare manuscript questioning the role of silica in eliminating aluminum toxicity to Atlantic salmon in comparison to the importance of organic anions in acidic water. (Lacroix)

3. Collaborate in publication of the Atlantic Salmon Regional Acidification Model and continue to facilitate the development of a Hydrochemical Submodel. (ESSA, Lacroix, Ritter, Amiro, Watt, Cutting)

4. Coordinate and manage the Scotia-Fundy LRTAP Program, represent region on the DFO LRTAP Subcommittee, and represent DFO on the Canada/US Air Quality Agreement Aquatic Effects Subgroup. (Lacroix)

5. Continue to assess the recovery of Atlantic salmon and the long-term effectiveness of limestone gravel bars in an acidic stream. (Lacroix)

6. Collaborate in the preparation of manuscripts relating behavior, and hormonal and olfactory activity in Atlantic salmon smolts to development and chemical imprinting in acidified and limed water. (Morin, Lacroix, Hara, Eales)

7. Given PY support, prepare a manuscript outlining the extent of physiological recovery in salmonids and reduced toxicity in an acidic stream in relation to slight seasonal increases in pH as expected from LRTAP control. (Lacroix)

8. Given PY support, evaluate and report on spatial and temporal trends in fish communities in acidic streams of Nova Scotia in response to changes in LRTAP over the past decade. (Lacroix)

9. Given PY support, report on the importance of movements by juvenile and adult Atlantic salmon in the recovery of populations in acidic rivers, and conduct additional tracking. (Lacroix)

6. Background:

Highlights:

Review and reorganization of the regional LRTAP Program resulted in a focussed program designed to meet the requirements of the region and of the Green Plan. Significant advances were made in modelling the production of Atlantic salmon in acidified rivers. Laboratory experiments on Al-L-gill dynamics have yielded new findings and challenged previous models. Streambed liming and biotelemetry are providing new insights into the potential for recovery of Atlantic salmon in acidified rivers.

Selected Involvements:

i. Collaborative Research -

Olfactory activity in Atlantic salmon. (Morin, SABS; Hara, DFO Winnipeg; Eales, University of Manitoba)
Atlantic Salmon Regional Acidification Model. (ESSA, DFO, DOE)
Electron microscopy of fish gills. (Belfry, University of New Brunswick)

ii. University Liaison -

Dr. J. G. Eales, University of Manitoba
Dr. K. T. Kan, Department of Engineering, University of New Brunswick
Dr. P. G. C. Campbell, INRS, Université du Québec
G. N. Bance and C. S. Belfry, Electron Microscopy Unit, University of New Brunswick

iii. Communications -

iv. Contracts Administered -

Biotelemetry study in relation to acid rain effects on fish and estimates of fish density in a recovery stream ($54.5 K), Statcom Consultants Ltd.
Application of the Atlantic salmon regional acidification model to the Westfield River ($22 K), ESSA Environmental and Social Systems Analysts Ltd.
Assessment of acidic deposition impacts on Atlantic salmon production in Nova Scotia - Phase III ($53.5 K), ESSA Environmental and Social Systems Analysts Ltd. (Co-managed with Ritter)

v. Other -

Supervisor of Visiting Fellow (Morin) in Canadian Government Laboratory.
Member of graduate steering committee for two Ph.D. students (Wilkinson, Roy) at the Université du Québec.

7. Publications:

i. Primary -

Lacroix, G. L. 1992. Mitigation of low stream pH and its effects on salmonids. Environmental Pollution 78: 157-164.

ii. Interpretive Scientific -

iii. Scientific and Technical -

Belfry, C. S. 1992. A histological examination of fish gills exposed to aluminum and citric acid. Contract Report, Electron Microscopy Unit, University of New Brunswick, Fredericton. (Prepared for G. Lacroix)

ESSA. 1992. Atlantic salmon regional acidification model: Version 2.0. User's guide, ESSA Environmental and Social Systems Analysts Ltd., Vancouver. (Prepared for Scotia-Fundy LRTAP Program)

Korman, J., D. R. Marmorek, and C. H. R. Wedeles. 1992. Atlantic salmon regional acidification model: Summary of data analyses completed in Phase II. Contract Report, ESSA Environmental and Social Systems Analysts Ltd., Vancouver. (Prepared for Scotia-Fundy LRTAP Program)

Washburn & Gillis Associates Ltd. 1992. Salmonid distribution and microhabitat selection in Fifteen Mile Brook, Nova Scotia. Contract Report, Washburn & Gillis Associates Ltd., Fredericton. (Prepared for G. Lacroix)

Washburn & Gillis Associates Ltd. 1992. Fish populations studies in acid streams of southwest Nova Scotia. Contract Report, Washburn & Gillis Associates Ltd., Fredericton. (Prepared for G. Lacroix)

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4701

Section:

Project Title: Quoddy Region Bio-Physical Interactions

Project Leader: Watson-Wright, W.; Page, F.; Robinson, S.

