PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Biological Oceanography Project No.: 603

Section:

Project Title: Physical Oceanography of Selected Features in Connection with Marine Ecological Studies

Project Leader: Horne, E.

Other Researchers:

Work Activity: W.A.1.1.1.8

Key Words: biological oceanography; primary production

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1. Project Description:

The principle goal of this project is to understand how turbulence affects biological production. Analyses are conducted on turbulence data from the Arctic, where the driving force is buoyancy due to melting ice, and from Georges Bank where the driving forces are tidal. Georges Bank data show a large variation of turbulence levels with the stage of the tide and we plan to compare our measurements to those from theoretical models. A new problem that has been studied is the measurement of underwater light spectra and how this affects primary production. This project collaborates with J. Loder, N. Oakey, and K. Drinkwater from PCSB on an ongoing basis.

2. Long-Term Objectives:

Understand how: turbulence levels on Georges Bank change over a tidal cycle; the high productivity levels on Georges Bank are maintained; ice influences turbulence levels in the Arctic; turbulence affects phytoplankton production; and, to predict oceanic primary production from light spectra measurements.

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

1. Complete a paper on the 1990 JGOFS data showing zooplankton grazing on chlorophyll profile.

   Progress was made on the data analysis for this paper but time constraints have not allowed the paper to be completed.

2. Analyze and write up the 1991 optical data collected during the WOCE cruise.

   The analysis is complete and the results were written up in a report for DREV. This report is in the process of being rewritten in a form suitable for primary publication.

3. Upgrade the spectral irradiance meter to use a thinned MPP CCD and to subtract the dark current in the instrument and then build two instruments to go on BUD.

   This upgrade has consumed much more time than was anticipated. There are several reasons for this the major ones being that:(a) The manufacturer's specifications for the CCD we used were wrong, which meant substantial redesign of the readout electronics (b) Reading out the data at 1Mhz, which is required to obtain a spectra every meter in depth from BUD, forces several components in the readout electronics to operate beyond their specs. It was found that the system is so highly tuned now that changing one chip with a supposedly identical one alters the timing and causes the instrument to not work properly. A design change is now underway to correct this problem. The good news is that the new CCD has worked very well and the dark current is much lower than that with the old CCD so that all this extra work is justified.

4. Use BUD operationally at sea with a full suite of sensors.

   This was accomplished on our 1991 JGOFS cruise and except for the problems noted above with the light meters all sensors worked well. The resolution of the depth sensor was improved so that it can now resolve 2cm. The real time display on the deck unit was improved to show more channels and graphs of light spectra. A great deal of progress was accomplished in doing real time display of the turbulence data using a separate PC from the deck unit equipped with a DSP card. It can now display light spectra, CTD profiles, fluorescence data and FFT's of the shear data in real time. What remains is to integrate the spectra and calculate dissipation which is not difficult. The BUD winch has become a problem since it can barely lift BUD. The winch contains the largest motor (1hp) that can be handled by a 120v line supply and cannot be geared down any more without making recovery time excessively long. The winch must be upgraded to a 220v supply and a larger motor installed before next years field season.

4. Additional Accomplishments:

The work describing the 1990 JGOFS measurements written with Dr. Head and described in last years report has been accepted for publication by DSR and is in press.

The analysis of the 1988 Georges Bank experiment data has continued and has resulted in two more publications. One is on the detailed structure of the currents and hydrography, including the internal hydraulic jump, and the other was prepared for the Royal Society Discussion Meeting on Understanding the North Sea System on the Circulation, Hydrographic Structure and Mixing at Tidal Fronts.

5. Goals/Expected Outputs for 1993:

1. Complete paper on 1990 JGOFS data.
2. Complete paper on 1991 WOCE optical data.
3. Participate in 1993 WOCE cruise to Canary Basin.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

The pressure cases used on BUD are made of carbon fibres. This is the first time that this material has been used at BIO for this purpose. This work was done in collaboration with the Advanced Materials Research Centre in Halifax. Work is continuing on trying to make endcaps out of the same material. The advantages are that it is about one half the weight of the equivalent aluminum case and does not suffer from corrosion (even under connectors in an anoxic environment)

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

Obtained and supervised $40K contract to Seimac Ltd. to provide engineering support for the development of the spectrometers.

v. Other -

7. Publications:

i. Primary -

Loder, J.W., D. Brickman, and E.P.W. Horne, 1992. Detailed structure of currents and hydrography on the northern side of Georges Bank. *Journal of Geophysical Research*, 97,14331-14351.

Loder, J.W., K.F. Drinkwater, N.S. Oakey, and E.P.W. Horne, 1992. Circulation, Hydrographic Structure and Mixing at Tidal Fronts: *The View From Georges Bank, Philosophical Transactions of the Royal Society of London, Series A,* In press.

Head, E.J.H., and E.P.W. Horne, 1992. Algal pigment transformation and vertical flux in an area of convergence in the North Atlantic. *Deep Sea Research,* In Press.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Biological Oceanography Project No.: 604

Section:

Project Title: Productivity of Marine Microorganisms

Project Leader: Li, W.

Other Researchers: Dickie, P.

Work Activity: W.A.1.1.1.8

Key Words: phytoplankton; bacteria; biological oceanography

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1. Project Description:

Photosynthetic (i.e. algae and cyanobacteria) and heterotrophic (bacterial) microorganisms are abundant and ubiquitous in marine plankton assemblages. They account for a large proportion of energy and material transfer in pelagic systems. Contemporary discussions about the 'microbial loop' of marine food webs rely on an understanding of these microorganisms. This project utilises observational and experimental methods to study the influence of environmental factors on the abundance, distribution and production of bacteria and phytoplankton in the ocean. Particular emphasis is placed on examination of bulk plankton properties from characterization of the properties of constituent organisms using techniques of single cell analysis.

2. Long-Term Objectives:

The long-term objective of this project is to provide the knowledge necessary to understand how the tropho-dynamic relationship between phytoplankton and bacterioplankton influences the productivity of marine food webs. This objective forms a rational basis on which to examine the details concerning the flux of biogeochemically significant elements and the extent to which such fluxes may be influenced by ecosystem perturbations. Implicitly, a goal of this project is to relate details of the microbial constituents to bulk and remote measures of plankton characteristics.

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

1. Conduct new work investigating the factors influencing rates of phytoplankton and bacterioplankton growth. (Li, Dickie)

   Accomplishments: New data concerning the distribution, abundance and metabolic activities of phytoplankton and bacterioplankton were collected on the 1992 JGOFS study. A time-series sampling programme was continued in the Bedford Basin to study bacterial dynamics. The primary production of oceanic phytoplankton was successfully measured at sea by flow cytometric sorting of radioactively-labelled cells.

2. Continue examination of samples acquired from previous work. (Li, Dickie)

   Accomplishments: Almost all of the samples collected during the 1991 field studies have been examined. Work is ongoing to process field samples collected during 1992. In addition, collaborative research was initiated with the Kinneret Laboratory (Israel) and the University of Oregon (USA) to examine picoplankton sampled from oligotrophic Mediterranean waters.

3. Continue analysis of acquired data in preparation for publication. (Li)

   Accomplishments: A total of eleven papers are at various stages of the publication procedure (4 published, 6 in press, 1 in review). In addition, co-editorial work is ongoing towards the completion of the proceedings of an ICES Symposium.

4. Organize an ICES Symposium on the Measurement of Primary Production in the Sea. (Li)

   Accomplishments: The Symposium was successfully realized.

4. Additional Accomplishments:

1. ICES Symposium on the Measurement of Primary Production in the Sea: member of organizing committee and co-editor of proceedings. (Li)

2. Member of the editorial board (referee) for Marine Ecology Progress Series. (Li)

3. Vice-chairman of the Bigelow Laboratory (USA) Flow Cytometer Advisory Committee. (Li)

4. Member of JGOFS expert group on 'Bacterial Biomass and Production'. (Li)

5. Supervision 2 PhD students and 1 participant in the Co-operative Education Training Programme. (Li)

5. Goals/Expected Outputs for 1993:

1. Conduct new work investigating the factors influencing the distribution and production of phytoplankton and bacterioplankton. (Li, Dickie)

2. Continue examination of samples acquired from previous and collaborative work. (Li, Dickie)

3. Continue analysis of acquired data in preparation for publication. Complete co-editorial task on the proceedings of the ICES Symposium. (Li)

4. Participate in NATO workshop on the microbial food web. (Li)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

Collaborative research with Dalhousie University (Halifax), University of Malaga (Spain), University of Oregon (USA), and the Kinneret Laboratory (Israel). Participation in international JGOFS activities.

ii. University Liaison -

Member of graduate student thesis committees.

iii. Communications -

Presentation at ICES Symposium on the Measurement of Primary Production in the Sea.

iv. Contracts Administered -

v. Other -

* Advise and assist CSSA Consultants (Montréal) in phytoplankton measurements.

*Responded to request from Massachusetts Institute of Technology (USA) for information regarding prochlorophyte distributions.

7. Publications:

i. Primary -

Li, W.K.W. 1992. Estimation of primary production by flow cytometry. *ICES Marine Science Symposia*: In press.

Li, W.K.W., P.M. Dickie, B.D. Irwin, and A.M. Wood. 1992. Biomass of bacteria, cyanobacteria, prochlorophytes and photosynthetic eukaryotes in the Sargasso Sea. *Deep-Sea Research* 39: 501-519.

Li, W.K.W., P.M. Dickie, 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.

Li, W.K.W., B.D. Irwin, and P.M. Dickie. 1992. Dark fixation of ^{14}C: variations related to biomass and productivity of phytoplankton and bacteria. *Limnology and Oceanography*: Submitted.

Li, W.K.W., M.R. Lewis, and A. Lister. 1992. Flow cytometric detection of prochlorophytes and cyanobacteria in the Gulf of Policastro, Italy. *Archiv für Hydrobiologie* 124: 309-316.

Li, W.K.W. and S.Y. Maestrini (Eds). 1992. The measurement of primary production from the molecular to the global scale. *ICES Marine Science Symposia*: In press.

Furuya, K. and W.K.W. Li. 1992. Evaluation of photosynthetic capacity of phytoplankton by flow cytometric analysis of DCMU-enhanced chlorophyll fluorescence. *Marine Ecology Progress Series*. In press.

Harrison, W.G., E.J.H. Head, E.P.W. Horne, B. Irwin, W.K.K. Li, A.R. Longhurst, M. Paranjape, and T. Platt. 1992. The western North Atlantic bloom experiment. *Deep-Sea Research*: In press.

Longhurst, A.R., I. Koike, W.K.W. Li, J. Rodriguez, P. Dickie, P. Kepkay, F. Partensky, B. Bautista, J. Ruiz, M. Wells, and D. Bird. 1992. Sub-micron particles in northwest Atlantic shelf water. *Deep-Sea Research* 39: 1-7.

Pan, Y., D.V. Subba Rao, K.H. Mann, W.K.W. Li, and R. Warnock. 1992. Temperature dependence of growth and carbon assimilation in *Nitzschia pungens f. multiseries*, the causative diatom of domoic acid poisoning. In: *Proceedings of the Fifth International Conference on Toxic Marine Phytoplankton*. Eds. T.J. Smayda and Y. Shimizu, Elsevier, New York. In press.

Partensky, F., N. Hoepffner, W.K.W. Li, O. Ulloa, and D. Vaulot. 1992. Photoacclimation of Prochlorococcus sp. (Prochlorophyta) strains isolated from the north Atlantic and the Mediterranean Sea. *Plant Physiology*: In press.

Subba Rao, D.V., F. Partensky, G. Wohlgeschaffen, and W.K.W. Li. 1992. Gametogenesis in Nitzschia pungens f. multiseries. *Journal of Phycology* 28: 754-576.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Biological Oceanography Project No.: 607

Section:

Project Title: Carbon Dioxide and Climate: Biogeochemical Cycles in the Ocean

Project Leader: Platt, T.

Other Researchers: Harrison, W.

Work Activity: W.A.1.1.1.8

Key Words: climate changes; phytoplankton; primary production; biological oceanography

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1. Project Description:

Carbon dioxide diffuses readily between ocean and atmosphere and is the primary substrate for nutrition and growth of phytoplankton. On a global scale, phytoplankton use 5×10^{10} tons CO_2 annually, or more than the entire input of CO_2 into the atmosphere from burning of fossil fuels. The increasing input of CO_2 into the atmosphere from fossil fuel consumption is believed to lead to significant changes in the earth's climate before the end of this century. This project examines the role of the oceanic biota as a possible sink for a significant fraction of the increased atmospheric CO_2. It is relevant to the aims of the Joint Global Ocean Flux Study (JGOFS).

2. Long-Term Objectives:

Determine by direct measurement, in a broad range of ocean environments: (a) the proportion of total primary production that sinks out of the photic zone; and (b) the vertical flux of nitrate into the photic zone. Construct and analyze ecological models for interpretation of results.

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

1. Further JGOFS field work, N. Atlantic.

   Successfully completed.

2. Participation in scientific leadership, JGOFS.

   Completed second year of 3-year term as Chairman of International Scientific Steering Committee for the Joint Global Ocean Flux Study.

4. Additional Accomplishments:

1. Participated in first meeting of ad hoc planning group for the Global Ocean Euphotic Zone Study (GOEZS), Victoria, Vancouver (April 29-May 1).
2. Chairman, Canadian Committee for Joint Global Ocean Flux Study.
3. Attended first meeting of Canadian JGOFS Steering Committee, Ottawa, (July 6).
4. Attended second meeting of Canadian JGOFS Canada Program, Montreal (October 27-29).
5. Chairman, International JGOFS Committee.
6. Member, Executive Committee, JGOFS and attended JGOFS Executive Meeting, London (March 25-27).
7. Member, JGOFS International Scientific Steering Committee and attended 7th meeting of JGOFS Scientific Steering Committee, Taipei, Taiwan (October 16-25).
8. Attended BES/ASLO Meeting, Cork, Ireland (April 5-8).
9. Chairman, Steering Committee, ICES Symposium on Primary Production Measurements, LaRochelle, France (April 18-25).
10. Member, Scientific Committee, International Geosphere-Biosphere Programme and attended 5th Meeting of Scientific Committee (IGBP), Durham, N.H. (September 30 - October 2).
11. President/American Society Limnology and Oceanography.
12. Co-leader, Productivity of Global Ocean Project, International Space Year.

5. Goals/Expected Outputs for 1993:

1. Further JGOFS field work in the N. Atlantic and Indian Ocean (Arabian Sea).

2. Participation in scientific leadership, JGOFS.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

Adjunct Professor, Biology Department, Dalhousie University.

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Platt, T. P. Jauhari, and S. Sathyendranath. 1992. The importance and measurement of new production. 43: 273-284. In: P.G. Falkowski and A.D. Woodhead [Eds]. *Primary Production and Biogeochemical Cycles in the Sea. Plenum Publishing.*

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.

Ulloa, O., S. Sathyendranath, T. Platt, and R.A. Quiñones. 1992. Light scattering by marine heterotrophic bacteria. *Journal of Geophysical Research* 97 (C6): 9619-9629.

Quiñones, R.A. and T. Platt. Patterns of biomass size-spectra from oligotrophic waters of the Northwest Atlantic. Submitted to *Marine Ecological Progress Series.*

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. The western North Atlantic bloom experiment. Submitted *Deep-Sea Research.*

Quiñones, R.A., T. Platt, J. Ruiz, and F. Echevarria. Biomass, respiration, and size in the pelagic ecosystem: an empirical study using size-spectra. Submitted to *Limnology and Oceanography.*

Kyewalyanga, M., T. Platt, and S. Sathyendranath. 1992. Ocean primary production calculated by spectral and broad-band models. *Marine Ecological Progress Series* 85:171-185.

Ulloa, O., T. Platt, S. Sathyendranath, W.G. Harrison, and J. Ruiz. Importance of the biological pump in the ocean carbon cycle. Submitted *Journal Geophysical Research.*

ii. Interpretive Scientific -

Platt, T. and S. Sathyendranath. Fundamental issues in measurement of 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.: 608

Section:

Project Title: Analysis of Pelagic Ecosystem Structure

Project Leader: Longhurst, A.

Other Researchers:

Work Activity: W.A.1.1.1.8

Key Words: modelling; zooplankton; secondary production; biological oceanography

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1. Project Description:

Investigations of how simplified quantitative models of marine ecosystems can be formulated although such ecosystems comprise a greater diversity of basic life forms - with a greater diversity of interactions - than any terrestrial ecosystem, which are frequently the basis for holistic ecological models, and for much of theoretical ecology. **See note in Section 8 below.**

2. Long-Term Objectives:

Contribute to the formulation of holistic models of marine ecosystems, which are essential for the development of predictive ecology as an element in marine science.

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

As time and opportunity avails, continue work on plankton diversity/water column stability, and on the effects of viscosity on the structure of the biological particle size spectrum, probably by soliciting cooperation by a physicist specializing in viscosity problems.

No significant activity in this project because of expansion of work in Project 612.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

No significant activity anticipated.

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.: 609

Section:

Project Title: Carbon and Nitrogen Utilization by Zooplankton and Factors Controlling Secondary Production

Project Leader: Conover, R.

Other Researchers: Head, E.J.H.

Work Activity: W.A.1.1.1.8

Key Words: secondary production; zooplankton; biological oceanography

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1. Project Description:

It is theoretically possible to estimate the 'P/B' ratio from information about ingestion, respiration and excretion of zooplankton, and this has been modelled on several occasions using allometric relationships between metabolic rate and size of the organism. Two approaches have been taken: 1) the search for 'indicators', such as key enzymes of intermediary metabolism, or, in the case of feeding by herbivores, the accumulation of chlorophyll-derived pigments in the body; and 2) the use of *in situ* metabolic chambers which capture natural populations of organisms in a presumably stress-free way to actually measure metabolic rates in the field.

2. Long-Term Objectives:

Develop a methodology for estimating 'instantaneous' production rate for pelagic animals by development of biochemical and physiological indices of zooplankton activity pertaining to metabolism and growth; development of *in situ* metabolic chambers to measure metabolism and plankton activity directly in the field.

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

Assuming that there will be money for arctic research (see Project No. 624), we will attempt to use 'conditioned' animals in grazing experiments to examine some of the factors that affect the loss of chlorophyll-derived pigment during gut passage (see also Project No. 613). The best opportunity to do this in the coming year will probably be during the cruise of the MV Arctic to Northwater, but we will try similar experiments in the late summer/fall at Resolute.

We intended to use primarily Green Plan resources for this second study of Northwater, which was to be a milestone for our revised project entitled 'Climate change and production in the high arctic', but most of the funds were deferred to a future fiscal year and the residual cut by 60%. The Institute for Ocean Sciences in Sidney, B.C., which collaborated and shared costs during the first Arctic cruise (1991), were unable to commit funds for 1992, at which point the cruise was abandoned. As plans to initiate an overwintering program at Resolute were also deferred until 1993, no progress was made on the primary objectives for the year.

4. Additional Accomplishments:

Work on the biology of gelatinous predators at high latitudes has resulted in two primary publications described under Project No. 619. The completion of two M.Sc. theses will be similarly described.

5. Goals/Expected Outputs for 1993:

The goals for this project remain little changed from 1992. Assuming that there will be money for arctic research (see Project No. 624), we will attempt to use 'conditioned' animals in grazing experiments to examine some of the factors that affect the loss of chlorophyll-derived pigment during gut passage (see also Project No. 613). We also intend to initiate studies on respiratory and excretory physiology to be continued over the full calender year at Resolute assuming the financial resources for the overwintering program are forthcoming.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

Dr. Nicolai Mumm, from the Institut fur Ostseeforschung, Rostock-Warnemunde, Germany, has recently arrive to participate in our arctic programs in 1993.

ii. University Liaison -

I have already mentioned that two of my students have successfully completed their graduate work at Dalhousie. Two others on whose committees I sit, Tony Windust and Henne Sonoko, have completed their research. Tony has defended his thesis 'Studies on the response of bacteria, microalgae and zooplankton to domoic acid, a neurotoxic metabolite of the diatom *Nitzschia pungens f. multi-series*' during the past summer, and Henne hopes to defend within the next few weeks.

I have a new student, Kate Moss, who will be involved in aspects of the arctic research program. In partial support of her arrival, I have request continued support for graduate student research at Dalhousie University from NSERC with the proposal 'ARCTIC ZOOPLANKTON IN WINTER: ADAPTATIONS FOR SURVIVAL WITH EMPHASIS ON THE FALL AND SPRING-SUMMER TRANSITION PERIODS'.

I also am giving a module in the Department of Biology during the still incomplete fall term at Dalhousie 'On zooplankton in cold environments', which includes not only the biology of polar plankton but also a description of the physical environment and the projected influence and implications of continued global warming on arctic environments and 'down-stream' fishing banks.

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Siferd, T.D. and R.J. Conover. 1992. An opening-closing plankton net for horizontal sampling through polar sea-ice. *Sarsia* 76:273-277.

Siferd, T.D. and R.J. Conover. 1992. Natural history of ctenophores in the Resolute Passage area of the Canadian high arctic with special reference to *Mertensia ovum*. *Marine Ecology Progress Series*. 86:133-144.

Harold E. Welch, M.A. Bergmann, T.D. Siferd, K.A. Martin, M.F.Curtis, R.E. Crawford, R.J. Conover, and H. Hop. 1992. Energy flow through the marine ecosystem of the Lancaster Sound region, Arctic Canada. *Arctic* 45: No.4 343-357.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Biological Oceanography Project No.: 611

Section:

Project Title: Secondary Production and the Dynamic Distribution of Micronekton in the Scotian Shelf

Project Leader: Sameoto, D.

Other Researchers: Kennedy, M.

Work Activity: W.A.1.1.1.8

Key Words: acoustics; secondary production; zooplankton; larvae; biological oceanography

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1. Project Description:

The influence of the physical oceanography and the bottom topography on secondary production and community structure is the main focus of this project. High resolution sampling, both vertical and geographic, of the zooplankton and fish communities provides detailed information on species distribution and interactions, including the role of biological and physical factors.

2. Long-Term Objectives:

Produce a model for the secondary production of the major species that incorporates temporal changes due to advection and mixing of the different water masses on the shelf. Determine the influence of shelf and slope water beyond the shelfbreak on the biomass, species composition, and production of zooplankton on the NE Nova Scotia Shelf at different seasons measured over a period of three consecutive years. Study the feeding dynamics of micronekton and fish in the shelf basins and canyons along the shelfbreak.

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

1. Study seasonal changes in the zooplankton community and biomass in deep basins on the SW Scotian Shelf and in the Gulf of Maine and relate biological changes in the physical environment. This will be done using new *in situ* sampling methods providing long term time series information.

   Field sampling of zooplankton combined with CTD measurements on the Nova Scotia Shelf and Gulf of Maine were completed during the months of January, March, April, June, July, and November, 1992. All the samples have been analyzed and these data used with the moored optical zooplankton counter (OPC) data collected during the year in Emerald Basin to monitor temporal changes in the zooplankton community associated with long term changes in water temperature. Preliminary results indicate that significant changes in the species composition and abundance of *Calanus* on the Nova Scotia Shelf resulted from a large influx of cold water from the Gulf of St. Lawrence. However, these changes were not seen in the Gulf of Maine.

2. Start field testing the new multi-frequency acoustic sampling instrument.

   Field testing of new software written for the multi-frequency acoustic instrument was very successful. Using this software we are able to detect and count individual euphausiids, plus larval and juvenile fish within layers of high zooplankton concentrations. In the past this was impossible to do.

4. Additional Accomplishments:

1. A new acoustic acquisition system was developed in co-operation with N. Cochrane of the Metrology Division. It utilizes hull mounted 12 kHz transducers and is designed to receive echoes from fish larvae and juvenile fish. The system was successfully used to record volume backscattering from fish on the transatlantic Hudson cruise and provided a complete acoustic record of mesopelagic fish backscattering between Nova Scotia and the coast of Africa. These data will be related to profiles of chlorophyll, and zooplankton concentrations and temperature contours. This is a ship of opportunity system that requires no man power once it is installed on ship.

2. Data from an acoustic Doppler current profiler (ADCP) moored for 50 days in La Have Basin was analyzed to extract hourly volume backscattering information for the entire water column. These fine scale long time series data showed that krill target strength varied predictably each day and that long term changes in the population size can accurately be measured. This study was conducted to determine the value of long term bottom moored acoustic instruments in measuring changes in concentration and biomass of pelagic organisms as a supplement to or replacement for ship based data collection. Climate effect studies require long time series data and this type of moored instrument is a powerful cost effective tool in collecting time series acoustic data.

3. An experiment to locate concentrations of juvenile fish acoustically through the water column

plus the effect of light on the their net avoidance reaction was successfully completed. This was based on recent research on the reaction of krill to light. The results showed the net avoidance reaction of many species of juvenile fish could be overcome by using light. However, some species of fish avoided the light. More experimentation has to be done to determine which species of larval and juvenile fish react positively to the light when sampling.

4. Continuous acoustic volume backscattering data for the entire water column were collected in November across the Nova Scotia Shelf and in all the major Basins on the Shelf in the Gulf of Maine. These data were obtained from the 150kHz ADCP and the 12 kHz acoustic system. This acoustic information combined with the BIONESS, Batfish OPC, CTD, and chlorophyll fluorometer data will be used to characterize the different regions of SW Nova Scotia Shelf and Gulf of Maine according to their zooplankton biomass levels and concentrations of larval and juvenile fish.

5. Goals/Expected Outputs for 1993:

1. The analysis of the zooplankton data from the Scotian Shelf and Gulf of Maine will continue with additional ship of opportunity zooplankton sampling occurring on the Shelf in support of the moored OPC program.

2. Analysis of the ADCP data plus krill samples collected in the mooring region and time period will continue with the aim of producing a manuscript on the effectiveness of a bottom moored acoustic profiling instrument for collection of long term time series data on macrozooplankton and fish.

6. Background:

Highlights:

The successful performance of the moored OPC in continually measuring changes in zooplankton populations in Emerald Basin over a period of 7 months, proving this instrument can successfully be used to collect long time series data on changes in zooplankton and euphausiid populations related to changes in ocean climate.

The successful development and use of the 12 kHz acoustic system in locating and estimating volume backscattering from larval and juvenile fish and using this information to accurately target these fish for BIONESS sampling plus using high intensity light on the BIONESS to overcome the avoidance reaction of the fish. These two sampling methods combined to give the highest and most accurate estimates of juvenile fish we have ever collected. These methods could easily be adapted to standard larval and juvenile fish surveys.

Selected Involvements:

i. Collaborative Research -

1. Moored OPC program in Emerald Basin to monitor ocean climate change effects on zooplankton. Collaborating with A. Herman of Metrology

2. Development of the 12 kHz ship of opportunity acoustic system. Collaborating with N. Cochrane of Metrology.

3. Development of the multi-frequency acoustic system. Collaborating with N. Cochrane.

4. The moored ADCP zooplankton backscattering data analysis. Collaborating with D. Belliveau and N. Cochrane of Metrology.

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Sameoto, D.D., and A.W. Herman. 1992. Effect of the outflow from the Gulf of St. Lawrence on Nova Scotia Shelf Zooplankton. *Canadian Journal of Fisheries and Aquatic Sciences* 49:857-869.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Biological Oceanography Project No.: 612

Section:

Project Title: Biological Stratification in the Ocean and Global Carbon Flux

Project Leader: Longhurst, A.

Other Researchers:

Work Activity: W.A.1.1.1.8

Key Words: climate changes; phytoplankton; primary production; biological oceanography

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1. Project Description:

Analyze the role of biological processes which are induced by the physical-chemical stratification of the upper ocean in the flux of energy and material in the marine environment. Interpret and apply the findings to problems of climate change and fisheries variability.

2. Long-Term Objectives:

An understanding and quantification of these processes will assist in (i) interpreting observed variability in fish stocks, (ii) in predicting the consequences of global climate change, and (iii) in quantifying the variable flux of carbon to sequestration in the interior of the ocean.

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

1. Complete analysis of biogeochemical regions as outlined above, and participate in computation of Atlantic primary production.

   A major new study was undertaken during this reporting period, partly supported by funds from European Space Agency. The preliminary sketch for how biogeochemical provinces might best be defined (started at the end of 1991) was expanded into a draft report (90 pp) on the dynamic biogeography of the Atlantic Ocean. This was supported by analysis of the data bases for water transparency (NOAA) and mixed layer depths (NASA-Goddard) and close examination of all relevant Level 3 CZCS browse file images on CD ROM. The results were surprising and suggested that some important mechanisms of oceanic algal bloom induction are ignored in global models. In particular, the Arctic summer bloom is discontinuous, and induced differently, from the migrating North Atlantic spring bloom, itself much modified regionally by mixed layer depth variability. Most importantly, pelagic algal blooms in the tropical ocean are induced by distantly-forced thermocline uplift, by wind-stress curvature or by eddy-upwelling. These observations lead to the finding that the tropical algal blooms in the three tropical oceans are induced differently, and to an explanation of paradoxes observable in the CZCS images.

   A new regionalized computation of basin-scale primary production in the North Atlantic (prepared as Contract Report to ESA) was supported by acquisition (correspondence with about 40 institutes/individuals) of a data base of more than 8000 chlorophyll profiles, about 5500 of which could be fit to a Gaussian model to derive the parameters required by the Platt and Sathyendranath algorithm for computation of primary production from satellite-observed surface chlorophyll. The conformity of these parameters with the provinces defined as described above was investigated prior to the computation.

   A manuscript entitled 'Seasonal Cooling and Blooming in Tropical Oceans' was prepared and submitted to Deep-Sea Research.

2. Complete study of North Atlantic particle spectra from MUTISIZER data.

   A transect of profiles was obtained from the Gulf Stream to the Moroccan upwelling, completing the data acquisition for this project, and confirming the results reported last year. Analysis of the data and completion of a manuscript awaits completion of the work described in (1) above.

3. Participate, as appropriate, in the Division's 1992 JGOFS voyage.

   Participated in this 35-day voyage to the eastern Atlantic, as noted above, and organized at-sea data analysis of the AquaShuttle transect made across the ocean.

4. If time avails, formulate (with Dr. W. Harrison) a simple compartment model of global carbon flux to examine the consequences of uncertainties concerning input functions and internal parameters present, but usually unstated, in current version of predictive geochemical models. User-friendly microcomputer system simulation software will be used for this.

   On the back burner. No time, no activity.

4. Additional Accomplishments:

Completed revision for publication of manuscript on seasonal vertical migration by North Atlantic copepods at OWS 'INDIA' (60N, south of Iceland) and the consequences of this migration for active vertical flux of carbon and nitrogen. It was concluded that such a flux must be a small number, and that previously published predictions of its significance were incorrect.

5. Goals/Expected Outputs for 1993:

1. Complete analysis of conformity of chlorophyll profile parameters with biogeochemical regions, and participate in formal computation of North Atlantic primary production for primary publication.

2. Either (if ESA contract is renewed) undertake global analysis of oceanic provinces and primary production computation, or (if contract not renewed) undertake and publish global analysis of oceanic provinces alone.

3. As time avails, complete analysis for publication of Atlantic particle spectrum data.

4. It seems unlikely that time will be available for the formulation of an uncertainty-sensitive global carbon flux compartment model referred to in the 1991 PREP, but this remains a useful study if the circumstances are right.

6. Background:

Highlights:

Much of the work undertaken within this project supports the DFO component of the Canadian JGOFS project, itself a component of the international JGOFS experiment coordinated by SCOR/ICSU. The highlight of this years activity has been that the results of many years study of the vertical structure of the layered pelagic ecosystem have been brought to bear on a practical problem, that of knowing the true amount of plant growth (and hence carbon incorporated) in the whole North Atlantic Ocean and how this number varies from year to year. There is presently a level of uncertainty of at least a factor of 2, and perhaps of 5, in knowing this total.

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

The study of biogeochemical provinces of the Atlantic Ocean, and their utility in partitioning the calculation of primary production, was done in collaboration with Dr. Sathyendranath of the Department of Oceanography, Dalhousie University, as well as other people from the Biological Oceanography Division (DFO at BIO).

Invited lecture on this subject delivered to student symposium on vertical flux in the ocean at University of Bremen, Germany, in June 1992. Lecture on role of marine biosphere in global carbon flux delivered to student seminar at Dalhousie University, May, 1992.

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Longhurst, A.R., and R. Williams. 1992. Vertical carbon flux by seasonally migrating copepods is a small number. *Journal of Plankton Research* 14 (11).

ii. Interpretive Scientific -

iii. Scientific and Technical -

Drafted Chapter 2 of the Contract Report to European Space Agency.

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Biological Oceanography Project No.: 613

Section:

Project Title: The Role of Copepods in Vertical Fluxes of Carbon and Pigments in the Ocean

Project Leader: Head, E.

Other Researchers: Harris, L.

Work Activity: W.A.1.1.1.8

Key Words: zooplankton; secondary production; nutrition; biological oceanography

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1. Project Description:

Phytoplankton in the surface layers of the ocean fix atmospheric carbon dioxide into organic carbon. Copepods grazing on phytoplankton produce faecal pellets which often constitute a significant proportion of the sedimenting organic carbon. In particular they produce specific chlorophyll a breakdown products, which may be identified and quantified in sediment traps where faecal pellets may be underestimated by microscopic examination because they have broken up. In this project we try to assess the contribution of copepods to the fluxes of sedimenting pigment and organic carbon and how they vary in different types of marine environment. The project involves measurements of zooplankton biomass, of faecal pellet composition and production rate and of sediment trap composition. From measurements of community defecation rates and pigment destruction efficiencies, in situ grazing rates are also estimated. The program constitutes one of the important elements of the JGOFS program.

2. Long-Term Objectives:

In a range of different marine environments:

1. To assess the contribution of copepod defecation to the vertical fluxes of pigments and organic carbon.
2. To assess the conditions under which pigment is less, or more, extensively destroyed during grazing and how this affects our estimates of the contribution of copepods to vertical flux.
3. To assess the contribution of copepod grazing to phytoplankton utilization.
4. To assess the contribution of ammonia excretion by copepods to nutrient regeneration.

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

1. Completion of sample analysis of material collected during the 1991 field season.

   Samples analysis of material collected during the 1991 field season has been completed.

2. Preparation of a manuscript for publication, based on data obtained on the 1991 JGOFS and CSS Dawson cruises, concerning the transformation and breakdown of pigments by copepod grazing.

   A manuscript was prepared and has been published in *Marine Ecology Progress Series*. (Head)

3. Participation in a JGOFS cruise to the sub-tropical North Atlantic and in investigations of the role of copepods in carbon and pigment flux.

   Dr. E. Head and L. Harris both participated in a JGOFS cruise in the North Atlantic in September and October of 1992 and made the measurements appropriate for examining the role of copepods in carbon and pigment flux.

4. Additional Accomplishments:

A manuscript, concerning the contributions of copepods, live and senescent algae to pigment flux in the central North Atlantic, was prepared and accepted for publication in *Deep Sea Research* (Head, Horne)

Pigment analysis was carried out on samples from sediment traps deployed as part of the 1992 Bedford Basin Spring Bloom Experiment. The data were analyzed and a manuscript has been prepared and submitted for publication. (Head)

In April Dr. E. Head and L. Harris participated in a cruise on the CSS Parizeau on the Scotian Shelf (Chief Scientist, M. Mitchell, Metrology Division, BIO). In May they also participated on the CSS Parizeau on the Newfoundland Shelf (Chief Scientist, Dr. S. Narayanan, DFO, St. John's). On these cruises they carried out further experiments to examine pigment transformation and degradation by

copepods grazing during the spring bloom. The pigment analyses resulting from these cruises has been completed, but zooplankton species enumeration and identifications have not.

5. Goals/Expected Outputs for 1993:

1. Samples collected during the 1992 field season will be analyzed.

2. Some material resulting from the 1992 field season will be prepared for publication.

3. A paper (Dr. E. Head, invited speaker) describing the pigment composition of particulate material, copepod faecal pellets and sedimenting material will be presented at the ASLO meeting in Edmonton in June, if cruise scheduling allows.

4. Participation in a JGOFS cruise in the sub-tropical Atlantic and in investigations of the role in carbon and pigment flux.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

Involved in the Institute-wide 1992 Bedford Basin Spring Bloom Experiment. In particular I collaborated with Drs. B. Hargrave and D.V. Subba Rao of the Habitat Ecology Division, to examine the contributions of copepods and live or senescent algae to sedimenting material during the spring bloom.

ii. University Liaison -

Invited a student from the University of Oviedo to come on the JGOFS cruise in September-October. He participated in our projects and hopes to find funding to come back to continue learning from our us and to carry out a collaborative research project in our laboratory.

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Head, E.J.H. 1992. Gut pigment accumulation and destruction by arctic copepods *in vitro* and *in situ* *Marine Biology* 112: 583-592

Head, E.J.H. 1992. Comparison of the chemical composition of particulate material and copepod faecal pellets at stations off the coast of Labrador and in the Gulf of St. Lawrence. *Marine Biology* 112: 593-600

Head, E.J.H., and L.R. Harris. 1992 Chlorophyll and carotenoid transformation and destruction by *Calanus spp.* grazing on diatoms. *Marine Ecology Progress Series* 86: 229-238

Head, E.J.H., and E.P.W Horne. In press. Pigment transformation and vertical flux in an area of convergence in the North Atlantic. *Deep-Sea Research*

Head, E.J.H., B.T. Hargrave, and D.V. Rao Subba. Submitted. The accumulation of a phaeophorbide a-like pigment in sediment traps during the late stages of a spring bloom: a product of dying algae? *Limnology and Oceanography.*

Harrison, W.G., E.J.H. Head, E.P.W. Horne, B. Irwin, W.K.W. Li, A.R. Longhurst, M. Paranjape, and T. Platt,. In press. The Western North Atlantic Bloom Experiment. *Deep-Sea Research.*

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Biological Oceanography Project No.: 619

Section:

Project Title: Shore-Based Studies of Under-Ice Epontic and Pelagic Plankton Communities

Project Leader: Conover, R.

Other Researchers: Harris, L.

