Canadian Stock Assessment
Proceedings Series 97/8

Fisheries Management Studies Working Group
Report of Meetings

21-22 January 1997 and 27-28 May 1997

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July 1997

Fisheries and Oceans Science
Pêches et Océans

Canada

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Abstract

The Fisheries Management Studies Working Group encourages research on fishery management issues, and the application of results in the management of Maritimes Region fisheries. At its meeting in January 1997 the Working Group produced a categorized list of fisheries management issues of importance in this Region, an inventory of relevant research projects currently ongoing, and identified the precautionary approach, fishing effort regulation, and the accuracy of landings statistics, as priority items for the Working Group's attention. The nature of the new comanagement/ partnering agreements being developed, the need to institutionalize fishery system performance reviews, and to develop measurements of compliance with regulations, were also flagged as very important issues for the Working Group's attention. The first steps to address these issues were taken at the May meeting of the Working Group.

Résumé

Le groupe de travail sur les études de gestion des pêches encourage la recherche sur des questions liées à la gestion des pêches ainsi que la mise en oeuvre des résultats aux fins de la gestion des pêches dans la région des Maritimes. À sa réunion de janvier 1997, le groupe de travail a produit une liste, par catégories, des points importants en matière de gestion des pêches dans la région et une liste des projets de recherche pertinents qui sont menés en ce moment. Il a également fait ressortir les questions de toute première importance sur lesquelles le groupe doit se pencher, soit l'approche préventive, la réglementation des pêches et l'exactitude des statistiques sur les débarquements. Le genre d'accords de cogestion et de partenariat à conclure, et la nécessité d'institutionnaliser les examens de rendement dans le secteur des pêches et d'établir des critères pour mesurer le degré de conformité aux règlements sont aussi perçus comme des points importants auxquels le groupe de travail doit s'attarder. Les premières démarches pour régler ces questions ont été prises à la réunion de mai du groupe de travail.

Final: 28 February, 1997

FISHERIES MANAGEMENT STUDIES WORKING GROUP
REPORT OF MEETING -- 21-22 JANUARY, 1997

1. Approval of Agenda

The agenda for the meeting, held at the Gulf Fisheries Centre, Moncton, is at Annex 1 and a list of participants at Annex 2.

2. Working Relationships of the Working Group (WG)

The chairman of the Maritimes RAP Steering Committee, R. O'Boyle, informed the WG (by memorandum) of the formation of a RAP Fisheries Management Subcommittee to be chaired by G. Peacock. The FMS WG was seen as supporting this Subcommittee.

The WG, therefore, will devote its attention to stimulating appropriate input to the Subcommittee by encouraging research on management issues of current or emerging importance, especially when coordination among branches and sites is necessary, reviewing and synthesizing analyses, serving as a centre for dissemination of information from ICES, NAFO Scientific Council and other groups active in the field of fisheries management research, and advising line management on research priorities.

The WG viewed the formation of the Fisheries Management Subcommittee as a very positive, possibly an essential, step for the practical utilization of the results of research in this field.

The chairman agreed to discuss with the chairman of the Maritimes RAP Steering Committee the most appropriate distribution of FMS WG reports.

ACTION: HALLIDAY

3. Reports from Other Groups

The following ICES working and study groups were identified as relevant to the activities of the FMS WG (Maritimes Region members and/or participants are named in parentheses):

- Comprehensive Fisheries Evaluation Working Group (A. Sinclair)
- Study Group on the Precautionary Approach to Fisheries Management (R. Stephenson)
- Study Group on the Management Performance of Individual Transferable Quota (ITQ) Systems (R. O'Boyle)
- Working Group on Ecosystem Effects of Fishing Activities (M. Sinclair)
- Study Group on Resource Management (R. Stephenson)

- Working Group on Fishing Technology and Fish Behaviour (C. Cooper)
- Study Group on Grid (Grate) Sorting Systems in Trawls, Beam Trawls and Seine Nets (C. Cooper)
- Study Group on the Use of Selectivity Measurements in Stock Assessment (R. Halliday)
- Study Group on Unaccounted Mortality in Fisheries (none)

The FMS WG, noting the upcoming retirement of C. Cooper, considered it important that Maritimes Regional representation on the Working Group on Fishing Technology and Fish Behaviour, and its study groups, continue, as its work is directly relevant to many Regional issues.

The NAFO Scientific Council does not have working and study groups comparable to those of ICES but sponsors Special Sessions, some of which are relevant to the work of the FMS WG. The most recent was a symposium held in 1993 on "Gear Selectivity/Technical Interactions in Mixed Species Fisheries", the report of, and papers from, which were published in the Journal of Northwest Atlantic Fishery Science Vol. 19 (1996). A symposium entitled "What Future Capture Fisheries?" is scheduled for 10-12 September, 1997, in St. John's, Nfld.

Reports on the current activities of ICES working and study groups follow (names of those who prepared these summaries are in parentheses):

ICES Comprehensive Fisheries Evaluation Working Group (A. Sinclair)

The inaugural meeting of the ICES Comprehensive Fisheries Evaluation Working Group was held in Copenhagen, June 17-26, 1996 (ICES CM 1996/Assess: 20). Its terms of reference were to define components required for comprehensive and interdisciplinary evaluations of multispecies and multifleet fisheries, to continue comprehensive evaluation of North Sea flatfish fisheries, and to develop a program of other case studies.

It was generally accepted that comprehensive evaluations would require considerable amounts of work and that it was impractical to do this during a meeting. Instead, a considerable amount of intersessional work is required with relatively active communications among interested researchers. The traditional assessment working groups would have to be involved to provide technical input and knowledge of the fisheries. Future working group meetings will be oriented towards peer review of comprehensive evaluations and techniques.

Recent international agreements on fisheries management and their implications on how ICES and other organizations provide management advice were discussed. Two important agreements which Canada has signed are The Code of Conduct for Responsible Fisheries adopted by the FAO Committee on Fisheries in November 1995, and the agreement on the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks adopted by the United Nations General Assembly in August 1995. The working group concluded that these conventions require that fisheries management systems have the following qualities:

- Fishing should be limited to sustainable levels
- Uncertainty should not be a reason to maintain high fishing mortality
- Stock biomass should be kept above that which will produce maximum sustainable yield (B_{MSY})
- Fishing mortality should be kept below that which will produce MSY (F_{MSY})
- There should be only low probability that biomass might fall below B_{MSY} and that fishing mortality should rise above F_{MSY}.

Biological reference points have been used to determine fisheries management measures such as total allowable catches (TAC). An example is $F_{0.1}$, the reference level of fishing mortality used for eastern Canadian groundfish. The working group recognized the distinction between two types of reference points. Target reference points are used to meet management objectives in normal circumstances. Limit reference points (or thresholds) are intended to constrain harvesting within safe biological limits and would trigger drastic action, such as closing a fishery. Given the wording of these international agreements, the working group interpreted B_{MSY} and FMSY as limit reference points.