Other Researchers: Wildish, D.

Work Activity:

Key Words: Quoddy Region; Passamaquoddy Bay; circulation; temperature; salinity; meteorology

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1. Project Description:

This is a multi-disciplinary, multi-purpose St. Andrews Biological Station project focussed on the Quoddy Region. Because of the area's proximity to a major research centre and lower logistic costs, the project is meant to serve as a testing ground for other sites and circumstances where similar processes may exist.

2. Long-Term Objectives:

Develop a summary and understanding of the physical oceanography within the Quoddy Region and apply this to study biological-physical interactions of any marine resource or process of interest. This could potentially involve aquaculture, wild vertebrate and invertebrate fisheries, and phytoplankton.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

Not applicable.

4. Additional Accomplishments:

Not applicable.

5. Goals/Expected Outputs for 1993:

1. Produce a summary of available oceanographic and meteorological data for the Quoddy Region. Progress on this is dependent on external funding.
2. Convene a meeting to discuss project direction and potential participants.
3. Deploy current meters at key locations in Passamaquoddy Bay to begin collection of data to resolve current patterns. This objective is contingent on external funding.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

1. Dr. Francisco Werner, Skidaway Institute of Oceanography, Georgia, U.S.A.
2. Dr. Bruce MacDonald, Dept. of Biology, Univ. New Brunswick, Saint John, N.B.

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4702

Section:

Project Title: Evaluation of Uptake and Release of Marine Phytotoxins in the Blue Mussel and Sea Scallop Grown in Suspension Culture in the Bay of Fundy, New Brunswick

Project Leader: Watson-Wright, W.

Other Researchers: Parsons, J.; Robinson, S.; Aiken, D.; Sims, G.

Work Activity: W.A.1.1.2.1

Key Words: aquaculture; phytotoxins; invertebrates; scallops; mussels; depuration

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1. Project Description:

This project is investigating the dynamics of the release and uptake in bivalve molluscs of natural toxins produced by marine phytoplankton.

2. Long-Term Objectives:

To evaluate the feasibility of an aquaculture industry in southwestern New Brunswick for suspended culture of bivalves with respect to seasonal patterns of phytotoxin concentration in various bivalve tissues.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

Not applicable.

4. Additional Accomplishments:

Not applicable.

5. Goals/Expected Outputs for 1993:

1. Establish study sites and construct the mooring systems to maintain the specimens. Collect scallop and mussel juveniles for initiation of the experiment.
2. Begin monitoring the water quality and phytoplankton populations at the different study sites.
3. Begin analysis of bivalve tissues for phytotoxins.
4. Interact with the aquaculture industry and the Inspection Branch of DFO to disseminate information on the project.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Biological Oceanography Project No.: 600

Section:

Project Title: Bio-Optical Properties of Pelagic Oceans

Project Leader: Platt, T.

Other Researchers:

Work Activity: W.A.1.1.1.8

Key Words: biological oceanography; phytoplankton; primary production

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1. Project Description:

Understand the transmission of visible light through the ocean, in particular the way it is affected by organisms. The largest variable component of light absorption in the ocean is that due to the pigments in phytoplankton. In turn, phytoplankton need light to grow by photosynthesis. The project aims at describing all these relationships in mathematical terms for a range of oceanographic regimes. This is important to the development of remote sensing technology and to optical communication underwater. Collaborative research is conducted with the Department of National Defence.

2. Long-Term Objectives:

Determine the optical characteristics of picoplankton suspensions including: optical absorption in relation to pigment compositions; the action spectrum for picoplankton cultures; the vertical profile of available light in the sea; vertical attenuation coefficients with respect to wavelength. Compare results with the vertical structure of plankton communities; the photoadaptive properties of phytoplankton under various conditions of turbulent mixing; the wavelength-dependence of photosynthesis for size fractionated field populations. Define algorithms for determining phytoplankton productivity from remotely sensed data. Apply research results from the above studies toward determining their significance for optical communication and understanding the trophic role of picoplankton; calculating quantum yields and upper limits of biological activity in the ocean.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Major cruise to North Atlantic for optics and biology.

   Successfully executed

2. Report on remote sensing for computation of ocean primary production.

   Completed and submitted to European Space Agency as final report on contract to them.

4. Additional Accomplishments:

1. Invited speaker, Canadian Meteorological Oceanographic Society (CMOS), Quebec (June 11-12).
2. Attended International Space Year Meeting, Munich, March 30 - April 4).
3. Invited lecturer, European Institute for Advanced Studies in Oceanography, Majorca, Spain (September 15-30).
4. Invited speaker, International Symposium on Mathematical Modelling and Scientific Computing, Bangalore, India, (December 7-11).