Work Activity: W.A.1.1.1.8

Key Words: Arctic research; zooplankton; secondary production; biological oceanography

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1. Project Description:

The work is carried out on the ice during spring break-up, or from shore-based facilities, using helicopters or tracked vehicles to reach selected study sites. Ice camps are established and holes cut in the ice serve for deployment of sampling gear and the continuous monitoring of the physical environment. Some analyses are performed on the ice or at our permanent laboratory facility at Resolute Bay, NWT. The environment is harsh and much of the sampling equipment must be specially developed. Cooperation with physical scientists and engineers of the Polar Continental Shelf Project is vital.

2. Long-Term Objectives:

Describe in detail the sub-ice pelagic ecosystem and the life cycles of key species; describe the linkages between pelagic and epontic components; describe how organic matter fixed by epontic and pelagic communities enters into the food web supporting higher trophic levels in the north; and provide baseline information on the status of pelagic and epontic communities in winter with emphasis on the Canadian archipelago.

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

We also hope to initiate the overwintering program mentioned earlier in this document, but details will be covered under Project No. 624.

As already explained under Project No. 609, the M.V. Arctic cruise planned for the spring of 1992 could not be carried out.

As an invited participant, I attended a symposium and workshop sponsored by the Churchill Northern Studies Centre on 'Circumpolar Ecosystems in Winter', February 12-16, 1992. A joint publication with T. D. Siferd entitled 'Dark-season survival strategies of coastal-zone zooplankton in the Canadian Arctic' was submitted, reviewed, revised and is now in press for the journal ARCTIC.

4. Additional Accomplishments:

Virtually no field work was carried out in 1992, but two of my students submitted and defended successfully their M.Sc. thesis based entirely on data gathered over the past several seasons at Resolute. Kent Gustavson defended his thesis 'Nutrition and Distribution of the Arctic Calanoid Copepod *Pseudocalanus acuspes* During Spring and Summer in Resolute Passage and Barrow Strait, N.W.T., Canada'. He found, as we had shown earlier, that *P. acuspes* could undergo diel migration in spring, but he made the new observation that later in the season, following breakup, the animals stayed close to the chlorophyll maximum rather than migrate. While no indication of selective feeding was shown in spring by the copepods when food was scarce and largely associated with the fast ice, by late summer, when food was super-abundant, they selected primarily larger cells, but rejected certain varieties which they apparently consumed earlier. He also demonstrated altered metabolism of nitrogen during periods of abundant food, as shown by very low O:N ratios (8.19-11.94). Even more interesting, these animals excreted more than half of this nitrogen as urea. The second thesis by Leslie Harris, 'The Importance of Ice Algae as an Early Season Food Source for Arctic Pelagic Copepods', showed that virtually all the dominant copepods were heavily dependant on the sub-ice primary production to maintain some growth prior to break-up. During this period, they accounted for 5.3 to 89 (mean 15.6) percent of the primary production, while later on in the summer, when food was no longer limiting, their role as grazers was of trivial significance (1.3% to 3.0% of total primary production). Joint papers for primary publication from both theses are anticipated.

5. Goals/Expected Outputs for 1993:

Financial arrangements, including air transport tickets, are in hand to initiate the Overwintering Program (Project No. 624) at Resolute in early January 1993 and to carry it through the end of the fiscal year. Details of the program will be considered under that project.

As an invited participant, I hope to attend the 'International Workshop on Arctic Polynyas', jointly sponsored by the Arctic Ocean Sciences Board (AOSB) and the International Arctic Polynya Program

(IAPP), to be held in Seattle, Washington, January 11-13, 1993. I will present a poster comparing the secondary production and population structure of the dominant copepods in Northwater with that of Resolute at the same season. This material will shortly be submitted as a primary publication.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

Dr. Nicolai Mumm, from the Institut fur Ostseeforschung, Rostock-Warnemunde, Germany, has recently arrive to participate in our arctic programs in 1993.

ii. University Liaison -

I have already mentioned that two of my students have successfully completed their graduate work at Dalhousie. Two others on whose committees I sit, Tony Windust and Henne Sonoko, have completed their research. Tony has defended his thesis 'Studies on the Response of Bacteria, Microalgae and Zooplankton to Domoic Acid, a Neurotoxic Metabolite of the Diatom *Nitzschia pungens f. multi-series*', during the past summer and Henne hopes to defend within the next few weeks.

I have a new student, Kate Moss, who will be involved in aspects of the arctic research program. In partial support of her arrival, I have requested continued support for graduate student research at Dalhousie University from NSERC with the proposal 'ARCTIC ZOOPLANKTON IN WINTER: ADAPTATIONS FOR SURVIVAL WITH EMPHASIS ON THE FALL AND SPRING-SUMMER TRANSITION PERIODS'.

I am also giving a module in the Department of Biology during the still incomplete fall term at Dalhousie on 'Zooplankton in Cold Environments', which includes not only the biology of polar plankton but also a description of the physical environment and the projected influence and implications of continued global warming on arctic environments and 'down-stream' fishing banks.

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Siferd, T.D. and R.J. Conover. 1992. An opening-closing plankton net for horizontal sampling through polar sea-ice. *Sarsia* 76:273-277.

Siferd, T.D. and R.J. Conover. 1992. Natural history of ctenophores in the Resolute Passage area of the Canadian high arctic with special reference to *Mertensia ovum*. *Marine Ecology Progress Series* 86:133-144.

At least one further, multi-authored paper is supposed to be published this month in ARCTIC.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Biological Oceanography Project No.: 620

Project Title: Summertime Shipboard Studies in the Eastern Canadian Arctic

Project Leader: Head, E.

Other Researchers: Harris, L.

Work Activity: W.A.1.1.1.8

Key Words: Arctic research; zooplankton; secondary production; biological oceanography

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1. Project Description:

Arctic zooplankton are studied during the open water period (July-September) when pelagic primary production and algal biomass are at their peak. During this period copepods congregate in the surface waters where they apparently ingest enough food and store enough fat to allow them to survive the 9-month Arctic winter. Aspects of the ecology and biology of Arctic zooplankton are investigated, including vertical distribution, biochemical composition, feeding behaviour, ingestion rate, assimilation efficiency and metabolic rates.

2. Long-Term Objectives:

To characterize the biochemistry and physiology of Arctic pelagic copepods during their active feeding season and investigate adaptive aspects of copepod behaviour, physiology and biochemistry in the Arctic environment. To assess the role of copepods in utilization of primary production and their contribution to carbon vertical flux through fecal pellets during the open water season.

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

This project is expected to remain dormant again in 1992, but see below under "Collaborative Research".

This project was dormant in 1992, due to the lack of any cruises to the Arctic.

4. Additional Accomplishments:

Two manuscripts, reporting work done on the Labrador Shelf which related to this project, were published in *Marine Biology* this year. (They have also been referred to in Project No. 613.)

5. Goals/Expected Outputs for 1993:

In the absence of any cruises to the Arctic this project will again remain dormant.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

Involved in designing a biological research program, which will be carried out on the proposed joint Canadian/U.S. International Transarctic Section cruise(s). I do not foresee active participation in the 1993 field program but perhaps in the cruise scheduled for 1994.

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Head, E.J.H. 1992. Gut pigment accumulation and destruction by arctic copepods *in vitro* and *in situ*. *Marine Biology* 112: 583-592.

Head, E.J.H. 1992. Comparison of the chemical composition of particulate material and copepod faecal pellets at stations off the coast of Labrador and in the Gulf of St. Lawrence. *Marine Biology* 112: 593-600.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Biological Oceanography Project No.: 621

Section:

Project Title: Dissolved Organic Carbon (DOC), Coagulation and Microbial Metabolism

Project Leader: Kepkay, P.

Other Researchers: Foda, A.

Work Activity: W.A.1.1.1.8

Key Words: DOC; bacteria; coagulation; microbiology; biological oceanography

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1. Project Description:

This project utilizes the methods of microbiology and physical chemistry to determine the role of coagulation in the regulation of microbial activity and carbon flux. Microbial respiration and nutrient regeneration are stimulated by the coagulation of colloid-sized DOC in the upper ocean. Coagulation is, in effect, a physical forcing of nutrient regeneration, and regulates the flux of carbon between DOC (one of three globally-important reservoirs of organic carbon) and CO_2. Given the possibility that primary production can sequester excess atmospheric CO_2 in the ocean, and given the close association of coagulation with DOC, gas flux and primary production, this project is a key element of JGOFS or any other program concerned with biological productivity in the ocean.

2. Long-Term Objectives:

Determine: (a) the role of coupled physical and microbial systems in the formation, maintenance and breakdown of organic aggregates; and (b) the effect of these organic-bacterial aggregates on the biogeochemical cycling of DOC and the regeneration of nutrients in the open ocean. The work is relevant to JGOFS, and is core microbiological and oceanographic research in the Biological Oceanography Division.

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

1. Continue the development of computerized oxygen electrode techniques. (Kepkay)

   A pulsed oxygen electrode system is in development and will be expanded to determine rates of photosynthesis at 16 different light intensities. It is clear from the results so far that the light history of phytoplankton cells is critical in determining both the onset and the increase of net photosynthesis as light intensity is increased. The onset of net photosynthesis at low light levels may also be critical in determining the rate of DOC release by actively growing or senescent cells.

2. Continue to investigate effects of photosynthesis, DOC and turbulence on particle aggregates as centres of microbial activity. (Kepkay)

   Colloid-sized DOC is scavenged from the water column by coagulation. Microbial respiration is stimulated by this physical scavenging of organic carbon from solution and has three important consequences: (i) The large pool of DOC in the ocean may be far more reactive than previously thought. This would solve a long-standing paradox, where DOC in seawater appears to be remarkably unreactive, yet has to be reactive to maintain a global balance between organic carbon in the ocean and CO_2 in the atmosphere. The respiration induced by coagulation may well be the process required to maintain this balance; (ii) Primary production (the main mechanism of sequestering excess atmospheric CO_2 in the ocean) is affected by surface coagulation because microbial nutrient regeneration is stimulated along with respiration. This change in the pattern of nutrient regeneration alters the balance between new and regenerated production; (iii) The short-term flux of CO_2 between atmosphere and ocean is directly affected, with the respiration induced by coagulation either equal to or greater than measurements of the short-term flux of CO_2 and the rate of CO_2 consumption by primary production.

   The role played by DOC in regulating coupled physical and biological systems remains to be determined, but a paper on the relationship between DOC and primary production in the upper ocean has been published. Results from a new-generation instrument for the analysis of DOC by high temperature catalytic oxidation (HTCO) show, for the first time, that DOC in surface waters can be simply correlated with such standard oceanographic parameters as chlorophyll concentration and apparent oxygen utilization (AOU). This obvious, but unique, finding highlights the central position of DOC in carbon cycling in the upper ocean.

   A keynote paper has been published which provides a theoretical framework for interpreting the fluid dynamics of organic particle coagulation and the biological responses induced by this coagulation. Models of the mass transfer of organic particles in fluid sheer show that organic colloids, as particles of about 1µm in diameter, are a source of nutrients which remains largely inaccessible to bacteria in surface waters. The coagulation of these colloids greatly enhances

the mass transfer of this untapped reservoir of nutrients to the bacteria. This work is important because it is the theoretical foundation for any future studies of coagulation and the biological lability of DOC in the ocean.

A joint project with S. Niven and T. Milligan (in the PCS Branch) has resulted in the first data on size fractionation of DOC during a spring bloom. These data have been submitted for publication, and outline the sequence of biological and physical events that regulate the production of colloidal DOC during the bloom.

3. Further define the potential nutritional and enzymatic status of organic aggregate bacteria. (Kepkay, Foda)

The bacteria associated with organic aggregates in the water column adapt to and control the nutrients regenerated to primary production. Given that surface coagulation increases both the magnitude and rate of this regeneration, the detailed physiological characterization of bacteria involved in the process provides the information which is crucial for any quantitative analysis of the amount and type of nutrients regenerated. A novel and unique microplate technique is under development for the rapid bioassay of specific fractions of DOC by whole bacterial populations in natural water.

One paper has been submitted and one is in preparation that characterize the suite of bacteria isolated from the organic aggregates produced by coagulation.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

1. Continue the development of computerized oxygen electrode techniques. (Kepkay)

2. Continue to investigate effects of photosynthesis, DOC and turbulence on particle aggregates as centres of microbial activity. (Kepkay,)

3. Further define the potential nutritional and enzymatic status of organic aggregate bacteria. (Kepkay, Foda)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

S.E.H. Niven and T.G. Milligan (PCS Branch), size fractionation and coagulation of DOC.
B.D. Johnson (Dalhousie University), organic aggregates produced by coagulation.
R.E. Helleur (Memorial University), carbohydrate and DOC analysis.

ii. University Liaison -

See above.

iii. Communications -

Time has been spend preparing talks for local schools and in supervising a junior high school science project. This work is part of an ongoing effort to communicate science to the general public (also reflected in contributions to BIO Open House '90 and numerous interviews with the press in 1989).

iv. Contracts Administered -

Scientific authority for DFO/NSERC subvention to Dr. R. E. Helleur - Analysis of carbohydrates and amino acids in seawater.

Scientific authority for DFO/NSERC subvention to Dr. B. D. Johnson - A gas tension device for the determination of gas flux across the air-sea interface.

v. Other -

7. Publications:

i. Primary -

Kepkay, P.E., and M.L. Wells. 1992. Dissolved organic carbon in North Atlantic surface waters. *Marine Ecology Progress Series* 80: 275-283.

Johnson, B.D., and P.E. Kepkay. 1992. Colloid transport and bacterial utilization of oceanic DOC. *Deep-Sea Research* 39: 855-869.

Kepkay, P.E., S.E.H. Niven and T.G. Milligan. 1992. Low molecular weight and colloidal DOC production during a phytoplankton bloom. *Marine Ecology Progress Series*. In review.

Foda, A. and P.E. Kepkay. 1992. Nutrition and physiology of bacteria associated with surface coagulation. *Marine Ecology Progress Series*. In review.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Biological Oceanography Project No.: 622

Section:

Project Title: Mathematical Models of Marine Pelagic Communities

Project Leader: White, G.

Other Researchers: Platt, T.

Work Activity: W.A.1.1.1.8

Key Words: modelling; biological oceanography

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1. Project Description:

Quantitative models play a vital role in the interpretation of field data. Models provide timely and cost effective answers for questions which would otherwise require expensive field studies. In cases requiring new field studies, modelling helps to ensure that resources are deployed to maximum benefit. Mathematical methods are necessary tools in the development of quantitative models. The effectiveness of mathematical methods stems, however, from the power of abstraction in facilitating interchange between diverse subject areas. This project includes research to: a) extend existing models and develop new types of models; b) analyze mathematical properties and develop analytical or numerical solution procedures for models of marine ecological systems; c) use models to better understand ecological processes; d) explore relationships between models for marine pelagic communities and those for other ecological systems; and e) expand mathematical knowledge in areas applicable to ecological modelling.

2. Long-Term Objectives:

Enlarge the range of space- and aspect-structured dynamic models for pelagic communities. Enhance the practical utility of models by improving analytical and numerical solution procedures. Develop relationships between distribution patterns (in size and space) and seasonal life cycles, physiological condition, and productivity in model systems. Contrast relationships developed from modelling studies with those observed in natural systems. Use models to develop new relationships between key ecological variables and properties observable in the field. Apply the results to extend and consolidate scientific understanding of marine pelagic communities in a way that will provide insight into the roles of pelagic biota in the global CO_2 cycle and the production of commercial species.

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

1. It is clear that efforts need to be focused on improving the reliability of the Divisions's basic computing facilities so that more effort can be devoted to research.

   Many of the Division's programs depend on access to computer systems, particularly the Division's unique image processing systems. These systems are heavily used by both internal and external users. In 1993, these systems were used effectively to produce new images of ocean production in the Arabian Sea and North Atlantic in support of a contract with the ESA and by external users, many of whom travel to BIO specifically to use these systems.

   A special effort has been made to analyze reasons for failures and take corrective actions within the existing budgetary constraints. In particular, Dr. White worked with L. Payzant, Dr. Horne, and J. Anning to increase supervision of shared systems, purge non-essential packages, improve network wiring, increase user awareness of measures to detect computer viruses, and obtain a dedicated file server for MS-DOS and Apple systems.

   In 1991-92, network problems were the major source of failures, followed by disk failures associated with bugs in the disk driver software used on the PC-Seapack systems and user errors. Network problems have been much less frequent since the installation of 10-baseT network wiring was completed, despite a large increase in the number of connected systems. A failure in the motherboard of the PC-Seapak system during a period of high demand required substitution of an existing PC. The unreliable disk subsystem was replaced at the same time.

   In the latter half of 1993, partly as a result of the increased usage of the systems, reliability problems on the shared MS-DOS and Macintosh systems were largely associated with configuration clashes stemming from conflicting user requirements. Dr. White has worked to develop alternatives to MS-DOS and Macintosh based application software using the Division's Unix and VMS hosts. These systems allow applications to be configured differently for each user.

2. Investigate the use of sums of exponentials for approximation of terms describing the decay of light intensity with depth.

   Efforts focused on improving the efficiency of calculating production at depth using attenuation

coefficients that depend on wavelength. Since these coefficients are known only from empirical tabulations, conventional methods for numerical quadrature are not suitable. A new method based on Gauss-Chebyshev quadrature was developed. This approach reduces computational cost for the quadrature by a factor of three over the existing method with negligible loss of accuracy.

3. Improve the environment for numerical computation.

Dr. White developed a specialized nonlinear regression program for the Division's Unix systems. The program was used to generate input parameters required to estimate primary production in the North Atlantic and the Arabian Sea. More than 6000 biomass-depth profiles in a wide range of data formats for the North Atlantic and Indian Oceans were processed in only a few months.

4. Additional Accomplishments:

Dr. White performed the copy editing and layout for a contract report to DND and for a report to the European Space Agency, as well as a small interim report to the ESA. The most demanding aspect of this work was in dealing with software problems relating to the production of illustrations for these documents.

Dr. White has been responsible for porting and installing software used in document production on the Division's Unix and VAX VMS systems, including TeX, metafont, xdvi, dvips, ghostscript, gnuplot, gri, and, in collaboration with G. Black, acon.

Dr. White continues to perform system management responsibilities for the Division's two NeXT systems, including the installation of a major OS upgrade. The NeXT systems are heavily used, yet have proven to be much more reliable than the Division's MS-DOS and Apple systems. They have proven capable of meeting demanding requirements for production of camera-ready documents containing a substantial mathematical component.

Dr. White is often consulted on problems in numerical computing, Unix, and networking by scientists outside the Division. This year, however, his ability to respond to external requests has been hampered by the heavy demands of work within the Division.

5. Goals/Expected Outputs for 1993:

(None -- this project will no longer appear as an independent scientific initiative).

6. Background:

Highlights:

Dr. White served as President UniForum Atlantic, a regional user's group for Unix and Open Systems users. During his term, a Software Porting Centre was established. Dr. White has organized courses in Unix System Administration for the volunteers who administer these systems.

Selected Involvements:

i. Collaborative Research -

Dr. White collaborated with a number of software developers to port existing software to the Division's Unix and VMS systems, eliminate bugs, and add new capabilities to software used in the Division. The most intensive work was with Dr. D. Kelley of Dalhousie University (port of gri to the KPC Titan with addition of color image capabilities), Dr. T. Rokicki of Radical Eye Software (bug fixes and port to VMS of dvips), and G. Black of DFO Scotia-Fundy (improvements to support for CMYK color and Adobe Illustrator 3 format, and port to Unix of acon).

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

None

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Biological Oceanography Project No.: 624

Section:

Project Title: Year Round Plankton Research in the Arctic

Project Leader: Conover, R.

Other Researchers: Harris, L.

Work Activity: W.A.1.1.1.8

Key Words: Arctic research; zooplankton; primary production; secondary production; winter research; ice algae

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1. Project Description:

The project is intended to fill in important gaps in our seasonal coverage, including the 'dark' season, of pelagic and ice-related biological research in the Arctic and is an integral part of our Green Plan submission (see Project No. 609). Present plans call for initiating preparations to be completed during the summer of 1992. Field observations will be initiated in early January 1993 with nearly continuous monitoring through the end of the fiscal year. We hope to have at least one person at Resolute throughout this period. Another period of intensive study will begin in late March 1993 and will be continued more or less continuously through the end of 1993. Over the entire year, particulates, nutrients, chlorophyll, vertical distribution of zooplankton, proximate biochemistry of zooplankton, including lipid content and composition for all important components in the ecosystem, and sedimentation will be sampled routinely whether or not BIO personnel are present. Physiological measurements (respiration, excretion, feeding, determination of reproductive state) will be determined on a regular basis on field populations. We intend to establish captive populations of zooplankton dominants in the wet laboratory which will be maintained on natural food resources and their physiology will be monitored for comparison with natural populations on a regular basis. Several periods in the annual seasonal cycle, particularly around freeze-up and again during the melt and break-up, will receive particularly intensive monitoring. Primary production, benthic biology, observations on certain mammals and contaminants monitoring will also be carried out on a regular basis by collaborating colleagues over the entire year. Sampling will be carried out from the ice during late fall, winter and spring and from inboard launches during open water season.

2. Long-Term Objectives:

Our objectives are still to describe in detail the sub-ice pelagic ecosystem in the Canadian Arctic and the life cycles of key species; to describe the linkages between pelagic and sympagic components; to describe how organic matter fixed by sub-ice and pelagic plant communities enters into the food web thereby supporting higher trophic levels; and to provide baseline information on the status of pelagic and sympagic communities at all seasons for comparison with the same or similar ecosystems in response to future climatic conditions.

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

1. To examine the vertical distribution and population structure of all the dominant zooplankton species, but particularly that of *Pseudocalanus acuspes*, through the late summer through freeze-up. An important question is whether all common species undergo a reduction in metabolism in the non-productive season and whether a true 'diapause' is practised by any of them.

2. To verify the existence and timing of ontogenetic migrations, particularly in *Pseudocalanus*, which is usually closely associated with the ice at the time of the spring bloom of ice-algae.

3. To verify the existence and the magnitude of a fall bloom of primary producers either in the water column or on the under-ice surface or both.

We have solved most of the logistical problems and a group of participating scientists spent several weeks in this past summer checking and repairing equipment and transferring that which will be needed early in the program to South Camp so that there will be minimum start-up delays in January.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

1. To examine the vertical distribution and population structure of all the dominant zooplankton species, but particularly that of *Pseudocalanus acuspes*, from the late summer through freeze-up. An important question is whether all common species undergo a reduction in metabolism in the non-productive season and whether a true 'diapause' is practised by any of them.

2. To verify the existence and timing of ontogenetic migrations, particularly in *Pseudocalanus*,

which is usually closely associated with the ice at the time of the spring bloom of ice-algae.

3. To verify the existence and the magnitude of a fall bloom of primary producers either in the water column or on the under-ice surface or both.

4. To examine the process of lipid storage in the pelagic community and its role in the transfer of atmospheric contaminants through the pelagic food web.

6. Background:

Highlights:

I spent two weeks in July in Resolute with other participants readying equipment for the field work.

Selected Involvements:

i. Collaborative Research -

The program will be a joint venture between DFO Central and Arctic Region, who own the facilities at Resolute, and two groups from BIO, Biological Oceanography, which will concentrate on interactions between climate and productivity, and Habitat Ecology, which will run a program on contaminants in the food web emphasizing pathways of entry. In addition we will supply the logistical base for several non-Canadian participants. A German exchange fellow, Dr. Nicolai Mumm, has already arrived and is actively participating in preparations for the start up in early January.

ii. University Liaison -

My new graduate student, Kate Moss, will be joining the project in Resolute as soon as her academic commitments for the year are completed, probably about May 1, 1993.

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: Habitat Ecology Division Project No.: 700

Section:

Project Title: Habitat Assessment Advice

Project Leader: Gordon, D.C.

Other Researchers: Staff, Habitat Ecology Division

Work Activity: W.A.1.1.3.1

Key Words: habitat; advice

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1. Project Description:

Provide timely and up-to-date scientific advice on freshwater, estuarine, and marine habitat issues as requested by DFO clients, in particular the Habitat Management Branch.

2. Long-Term Objectives:

Contribute to Science Sector support of the DFO Fish Habitat Management Policy which calls for maintenance of current habitat productive capacity, restoration of damaged habitats, and habitat development. Ensure that the best possible scientific information and opinions are available when important decisions are made which affect the future health of the natural environment. Advice is also given to private industry, other government departments, the public-at-large, and international organizations.

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

1. Serve on habitat-oriented committees and provide scientific advice as requested. (Staff, Habitat Ecology Division)

Divisional staff served on numerous habitat-oriented committees at the local, Regional, national, and international level; reviewed over 28 habitat documents or proposals for DFO, provincial agencies, universities, and private industry; prepared 9 habitat reports for DFO, universities, and private industry; responded to over 67 habitat information requests from DFO, other government departments (including overseas), provincial agencies, universities, consultants, private industry, and the public-at-large; attended over 39 meetings or workshops dealing with habitat issues; and presented over 34 lectures or interviews to DFO staff, other government departments, international meetings, universities, various media types, schools, industry, and the public-at-large. The most important client continues to be the Habitat Management Branch.

Major habitat issues addressed included: chlorinated contaminants (B.T. Hargrave, G.C. Harding), Georges Bank hydrocarbon exploration/development (P.J. Cranford, D.C. Gordon), tidal power impacts (T.W. Rowell), Halifax Harbour (B.T. Hargrave), phycotoxins (J.E. Stewart, S.R.V. Durvasula, P.D. Keizer), ghost fishing by gillnets (W.P. Vass, G.C. Harding), effects of mobile gear on benthic habitat (T.W. Rowell, W.P. Vass, D.C. Gordon), environmental impacts of aquaculture (P.D. Keizer, W.L. Silvert, J.E. Stewart, B.T. Hargrave, D.C. Gordon), harbour porpoise bycatch (P.F. Brodie), ballast water impacts (S.R. Kerr and S.R.V. Durvasula), rockweed harvesting (K.H. Mann), and the Habitat Sensitivity Mapping system (P.R. Boudreau).

4. Additional Accomplishments:

1. Analyzed data collected in the 1991 Metro Area Lake Survey and prepared a draft report in cooperation with Environment Canada and the Nova Scotia Department of Environment.

5. Goals/Expected Outputs for 1993:

1. Serve on habitat-oriented committees and provide scientific advice on habitat matters as requested by DFO colleagues and external clients. (Staff, Habitat Ecology Division)

6. Background:

Highlights:

Responded to the best of the Division's ability to all requests received.

Selected Involvements:

i. Collaborative Research -

This project is heavily dependent on collaboration with numerous scientists in other Divisions, H.B. Nicholls and staff in the Marine Assessment and Liaison Division, and A. Ducharme and staff of the Habitat Management Branch.

ii. University Liaison -

iii. Communications -

Numerous habitat-related talks and interviews were given as documented above.

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

Gordon, D.C., Jr. 1992. Current applications and future developments in the use of mathematical models in the implementation of monitoring programs and regional assessments. Discussion paper prepared for the ICES Working Group on Environmental Assessment and Monitoring Strategies. Annex 3. Int. Counc. Explor. Sea C.M.1992/Poll:9(Sess. V).

Gordon, D.C., Jr. 1992. Theoretical framework for using benthic organisms to assess environmental change. Discussion paper prepared for the ICES Benthos Ecology Working Group. Annex 12. Int. Counc. Explor. Sea. C.M.1992/L:11.

Harding, G.C. 1992. A review of the major marine environmental concerns off the Canadian East Coast in the 1980s. Can. Tech. Rep. Fish. Aquat. Sci. 1885: vi + 38 p.

Harding, G.C. 1992. American lobster (Homarus americanus Milne Edwards): A discussion paper on their environmental requirements and the known anthropogenic effects on their populations. Can. Tech. Rep. Fish. Aquat. Sci. 1887: vi + 16 p. (This publication was prepared specifically for habitat managers.)

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division

Project No.: 701

Section:

Project Title: Microbial Ecology

Project Leader: Stewart, J.E.

Other Researchers: Marks, L.J.

Work Activity: W.A.1.1.3.2

Key Words: habitat research; microbiology; bacteria; aquaculture

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1. Project Description:

Development of more rapid techniques for determination of bacterial types (genera), abundance, and activities; application of those techniques in areas of interest to gauge impact of man-derived loadings on habitats, i.e. fish farms, shellfish culture units, and areas flooded by sewage compared with a control area; measurements of impacts of surplus antibiotics and their effects on microbial systems; ultimately develop improved methods to measure nutrient flow via microorganisms and protozoa, and evaluate control over microbial activities by predators such as the Bdellovibrio and relevant protozoa.

2. Long-Term Objectives:

Assess and evaluate the roles and activities of microorganisms and their immediate predators (protozoa) in the marine and freshwater environments as agents of mineralization and convertors and conveyors of nutrients and the influence of specific factors on this system. As up to 50% of the primary production is channelled through the microbial system with possibly up to one-half of that entering the food chain through predation of bacteria, this is an important route in gauging overall aquatic production. Coupled with this is the fact that the microbial system is the route whereby organic waste such as sewage, surplus fish food and faeces, and dead material (plant and animal) is recycled and returned to the metabolic pool in useable forms. Obviously these systems can be affected by increased loadings and by specific contaminants including the large quantities of antibiotics from aquaculture. These have the capacity to materially alter microflora and induce bacterial resistance to antibiotics posing among other aspects the threat of producing dangerous strains of pathogens against which fish farmers will have little defense. These studies should aid in answering questions on productivity and habitat questions such as those concerned with the impact of aquaculture on coastal environments.

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

1. Continue and extend the development of quantitative methods to measure microbial biomass and associated activities.

2. To begin, under trial conditions, to apply these methods to determine the impact that organic substances, such as surplus fish foods, feces from cultured species, sewage, and antibiotics have on microbial activities, including mineralization.

3. Attempt to develop a better understanding of the control exercised over the microorganisms by predators (viruses, other bacteria, etc.) by utilizing Goals 1 and 2.

4. If feasible, attempt, for a second time, to arrange a Canada/Norway workshop on environmental impacts of aquaculture.

Limited work was done on this project in 1992. With the several budget reductions the amount of funding was insufficient to conduct the studies. It was agreed with the Division Chief that it would be better to amalgamate resources and concentrate efforts on Project 702.

The only work done was to arrange the workshop "The Impacts of Aquaculture on the Environment," in collaboration with our Norwegian counterparts under the Science and Technology agreement with Norway. This workshop is scheduled for February 8-10, 1993 in Bergen, Norway.

4. Additional Accomplishments:

Attempts were made to procure funding from the Green Plan for work on antibiotics in fish feed in collaboration with DFO colleagues from other laboratories and regions.

5. Goals/Expected Outputs for 1993:

1. Develop quantitative methods to measure microbial biomass and mineralization determinations.

2. If DFO Green Plan Toxics program (Chemicals component) funding is awarded, the following will be undertaken:

a) assess, in conjunction with the chemical and microfaunal studies of collaborators, the impact antibiotics, chemicals, and wastes have on microorganisms' abundance and types as well as their enzymatic capacities and the mineralization rates and degrees under these circumstances (i.e., including the development of anaerobiosis and the factors ensuring the maintenance and prolongation of this condition); and
b) evaluate the degree to which antibiotics used in aquaculture induce microbial antibiotic resistance and the role of antibiotics in creating disease and other hazards by inducing drug resistance in fish pathogens and other resident microorganisms retained in the vicinity of the culture operations.

3. If Green Plan funding becomes available, collaboration with colleagues is contemplated.

6. Background:

Highlights:

Procured initial planning funding from the Green Plan Toxics program. Also procured travel funding ($12.0 K) for a Canada/Norway workshop from the Going Global program (Department of External Affairs).

Selected Involvements:

i. Collaborative Research -

V. Zitko and D.J. Wildish (St. Andrews Biological Station, St. Andrews, N.B.)
C. Levings (West Vancouver Laboratory, DFO Pacific Region)

ii. University Liaison -

F. Markham (University of Prince Edward Island, aquaculture industry)

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Marks, L.J., J.E. Stewart, and T. Hastein. 1992. Evaluation of an indirect fluorescent antibody technique for detection of Aerococcus viridans (var.) homari, pathogen of homarid lobsters. Dis. Aquat. Org. 13: 133-138.

ii. Interpretive Scientific -

Stewart, J.E. 1991. A brief review of the International Council for the Exploration of the Sea (ICES) on the occasion of the formation of the North Pacific Marine Science Organization. Can. J. Fish. Aquat. Sci. 48(12): 2543-2550.

Stewart, J.E. 1991. Introductions as factors in diseases of fish and aquatic invertebrates. Can. J. Fish. Aquat. Sci. 48(Suppl. 1): 110-117.

Stewart, J.E. 1993. Infectious diseases of marine crustaceans, p. 319-341. In J.A. Couch and J. Fournie [ed.]. Pathobiology of Marine and Estuarine Organisms, Chapter 12. CRC Press Inc. (Boca Raton, Florida): 552 p.

iii. Scientific and Technical -

Stewart, J.E. and R.H. Cook. 1992. Final progress report of the Study Group on the Potential for Culture of Species. Int. Counc. Explor. Sea C.M.1992/F3 (Maricult. Comm.): 24 + Append.

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division Project No.: 702

Section:

Project Title: Microbial-Marine Toxin Interactions

Project Leader: Stewart, J.E.

Other Researchers: Durvasula, S.R.V.; Marks, L.J.

Work Activity: W.A.1.1.3.2

Key Words: domoic acid; aquaculture; habitat research; microbial degradation; paralytic shellfish poisons (PSP)

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1. Project Description:

Publication of the literature review of toxins will entail work periodically during the year. Studies on microbial degradation will be carried out to determine which organisms degrade domoic acid and by which biochemical routes. Studies of the microbial involvement in algal domoic acid and PSP production will be pursued.

2. Long-Term Objectives:

Provide an understanding of the processes whereby marine toxins are produced and their ultimate disposition in nature. Products and methods such as the tissue culture bioassay for PSP will be useful by-products of these studies.

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

1. Advance the studies on the fate (biodegradability) of domoic acid in light of results obtained in 1991.

The 2 g of domoic acid purchased in 1991 has allowed an expansion of these studies. A wide range of microorganisms acquired from A. Foda (Biological Oceanography Division, Biological Sciences Branch), isolated from Bedford Basin and isolated from waters and sediments of Cardigan Bay and from several sources, have been examined for their capacity to utilize or grow at the expense of domoic acid. Despite intensive and wide- ranging metabolic and growth experiments, only one bacterium was found that gives significant signs of being able to grow at the expense of domoic acid. The others either will not utilize it or appear to be inhibited. Co-factors seem to be required for any activity or growth.

These studies have consumed a lot of effort, and the results are extremely baffling. Very few natural compounds are completely refractory, and the techniques being applied are those successful in virtually all other circumstances. This project is being re-thought; more work is necessary. Obviously, domoic acid must be utilized and removed from the environment; otherwise, we would expect to find large amounts in nature.

2. Expand studies on the role of microorganisms in the production of marine toxins by phytoplankton to capitalize on the results obtained in 1991. The following discrete results were gained:

a) Acquisition, preparation and maintenance of axenic and non-axenic cultures of Alexandrium spp., the producer of PSP toxins, and Nitzschia species for production of domoic acid.
b) Examination of growth characteristics show that the bacteria-free dinoflagellates (Alexandrium spp.) grew poorly compared to those growing with bacteria. The axenic cultures, however, produced far more toxin per cell than the non-axenic cultures with the use of 'Instant Ocean' as the seawater base.
c) The bacteria growing consistently and persistently with the Alexandrium and Nitzschia species have been identified to the genus level.
d) Nitzschia sp. grown axenically and non-axenically exhibit a high degree of heterotrophism: a wide variety of amino acids stimulate and support growth.
e) Bacteria associated with Nitzschia have been shown to produce lactones and glutamic acid when grown in the presence of certain amino acids. These appear to have a marked influence on growth and possibly morphology of Nitzschia (collaborative studies with the National Research Council [Ottawa, Ont., and Halifax, N.S.] and DFO Inspection Services Branch).
f) A tissue culture bioassay, originally put forward by Kogure et al., was modified to permit automation of the endpoint determination. It was standardized and compared with the mouse bioassay and found to be more sensitive and to give identical results.

3. Arrange for publication of phycotoxin review.

Correspondence on publication of this comprehensive and extensive review was initiated with Lewis Publishers. This arose partly through an invitation following publication of a chapter written for a

book they published on pathobiology. An outline and a description of the toxin work was sent, telephone conversations followed, and a general understanding reached. As a result, several chapters were promised for their viewing. These are virtually complete and only need final editorial refinements. Delays have been imposed largely by the need for work in the Green Plan and a larger than expected workload for the Canadian Council on Animal Care.

Both we and the publishers appear to be in general agreement at this point and the tidying up and final stages are expected to be completed or well advanced by the end of the fiscal year.

4. Additional Accomplishments:

Work comparing the relative toxicity of reference toxins (saxitoxin, neosaxitoxin, gonyautoxin [2 and 3], and decarbamoylsaxitoxin) was carried out to give toxin profiles comparisons with results obtained with the mouse bioassay.

5. Goals/Expected Outputs for 1993:

1. Continuation of studies on the microbial involvement of microorganism in the production of toxins by marine algae capitalizing on the results listed above.

2. Re-examine all data on studies of biodegradation of domoic acid and where appropriate extend the studies and discover what appears to be the basis for the apparent refractory nature of the compound.

3. Examine possibilities of utilizing the same end point determination approach to semi-automate tissue culture methods for diarrhetic shellfish poisoning (DSP).

6. Background:

Highlights:

Publication of tissue culture bioassay data and the presentation of the method has generated widespread interest in it. National Health and Welfare (Ottawa, Ont.), the United States Food and Drug Administration, United Kingdom laboratories and individual scientists are interested in putting it into practice.

Selected Involvements:

i. Collaborative Research -

J.F. Jellett has been working as a post-doctoral fellow in this laboratory on the production of PSP and the role of microorganisms in its production. Bioassay methods are a part of and a by-product of these studies.

Collaboration with the National Research Council (Ottawa, Ont.) and the DFO Inspection Services Directorate (Ottawa, Ont.) has resulted in identification of a lactone produced by the bacteria growing in the presence of domoic acid-producing diatoms.