Study Group on the Precautionary Approach to Fisheries Management (R. Stephenson)

The study Group is to meet in early February to incorporate elements of the precautionary approach, referred to in the Code of Conduct for Responsible Fisheries and international agreements agreed to by many countries, into a new form of advice to be used by the Advisory Committee on Fisheries Management (ACFM) of ICES. The study group is expected to extend the discussion contained in the 1996 report of the ICES Comprehensive Fisheries Evaluation Working group regarding target and limit reference points implied by the precautionary approach, the documentation of uncertainty, and the form of advice.

Study Group on the Management Performance of Individual Transferable Quota (ITQ) Systems (R. Stephenson)

The Study Group worked by correspondence during 1996 to produce a review of available literature information on ITQ case studies (ICES CM 1996/Assess: 19). The group is to meet in May 1997 to develop a performance appraisal system with respect to biological, socioeconomic, and management dynamics of fisheries - and to apply this appraisal system to a selection of ITQ case studies.

Working Group on Ecosystem Effects of Fishing Activities (R. Halliday)

This working group met in March 1996 (ICES CM 1996/Assess/Env: 1, Ref.: G) and is scheduled to next meet in November 1997. It is addressing the effects of fishing on biodiversity and on community structure and function. Relevant issues include the effects of fishing on the seabed, evaluation of area closures, estimation of discards and their utilization, and the effects of fishing on non-target species.

Study Group on Resource Management (R. Stephenson)

This Study Group has been formed to work (by correspondence) during 1997 to produce a discussion paper on the form and function of a proposed new Resource Management Committee. The Study Group is expected to summarize multidisciplinary resource management studies currently being undertaken by ICES countries, and to develop a list of strategic issues that may be considered by the new committee.

Working Group on Fishing Technology and Fish Behaviour (R. Halliday)

This WG meets annually, the next meeting being in April 1997 when new data on codend selectivity in towed gears will be evaluated and future research on this topic will be considered, progress in estimating and improving both catching efficiency and size and species selectivity in fixed gears will be reviewed, and progress of two of its study groups will be discussed. That on grate sorting systems is compiling selectivity parameters for nets with grates, estimating the effects of grate use on discards, and compiling a comprehensive bibliography on grates. That on unaccounted mortality is developing priorities for future work in this field. The remaining study group, that on the use of selectivity measurements in stock assessment, is validating the selectivity parameters obtained from mesh selection experiments against values obtained from other methods, assessing the impact of post-selection mortality on total fishing mortality, and further developing analytical methodologies. The working group has completed a "Manual of Methods of Measuring the Selectivity of Towed Fishing Gears" and this was published in 1996 as ICES Cooperative Research Report No. 215, 126p. This provides invaluable guidance for those initiating field selectivity experiments.

4. Research Planning

The WG was of the view that its work should encompass fishery management planning in its broadest context, and endorsed the description of the planning process that had been prepared by the Chairman (Annex 3) as a satisfactory statement of the Group's scope of work. The motivation for the present meeting came from MFD, Science Branch, which requested guidance on research program priorities as a basis for a strengthened program in this field, prior to its annual Program Planning and Evaluation exercise. Thus, finfish fisheries only were considered.

An inventory of ongoing research on finfish fisheries management systems and measures was compiled to establish the present level of activity in this field and its distribution by subject area. This inventory is at Annex 4.

A list of fisheries management issues, categorized into Policy Issues, Regulation of Fishing, System Monitoring, and System Performance Review, was accepted as a basis for describing Regional management problems and priorities for research. An alternative classification, based on the Business Model used in the Report of the Second Workshop on Scotia-Fundy Groundfish Management (Can. Tech. Rep. Fish. Aquat. Sci. 2100), was considered less suitable for present purposes where the emphasis is on taking an integrated approach to

examination of issues. The content of the list, however, is based largely on the recommendations contained on pages 16-19 of the 2nd Workshop report, augmented by items in the 1996 MFD PREP documents, as well as from a discussion paper of 4 December 1996 on a Framework for Evaluating Fisheries Management Measures prepared for MFD for planning purposes (Annex 5), and by additional items agreed to in the WG meeting. All of the 2nd Workshop recommendations that appeared relevant to the work of the WG (17 of 32) are carried forward to the present list. The list of issues, as it presently stands, is for finfish fisheries only. However, it was viewed only as an initial list which would evolve and expand with the benefit of further input.

The categorized list of management issues which follows is cross-referenced to the inventory of research programs in Annex 4, and footnotes to the list contain comments and recommendations regarding specific items on it.

CATEGORIZED LIST OF FISHERIES MANAGEMENT ISSUES OF IMPORTANCE TO THE MARITIMES REGION.

(DP=Discussion Paper on a Framework for Evaluating Fisheries Management Measures, 4 Dec., 1996; TR2100=Can. Tech. Rep. Fish. Aquat. Sci. 2100, 1996; four-digit numbers=PREP ref. nos. 1996; MESD HPF=Marine Environmental Sciences Division High Priority Funding proposal; NEW=none of above.)

A) POLICY ISSUES

1) Structure and process for decision making.	ANNEX 4: A.1
a) incorporate management science techniques into planning and decision-making. (DP:5; 1320:4)	ANNEX 4: A.1.a
b) development of co-management and partnership concepts and their incorporation in management plans. (Example: the Scotia-Fundy herring fisheries.) (1301; 1320:4)	ANNEX 4: A.1.b; FOOTNOTE A.1.b
2) Transboundary stock management.	FOOTNOTE A.2
a) develop the notion of "consistent" management measures for Canada/USA transboundary resources and investigate implementation rules and monitoring mechanisms. (1320:2)	ANNEX 4: A.2.a
b) evaluate the implications of stock status uncertainty and stochastic recruitment on the yield per recruit benefits from a unilateral Canadian strategy of $F_{0.1}$ for Georges Bank stocks. (DP:3, 1313; 1324)	ANNEX 4: A.2.b

3) Quasi-property rights.

a) evaluate the effects of EAs and ITQs on fleet capacity, participation, concentration of ownership, enterprise profitability, and on achievement of conservation objectives. (TR2100:23, DP:6) ANNEX 4: A.3.a

b) examine the effects of entry rules, licence fees, vessel replacement policies, and licence buy-outs (through Harvesting Adjustment Boards - HABs) on fleet capacity. (NEW)

4) Policy analysis (projection of the social, economic, and conservation implications of proposed policies).

a) evaluation of Harvest Management Plans, formulated under the new Fisheries Act, prior to their implementation. (NEW)

b) Analysis of income support and licensing policies. (NEW) ANNEX 4: A.4.b

5) Within-season management.