5. Goals/Expected Outputs for 1993:

1. Major cruise to North Atlantic for optics and biology.
2. Report on mathematical models for computation of primary production.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

European Space Agency Joint Venture $72.0K
Joint Research Centre Joint Venture $150.0K
DND Valcartier under Task # 13/1-1990 (91911).

ii. University Liaison -

Supervision of 4 graduate students (Oceanography and Biology Departments).
Through Canadian Committee for NSERC, with Dr. Sathyendranath (Dalhousie University).

iii. Communications -

Many public lectures

iv. Contracts Administered -

Porter Computing: Bio-optical modelling ($29.0K)

v. Other -

7. Publications:

i. Primary -

Platt, T. and S. Sathyendranath. Estimators of primary production for interpretation of remotely-sensed data on ocean colour. Submitted to *Journal of Geophysical Research*.

Platt, T. and S. Sathyendranath. Commentary on 'The remote sensing of ocean primary productivity: use of a new data compilation to test satellite algorithms' by William Balch et al. Submitted to *Journal of Geophysical Research*.

Sathyendranath, S. F.E. Hoge, T. Platt, and R.N. Swift. Detection of phytoplankton pigments from ocean colour: improved algorithms. Submitted to *Applied Optics*.

Sathyendranath, S. and T. Platt. Underwater light field and primary production: application to remote sensing. In press in *'Ocean Colour' Theory and Applications in a Decade of CZCS Experience*'. Edited by V. Barale and P. Schlittenhardt.

Platt, T. and S. Sathyendranath. Scale, Pattern and Process in Marine Ecosystems. In press in *Proceedings of the British Ecological Society*.

ii. Interpretive Scientific -

Sathyendranath, S. and T. Platt. Remote sensing of water-column primary production. In press, In: W. Li and S. Maestrini (eds.), The Measurement of Primary Production From the Molecular to the Global Scale. *ICES Marine Science Symposium*.

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Biological Oceanography Project No.: 602

Section:

Project Title: Nutrient Dynamics: Effects on Primary Production, Global Climate and Fisheries

Project Leader: Harrison, W.

Other Researchers: Platt, T.; Horne, E.; Head, E.J.H.

Work Activity: W.A.1.1.1.8

Key Words: phytoplankton; biological oceanography; primary production

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1. Project Description:

Dissolved nutrients, along with temperature and light, are the environmental properties critical in determining the levels of primary production in the oceans. In most of the world's oceans, nutrients (and specifically nitrogen) are thought to be the primary limiting factor and are the key to understanding the biogeochemical cycles of most other elements dissolved in seawater. This project investigates the distribution, uptake, and regeneration of nutrients and the role they play in the primary production of the oceans. This has relevance to fisheries problems and to the longer-term global problems of ocean circulation and climate.

2. Long-Term Objectives:

Determine the role dissolved nutrients play in the distribution, biomass, and production of marine phytoplankton; identify and quantify the sources of nutrients available to phytoplankton, and especially the role microplankton play in the regeneration of nutrients from organic matter in seawater; determine how much primary production is supported by 'new' nutrients (i.e., from external sources) and how this varies in space and time.

3. Goals/Expected Outputs vs. Accomplishments in 1992:

1. Continue analysis and interpretation of data collected during 1990 and 1991 JGOFS cruises.

   Data analysis of the 1990 and 1991 JGOFS cruises has been completed. In addition, data collected from the 1991 north Atlantic WOCE cruise have been processed. Several informal presentations of the preliminary results have been made (e.g. at the North Atlantic Task Team meeting in Wormley and at the Oligotrophic Pacific Process Study meeting in San Diego) and activities have been described in Departmental documents (Weekly Briefing) and trade periodicals (CMOS News Letter). Some of the results from the 1990 cruise work were published in the journal Nature this year. Interpretation of the data and additional publications are in preparation.

2. Implement field program for 4th JGOFS cruise to the subtropical eastern Atlantic.

   A 35-day cruise (16 September-21 October) from Halifax to the coast of Morocco was successfully completed. The cruise was a multidisciplinary, multinational voyage including biological, chemical and atmospheric scientists from Italy, Germany, France, Spain and South Africa. Studies focused on the atmospheric sulphur cycle and ocean bio-optics.

3. Implement new collaborative studies with Chile (IFOP) as part of the JGOFS Eastern Boundary Current Study.

   This project did not materialize for us due to Program funding shortfalls (in Chile). We are, however, maintaining an informal collaborative arrangement with IFOP to advise and train their staff in measurements of primary production and nutrients and to assist in sample analysis. Future, more formal, arrangements are anticipated when the funding situation improves.