Collaboration with the DFO Inspection Services Branch (Halifax, N.S.) and the National Research Council (Halifax, N.S.) has resulted in bioassays of toxicity of PSP toxin standards produced by the National Research Council and the development of toxicity profiles using the tissue culture bioassay and the mouse bioassay.

Collaboration with the National Research Council (Halifax, N.S.) has shown the course of amino acid utilization and glutamic acid production by bacteria isolated from Nitzschia sp. This information is being used in further studies of domoic acid production.

ii. University Liaison -

iii. Communications -

Media interviews on new tissue culture bioassay methods.

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Jellett, J.F., L.J. Marks, J.E. Stewart, M.L. Dorey, W. Watson-Wright, and J.F. Lawrence. 1992. Paralytic shellfish poison (Saxitoxin family) bioassays: Automated endpoint determination and standardization of the in vitro tissue culture bioassay, and comparison with the standard mouse bioassay. Toxicon 30(10): 1143-1156.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Jellett, J.F., and J.E. Stewart. 1992. The role of bacteria in the growth and production of paralytic shellfish poisons by the toxic dinoflagellate Alexandrium tamarense, p. 15. In J.-C. Therriault and M. Levasseur [ed.]. Proceedings of the Third Canadian Workshop on Harmful Marine Algae, Maurice-Lamontagne Institute, Mont-Joli, Québec, May 12-14, 1992. Can. Tech. Rep. Fish. Aquat. Sci. 1893: iv + 154 p. (Abstract)

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division

Project No.: 703

Section:

Project Title: Physiological Ecology of Toxic Algae

Project Leader: Durvasula, S.R.V.

Other Researchers: Stewart, J.E.; Mann, K.H.

Work Activity: W.A.1.1.3.2

Key Words: DSP; domoic acid; aquaculture; habitat research; physiology; perturbations; microcosms; nutrient stress

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1. Project Description:

Data from the phytoplankton monitoring program showed the occurrence of Nitzschia pungens f. multiseries (NPM) and N. pseudodelicatissima at all five coastal stations off Nova Scotia. These two diatoms are known to produce under certain culture conditions the neurotoxin domoic acid. Although natural blooms of these two diatoms did not occur thus far in our waters, the potential for development of blooms of these diatoms should not be ruled out. As has been known, all blooms may not be necessarily toxic, and a physiological stress seems to be a factor in the production of phycotoxins (Subba Rao et al. 1990; 1991).

Analyses of phytoplankton monitoring program data collected since 1988 at five stations in the coastal waters of Nova Scotia showed the presence of toxigenic strains of NPM. Its seasonal distribution followed the temperature cycle, exhibiting a preference for 15°C at Woods Harbour and Digby, N.S. The maximum abundance was <0.25 million cells per litre. As a potential for the development of harmful toxic Nitzschia blooms exists at these sites, perturbation experiments would be carried out to establish the environmental variables that would induce such blooms.

A study is proposed along the lines of Platt, Subba Rao, and Denman (1977), utilizing natural assemblages of phytoplankton containing Nitzschia; and through manipulation of the environmental conditions, monospecific blooms of this diatom would be induced. Levels of domoic acid in the algae will be determined.

2. Long-Term Objectives:

Establish the conditions that would be necessary to induce the development of toxic algal blooms in natural assemblages of phytoplankton samples maintained in laboratory cultures. Utilize algal cultures as analogues of natural blooms in a study of phycotoxin production with a view to predict the occurrence of toxic algal blooms.

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

1. Continue investigations on the physiology of isolates of Nitzschia pungens f. multiseries (NPM) and N. pseudodelicatissima domoic acid production.

Several strains of NPM were isolated and brought into culture, and a few yielded domoic acid. Photosynthesis-irradiance (P-I) relationships of NPM were unique as evident from the low initial slope of photosynthesis and the low carbon assimilation numbers. Nutrient assimilation characteristics of this toxigenic alga were also different from that of benign algae.

In continuous cultures of NPM, production of domoic acid decreased with an increase in dilution rate but increased with an increase in alkaline phosphatase activity.

Cultures of NPM, stressed for silicates, did not show any change in domoic acid production when enriched with silicates.

2. Prepare several manuscripts for scientific journals on Dinophysis norvegica, phytoplankton distributions, and physiological ecology of NPM.

Published or communicated several primary publications which documented:

a) the design of a new incubator for mass cultivation of toxigenic algae in the laboratory;
b) that blue mussel and scallops, the two commercially important bivalves, have differential rates and mechanisms of toxin transfer and scallops retained domoic acid for a longer time than Mytilus;
c) a single two-compartmental model, incorporating the rate of growth of Nitzschia, and the rate of production of domoic acid and rate of filtration by mussels, was developed to explain domoic acid flux in Cardigan Bay, P.E.I.;
d) the occurrence of algal blooms, a few species for the first time in and around Nova Scotia;

e) that Dinophysis norvegica blooms contained okodaic acid (OA), and scallops that fed on these algae accumulated OA;
f) photosynthesis measurements on red-tides of the dinoflagellates Gonyaulax digitale and Dinophysis norvegica, reported for the first time. Both the initial slope of P-I curves and the maximum rate of photosynthesis were low and comparable to those obtained on the toxigenic Nitzschia; and
g) in NPM, the Q_{10} for the maximum carbon assimilation rate in the temperature range 5-15°C was 10 to 17, about five times higher than the 2-3, usual for non-toxigenic algae.

3. Set up laboratory-scale experimental microcosms similar to a vat immersion core illumination incubator (Wohlgeschaffen, Subba Rao, and Mann 1991]) in tanks with circulating seawater from Bedford Basin. Fill the mesocosms with seawater collected from Digby station and set up a nutrient gradient by spiking techniques. Monitor phytoplankton composition and species succession patterns to determine conditions necessary for the inducement of Nitzschia blooms.

A large-scale experiment to test the hypothesis that toxigenic blooms can be induced through perturbations in mesocosms and such blooms could serve as analogues of natural toxic blooms was set up. Two tanks, each with four mesocosms of 120 L, were set up at 10°C. Freshly collected Digby sea water was the control in each set. A gradient in the Nitzschia populations was created in the remaining three mesocosms of each set by adding known volumes of washed cultures. Responses of the populations to these perturbations over a 50-day period were monitored. Development of phytoplankton blooms in all mesocosms was noticed by Day 8. In a few mesocosms, blooms of Nitzschia grew by Day 15. The data are being processed, and further experiments are in progress.

4. Continue the present sampling protocol seasonally and through the various growth phases of blooms and determine domoic acid levels.

Monitoring of phytoplankton around Nova Scotia for toxic algae continued (see Project 704).

5. Continue analyses of data from the phytoplankton monitoring program in collaboration with Physical and Chemical Sciences Branch scientists with a view to bring to publication.

Analysis of phytoplankton abundance was pursued in collaboration with Physical and Chemical Sciences Branch scientists. Results are embodied in a few publications which showed:

a) there are nine suspect toxigenic species in our area;
b) some of these occur in considerable concentrations, at times resulting in red-tide populations; and
c) a potential exists for toxigenic species to bloom in the vicinity of aquaculture sites around Nova Scotia.

4. Additional Accomplishments:

1. Collaborated with a host of scientists from the Coastal Oceanography and Marine Chemistry Divisions (Physical and Chemical Sciences Branch), Dalhousie University, Atlantic Remote Sensing, and Habitat Ecology and Biological Oceanography Divisions (Biological Sciences Branch) on the origin, progression, and evolution of the 1992 'Spring Bloom' in Bedford Basin, N.S. Some of the data were incorporated into a primary publication submitted to the Journal of Plankton Research (see Section 7i). The data are being processed.

2. Collaboration with P. Strain and P. Yeats (Marine Chemistry Division, Physical and Chemical Sciences Branch) on the formation of oxygen-poor waters in Ship Harbour and analysis of data from ten surveys each consisting of 13 stations is progressing.

3. Collaborated with A. Lawrence (National Research Council, Ottawa) and J.E. Stewart on methods of domoic acid determination in culture.

5. Goals/Expected Outputs for 1993:

1. Continue investigations on the physiological ecology of algae and focus on measurements to characterize toxigenic algae utilizing new isolates of algae.

2. Test the hypothesis that blooms of toxigenic algae can be induced in laboratory mesocosms through perturbations.

3. Bring to publication data on phytoplankton blooms and growth characteristics of toxic algae.

4. Collaborate with other scientists on the analysis of data collected: a) in the 1992 Bedford Basin Spring Bloom exercise; b) on the formation of oxygen-poor waters in Ship Harbour, N.S.; and c) on the Scotia-Fundy Region phytoplankton-monitoring program.

5. Collaborate with T. Platt and M. Kwewalyanga on action spectra characteristics of NPM.

6. Collaborate with M.W. Gilgan (Inspection Services Branch) on screening dinoflagellate cultures for DSP toxins.

7. Prepare a publication in cooperation with G.W. Sprules (University of Toronto), incorporating the data based on the analyses of 96 ballast water samples.

8. If funds are available, initiate systematic collection of water and sediment samples from ships calling in the Scotia/Fundy Region, analyse samples for algae, and establish cultures of suspect toxigenic species.

6. Background:

Highlights:

This work is a continuation of a long-range study of the physiological ecology of toxigenic algae utilizing laboratory cultures and blooms induced in the laboratory through perturbations as analogues of natural blooms. Some aspects of the work indicate the excellent inter-divisional and inter-institutional cooperation, in particular, Dalhousie University. More can be accomplished if a post-doctoral fellow can be supported and by recruiting another graduate student.

Selected Involvements:

i. Collaborative Research -

Colleagues from the Marine Chemistry and Coastal Oceanography Divisions (Physical and Chemical Sciences Branch) and the Biological Oceanography Division (Biological Sciences Branch).

ii. University Liaison -

Collaborated with a graduate student Y. Pan (Dalhousie University), J.S.S. Lakshminarayana (University of Moncton), and a scientist from the University of Paris.

iii. Communications -

iv. Contracts Administered -

Sprytech Biological Services Ltd.: Isolation, maintenance, and physiological experiments on coastal Atlantic phytoplankton (DSS File No. OSC92-00783-[004]) - $22.5 K.

G. Wohlgeschaffen: Maintenance and culturing of algae for phycotoxin studies (DSS File No. OSC92-00038-[011]) - $9.1 K.

Y. Pan: Processing of freshly collected phytoplankton water samples for chlorophylls - $0.5 K.

v. Other -

7. Publications:

i. Primary -

Amadi, I., D.V. Subba Rao, and Y. Pan. 1992. A Gonyaulax digitale red water bloom in the Bedford Basin, Nova Scotia, Canada. Bot. Mar. 35: 451-455.

Head, E., B.T. Hargrave, and D.V. Subba Rao. 1992. The accumulation of a phaeophorbide a-like pigment in sediment traps during the late stages of a spring bloom: A production of dying algae? Limnol. Oceanogr.: submitted.

Silvert, W.L. and D.V. Subba Rao. 1992. Dynamic model of the flux of domoic acid, a neurotoxin, through the Mytilus edulis population of Cardigan Bay, P.E.I. Can. J. Fish. Aquat. Sci. 49(2): 400-405.

Subba Rao, D.V. and Y. Pan. 1992. Photosynthetic characteristics of Dinophysis norvegica Claparede & Lachmann, a red-tide dinoflagellate. J. Plankton Res.: submitted.

Subba Rao, D.V., Y. Pan, V. Zitko, G. Bugden, and K. Mackeigan. 1992. Diarrhetic shellfish toxigenic red tide in the Bedford Basin, novel to eastern Canada. Mar. Ecol. Prog. Ser.: submitted.

Wohlgeschaffen, G.D., K.H. Mann, D.V. Subba Rao, and R. Pocklington. 1992. Dynamics of the phycotoxin domoic acid: Accumulation and excretion in two commercially important bivalves. J. Appl. Phycol. 4: 297-310.

Wohlgeschaffen, G., D.V. Subba Rao, and K.H. Mann. 1992. Vat incubator with immersion core illumination - a new inexpensive set-up for mass phytoplankton culture. J. Appl. Phycol. 4: 25-29.

Subba Rao, D.V., F. Partensky, G. Wohlgeschaffen, and W.K.W. Li. 1992. Gametogenesis in Nitzschia pungens f. multiseries. J. Phycol. 28: 574-576.

ii. Interpretive Scientific -

iii. Scientific and Technical -

Pan, Y., D.V. Subba Rao, K.H. Mann, W.K.W. Li, and R.E. Warnock. 1992. Temperature dependence of growth and carbon assimilation in Nitzschia pungens f. multiseries Hasle, the causative diatom of domoic acid poisoning. Proceedings of Fifth International Conference on Toxic Marine Phytoplankton (Rhode Island, U.S.A., October 28-November 1, 1991): in press.

Sinclair, M., S. Wilson, and D.V. Subba Rao. 1992. Overview of the biological oceanography of the Gulf of Maine, p. 1-24. In Proceedings of the Conference on The Gulf of Maine Coastal Zone Management (Woods Hole, Mass., January 1991): in press.

Subba Rao, D.V. 1992. Lessons from phytoplankton monitoring program in Nova Scotian coastal waters. Proceedings of the Fifth International Conference on Toxic Marine Phytoplankton (Rhode Island, U.S.A., October 28-November 1, 1991): in press.

Subba Rao, D.V. 1992. Ocean sciences: Mariculture in developing countries. Keynote address, IAPSO Symposium PS02, CODC, XX General Assembly IUGG (Vienna, Austria, August 1991): in press.

iv. Popular and Miscellaneous -

Bugden, G., P. Butts, P.D. Keizer, K. Kranck, T. Milligan, A. Orr, D.V. Subba Rao, and P. A. Yeats. 1992. The Scotia-Fundy phytoplankton monitoring program; the Nova Scotian component, p. 39. In J.-C. Therriault and M. Levasseur [ed.]. Proceedings of the Third Canadian Workshop on Harmful Marine Algae. Maurice-Lamontagne Institute, Mont-Joli, Québec, May 12-14, 1992. Can. Tech. Rep. Fish. Aquat. Sci. 1983: iv + 154 p. (Abstract)

Bugden, G.L., D.V. Subba Rao, and P.A. Yeats. 1992. The phytoplankton profiling project. Biennial Review, Bedford Institute of Oceanography. DFO Internal Rep.: in press.

Subba Rao, D.V., and Y. Pan. 1992. Physiological ecology of Dinophysis norvegica, a redwater bloom species, in Bedford Basin, Nova Scotia, p. 43. In J.-C. Therriault and M. Levasseur [ed.]. Proceedings of the Third Canadian Workshop on Harmful Marine Algae. Maurice-Lamontagne Institute, Mont-Joli, Québec, May 12-14, 1992. Can. Tech. Rep. Fish. Aquat. Sci. 1983: iv + 154 p. (Abstract)

Subba Rao, D.V., J. Sita Devi, and J.S.S. Lakshminarayana. 1992. Harmful marine phytoplankton of Canadian Atlantic waters, p. 43. In J.-C. Therriault and M. Levasseur [ed.]. Proceedings of the Third Canadian Workshop on Harmful Marine Algae. Maurice-Lamontagne Institute, Mont-Joli, Québec, May 12-14, 1992. Can. Tech. Rep. Fish. Aquat. Sci. 1983: iv + 154 p. (Abstract)

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division Project No.: 704

Section:

Project Title: Coastal Phytoplankton Dynamics

Project Leader: Keizer, P.D.

Other Researchers: Durvasula, S.R.V.; Orr, E.A.

Work Activity: W.A.1.1.3.2

Key Words: phytoplankton; toxic algae; phycotoxin; habitat research

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1. Project Description:

Beginning in October 1988, a 3-year monitoring program was conducted at five coastal sites in Nova Scotia to establish a data base of the qualitative and quantitative abundance of phytoplankton as well as information on some environmental variables. This program successfully achieved its short-term goal. In so doing, it has demonstrated the remarkable variety in the species and relative abundances of phytoplankton present in our Atlantic coastal waters. In order to remain cognizant of this complex population, it is essential that a commitment be made to long-term (decadal) monitoring. Therefore, two long-term monitoring sites were established on the Atlantic coast of Nova Scotia. One of these sites, at Indian Point in Mahone Bay, N.S., is representative of a coastal embayment which is being utilized for aquaculture. The second site, at Sambro Head, N.S., is more representative of a coastal environment with minimal impact from local anthropogenic effects.

Three kinds of shellfish toxins occur in the marine environment of the Maritime provinces: paralytic shellfish poisoning (PSP), amnesic shellfish poisoning (ASP), and diarrhetic shellfish poisoning (DSP). These toxins are produced by phytoplankton and/or associated microorganisms. Under this project, water samples are collected on a regular and frequent basis at the above-noted sites and other locations along the Atlantic and Fundy coasts of Nova Scotia. Phytoplankton species present are identified and enumerated. In addition, a variety of physical and chemical variables (light, temperature, salinity, SPM, chlorophyll, nutrients, etc.) are measured at the study sites. Water samples are also returned to the laboratory for culture studies.

This project is part of an Atlantic Zone program involving the Québec and Gulf Regions as well as the St. Andrews Biological Station (St. Andrews, N.B.).

2. Long-Term Objectives:

Establish a data base of the qualitative and quantitative abundance of phytoplankton and associated physical and environmental variables in two coastal sites on the Atlantic coast of Nova Scotia for the purpose of determining interannual variations and long-term trends. The specific objectives are to:

1. compile a long-term inventory of the phytoplankton species which are found at the monitoring sites;
2. estimate the abundance of the dominant species present;
3. define seasonal maxima and minima and the principal points of inflection in the physical and environmental data; and
4. determine the interannual variation and long-term trends in the data.

In addition, collect similar samples for analyses in support of other research projects directed at specific problems related to the occurrence of phycotoxins in Atlantic coastal waters.

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

1. The data base (for the original five monitoring sites) will be given to the end users early in 1992, as soon as the data from the last stations in December are entered and some quality control tests are conducted on the data base. (Keizer, Orr)

The data base has been tested and has been provided to end users.

2. A 'Canadian Technical Report of Fisheries and Aquatic Sciences' will be prepared summarizing the data collected at the five sites. (Keizer, Orr, Bugden, Yeats, Durvasula)

This report was not prepared.

3. Continue the present sampling protocol at one location to provide a long-term record of the variability of the measured variables. Sample collection, phytoplankton identification, ammonia, and chlorophyll analyses will be done under contract. (Keizer, Bugden, Durvasula, Yeats)

Sampling was continued at the Ship Harbour, N.S., location in support of investigations by the Marine Chemistry Division (Physical and Chemical Sciences Branch), Inspection Services Branch, and the Institute for Marine Biosciences (National Research Council) into the presence of unidentified marine toxins at this site. Sampling and the phytoplankton analyses were done under contract. An internal summary report is in preparation.

4. Additional Accomplishments:

The same suite of samples was also collected at the Digby, N.S., site, one of the five original phytoplankton-monitoring locations, in conjunction with the large-volume water samples collected by the contractor for Project 703.

The following additional goals, and the accomplishments, relating to long-term monitoring were established after the program review exercise conducted in February 1992.

1. Establish the two sites and protocols for sampling and conduct the sampling under contract. (Keizer, Bugden)

Two long-term monitoring sites were selected. One site is located at Indian Point in Mahone Bay, N.S., near the mussel culture operation of P. Darnell. The other site is located at the mouth of Sambro Harbour and is accessed with the assistance of the Canadian Coast Guard (CCG) staff at CCG Sambro, N.S.

2. Analyze samples and enter data into a data base management system. (Keizer, Durvasula, Orr)

Samples for chlorophyll, salinity, and nutrients were analyzed in DFO laboratories. Samples for phytoplankton identification and enumeration were analyzed under contract. Data were entered in a FoxPro software data base and are readily accessible to other researchers.

3. Report results at meetings and workshops. (Keizer, Durvasula, Bugden, Yeats)

The meetings of the Phycotoxin Information Exchange Group have been regularly attended, and information from this project is communicated when it is relevant to discussions. S.R. Durvasula, P.D. Keizer, and E.A. Orr attended the Third Canadian Workshop on Harmful Marine Algae (Mont-Joli, P.Q., May 12-14, 1992) and presented two papers (posters).

5. Goals/Expected Outputs for 1993:

1. Collect and analyze samples from the two long-term monitoring sites and enter and maintain information in the established data base. (Keizer, Orr, Bugden, Yeats, Durvasula)

2. In conjunction with the Nova Scotia Department of Fisheries, DFO Inspection Services Branch, and the Aquaculture Association of Nova Scotia, evaluate the need for short-term sampling at new sites along the coast of Nova Scotia. (Keizer)

3. Prepare a document describing the Ship Harbour, N.S., data set from January 1989 to December 1992. (Keizer, Orr, Bugden, Yeats, Durvasula)

4. Report results at meetings and workshops. (Keizer, Durvasula, Bugden, Yeats)

5. Under contract, conduct a study to identify companies which can provide phytoplankton identification services and conduct an intercalibration exercise in the Scotia-Fundy Region. (Keizer, Durvasula)

6. Background:

Highlights:

The long-term monitoring component of this project has been so designed to minimize costs and to increase the likelihood of the project being funded in times of fiscal restraint. To this end, the site at Mahone Bay, N.S., is easily accessible by small boat and its presence is strongly supported by the nearby mussel farm owner, P. Darnell. At Sambro the project was enthusiastically supported by the local Canadian Coast Guard staff. Without their assistance access to this headland site would have been restricted during severe weather conditions.

Selected Involvements:

i. Collaborative Research -

Colleagues in the Physical and Chemical Sciences Branch (G. Bugden, P. Yeats) assisted in the selection of long-term monitoring stations and the design of the sampling protocol. Data from this project are shared with the Coastal Oceanography Division (Physical and Chemical Sciences Branch) (G. Bugden), Marine Chemistry Division (Physical and Chemical Sciences Branch) (P. Strain, P.A. Yeats), Inspection Services Branch (M. Dorey, M.W. Gilgan), and the Institute for Marine Biosciences (National Research Council) (J.L.C. Wright).

ii. University Liaison -

iii. Communications -

Summaries of data from the original five monitoring sites were prepared and distributed to departmental clients.

There were three poster presentations at the Third Canadian Workshop on Harmful Marine Algae (Mont-Joli, P.Q., May 12-14, 1992).

iv. Contracts Administered -

Sprytech Biological Services: Collection and processing of water samples (DSS File No. OSC90-00579-[011]) - $11.8 K.

Phyllis Butts: Identification and enumeration of phytoplankton in seawater samples (DSS File No. OSC92-00037-[011]) - $7.9 K.

Maritime Testing Limited: Identification and enumeration of phytoplankton in seawater samples (DSS File No. OSC92-00717-[014]) - $21.0 K.

Sprytech Biological Services: Collection and initial processing of samples (DSS File No. OSC92-00216-[004]) - $6.0 K for FY 1992/93. (This is 5-year, $44.2 K contract ending on March 31, 1997.)

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

Bugden, G.L., P. Butts, P.D. Keizer, K. Kranck, T. Milligan, E.A. Orr, D.V. Subba Rao, and P.A. Yeats. 1992. The Scotia-Fundy phytoplankton monitoring program; the Nova Scotian component, p. 39. In J.-C. Therriault and M. Levasseur [ed.]. Proceedings of the Third Canadian Workshop on Harmful Marine Algae. Maurice-Lamontagne Institute, Mont-Joli, Québec, May 12-14, 1992. Can. Tech. Rep. Fish. Aquat. Sci. 1893: iv + 154 p. (Abstract)

Bugden, G., R. Forbes, D.C. Gordon, B. Huppertz, P.D. Keizer, M. Levasseur, J.L. Martin, R. Penney, J.C. Smith, D.V. Subba Rao, D.J. Wildish, and P. Yeats. 1992. Overview of Canadian phytoplankton monitoring programs, p. 15. In J.-C. Therriault and M. Levasseur [ed.]. Proceedings of the Third Canadian Workshop on Harmful Marine Algae. Maurice-Lamontagne Institute, Mont-Joli, Québec, May 12-14, 1992. Can. Tech. Rep. Fish. Aquat. Sci. 1893: iv + 154 p. (Abstract)

Bugden, G.L., D.V. Subba Rao, and P.A. Yeats. 1992. The phytoplankton profiling project. Biennial Review, Bedford Institute of Oceanography: in press.

Subba Rao, D.V., J. Sita Devi, and J.S.S. Lakshminarayana. 1992. Harmful marine phytoplankton of Canadian Atlantic waters, p. 43. In J.-C. Therriault and M. Levasseur [ed.]. Proceedings of the Third Canadian Workshop on Harmful Marine Algae. Maurice-Lamontagne Institute, Mont-Joli, Québec, May 12-14, 1992. Can. Tech. Rep. Fish. Aquat. Sci. 1893: iv + 154 p. (Abstract)

Subba Rao, D.V., and Y. Pan. 1992. Physiological ecology of Dinophysis norvegica, a redwater bloom species, in Bedford Basin, Nova Scotia, p. 43. In J.-C. Therriault and M. Levasseur [ed.]. Proceedings of the Third Canadian Workshop on Harmful Marine Algae. Maurice-Lamontagne Institute, Mont-Joli, Québec, May 12-14, 1992. Can. Tech. Rep. Fish. Aquat. Sci. 1893: iv + 154 p. (Abstract)

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division Project No.: 705

Section:

Project Title: Biological-Physical Interactions in Coastal Habitats

Project Leader: Mann, K.H.

Other Researchers: Durvasula, S.R.V.

Work Activity: W.A.1.1.3.1

Key Words: kelp; marine plants; primary production; domoic acid; habitat research; biological-physical interactions

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1. Project Description:

Long-term studies on the role of seaweed and seagrass beds as habitats for invertebrate animals in the coastal zone of Nova Scotia. Particular attention to the origin and fate of domoic acid in coastal zone food webs. Increasing emphasis on the role of physical oceanography in determining changes in stocks of fish and shellfish in coastal waters of eastern Canada.

2. Long-Term Objectives:

Understand the role of kelp beds (Laminaria and Agarum spp.), intertidal seaweeds (Fucus and Ascophyllum), and seagrass (Zostera) in providing habitat for the invertebrate food web of coastal waters, including commercial species such as lobsters, scallops, and shrimps; understand the role of sea urchins, which have the ability to destroy kelp beds; and understand the environmental factors controlling the production of domoic acid by Nitzschia and the mechanism of its transfer to mussels. Increasing emphasis on the role of physical environmental factors in determining changes in the stocks of fish and shellfish in coastal waters.

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

1. In collaboration with N.T. Hagen (Institute of Fisheries and Aquaculture, Bodo, Norway), prepare and submit for publication a further paper on the role of predators in controlling numbers of the green sea urchin, which is capable of destroying kelp habitats.

A paper is in the final stages of preparation.

2. In collaboration with G. Wohlgeschaffen and S.R.V. Durvasula, prepare and submit for publication a further paper on the conditions under which mussels take up domoic acid from the diatom *Nitzschia pungens*.

A paper appeared in the Journal of Applied Phycology (see Section 7i).

3. In collaboration with S.R.V. Durvasula, supervise a student involved in the investigation of the uptake of domoic acid from cultures of *Nitzschia pungens* by mussel larvae.

Supervision continues.

4. Act as associated editor for a volume reporting the proceedings of a scientific conference on 'Benguela Trophic Functioning' (Cape Town, South Africa, September 8 to 13, 1991).

Editing is complete; a volume is in press with a late-1992 publication date anticipated.

5. Respond to the invitation of the General Secretary of the International Council for the Exploration of the Sea (ICES) to present the traditional 'Open Lecture' at the opening session of the General Assembly of the ICES 80th Statutory Meeting (Rostock, Germany, September 24, 1992).

A lecture was given. The ICES Journal of Marine Science invited publication of the lecture. A manuscript was submitted.

6. Negotiate with Blackwell Scientific Publications Ltd. for the publication of a revised and updated version of Dr. Mann's monograph Ecology of Coastal Waters: A Systems Approach, first published in 1982.

The project is on hold for the time being.

4. Additional Accomplishments:

1. Publication of a review of the book: Oceanography of a Large-Scale Estuarine System: The St. Lawrence, by editors M.I. El-Sahb and N. Silverberg (see Section 7iii).

2. Provision of advice to the CAFSAC Habitat Science Subcommittee on the effects of harvesting rockweed from intertidal habitats in the Bay of Fundy. Published as a CAFSAC Research Document (see Section 7iii).

5. Goals/Expected Outputs for 1993:

1. Publication, jointly with N.T. Hagen (Institute of Fisheries and Aquaculture, Bodo, Norway), of a paper on the factors influencing the formation of destructive feeding aggregations by green sea urchins in Nova Scotia coastal waters.

2. Publication of a symposium volume of which Dr. Mann was a co-editor: 'Benguela Trophic Functioning.'

3. Publication of a paper in the South African Journal of Marine Science: 'Physical Influences on Biological Processes: How Important are They?'

4. Publication of a paper: 'Physical Oceanography, Food Chains and Fish Stocks,' in the ICES Journal of Marine Science.

5. Presentation of a paper to a meeting of the CAFSAC Fisheries Oceanography Subcommittee on the importance of physical oceanography in determining the sizes of stocks of fish and shellfish in the northwestern Atlantic.

6. To achieve a clearer understanding of the role of physical oceanographic factors in determining the sizes of stocks of fish and shellfish in eastern Canada.

6. Background:

Highlights:

Work on biological interactions in kelp and seagrass beds has been the result of long and fruitful collaboration with graduate students at Dalhousie University. More and more of Dr. Mann's time has recently been devoted to reviewing the role of physical oceanographic processes in determining the stock sizes of fish and shellfish in eastern Canada. This work has been undertaken at the direct request of the A/Assistant Deputy Minister of Science.

Selected Involvements:

i. Collaborative Research -

Collaboration with university personnel (see Section 6ii).

ii. University Liaison -

Most of the above-noted research is funded by the Natural Science and Engineering Research Council through Dalhousie University and is carried out collaboratively with Dalhousie University personnel.

iii. Communications -

Keynote address at the opening of the General Assembly of the ICES 80th Statutory Meeting (Rostock, Germany, September 1992).

Public lecture sponsored by the Nova Scotian Institute of Science: 'Physical Oceanography, Food Chains and Fisheries' (September 24, 1992).

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Schneider, F.I., and K.H. Mann. 1991. Rapid recovery of fauna following simulated ice rafting in a Nova Scotia seagrass bed. Mar. Ecol. Prog. Ser. 78: 57-70.

Hagen, N.T., and K.H. Mann. 1992. Functional response of the predators American lobster *Homarus americanus* (Milne-Edwards) and Atlantic wolffish *Anarhichas lupus* (L.) to increasing numbers of the green sea urchin *Strongylocentrotus droebachiensis* (Müller). J. Exp. Mar. Biol. Ecol. 159: 89-112.

Mann, K.H. 1992. Physical influences on biological processes: How important are they? S. Afr. J. Mar. Sci. 12: 107-121.

Wohlgeschaffen, G.D., K.H. Mann, D.V. Subba Rao, and R. Pocklington. 1992. Dynamics of the phycotoxin domoic acid: Accumulation and excretion in two commercially important bivalves. J. Appl. Phycol. 4: 297-310.

ii. Interpretive Scientific -

Payne, A.I.L., K.H. Brink, K.H. Mann, and R. Hillborn [ed.]. 1992. Benguela trophic functioning. Proceedings of a symposium. S. Afr. J. Mar. Sci. 12: 1-884.

iii. Scientific and Technical -

Mann, K.H. 1992. Review of M.I. El-Sabh and N. Silverberg [ed.], Oceanography of a large-scale estuarine system: The St. Lawrence. Quart. Rev. Biol. 67: 220.

Mann, K.H. 1992. The extent and importance of rockweed as a habitat for finfish, shellfish and other species. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 92: in press.

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division

Project No.: 707

Section:

Project Title: Inshore Molluscan Habitat Studies

Project Leader: Rowell, T.W.

Other Researchers: Woo, P.

Work Activity: W.A.1.1.3.1

Key Words: clams; habitat research

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1. Project Description:

This project involves basic biological and ecological research necessary for the management of the inshore molluscan habitat resources of the Scotia-Fundy Region. Research is directed at defining those biological and ecological parameters of key importance in the life cycle and productivity of inshore molluscs with the objective of providing scientific advice to fisheries habitat managers, fishermen, and aquaculturists.

2. Long-Term Objectives:

Develop scientific information on the biology and ecology of inshore molluscan shellfish resources and their habitat in order to optimize their production and define their importance to the productivity of inshore communities, and provide timely and scientifically sound advice to management.

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

1. Continuation of studies evaluating environmental changes in the Annapolis Basin, N.S., their relationship to man-made structures such as the causeway and hydro-electric facility, and their impact on soft-shell clam production. The apparent 'reconditioning' of the flats and rebuilding of clam populations in the upper Basin will be monitored and collaborative studies with scientists in Atlantic Geoscience Centre (Department of Energy, Mines and Resources) and at Dalhousie, Acadia, and Liverpool Universities continued. (Rowell)

A preliminary 1990 study of the magnetic properties of surficial and sub-surface sediments throughout the Annapolis Basin had produced results suggesting that installation and (or) operation of the Annapolis tidal power facility had changed the distribution and nature of surficial sediments and was likely a key factor in the decline of the soft-shell clam population. As in 1991, it was planned to continue this investigation, with further typing of sediments and their movements; but, again, hopes for funding under the Green Plan did not materialize. This study will be reactivated should funding become available in FY 1993/94.

Further sampling of established transects was carried out to monitor soft-shell clam settlement, survival, and growth (Goal 2 below). For the fourth consecutive year, a heavy settlement took place over the Oak Point area where, in the years from 1982 to 1988, surface sediments appear to have blocked settlement or survival.

2. Continuation of studies into factors influencing soft-shell clam settlement, growth, and mortality which have direct relevance to habitat management and possible means of enhancing productivity of the flats. Emphasis will focus primarily on factors influencing clam settlement and the subsequent distribution and survival of juveniles. Predator/prey studies will be continued with the aim of evaluating the degree to which Mya is preferentially preyed upon by Cerebratulus and the relative importance of this and other predators in relation to clam mortalities. (Rowell)

Carried out sampling of the 1991 year-class (juveniles) and the earliest-settling 1992 soft-shell clams to further evaluate distribution patterns relative to area of Basin, level on intertidal, and sediment type. Lack of student assistance or funding for contracts has prevented sorting.

Support and guidance are being provided to a doctoral student at Dalhousie University in studies of factors influencing the initial settlement of larval clams and the subsequent, often quite different, distribution of juveniles (and, in consequence, adults).

3. Continuation of analysis and evaluation of outputs of the Clam Enhancement Project and the provision of biological advice for implementing and evaluating longer-term soft-shell clam enhancement activities by various clam fishermen's associations. Under this goal there will continue to be considerable collaboration with the clam assessment biologist (S. Robinson) at the St. Andrews Biological Station (St. Andrews, N.B.), including analysis and publication of some elements of the project. (Rowell)

Progress on analysis and publication has been very limited due to time requirements associated with higher- priority projects being handled by both investigators.

4. Publication of reports and papers on some or all of the following: predation of the nemertean worm C. lacteus on M. arenaria and the importance of M. arenaria relative to other prey items (Rowell); the indirect effects of clam digging on the viability and growth of small (2-10 mm) juvenile clams (Rowell); analysis and reporting of the biological and fisheries assessment components of the Clam Enhancement project (Rowell, Robinson); and, should funding be available, recent erosion and deposition patterns in the Annapolis Basin as revealed by magnetic properties of the sediments. (Rowell, Amos, Oldfield)

One primary publication bearing on both the environmental and biological aspects of the Annapolis Basin clam population decline was produced.

4. Additional Accomplishments:

1. Participated on the Non-Indigenous Species Introductions Committee in the review of a number of proposed introductions involving shrimp, marine and freshwater fish, bivalve molluscs, and echinoderms.

2. Presented a display on the impact of tidal power, in conjunction with nemertean predation, on the Annapolis Basin clam population for the DFO display at Digby Scallop Days (Digby, N.S., August 1992).

5. Goals/Expected Outputs for 1993:

In FY 1993/94, activities currently covered under this project will be covered under the Benthic Habitat Studies project (Project 710).

6. Background:

Highlights:

Due to the high priority given to the trawling impact project, there was only limited effort expended on this project this year and, hence, no true highlights.

Selected Involvements:

i. Collaborative Research -

Continued collaboration with S. Robinson (St. Andrews Biological Station, St. Andrews, N.B.)

Planning for further studies into sediment transport and its influence on clam recruitment in the Annapolis Basin involved contact with an assortment of DFO scientists and operations people (Fisheries and Habitat Management) as well as the Department of Energy, Mines and Resources (Atlantic Geoscience Centre), the Canadian Hydrographic Service, Acadia University (Estuarine Research Centre), Dalhousie University (Department of Oceanography), and Liverpool University (Department of Geography).

ii. University Liaison -

Dalhousie University (Department of Oceanography): J. Grant and C. Roegner on studies of factors influencing the initial settlement of larval clams and the subsequent distribution of juveniles and adults. Serving on C. Roegner's Ph.D. committee.

Liverpool University (Department of Geography): F. Oldfield on 'fingerprinting' Annapolis Basin sediments by their magnetic properties and determining the source of sediments covering formerly productive clam flats in the upper Basin. Further collaboration is dependent on available funding.

iii. Communications -

A large number of advisory activities were undertaken. They included: advice and information on ocean quahaug research proposals, benthic sampling techniques, benthos on Western Bank, oyster aquaculture strategies, development plans for oyster farming, sarcomas in soft-shell clams, nemertean predation on clams and other bivalves, the soft-shell clam fishery, clam aquaculture, effects of sediments on oysters and quahaugs, hydraulic harvesting gear for bivalves, juvenile squid, popular molluscan nomenclature, environmental change in the Annapolis River and Basin, horse mussel distribution, oyster shipping, and blue mussel culture potential in the Bras d'Or Lakes.

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Rowell, T.W. 1992. Destruction of a clam population (Mya arenaria Linné) through the synergistic effects of habitat change and predation by a nemertean (Cerebratulus lacteus Verril). Proc. 25th Europ. Mar. Biol. Symp.: 263-269.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division Project No.: 708

Section:

Project Title: Scallop Habitat Research

Project Leader: Cranford, P.J.