a) evaluate benefits of an in-season management approach in the 4WX herring fishery. (DP:4; 1301) ANNEX 4: A.5.a

b) evaluate effectiveness of in-season evaluations of fishing plans such as in herring and salmon fisheries. (DP:7) ANNEX 4: A.5.b

B) REGULATION OF FISHING

1) Exploitation level - general. ANNEX 4: B.1

a) develop framework to evaluate the use of Minimum Acceptable Biological Levels (MBALs) and harvest rate targets for groundfish species. (1203:C4) ANNEX 4: B.1.a; FOOTNOTE B.1.a

b) develop management strategies for mixed species fisheries. (DP:2) (see ANNEX 4: B.3.a)

2) Exploitation level - Fishing effort management. FOOTNOTE B.2

a) establish a real-time, two-level monitoring system using catch and effort to identify problems in stock assessment or misreporting, for a selected fishery on a trial basis. (TR2100:4,12)

b) establish methods for estimating fishing effort targets. (1203:C3) ANNEX B.2.b

c) estimate days at sea needed by fleet sector to catch quota share in support of a two level monitoring system. (TR2100:32)

d) evaluate costs of a real-time two level monitoring system. (TR2100:25)

e) consider, for a competitive fishery, easily monitored effort regulations such as fishing at alternate times (i.e., days, weeks, months). (TR2100:18)

f) compare and contrast quota versus effort management in implementing a constant fishing effort strategy. (DP:8)

3) Exploitation level - Catch quota management.

a) evaluate the implications of stock status uncertainty and stochastic recruitment, and natural mortality, on the achievement of target fishing mortality strategies when carry-over allocation is implemented as a strategy. (DP:11) ANNEX 4: B.3.a

b) evaluate data and monitoring needs for a year-class quota system, and explore implementation in a fishery in which different fleet components harvest different age classes. (TR2100:7,27)

c) set criteria for inter-annual carry-over of catch allocations. (TR2100:9) FOOTNOTE B.3.b and c

4) Exploitation pattern (size selection). FOOTNOTE B.4

a) evaluate tactics, including mesh regulation, fish size regulation, small fish protocols (i.e., real-time area closures) and permanent closures, for reduction of small fish mortality based on comparisons of results in different management regimes. (DP:10, 1100) ANNEX 4: B.4.a

b) evaluate the necessity for, and the effectiveness of, small fish protocols and other measures to avoid the capture of small redfish in Unit 3. (1050) ANNEX 4: B.4.b

c) assess the effectiveness of changes to the position of the Small Mesh Gear Line (SMGL), and to the fishing season, for silver hake on the Scotian Shelf in reducing by-catches of small haddock. (1040) ANNEX 4: B.4.c

5) Preservation of spawning potential.

a) define new closed areas and seasons to protect spawners and retain present ones on Browns and Georges banks but review their duration with respect to optimal benefits (TR2100:5,29), and evaluate the costs

of closed area and season regulations. (TR2100:24) FOOTNOTE B.5.a

b) estimate minimum spawning stock biomass for as many management units as possible in order to prevent recruitment overfishing (TR2100:28), and evaluate spawning stock biomass thresholds for closing and opening fisheries. (DP:1) FOOTNOTE B.5.b

6) Reduction of wastage (by-catches, species selection). FOOTNOTE B.6

a) quantify mortality incidental to the catching process (post-selection mortality, ghost fishing (GN), roadkill (OT), float-out (OT, DS), drop-out (GN), drop-off (LL), predation in/on gear). (NEW)

b) develop species selective gears. (NEW)

c) evaluate by-catch in the Unit 3 redfish fishery. (1050) ANNEX 4:B.6.c

d) measure the effectiveness of acoustic alarms (pingers) as a mitigative measure to reduce by-catches of harbour porpoises in demersal gillnets. (1330:1)

7) Effects of fishing gear on habitat. FOOTNOTE B.7

a) examine the effects of otter trawling and offshore clam dredging on benthic habitat and communities. (MESD HPF proposal)

C) SYSTEM MONITORING

1) Record of management measures.

a) prepare annual reports on management measures adopted for each fishery. (1060) ANNEX 4: C.1

2) Unreported catches.

a) develop indices of discarding (from observer and other at-sea monitoring), and of misreporting, use these to estimate unreported catches, and simulate the effects of discarding on stock assessment results. (TR2100:11,31; 1050; 1125:4,5; 1203:A8; 1204; 1330:2-harbour porpoise) ANNEX 4: C.2.a

b) audit landings and effort data collected through Dockside Monitoring Programs (DMP). (1125:1,3) FOOTNOTE C.2.b

3) Measurement of compliance.	FOOTNOTE C.3
a) analyze the costs and effectiveness of enforcement. (TR2100:22)	
4)Economic and social indicators.	
a) develop a landed price monitoring system. (TR2100:21)	ANNEX 4: C.4.a
b) develop protocols for, and monitor, licensed fleet capacity. (NEW)	ANNEX 4: C.4.b
c) monitor number of licensed fishermen and their level of activity on an annual basis. (NEW)	
d) document measures of industry profitability and fishermen's incomes. (NEW)	ANNEX 4: C.4.d
D. SYSTEM PERFORMANCE REVIEW	
(Elements of the projects described above (A.1.a, A.3.a, B.4, B.6, C) also fall under this category.)	FOOTNOTE D

FOOTNOTES

A.1.b. Much more could usefully be done, but the WG needs to become more conversant with the issues. The WG asked C. Annand to request G. Peacock to provide an inventory of existing co-management / partnership agreements and a statement of the direction the Department was going with these.

(ACTION: ANNAND)

A.2. Recent developments, such as the recognition by the USA of $F_{0.1}$ as a target, moves towards reinstitution of joint scientific assessment of Georges Bank stocks, and common concerns about orderly development of fisheries as stocks recover, make it increasingly likely that transboundary stock management will become a priority issue.

B.1.a. A high priority needs to be given to the matter of threshold and target reference points. See Agenda item 6.

B.2. Publication of the FRCC's Discussion Paper on effort and catch controls, and the likelihood that fisheries could be reopened soon, make effort regulation a topical issue. Development of a sound technical basis for policy is a high priority. A pilot effort regulation/monitoring study was conducted for the under 65 feet vessels fishing groundfish on Georges Bank in 1996 in fulfillment of a recommendation from the 2nd Groundfish Workshop. This demonstrated some of

the practical problems involved, but a full report of the study is not yet available. See Agenda item 6.

B.3.b&c. Advice on carry-over of annual allocations has already been provided (DFO Maritimes Regional Fisheries Status Report 96/1). It is important that the criteria for carry-overs be addressed quickly because these will determine the usefulness of further research work, and the possibilities of implementing a year-class quota system. C. Annand was asked to document Resource Allocation Branch views and/or decisions on carry-over.