4. Additional Accomplishments:

1. Published manuscript (with co-authors) on seasonal nitrogen dynamics in the subtropical Pacific.
2. Published manuscript (with co-author) on new production in polar waters.
3. Published manuscript (with co-authors) on nitrogen cycling in the equatorial Pacific.
4. Published manuscript (with co-authors) on nutrient control of photosynthetic parameters in North Atlantic.
5. Published two manuscripts (with co-authors) on the Canadian contribution to the JGOFS North Atlantic Bloom experiment in 1989.

6. Published peer reviewed review article (with co-author) on nutrient effects on primary production in polar waters.

7. Published peer reviewed review article on nutrient regeneration in the worlds oceans.

8. Published peer reviewed review article on nutrient regeneration in productivity experiments.

9. Participated, as Canadian representative, in international JGOFS meeting of the North Atlantic Task Team to formulate future international JGOFS studies in the North Atlantic: IOS, Wormley (7-10 January).

10. Seminar presented at BIO on Canadian JGOFS activities (19 February).

11. Public Service Club lecture given on DFO's role in international climate-related research (20 February).

12. Participated in Phytotoxin workshop/meeting: BIO (11-12, and 25 February).

13. Invited speaker, ICES symposium on primary production measurements: LaRochelle, France (18-25 April).

14. Canadian representative to US JGOFS workshop on proposed process studies in the oligotrophic Pacific Ocean: San Diego, CA (27-29 May).

15. DFO (Scotia-Fundy) representative to PERD 4.8 (Generic Environment) Panel: Ottawa (21 July).

16. Senior Scientist, 35-day CSS HUDSON cruise 92-037, Halifax-Morocco (16 September-21 October).

17. Participated in intensive course on estimation of primary production from remotely-sensed data on ocean colour: BIO (9-12 November).

5. Goals/Expected Outputs for 1993:

1. Continue analysis and interpretation of data from 1990, 1991 and 1992 JGOFS Cruises.

2. Participate in WOCE North Atlantic Tracer Release Experiment in Canary Basin and implement field program for 5th JGOFS cruise, a repeat of previous years work in the subtropical eastern Atlantic.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

Final (wrap-up) manuscript of collaborative study with U.S. scientists on NSF-funded VERTEX program published (Contact: Dr. G.A. Knauer, NSTL, Mississippi, USA).

Several manuscripts in preparation from collaborative studies on Georges Bank (participants: BIO-Biological Sciences, Physical and Chemical Sciences Branch, St. Andrews and Dalhousie Univ.).

Collaborative studies with scientists from the Joint Research Centre, Ispra, Italy, on ocean-atmosphere interactions as part of JGOFS cruise aboard CSS HUDSON 92-037 (Contact: Dr. Peter Schlittenhardt, JRC, Ispra, Italy).

Consultation on experimental procedures and analytical techniques for primary production and nutrients with the Chilian Federal Fisheries Department, IFOP (Contact: Dr. Patricio Bernal, Director, Instituto de Fomento Pesquero, Santiago, Chile).

ii. University Liaison -

Honorary Research Associate with the Department of Oceanography and Biology at Dalhousie; supervision of graduate student research and Honorary Adjunct Professor, Biology Department.

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Harrison, W.G., L.R. Harris, D.M. Karl, G.A. Knauer, and D.G. Redalje. 1992. Nitrogen dynamics at the VERTEX time-series site. *Deep-Sea Research*, 39: 1535-1552.

Platt, T., S. Sathyendranath, O. Ulloa, W.G. Harrison, N. Hoepffner, and J. Goes. 1992. Nutrient control of phytoplankton photosynthesis in the western North Atlantic. *Nature*, 356: 229-231.

PÃna, M Angelica, W.G. Harrison, and M.R. 1992. New production in the central Equatorial Pacific. *Marine Ecology Progress Series.*, 80: 265-274.

Smith, W.O., Jr. and W.G. Harrison. 1992. New production in polar regions: the role of environmental controls. *Deep-Sea Research*, 38:1463-1479.

Harrison, W.G., E.J.H. Head, E.P.W. Horne, B. Irwin, W.K.W. Li, A.R. Longhurst, M.A. Paranjape, and T. Platt. 1992. The Western North Atlantic Bloom Experiment. *Deep-Sea Research*, In press.

Li, W.K.W., Dickie, P.M., W.G. Harrison, and B.D. Irwin. 1992. Biomass and production of bacteria and phytoplankton during the spring bloom in the western North Atlantic Ocean. *Deep-Sea Research*, In press.

ii. Interpretive Scientific -

Harrison, W.G. 1992. Regeneration of nutrients, 385-407, In: P. Falkowski (ed.), Primary Productivity and Biogeochemical Cycles in the Sea. *Brookhaven Symposium in Biology No. 37, Plenum Press*, New York.

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