Other Researchers: Gordon, D.C.; Keizer, P.D.; Hargrave, B.T.

Work Activity: W.A.1.1.3.2

Key Words: scallops; habitat research; contaminants; near-bed particle field; particle transport; diet quality

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1. Project Description:

Study the interaction between scallops (Placopecten magellanicus), their trophic resources and potential contaminants and relate to habitat quality. Characterize the near-bed particle field under natural conditions in productive offshore and coastal scallop habitats. Assess the capacity of adult sea scallops to compensate for and adapt to natural and man-induced variations in diet quality. Develop techniques to study and monitor the dispersion, dynamics, and benthic boundary-layer transport of operational discharges from petroleum exploration and production activities. Investigate and predict the potential impact zone of operational discharges with regard to: 1) the near-bed particle field; 2) the nature of available particulate food resources; and 3) the sublethal impacts on scallop physiological energetics, growth, and reproduction.

2. Long-Term Objectives:

Identify processes which underlie scallop production and reproduction and determine critical variables. Provide predictive relationships for scallop production and reproduction as a function of environmental variables and stresses with emphasis on the supply and quality of organic seston to scallop beds, the dynamics of the near-bed water column, and the impact of potential contaminants.

Identify the ecological consequences of discharged wastes associated with hydrocarbon exploration and production on the commercially important Georges Bank scallop stocks by providing data on the fate and impact of solid wastes and developing numerical models that can be used for estimating the size and duration of impact zones around drilling rigs. Provide methodology for routine monitoring of drilling discharges and their dispersion. Provide water quality guidelines for addition of inorganic suspended solids to sea scallop habitat.

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

1. Continue to conduct Panel on Energy Research and Development (PERD) funded research on the sublethal effects of drilling wastes on sea scallops, analyze samples, interpret data, and communicate results. (Cranford, Gordon)

Long- and short-term studies of the sublethal effects of used water-based drilling muds were conducted during two periods (winter and summer). Samples and data from the bentonite exposure have been analyzed, and a manuscript titled 'The Influence of Dilute Clay Suspensions on Sea Scallop Feeding Activity and Tissue Growth' was completed and accepted for publication in The Netherlands Journal of Sea Research. A second manuscript is currently being prepared that will assess the capacity of sea scallops to regulate energy acquisition and metabolic expenditure to compensate for and adapt to the presence of non-nutritious food particles. P.J. Cranford presented two papers at the conference 'Managing the Environmental Impact of Offshore Oil Production' (St. John's, Nfld., April 2-3, 1992). Data were presented on the sublethal effects of bentonite clay and barite on sea scallops, and the second paper outlined the DFO research strategy for predicting the impact of Georges Bank oil and gas exploration on scallop stocks.

2. If the Green Plan proposal is approved, develop and contract studies on the sublethal impacts of heavy metal contaminants on sea scallops. (Cranford, Keizer, Gordon)

This project did not receive funding.

3. Interpret data collected from Georges Bank and publish results in terms of assessing the role of scallops and other bivalves in benthic/pelagic exchanges and the impact of sediment resuspension on diet quality. (Cranford, Hargrave, Muschenheim)

This project is proceeding slowly, owing to its low priority relative to the sublethal impact research. However, a manuscript entitled 'Sediment Resuspension Rates, Organic Matter Quality, and Its Utilization by Sea Scallops (Placopecten magellanicus) on Georges Bank' has been prepared in collaboration with J. Grant and C. Emerson (Dalhousie University) and will be submitted for publication by the end of the year. Data for a second paper has been compiled on the contribution of macrobenthic suspension-feeding bivalves to benthic metabolism, phytoplankton consumption, and

nutrient regeneration on Georges Bank. Results of these data are also being used in an overview paper on the influence of physical processes on the biological productivity of the Bank.

4. Conduct particle fall velocity and flocculation experiments with drilling wastes supplied from LASMO Nova Scotia operations near Sable Island. Modify and utilize carousel tanks in turbulent suspension experiments. (Muschenheim)

Settling and flocculation studies of drill wastes have continued, although at a slower pace than anticipated due to chronic analytical problems caused by the inconsistent performance of the Coulter Multisizer II particle size analyzer. One carousel tank has been modified to enable photographic work on particle flocs to continue in a laboratory setting. Still-water settling velocities have been obtained for water-based drill fluid wastes, and studies of the role of turbulence in the flocculation and settling process are continuing.

5. Pursue opportunities to continue sampling at ROWAN GORILLA III drilling operations at the Cohasset and Panuke fields. (Muschenheim)

No additional sampling trips were made to the Panuke/Cohasset site this year, but liaison with LASMO Nova Scotia has continued and plans are being made to conduct an extended sampling program. This has been made possible by the approval of an additional proposal to the Panel on Energy Research and Development (PERD) specifically related to monitoring offshore drill wastes dispersion. The SPANS/LASMO observer program will provide additional opportunities to obtain samples during drill wastes discharge events, and the observers hired by LASMO were trained in basic water sampling techniques by D.K. Muschenheim (contract employee). Data from the 1991 field work have been analyzed completely and presented the conference 'Managing the Environmental Impacts of Offshore Oil Production' (St. John's, Nfld., April 2-3, 1992). (Muschenheim)

6. Participate in a planned Metrology Division (Physical and Chemical Sciences Branch) research cruise to a Georges Bank site to extend benthic boundary layer current measurements and seston studies. (Muschenheim)

The PARIZEAU research cruise (Cruise No. 92-029) to Georges Bank was successful, and the redesigned bottom current meter mooring provided detailed data on boundary-layer current structures and bed shear stresses. A 24-hour anchor station was conducted with samples taken for water column and benthic boundary layer seston concentrations, bottom sediments, and CTD profiles. Microbial metabolic studies were carried out by K. Lee (DFO Québec Region). All samples taken on this research cruise have been analyzed, and data reduction and analysis is ongoing.

7. Produce a technical report on guidelines and methodology for the monitoring of particulate food supplies available to commercially important bivalve species exposed to the potential impacts of offshore hydrocarbon development. (Muschenheim)

All data for production of the technical report on guidelines and methodology for monitoring particulate waste emissions from offshore oil operations are collected, and writing of the report is under way. The report is expected to be ready for publication early in 1993.

8. Finalize plans for numerical modelling component of the PERD project. (Gordon)

Numerous discussions and meetings to refine planning were held with scientific colleagues in Canada, The Netherlands, and Denmark. It was decided that the impact assessment model should have three separate but interactive submodules: a) plume dispersion, b) benthic boundary layer, and c) deposition. The necessary water column trajectories will be obtained by the new finite element physical oceanographic model currently under development by Physical and Chemical Sciences Branch. Model output will be reported as waste concentration as a function of distance and time from the release point under a drilling rig. State-of-the-art computer graphics will be employed.

4. Additional Accomplishments:

1. B.T. Hargrave and P.J. Cranford, working in collaboration with faculty and students from Dalhousie and Memorial Universities under the Ocean Production Enhancement Network (OPEN), conducted work in Lunenburg Harbour to measure scallop ingestion, digestion, and fecal matter production under in situ field conditions over a tidal cycle. This was the first field test of a new technique developed at the Bedford Institute of Oceanography for conducting feeding studies on scallops under natural conditions of varied food supply. These observations will provide field validation of parameters used in models of scallop feeding and digestion that are critical for predicting growth under conditions of variable food supply.

2. A new sampling device constructed at the Bedford Institute of Oceanography by the Engineering and Technical Services Division (Management Services Branch) for B.T. Hargrave was deployed for the first time in Lunenburg Harbour during the OPEN field study. The 'SMART TRAP' collects settling particles in cups programmed to rotate under a collecting funnel in a similar manner as its predecessor, the BIO TRAP. However, each cup under the SMART TRAP is programmed to collect settling particles only when specific current speed and direction criteria are detected by the instrument package. Data collected with this instrument will provide information on environmental controls on the supply of food particles to scallops.

3. Project co-ordination with the Metrology Division (Physical and Chemical Sciences Branch) has resulted in agreement on the development direction of the PERD-funded MIMS project and the development and incorporation of particle size sensing equipment within the package. Some sensors and data-logging equipment have already been purchased.

5. Goals/Expected Outputs for 1993:

1. Continue to conduct Panel on Energy Research and Development-funded research on the sublethal effects of drilling wastes on sea scallops, analyze samples, interpret data, and communicate results. (Cranford)

2. Interpret data collected from Georges Bank and publish results on the role of scallops and other bivalves in benthic/pelagic exchanges. (Cranford)

3. Deploy particle traps at a scallop aquaculture site to investigate variations in the food supply and subsequent physiological responses of scallops. Analyze samples, interpret data, and communicate results from previous field measurements in Lunenburg Bay, N.S. (Hargrave, Cranford)

4. Begin development of the impact assessment simulation model. (Gordon, Keizer)

5. Complete longer-term flocculation work, focusing on the role of the microbial community and the effect of additives which inhibit microbial activity. Monitor particle size spectra and microbial numbers, activity, and respiration. (Muschenheim)

6. Analyze results of dissolved organic carbon (DOC) experiments and the impact of increasing and decreasing DOC concentrations. (Muschenheim)

7. Install particulate matter sensing equipment on a BOSS frame and in a towed body. Study the dispersion and deposition of drill wastes around the jack-up rig ROWAN GORILLA III on the Scotian Shelf. (Muschenheim)

8. Determine long-term changes in settling rate of flocculated drilling muds. (Muschenheim)

9. Continue development of in situ particle size analysis equipment in cooperation with MIMS project. (Muschenheim)

6. Background:

Highlights:

Fisheries managers and industry representatives comprising the Georges Bank Steering Committee continue to have input to this project and are satisfied with the approach being taken. Long-term exposures to two major drilling mud additives (bentonite and barite) and whole water-based drilling muds have been conducted using the high-energy exposure protocol; and the results are providing insight into the animals' sensitivity to inorganic suspended solids, their physiological compensation strategies, and potential for recovery. Collaborations between DFO and university scientists on scallop habitat research continue to provide fundamental knowledge on the trophic resources and physiological energetics of scallops in their natural environment. These data are critical for verifying and interpreting results obtained in the laboratory.

Selected Involvements:

i. Collaborative Research -

Sedimentological aspects of this project are led by D.K. Muschenheim (contract employee).

Attended workshops and contributed scallop data to a multidisciplinary group studying the coupling of physical and biological processes on Georges Bank. (Cranford) Conducted field work in Lunenburg Harbour along with faculty and students from Dalhousie and Memorial Universities to measure natural variations in the abundance and nutritional quality of the suspended particle field, vertical particle fluxes, environmental controls on the particle field, and the physiological responses of scallops to a varied diet. (Hargrave, Cranford)

The project is dependent on collaboration with J. Loder (Ocean Circulation Division, Physical and Chemical Sciences Branch), K. Kranck (Coastal Oceanography Division, Physical and Chemical Sciences Branch), K. Lee (DFO Québec Region), and C. Amos (Atlantic Geoscience Centre, Department of Energy, Mines and Resources). Instrumentation support has been provided by the Metrology Division (Physical and Chemical Sciences Branch). LASMO continues to supply field support.

ii. University Liaison -

P.J. Cranford and B.T. Hargrave maintain close ties with university scientists conducting scallop research under OPEN. Collaborative research is being conducted with J. Grant (Dalhousie University) and B.A. MacDonald and J.E. Ward (University of New Brunswick) on various aspects of sea scallop nutrition, growth, and physiology. P.J. Cranford is currently serving as a committee member for Dalhousie University Masters degree candidate B. Vaercamer.

iii. Communications -

Three papers were presented at a conference entitled "Managing the Environmental Impact of Offshore Oil Production" (St. John's, Nfld., April 2-3, 1992):

a) "Georges Bank Oil and Gas". I. Research Strategy for Predicting the Impact on Scallop Stocks." (Cranford)
b) "Georges Bank Oil and Gas". II. Boundary-Layer Particle Transport and Its Significance in Impact Studies of Sea Scallop Populations. (Muschenheim)
c) "Georges Bank Oil and Gas". III. Sublethal Effects of Solid Drilling Wastes on Sea Scallops." (Cranford)

A manuscript was prepared for publication in the conference proceedings. (Gordon, Cranford, Muschenheim, Keizer)

Overview lectures on this project were given in The Netherlands, Norway, and Denmark. (Gordon)

Progress reports and planned research were presented at two meetings of the Georges Bank Steering Committee. (Gordon, Cranford, Muschenheim, Keizer)

A poster was prepared and presented at the annual OPEN meeting (Dalhousie University, Halifax, N.S.).

iv. Contracts Administered -

BDR Research Limited (R. Gershey): Analysis of inorganic desegregated grain size using precision Coulter Counter techniques and PDL data processing techniques (DSS File No. OSC92-00054-[009]) - $86.3 K.

Bland Research Applications (D.K. Muschenheim): Flocculation of drilling muds and their behaviour in the benthic boundary layer (DSS File No. OSC92-00056-[004]) - $52.8 K.

v. Other -

7. Publications:

i. Primary -

Cranford, P.J., and D.C. Gordon, Jr. 1992. The influence of dilute clay suspensions on sea scallop (Placopecten magellanicus) feeding activity and tissue growth. Neth. J. Sea Res. 30(1): in press.

Muschenheim, D.K., and C.R. Newell. 1992. Utilization of seston flux over a mussel bed. Mar. Ecol. Prog. Ser. 85: 131-136.

ii. Interpretive Scientific -

iii. Scientific and Technical -

Gordon, D.C., Jr., P.J. Cranford, D.K Muschenheim, J.W. Loder, P.D. Keizer, and K. Kranck. 1992. Predicting the environmental impacts of drilling wastes on Georges Bank scallop populations. In Proceedings of the Canadian Society of Environmental Biologists Conference on Managing the Environmental Impact of Offshore Oil Production (St. John's, Nfld., April 2-3, 1992): in press.

iv. Popular and Miscellaneous -

Hargrave, B.T., P.J. Cranford, B.A. MacDonald, and J.E. Ward. 1992. In situ feeding studies on adult sea scallops. Presentation at the annual Ocean Production Enhancement Network meeting (Dalhousie University, Halifax, N.S.). (Poster)

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division

Project No.: 709

Section:

Project Title: Zooplankton Habitat Studies

Project Leader: Harding, G.C.

Other Researchers: Vass, W.P.; Reimer, D.P.; Hargrave, B.T.

Work Activity: W.A.1.1.3.1

Key Words: zooplankton; lobster; organochlorines; habitat research

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1. Project Description:

Studies on the effects of natural and anthropogenic changes on the marine pelagic community, which includes long- and short-term vagrancies of the 'weather,' alteration of freshwater input, contamination with pollutants, alteration of geochemical cycles, ghost fishing by gillnets, and excessive fishing.

2. Long-Term Objectives:

Conduct scientific research to provide information and advice for management to address our marine environmental issues.

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

1. Prepare a manuscript on the evidence for lobster larval dispersal from Georges Bank. (Harding, Drinkwater, Pringle, others)

This was not completed due to emphasis being switched elsewhere; however, a paper was given on this topic at the Canadian Conference for Fisheries Research (Halifax, N.S., January 1992).

2. Analyze and prepare a manuscript on the long-term trend of organochlorines in the pelagic food webs of the southern Gulf of St. Lawrence. (Harding, Addison, Hargrave, LeBlanc, others)

The analysis of data has progressed well with the assistance of Annie Dupuis (Co-operative Employment Program employee), and the preparation of a first publication is progressing well ('Results' section almost complete).

3. Conduct a field study to track the dispersal of patches of larval lobsters from the northwestern edge of Browns Bank using Loran-C drifters and the Vass-Tucker trawl. (Harding, Drinkwater, Pringle, Vass, others)

This study did not take place because the seven Loran-C drifters that were to be used in the study were lost in a previous study off the Labrador Shelf. The study will have to be put off until this equipment can be replaced in better economic times. This study would be very useful in helping to resolve whether lobster recruitment in the lucrative inshore fishery off southwestern Nova Scotia comes partially or in large part from offshore lobsters.

4. Prepare a manuscript on the effects of Hudson Strait outflow on the Labrador Shelf ecosystem based on changes in the biomass spectrum. (Drinkwater, Harding, others)

This project is not completed. It is still at the data analysis and interpretative stages.

4. Additional Accomplishments:

1. The first paper on the interaction of the Georges Bank tidal front on planktonic distributions has been prepared and accepted for publication (see Section 7i).

2. Progress is being made on the analyses for the second Georges Bank tidal front paper. (Harding, others)

3. An overview of the Georges Bank tidal study was prepared for the BIO Science Review (see Section 7iv).

4. A study of bioaccumulation of organochlorine compounds in the Arctic Ocean has been published (see Section 7i).

5. Preparations were made for next season's organochlorine study in the southern Gulf of St. Lawrence once Green Plan funding was obtained.

6. A study of lobster stocks in the Maritimes, based on larval morphometrics, has been accepted for publication (see Harding et al.).

7. A review paper prepared for the Marine Atlantic Standing Subcommitee on Habitat (MASSH) on the subject of environmental requirements and known anthropogenic effects on lobster populations along the East Coast of Canada was published (see Section 7iii).

8. A review paper was prepared and given at the Canadian Atlantic Fisheries Scientific Advisory Committee's Invertebrates and Marine Plants Subcommittee meeting (Halifax, N.S., November 19-21, 1992) on larval lobster ecology and recruitment (see Section 7iii).

9. Most details of a working paper prepared in 1989/90 for the national "State-of-the-Environment" report were not used in the fall 1991 publication. Three months were spent updating the initial working document rather than see this initial effort wasted. This publication should make the work involved in this exercise considerably easier next time around for the next person (see Section 7iii).

10. Responded to various environmental issues, most noteworthy of which being: a) prepared a critique and attended a meeting held by Environment Canada on the Point Aconi, N.S., power plant; b) participated in the Gulf of Maine Monitoring Committee; c) gave advice to Environment Canada on the effect of chlorinated water effluent on marine organisms; d) participated in a workshop on the implications of hydroelectric development in the James Bay and Hudson Bay watershed (Proceedings of a Workshop on the Potential Cumulative Impacts of Development in the Region of Hudson and James Bays, [Ottawa, Ont., June 17-19, 1992], J.N. Bunch and R.R. Reeves [ed.]. Can. Tech. Rep. Fish. Aquat. Sci. 1874: 39 p.).

5. Goals/Expected Outputs for 1993:

1. Under Green Plan funding, conduct a field study on organochlorine levels in the marine food web of the southern Gulf of St. Lawrence and its transport into the region via the atmosphere and rainfall. (Harding, Vass, others)

2. Prepare a manuscript on bioaccumulation of organochlorines in the pelagic food web of the southern Gulf of St. Lawrence. (Harding, Addison, Hargrave, LeBlanc, others)

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

4. Continue analysis of Labrador shelf biomass spectrum data. (Drinkwater, Harding, Schwinghamer, Dickie, others).

5. Complete gillnet studies and prepare a final report. (Vass)

6. Background:

Highlights:

Made significant advances and prepared manusripts or presentations on: the effect of convergences on the dispersion and retention of zooplankton and lobster larvae over Georges Bank, organochlorine contamination in the Arctic food web and its relation to global transport via the atmosphere, freshwater run-off and ocean currents, and stock determinations of lobsters in the Maritimes.

Selected Involvements:

i. Collaborative Research -

R.F. Addison (Marine Chemistry Division, Physical and Chemical Sciences Branch): Long-range atmospheric transport of organochlorines.

K.F. Drinkwater (Coastal Oceanography Division, Physical and Chemical Sciences Branch): Retention and dispersal of larval lobsters from frontal systems.

J.D. Pringle (Benthic Fisheries and Aquaculture Division, Biological Sciences Branch): Ecological studies on larval lobsters.

E. Ketchington and R.J. Miller (Benthic Fisheries and Aquaculture Division, Biological Sciences Branch): Morphometrics of lobster larvae around the Maritimes.

K.F. Drinkwater (Coastal Oceanography Division, Physical and Chemical Sciences Branch) and R. Sheldon and P. Schwinghamer (Experimental Sciences Division, Science Branch, Newfoundland Region): Evaluation of the Sutcliffe hypothesis of biological production in the Labrador Current.

R.I. Perry (OES, Biological Sciences Branch, Pacific Region): Frontal studies on Georges Bank.

ii. University Liaison -

S. Pearre, Jr. (Department of Oceanography, Dalhousie University): Frontal studies and vertical migration.

iii. Communications -

Papers were presented at: 1) the Canadian Conference for Fisheries Research (Halifax, N.S., January 1992) titled "Offshore Studies of Larval Lobsters (Homarus americanus) in the Georges and Browns Banks Region;" and 2) the Canadian Atlantic Fisheries Scientific Advisory Committee's Invertebrates and Marine Plants Subcommittee (Halifax, N.S., November 19-21, 1992) on larval lobster ecology and recruitment (see Section 7iii).

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Hargrave, B.T., G.C. Harding, W.P. Vass, P.E. Erickson, B.R. Fowler, and V. Scott. 1992. Organochlorine pesticides and polychlorinated biphenyls in the Arctic Ocean food web. Arch. Environ. Contam. Toxicol. 22: 41-54.

Perry, R.I., G.C. Harding, J.W. Loder, M.J. Tremblay, M.M. Sinclair, and K.F. Drinkwater. 1993. Zooplankton distributions at the Georges Bank frontal system: Retention or dispersion. Cont. Shelf Res.: in press.

Harding, G.C., E. Kenchington, and Z. Zheng. 1993. Morphometrics of American lobster (Homarus americanus) larvae in relation to stock determinations in the Maritimes, Canada. Can. J. Fish. Aquat. Sci.: in press.

ii. Interpretive Scientific -

iii. Scientific and Technical -

Harding, G.C. 1992. A review of the major marine environmental concerns off the Canadian East Coast in the 1980s. Can. Tech. Rep. Fish. Aquat. Sci. 1885: vi + 38 p.

Harding, G.C. 1992. American lobster (Homarus americanus Milne Edwards): A discussion paper on their environmental requirements and the known anthropogenic effects on their populations. Can. Tech. Rep. Fish. Aquat. Sci. 1887: vi + 16 p.

Drinkwater, K.F., B. Petrie, and G.C. Harding. 1993. Overview of oceanic conditions, 6 p. In D.S. Pezzack and L. Savard [ed.]. The Year of the Lobster. (Can. Atl. Fish. Sci. Adv. Comm., Invertebrates and Marine Plants Subcommittee, November 19-21, 1992). Can. Tech. Rep. Fish. Aquat. Sci.: in press.

Harding, G.C. 1993. Lobster ecology and recruitment, 6 p. In D.S. Pezzack and L. Savard [ed.]. The Year of the Lobster. (Can. Atl. Fish. Sci. Adv. Comm., Invertebrates and Marine Plants Subcommittee, Nov. 19-21, 1992). Can. Tech. Rep. Fish. Aquat. Sci.: in press.

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. BIO Sci. Rev. 1990 and 1991: 57-61.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division Project No.: 710

Section:

Project Title: Benthic Habitat Studies

Project Leader: Rowell, T.W.

Other Researchers: Woo, P.; Prena, J.; Gordon, D.C.

Work Activity: W.A.1.1.3.1

Key Words: benthos; habitat research

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1. Project Description:

The benthic community is an important component of demersal fish habitats. Consequently, an understanding of its biological processes is essential to fisheries and habitat management. To that end, quantitative data on benthic invertebrate biomass, size distribution, and composition by major taxa are being collected from the coastal and shelf waters of eastern Canada. The influence of habitat change, as a result of fishing activities, hydro-electric development, ocean dumping, or other anthropogenic activities on benthic communities is an area of concern to fisheries. (This project description has been modified to indicate the consolidation of the Inshore Molluscan Habitat Studies project [Project 707] and the mobile gear component of Effect of Fishing Activity on Fish Habitat project [Project 977] into this project in FY 1993/94.)

2. Long-Term Objectives:

Measure and describe production processes of the benthic communities on the fishing grounds of Atlantic Canada. Benthic production will be related to such oceanographic processes as turbulent mixing, water depth, sedimentation, and primary production, and to the production of demersal fish which feed on benthos. The influence of man-induced habitat change on benthic communities will be evaluated with the aim of recommending mitigative measures to reduce or eliminate negative effects. (These long-term objectives have been modified to indicate the consolidation of the Inshore Molluscan Habitat Studies project [Project 707] and the mobile gear component of the Effect of Fishing Activity on Fish Habitat project [Project 977] into this project in FY 1993/94.)

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

Most benthic work during 1992 was done under the Atlantic Fisheries Adjustment Program (AFAP), which is reported under Project 977.

1. Continued representation of Canada on the International Council for the Exploration of the Sea (ICES) Working Group on the Effects of Extraction of Marine Sediments on Fisheries and on the Study Group on Ecosystem Effects of Fishing Activities. (Rowell)

Prepared and presented the Scotia-Fundy Region's input to the ICES Study Group on Ecosystem Effects of Fishing Activities. The Study Group was subsequently upgraded to Working Group status.

2. Continued analysis of earlier samples as resources permit. (Rowell, Woo)

Samples from the 1989 research cruise (E.E. PRINCE - Cruise No. P385) were re-sorted, identified, quantified, and the data entered.

4. Additional Accomplishments:

1. A large number of Ocean Dumping Proposals were reviewed and recommendations made.

2. The molluscan reference collection was significantly augmented with material from earlier research cruises (Peer, Rowell) and from the 1991 and 1992 trawling impact cruises.

3. Samples were collected to produce better photographs of common megabenthic species for use in a rapid identification manual for use by the Observer Program and the Groundfish Survey in providing benthic mapping data.

4. Samples were collected to provide material from which to determine volume to weight conversion factors for megabenthic species.

5. Goals/Expected Outputs for 1993:

Beginning in 1993, this project also includes Projects 707 and 977.

Accomplishment of many of the goals which follow, under the Benthic Habitat Studies component (a), will be dependent on the funding level of this project as well as on the time available after requirements of the Trawling Impact Studies component (b) are met.

a) Benthic Studies Component:

1. Continue to represent Canada on the ICES Working Group on the Effects of Extraction of Marine Sediments on Fisheries and on the Working Group on Ecosystem Effects of Fishing Activities, and to provide the Scotia-Fundy Region's input to them. (Rowell)

2. Provide reviews and recommendations on the effects of extraction of sediments on fisheries and the marine environment, on ocean dumping, and on the ecosystem effects of fishing activities. (Rowell)

3. Work up previously collected samples to provide volume to weight conversion factors for megabenthic species. Collect further samples to augment and (or) refine these factors. (Woo)

4. Upgrade the rapid identification manual for use by the Observer Program and the Groundfish Survey in providing benthic mapping data with better photographs of common megabenthic species. (Rowell, Woo)

5. Continue analysis of existing benthic samples, both offshore and Annapolis Basin, N.S., clam transects, as resources permit. (Rowell, Woo)

6. Continue augmentation of the reference collections with material from the 1993 trawling impact research cruises. (Woo, Prena)

b) Trawling Impact Studies Component:

1. Make further modifications to the video grab system, the benthic sled, and BRUTIV, and carry out field testing of the modified equipment in collaboration with the Metrology Division (Physical and Chemical Sciences Branch) and Engineering and Technical Services Division (Management Services Branch). (Rowell, Vass, Reimer, Woo)

2. In collaboration with the DFO Newfoundland Region and the Atlantic Geoscience Centre (Department of Energy, Mines and Resources), plan and conduct a series of four research cruises, commencing in late June/early July, to carry out two trawling impact studies near Hibernia. One will involve experimental trawling within established corridors in the 'closed area' and the other a single 'long-trawl' over differing energy and sediment regimes. (Rowell, Gordon, Schwinghamer, Vass, Woo, Reimer)

3. In collaboration with the DFO Newfoundland Region and the Atlantic Geoscience Centre (Department of Energy, Mines and Resources), plan and conduct a series of submersible dives to evaluate trawl tracks laid down in the trawling impact experiments on the Grand Bank as well as known-age tracks resulting from the DFO Newfoundland Region's Groundfish Surveys. (Rowell)

4. Advice and guidance will be provided to any further side-scan studies in the Bras D'Or Lakes. (Rowell, Vass)

5. Complete the paper on the results of the Minas Basin, N.S., trawling experiments. (Gordon)

6. Background:

Highlights:

This year, due to the high priority given to the trawling impact project (Project 977), there was very little effort directly attributable to this project and, hence, no true highlights. In 1993, Project 977 will be discontinued and the trawling impact studies carried out under this project.

Selected Involvements:

i. Collaborative Research -

General benthic studies with P. Schwinghamer (DFO Newfoundland Region) and D. Marcogliese (DFO Québec Region).

Under the trawling impact studies: P. Schwinghamer, M. Hawryluk, and K. Gilkinson (DFO Newfoundland Region); J. Gibson (Acadia University); J. Guigné (Guigné International Ltd.), R. Parrot, G. Sonnichsen, R. Millar, and D. Locke (Atlantic Geoscience Centre, Department of Energy, Mines and Resources); G. Gilbert (Canadian Seabed Research Ltd.); D. McKeown, D. Harvey, and S. Young (Metrology Division, Physical and Chemical Sciences Branch); M. Chin-Yee, G. Steeves, R. Vine, and K. Bentham (Engineering and Technical Services, Management Services Branch); and M.J. Bergman (The Netherlands Institute for Sea Research).

ii. University Liaison -

The Minas Basin, N.S., trawling experiments were done in collaboration with Acadia University.

iii. Communications -

Progress and plans of the trawling impact studies were discussed at the annual meeting of the International Council for the Exploration of the Sea Benthos Ecology Working Group and Study Group on Ecosystem Effects of Fishing Activities and at The Netherlands Institute for Sea Research.

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: Habitat Ecology Division Project No.: 711

Section:

Project Title: Environmental Interactions With Aquaculture

Project Leader: Keizer, P.D.

Other Researchers: Hargrave, B.T.

Work Activity: W.A.1.1.3.1

Key Words: benthos; habitat research; aquaculture

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1. Project Description:

The culture of finfish and shellfish in marine coastal waters is a rapidly growing industry in Atlantic Canada. From its infancy in the mid 1970s the industry has grown to the extent that in 1991 the landed value of aquaculture products in the Scotia-Fundy Region exceeded $100 million, approaching 20% of the landed value of the traditional fishery. With the decline of the traditional fishery and the introduction of additional species of finfish for culturing, the aquaculture industry is certain to be a significant long-term component of the fishery in the Scotia-Fundy Region. To ensure the long-term viability of mariculture, it is critical that its interactions with the environment be predictable and controlled. The profitable growth of cultured finfish and shellfish is highly dependent on the quality of the marine environment.

2. Long-Term Objectives:

The cage culture of finfish in Atlantic coastal waters has grown rapidly over the past 5 years and urgently requires scientifically based management and regulation tools. The quality of the water and surface sediments near the cage sites is dramatically affected by the dissolved and particulate wastes from the farms. Also, there is potential for the wastes from one farm impacting neighbouring farms or interfering with traditional resource users such as weir operators and inshore fishermen. This project will provide the necessary information to understand and quantify the flux and fate of wastes from marine finfish farms.

Specific objectives are to determine the environmental and operational factors that could limit the selection and expansion of sites for finfish cage cultures in the Scotia-Fundy Region. As part of the overall program to develop tools to help manage and regulate this industry, the energy flows associated with salmonid aquaculture are being studied in order to determine the fate of the dissolved and particulate wastes associated with the industry. Results from this project will be used to verify a numerical model (Project 718) which in turn will be interfaced with water quality models to predict cumulative impacts in coastal systems.

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

1. Primary publications (two) of the results of the 1989-1991 field work in L'Etang. (Keizer, Hargrave)

   One manuscript has been accepted for publication (see Section 7i). Another manuscript has been submitted for publication (see Section 7i).

2. Conduct a laboratory bioassay of the acute effects of the dye rhodamine B on juvenile and adult Atlantic salmon. This work would be done under contract. (Keizer)

   No progress was made, as no funds were available.

3. If the use of rhodamine B as a tracer proves acceptable, conduct dye tracer experiments at the SeaFarm Canada site in Bliss Harbour, N.B., to determine the flushing rate of dissolved and particulate wastes from the farm cages. (Keizer, Bugden)

   No progress was made, as no funds were available.

4. In conjunction with Goal 3 above, conduct field experiments to measure the nitrogen budget for a salmon cage.

   No progress was made, as no funds were available.

5. Engage a post-doctoral fellow to conduct studies of the microbiological processes affecting the mineralization of particulate wastes from salmon fish farms.

   No progress was made, as no funds were available.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

1. Continue an assignment with the Regional Aquaculture Coordination Office. (Keizer)

2. In collaboration with the Nova Scotia Department of Fisheries, prepare guidelines for the evaluation of sites in Nova Scotia for aquaculture potential. (Keizer)

3. As a member of an inter-agency technical committee, guide the development of a Geographic Information System-based information support system for aquaculture development in the L'Etang area of southwestern New Brunswick. (Keizer)

4. In collaboration with G. Bugden (Coastal Oceanography Division, Physical and Chemical Sciences Branch), determine the influence of cage design, configuration, and cage fouling on the rate at which particulate and dissolved materials are flushed from sea cages. (Keizer)

5. The removal of a large array of sea pens from one site at Fyre Island to an adjacent site in July 1992 provides an opportunity for long-term study of benthic recovery. If funding can be arranged, studies will be initiated under contract in FY 1993/94 to monitor the recovery of this finfish aquaculture site after cage removal. (Keizer)

6. Background:

Highlights:

There were very limited personnel and financial resources for this project this fiscal year.

Selected Involvements:

i. Collaborative Research -

D.J. Wildish (Aquatic and Invertebrate Fisheries Division, Biological Sciences Branch) - seasonal and tidal variations in water chemistry and benthic fluxes at a salmon aquaculture site in Bliss Harbour, N.B.

G. Bugden (Coastal Oceanography Division, Physical and Chemical Sciences Branch) - currents and water structure at a salmon aquaculture site in Bliss Harbour, N.B.

ii. University Liaison -

D. Scott (Dalhousie University) - collaboration on a strategic grant investigating the use of microfossil sediment records to infer historical environmental quality at potential aquaculture sites.

iii. Communications -

January 22, 1992 - Assimilation Capacity Workshop (St. Andrews Biological Station, St. Andrews, N.B.) (posters [two] and presentations [several]).

A media briefing on an integrated approach to the study of environmental interactions with the finfish cage culture industry was made (Saint John, N.B., July 11, 1992). (Keizer)

A poster was presented at the Aquaculture Fair (St. Andrews, N.B., June 18-21, 1992).

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Hargrave, B.T., and D.J. Wildish. 1993. Seasonal changes in benthic fluxes of dissolved oxygen and ammonium associated with marine cultured Atlantic salmon. Mar. Ecol. Progr. Ser.: submitted.

Wildish, D.J., P.D. Keizer, A.J. Wilson, and J.L. Martin. 1993. 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 -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division Project No.: 713

Section:

Project Title: Bioenergetics of Marine Mammals

Project Leader: Brodie, P.F.

Other Researchers:

Work Activity: W.A.1.1.3.1

Key Words: marine mammals; whales; seals; fisheries interactions; habitat biomechanics

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1. Project Description:

Conduct research on the morphology, physiology, mechanics, feeding, and population energetics of marine mammals in the northern Atlantic, with emphasis on the baleen whales. Knowledge gained from these studies is applied to a variety of scientific and operational problems including zooplankton sampling design, fishing gear design and operation, contaminant (DDT and PCBs) accumulation in seal populations, and habitat alteration.

2. Long-Term Objectives:

The study of biomechanics and physiology and energetics of marine mammals provides a cost-effective approach to understanding animals in their habitat. One advantage of this approach is that studies can be based on small numbers of samples; therefore, effective field programs can be run on small budgets and can very often be opportunistic. In the present state of funding for research, this is of considerable advantage. By understanding the mechanics of animals there are increased opportunities for technology transfer (for example, to sampler design or commercial fishing gear).

Studies of the infrastructural design of tissues, such as marine mammal blubber, indicate that it plays an important role in elastic energy storage, power transmission and propulsion, as well as providing insulation and a metabolic energy reserve. This understanding is important when assessing relative condition of marine mammal populations, their energy requirements, as well as applying this to studies of ecotoxicology and accumulation rates of toxins by marine mammals. In light of the present state of Atlantic fisheries, improved understanding of distribution, feeding behaviour, condition, and dynamics of millions of marine mammals in the northwestern Atlantic is more important than ever.

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

1. Continue studies of rorqual feeding mechanics.

A manuscript has been completed for publication, addressing one aspect of feeding mechanics, and has been distributed to laboratory colleagues for review: 'Noise Generated by the Jaw Actions of Fin Whales.' Field observations of feeding whales and biomechanical studies in Iceland indicate that mechanical noise, rather than vocalizations, are generated by fin whales when engulfing pelagic fish and euphausiids. It is proposed that the precise timing of the pulse is used to initially retain high concentrations of engulfed prey. Such a mechanism is required of whale predators which engulf prey concentrations along with many tons of seawater, rather than those which continually filter (e.g. the Right whale). The origin of these noises associated with the presence of fin whales has been of scientific and strategic interest for over 40 years. (Department of National Defence)

2. Continue studies of seal and walrus energetics and mechanics.

No further field data were collected this year, but analysis of information collected previously continued.

3. Continue to monitor harbour porpoise/fisheries in the Bay of Fundy/Gulf of Maine (proposed a joint paper with Guelph University colleagues to reassess the problem).

A working paper was tabled at the March 1992 meeting of the Canadian Atlantic Fisheries Advisory Committee Marine Mammals Subcommittee. A working paper was also presented at the workshop 'Harbor Porpoise in Eastern North America: Status and Research Needs' (Woods Hole, Mass., May 5-8, 1992). This study examined the evidence which had been proposed to support the hypothesis that the Bay of Fundy/Gulf of Maine population was in decline - a consequence of fishing bycatch. An alternative interpretation was proposed, based on ongoing studies of growth and energetics, as well as species interaction. The findings were consistent with advice given in 1991: that low estimates of population numbers were a consequence of redistribution which was associated with prey (herring) distribution. Changes in growth rate, which had been attributed to a density-dependent response to a

declining stock, were better related to fluctuations in numbers and energy density of herring, their primary prey. The importance of changes in the level of predation on porpoises by sharks was also considered.