(ACTION: ANNAND)

B.4. Although analysis and interpretation of previously collected data continues, no gear research on size selection is presently being funded by DFO regionally. Some experimental work is being conducted in the Southern Gulf of St. Lawrence, however, which is funded jointly by DFO-Ottawa and the Province of New Brunswick. Results of this work are available to the industry and the WG thought it important that it have an opportunity to review reports produced in order to provide appraisals to Regional staff. The chairman agreed to try to obtain copies from Headquarters.

(ACTION: HALLIDAY)

Despite the implementation of juvenile area closures, both permanent and temporary, for a number of years, there has been no review of their performance. The WG agreed that it should devise methods to conduct proper evaluations of these. R. Branton agreed that the ongoing research on small fish closures for Unit 3 redfish could be conducted in such a way as to serve as a test case for evaluation of the usefulness of the small fish protocols in general.

(ACTION: BRANTON)

B.5.a. The WG did not consider that the merits of closed areas to protect spawners was well enough established that the next step should be general implementation of such closures for groundfish species. It noted also that previous evaluations of the costs of closed areas had been conducted and that further evaluations at this stage is a low priority. The recent results of Morgan and Trippel (ICES J. mar. Sci., 53) concerning the possible effects of spawning closures on the sex ratio of removals was also noted, and it was concluded that a more thorough scientific review is needed before the number of spawning area closures is increased.

B.5.b. Spawning stock targets and thresholds form a subset of biological reference points and were thus considered to be covered under B.1.a (see Footnote B.1.a).

B.6. In addition to the work on by-catch of other groundfish in the Unit 3 redfish fishery (B.6.c), the work on reduction of by-catches in the silver hake fishery reported under B.4.a and c (separator grate and modification to the SMGL) are relevant here. The DFO/Province of New Brunswick gear trials in the Gulf of St. Lawrence, referred to in Footnote B.4, may prove to fit in here also (under B.6.b - development of species selective gears) once there purpose is

discovered. However, the research project on by-catches of harbour porpoises in groundfish gillnets is completed and advice has already been provided (DFO Maritimes Regional Fisheries Status Report 96/3), and is being replaced by routine monitoring of by-catches. With regard to B.6.a, no work on these issues is contemplated at this time. Some of these are likely of little or no importance, but otter trawl post-selection mortality remains a potentially big issue. The cost of initiating research in this field is prohibitive, but results of work elsewhere should be closely followed. (Gear selection issues for groundfish were reviewed in the Report of the Second Workshop on Scotia-Fundy Groundfish Management.)

B.7. While the results of specific experiments on the effects of towed gears on benthic animals and on the sea bed are perhaps best reviewed elsewhere, the ecosystem effects of fishing activities in general are of interest to this WG.

C.2.b. Evaluation of the accuracy of landings and fishing effort data, collected at point of landing, has historically been neglected. It is nonetheless almost universally recognized that a knowledge of the accuracy of landings statistics is essential to assessment of the performance of the TAC system that is the foundation of groundfish regulation, and to diagnosis of root causes of overall regulatory system failures. The Dockside Monitoring Programs (DMPs) that are being widely implemented offer the potential to capture much more comprehensive and accurate landings statistics than has been possible previously. This implementation phase is the ideal time to conduct the necessary evaluations to ensure that the potential improvements in accuracy and completeness are realized, and maintained. As a first step, the WG asked C. Annand to prove it with documentation on the history of DMP implementation and evaluation so that a course of action regarding further evaluation can be established.

(ACTION: ANNAND)

C.3. Measurement of compliance with regulations is not a standard feature of Departmental activities. As a result, evaluations of the effectiveness of measures must be based on anecdotal evidence, the reliability of which is impossible to ascertain. There are important benefits to be obtained from coordinating analyses of data from different sources, and by bringing together teams from different branches, to investigate compliance levels. Benefits include insights which allow improved regulatory decision making, as well as more effective utilization of enforcement resources and possibly the use of surveillance data to improve stock assessments. It is essential that there be participation by enforcement staff in the work of the WG if these possibilities are to be realized.

(ACTION: HALLIDAY)

D. It was noted that, although stock assessments did provide regular evaluations of whether target exploitation levels were met on a stock by stock basis, and a number of projects listed in Annex 4 were relevant to this issue, there was very little analysis that could be classified as specifically directed to system performance review. This emphasizes the need for this WG and its parent-to-be, the Fisheries Management Subcommittee. This topic is not listed as a priority only because action is already in hand.

5) Other Matters

Production modelling and MSY as a reference point.

A. Sinclair presented calculations using an age-structured production model that illustrated the effects of fishing at various biological reference points when a particular stock-recruitment relationship is assumed to exist (Annex 6). The WG agreed that these calculations provided a useful way to explore the properties of reference points, in an attempt to define those that could be used to give practical application to the concepts in recent international agreements. It is neither logical to assume existence of a particular stock-recruitment relationship, nor to deny the existence of one, when providing advice on potential yields. Thus, exploring the bounds of possibilities with regard to such relationships, and their implications to potential yields, as a way to evaluate reference points, would appear to have merit. (See Agenda item 6 re action recommendations.)

Report outlines - evaluation of the impact of carry-over of quotas; effects of assessment uncertainty on harvest strategy for transboundary resources.

These items were not available to the WG as S. Gavaris was unable to attend the meeting.

FRCC Discussion Paper on Quota Controls and Effort Controls: Conservation Considerations.

M. Sinclair, Manager, MFD, referred this paper to the WG for review, this review presumably to form the Regional Science response to the request for input made by W. G. Doubleday, D/G Fisheries and Oceans Sciences, Ottawa. The document had been distributed prior to the meeting with a request that comments be made available to A. Sinclair, who had agreed to compile these. Four responses were available, but further comments were anticipated. It was agreed that, once these remaining comments were received, A. Sinclair would circulate a draft consolidated review and initiate a conference call among those making comment to finalize a WG response.

(ACTION: A. SINCLAIR)

Workshop on Assessment and Management of Atlantic Herring, March/97.

It was noted that the Canadian Stock Assessment Secretariat (CSAS - Coordinator, J. Rice) was holding a Zonal workshop in Moncton at the end of March on:

- strengths and weaknesses of assessment data and models,
- reference points and advice to managers, and
- pre-season and in-season information, advice, and decisions.

In addition, a Maritimes Regional workshop is planned for February to discuss conservation objectives and decision rules for management (coordinator: M. Sinclair). The WG recognized the importance of these meetings in furtherance of its own agenda, and accepted the offer of R. Stephenson to provide a full report of the workshops at its next meeting.