Two surveys conducted by colleagues at Woods Hole, Mass. (National Marine Fisheries Service) in 1991 and 1992 have indicated that the population is substantially larger and that the error in earlier population estimates was probably related to herring distribution. While the study conducted by the United States involved several scientists and approximately $500 K, this study was done on existing funds ($1 K for travel).

A manuscript has been completed for publication, titled 'A Reconsideration of Some Aspects of the Status and Energetics of the Harbour Porpoise (Phocoena phocoena) in the Gulf of Maine/Bay of Fundy.' The manuscript was sent to A. Read (Guelph University, then National Marine Fisheries Service) for comment, who found 'no factual errors or serious omissions' in the first draft, but declined the offer of co-authorship. His comments will be considered.

4. Continue to have input on the Great Whale Hydroelectric Development Program and marine mammal habitat.

Some of the concerns regarding beluga habitat alteration via hydroelectric development resulted from earlier field studies of beluga life history. There have been few opportunities for input after attending an initial DFO/DOE workshop on Arctic issues (Montreal, P.Q., January 27-27, 1992). Advice regarding the design of a field study have been submitted through regional DFO representatives. Eighteen research papers and relevant documents were tabulated and submitted in response to the request by the Grand Council of the Crees (of Québec) through the Access to Information Act.

4. Additional Accomplishments:

1. Contribution to the Trawling Impact Workshop (Dartmouth, N.S., October 19): This presentation demonstrated the application of marine mammal energetics and biomechanics as research tools. Prey distribution can be reasonably defined by the distribution of large whales. This was extended to demonstrate that the studies of gray whales feeding on bottom fauna in the northern Pacific have an additional application in demonstrating the regeneration process of benthic organisms which have been disturbed through bottom restructuring by 20,000+ large whales, on a scale which may approximate the disturbance caused by bottom trawling in the Atlantic.

2. Fin whale distribution as an indicator of winter herring distribution and abundance: Earlier studies of intraspecific growth, energetics, and feeding strategies of baleen whales emphasized the association of northern Atlantic fin whales in winter with the distribution of herring. A joint helicopter/ship survey, with colleagues from the St. Andrews Biological Station (St. Andrews, N.B.) is planned for January 1993, using fin whale sightings as an indicator of herring distribution. There appears to be a strong correlation; therefore, the technique has the potential to reduce survey costs.

3. Midwater trawl modification: Studies of baleen whale feeding behaviour and biomechanics resulted in technology transfer, suggesting modifications to midwater trawl design. The modifications required of conventional trawl gear are simple and inexpensive, enhancing the function of warps and bridles as more effective concentrators of fish. Simulation of feeding actions by natural whale predators, through the use of white streamers appropriately attached to trawl gear, may increase the concentrating capability. The objective is to reduce the catching effort by increasing the effective cross section of the trawl and possibly reducing the towing speeds, and thus fuel costs presently required for capturing pelagic species. Application to small pair-trawlers may diversify the capability of vessels in the near-shore fleet. This has generated renewed interest among fishermen, who are willing to participate in field trials. No funds were available; therefore, the field trials are planned to be conducted on an opportunistic basis with interested fishermen. A trawler captain advises that this may also be applicable to silver hake.

5. Goals/Expected Outputs for 1993:

1. Investigate the potential for modification of sampling equipment and fishing gear, based on recent findings in cetacean biomechanics.

2. Continue studies of marine mammal biomechanics with emphasis on feeding and propulsion efficiency.

3. Continue the joint investigation with St. Andrews Biological Station (St. Andrews, N.B.) colleagues of using fin whale distribution to locate winter herring.

4. Continue to monitor harbour porpoise/fisheries interactions in the Bay of Fundy.

6. Background:

Highlights:

The study of cetacean feeding mechanics appears to have shed light on feeding, the origin of certain underwater sounds which has intrigued acoustic investigators, and has suggested some modifications for sampling and fishing gear.

Studies of respiration dynamics have been expanded to include the variation in the design of lungs of terrestrial and marine mammals, with emphasis on aerial contaminants.

Earlier advice given to DFO with regard to harbour porpoise habitat, growth, energetics, and distribution appears to be confirmed by extensive studies conducted by United States colleagues.

DFO Central and Arctic Region, colleagues observe that earlier research and advice and predictions regarding beluga population in Baffin Island continues to be confirmed.

Renewed interest in a previously proposed technique of using fin whale distribution to detect herring in winter.

Selected Involvements:

i. Collaborative Research -

While budget cuts have eliminated any travel to other laboratories, contact is being maintained with Duke University, SINTEF (Norway), as well as the possibility of conducting additional thermophysiological research with a colleague at the University of Helsinki.

ii. University Liaison -

Member of the advisory committee for Ph.D. research on feeding and energetics of bowhead and right whales (Guelph, Ont.). Occasional lectures at Dalhousie University (Halifax, N.S.).

iii. Communications -

Six major public lectures through schools and the Halifax Library lecture to the Nova Scotian Institute of Science lecture at BIO during Science Week. Lecture to staff of the Nova Scotia Museum school tour program which involves 15,000 to 20,000 children annually.

Interview on CBC Television 'Newsworld': The International Whaling Commission, Norway, Iceland, Japan, and commercial whaling.

iv. Contracts Administered -

v. Other -

Editorial board member of the Canadian Journal of Zoology.

7. Publications:

i. Primary -

Brodie, P.F. 1993. Some aspects of the physiological and bio-mechanical research conducted on rorquals from the Icelandic catch, and their application. Proceedings of the Special Meeting on the North Atlantic Fin Whale (Reykjavik, February-March 1991). Sci. Proc. Int. Whaling Comm.: in press.

ii. Interpretive Scientific -

iii. Scientific and Technical -

Brodie, P.F. 1992. Status, energetics and incidental by-catch mortality of harbour porpoise in the Gulf of Maine/Bay of Fundy. In: NOAA/National Marine Fisheries Service. Harbour Porpoise in Eastern North America: Results of a Scientific Workshop (Woods Hole, Mass., April-May 1992). Northeast Fish. Sci. Center Ref. Doc. 92-06.

iv. Popular and Miscellaneous -

Brodie, P.F. 1992. Whale mechanics and fisheries oceanography. Sou'wester, September 15, 1992.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division Project No.: 715

Section:

Project Title: Size-Dependent, Bioenergetic Processes in Fish Habitat

Project Leader: Kerr, S.R.

Other Researchers: Silvert, W.L.; Boudreau, P.R.

Work Activity: W.A.1.1.3.1

Key Words: modelling; habitat research; bioenergetics; heritability; ballast water; ecosystem integrity

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1. Project Description:

Evaluation of the effects of environmental factors and habitat change on fish habitat productivity.

2. Long-Term Objectives:

Develop procedures for evaluating and predicting the interaction of habitat variables with the production capacities of fish stocks and communities.

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

1. Carry out medium-term research on alternative procedures for fish production forecasting and analysis, in relation to habitat variables. This will entail continued development of a major 5-year research program in cooperation with the various participants in the Ocean Production Enhancement Network (OPEN), occupying a major portion of the project leader's time. (Kerr)

This program is producing significant results in several dimensions. The genetic fingerprinting (heritability) component has been very successful, with polymorphisms of the requisite degree of resolution obtained such that local stocks of cod can for the first time be reliably and easily distinguished. We have also found that the genetically distinct stocks also differ appreciably in their metabolic performance characteristics. Both of these findings have substantial implications for the management of cod stocks on a biological basis. It has also become clear from this work that adult cod are remarkably sensitive to minute variations in their habitat (temperature, salinity, oxygen tension) and exhibit a complex set of behavioral and physiological responses to habitat variation. We have also established that larval cod undergo a series of discrete stages of physiological performance that is closely linked to morphological landmarks of development. This work will continue for the near future, with increasing emphasis on the development of realistic models of cod production bioenergetics. The most immediate implications of the work to date are its obvious implications for applying modern, state-of-the-art genetic and physiological findings to the troubled cod fisheries of Atlantic Canada.

2. Continue collaborative studies of size-dependent production processes. (Kerr, Dickie)

This body of work has progressed to the point that Columbia University Press has offered a book contract (to S.R. Kerr and L.M. Dickie) to prepare a book synthesizing the essential contributions of size spectrum theory to the analysis of aquatic production systems. This prospect is currently being considered, although current thinking is that the time is right to proceed with the proposal.

3. Comparative analysis of the size-structures of research trawl survey data for the Scotian Shelf. Supported by a Natural Sciences Engineering Research Council Operating Grant. (A second student has recently joined S.R. Kerr to carry on with the temporal distribution phase.) (De Aracama, Duplisea, Kerr)

De Aracama has completed the distributional phase of this work, with the successful defense of his Dalhousie University (Halifax, N.S.) M.Sc. thesis: 'De Aracama, J. 1992. Size-distribution of demersal fishes on the Scotian Shelf. M.Sc. thesis' (sponsored by Dalhousie University).

Three important results follow from this innovative study. First, the observations by Pope and colleagues that orderly size-distributions obtain on a Scotian Shelf-wide basis for the relatively narrow size-window of the trawlable demersal fishes have been confirmed. Second, for the first time it has been shown that the characteristic size distributions remain discernible at the smaller scales of individual statistical regions within the Shelf sampling area. Third, the characteristic size-distribution patterns are consistent with species assemblage patterns that have been identified earlier in the literature, on the basis of independent multivariate statistical techniques. These results are currently being readied for primary publication.

The second phase of this work, the examination of time-dependent behaviour of the same trawl-sampling data, is now under active investigation by a subsequent M.Sc. student, D. Duplisea. In brief, his

analysis clearly indicates that stable size spectra have persisted over the Scotian Shelf over the past 21 years, despite appreciable changes in landings and species composition. Examination of spatial scale and day-night differences are proceeding with completion of the thesis expected in 1993. A further student is expected to join in the coming months, allowing the analysis to continue.

4. Continue working with the DOE/USEPA subcommittee on ecological criteria for assessing the health of the Lake Ontario ecosystem. (Kerr)

This report is now in its first draft, with final preparation and submission planned for early 1993.

4. Additional Accomplishments:

The proceedings of a ballast water workshop were prepared for publication, and scientific contacts on this issue have been maintained.

5. Goals/Expected Outputs for 1993:

1. Carry out medium-term research on alternative procedures for fish production forecasting and analysis, in relation to habitat variables. This will entail continued development of a major 4-year research program in cooperation with the various participants in the Ocean Production Enhancement Network, occupying a major portion of S.R. Kerr's time. At present, this program will probably terminate at the end of FY 1993/94. (Kerr)

2. Continue collaborative studies of size-dependent production processes. (Kerr, Dickie)

3. Comparative analysis of the size-structures of research trawl survey data for the Scotian Shelf. The emphasis in FY 1993/94 will shift away from description to focus on the ecological basis for the observed patterns. (Duplisea, Kerr)

4. A continuing contact will be maintained on the ballast water issue and, in particular, a search for resources that could be used to investigate the problem in Atlantic Canada.

6. Background:

Highlights:

The Ocean Production Enhancement Network program which Dr. Kerr co-supervises is showing remarkable success in its interdisciplinary focus on cod bioenergetics and heritability. It is now reaching the stage where the physiological and genetic information can begin to be combined with the physical and other field components of the program.

Selected Involvements:

i. Collaborative Research -

Extensive collaboration is involved with the various personnel and agencies in the Ocean Production Enhancement Network. A new collaboration with W.D. Bowen (Marine Fish Division, Biological Sciences Branch) and R. Ackman (Technical University of Nova Scotia) has become possible with the successful funding of a Natural Sciences and Engineering Research Council Strategic Grant to investigate fatty acid signatures as a tool for identifying food chain transfers. Additional collaborations will continue with L.M. Dickie (Marine Fish Division, Biological Sciences Branch) and R.A. Ryder (Ontario Ministry of Natural Resources).

ii. University Liaison -

Adjunct Professor in the Departments of Biology and Oceanography, Dalhousie University (Halifax, N.S.). Currently supervise four graduate students and serve on the research advisory committees of three others. One graduate student successfully defended a M.Sc. thesis in 1992. Dr. Kerr also taught a graduate module in fisheries bioenergetics and taught approximately one-half of the population ecology undergraduate course. Dr. Kerr continues to serve on the Dalhousie Aquatron Advisory Committee (Dalhousie University), and more recently on the Dalhousie Aquatron Management Review Subcommittee.

iii. Communications -

Conducted a Physiology Workshop (Bedford Institute of Oceanography).

Served on a panel discussion of the Ocean Production Enhancement Network program at the annual meeting of the Canadian Society of Zoologists.

Became an Associate Editor of Ecosystem Health and Medicine, a new Elsevier Science journal.

Conducted an interview on the ballast water problem with R. North (CBC).

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Kerr, S.R., and R.A. Ryder. 1992. Effects of cultural eutrophication on coastal marine fisheries. Sci. Total Environ. (Suppl.): 599-614.

ii. Interpretive Scientific -

Volterra, L., and S.R. Kerr. 1992. Summary of discussions of Workshop 2: Impact of Marine Eutrophication on Humans and Economic Activities. Sci. Total Environ. (Suppl.): xix-xx.

iii. Scientific and Technical -

Smith, T.E., and S.R. Kerr. 1992. Introductions of species transported in ships' ballast waters: The risk to Canada's marine resources. Can. Tech. Rep. Fish. Aquat. Sci. 1867: v + 16 p.

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division Project No.: 716

Section:

Project Title: Habitat Mapping

Project Leader: Boudreau, P.R.

Other Researchers: Keizer, P.D.; Silvert, W.L.; Orr, E.A.

Work Activity: W.A.1.1.3.1

Key Words: GIS; habitat sensitivity mapping

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1. Project Description:

To explore and develop the application of a Geographic Information System (GIS) for evaluating the productive capacity of freshwater, estuarine, and marine habitats, for monitoring changes in these habitats as a result of man's activity, and for making scientific data readily available to environmental managers.

2. Long-Term Objectives:

To establish methods and the capability of using GIS for data entry, storage, manipulation, and information dissemination on environmental variables affecting the productive capacity of freshwater, estuarine, and marine habitats. The resulting data bases and accompanying software will be used in support of habitat science research projects, to improve information exchange among DFO science Divisions, and to improve the provision of science advice to habitat managers. GIS systems must be developed under careful regional coordination, and this project will complement efforts in other divisions and departments.

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

1. To be scientific authority for the Habitat Sensitivity Mapping project contract.

Two contracts were carried out under this project: 1) habitat sensitivity mapping work carried out by Earth & Ocean Research Limited (Dartmouth, N.S.), and 2) development work on an ICOIN carried out by ICOIN Industries Inc. (Fredericton, N.B.). Both of these contracts are to be completed by March 31, 1993. This work involved consultation with the companies involved as well as with other parties who have contributed data/information to the Habitat Sensitivity Mapping system.

2. To set up the hardware and software system to run the INFOCUS/QUIKMAP mapping system for use in managing Divisional data bases on habitat parameters.

No work was done on this objective due to lack of time on the part of the project leader (see 'Additional Accomplishments' section below.)

4. Additional Accomplishments:

The project leader was on assignment to the Canadian Hydrographic Service for 10 months of the year to aid in the coordination and promotion of geomatics within the Atlantic region. This effort included representing DFO on the Data and Information Management Committee of the Gulf of Maine Council on the Marine Environment and the Atlantic Coastal Zone Information Management Committee. In conjunction with these two committees, several publications were prepared.

5. Goals/Expected Outputs for 1993:

1. Be scientific authority for the Habitat Sensitivity Mapping (Earth & Ocean Research Limited) project contract and the Passamaquoddy Bay (ICOIN Industries Inc.) contract. (Boudreau)

2. Provide advice on habitat and resource mapping to Biological Sciences Branch, Habitat Management Branch, and Marine Assessment and Liaison Division within DFO, as well as other federal, provincial, and private agencies. (Boudreau)

3. Maintain the Habitat Sensitivity Mapping system for use by the Habitat Ecology Division in maintaining and disseminating habitat information to clients. (Boudreau, Keizer, Silvert)

6. Background:

Highlights:

Gave numerous demonstrations of the developing Habitat Sensitivity Mapping system which were enthusiastically received.

Ten-month assignment to Canadian Hydrographic Service to work on the development of Regional geomatic initiatives.

Continued to receive funding for this project for the Green Plan (Brander-Smith component).

Selected Involvements:

i. Collaborative Research -

Interacted with Habitat Management Branch and Marine Assessment and Liaison Division in developing, testing, and applying the Habitat Sensitivity Mapping system.

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

Earth & Ocean Research Limited: Habitat Sensitivity Mapping (DSS File No. OSC92-00780-[025] - $19.1 K.

ICOIN Industries Inc.: Passamaquoddy Bay Project - $10 K of $500 K total contract cost.

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

Boudreau, P.R. 1992. Data and Information Management Committee of the Gulf of Maine Council on the Marine Environment directory of data bases. DFO Internal Rep.

Boudreau, P.R. 1992. DFO component of the Atlantic Coastal Zone Information Management Steering Committee directory of data bases. DFO Internal Rep.: 550 p.

Boudreau, P.R. 1992. DFO user needs survey for the Gulf of Maine. DFO Internal Rep.: 54 p.

Boudreau, P.R. 1992. Habitat Sensitivity Mapping Workshop: Review, strategy and recommendations. DFO Internal Rep.: 49 p.

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division Project No.: 718

Section:

Project Title: Evaluation of Estuarine and Continental Shelf Habitats

Project Leader: Silvert, W.L.

Other Researchers: Durvasula, S.R.V.; Gordon, D.C.; Hargrave, B.T.; Keizer, P.D.

Work Activity: W.A.1.1.3.1

Key Words: ecological modelling; habitat evaluation

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1. Project Description:

Using ecological modelling tools, and other appropriate methods, integrate available physical, chemical, and biological data to improve general understanding of the structure, distribution, and dynamics of estuarine and continental shelf habitats which support valuable fishery resources. Apply knowledge gained to the assessment of marine habitat issues, including environmental impact assessment.

2. Long-Term Objectives:

Maintain, and if possible increase, the current productive capacity of important estuarine and continental shelf habitats off eastern Canada through knowledge of factors controlling the productive capacity, by assessing the relative importance of specific habitats and assessing the effects of anthropogenic chemical, physical, and biological changes on habitat and the fishery resources they support.

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

1. Continue to develop, in collaboration with other divisions and with input from habitat managers, an ecological model for the L'Etang Inlet which can be used to evaluate the carrying capacity for salmon cage aquaculture. (Gordon, Hargrave, Silvert, Keizer)

This work has continued throughout the year. A primary publication on this work appeared in 1992. Several models were developed. Some were published in the primary literature, others were presented at workshops and international conferences. A decision support system for aquaculture licensing was designed and a prototype built, which was presented at several international meetings.

2. Continue development of models of shellfish toxicity which can be used to plan research and monitoring programs. (Silvert, Durvasula)

A primary publication on this work appeared in 1992. This project is complete.

3. Continue development and maintenance of the BSIM modelling package. (Silvert)

This work continued throughout the year, and several refinements were made to the BSIM package. Due to limited time and the unavailability of a suitable Macintosh computer, support for the Macintosh version of BSIM had to be suspended during 1992. Three of the manuals were updated, and support was added for a VAX-VMS version of BSIM. Alternate formulations of BSIM were examined, and the possibility of using an object-oriented language for further development was investigated. Several models were created and documented using these alternate formulations with an idea to publication.

4. Continue development of the generic model of continental shelf habitats with particular emphasis on benthic submodels and dynamic stability of these systems. (Silvert)

This work was suspended during 1992, partly due to a lack of time and partly because of the retirement of the benthic ecologist (D.L. Peer) who was collaborating on this work.

5. Maintain a Habitat Ecology Division computer system, particularly with respect to support for the modelling program. (Silvert, Keizer)

This work proceeded throughout the year, involving both maintenance of the Divisional unit server (Silvert) and implementation of a Banyan Vines network for the Division (Keizer). The networking has proceeded slowly, mainly due to financial constraints and unexpected difficulties encountered by the contractor. Other work has proceeded satisfactorily.

6. Investigate physical factors affecting estuarine habitat, and establish liaison with Physical and Chemical Sciences Branch concerning estuarine classification and interfaces between physical and biological models. (Silvert, Messieh)

This work was not completed due to the retirement of S.N. Messieh. Liaison with the Physical and

Chemical Sciences Branch in connection with the L'Etang project which was reported under this heading last year has been transferred to Goal 1.

7. Resume earlier objective of developing models for studying the effects of habitat changes on early life stages of fish. (Silvert)

This work proceeded very slowly. There were no funds for contact with the Portuguese co-workers on this project, so research had to proceed by the exchange of mail. Earlier drafts of the work were revised, and additional hydrographic data were included in the analysis.

4. Additional Accomplishments:

Organized a workshop in (St. Andrews, N.B., January 22, 1993) to review the assimilative capacity of the L'Etang Inlet for salmonid aquaculture wastes which was well attended by scientists, environmental managers, and fish farmers.

5. Goals/Expected Outputs for 1993:

1. Continue to develop, in collaboration with other Divisions and with input from habitat managers, an ecological model for the L'Etang Inlet which can be used to evaluate the carrying capacity for salmon cage aquaculture. (Gordon, Hargrave, Silvert, Keizer)

2. Continue development of a decision support system for aquaculture regulation. (Silvert, Keizer)

3. Continue development and maintenance of the BSIM modelling package. (Silvert)

4. Continue development of the generic model of continental shelf habitats with particular emphasis on benthic submodels and dynamic stability of these systems. (Silvert)

5. Maintain a Habitat Ecology Division computer system, particularly with respect to support for the modelling program. (Silvert, Keizer)

6. Resume earlier objective of developing models for studying the effects of habitat changes on early life stages of fish. (Silvert)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

This project involves close collaboration with Coastal Oceanography Division (Physical and Chemical Sciences Branch) (R.W. Trites, G. Bugden) and the St. Andrews Biological Station (D.J. Wildish, B. Chang).

Instituto Portuguese de Investigaçãos Maritimas. (Silvert)

ii. University Liaison -

iii. Communications -

There were numerous oral and poster presentations of this work, including several workshops in St. Andrew's, N.B., the International Council for the Exploration of the Sea (ICES) 80th Statutory Meeting (Rostock, Germany, September 1992), the International Conference on State-of-the-Art in Ecological Modelling (Kiel, Germany, September 1992), and Fish Farm Effluents and Their Control in EC Countries: Environmental Aspects, Regulations, and Future Perspectives: A Workshop (Hamburg, Germany, November 1992). (Silvert, Keizer, Gordon)

iv. Contracts Administered -

Maritime Tel and Tel: Installation of Banyan Vines Network (DSS File No. OSC92-00604-[031]) - $7.1 K. (Keizer)

Department of Mathematics, Statistics and Computer Science, Dalhousie University: Communications services - $0.5 K. (Silvert)

Department of Mathematics, Statistics, and Computer Science, Dalhousie University: UUCP network and communications programming support - $0.5 K. (Silvert)

v. Other -

7. Publications:

i. Primary -

Silvert, W.L. 1992. Assessing environmental impacts of finfish aquaculture in marine waters. Aquaculture 107: 67-71.

Silvert, W.L., and D.V. Subba Rao. 1992. Dynamic model of the flux of domoic acid, a neurotoxin, through a Mytilus edulis population of Cardigan Bay, P.E.I. Can. J. Fish. Aquat. Sci. 49(2): 400-405.

ii. Interpretive Scientific -

Silvert, W.L. 1992. Many risks, many models: Addressing the variety of problems that pollution can cause. ICES 1992 Mini-Symposium on Ecosystem Modelling as a Tool to Predict Pollution Associated Risks for the Marine Environment. Proceedings of the International Council for the Exploration of the Sea Statutory Meeting. Int. Counc. Explor. Sea C.M.1992/Mini:4: 4 p.

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

The following software manuals were revised and reissued in 1992:

Silvert, W.L. 1992. BSIM Cookbook Supplement for MS-DOS. BSIM-Central. DFO Internal Rep.: 8 p.

Silvert, W.L. 1992. BSIM Cookbook Supplement for Unit and VAX-VMS Systems. BSIM-Central. DFO Internal Rep.: 7 p.

Silvert, W.L. 1992. Introduction to BSIM. BSIM-Central. DFO Internal Rep.: 5 p.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division Project No.: 719

Section:

Project Title: Contaminant Fluxes in Marine Benthic Food Webs

Project Leader: Hargrave, B.T.

Other Researchers: Phillips, G.A.

Work Activity: W.A.1.1.3.2

Key Words: contaminants; benthic habitat research

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1. Project Description:

Consider the impact of chemical contaminants, physical disturbance, and temperature changes on marine benthic systems.

2. Long-Term Objectives:

Develop monitoring techniques which quantify the impact of chemical contaminants, physical disturbance, and temperature changes on benthic species community structure and community functional processes such as nutrient fluxes and metabolic activities.

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

1. Completion of benthic fauna colonization studies with C. Schafer (Atlantic Geoscience Centre, Department of Energy, Mines and Resources). Data will be compiled and results for effects of temperature on colonization and growth of different-sized organisms assessed. (Hargrave)

Analyses of meiofauna biomass (numbers and volume) for major taxonomic groups in sediments exposed to different temperatures was completed during the year. Statistical evaluation of the data by analysis of variance is planned to compare temporal changes in biomass using similar techniques as applied to foraminifera species.

2. Participate in a multi-disciplinary study of particle fluxes during the Spring Bloom in Bedford Basin, N.S. Settled material will be analyzed for grain size, organic carbon, nitrogen, plant pigments, trace metals, and ^{234}Th. (Hargrave)

The 4-month study (January to April) was prolonged due to late development of the bloom. Sampling was continued at 4-day intervals until December 1992. Samples were analyzed for inorganic/organic matter composition, organic carbon and nitrogen, plant pigments, and grain size. Results for the first 6 months of the study were summarized at a 1-day workshop in December for participants in the experiment.

3. If Green Plan funds are available, a summer student will carry out field and laboratory studies to monitor sediment-water fluxes of trace metals. (Hargrave)

Funding for a summer student was not available during 1992. Green Plan Toxic program (Chemicals component) funding will begin in 1993; however, an advance of $5 K from the Physical and Chemical Sciences Branch (P. Yeats) in 1992 allowed an early start on machining for a magnetic coupling for a benthic chamber that will be modified to measure sediment-water trace metal fluxes. This will allow the equipment to be tested in Halifax Harbour, N.S., as early in 1993 as possible.

4. Additional Accomplishments:

1. A primary paper was published during 1992 summarizing elemental distributions in a deep-sea amphipod.
This work was carried out as part of a Deep-Ocean Ecology project which is terminated. The study was conducted as part of the Canada-France Science and Technology Exchange program.

5. Goals/Expected Outputs for 1993:

1. Completion of analysis of variance of biomass distribution in sediments exposed to different temperature regimes in Bedford Basin, N.S. A draft of a primary publication summarizing this data will be prepared. (Hargrave)

2. Trace metal and ^{234}Th analyses of settled material collected during the Bloom '92 experiment will be completed by staff in the Physical and Chemical Sciences Branch (Marine Chemistry Division) and the Department of Energy, Mines and Resources (Environmental Geology). Results will be combined with data for other physical-chemical observations during the Bloom '92 experiment for publication as a Data Report of Fisheries and Aquatic Sciences.

3. Preliminary testing of modified benthic chamber to measure sediment-water trace metal fluxes in Halifax Harbour will be completed when the new magnetic coupling is fabricated. (Hargrave)

6. Background:

Highlights:

The duration of the 12-month study of sedimentation conducted in Bedford Basin during 1992 was unplanned. The delay of the spring phytoplankton bloom until late April resulted in a decision to continue sediment trap collections of settled material throughout the summer and fall months. This provides a set of seasonal samples for trace metal analyses that will be used for assessing the annual input of trace metals to sediments in the Basin through particle sedimentation. The data will be used for mass balance calculations in combination with results from studies of sediment-water exchanges of trace metals to begin during 1993.

Selected Involvements:

i. Collaborative Research -

This project involves close collaboration with the Marine Chemistry Division (Physical and Chemical Sciences Branch) (P. Yeats) and the Atlantic Geoscience Centre (Department of Energy, Mines and Resources) (R. Cranston and C. Schafer).

ii. University Liaison -

Co-investigator with J. Grant (Department of Oceanography, Dalhousie University) in a Natural Science and Engineering Research Council Centre of Excellence (Ocean Production Enhancement Network) (1991-1995) (Adult Scallop Trophic Resources). Results from this research contribute to an understanding of factors controlling scallop feeding and growth reported under Habitat Ecology Division Project 708.

Dr. Hargrave served as a Departmental Scientific Liaison Advisor for two DFO Science Subvention grants during the year. P. Wangersky (Department of Oceanography, Dalhousie University) with his student W. Chen is evaluating a high-temperature combustion method for determination of dissolved organics and nitrogen in seawater. R. Marinelli, a post-doctoral fellow with B. Boudreau (Department of Oceanography, Dalhousie University) has carried out micro-electrode profiling studies of variables which will be used to model pore water irrigation by benthic polychaete worms.

iii. Communications -

Benthic Ecology Meeting (Newport, R.I., March 26-29, 1992). Presentation of a paper - "Horizontal and Vertical Particle Fluxes in Relation to Scallop Food Resources" (jointly with J. Grant, C. Emerson, and B. MacDonald).

OPEN 3rd Annual Scientific Meeting (Halifax, N.S., November 6-8, 1992). Poster presentation - "*In situ* Feeding Rates of Adult Scallops" (jointly with P.J. Cranford, B. MacDonald, and E. Ward).

Ocean Business Day, Bedford Institute of Oceanography (Dartmouth, N.S., December 3, 1992). Poster presentation - "Current-Driven Particle Trap, Smartrap" (jointly with G. Siddall, G. Steeves, and G. Awalt).

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Hargrave, B.T., P. Germain, J.-C. Philippot, G. Hermon, and J.N. Smith. 1992. Stable elements and ^{210}Po in the deep-sea amphipod *Eurythenes gryllus*. Deep-Sea Res. 39: 37-44.

ii. Interpretive Scientific -

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division Project No.: 722

Section:

Project Title: Instrumentation Support

Project Leader: Vass, W.P.

Other Researchers: Reimer, D.P.

Work Activity: W.A.1.1.3.1

Key Words: instrumentation; data processing

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1. Project Description:

Develop, test, repair, and operate field equipment used to gather habitat and living resource data.

2. Long-Term Objectives:

Facilitate the procurement of field data needed to fulfill the mandate of the Habitat Ecology Division and Biological Sciences Branch.

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

1. Provide instrumentation support to field programs in the Habitat Ecology and Marine Fish Divisions (Biological Sciences Branch) (Marine Fish Division: 1992 Atlantic Fisheries Adjustment Program [AFAP] [T.C. Lambert], November [K. Frank], December [K. Frank], CSS MATTHEW Gear Trial [K. Frank]; Habitat Ecology Division: May [W.P. Vass, side-scan], July [G.C. Harding, lobster], September [T.W. Rowell, AFAP - sled].

Instrumentation support was provided for field programs in the Habitat Ecology Division's Atlantic Fisheries Adjustment Program (T.W. Rowell - trawl impact), as well as some support to Marine Fish Division (T.C. Lambert) before the program was cancelled. Field programs for K. Frank and G.C. Harding were also cancelled due to lack of funding.

2. Completion of instrumented meter block.

Assistance was provided to the Marine Fish Division (Biological Sciences Branch) [J. Reid] for the completion of the instrumented block. Further support may be required in 1993 to enhance the operation of the instrumented block.

3. Completion of acquisition and analysis software development for Netminder II systems.

A joint Habitat Ecology Division and Marine Fish Division (Biological Sciences Branch) (J. McRuer) project is still ongoing.

4. Continue involvement in portable winch development.

This project was not started.

5. Provide assistance in the development of a video system for bottom sampling devices.

Prepared for and participated in the trawl impact research cruise. Modifications were made for the sled and assistance given in video grab cable repairs.

6. Develop and install external (magnetic) switches for data loggers.

This project was completed.

7. Provide supervision and assistance to engineering students working on an oxygen sensor project for S.R.V. Durvasula (Habitat Ecology Division, Biological Sciences Branch).

This project was started but was terminated when the engineering student quit university. New sensors were ordered, and the project will be attempted again.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

1. Construct rain gauge data logger. (Vass - Georges Bay)

2. Assemble and test Georges Bay acoustic depth telemetry equipment. (Vass)

3. Modify camera and sensor data telemetry systems on the epibenthic sled. (Rowell - trawl impact)

4. Provide instrumentation support to field programs in the Habitat Ecology and Marine Fish Divisions (Biological Sciences Branch). (Rowell - trawl impact research cruises as required; Frank - November).

5. Continue development of a mini-Netminder (Habitat Ecology Division and Marine Fish Division, Biological Sciences Branch).

6. Provide supervision and assistance to engineering students working on an oxygen sensor project for S.R.V. Durvasula (Habitat Ecology Division, Biological Sciences Branch). (New sensors were purchased, and this project will probably go ahead, with or without the student.)

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: Habitat Ecology Division Project No.: 723

Section:

Project Title: Ballast Waters as a Source of Algal Blooms

Project Leader: Durvasula, S.R.V.

Other Researchers: Kerr, S.R.

Work Activity: W.A.1.1.3.2

Key Words: toxic blooms; ballast water; exotic algae

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1. Project Description:

There is ample evidence in support of a global spread of toxic (DSP, PSP) algal blooms to the coastal mariculture sites which could be, in part, due to inadvertent transoceanic and interoceanic introduction of harmful unwanted algae through ships' ballast discharges. Approximately 40,000 major ships carry billions of tonnes of ballast waters annually.

A preliminary analysis of the data from our phytoplankton monitoring program revealed an increase in the frequency of occurrence and succession of toxic algal blooms during summer in and around Nova Scotia, which is of interest and could be attributed to general processes of eutrophication and the introduction of seed populations, i.e. cysts or normal cells. Besides inducing toxic algal blooms, these exotic species could also introduce pathogens resulting in a disastrous effect on our aquaculture industry. These recent episodes are flagged as anomalous events which merit a detailed systematic study of the taxa, their physiological state, viability, conditions necessary for bloom formation, and their potential for toxic episodes. Consistent with this, the Steering Committee of the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) recommended that studies and experiments be conducted on ballast waters.

2. Long-Term Objectives:

Document algal blooms from representative Canadian Atlantic ports (such as Halifax, Sydney, and Port Hawkesbury, N.S.) which could be attributable to ballast water discharges and sediments from ballast holdings. Establish toxicity of such blooms.

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

1. Complete identification of samples generated by G.W. Sprules (University of Toronto). (Durvasula)

Identified approximately 100 taxa from preserved water samples supplied by G.W. Sprules (University of Toronto). Enumeration of ballast water algae from 96 samples, collected from the ballasts of ships originating from far-flung regions, was completed.

2. Sample, isolate, and culture several other algae from ballast waters of ships visiting Nova Scotian ports. (Durvasula)

Isolated and brought into culture several algae from live samples of ballast waters, kindly forwarded by G.W. Sprules (University of Toronto).

4. Continued involvement with the ballast water issue is planned, including publication of the summary of the 1991 workshop. (Kerr)

Assisted S.R. Kerr in preparation of a summary of a 1991 workshop on ballast water introductions (see Section 7iii).

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

In FY 1993/94, this project will be consolidated under the Physiological Ecology of Toxic Algae project (Project 703).

6. Background:

Highlights:

This project addresses a priority identified by the Canadian Atlantic Fisheries Scientific Advisory Committee. Proposals for funding were submitted to the Atlantic Fisheries Adjustment Program, the Natural Sciences and Engineering Research Council, and Green Plan (Dalhousie University), but were unsuccessful.

Selected Involvements:

i. Collaborative Research -

J.S.S. Lakshminarayana (University of Moncton).

ii. University Liaison -

G.W. Sprules (University of Toronto).

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

Smith, T.E., and S.R. Kerr. 1992. Introductions of species transported in ships' ballast waters: The risk to Canada's marine resources. Can. Tech. Rep. Fish. Aquat. Sci. 1867: v + 16 p.

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division Project No.: 977

Section:

Project Title: Effect of Fishing Activity on Fish Habitat

Project Leader: Vass, W.P.

Other Researchers: Gordon, D.C.; Harding, G.C.; Reimer, D.P.; Rowell, T.W.; Woo, P.

Work Activity: W.A.1.1.3.1

Key Words: benthos; habitat research; fishing activity; benthic samplers

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1. Project Description:

There has been increasing concern that the operation of some types of fishing gear may affect fish habitat and have a negative influence on the abundance of fish stocks. Quantitative information on this issue is very limited. This project has been investigating the impacts of abandoned gillnets (i.e. ghost-fishing) and bottom trawls on fish habitat in Atlantic Canada, both coastal and on the continental shelf.

2. Long-Term Objectives:

To quantify the impacts of mobile fishing gear, such as bottom trawls, and lost or abandoned gillnets on fish habitat, benthic communities, and commercial fish stocks, and to recommend mitigative measures to reduce/eliminate negative effects.

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

1. Test the feasibility of using a dual-frequency, high-resolution side-scan sonar to map locations of lost gillnets with an experiment near Halifax Harbour, N.S. Use the results to determine the feasibility of using this equipment in a gillnet-recovery project on Georges Bank. (Vass)

This project was completed in November after a 5-day experiment conducted from the M.V. NAVICULA off Halifax Harbour, N.S. Gillnets were set on both sandy and cobble bottom, and in both normal and tangled configuration. The test involved the deployment of both the 100 khz and 500 khz frequency side-scan sonar towfish. Results on the sandy bottom were quite striking. The gillnets showed clearly in both normal and tangled configuration with both models of towfish. The results on cobble bottom were disappointing. No clear detection of the gillnets was possible with either towfish. The results of this experiment indicate that this technology would not be applicable for mapping lost gillnets on the gravel or cobble bottom of Georges Bank. This experiment was funded by the Industry Services and Native Fisheries Branch of DFO and was a joint project between the Habitat Ecology Division and Canadian Seabed Research Ltd.