(ACTION: STEPHENSON)

6. Plans for Future Activities of the WG

It was decided to meet next in the last week of May. By this time a number of meetings of other groups that conduct work relevant to the mandate of the WG will have met and their reports should be available for review. Program planning will be complete and the influence of the WG's advice will be determinable. There may also be progress by then in establishing the RAP Fisheries Management Subcommittee, allowing the implications to the WG agenda and timetable to be determined. Three matters stand out as issues which should be addressed urgently.

The first issue is that of appropriate biological reference points in the light of the new international agreements to which Canada is signatory. The calculations of reference points presented to the WG by A. Sinclair (see above) should be extended to other stocks and this could best be done by the experts for each stock. The results need to be reviewed, in conjunction with those for stocks in other parts of the Atlantic. A plan of work is required to culminate in a national workshop (organized by CSAS?) to make recommendations on appropriate reference points for Canadian marine fisheries. A. Sinclair and R. Halliday are to initiate discussions on this with the regional RAP coordinator, R. O'Boyle, and present a draft plan to the next WG meeting.

(ACTION: HALLIDAY, O'BOYLE and SINCLAIR)

The second issue is that of effort regulation. The Departmental and industry response to the FRCC paper should be available for the next meeting, as should a report on the Georges Bank pilot study in 1996. Development of a plan of work will be an agenda item for the May meeting.

Lastly, the accuracy of landings statistics, which is crucial to the debate on effort regulation as much as to most other aspects of regulatory decision-making, needs to be addressed expeditiously. The background paper that C. Annand has undertaken to produce (see above) is seen as a starting point and it is thus important that its production be awarded a high priority. C. Annand and R. Halliday are to discuss the scope of this report and what is required to have it available to the next meeting.

(ACTION: ANNAND and HALLIDAY)

Chairman: R. G. Halliday

Annex 1. AGENDA- FMS WG
21-22 JANUARY, 1997

1) Approval of agenda and timetable

2) Working relationships of the WG

3) Reports from other groups:

- ICES Comprehensive Fisheries Evaluation WG (A. Sinclair)
- ICES Study Group on the Precautionary Approach to Fisheries Management (R. Stephenson)
- ICES Study Group on the Management Performance of Individual Transferable Quota (ITQ) Systems
- ICES Working Group on Ecosystem Effects of Fishing Activities
- Others?

4) Research planning:

- scope (Fisheries Management Planning statement - Halliday)
- inventory of ongoing research on fisheries management systems and measures
- categorized list of management issues of importance to the Maritimes Region
- program areas requiring additional attention.

5) Other matters

- production modelling and MSY as a reference point (A. Sinclair)
- report outline: evaluation of impact of carry over of quotas (S. Gavaris)
- report outline: effects of assessment uncertainty on harvest strategy on transboundary resources (S. Gavaris)
- FRCC Discussion Paper on Quota Controls and Effort Controls: Conservation Considerations
- Workshop on Assessment and Management of Atlantic Herring, March/97

6) Plans for future activities of the WG

Annex 2.

LIST OF PARTICIPANTS

Christina Annand, Resource Allocation Branch, Halifax
Maurice Bourque, Policy and Economics Branch, Moncton
Leo Brander, Policy and Economics Branch, Halifax
Robert Branton, MFD, BIO
Ross Claytor, MFD, GFC (am 22nd. only)
Ralph Halliday, MFD, BIO
Réjean Hébert, Resource Allocation Branch, Moncton
Rod Morin, MFD, GFC (am 22nd. only)
Mark Showell, MFD, BIO
Alan Sinclair, MFD, GFC
Robert Stephenson, MFD, STABS

Annex 3.

DESCRIPTION OF THE FISHERY MANAGEMENT PROCESS

FISHERY MANAGEMENT PLANNING

The following are the necessary elements of fishery management planning and implementation:

- a structure and process for decision-making;
- a statement of policy;
- criteria which describe satisfactory system performance (i.e. operational definitions of policy objectives);
- selection of mechanisms (strategies) through which objectives are to be achieved;
- choice of tools (tactics) to implement the plan;
- encouragement of compliance with management measures adopted;
- collection of data on key indicators of system performance; and
- system performance review procedures.

R. G. Halliday
20 December 1996

Annex 4.

FMS FINFISH PROJECTS PRESENTLY ONGOING

(Reference no. is to CATEGORIZED LIST OF FISHERIES MANAGEMENT ISSUES OF IMPORTANCE TO THE MARITIMES REGION in FMS Meeting Report of 21-22 January, 1997. MFD Project numbers are provided for cross-reference to Program Planning and Evaluation documents.)

A) POLICY ISSUES

A.1 Structure and process for decision making (MFD Project No. 1106)

Discussion Paper on the Organization of Fisheries Management in the Maritimes Region (O'BOYLE)

This project endeavors to compare and contrast management institutions in the North Atlantic and South Pacific, particularly as they relate to power sharing, user representation, governance, and decision making. Funding arrangements will also be documented. The current Canadian system will be evaluated and recommendations made on what changes could be made to facilitate implementation of co-management. In 1996/97, work focused on understanding the Australian situation, as well as producing a draft outline of a discussion paper. Work in 1997/98 will include addition of observations from the North Atlantic and circulation of the discussion paper for comment. This project is in support of recommendation 1 of the 2nd Groundfish Workshop. (collaborator: S. D'Entrement, Inshore Fisheries, Pubnico, N.S.)

A.1.a (MFD Project No. 1320)

Incorporation of management science techniques into planning and decision making in fisheries (STEPHENSON)

Shortcomings of fisheries management systems include the inability to make decisions that account for multiple objectives of a variety of participants, and an inherently variable environment. Future management needs to focus on integrating biological, economic, social and political considerations of fisheries systems through new management structures and processes. This requires development of both a conceptual framework and an appropriate methodology for interdisciplinary decision making in fisheries management. This project is an attempt to integrate the traditional fields of fisheries science and fisheries management with the structured techniques of scientific problem solving and decision analysis from the field of management science (or operations research). Recent papers have described the rationale and context for this project. The term "fisheries management science" has been put forward to denote this framework for developing strategic management alternatives and for evaluation of these relative to biological, economic, sociological and political considerations. Future work will focus on the further development of a suite of descriptive and analytical tools to assist in decision making (including: a bioeconomic model of the fishery for scenario comparison and a spatial-temporal

database to assist in evaluating in-season observations), using the 4WX herring fishery as the primary case study. (collaborator: D. Lane, University of Ottawa)

A.1.b (MFD Project No. 1320)

Development of comanagement and partnership concepts, and their incorporation into management plans (STEPHENSON)