2. Conduct a third gillnet experiment in St. Margaret's Bay, N.S., with emphasis on the correlation of residence time and scavenger population density. Prepare a report on the findings of the three gillnet experiments. (Vass)

Funding was not available for this project.

3. Complete and field test the new grab and video system, the modified epibenthic sled, and a rejuvenated and upgraded BRUTIV. These, in conjunction with side-scan sonar, will provide a powerful new suite of equipment for the trawling impact study as well as future benthic studies. (Rowell, Vass, Reimer)

In August, the new grab and video system was completed and field tested, as was the modified epibenthic sled and the upgraded BRUTIV. These gears were then successfully used in the September trawling impact research cruise. Although they worked well, particularly the video grab and BRUTIV, there remain improvements to be made in all three prior to the experiments proposed for 1993.

4. In collaboration with the DFO Newfoundland Region, plan and conduct a 2-week research cruise to collect samples of benthos in the two trawling impact study sites (Hibernia and Western Bank). (Rowell, Gordon, Vass, Woo, Reimer)

A very successful research cruise to the closed areas of the Grand Bank and the Western Bank provided the information and data necessary to the final selection of the Grand Bank site for our first trawling impact study in 1993.

Carried out, in collaboration with other DFO and Atlantic Goescience Centre scientists, the initial design for the 1993 trawling impact study on the Grand Banks "closed" area and the associated "longtrawl" experiment.

5. Prepare a scientific paper on the results of the Minas Basin trawling experiments. (Gordon)

A manuscript has been prepared with colleagues at Acadia University and is almost ready for submission as a primary publication.

6. Preliminary analysis of data resulting from the 1991 and 1992 trawling impact research cruises, as well as earlier relevant data. (Rowell, Woo)

Sorting, identification, and quantification of molluscan samples from the 1989, 1991, and 1992 research cruises has been completed and the data entered. Sorting and identification of the 1991 macrobenthos is complete and that from 1992 complete for the Grand Bank area. P. Schwinghamer (DFO Newfoundland Region) is currently working-up the meiobenthic samples.

4. Additional Accomplishments:

1. A workshop on results to date and proposed trawling impact study plans was held (October) and a formal proposal subsequently developed.

2. Advice and guidance was provided for a side-scan survey of trawled and dredged (scallop) areas of the Bras D'Or Lakes (Fisheries and Habitat Management [C. Cooper], under contract).

5. Goals/Expected Outputs for 1993:

In FY 1993/94, this project will be consolidated under the Trawling Impact Component of the Benthic Habitat Studies project (Project 710).

6. Background:

Highlights:

J. Prena (Germany) arrived in October to work on this project for 2 years under German funding.

Completion of the video grab system and its successful use in the 1992 trawling impact research cruise. This newly developed grab provides a powerful tool for use in the trawling impact studies and benthic sampling in general.

Successful modification and use in the 1992 trawling impact research cruise of the epibenthic sled and BRUTIV.

The successful completion of the trawling impact research cruise and final selection of the 1993 Grand Bank study site.

Selected Involvements:

i. Collaborative Research -

P. Schwinghamer, M. Hawryluk, and K. Gilkinson (DFO, Newfoundland Region); J. Guigné (Guigné International Ltd.); R. Parrot, G. Sonnichsen, R.O. Miller, and D. Locke (Atlantic Geoscience Centre); G. Gilbert (Canadian Seabed Research Ltd.); D. McKeown, D. Harvey, and S. Young (Metrology Division, Physical and Chemical Sciences Branch); M. Chin-Yee, G. Steeves, R. Vine, and K. Bentham (Engineering and Technical Services Division, Management Services Branch); M.J. Bergman (The Netherlands Institute for Sea Research); and C. Cooper (Industry Services and Native Fisheries Branch).

ii. University Liaison -

M. Brylinski and J. Gibson (Estuarine Research Centre, Acadia University).

iii. Communications -

Interview given to ATV's 'Live at Five' on the Atlantic Fisheries Adjustment Program trawling impact study and the associated sampling gear (August 21).

Presentation on the trawling impact studies and associated sampling gear to the Atlantic Geoscience Centre's 'Mud Club' (November 18).

Information provided to The Netherlands Institute for Sea Research, The Netherlands Institute For Fisheries Research, and the North Sea Directorate relative to the mobile groundfish gear 'closed area' on Western and Emerald Banks.

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

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iii. Scientific and Technical -

Anon. 1992. Report of the ICES Study Group on Ecosystem Effects of Fishing Activities (Copenhagen, Denmark, April 7-14, 1992). Int. Counc. Explor. Sea C.M.1992/G:11.

Rowell, T.W. 1992. Studies relevant to the ICES Study Group on Ecosystem Effects of Fishing Activities. Working Document presented to the ICES Study Group on Ecosystem Effects of Fishing Activities (Copenhagen, Denmark, April 7-14, 1992).

iv. Popular and Miscellaneous -

O'Boyle, R.N., K. Drinkwater, B. Petrie, T.W. Rowell, and W.P. Vass. 1993. The Atlantic Fisheries Adjustment Program. 1992 BIO Annual Review: 68-74.

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Habitat Ecology Division Project No.: 5021

Section:

Project Title: Organochlorines in Arctic Ocean Marine Food Webs

Project Leader: Hargrave, B.T.

Other Researchers: Phillips, G.A.; Vass, W.P.; Harding, G.C.

Work Activity: W.A.1.1.3.2

Key Words: contaminants; habitat research; Arctic Ocean

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1. Project Description:

Quantify the long-range atmospheric and marine transport of organic contaminants and their incorporation into food webs in the Arctic Ocean.

2. Long-Term Objectives:

Provide baseline measurements of major semi-volatile organics (chlorinated pesticides, PCBs) in the Canadian high Arctic Ocean environment by sampling seawater (dissolved and particulate phases), plankton, benthos, fish, and sediments. Assess the relative importance of atmospheric versus oceanic input of these contaminants to the Arctic Ocean by seasonal measurements. Evaluate the bioconcentration of these compounds for comparison with data from more southern-latitude ocean sites to assess input of organochlorines to food webs utilized as food by native populations.

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

1. Initiate a 12-month over-wintering sampling program for organochlorines at Resolute Bay, NWT. The project will begin with the first trip (September 5-15, 1991) during the open-water period, and continue with monthly sampling of seawater, planktonic and benthic crustaceans, and fish until August 1993. (Hargrave, Phillips, Vass)

A planning meeting was held to coordinate activities of DFO staff involved with the year-long study (POLARPRO) to be carried out from a research camp at Resolute Bay, NWT. The start-up date was delayed until January 1993 from September 1992 to allow food, laboratory supplies, and equipment to be shipped to the DFO research station in Resolute Bay and to ensure that sufficient land-fast ice would form to allow establishment of a camp on the ice. Monthly sampling of organochlorines in seawater and lower trophic-level organisms will commence in January 1993 and continue throughout the year as long as funding permits.

2. Publish a primary paper summarizing results from the 12-month deployment of sediment traps under the Ice Island. (Hargrave)

The paper has been prepared and will appear in the journal Continental Shelf Research (see Section 7i).

4. Additional Accomplishments:

1. Three primary papers on contaminants in Arctic marine ecosystems were published during 1992.

2. A Data Report of Fisheries and Aquatic Sciences on an intercalibration study for organochlorines in biota was published in 1992.

5. Goals/Expected Outputs for 1993:

1. To initiate the 12-month over-wintering experiment POLARPRO (January 1993-December 1993) to be carried out in Resolute Bay/Barror Strait for seasonal sampling of organochlorines in seawater and lower trophic-level organisms to document changes in these contaminants and lipid levels in biota. If funds are available through the Green Plan (Arctic Environmental Strategy program) beyond those needed to cover field expenses, a contract for organochlorine analyses in samples collected during the first months of POLARPRO will be prepared.

6. Background:

Highlights:

Funding for sample collection and analytical costs associated with this project is fully provided through the Green Plan (Arctic Environmental Strategy program) as part of DFO's contribution to the Inter-departmental Committee on Northern Contaminants Research. Collaboration occurs with D. Stone (Department of Indian Affairs and Northern Development), L. Barrie and D. Gregor (Department of

Environment), B. Hrycyk (Department of Energy, Mines and Resources), and R. MacDonald and D. Muir (Department of Fisheries and Oceans) through annual workshops and planning meetings and joint publications. The study is a continuation of work begun to document the occurrence of organochlorines in seawater and lower trophic-level marine biota in samples collected from the Canadian Ice Island. New resources provided by the Green Plan (Arctic Environmental Strategy program, Contaminants in Native Diets component) will allow, for the first time, seasonal sampling to document changes in concentrations of these contaminants and lipids in biota from lower trophic levels throughout the year.

Selected Involvements:

i. Collaborative Research -

This project involves collaboration with the Biological Oceanography Division (Physical and Chemical Sciences Branch) (R.J. Conover) and the DFO Central and Arctic Region (H. Welch).

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

Barrie, L.A., D. Gregor, B.T. Hargrave, R. Lake, D. Muir, R. Shearer, B. Tracey, and T. Bidleman. 1992. Arctic contaminants: Sources, occurrence and pathways. Sci. Total Environ. 122: 1-74.

Hargrave, B.T., G.C. Harding, W.P. Vass, P.E. Erickson, B.R. Fowler, and V. Scott. 1992. Organochlorine pesticides and polychlorinated biphenyls in the Arctic Ocean food web. Arch. Environ. Contam. Toxicol. 22: 41-54.

Muir, D.C.G., R. Wagemann, B.T. Hargrave, D.J. Thomas, D.B. Peakall, and R.J. Norstrom. 1992. Arctic marine ecosystem contamination. Sci. Total Environ. 122: 75-134.

Hargrave, B.T., B. von Bodungen, P. Stoffyn-Egli, and P.J. Mudie. 1993. Seasonal variability in particle sedimentation under permanent ice cover in the Arctic Ocean. Cont. Shelf Res. 12: in press.

ii. Interpretive Scientific -

iii. Scientific and Technical -

Phillips, G.A., and B.T. Hargrave. 1992. Intercalibration of organochlorine residues in biota. Can. Data Rep. Fish. Aquat. Sci. 879: iv + 65 p.

iv. Popular and Miscellaneous -

ADMINISTRATIVE/EDP PROJECTS

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Marine Fish Division Project No.: 0000

Section: Administration

Project Title: Division Administration

Project Leader: O'Boyle, R.

Other Researchers: Bowen, D.; Zwanenburg, K.; Waldron, D.; Campana, S.; Stobo, N.; Branton, R.

Work Activity: W.A.1.1.1

Key Words: administration

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1. Project Description:

Administration of the Marine Fish Division.

2. Long-Term Objectives:

Administer the Marine Fish Division efficiently and to provide scientific leadership in interpreting and accomplishing the mandate of the Division.

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

1. Provide full range of administrative and secretarial support for the BIO component. Particular attention will be given to improved requisition processing and budget reporting, the monitoring of leave and overtime and establishment of a system to control salary dollar utilization. (O'Boyle, with Stobo, Myra and McMillan)

A fully computerized financial system was developed and implemented which includes O&M, Capital, salary, overtime and leave expenditures. This system will be used to monitor budgets under the Single Operating Budget environment.

2. Develop and implement a plan for establishment of new activities at BIO and STABS, as part of the new mandate sharing arrangement. Dependent upon budgets, this plan should be completed by 31 March 1993. (O'Boyle)

Discussions were held with the acting Director (D. Aiken) and subsequently the new Director (W. Watson-Wright), on the split of administrative functions between the two sites. While not formally approved, the draft plan is being used to guide administrative activities.

3. Develop new working relationship with STABS staff which focuses on program rather than administrative issues. As part of this, develop working relationship with new Station Director. As well, conduct Division-wide long-term planning exercise. (O'Boyle)

The new working relationship with MFD/STABS based on program activities was developed. Consultations were held with the new Director on a regular basis to ensure communication on issues as and when they arose. The long-term planning was conducted as part of PREP.

4. Process tag returns from historical tag experiments. (Nelson)

Tag returns were processed as in previous years.

4. Additional Accomplishments:

1. R. O'Boyle was invited by the Australian Government to conduct a review of the Science-Industry interaction on fisheries issues that occurs in that country. The review provided insight into how improvements can be made in Australia, but also had observations relevant to Canada. (O'Boyle)

2. R. O'Boyle was invited by the World Wildlife Fund (WWF) to participate as a panellist in a workshop on Limited Access Fisheries. A presentation on the ITQ experience in Nova Scotia was given. The workshop has led to further collaborations which will be of long-term benefit to the development of regional and zonal regulatory initiatives. (O'Boyle)

3. R. O'Boyle developed new section head organization that should lead to longer-term flexibility in work assignments and greater opportunity for career development.

5. Goals/Expected Outputs for 1993:

1. Provide full range of administrative and secretarial support for Division. Complete audit of expenditure history and develop procedures to reduce costs, particularly in regards to telephones. (O'Boyle, with Stobo, Myra, McMillan)

2. Review status of computer section and consider ways and means of 1) obtaining BIO central

facility support for Division, and 2) redirecting Divisional CS resources to scientific programs. (O'Boyle, with Branton)

6. Background:

Highlights:

Developments of Single Operating Budget System; Institution of new computer system based on PC 486 technology. (O'Boyle)

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

O'Boyle, R. 1993. Fisheries management organization: A study of uncertainty. Can. Spec. Publ. Fish. Aquat. Sci.: (in review)

ii. Interpretive Scientific -

O'Boyle, R. 1993. The Management of marine habitat. Proceedings of ASFB Workshop on Habitat. 12-13 August 1992, Victor Harbour, Australia: (in press).

O'Boyle, R., C. Annand, and L. Brander. 1993. Individual quotas in the Scotian Shelf groundfishery off Nova Scotia, Canada. Proceedings of WWF/CMC Workshop. 20-22 September 1992, Annapolis, Maryland, U.S.A.: (in press).

iii. Scientific and Technical -

O'Boyle, R. 1993. Report on a visit to Australian fisheries institutions. 17-26 August 1992. Internal Manuscript.

iv. Popular and Miscellaneous -

O'Boyle, R., K. Drinkwater, B. Petrie, T. Rowell, and P. Vass. 1993. The Atlantic Fisheries Adjustment Program. Scotia-Fundy Science Review: (in press).

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Marine Fish Division / St. Andrews Project No.: 1310

Section: Computing / Gulf of Maine

Project Title: EDP Support

Project Leader: Branton, R.; Gale, J.

Other Researchers: Charlton, B.; McMillan, J.; St. Andrews Computing; BIO Computing

Work Activity:

Key Words: administration; data processing

1. Project Description:

Analyze requirements, design and implement application systems and data bases. Provides consultation and assistance for staff developing their own applications and data bases. Research new techniques for analysis and information needs to keep operations up to date with developments. Provide management procedures for Divisional data bases. Provide application and data base advice to technical users and data base personnel.

2. Long-Term Objectives:

The MFD Computer Section is responsible for the development, maintenance and effective use of MFD scientific and administrative electronic data processing systems. Activities include: requirements analysis; application/data base design and implementation; user training and support; consultation and assistance for staff developing their own applications/data bases; research into new data analysis and storage techniques.

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

1. Improve MFD/BIO local area network and associated computing facilities. Includes: ethernet LAN to all MFD/BIO and CAFSAC workstations; evaluate need for ethernet router; PC/NFS (network file system) licences for all MFD/BIO and CAFSAC workstations; MSWindows, SQL*NET and ORACLE Card for selected workstations (i.e. all Computer Section workstations and one each for Central Shelf and Southern Shelf sections); multi-user access to PC486 UNIX workstation (starting with Computer Section Data Base conversion projects); PC486 SQL*net access to STA VAX and CYBER Replacement; expanded and air-conditioned computer room; and new laser and/or colour printer(s). (Branton, Charlton, McMillan)

An ethernet LAN complete with router, print server and ftp server is operational. PC/TCP software for all MFD and CAFSAC PCs was obtained. NCSA Telnet for all MFD MACs was obtained. One copy of Interprint for MAC was obtained and is under review. All but 5 Pcs and 2 MACs are now using ethernet. (McMillan, Branton)

MSWindows was installed on all Computer Section PCs and on several scientific PCs. SQL*Net and ORACLE Card for one PC was acquired but not installed. (Charlton, McMillan, Branton)

Multi-user access to PC486 UNIX workstations for Computer Section staff, including Observer and National Sampling conversion projects using TCP/IP protocol is operational. SQL*net links between the PC486 workstations, STABS VAX and BIO CYBER were established. Problems with the CYBER portion of SQL*NET were reported. Investigation by BIO Computing revealed that NOS/VE and ORACLE upgrades on the CYBER would be required to correct the problem. Given that the CYBER will be retired shortly, this will not be done. (Charlton, Branton)

The MFD computer room was not expanded. Instead of doing this, PC486 workstations and air conditioning were installed in Bev Charlton's office. (Charlton)

The original 8 page/min (ppm) laser broke down and was retired. It was temporarily replaced by a 4 ppm laser borrowed from BIO Computing. A new 20 ppm laser was acquired as permanent replacement. A colour printer was not acquired. (McMillan, Branton)

2. Convert MFD/BIO ORACLE data base systems away from the CYBER NOS/VE platform. Includes: Commercial Samples, Commercial Landings, Groundfish Surveys and the Observer Program. Alternative target platforms in order of preference are: MFD/BIO PC486 UNIX; single user PC386 DOS; and the yet to be defined CYBER replacement. Every reasonable effort will be made to accommodate all collection/editing systems on the PC486 and only progress to other systems if absolutely necessary. The capabilities of the PC486 will require continued exploration may have to be upgraded (e.g. archive/backup hardware/software, more memory, more disk, and faster CPU). A second PC486 for ad-hoc analysis and file serving, leaving the first for collection/editing type work only, must also be considered. (Branton, Charlton, McMillan)

The PC486/33 (33 mhz CPU, 32 Mbyte RAM, 350 Mbyte disk) acquired in Oct '91 for ORACLE development, when loaded with SCO UNIX and ORACLE had little room for data and was upgraded with a 650 Mbyte of

hard disk. Conversion of the Commercial Samples and Observer Edit away from NOS/VE, using the PC486/33 was initiated. Processing trials, indicated that all MFD production computing, except Commercial Catch and multi-year Observer could be accommodated on a suitably equipped PC486. A second PC486/50 (50 Mhz CPU, 64 Mbyte of RAM, 2.5 Gbyte of disk, DAT tape, UPS) was therefore acquired. Commercial Catch and Observer will remain on the CYBER and/or its replacement which is expected to arrive in mid '93. (Charlton, Branton)

Both PC486 workstations were configured with various portions of the DOS operating system, UNIX operating system and ORACLE relational data base management system. Automatic backup procedures were developed and are now being used by BIO Computer Centre operations staff to maintain offsite backups of both PC486 workstations. Network File System (NFS) software was installed on both PC486 workstations and has been successfully tested from the BIO and STABS LANS. Installation of equipment and software for this project has been extremely difficult. Problems included: hardware errors introduced by vendor trained service staff; defective installation procedures provided by software developers; defective software requiring patches; and incorrect/incompatible software versions. Major effort was required to overcome these problems. (Charlton)

3. Continue support and development of the Commercial Samples data system and continued expansion and improvement of services to field staff. Includes: conversion away from CYBER NOS/VE; end-user access to the ORACLE data base; PC Alsys software support and user training; commercial catch at age data products; length frequency data products; and all Port Technicians on line. (Charlton, Zwanenburg)

The Commercial Samples Entry System successfully provided all '91 sample data collected and entered by National Sampling Technicians (i.e. BIO, Lunenburg, Yarmouth, and Lockeport) to the scientific staff at BIO and STABS in time for the '92 CAFSAC meeting. (Charlton, Zwanenburg)

Conversion from NOS/VE to UNIX was initiated. The Main Sample Entry form was converted from SQL*Forms 2.3 to 3.0, Pro*Fortran extraction programs were converted from NOS/VE to UNIX, and some procedures were converted from NOS/VE to UNIX. Conversion of Ager Entry form and SQL*PLUS report and system testing are outstanding. (Charlton)

End-user access to the Commercial Samples ORACLE data base was provided in the form of a briefing and written handout to all interested MFD staff. PC Alsys software, user training and support were provided to all BIO assessment staff. PC Alsys was successfully used by all BIO requiring Commercial and Observer Program catch at age information for the '92 CAFSAC and NAFO meetings. (Charlton, Zwanenburg)

Development of commercial catch at age and length frequency data products and extension of direct entry all National Sampling Technicians (i.e. Sydney and Canso) were postponed until UNIX conversion is complete.

4. Continue support and development of Commercial Landings data system. Includes: ZIF working group; ZIF production runs using old (i.e. flat file) system for 1992 assessments; ORACLE ZIF test runs for 1992 assessments; conversion of ORACLE ZIF away from CYBER NOS/VE; and end-user access to the ZIF ORACLE data base; and more timely access to IQ data bases; and ZIF Verification Workshop in preparation for 1993 assessments. (Annand, Branton, McMillan, ZIF Working Group)

The Commercial Landings System successfully provided '91 data to scientific staff in all Atlantic Zone regions in time for the '92 CAFSAC meeting. (McMillan)

The ZIF working group prepared a test ORACLE data base of '91 catch data (not in time for '92 CAFSAC meeting) using Quebec, Gulf and Scotia-Fundy data. Newfoundland data could not be loaded due to date coding problems. Comparisons of Scotia-Fundy flatfish stocks using ORACLE and SPSSx produced identical results. (McMillan, Annand, Branton)

End-user access to the test ZIF ORACLE data base was provided in the form of a briefing and written handout to all interested MFD staff. (McMillan)

A request for more timely access to IQ data bases was prepared for, presented to, and accepted by Statistics Branch. Data should be available in early '93. (McMillan, Annand)

A '92 ZIF Verification Workshop was held and attended by all Atlantic Science and Statistics Branches except Newfoundland Stats. Agenda items included: data base status; draft job descriptions for zonal regional data coordinators, region by region comparisons of species and gear codes; and region by region processing change requests. The processing change requests were subsequently endorsed by SSSS and the regional Science Directors and should be in affect for the '93 CAFSAC meeting. (McMillan, Annand, Branton)

Conversion of ORACLE ZIF away from CYBER NOS/VE was postponed. The CYBER replacement is now scheduled for mid '93.

5. Continue support and development of Observer Program data system. Includes: review and continued development of the CYBER NOS/VE system ; end-user access to the ORACLE tables; interfacing to PC ALSYS; conversion away from CYBER NOS/VE; and development of various standardized data products. (Branton, Showell)

The CYBER NOS/VE Observer system was successfully used to process all '92 Observer data. A number of editing problems were identified and corrected. All years of Observer data, dating back to 1978 were available to MFD and FHM staff. End-user access to the Observer data base was provided in the form of a briefing and written handout to all interested MFD staff. (Showell, Branton)

The Observer Data Base was interfaced to PC ALSYS by developing an extraction procedures based on the Commercial Samples system procedures. Observer catch at age information was successfully used for the '92 CAFSAC and '92 NAFO meetings. (Bourbonnais, Charlton, Branton)

Conversion of the Observer Edit away from CYBER NOS/VE was initiated. ORACLE Data Loader scripts were converted to SQL*Loader and the Pro*Fortran editor was converted from NOS/VE to UNIX by Software Kinetics Limited. A prototype SQL*Forms 3.0 user interface was developed. Report procedures, system integration and testing are outstanding. (Branton)

Development of standardized data products was conducted by Observer program staff and did not require direct computer section involvement.

6. Continue support and development of Groundfish Survey data system. Includes: maintain copy of data base at BIO for end-user access; access to STA via SQL*NET; review of data base structure; and development of various standardized data products. (Branton, McMillan, Gale)

Maintaining a copy of the Groundfish survey data base at BIO for end-user access was abandoned in favour of ad-hoc user access to the STABS VAX.

Access to STABS via SQL*NET has been established, however problems with CYBER SQL*NET have been identified therefore limiting its usefulness as an effective end-user tool. SQL*NET has been installed on the PC486 workstations and will be used instead. (Charlton, Branton)

A review of Groundfish Survey data base structure was conducted and provided to the Survey's data manager. Development of standardized data products was investigated resulting in SQL*PLUS scripts to duplicate a number STRAP reports. These scripts were subsequently used to identify a number of problems in the Surveys data base and the STRAP program. These are currently under investigation by the Survey's data manager. A number of ad hoc queries were developed, including: biomass spectrum, under-utilized species, age at maturity and a trawl opening plot. (Simon, Comeau, Beanlands, Smith, Branton)

7. Continue support for and involvement in MFD Computer User Group. This includes: selecting, recommending and supporting a PC statistical graphic standard; Structured Query Language Interest group; development and support of MFD/BIO Hardware/Software inventory data base; and experiments with INFOCUS mapping system. (Branton, Charlton, McMillan, MFD Computer User Group)

The MFD Computer User Group appears to have been abandoned. There has been some computer related discussions at General Staff meetings.

A MFD/BIO hardware/software inventory data base was developed with the aid of Kent Woolem (a summer student) and loaded with network configuration data. Loading of other data is outstanding. (McMillan)

SQL Interest Group sessions were held to provide information on all currently available production data bases. (Charlton, McMillan, Branton)

8. Improve graphical and geographical analysis capability. Includes: production version of PC ACON; PC486 UNIX version of ACON; and ORACLE Data Base links. (Branton, Black)

The production version of PC ACON remains under development. Development has shifted from simple Borland C on DOS to Borland C on DOS with the PHARLAP DOS extender and a number of prototypes were developed. Problems identified with the first prototype have been eliminated, however new ones have appeared and are under investigation. A PC486 UNIX version of ACON with ORACLE Data Base links has been developed and subjected some limited testing. (Black, Branton)

9. Improve MFD/BIO administrative tracking systems. Includes: Paradox PC data base. (McMillan, O'Boyle, Stobo, N.)

An administrative data base system using PC Paradox was developed and successfully used for the staffing of all '92 field programs and the tracking of all '92 budgetary expenditures. (McMillan, Stobo, N.)

10. Ongoing external technical liaisons. These include: MFD/STA computing staff; BSB Computer Committee, Scotia-Fundy Informatics Working Committee and various subcommittees; BIO Computer Centre; and STA Computer Centre. (Branton, Charlton, McMillan)

Contacts were maintained with STABS computing staff, including day-to-day use of the STABS VAX, use of the Research Survey data base, and the transfer of data between BIO and STABS. (Charlton, McMillan, Branton)

Contacts were maintained with the BSB Computer Committee, including representing MFD, chairing and reporting all meetings, preparing the BSB EDP Plan and preparing the EDP Status Report. (Branton)

Contacts were maintained with Scotia-Fundy Informatics Working Committee and various subcommittees, including: development of CYBER Replacement Specifications, Evaluation of CYBER Replacement proposals, and declaration regional PC/TCP software standard. (Branton)

Contacts were maintained with BIO Computer Centre, including: day-to-day use of the CYBER, CYBER ORACLE defragmentation, and MFD PC486 backup procedures. (Charlton, McMillan, Branton)

11. Participate in field trips and cruises. (Branton, Charlton, McMillan)

J. McMillan - 5 May 1992 to 30 June 1992 -- Sable Island harbour seal studies
- 22-26 July 1992 -- Sable Island harbour seal studies (branding)
- 4-27 January 1993 -- Sable Island harbour/grey seal studies

B. Charlton - 6-17 July 1992 -- Alfred Needler - Scotian Shelf groundfish survey

12. Complete development of Pelagic Edit System online age and length frequency data entry. (Gale)

See St. Andrews.

13. Revise the groundfish edit system and document as part of the Groundfish Surveys Manual. (Gale)

See St. Andrews.

14. Continue the development of an APL to ORACLE interface and/or investigate STSC option. (Gale)

See St. Andrews.

15. Develop a larval herring data base and utilities. (Gale)

See St. Andrews.

16. Revise the ZIF data base with the final structure as set by the ZIF working group. (Gale)

See St. Andrews.

17. Monitor the performance and tune all major Divisional data bases. (Gale)

See St. Andrews.

18. Continue development and documentation of data management utilities for updating and maintaining all production data bases. Canadian and U.S. groundfish surveys, commercial landings and commercial samples data bases. Also, pelagic samples and new larval data bases. Assist the various data base managers with effective use of new utilities. (Gale)

See St. Andrews.

19. Investigate real time data entry and editing at sea for the groundfish surveys. (Gale)

See St. Andrews.

20. Continue to instruct technical users and data base personnel and provide application and data base advice and assistance. (Gale)

See St. Andrews.

21. Continue to provide technical assistance and advice for the operation of the PathWorks and X-Windows environments. (Gale)

See St. Andrews.

22. Continue maintenance of major Divisional applications including STRAP and CATCH. (Gale)

See St. Andrews.

23. Expand list of drivers available for ACON. (Black, Gale)

See St. Andrews.

4. Additional Accomplishments:

A correspondence tracking data base using PC Paradox was developed and successfully used by the CAFSAC office for all '92 correspondence. (Murphy, Branton, Summer Student)

5. Goals/Expected Outputs for 1993:

1. Continue support and improvement of MFD/BIO local area network and PC486 workstations, including: connect all PCs and MACs to LAN; provide end-user training for LAN & PC486; acquire second laser printer and server; acquire colour printer; acquire statistical software for PC486; upgrade PC486/33 to 66mhz and add DAT drive; upgrade SCO UNIX to latest release; and load hardware/software inventory data base. (Branton, Charlton, McMillan)

2. Continue support and development of the Commercial Samples data system, including conversion to PC486, extension of direct entry to Canso and Sydney port technicians, connection of all port technicians to Scotia-Fundy Regional Network, training all port technicians to use the new system, and development of new data products as requested by program staff. (Charlton, Zwanenburg)

3. Continue support and development of Commercial Landings data system , including processing support for '93 assessment meeting, extending ORACLE system to include positional data, ORACLE data base loaded with '91 and '92 data in time for '93 assessment meeting, conversion to CYBER replacement, begin loading of historic data, direct access to Log Book System, investigation of Operations Centre procedures, '93 ZIF Verification Workshop. (Branton, McMillan, Annand)

4. Continue support and development of Observer Program data system, including complete conversion edit system to PC486 UNIX, and migration of historic data to CYBER replacement. (Branton, Showell)

5. Continue support and development of Groundfish Survey, including continued development of data products, development of SQL*NET links to STABS and paper for Fisheries Society of America titled 'Data Systems for the Scientific User'. (Branton, Smith)

6. Improve graphical and geographical analysis capability, including completion of PC & PC486 ACON development, development of ACON examples Guide. (Branton, Black)

7. Support and improvement of MFD financial tracking systems, including interfaces with online Financial and Pay systems. (McMillan, Stobo, N.)

8. Ongoing external technical liaisons, including CYBER Replacement Project, BSB Computer Committee, BIO Computer Centre, and STABS Computer Centre. (Branton, Charlton, McMillan)

9. Participation in field trips and cruises. (Branton, Charlton, McMillan)

6. Background:

Highlights:

Acquisition and installation of second PC486 Workstations, including SCO UNIX and ORACLE software; installation of local area network (i.e. TCP/IP ethernet), including router, PC & MAC network adapters, PC/TCP software, new 20 ppm laser printer, and print server; development of new ZIF data base; and initiation of conversion from NOS/VE to UNIX for Commercial Samples and Observer data systems. (Branton, Charlton, McMillan)

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

Convert Observer Edit from NOS/VE to UNIX. (Software Kinetics, Branton)

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

iii. Scientific and Technical -

Branton, R. 1992. ZIF Verification Workshop Report#2.

Branton, R. 1992. BSB 1992 EDP Status Report.

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 200

Section: Informatics and Administrative Section

Project Title: Informatics

Project Leader: Swetnam, D.

Other Researchers: Hunter, C.

Work Activity: W.A.1.1.1.3

Key Words: support; data processing; computer

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1. Project Description:

This project will change from 200 to 2310 for 1993.

This project provides essential support for the research scientists and other BF&A Division staff. The provision of computing resources, training, development of specialized computer software, EDP planning, selection and procurement of EDP equipment and software, and consultation on data processing matters for the Division and Laboratory have been concentrated into this project. The project personnel also provide critical contacts with the fast moving computer field, making it possible for the scientific staff to accrue the benefits of recent developments and new techniques.

2. Long-Term Objectives:

To provide electronic data processing and analyses to scientific research and management projects of the BF&A Division by:

1. Computer programming, systems analysis, and consultative services to Division personnel.
2. Making available computing facilities and resources, both hardware and software, to the Division.
3. Designing and implementing data entry, storage and retrieval systems.

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

1. To provide leadership to the Section with particular emphasis in 1992 on the new mathematics position. (Swetnam)

This was provided with the section meeting the needs of the Division. The new mathematical position is offering a valued service to clients. A computer newsletter was started and staff were given new computer related information at staff meetings.

2. Supply day-to-day EDP service, support, development and training. (Hunter, Swetnam)

Hunter; installation and upgrading of software, writing of SQLPLUS scripts, additional features added to lobster length frequency, system, selection and purchasing of computer peripherals, recovery of lost data files.
Swetnam; network installations and upgrades, equipment selection and purchases, file translations and recoveries, day to day software advice.

3. Integration of the Halifax Lab analyses systems via Regional WAN and SQL*NET to off site ORACLE databases. (Swetnam, Hunter, Black)

Project slowed due to technical problems in providing SQL*NET access into St. Andrews; access expected in January. The Bay of Fundy database will be used as the pilot project.

4. Evaluate and, if feasible, extend, E-Mail services to the desktop in a real time fashion, and train staff. (Swetnam)

This was evaluated; software selected and installed, users trained and the system is working very well.

5. Continued training of staff in the use of newly implemented systems such as ORACLE. (Hunter)

J. Tremblay, R. Duggan, D. Duggan and M. Eagles trained in use of Lobster data base. Mark Lundy trained in use of Bay of Fundy scallop data base.

6. Design creation and implementation of ORACLE data bases such as IOP invertebrate edits. (Hunter, Swetnam)

The Bay of Fundy scallop logbook data base (90-92 data) and analysis system was created in St. Andrews. IOP invertebrate system was not done due to the offshore clam fishing effort moving to Nfld. waters.

7. Conversion of Cyber systems to Cyber replacement(s). (Hunter, Swetnam)

Due to the delay in funding, delivery of the new equipment is not expected until mid Feb. 93, if at all.

8. Advise the Branch Executive and SIWC on EDP matters. (Swetnam)

D. Swetnam stepped down as BSBCAC chair, but retains chair of Communications subcommittee and technical committee participation. Much time was required as tech. committee rep. in preparing the proposal for the new science computing environment.

4. Additional Accomplishments:

1. The section assisted staff from other Divisions; FWA, HED and MFD. Support was also given various graduate students, visiting scientists, summer students and other Branches of DFO. (Swetnam, Hunter, Rodger)

2. Additional scallop logbook analyses programs were written. (Hunter)

3. All ORACLE database forms were converted to version 3.0. (Hunter)

4. Documentation of the Lobster Tag system was prepared. (Swetnam)

5. Bay of Fundy Scallop data base bulk load Fortran edit system written, tested and implemented. (Hunter)

5. Goals/Expected Outputs for 1993:

1. To provide leadership to the Section, with particular emphasis on service to clients, and participate in Division and Laboratory Management Committees. (Swetnam)

2. Supply day-to-day EDP service, support, development and training. (Hunter, Swetnam)

3. Integrate existing computer resources and train staff in the use of the new science computing environment. (Cyber replacement, Hunter, Swetnam)

4. Manage, maintain and enhance the Local Area Network and its connections to the Wide Area Network. (Swetnam, Hunter)

5. Continue to develop new Oracle data bases (Lobster Logbook a possibility), train staff, enhance existing data bases and port all existing to the new Oracle environment at BIO. (Hunter)

6. Ensure a smooth conversion to the new computing environment at BIO, this will require some UNIX training for Dave and Chris.

6. Background:

Highlights:

The upcoming year will see another conversion effort end as the Cyber lease expires, a continuance of ORACLE work and closer network ties with the Regional network. Also a considerable amount of time will be spent training staff to use new software systems.

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 -

Hunter, C.M. & Tremblay, M.J. 1992. A Database for catch and length composition data related to the Scotia-Fundy lobster fishery. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2149

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 220

Section: Informatics and Administrative Section

Project Title: Statistical Consulting

Project Leader: Rodger, R.

Other Researchers:

Work Activity: W.A.1.1.1.3

Key Words: statistical analysis; sampling; experimental design

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1. Project Description:

This project will change from 220 to 2320 for 1993.

Collaborate with and advise other researchers on projects requiring experimental design and\or statistical analysis and modelling.

2. Long-Term Objectives:

To act as the mathematical and statistical consultant for the Benthic Fisheries and Aquaculture Division. To provide advice on appropriate techniques used in the assessment and research of benthic populations and develop sound sampling techniques and experimental design.

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

1. Collaborate with and advise other researchers on projects requiring experimental design and\or statistical analysis and modelling.

Collaborate with and advise other researchers on projects requiring experimental design and/or statistical analysis and modelling (see below).

2. Assisting Dr. J. Castell in the design and analysis of his experiment on various dietary equivalents for lobsters and their attractant properties.

Assisting Dr. J. Castell in the design and analysis of his experiment on various dietary equivalents for lobsters and their attractant properties. Goal met. Design completed and implemented. No further consultation on analysis.

3. Assisting J. Kean-Howie in the analysis of her data on nutritional requirements of lobsters.

Assisting J. Kean-Howie in the analysis of her data on nutritional requirements of lobsters. Goal partially met. This process is continuing.

4. Assisting Dr. R. Miller in the design, analysis and interpretation of his experiments on the effect of 'strangers' and of local population density on the capture rate of crabs.

Assisting Dr. R. Miller in the design, analysis and interpretation of his experiments on the effect of 'strangers' and of local population density on the capture-rate of crabs. Goal met. Design implemented; no further involvement in analysis, a comment provided on interpretation.

5. Advising B. Jessop on the analysis and interpretation of his data on fecundity in anadromous alewives and blueback herring.

Advising B. Jessop on the analysis and interpretation of his data on fecundity in anadromous alewives and blueback herring. Goal met. This item is finished.

6. Assisting Dr. C. Hudon in her analysis of the advection of lobster in Iles de la Madelaine.

Assisting Dr. C. Hudon in her analysis of the advection of lobster in Iles de la Madelaine. Goal met. The data proved to be insufficient for Dr. Rodger to answer the questions that were being asked.

7. Assisting K. Freeman in the analysis and interpretation of his data on condition indices for mussels.

Assisting K. Freeman in the analysis and interpretation of his data on condition indices for mussels. Goal met. This item is finished.

8. Advising R. Santos on the analysis and interpretation of his data on the distribution of seaweeds.

Advising R. Santos on the analysis and interpretation of his data on the distribution of seaweeds. Goal partially met. This work continues.

9. Advising Dr. Tremblay on sample-size and power for his data on assessment of catch.

Advising Dr. J. Tremblay on sample-size and power for his data on assessment of catch. Goal met. Drs. Tremblay, Pezzack and Rodger gave a paper on this topic at the Year of the Lobster meeting of CAFSAC in November 1992. A revision of that paper is being prepared for publication.

10. Advising R. Ugarte in the analysis and interpretation of his data on the colony of berried females and experimental design of laboratory studies.

Advising R. Ugarte in the analysis and interpretation of his data on the colony of berried females and experimental design of laboratory studies. Goal met. This item is finished.

11. To advise T. Lee (Honours BSc) on the analysis and interpretation of his data on lobster molting and sexual behaviour.

Advising T. Lee on the analysis and interpretation of his data on lobster molting and sexual behaviour. Goal met. This item is finished.

12. If time and priorities permit, plan and implement a workshop on multiple contrasts, power and sample size.

Provided a workshop on the evaluation of multiple contrasts, power and sample size in statistics. Goal met. This continued for six sessions. Attendance ranged from about 17 scientists to 6. The series was quite successful and it might be possible to offer another, but geared more closely to research actually in progress.

4. Additional Accomplishments:

Other scientists (C. DiBacco, G. Sharp, G. Robert, M. Lundy, D. Roddick, T. Kenchington, S. Lall, H. Stone, J. Kean-Howie) sought advice and assistance, which were given. Attended both the Statistics and I&MP, CAFSAC subcommittee meetings

5. Goals/Expected Outputs for 1993:

1. Collaborate with and advise other researchers on projects requiring experimental design and/or statistical analysis and modelling.(see below)

2. Assisting J. Kean-Howie in the analysis of her data on nutritional requirements of lobsters.

3. Advising R. Santos on the analysis and interpretation of his data on the distribution of seaweeds.

4. Preparing for publication, with M.J. Tremblay and D. Pezzack, manuscript on sample-size and power in assessment of catch.

5. Assisting Dr. T. Kenchington in the analysis and interpretation of his hook and bait size experiment.

6. Preparing a comment on SIU units and spelling, for circulation.

7. Continue as Division representative on the Statistics, Sampling and Surveys Subcommittee of CAFSAC.

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.: 225

Section: Population Biology

Project Title: Section Administration

Project Leader: Robert, G.

Other Researchers:

Work Activity: W.A.1.1.1.3

Key Words: administration

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1. Project Description:

This project will change from 225 to 2500 for 1993.

The Section is responsible for providing biological advice on the management of commercially important invertebrate and marine plant resources and carry out research deemed to improve the biological advice. Administrative and scientific leadership is provided to Section personnel.

2. Long-Term Objectives:

Provide an environment conducive to high quality biological advice and excellent science given the resources available. Provide accurate and timely administration.

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

1. To provide leadership in the management of all Section resources.

Initiated an industry-funded proposal to explore the possibility of a commercial shrimp fishery off southwest Nova Scotia. Review of invertebrates research projects to match the reductions in available resources. Supportive role in a CAFSAC workshop entitled 'The Year of the Lobster'. The workshop provided an excellent opportunity to establish reference points with respect to current issues in assessment-related lobster science. Participation in discussion group of CAFSAC invertebrates subcommittee to examine the subcommittee's terms of references.

2. The provision of accurate and timely biological advice by Section staff, in a manner comprehensible to the client.

Section staff have attended numerous meetings of pertinent Advisory Committees, ad hoc meetings dealing with local issues of multi-resource usage,environment, and habitat. They have also participated in sessions on habitat issues in the Canadian Arctic and jurisdiction of the marine plants resource. They were involved as DFO representatives at Fishery Exhibitions and the Digby Scallop Days. They have also been involved in discussions about native fisheries in southwest Nova Scotia and Cape Breton (Bras d'Or Lakes).

3. That the scientific projects carried out are those deemed most important to improve biological advice.

An evaluation of scallop resources within the territorial seas off Yarmouth, N.S. was carried out to supplement our biological advice toward inshore stocks. Lobster scientists in the Section set up a joint pilot project in the Shad / Prospect Bay area to consider the potential of lobster recruitment indices.

4. To provide Section personnel with opportunities for career development.

Section personnel were provided with opportunities for development (assignment request and training). Lobster technicians took a database management course in Oracle; this will allow enhancement and timely update of the lobster fishery database. Put Ang, University of British Columbia, post-doctoral fellow on marine plants population modeling offered more than modeling in exchanges with Section's personnel.

5. To assist in the management of both the Division and Laboratory, and in 1992-93, to provide advice on choosing a creative mechanism for allocating meagre O&M resources.

Consultations via the Division Executive and Laboratory Management Committees. Judicious planning and sharing of decreasing resources were required. Up-to-date inventory of spent resources(O&M and especially OT) also proved most useful.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

1. To provide leadership in the management of all Section resources.
2. The provision of accurate and timely biological advice by Section staff, in a manner comprehensible to the client.
3. That the scientific project carried out are those deemed most important to improve biological advice.
4. To provide Section personnel with opportunities for career development.
5. To assist in the management of both the Division and Laboratory, and in 1992-93, to provide advice on choosing a creative mechanism for allocating meagre O&M resources.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

Section personnel are approached on numerous occasions to provide scientific background information to journalists in charge of articles for fishery trade publications (scallop, lobster, marine plants, etc) when it is not for direct interviews over a wide range of topics from assessments to habitat issues. Many scientists have also been invited at local High Schools for varied Science presentations; contingents of students (Student Provincial Environmental Conference taking place at Cole Harbour District High School was the largest) visited the Halifax Laboratory to experience invertebrates sciences first hand.

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.: 226

Section: Division Chief/Laboratory Director

Project Title: Division/Laboratory Administration

Project Leader: Pringle, J.

Other Researchers: Field, B.; Covey, M.; Shellnutt, S.; Wentzell, C.; Clayton, V.

Work Activity: W.A.1.1.2.1; W.A.1.1.1.3; W.A.1.1.2.3

Key Words: administration ; planning

1. Project Description:

This project will change from 226 to 2300 for 1993.

The Division has three equally important, areas of responsibility, all of which involve the provision of biological advice: first, Regional (excluding the Bay of Fundy) stock assessment advice is provided on commercially important, invertebrate and marine plant resources; secondly, advice is provided on the disease and nutrition of commercially important finfish and invertebrate species; and thirdly, advice is provided on those species of invertebrates important to aquaculturalists along the southern and eastern shores of Nova Scotia. Division personnel carry out that research deemed most important to upgrade the advice. This project is responsible for ensuring that Division personnel have sound scientific leadership and that the HFRL provides good administrative support for all occupants.

2. Long-Term Objectives:

Maintain a Division whose scientific personnel provide the best possible biological advice to clients, and conduct the research most pertinent for improving the quality of advice given. Maintain the best possible research environment for laboratory personnel that available resources can provide. Maintain an administrative team that provides the best possible service to scientific personnel and completes administrative tasks in a timely and accurate fashion.

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

1. To ensure the Division is financially solvent through the fiscal year.

Goal met. The Division's fiscal resources were well managed.

2. To develop a unique plan for the funding of stock assessment and resource science projects based on an O&M budget insufficient to continue the use of past practices in the dispersion of monies.

Goal not met. The Division monies were allocated using the same scheme as in the past.

3. To ensure the Division meets its administrative and advisory responsibilities in a timely and professional manner.

Goal met.

4. To ensure significant improvements in the publishing record of certain Division members.

Goal met. Plans were put in place which has improved the publication goals of the Division.

5. To organize and chair meetings, both of the Division Management Committee and Staff, and attend meetings of the Building Management Advisory Committee, Tuesday Club, Branch Advisory Committee and others as arranged.

Goals met. Most meetings attended. Those chaired had prearranged agendas and minutes followed.

6. To take a course in science leadership (possibly at the Canadian Center for Management Development).

Goal not met. Course cancelled by organizers.

7. To perform the duties of Core Member of the CAFSAC Invertebrates and Marine Plants subcommittee.

Goal not met. Core member role transferred to another Divisional member.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

1. To ensure the Division is financially solvent through the fiscal year.

2. To ensure the Division meets its administrative and advisory responsibilities in a timely and professional manner.

3. To ensure significant improvements in the publishing record of certain Division members.

4. To organize and chair meetings, both of the Division Management Committee and Staff, and attend meetings of the Building Management Advisory Committee, Tuesday Club, Branch Advisory Committee and others as arranged.

5. To take a course in science leadership (possibly at the Canadian Center for Management Development).

6. To play a key role in planning the move of HFRL staff to BIO; to work toward the provision of excellent facilities at the new location.

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.: 235

Section: Informatics and Administrative Section

Project Title: Resource Mapping and Special Projects

Project Leader: Black, G.

Other Researchers: Robert, G., Branton, R., Hunter, C.

Work Activity: W.A.1.1.1.3

Key Words: resource surveys; mapping; data processing

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1. Project Description:

This project will change from 235 to 2330 Resource Mapping and Analysis for 1993.

Conducts the Branch Resource Mapping Program. Undertakes projects requiring specialized computer graphics skills and methods, and provides support to other projects with mapping or computerized graphics requirements. Provides analytical support for the offshore scallop assessment.

2. Long-Term Objectives:

Provide a vehicle in which the Branch's research analyses are facilitated, allowing the results to receive wider distribution in support of the DFO goal of increasing the visibility of Science Sector programs.

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

1. If the Atlas publication series is continued, conduct work toward an additional publication. The subject may be cod, herring, or some other Branch research area. Final determination of the direction has yet to be determined. (Black)

Goal met. Additional work was required on the Scallop Atlas which is now in press. A decision was made not to continue with additional atlases at this time.

2. Extend the graphics software program ACON to include support for interprocess communication, presentation of variance estimates, and vector/matrix operators. (Black)

Goal met. Added support for interprocess communication, enhanced textual output. In addition, support for the CMYK colour model, generalized colour names, and colour ramps to support a greater number of colours in displaying colour-shaded contoured data were added. Enhancement of variance estimates is ongoing.

3. Participate in the 5zc scallop assessment as required. Document existing assessment techniques used more fully. (Robert, Black)

Goal met. Documentation is pending changes to the interface.

4. Improve the interface and documentation for the Graphical Tuning Assessment software. (Black)

Goal met. The assessment software used for the 5zc scallop assessment was modified to improve the user interface, and provide a more flexible basis for evaluating alternative models in the assessment. The software was extended to include support for a crustacean yield per recruit model. (see additional accomplishments below)

5. Support the VAX and PC implementations of ACON as directed. (Black, Branton)

Goal met. Revised versions of ACON were released for both the PC and VAX.

6. Integration of Lobster and Scallop databases and ACON using imbedded SQL scripts for automated graphical analysis. (Black, Hunter)

Goal not met. This project was re-scheduled pending the availability of SQL-net support at St. Andrews. Estimated completion date is March 1993 (SQL-net dependent).

7. Research and analysis as mandated by line management during the year. (Black)

Goal met. The project leader was involved in enhancing ACON used in the creation of the ESA Ocean Productivity Atlas produced by Biological Oceanography Division. In addition, to the Mac, PC, and VAX versions of ACON, unix versions were implemented on the Stardent (non-ANSI standard), SCO486 unix and NeXt (ANSI standard) platforms.

4. Additional Accomplishments:

The Caddy (1979) crustacean yield per recruit model was rewritten as an interactive graphical software package, and the paper 'Graphical Tuning of a Crustacean Yield per Recruit Analysis' was submitted at the CAFSAC 'Year of the Lobster' session. Interest in this software has been expressed from a number of Regions.

The project leader continued to be involved in numerous ad hoc, but related studies, which impacted on the completion of the expected outputs.

5. Goals/Expected Outputs for 1993:

1. Participate in the 5zc scallop assessment. (Black, Robert)

   This project continues the past involvement in the 5zc scallop assessment in an active support role. This project will adapt assessment software to the quarterly weight based scallop model by modifying existing software, testing new models, and improving the user interface to the software.

2. Graphical representation of stock status information and management risk analysis. (Black, Mohn)

   This project would provide a graphical interface to integrate knowledge of the stock status and management/conservation criteria. A status data base would be developed which is integrated with yield per recruit, production, spawning stock biomass models. The package would allow scientist to investigate management options interactively with reference to biological/management criteria. A working program would be developed in 1993/4.

3. Integration of spatial information into stock assessments. (Mohn, Black)

   This project is defined under MFD project 1022 - 4VsW Cod Assessment. It is repeated here as it is expected to be a significant portion of the work plan for 1993/94. Expected output for 1993/4 are the preparation of the data and the development of prototype models.

4. Graphics Software Development for the BOD Ocean Productivity Atlases. (Black, White)

   There are a number of issues raised from the production of the last Ocean Productivity Atlas which should be addressed to improve the document production process. Examples of the issues include: the creation of improved dvi output from Tex for colour production, optimization of the ACON delaunay triangulation, incorporation of portions of ACON as an AVS module, and improved colour output for ACON. This is raised as a separate project from the Ocean Productivity Atlases, as the results are usable by a much larger group of users, for a wide variety of projects. The final choice of a specific task to implement would depend on BOD priorities during the Atlas production.

5. Graphics Software Support. (Black)

   The wider implementation of ACON on a larger number of platforms will necessitate an increased level of support. If a suitable cross-platform development package is acquired, a multi-platform windowing version of ACON will be developed.

6. Research and analysis as mandated by line management during the year. (Black)

6. Background:

Highlights:

Participation in the 5zc scallop assessment remained a challenging task for this review period.

ACON has proved successful in providing the required functionality to fill a number of application niches not yet supported by commercial software. Development of this tool will continue as necessary to meet new requirements for scientific visualization when appropriate.

Selected Involvements:

i. Collaborative Research -

G. White - Extension of colour support for ACON. Implementation of ACON on the Stardent, and NeXt computers.

R. Branton - Implementation of ACON on the PC, and SCO486 unix computers.

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

v. Other -

7. Publications:

i. Primary -

ii. Interpretive Scientific -

Black, G.A.P., R.K. Mohn, G. Robert, and M.J. Tremblay. 1992. Atlas of the biology and distribution of the Sea scallop Placopecten magellanicus and Iceland scallop Chlamys islandcus in the Northwest Atlantic. Can. Spec. Publ. Fish. Aquat. Sci. XXXX. (in press)

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: Benthic Fisheries and Aquaculture Project No.: 241

Section: Aquaculture

Project Title: Administration - Aquaculture Section

Project Leader: Cornick, J.

Other Researchers:

Work Activity: W.A.1.1.2.1; W.A.1.1.2.3

Key Words: administration; data processing

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1. Project Description:

This project will change from 241 to 2410 for 1993.

Manage administration of research and service unit comprising 16 PYs and $256K.

2. Long-Term Objectives:

Overall effective management of section programs within budget allocations.

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

1. Provide effective administrative and scientific leadership to the section. Emphasis will be placed on bringing a backlog of data to publication stage. (Cornick)

Goal met. Assumed A/section head duties in April when D. Scarratt placed on assignment. Goals partially met. (A) Administrative objectives met: (1) Policy of fiscal restraint initiated with more responsibility delegated to project leaders to manage budgets. Successful to date; budgets although low are not in deficit; (2) Encouraged project leaders to seek non-DFO funding to supplement dwindling A base support. Appears successful as 3 projects have Joint Venture Agreement funding: (B) Scientific leadership objectives partially met; most emphasis has been on admin. problems but some emphasis on resolving problems within the Molluscan Culture Unit. (Cornick)

2. Contribute to Division and Laboratory leadership. (Scarratt)

Goal met. Morale within the section appears relatively high despite staffing and budget constraints. Time spent on trying to minimize the impact of a recent staffing freeze and potential staffing cuts appears to have been partially successful. (Cornick)

3. Review format and organize the 15th Regional Fish Health Workshop. (Scarratt)

Goal not met. Due to budget and time constraints the 15th Regional Fish Health Workshop was deferred to August, 1993, and will be held in conjunction with the AAC meeting in Charlottetown. G. Olivier will chair the workshop and preliminary organization is underway.

4. Co-chair the Laboratory Safety Committee. (Scarratt)

Goal not met. The co-chair of the Safety Committee was reassigned due to reassignment of D. Scarratt.

5. Coordinate reviews of lease and permit applications for Branch (Project 247 1989/90). (Scarratt)

Goal met. Fifteen applications for aquaculture leases were reviewed to mid Nov. 92. (Cornick)

4. Additional Accomplishments:

Considerable effort was expended in developing joint venture agreements with clients.

5. Goals/Expected Outputs for 1993:

1. Provide effective administrative and scientific leadership to the section. Emphasis will be placed on fiscal management and publication of data backlog. (Cornick)

2. Contribution to Division and Laboratory leadership. (Cornick)

3. Review format and plan the 16th Regional Fish Health workshop. (Cornick)

4. Coordinate reviews of lease and permit applications for Branch. (Cornick)

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

iii. Communications -

iv. Contracts Administered -

Darcel Williams - Joint venture Agreement with N.B. Salmon Growers Assoc.

Katharina Keiser - Contract for BKD Broodstock Monitor Program.

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.: 300

Section: Administration

Project Title: Division Administration

Project Leader: Ritter, J.

Other Researchers: Glass, D.

Work Activity: W.A.1.1.1

Key Words: research direction, Division administration

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1. Project Description:

This program manages the overall scientific and administrative operation of the Division by providing: (a) professional level advice and direction to Section needs; (b) administrative support to all staff; and (c) executive level contact with clients, the general public, and other government divisions and branches (federal, provincial, international).

2. Long-Term Objectives:

The continuing objective of this project is to direct the activities of the FW&A Division to effectively meet the requirements of the Division's mandate.

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

1. Ensure that the Division's mandate and the requests from the Science Directorate in FY 1992/93 are carried out and met in the most effective manner. (Ritter)

Expected outputs and accomplishments are principally reflected in the degree to which the goals and outputs of the other projects within the Division have been met; such accomplishments are shown in the other project review/evaluation sheets which make up the Division activities. Division Administration has ensured the most effective and efficient overall application and use of 1992/93 resources to meet these goals. Deadlines for providing input to the Branch level have been met.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

1. Ensure that the Division's mandate and the requests from the Science Directorate in FY 1993/94 are carried out and met in the most effective manner. (Ritter)
2. Deliver Science obligations under Recreational Fisheries initiatives for N.B. and N.S. (Ritter)
3. Lead Science in the development of new partnership arrangements with recreational fishing interest groups and Native communities. (Ritter)
4. Restructure Division administration. (Ritter)

6. Background:

Highlights:

Biological advice is largely disseminated through the Chief and Division professional staff to: (a) federal and provincial fisheries managers; (b) Native, recreational and commercial fishermen; (c) public; (d) the aquaculture industry; (e) other research groups working in similar or related fields; and (f) senior departmental authorities.

The day-to-day administrative burden continues to increase as more of the responsibility for purchasing and financial control is downloaded to the Division.

Program delivery continues to be heavily dependent upon outside funds. Staff morale continues to be good, in spite of restricted budgets and seemingly overburdening administration and controls on finances and person-power utilization.

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.: 311

Section: Stock Assessment and Enhancement

Project Title: Divisional Informatics

Project Leader: O'Neil, S.

Other Researchers: Amiro, P.; Cutting, R.; Harvie, C.; Marshall, L.; Boudreau, P.R.

Work Activity: W.A.1.1.1.1

Key Words: administration; data processing; informatics

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1. Project Description:

Directs Freshwater and Anadromous Divisional informatics programs including planning and review, the development of software, software evaluation, hardware acquisition and maintenance, staff training or coordination of EDP related training and data base management system development. Provides advice to Division staff on software, hardware and program-related EDP requirements.

2. Long-Term Objectives:

Continue to provide software development and maintenance service, and system management expertise. Upgrade the level of competence of Division staff on in-house micro-computer and mainframe systems (software and hardware). Ensure that Division EDP requirements are addressed and provided, wherever possible, and work towards having Division staff make more effective use of the data on hand and to prepare for efficient use of any new data being collected.

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

1. Conduct comprehensive review of data base management requirements for the Division, evaluate options and recommend course of action. A tentative plan to prepare a large scale DBMS with links to statistical and graphical software will be carefully considered during the review because of the significant costs involved. (O'Neil, Harvie, Marshall, Cutting)

A comprehensive review of data base management requirements was conducted, and Foxpro was chosen as the divisional data base system. The distribution and Tag Clearing House data bases will be converted from ORACLE to Foxpro in 1993. An outline for a DBMS Grand Plan, linking all data bases and graphical software, has been prepared. (Harvie, O'Neil, Division staff)

2. Complete (pending the outcome of 1) development of the trap data base system. (O'Neil, Harvie, Marshall)

The trap data base is 80 percent complete and will be completely developed in Foxpro by the end of 1992. (O'Neil, Harvie, Marshall)

3. Provide informatics consulting support, including software development and training to Division staff. (Harvie, O'Neil)

Consultative support and software development were provided as required. A course in Foxpro was prepared and taught to 15 staff members. (Harvie, O'Neil)

4. Prepare a long-range informatics plan which reflects anticipated informatics need and the changes in technology. (O'Neil, Harvie)

The current-long range informatics plan has been reviewed and is in the process of being updated. The plan will be completed for distribution by the end of 1992. (Harvie, O'Neil)

5. Complete evaluation of a network proposal for in-house (LAN) and, if approved, install, test and support. (Harvie)

Several options for an in-house network have been reviewed and are in the process of being updated. The plan will be completed for distribution by the end of 1992. (Harvie, O'Neil)

6. Evaluate feasibility of use of GIS for graphical display of geobased data or modelling. (Harvie, Boudreau, O'Neil)

Secondment of Mr. Boudreau outside the Division meant no progress was made. (Boudreau)

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

1. Complete conversion of distribution and Tag Clearing House data bases from ORACLE to Foxpro. (Harvie)
2. Prepare an in-depth evaluation for implementing the DBMS Grand Plan, to link all data bases and graphical software. (Harvie, O'Neil)
3. Provide informatics consulting support, including software development and training to Division staff. (Harvie, O'Neil)
4. With the approval of an in-house network system (LAN), install, test, support and train users in its use. (Harvie)
5. Represent the Division in Branch and region-wide EDP initiatives and reviews. (Harvie)
6. Oversee network option resolution and implementation in the new office location. (Harvie, O'Neil)
7. Oversee movement of EDP equipment to the new location (Maritime Centre). (Harvie, O'Neil)

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 -

Harvie, C., and A. Bullerwell. 1992. Data Base Management System Evaluation Report. In-house report.

iii. Scientific and Technical -

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 4500

Section: Gulf of Maine and Pelagic Fisheries

Project Title: Program Direction

Project Leader: Gavaris, S./Stephenson, R.

Other Researchers:

Work Activity: W.A.1.1.1

Key Words: administration

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1. Project Description:

Administration of the Marine Fish Programs.

2. Long-Term Objectives:

Administer the Marine Fish Programs efficiently and to provide scientific leadership in interpreting and accomplishing the mandate of the Division.

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

1. Provide full range of administrative and secretarial support for the BIO component. Particular attention will be given to improved requisition processing and budget reporting, the monitoring of leave and overtime and establishment of a system to control salary dollar utilization. (O'Boyle, with Stobo, Myra and McMillan)

2. Develop and implement a plan for establishment of new activities at BIO and STABS, as part of the new mandate sharing arrangement. Dependent upon budgets, this plan should be completed by 31 March 1993. (O'Boyle)

3. Develop new working relationship with STABS staff which focuses on program rather than administrative issues. As part of this, develop working relationship with new Station Director. As well, conduct Division-wide long-term planning exercise. (O'Boyle)

4. Process tag returns from historical tag experiments. (Nelson)

Processed all tags received.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

Plan, direct and coordinate the groundfish and pelagic programs at St. Andrews and conduct administrative functions. Represent the programs at management functions. The orderly and focused conduct of section activities result in cohesive and efficient service to the Scotia-Fundy groundfish and pelagic fishing industries. Lack of attention to these functions may result in poorer use of resources and inadequate response to client issues. (Gavaris and Stephenson)

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.: 4510

Section: Gulf of Maine and Pelagic Fisheries

Project Title: EDP Support

Project Leader: Gale, J.

Other Researchers:

Work Activity:

Key Words: administration; data processing

1. Project Description:

Analyze requirements, design and implement application systems and databases. Provides consultation and assistance for staff developing thier own applications and databases. Research new techniques for analysis and information needs to keep operations up to date with developments. Provide management procedures for Divisional Databases. Provide application and database advice to technical users and database personnel.

2. Long-Term Objectives:

As above.

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

1. Improve MFD/BIO local area network and associated computing facilities. Includes: ethernet LAN to all MFD/BIO and CAFSAC workstations; evaluate need for ethernet router; PC/NFS (network file system) licences for all MFD/BIO and CAFSAC workstations; MSWindows, SQL*NET and ORACLE Card for selected workstations (i.e. all Computer Section workstations and one each for Central Shelf and Southern Shelf sections); multi-user access to PC486 UNIX workstation (starting with Computer Section Data Base conversion projects); PC486 SQL*net access to STA VAX and Cyber Replacement; expanded and air-conditioned computer room; and new laser and/or colour printer(s). (Branton, Charlton, McMillan)

2. Convert MFD/BIO ORACLE data base systems away from the Cyber NOS/VE platform. Includes: Commercial Samples, Commercial Landings, Groundfish Surveys and the Observer Program. Alternative target platforms in order of preference are: MFD/BIO PC486 UNIX; single user PC386 DOS; and the yet to be defined Cyber replacement. Every reasonable effort will be made to accommodate all collection/editing systems on the PC486 and only progress to other systems if absolutely necessary. The capabilities of the PC486 will require continued exploration may have to be upgraded (e.g. archive/backup hardware/software, more memory, more disk, and faster CPU). A second PC486 for ad-hoc analysis and file serving, leaving the first for collection/editing type work only, must also be considered. (Branton, Charlton, McMillan)

3. Continue support and development of the Commercial Samples data system and continued expansion and improvement of services to field staff. Includes: conversion away from Cyber NOS/VE; end-user access to the Oracle data base; PC Alsys software support and user training; commercial catch at age data products; length frequency data products; and all Port Technicians on line. (Charlton, Zwanenburg)

4. Continue support and development of Commercial Landings data system. Includes: ZIF working group; ZIF production runs using old (i.e. flat file) system for 1992 assessments; Oracle ZIF test runs for 1992 assessments; conversion of ORACLE ZIF away from Cyber NOS/VE; and end-user access to the ZIF Oracle data base; and more timely access to IQ data bases; and ZIF Verification Workshop in preparation for 1993 assessments. (Annand, Branton, McMillan, ZIF Working Group)

5. Continue support and development of Observer Program data system. Includes: review and continued development of the Cyber NOS/VE system ; end-user access to the Oracle tables; interfacing to PC ALSYS; conversion away from Cyber NOS/VE; and development of various standardized data products. (Branton, Showell)

6. Continue support and development of Groundfish Survey data system. Includes: maintain copy of data base at BIO for end-user access; access to STA via SQL*NET; review of data base structure; and development of various standardized data products. (Branton, McMillan, Gale)

7. Continue support for and involvement in MFD Computer User Group. This includes: selecting, recommending and supporting a PC statistical graphic standard; Structured Query Language Interest group; development and support of MFD/BIO Hardware/Software inventory data base; and experiments with INFOCUS mapping system. (Branton, Charlton, McMillan, MFD Computer User Group)

8. Improve graphical and geographical analysis capability. Includes: production version of PC

ACON; PC486 UNIX version of ACON; and Oracle Data Base links. (Branton, Black)

9. Improve MFD/BIO administrative tracking systems. Includes: Paradox PC data base. (McMillan, O'Boyle, Stobo)

10. Ongoing external technical liaisons. These include: MFD/STA computing staff; BSB Computer Committee, Scotia Fundy Informatics Working Committee and various subcommittees; BIO Computer Center; and STA Computer Centre. (Branton, Charlton, McMillan)

11. Participate in field trips and cruises. (Branton, Charlton, McMillan)

12. Complete development of Pelagic Edit System online age and length frequency data entry. (Gale)

System complete.

13. Revise the groundfish edit system and document as part of the Groundfish Surveys Manual. (Gale)

Edit procedures included in the Groundfish Surveys Manual and a separate user's manual written for the Edit System.

14. Continue the development of an APL to ORACLE interface and/or investigate STSC option. (Gale)

15. Develop a larval herring data base and utilities. (Gale)

Sheduled for later this year.

16. Revise the ZIF data base with the final structure as set by the ZIFF working group. (Gale)

Made several revisions using recommendation from ZIF. Became an active member of the ZIF working group.

17. Monitor the performance and tune all major Divisional data bases. (Gale)

Goal met and monitoring continues. Several database changed as a result of performance and usage monitoring.

18. Continue development and documentation of data management utilities for updating and maintaining all production data bases. Canadian and U.S. groundfish surveys, commercial landings and commercial samples data bases. Also, pelagic samples and new larval data bases. Assist the various data base managers with effective use of new utilities. (Gale)

Manuals for some of the databases were written. Others are scheduled for next year.

19. Investigate real time data entry and editing at sea for the groundfish surveys. (Gale)

Analysis and design of system begun.

20. Continue to instruct technical users and data base personnel and provide application and data base advice and assistance. (Gale)

Goal met.

21. Continue to provide technical assistance and advice for the operation of the PathWorks and X-Windows environments. (Gale)

Goal met.

22. Continue maintenance of major Divisional applications including STRAP and CATCH. (Gale)

Revision made to divisional applications as requested. CATCH was modified with protions of the key generation rewritten in APL.

23. Expand list of drivers available for ACON. (Black, Gale)

Rescheduled for later this year.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

1. Continued support services for the design, developement, enhancement and effective use of local databases for the Gulf of Maine and Pelagic Sections. Major databases include the U.S. and Canadian Groundfish Surveys, Commercial Landings and Commercial Samples. Also the Pelagic Samples, Larval Herring and Purse Seine Logs databases. Monitor performance and tune all major databases.

2. Continued developement, maintainance and documention of database management utilities for backup/recovery, updating and maintaining all major databases and provide assistance to the database managers with effective use of new utilities and provide technical advice to other staff. Investigate and resolve database anomalies.

3. Continued maintainance and developement of applications systems including interface with the databases. Applications include the various edit and data entry systems, menu access such as DBGUIDE and data analysis tools such as STRAP and CATCH.

4. Continued consultation giving advice and assistance to those scientists who wish to undertake thier own system design and implementation.

5. Continued technical assistance and advice for efficient utilization of computer facilities. Provide standardized procedures and assistance for the PC(DOS) and VAX(VMS) envirnoments.

6. Research into the application of new techniques and knowledge for analysis and information needs to develope recommendations for improving the computing environment.

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.: 5000

Section:

Project Title: Biological Station Director

Project Leader: Watson-Wright, W.

Other Researchers: Chang, B.; Fawkes, G.

Work Activity: W.A.1.1.5; W.A.1.1.1; W.A.1.1.2; W.A.1.1.3; W.A.1.2.2

Key Words: administration

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1. Project Description:

Provision of scientific and administrative direction for all programs at the St. Andrews Biological Station. The Biological Station responsibilities include: assessment and research on groundfish, pelagics, and invertebrate fisheries; research on aquaculture, ecology, and marine chemistry; provision of support services for the scientific activities.

2. Long-Term Objectives:

Plan, direct, and coordinate scientific programs relevant to the mandate of the Biological Station. Manage and provide facilities and services necessary to support these scientific activities.

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

1. Manage the scientific research programs carried out at the St. Andrews Biological Station on aquaculture, marine fish and invertebrate fisheries, habitat ecology and marine chemistry in the Bay of Fundy/Gulf of Maine area. (Watson-Wright)

Successfully managed scientific activities at the Biological Station, including through the transition to a new Director and Station reorganization. R. Cook left as Station Director at the end of March 1992. D. Aiken served as Acting Director for the next 3 months, until W. Watson-Wright began duties as Director. The new Station organization became effective on 1 April 1992. The major change was to transfer the Gulf of Maine and Pelagic Fisheries Sections (both located at St. Andrews) from the Marine Fish Division to the Biological Station, so that all BSB programs located at the Biological Station now report to the Station Director. The Toxicology and Organic Contaminants Section (part of Marine Chemistry Division, PCSB) has become more closely integrated with other scientific activities located at the Station.

2. Serve as Station Director and coordinate, by means of a Station Management Committee, the provision of scientific and administrative support services to all programs at the St. Andrews Biological Station. (Watson-Wright)

Support services have been provided, as required, within the limits of available resources. Under the new Station organization, the Station Management Committee has taken a stronger role in the coordination of support services.

3. Coordinate the evaluation of aquaculture site applications in SWNB and provide a scientific focus for aquaculture development and activities arising from the St. Andrews research programs. (Chang)

Continued to coordinate Station input into SWNB aquaculture site application approval process, through participation in the site approval referral process and membership in the Federal-Provincial Fundy Region Aquaculture Advisory Committee, the Aquaculture Environmental Coordinating Committee for Southern New Brunswick, and the DFO SWNB Aquaculture Working Group. The amount of input provided per site referral has decreased this year, due to a combination of the increased administrative work load in this project and the greatly increased number of referrals received.

4. Provide support to the computing needs of the aquaculture, invertebrate fisheries and habitat ecology research projects at the Biological Station. (Fawkes)

EDP equipment trouble-shooting was provided as required. Programming requirements were also supplied as needed, including: plotting of scallop and lobster tag recovery data, plotting of scallop surveys. Participated in Station Computer Centre Management Advisory Board, as required.

4. Additional Accomplishments:

1. Served as Scientific Authority and on Management Committee for the Salmon Genetics Research Program; on Management Committee for the Atlantic Salmon Demonstration and Development Farm; member of Southern New Brunswick Aquaculture Development Committee; member of Scotia-Fundy Phycotoxin Advisory Committee (Watson-Wright).

2. The new building for the Atlantic Reference Centre was completed and the reference collection was transferred to the new building. Some deficiencies remain in the new building; these are to be rectified by Public Works by spring 1993.

3. Successfully organized workshop on Strategies for a Teamwork Approach to Better Service at St. Andrews Biological Station, as a follow-up to the Regional 'Service Challenge' workshop held in Sydney, and to give all staff the opportunity to discuss and propose ideas as to how the Station may best approach the future.

5. Goals/Expected Outputs for 1993:

1. Manage the scientific research programs carried out at the St. Andrews Biological Station on aquaculture, marine fish and invertebrate fisheries, habitat ecology and marine chemistry in the Bay of Fundy/Gulf of Maine area. (Watson-Wright)

2. Serve as Station Director and coordinate, by means of a Station Management Committee, the provision of scientific and administrative support services to all programs at the St. Andrews Biological Station. (Watson-Wright)

3. Coordinate the evaluation of aquaculture site applications in SWNB and provide a scientific focus for aquaculture development and activities arising from the St. Andrews research programs. (Chang)

4. Provide support to the computing needs of the aquaculture, invertebrate fisheries and habitat ecology research projects at the Biological Station. (Fawkes)

5. Organize activities for celebration of 85th anniversary of the Biological Station.

6. Background:

Highlights:

This project replaces project 400, with the following changes: delete the role as Senior Branch Advisor on aquaculture (transferred to new Aquaculture Coordination Office); add provision of administrative support for former Marine Fish Division components located at Biological Station.

Selected Involvements:

i. Collaborative Research -

- Presented joint paper with J.-P. Thonney (N.B. Dept. of Environment) at Aquaculture Association of Canada meeting (Chang).

- Dr. J. Lawrence (NHW); M. Gilgan, G. Sims, M. Dorey (Inspection Services); Aquaculture Assoc. of N.S.; NRC-Institute for Marine Biosciences - Dr. J.L.C. Wright; Drs. J. Stewart, J. Jellett, Habitat Ecology; Dr. D. Sinclair, Victoria General Hospital, Halifax.

ii. University Liaison -

Served as voting member of the Huntsman Marine Science Centre, which includes the participation of several universities. Encourage staff participation as adjunct professors and supervisors of postgraduate students.

iii. Communications -

Ongoing collaboration with communications officer at St. Andrews. Participated in DFO booth at the Atlantic Aquaculture Fair and Eastport (Maine) Salmon Festival. Participated in Career Expo 92 at Saint John. Served as advisor to St. Croix Estuary Project (part of Environment Canada's Atlantic Coastal Action Program)(Chang). Talks on aquaculture given to public and student groups. Tours of Biological Station provided to scientific and academic visitors. Hosted visit by delegation from the National Defence College; two-part interview with St. Croix Courier (Watson-Wright).

iv. Contracts Administered -

Atlantic Reference Centre, Huntsman Marine Science Centre, $85K (1991-92) (Core funding base; see project 5300 for details).

Salmon Genetics Research Program, Atlantic Salmon Federation, $193.2K (1991-92) (DFO share; see project 4600 for details).

v. Other -

7. Publications:

i. Primary -

Jellett, J.F., L.J. Marks, J.E. Stewart, M.L. Dorey, W. Watson-Wright, and J.F. Lawrence. 1992. Paralytic shellfish poison (saxitoxin family) bioassays: automated endpoint determination and standardization of the in vitro tissue culture bioassay, and comparison with the standard mouse bioassay. Toxicon 30: 1143-1156.

ii. Interpretive Scientific -

iii. Scientific and Technical -

Watson-Wright, W.M., C. Smyth, G. Sims, J. Marr, J. Lawrence, D. Sinclair, and M. Gilgan. 1992. Recent food safety incidents involving marine biotoxins in Atlantic Canada, p. 69-79. In K. Mise and J.L. Richard (ed.) Proceedings of the 7th UJNR International Symposium on Emerging Food Safety problems Resulting from Microbial Contamination. Tokyo, Japan.