A management system is characterized by :1) its strategic plan (mission statement, objectives, and action plan of the organization), 2) the degree of involvement and organization of participants, 3) the management process used in identifying responsibilities for decisions, and 4) the tools used to assist the decision process. This project explores the evolution of these aspects toward comanagement, using the 4WX herring fishery as a case study. A discussion paper has summarized the experience of advanced comanagement relationships elsewhere, and outlined the issues of particular relevance to improved comanagement in this industry. Future work will include development of decision making tools which will be required as the industry moves further toward comanagement and in-season management. (collaborators: G. Melvin, D. Lane and others)

A.2. Transboundary stock management

A.2.a (MFD Project No. 1320)

Consistent management (GAVARIS)

Following the establishment of the Canada/USA boundary on Georges Bank, it was suggested that a "consistent management" strategy between the two countries should be investigated. A mutually beneficial approach where the expected benefits from management measures implemented by one country would not be undermined by activities of the other was required. The notion of "consistent" management needs to be defined operationally and practical "performance" measures to monitor the compliance by each country to the stated strategies need to be developed. The work needs to consider how spatial and temporal patterns of distribution and migration impact on the definition of consistency and on the calculation of the performance measures.

The beginnings of a recovery of haddock on eastern Georges Bank have sparked interest in the USA for less stringent management measures. The impending increase in USA fishing activity on eastern Georges Bank has stimulated some interest among the Canadian fishing industry to explore the implications of pursuing a "consistent" management strategy. Work on defining and elaborating on these concepts is planned for 1997. (collaborators : R. Halliday, R. L. Stephenson)

A.2.b (MFD Project No. 1313)

Transboundary harvest strategies (GAVARIS)

Early research following the establishment of the Canada/USA boundary focused on reviewing available data for the broad area called Gulf of Maine (Divs. 4X, 5Y and 5Z) to determine appropriate management units for Canada to consider for all the transboundary resources. Based on knowledge of distribution, migration, state of the stock and interest by the industry to harvest any given species, immediate need to consider USA actions when establishing Canadian management measures was limited to a few stocks, haddock, herring and perhaps cod. Subsequent work on herring focused on monitoring the recovery while that for haddock and cod concentrated on describing spatial distribution and migration on a finer scale and particularly with respect to the Canada/USA boundary. This was followed by deterministic yield per recruit analyses to evaluate the impact of USA actions on the benefits that might be achieved if Canada pursued an $F_{0.1}$ strategy.

During 1996, the distribution and migration results were refined and updated with more recent data, and there was further exploration and interpretation of the patterns observed when the exceptional 1962 and 1963 year-classes recruited. This work is completed and being reviewed now. It is planned to update the yield per recruit analysis using the results from the recent distribution and migration analysis and while doing this it is proposed that the implications of assessment uncertainties and stochastic dynamics would be explored. This work will be started in 1997. These last two projects are based on integrating assessment results with detailed temporal/spatial information from survey abundance indices. It was noted that there might be merit in modifying the assessment model so that the population can be reconstructed to the desired temporal/spatial detail. Work on modifying assessment software to accommodate temporal detail has been completed and the models to accommodate a two component spatial VPA have been developed. Work on programming the two component spatial VPA within ADAPT will be started in 1997.

It is hoped that some operational definition of "consistent" management along with the complementary information on temporal/spatial detail of stock status will provide the basis for evaluating harvest strategies which are mutually beneficial to Canada and USA. It should be noted that most of this work and analysis has been aimed at haddock. The state of knowledge for other species is generally lagging and increased attention will have to be given to these if similar information is desired. At present, the finfish species which are most likely to require such attention are cod, yellowtail, herring, monkfish and white hake. (collaborators: L. Van Eeckhaute and E. Trippel)

A.3 Quasi-property rights

A.3.a (MFD PREP Project No. 1106)

An Evaluation of the ITQ System in Southwestern Nova Scotia (O'BOYLE)

This project will undertake a case study of the SWNS ITQ system. It will document the events leading up to implementation in 1991, how they were implemented, and what has been the results, in terms of the impacts on capacity and the community. Preliminary work on this was done in 1992 and 1993 and will be updated with recent observations. It is planned to present preliminary observations at the ICES ITQ WG in May, 1997. This project is in support of recommendation 23 of the 2nd Groundfish Workshop. (collaborators: G. Peacock, C. Annand, L. Brander, D. Liew.)

A.4 Policy Analysis

A.4.b

Assessment of income assistance and licensing policies (BRANDER)

A considerable amount of impact assessment work was done prior to implementation of TFAA and TAGS income assistance programs. Similar analysis was done for the CORE licensing policy, and for the new licence fee structure. Currently regional policy staff are active on a national working group developing a user charges policy for the department.

A.5 Monitoring of system performance

A.5.a (MFD Project No. 1320)

Evaluation of the benefits of an in-season management approach in the 4WX herring fishery (STEPHENSON)

In the past two years the 4WX herring fishery has moved toward the management of individual spawning components of the stock complex by subdividing the TAC and an increasing degree of in-season management. This has resulted in increased involvement of the participants in data gathering and presentation (including ongoing industry surveys), a considerable increase in the speed of information summary, and increased participation of the industry in regular (weekly) discussion regarding management. This project will evaluate the pros and cons of this new approach. (collaborators: G. Melvin, M. Power and others)

A.5.b(MFD Project No. 1206)

Effectiveness of in-season evaluation of fishing plans such as in herring and salmon fisheries (CLAYTOR)

In-season forecasts and harvest allocations would have improved management of summer returning Atlantic salmon (*Salmo salar*) compared to pre-season forecasts and harvest allocations at 12 stock assessment sites in Southern Gulf of St. Lawrence rivers. Reducing under-harvest and increasing harvest variation were the greatest management effects. The relative effectiveness of making a single in-season allocation versus weekly sequential in-season allocations depended on the penalty associated with over-harvesting. Sequential allocations were always better when penalties for over-harvesting and under-harvesting were equal. When the penalty for over-harvesting was greater than under-harvesting, the management performance of single versus sequential allocations was site dependent. Sites with runs of shorter duration were better managed by single allocations. Sites with mean returns which were three times higher than the spawning escapement target were not improved by in-season management. A one or two week window exists for effective in-season management with single allocations. Defining the relative penalty to place on over-harvesting is the most important factor in determining how in-season management is implemented.

B) REGULATION OF FISHING

B.1 Exploitation level - general (MFD Project No. 1301/1320)

Management with increasing attention to the forage issue (STEPHENSON)

Forage considerations, or the trophic contributions made to predatory species, usually are considered part of a natural mortality rate, which most often has been considered to be a constant value. However there has been increasing awareness, interest and concern about the necessity to include forage considerations as a specific factor in resource evaluation of common prey species (e.g. herring), and in management objectives and allocations. This project is investigating this issue using herring as a case study.

B.1.a (MFD PREP Project No. 1203)

Develop a Framework for Evaluating Minimum Acceptable Biological Levels and Harvest Rate Targets for Groundfish Species (A. SINCLAIR, BLACK, MOHN, GAVARIS)

This project involves developing a fisheries system simulation framework that may be used to investigate the characteristics of alternative limit and target biological reference points relevant to groundfish fisheries management. The framework consists of a) an underlying system which defines the "true" biological, fishery and ecosystem dynamics, b) an observation process which generates stock assessment and monitoring data, c) an assessment component which estimates the "perceived" state of the system (stock size, stock histories, biological reference points), and d) a management component where pre-defined fishery control laws are

used to define management measures. Simulations would include different levels of error, for example differences between how the "true" system functions and the assumptions used in stock assessments, errors in the implementation of tactics (e.g. misreporting of catches), measurement errors in the observation component. A principle objective of the simulations is to test the robustness of alternative management measures to uncertainties about the management system. The framework may also be used to evaluate tactics, investigate the effects of system errors on assessment parameters, and to identify important areas of future research. A prototype simulation has been developed in APL and a report is in preparation. Current work involves developing an ACON implementation and optimizing the computer intensive components.

B.2 Exploitation level - Fishing effort management

B.2.b (MFD Project No. 1203)

Establish Methods for Estimating Fishing Effort Targets (SINCLAIR, CHOUINARD)

Fishing effort and fishing mortality increased dramatically on several cod stocks in the years leading to current moratoria. These trends were missed because stock assessments concentrated on stock size estimates and management relied on TACs. Errors in stock assessments and uncertainties in the management system resulted in TACs being set too high, and this required more fishing effort and therefore fishing mortality to catch them. Future stock assessments should monitor both stock size and fishing effort.

The current management strategy is to maintain fishing mortality constant at $F_{0.1}$. This implies that TACs will vary with stock size but that fishing effort will be relatively constant. This project is designed to develop methods for estimating fishing effort targets which can be used for management. It will focus on three aspects of the relationship between fishing effort and fishing mortality, the fishing power of vessels of different sizes and gear, the seasonal variation in catchability of the stocks, and possible stock-specific relationships between stock size and catchability.

B.3 Exploitation level - Catch quota management

B.3.a (MFD Project No. 1320)

Carry-over allocation (GAVARIS)

As a means of providing flexibility in achieving multiple quotas in mixed fisheries, a method of carry-over allocation was described and illustrated using 5Zjm haddock as an example. It was suggested that carry-over allocations could reduce or eliminate incentives to discard "low quota" species in a mixed fishery and might provide economic advantages with marketing (flexibility in "when" to harvest). Although a mechanism to prevent the biomass from falling below the level that would have occurred if the "annual" quota were caught in its entirety was proposed, its effectiveness needs to be tested for robustness to assessment uncertainty and process stochasticity (recruitment and natural mortality). It is intended to conduct mid-long term

projections which incorporate uncertainty and stochasticity and compare population state variables under "constant target" (not necessarily achieved) $F_{0.1}$ against some carry-over scenarios. It is expected that the most important carry-over scenario to examine is when a substantial quantity is carried over for some years and then harvested in a short period (greatest departure from a constant F strategy).

B.4 Exploitation pattern

B.4.a (MFD Project No. 1113)

Comparisons of North Atlantic fishery management regimes (HALLIDAY)

This project compares and contrasts the effects of different management measures on stocks of the same species in different (although in some cases quite similar) management regimes, as a substitute for experimental management. A description of North Atlantic fishery management regimes, including comparison of the effects on fishing mortality of controls (or the lack thereof) on the level of removals, was completed in 1996. Present research is on an evaluation of the effectiveness of regulations intended to increase the size/age at first capture on the partial recruitment of North Atlantic groundfish stocks, and should be completed in 1998. (collaborator: A. T. Pinhorn, NWAFC, St. John's)

Size selection of groundfish fishing gears (HALLIDAY)

This ongoing project (conducted in partnership with C. G. Cooper) generates new knowledge through field experiments, and applies existing information, to provide advice on the most appropriate gear regulations for groundfish fisheries in the Maritimes (Scotia-Fundy) Region. A review of conservation issues relating to gear technology in the Region was completed in 1996. Present research is directed at completion of analysis of size selection of square and diamond mesh netting in otter trawl codends based on experiments conducted in 1988-91 for cod, haddock and pollock. Reports are also in preparation on the selection of separator grates in the silver hake fishery, and on the selection of square and diamond mesh codends for silver hake. Subsequently, it is intended to analyze the results of four field experiments on longline selection conducted in 1991-95.

No new field experiments are proposed at this time. Efforts will be directed towards clearing up the backlog in analysis, and keeping abreast of new developments in the field. It remains to be seen whether the anticipated FRCC report on gear technology will have implications for the future direction of this project, but the anticipated retirement of C. G. Cooper will restrict capability to respond to any new opportunities.

B.4.b (MFD Project No. 1050)

Necessity for and Effectiveness of Measures to Avoid Capture of Small Redfish in Unit 3 (BRANTON)

This project has two objectives. 1) The first objective is to determine the consequences of capturing small redfish in Unit 3. Progress to date primarily consists of implementing enhanced survey sampling and specimen processing to obtain species specific data (e.g., length, weight, and maturity). Future activities will consist of: continuing enhanced sampling for another year; reading otoliths taken as part of the enhanced sampling to determine age; determining species specific life history parameters (i.e. length at age, maturity at length and maturity at age); and conducting a series of yield per recruit analyses varying the size of first capture. 2) The second objective is to compare and contrast the effectiveness of various management measures currently being used to avoid the capture of small redfish. Progress to date consists of: interviews with industry representatives; an analysis of port and observer samples to estimate numbers of small fish being landed; and a general description of management measures being used (i.e. closed areas and gear modifications). Future activities will include further analysis of observer samples to obtain a detailed description of test fishing, and identification of discrepancies between port and observer samples. Problems that could adversely affect the outcome of both objectives include difficulty in obtaining necessary technical expertise to read otoliths (Nfld. is to conduct this as part of a larger effort to investigate spatial variation of life history parameters in the Atlantic Zone), and separating test fishing sets from normal commercial fishing sets in the observer data base. This project is supported in part by Redfish High Priority Funding and is not expected to be completed until at least 1999. (collaborators: R. Halliday, MFD BIO; J-M. Sevigny and B. Morin, IML, Que.; D. Power and B. Atkinson, NWAFC, Nfld.)