Watson-Wright, W.M., G. Sims, C. Smyth, M. Gillis, M. Maher, D.E. Sinclair, and M. Gilgan. 1992. Identification of tetramine as toxin causing food poisoning in Atlantic Canada following ingestion of whelks (*Neptunea decemcostata*). Proceedings of the 10th World Congress on Animal, Plant and Microbial Toxins 2: 634-641.

Todd, E.C.D., T. Kuiper-Goodman, W.M. Watson-Wright, M. Gilgan, S. Stephen, J. Marr, S. Pleasance, M.A. Quilliam, H. Klix, H.A. Luu, and C.F.B. Holmes. 1992. Recent illnesses from seafood toxins in Canada: paralytic, amnesic and diarrhetic shellfish poisoning. Proceedings of Fifth International Symposium on Toxic Marine Phytoplankton. Rhode Island (in press).

Chang, B.D. and J.-P. Thonney. 1992. Overview and environmental status of the New Brunswick salmon culture industry. Bull. Aquacul. Assoc. Canada 92-3: in press.

iv. Popular and Miscellaneous -

Carver, C.E., S. Hancock, G.G. Sims and W. Watson-Wright. 1992. Phytoplankton monitoring in Nova Scotia, p. 30-31. In J.-C. Therriault and M. Levasseur (ed.) Proceedings of Third Canadian Workshop on Harmful Marine Algae. Can. Tech. Rep. Fish. Aquat. Sci. 1893.

Watson-Wright, W.M., M.M. Maher, G.G. Sims, and J.F. Lawrence. 1992. Cooking-induced changes in toxicity and profile of paralytic shellfish poisons in lobster hepatopancreas. VIII International IUPAC Symposium on Mycotoxins and Phycotoxins, Mexico City, November 1992 (Abstract).

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 5100

Section: Scientific Support Services

Project Title: Administration and Support Services

Project Leader: Ross, P.

Other Researchers: Best, B.; Carney, C.; Hurley, J.; Polar, S.

Work Activity: W.A.1.1.0.0

Key Words: administration; technical support services

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1. Project Description:

Provide scientific support to meet the requirements of scientists and technicians at the Biological Station. In particular, provide the following for all research projects at St. Andrews: word processing and secretarial service, small vessels, electronic services, and implementation of the Management Services functions delegated to the Station (Materiel Management, Facilities, Library, Central Registry, Photography, and Drafting).

2. Long-Term Objectives:

Continue to provide efficient and up-to-date scientific support services in the areas noted above to all Station users requiring these services. Also, continue to provide a smooth working relationship at the Station level between the Management Services and Science Sectors.

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

Provided efficient scientific support services for scientific staff within the resources provided. Secretarial support for the Director was provided through the reorganization of the Biological Station. Within the delegated Management Services functions, staffing of the vacant maintenance position has yet to be completed, causing problems in maintaining facilities. Construction of the Sample Storage Building was completed; the Atlantic Reference Centre material, the Templeman collection from Newfoundland and Biological Station specimens are now under one roof. Secretarial and word processing work descriptions were rewritten as part of the GE conversion.

4. Additional Accomplishments:

A used tractor/loader was acquired through MSB for grounds maintenance. Two new vehicles were acquired under the Departmental Vehicle Acquisition Program.

5. Goals/Expected Outputs for 1993:

During 1993, the plan is to provide efficient scientific support services for scientific staff within the resources provided. Staffing of the maintenance position is a necessity or serious facilities maintenance problems will develop. The Station Coordinator's position has been filled through the Scotia-Fundy Assignment Program since 1991. This position should be staffed to provide continuity and direction to the services provided. A proposal by Public Works Canada to take over operation of the facilities will be cause for concern this year.

6. Background:

Highlights:

Scientific support services has historically encompassed a wide range of functions from mechanical and electronic technologies to word processing and secretarial services. Within the restrictions of PY allocations, the services have been reduced both in areas covered and level provided. The use of computer technology in word processing and secretarial services has brought those functions completely up to date. Electronic technology service continues to suffer from a lack of 'state-of-the-art' monitoring equipment.

The operation of Management Services functions on a delegated basis under the Station's scientific support group continues to operate reasonably effectively. An area of concern is the process of communication and rationale for funding level - especially in the Library.

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.: 5200

Section: Scientific Support Services

Project Title: Computer Centre

Project Leader: Ross, P.

Other Researchers: Bellis, S.; Fawkes, S.; Hatt, B.

Work Activity: W.A.1.1.5.0

Key Words: computer centre; data processing

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1. Project Description:

Provides computing power, programming and system support (both hardware and software), and Data Entry services to scientific staff in the Biological Sciences Branch.

2. Long-Term Objectives:

Ensure that the Biological Station computing system is upgraded and enhanced to keep pace with technological developments relevant to fisheries research.

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

The operation of the VAX 6210 was improved by in-house modification of system parameters and the installation of new operating system software (i.e. VMS 5.5). Though acquisition of a full backup package was not acquired because of funding constraints, steps were taken to improve the existing backup facilities to allow for enhanced management of the disk facilities on the VAX 6210. Connections to the Regional Network have been completed with the Network now running at 50 KB. Facilities were evaluated and an upgrade path was proposed for inclusion in both the Regional business case and RFP to acquire hardware and software for Regional data processing.

4. Additional Accomplishments:

Training for the computer staff was a priority with both the computer system operator and the data conversion operator receiving specialized VMS training. Work descriptions were also completed for these two positions as part of the GE conversion exercise. The staff reporting structure was reorganized with all positions now reporting directly to the Coordinator, Station Support Services.

5. Goals/Expected Outputs for 1993:

Acquisition of the computing resources as defined in the business case and RFP.

Provision of secondary resource server on the network in the event that the RFP acquisitions cannot be actioned.

Provision of access to Banyan Vines Network through a local server connected to the Regional Network. This service to be provided to at least the RCM level within Science and to non-Science users as required.

A policy that will provide effective PC support will be developed.

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.: 5300

Section: Scientific Support Services

Project Title: Atlantic Reference Centre

Project Leader: Watson-Wright, W. (Scientific Authority) ; Sulak, K. (Huntsman Marine Science Centre)

Other Researchers: Pohle, G.; Van Guelpen, L.; Hogans, W.; Gratto, G.; Marques, F.

Work Activity: W.A.1.1.1.1; W.A.1.1.1.2; W.A.1.1.1.6; W.A.1.1.1.7

Key Words: taxonomy; systematics; identification; collection; zoogeography; functional morphology; life history; population biology; parasitology; environmental baseline and monitoring

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1. Project Description:

The Atlantic Reference Centre (ARC) provides taxonomic and ecological expertise centered on an extensive reference collection of aquatic organisms from the Atlantic Canada region. The ARC functions to maintain, expand, document and manage the reference collection; provide identification services for DFO scientists; prepare appropriate taxonomic guides; collaborate with DFO investigations in appropriate areas of ARC staff expertise; promote and facilitate collection-based research by visiting investigators. The ARC is a joint project of DFO Scotia-Fundy Region and the Huntsman Marine Science Centre. In addition to core DFO and HMSC support, considerable supplementary contract and grant support contributes substantially to overall project funding.

2. Long-Term Objectives:

To maintain and expand a comprehensive preserved reference collection of aquatic organisms representing the biota of Atlantic Canada. To maintain important DFO survey program material for further research and reference. Maintain a working series of common commercially, ecologically or environmentally important fish and invertebrate species to enable directed life history research and reference. Serve as the primary repository for important aquatic biota collections from the Atlantic Canada region, including published voucher specimens. Promote research utilization of the reference collection by DFO, HHSC and visiting scientists. Develop and maintain a highly trained scientific and technical staff able to provide service primarily in taxonomic identification, and in other areas including environmental baseline and monitoring studies, population biology studies, larval and juvenile rearing work, and parasitology. Publish a continuing series of technical guides aimed at facilitating field and laboratory identification of difficult taxa of marine organisms. Provide technical training and advice in taxonomic identification and methodology of sampling, preserving, processing biological specimens, and in techniques of microscopic examination. Provide public advisory service with respect to the regional fauna in terms of identity, life history and distribution of marine organisms.

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

1. Continue identification, verification, re-conditioning, cataloging and computer documentation of backlog and new biological material. Continue computerization of the collection data base using the MUSE collection inventory software system. Continue to research missing locality data necessary for documentation of the ARC collection.

Collection emphasis throughout 1992 was primarily on the move to the new museum and on reconditioning of DFO Newfoundland material (below), rather than cataloging. However, several hundred lots of existing Scotia-Fundy region backlog material (fishes, fish larvae, lobster larvae) was re-conditioned, identified, and documented preparatory to cataloging. Extensive identified and unidentified squid material was consolidated for ID or ID verification in 1993. A general re-organization of unidentified and uncataloged fish and invertebrate material also took place concurrently with the move to the new building. Loans of preserved specimens were processed to DFO and university scientists for taxonomic and morphological research.

ARC PC was upgraded with a modem and virus protection software; problems with MUSE operation were addressed (Van Guelpen).

2. Continue processing, documentation, and incorporation of DFO Newfoundland material.

All material in the DFO Newfoundland fish collection held in storage at HMSC was moved into new museum, reorganized into family groups, and shelved prior to cataloging. Reconditioning (new jars, lids, liners, alcohol, labels) was completed for all lots, except for specimen lots held in bulk containers (200 L barrels). Cephalopod material remains in storage.

3. Continue organization and packing of ARC collection in preparation for move into new collection building in 1992.

Extensive ARC consultation with DFO, Public Works Canada, and contractors (Van Guelpen, Sulak) accompanied completion of the new collection building. All ARC staff helped vacate the former trailer museum and laboratories, erect shelving in the new museum, oufit the new building, and move and reshelve the collection. The entire ARC collection was transferred over prior to 1 November 1992. The cataloged reference collection has been re-organized in proper systematic order. Uncataloged material remains to be reorganized.

4. Complete and print ID leaflets on flounders and eelpouts; continue work on skate ID leaflet.

'Guide to Adult Flatfishes (Poissons Plats) of the Canadian Atlantic (Sulak) was published and distributed in March 1992. Eelpout leaflet preparation continues incorporating of extensive new DFO Newfoundland material records.

Final ink illustrations of six species of skates were prepared for ID leaflet in progress (MacWhirter). Study of preserved material continued (Sulak), along with compilation of distributional and habitat information.

5. Initiate planning for revision of faunal guide to marine invertebrates of Passamaquoddy Bay (Lim, Pohle, Gratto).

Dr. Lim has matriculated to a new post in Singapore, passing primary responsibility to Pohle (with Sulak and Gratto) for this project. ARC staff have critiqued the existing guide to identify taxonomic, text, format and illustration deficiencies. A prototype final ink illustration has been prepared (MacWhirter) to serve as a standard for all illustrations.

6. Complete major faunal manuscript on taxonomic composition of the aquatic fauna of Kouchibouguac National Park and watershed.

Manuscript, including tables of sampling sites and taxa collected, has been prepared in draft form (Sulak). Outside scientists have been consulted regarding records of species new to the region. Background literature incorporation (Pohle and Gratto) and manuscript editing (Hogans) prior to submission are in progress. Submission anticipated by April-June 1993.

4. Additional Accomplishments:

1. Completed processing and identification of unusual pelagic fishes from R. Halliday and Observer Program fishes from M. Showell; ID of unusual fishes for B. Atkinson, DFO Newfoundland; arrangement with D. Kulka to ID DFO Newfoundland Observer Program fishes.

2. With primary sponsorship from Canada External Affairs, ARC participated in the International Symposium and First World Congress on the Preservation and Conservation of Natural History Collections, Madrid, Spain, poster display (Pohle) featured DFO commitment to natural history collections in terms of the ARC Programme and the construction of a dedicated regional collection facility.

3. Final proposals tendered: DFA for follow-up study on effects of salmonid cage-culture; AFAP programme re same (Lim); DFO Subvention Proposal for striped bass aquaculture pilot project (Hogans); NSERC Equipment Grant proposal to provide a high quality video printer system to enable publication quality prints from videotapes, video output from microscopes, and computer graphics output. ARC draft proposals tendered: NB Environmental Trust Fund (DOE) and Canadian Museum Assistance Programme seeking partial funding for compactor shelving. Representative of latter programme conducted a site visit.

4. Initiated work (Hogans) on ID leaflet on marine fish parasites. Submitted proposal to NSERC Publications Grant programme to sponsor publication via ARC of P. Pocklington's comprehensive guide to polychaetes of Canadian Atlantic marine waters.

5. Extended specimen loans to DFO and outside scientists, including initial loan of SSIP material to K. Frank pilot biochemical genetics project on larval fish populations.

6. Significant additions to ARC collection: midwater fishes (Halliday); Observer Programme fishes (Showell; Atkinson); aquatic insect larvae (Peterson, NB DOE & ARC); parasitic nematodes (Brattey, DFO Newfoundland); parasitic copepods (DFO Fish Health Unit); slopefishes (Sulak/NURP); northern marine fish larvae (Pepin, DFO Newfoundland); St. Croix estuary benthos (ARC).

5. Goals/Expected Outputs for 1993:

1. Continue processing preserved material; emphasis on cataloging of identified DFO material, plus ARC Benthos and Kouchibouguac projects material. Host M. Vecchione of the U.S. National Museum to ARC for two weeks to identify cephalopod holdings.

2. Become fully integrated with Biological Station computer network via Dell PC.

3. Complete and print ID leaflets on crustacean parasites of marine fishes and on eelpouts; complete final ink illustrations for skate ID leaflet; initiate collaborative ID leaflet (Pohle and Watson-Wright) on potentially toxic shellfish of Atlantic Canada; publish a minimum of five scientific manuscripts in primary journals; pursue staff research supported by DFO Subvention Programme, NSERC, U.S. National Undersea Research Program, Smithsonian Visiting Scientist Program, New Brunswick Museum Christie Fellowship.

4. Begin substantive work on Marine Invertebrates of Passamaquoddy Bay guide, undertaking each major group in sequence.

5. Submit summary manuscripts on marine benthic invertebrates of Passamaquoddy Bay to scientific journal (3-year Benthos Project), and on taxonomic composition of aquatic fauna of Kouchibouguac National Park and adjacent watershed.

6. Develop unsolicited proposal seeking funding to establish an Atlantic Canada aquatic biota biodiversity survey with the ARC as the focus of reference collections. Proposal would centre on dedicated long-term study sites modeled after the ARC Kouchibouguac survey project, continuing with the ongoing Passamaquoddy Bay and St. Croix watershed projects.

7. Continue to seek funds for ARC facilities development via proposals to appropriate agencies and programmes. Priority is on outfitting new building with compactor shelving.

6. Background:

Highlights:

Since 1984 the ARC has served as a source of taxonomic, morphological and ecological expertise with respect to aquatic biota of Atlantic Canada. It has developed substantially in terms of staff, facilities, external support and capabilities. It has expanded the breadth of its activities and expertise. The ARC represents a very appropriate interface between DFO and university scientists (via HMSC). It serves as the single major regional repository for aquatic biota of Atlantic Canada for research, teaching, and environmental baseline and monitoring purposes. It serves as a source of expertise, training and advice - drawn upon by DFO and other government agencies and the public. It provides a venue for a research into the systematics, taxonomy, ontogeny, comparative functional morphology, rearing, ecology, life history, and zoogeography of aquatic organisms. It also serves as a centre for dissemination of scientific information on marine life. Currently, the core staff of four is supplemented by one additional Ph.D. biologist, and a term staff of nine technical assistants.

Selected Involvements:

i. Collaborative Research -

1. Hogans with R. Peterson on striped bass culture pilot project; with Marcogliese (DFO Quebec) on parasites of crustacea; with Porter and Stokesbury in publication of 'A mark-recapture experiment on bluefin tuna (Thunnus thynnus L.) from the Browns-Georges banks region of the Canadian Atlantic. I. Stock size estimates, 1991, II. Ultrasonic telemetry experiments.' (for International Commission for the Conservation of Atlantic Tunas, Col. Vol. Sci. Pap., Madrid).
2. Pohle with W. Watson-Wright (planned 1993-1994) on a leaflet concerning potentially toxic shellfish species of our region.
3. Van Guelpen with R. Stephenson and M. Power (1993-1994) on synopsis of DFO larval fish survey work of the past two decades.
4. Sulak R. Halliday (BIO), D. Themelis (Dalhousie) and Gartner (Florida Institute of Marine Research) on the taxonomy and distribution of midwater fishes of Scotian slope (continuing).
5. Pohle with R. Halliday on potentially exploitable deepwater resources off Atlantic Canada

ii. University Liaison -

1. Sulak with Ross (University of North Carolina) and Gartner (Florida Marine Research Institute) on demersal bottomfish fauna of U.S. East Coast continental slope; with Shcherbachev (Institute of Oceanology, Moscow) on taxonomy and distribution of deep-sea fishes; with Crabtree (Florida Marine Research Institute) on systematics and morphology of deep-sea fishes. Ross will visit the ARC in February 1992 to pursue collaborative research.
2. Sulak and Gratto with S. Lim, Nanyang Technological University, Singapore, R. Diaz (Virginia Institute of Marine Science) and R. Findlay (University of Maine) on manuscripts resulting from the ARC Benthos Project.
3. Sulak with B. Seret, Mus{um National d'Histoire Naturelle, Paris, on MUSORSTOM Project (Deep-water fishes of New Caledonia region).
4. Hogans NB Dept. Natural Resources and the Canadian Wildlife Service in seaduck population census and heavy metals analysis work.
5. ARC staff with P. Pocklington, Dalhousie University associate, on publication of a guide to polychaetes of Atlantic Canada.
6. Van Guelpen with Sulak and W. B. Scott (HMSC) in a taxonomic study of the parr stages of salmonid species of Atlantic Canada.

iii. Communications -

1. Pohle presented a poster on the ARC museum at the First World Symposium of Natural History Collections in Madrid, Spain. Subsequently, he began an 8-month scientific exchange with the Spanish equivalent of the ARC in Barcelona, Spain (Instituto de Ciencas del Mar). He will refurbish the IMS decapod crustacean collection and conduct taxonomic research on lithodid crabs.
2. Van Guelpen prepared a solicited communication to the International Committee on Pelagic Biogeography advertising extensive ARC holdings of pelagic fishes, fish larvae and zooplankton.
3. Hogans prepared and submitted to DFO Gulf Region: 'A management plan for striped bass (Morone saxatilis) in New Brunswick'; also participated in DFO workshop 'Implications of striped bass culture in Atlantic Canada', Moncton.
4. Gratto will present a synopsis of the ARC Benthos Project findings at the Aquaculture-Environment Interaction Workshop in February 1993 at the Biological Station.
5. Sulak presented two papers on demersal slopefish communities at the annual meetings of the American Society of Ichthyologists and Herpetologists, University of Illinois.
6. Marques and Pohle presented a paper on ontogeny and morphology of pinnotherid crabs at the summer meeting of the Crustacean Society in Charleston, South Carolina.
7. Lim presented a seminar at DFO Biological Station on the environmental impact of salmon cage farming.

iv. Contracts Administered -

a. DFO Supporting Region Contracts Undertaken - FY 1991-1992 -

1. Sorting and identification of Scotia-Fundy ichthyoplankton from Georges Bank - DFO, Melvin.
2. Sorting and identification of ichthyoplankton from Bay of Fundy herring program - DFO, Stephenson/Melvin

b. Supplementary Contracts Undertaken - FY 1991-1992 -

1. Identification of aquatic insects from Keswick River - NB/DOE
2. Sorting and identification of ichthyoplankton from northeast Newfoundland shelf - DFO Newfoundland
3. Kouchibouguac National Park incidental fisheries species population analysis - Parks Canada
4. Striped bass culture pilot project - subcontract to Maritime Culture Systems.
5. Variability of zooplankton (copepods) abundance and composition in the southern Gulf of St. Lawrence - DFO Quebec.
6. Assessment of status of freshwater sport fisheries in New Brunswick - subcontract to LGL Ltd.

v. Other -

1. Deep-sea bottomfish population investigations, Hatteras continental slope - U.S. National Undersea Research Program (Sulak).
2. Systematics and evolution of Crustacea based on comparative functional morphology of setae and associated components - NSERC Operating Grant (Pohle).

7. Publications:

i. Primary -

Hogans, W. E., and K. J. Sulak. (1992, in press). *Diocus lycenchelus* n. sp. (Copepoda: Chondracanthidae) parasitic on the eelpout *Lycenchelys verrillii* (Zoarcidae) from the Hatteras slope of the northwestern Atlantic Ocean. Bull. Mar. Sci. (Nov. 1992).

Hogans, W. E. (in press). Redescription of *Acanthochondria ateleopi* Capart, 1959 (Copepoda, Poecilostomatoida) parasitic on the demersal fish, *Ateleopus loppei* from the eastern Gulf of Mexico. J. Zool.

Hogans, W. E. (in press). Branchiura. Genus *Argulus*. In: Procedures for the identification of certain pathogens of cultured fishes. Fish Health Blue Book. Spec. Publ. Am. Fish. Soc. (Second Edition).

Hogans, W. B. (in press, 1993). Guide to common external parasites of Canadian Atlantic fishes. I. Crustacea (Copepods, Branchiura, Isopoda and Amphipoda. ARC Species ID Leaflet No. 92-02I.

Lim, S. and R. H. Green. (submitted). Rate of oxygen consumption of the tellinid bivalve *Macoma balthica* (L.) from Hudson Bay are related to tide level, degree of heterozygosity, parasite load and temperature. Can. J. Fish. Aquat. Sci.

Lim, S., G. Gratto and K. J. Sulak. (in press). Rapid localized response of the benthic community to Atlantic salmon mariculture. Aquaculture.

Pohle, G. 1992. First Canadian record of *Paralomis bouvieri* Hansen, 1908 (Decapoda: Anomura: Lithodidae), infected by the rhizocephalan *Briarosaccus callosus* (Cirripedia: Peltogastridae) and carrying a hyperparasitic cyrptoniscinid isopod (Epicardea). Can. J. Zool. 70: 1625-1629.

Pohle, G. (in press). Larval development of Canadian Atlantic oregoniid crabs (Brachyura: Majidae), with emphasis on *Hyas coarctatus alutaceus* Brandt 1851, and a comparison with Atlantic and Pacific conspecifics. Can. J. Zool.

Pohle, G. (in press). Northern range extension of the deep-sea shrimps *Acanthephyra eximia*, *A. acutifrons* and *Ephyrina figueirai* (Decapoda: Oplophoridae). Crustaceana.

Pohle, G. (in press). First record of the rhizocephalan *Briarosaccus callosus* (Cirripedia: Peltogastridae) infecting the Atlantic porcupine stone crab *Neolithodes grimaldii* (Decapoda: Anomura: Lithodidae). Crustaceana.

Sulak, K. J. and S. W. Ross. (in press). Lilliputian bottom fish fauna of the Hatteras continental slope. Deep-Sea Research.

Van Guelpen, L. (in press) Darwin's slimehead, *Gepyroberyx darwini* (Pisces: Berycoidei) on the Scotian Shelf, a range extension and first Canadian record. J. Fish Biol.

ii. Interpretive Scientific -

iii. Scientific and Technical -

Sulak, K. J. 1992. Guide to adult flatfishes (Poissons Plats) of the Canadian Atlantic. ARC Species ID Leaflet No. 91-01F, March 1992, 22 pp.

Pohle, G., T.J. Kenchington, and R. G. Halliday. 1992. Potentially exploitable deepwater resources off Atlantic Canada. Can. Tech. Rep. Fish. Aquat. Sci. 1843, v + 79 pp.

iv. Popular and Miscellaneous -

PROGRAM REVIEW, EVALUATION AND PLANNING 1992/93

Division: St. Andrews Biological Station Project No.: 5800

Section: Scientific Support Services

Project Title: S/V PANDALUS III

Project Leader: Ross, P.

Other Researchers: Miner, Capt. W.

Work Activity: W.A.1.1.0.0

Key Words: research vessel

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1. Project Description:

Operate the S/V PANDALUS III primarily as a day boat to serve the Station's resource and stock assessment and associated biological research programs in the most effective manner. The PANDALUS is required to carry out a wide range of work, i.e. bottom trawling, scalloping, water and bottom sampling, as well as utilizing specialized gear in the Passamaquoddy Bay area.

2. Long-Term Objectives:

Continue providing an acceptable level of research vessel service for St. Andrews Biological Station programs; ensure that scheduled requirements are met and the cost effectiveness of the vessel maintained.

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

In 1992-93, the Pandalus III provided 185 sea days of operation. The operation of the boat with only 1 PY continues to hamper the ability to provide trawling without supplementation by scientific programs. the level of utilization continued to be very heavy, leaving minimal time for maintenance. all programs at the Biological Station utilized the Pandalus III, with greatest use by scallop, phytoplankton, benthic sampling and aquaculture programs. The annual refit was done February 22-March 5.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

Output for 1993-94 should be approximately the same level. Operation of the Pandalus III with only one crew continues to be a concern on the basis of safety. Vessel requirements for trawling will not be met without participation by scientific staff or the provision of extra crew by program funds. The Pandalus III can be expected to lose about 20 days/year due to staff vacation and sickness.

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.: 5900

Section: Scientific Support Services

Project Title: S/V J.L. HART

Project Leader: Ross, P.

Other Researchers: Lumsden, J. D.; Banks, M.; O'Neil, R.; Lumsden, D. G.

Work Activity: W.A.1.1.0.0

Key Words: research vessel

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1. Project Description:

Operate the S/V J.L. HART to serve the Station's stock assessment associated biological research programs in the most effective manner. The HART conducts a wide range of work, i.e. midwater and bottom trawling, scalloping, water and bottom sampling, as well as utilizing specialized gear over an area from St. Andrews to Georges Bank.

2. Long-Term Objectives:

Continue providing acceptable research vessel service for St. Andrews Biological Station programs as well as those from Halifax and the Gulf Region; ensure that scheduled requirements are met and the cost effectiveness of the vessel is maintained.

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

For the 1992-93 season, the J.L Hart provided 79 sea days of work. April and May were lost because of repairs to the gear box. Undertakings this year included: Bay of Fundy scallop survey, Fundy toxin survey, SW Nova inshore trawling survey, Passamaquoddy Bay scallop survey, Lurcher survey, Grand Manan scallop survey and SW Nova lobster surveillance cruise for Fisheries and Habitat Management.

4. Additional Accomplishments:

The level of overtime funding for the crew caused problems for scientific staff in terms of their ability to conduct surveys in the most logical manner. The crew should be commended for their cooperation and competency in ensuring surveys were successful. The Chief, Marine Services, stated that the J.L. Hart was one of the best kept vessels in the Scotia-Fundy fleet.

5. Goals/Expected Outputs for 1993:

Outputs for 1993-94 will depend in large part on program requirements - expected to be about the same as in 1992-93. Beyond this level, the J.L. Hart could easily increase her sea days if she operated on a 12-month basis. Staffing of the Master, Mate and Cook/Twinehand positions on a full-time seasonal basis should be done to provide continuity of service.

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: Habitat Ecology Division Project No.: 000

Section:

Project Title: Division Administration and Management

Project Leader: Gordon, D.C.

Other Researchers: Keizer, P.D.; Morgan, S.P.; Parnell, J.E.; Rowell, T.W.; Vass, W.P.

Work Activity: W.A.1.1.3.1

Key Words: administration; financial management; personnel management; scientific management

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1. Project Description:

Administration and financial, personnel, and scientific management of the Habitat Ecology Division.

2. Long-Term Objectives:

Administer the Habitat Ecology Division efficiently, provide scientific leadership and coordination in interpreting and accomplishing the mandate of the Division, and procure financial resources for carrying out Divisional programs.

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

1. Administer and manage the Habitat Ecology Division efficiently. (Gordon, Keizer, Morgan, Parnell, Rowell, Vass)

Administrative procedures have proceeded smoothly during 1992 despite a continuing heavy workload and personnel changes. J.E. Parnell (ST-SCY-2) left on maternity leave in October and, since a Biological Sciences Branch staffing 'freeze' prevented hiring a replacement, her duties have had to be taken on by S.P. Morgan (AS-1). The Division chief, D.C. Gordon, was away on program travel for 4 months, but his duties were ably looked after by P.D. Keizer. Severe financial problems affecting the whole Division were experienced when anticipated Atlantic Fisheries Adjustment Program funds did not materialize. The Divisional financial accounting system maintained by S.P. Morgan continues to be a valuable asset for financial management and planning. The Division chief has begun training to prepare for the new Single Operating Budget system scheduled to begin in FY 1993/94.

2. Provide scientific leadership and coordination in interpreting and accomplishing the mandate of the Habitat Ecology Division. (Gordon)

The Division program continues to evolve in response to the priorities for habitat research established by DFO, Departmental clients, and the scientific community. However, progress is limited by cuts in both personnel and financial resources. A Divisional overview, summarizing the past 5 years and concerns about the future, was prepared and circulated to staff and management.

3. Seek external funding for new programs that cannot be supported with A-Base resources. (Gordon)

External funding was again obtained from the Panel on Energy Research and Development (PERD) to continue studies of the potential impact of drilling wastes on scallop populations. Green Plan funding was obtained for research on chlorinated hydrocarbons, aquaculture impacts, and the Habitat Sensitivity Mapping system. Several staff were also successful again in obtaining Natural Sciences and Engineering Research Council (NSERC) funding through university affiliations. Despite efforts to obtain them, Atlantic Fisheries Adjustment Program (AFAP) funds did not materialize.

4. Liaise with other Science Sector divisions, the Marine Assessment and Liaison Division, and the Habitat Management Branch to implement the DFO Fish Habitat Management Policy. (Gordon)

Coordinated the Regional phytotoxin program, served as chairperson of the DFO Phycotoxins Working Group, and coordinated the PERD Project 6.7 impacts program. Sat on numerous habitat-related committees and attended many meetings. Helped build improved collaboration with other divisions and departments. Helped establish the new Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) Habitat Science Subcommittee.

5. Review new purchasing procedures and provide staff with clear instructions for following them. (Morgan)

A purchasing manual was prepared and distributed to staff.

4. Additional Accomplishments:

   1. Continued an informal lunch-time seminar series which included speakers affiliated outside of the Habitat Ecology Division.

5. Goals/Expected Outputs for 1993:

   1. Administer and manage the Habitat Ecology Division efficiently. (Gordon, Morgan, Parnell, Rowell, Vass)

   2. Provide scientific leadership and coordination in interpreting and accomplishing the mandate of the Habitat Ecology Division. (Gordon)

   3. Seek external funding for new programs that cannot be supported with A-Base resources. (Gordon, other Habitat Ecology Division staff)

   4. Liaise with other Science Sector divisions, the Marine Assessment and Liaison Division, and the Habitat Management Branch to implement the DFO Fish Habitat Management Policy. (Gordon)

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: Project No.: 5900

Section:

Project Title: Regional Director, Science Sector

Project Leader: MacPhee, S.B.

Other Researchers: Guilderson, J. ; Henderson, J.

Work Activity: W.A.1.1.5

Key Words: administration

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1. Project Description:

To provide the scientific information necessary for the sustainable development of Scotia-Fundy Fisheries and Canada's Oceans; to ensure the availability of scientific information of the highest possible standard to internal and external clients for use in developing policies, regulations, legislation, and plans pertaining to the Region's aquatic activities such as fishing, industrial development projects, and aquaculture; to acquire and communicate scientific information on the impact of deleterious substances on aquatic ecosystems and habitats, on climate processes and how they influence marine resources, and on environmental parameters relevant to marine activities such as marine engineering and transportation; to chart Canadian Atlantic and Arctic waters to facilitate safe navigation, fishing and aquatic development activities; to develop and refine methods and technology necessary for the Region's scientific role, and transfer relevant technology to Canadian industry.

Note that the official Work Activity structure places this project within W.A. 1.1 (Biological Sciences) under the administrative W.A. 1.1.5. Resources in this project, although often reported as Biological Sciences resources in higher level roll-ups (e.g. National), refer to the Science Sector as a whole.

2. Long-Term Objectives:

Continue to administer Science Sector activities according to Departmental priorities and the scientific requirements associated with the Departmental mandate. Continue to improve the advice provided to resource and habitat managers and industry by expanding the knowledge base on renewable resources in the aquatic environment.

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

Achievements are outlined in the Scotia-Fundy Region Year-End Review prepared by the Comptroller's Branch.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

Goals for 1993 are given in the current Accountability Accord for the Science Sector, and in the detailed project forms given in PREP documents prepared by the three Science Branches.

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: Project No.: 5910

Section:

Project Title: Director, Biological Sciences Branch

Project Leader: Sinclair, M.

Other Researchers: Lavoie, R.E. ; Guilcher, D. ; Harrie, K.

Work Activity: W.A.1.1.5

Key Words: direction; administration

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1. Project Description:

Provision of scientific and administrative direction for the Biological Sciences Branch, Scotia-Fundy Region.

2. Long-Term Objectives:

To direct the activities of the Biological Sciences Branch according to Departmental priorities and the scientific requirements associated with the Departmental mandate. Continue to improve the advice provided to resource and habitat managers and industry by expanding the knowledge base on renewable resources in the aquatic environment.

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

Achievements are outlined in the Scotia-Fundy Region Year-End Review prepared by the Comptroller's Branch, and provided in detail within the projects given in the Branch PREP document.

4. Additional Accomplishments:

Co-chaired (with a provincial counterpart) the Nova Scotia Aquaculture Coordinating Committee. (Lavoie)

Led a mission in Sao Tome y Principe (West Central Africa) and provided an evaluation on progress made towards the establishment of a fisheries research capability for the country. Also prepared an action plan for 1993. (Lavoie)

5. Goals/Expected Outputs for 1993:

Goals for 1992 are given in the current Accountability Accord for the Science Sector, and in detail within the projects given in the Branch PREP document.

6. Background:

Highlights:

Selected Involvements:

i. Collaborative Research -

ii. University Liaison -

R. Lavoie is a member of the Aquaculture Committee of APICS (Atlantic Provinces Inter-university Council on the Sciences).

iii. Communications -

Invited speaker:

- Great Atlantic Shellfish Exchange, Montague, P.E.I.
- Yarmouth Aquaculture Symposium, Yarmouth, N.S.

Co-chaired the organizing committee of the Service Challenge regional workshop.

iv. Contracts Administered -

M.J. Dadswell ($4K). Survey of sea scallop (Placopecten magellanicus) spat settlement on the Atlantic Coast of Nova Scotia and Annapolis Basin, Bay of Fundy.

D.J. Scarratt ($10K). Preparation of a "Handbook of northern mussel culture".

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: Marine Assessment & Liaison

Project No.: 5901 to 5907

Section: Marine Assessment & Liaison (5901), Scientific Computing (5902-05), CAFSAC (5906) and SCOR (5907)

Project Title: Marine Assessment & Liaison

Project Leader: Nicholls, H.B.

Other Researchers: Koeller, P. ; Porteous, D. ; Seibert, G. ; Maguire, J.-J.

Work Activity: W.A.1.1.5

Key Words: administration ; computing ; CAFSAC ; habitat

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1. Project Description:

This Division, reporting directly to the Regional Director of Science, provides a wide variety of services and functions for the Science Sector and its clients. It provides administrative support by coordinating Science Work Planning, Atlantic Science Vessel Scheduling, reporting of Sector activities, and Science communications with the public (e.g. Weekly Scientific Briefing newsletter). The Division provides and coordinates Science Sector advice required by DFO Habitat Managers, including major reviews under EARP. It also provides scientific computing services to regional scientists in the form of data communications and mainframe support. The Division provides the secretariat for the Canadian National Committee for SCOR/ECOR. The CAFSAC secretariat, although an Atlantic-wide function, is situated in Scotia-Fundy and is placed under the Regional Science Director, and within this project, for administrative convenience.

Note that the official Work Activity structure places this project within W.A. 1.1 (Biological Sciences) under the administrative W.A. 1.1.5. Resources in this project, although often reported as Biological Sciences resources in higher level roll-ups (e.g. National), refer to the Science Sector as a whole.

2. Long-Term Objectives:

Continue to administer Science Sector activities according to Departmental priorities and the scientific requirements associated with the Departmental mandate. Continue to improve the advice provided to resource and habitat managers and industry by expanding the knowledge base on renewable resources in the aquatic environment.

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

Achievements are outlined in the Scotia-Fundy Region Year-End Review prepared by the Comptroller's Branch.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

Goals for 1993 are given in the current Accountability Accord for the Science Sector, and in the detailed project forms given in PREP documents prepared by the three Science Branches.

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: Marine Services

Project No.: 5518 to 5522

Section: EE Prince (5518), Alfred Needler (5519), Lady Hammond (to August 1993 - 5520), Sigma-T (5521), Navicula (5522)

Project Title: Biological Sciences Ships

Project Leader: Wheelhouse, J.

Other Researchers:

Work Activity: W.A.1.1.5

Key Words: ships; vessels; administration

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1. Project Description:

Science ships - EE Prince, Alfred Needler, Lady Hammond (charter), Sigma-T, Navicula. Although these vessels are often used by DFO Regions other than Scotia-Fundy, and sometimes by Work Activities other than W.A. 1.1, and by other government departments and by universities, they are placed under this W.A. (1.1.5) for accounting convenience. Note that the vessels are administered and operated by the Management Services Sector.

The substantial resources in this project, although often reported as Biological Sciences, Scotia-Fundy resources in higher level roll-ups (e.g. National), also refer to vessel support provided to other DFO Atlantic Regions, and to other government agencies and universities.

2. Long-Term Objectives:

Continue to provide research platforms required for the variety of marine research conducted on the Atlantic Coast.

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

Achievements are outlined in the Scotia-Fundy Region Year-End Review prepared by the Comptroller's Branch, and by the MISAR ship activities reporting system.

4. Additional Accomplishments:

5. Goals/Expected Outputs for 1993:

Goals for each vessel are outlined in the 1993/94 Vessel Work Plans prepared by Marine Services Division, and in the official Atlantic Science Vessel schedule prepared by the Marine Assessment & Liaison Division.

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 -

Key Words