B.4.c (MFD Project No. 1040)

Effectiveness of Measures to Reduce By-catch of Other Groundfish in the Foreign Silver Hake Fishery (BRANTON)

This project monitors the effectiveness of boycott reduction measures employed in the Scotian Shelf foreign small mesh gear fishery for silver hake. In 1993 an analysis of the fishery over the previous 11 years indicated that relocation of the small mesh gear line (SMGL) seaward (south) into deeper water (190 metres and greater), and an earlier fishing season, would significantly reduce the by-catch of cod, haddock, and pollock without affecting the catch rate of silver hake. Results were presented to the Harris Panel in early 1994 and provided a basis for the panel's recommendation that the SMGL be moved to approximately 190m and an earlier season introduced. (It recommended also that the use of separator grates, made mandatory at the end of the 1993 fishery, continue to be required.) Extensive exemptions to the new SMGL in 1994-96 have allowed the effectiveness of the separator grate to be confirmed for cod, pollock, and larger haddock, but the new SMGL has been demonstrated as necessary for the protection of small haddock, which co-occur with similar sized silver hake in the latter part of the season.

In 1997, analyses to date will be presented to the NAFO Scientific Council Meeting in June, with particular attention being paid to the effects of regulations on the catch rate of silver hake, and subsequently prepared for publication. In addition to this, a GIS type analysis will be used to define an optimal position for the SMGL, which would minimize the by-catch of small haddock while providing the greatest area of good silver hake catch rates for directed fishing. (collaborators: R. Halliday, and M. Showell MFD)

B.5 Preservation of spawning potential

B.6 Reduction of wastage

B.6.c (MFD Project No. 1050)

Effectiveness of Measures to Reduce By-catch of Other Groundfish in the Unit 3 Redfish Fishery (BRANTON)

The object of this project is to compare and contrast the effectiveness of the various management measures currently being used to reduce the boycott of other groundfish in the Unit 3 redfish fishery. Progress to date on this project includes: interviews with industry representatives; an analysis of landings during the period 1991 to 1996 in order to identify and describe the by-catch species; and a general description of the measures used (i.e., closed areas, and gear modifications). Future activities for this project will include an analysis of at-sea observations of commercial fishing activity, a detailed description of test fishing, and identification of discrepancies between landings and at-sea observations of commercial activity. Potential problems that could adversely affect the successful out of this project include separating test fishing sets from normal commercial fishing sets in the observer data base. This project is supported in part by Redfish High Priority Funding and should be completed in 1998. (collaborators: R. Halliday, C. Annand, M. Showell, MFD BIO)

C) SYSTEM MONITORING

C.1 Record of management measures

C.1.a (MFD Project No. 1060)

Record of management measures (ANNAND)

A record of management measures has been produced annually for groundfish fisheries in the previous Scotia - Fundy Region for several years and has proved very valuable for scientists doing stock assessments. It provides the only operational record of the application of regulatory tactics during the fishing season. Although amalgamation of Regions, and changes in personnel, require changes in geographical scope and redistribution of workloads, efforts are being made to continue the report's production. (collaborator: J. Hansen)

C.2 Unreported catches

C.2.a (MFD Project No. 1116 and 1203)

Develop Indices of Discarding and Investigate the Effects of Discarding on Stock Assessments (SINCLAIR, FANNING)

Two methods for estimating discarding in groundfish fisheries have been applied to observer at-sea and port sampling data for the following stocks:

4TVn Cod	1990-95
3Pn4RS Cod	1990-95
4VsW Cod	1980-95
4TVW Haddock	1980-95
4T Plaice	1990-95

Observers estimate the quantity of fish discarded on a set-by-set basis and collect length frequency samples of discarded and unculled catches. Discarding was legal up to 1992, and it was possible to estimated the quantity and size composition of discards directly from observer data. Discarding became illegal in 1993, and subsequently there are very few reported cases of discarding of the above stocks reported by observers. However, comparison of the size composition of fish from unculled at-sea samples with shore-based port samples indicated that discarding continues. Thus, a methodology for estimating the quantities of discards and their size composition indirectly from these two data sources is being developed. Preliminary results will be included in the 1997 spring RAP. The project is funded by the cod mortality HPF.

A second component of the project is to investigate the impact of discarding on stock assessments. Two questions will be asked. 1) in cases where discard estimates are available, what was the impact of discarding on stock production and yield? 2) in cases where discarding is thought to be a major contributor to the decline in stock abundance (e.g. 4TVn cod), are the available estimates of discarding sufficient to account for the decline in the stock?

Investigate means of obtaining quantitative or semiquantitative measures of historical discarding or other confounding practices through sociological methods (FANNING)

This research is being conducted with funding from the high priority science project on cod mortality. Kerry Marsh, a sociology graduate student from Memorial University has been working at MFD on his thesis research into the development of a conservation ethic in the offshore fishing industry. This will involve extensive interviews, up to three hours in length, with current and past participants in the offshore groundfish fishery. Interviewees include vessel captains, fleet operators, processing crew and DFO staff. In parallel to the interviews the offshore logbooks from 1980 to 1990 are being examined and the discards recorded in the logbooks are being computerised. This is required as the DFO Statistics system did not capture discards from the logbooks until 1988 or 1989. The data collection and data entry activities should be completed in the current fiscal year and it is intended that a preliminary analyses be conducted by

myself and Mr. Marsh, both independently and jointly, early in the next fiscal year. The planned analyses will include comparisons of observer estimates with the logged values for both kept and discarded catch; estimating the effect of observers on the logging practices; adjustment of logged values to account for practices reported in the interviews; and, if possible, put bounds on the overall estimates of discarded fish by year and area.

C.3 Measures of compliance

C.4 Economic and social indicators

C.4.a

Develop a landed price monitoring system (BRANDER)

The Policy and Economics Branch is investigating, with other Atlantic Regions, options for dealing with price information which is often absent as a result of new landings collection methods, and is less reliable due to new incentives to under-report.

C.4.b

Defining fishing capacity (LIEW)

A project is underway in Policy & Economics Branch to find a suitable definition of fishing capacity and to propose a methodology to measure capacity in the groundfish fishery).

C.4.d

Monitoring of incomes and profitability (BRANDER)

Emergencies related to TAGS diverted staff from ongoing development of time-series of economic and social indicators, but the previously produced annual Harvesting Sector Overview and the Costs and Earnings series have not been abandoned, and an account of Landed Values, Fishing Capacity Trends and Economic Performance to 1995 was released as DFO Maritimes Regional Fisheries Status Report 96/2. An experimental project with Statistics Canada is underway, led by Laurentian Region, utilizing taxation records to evaluate earnings of groups of fishermen. This is intended to supplement costs and earnings surveys in future. The Branch will continue to publish an annual harvesting overview, which is being expanded to include all Maritimes fisheries and more data sets.

D) SYSTEM PERFORMANCE REVIEW

Elements of the projects described above (A.1.a, A.3.a, B.4, B.6, C) also fall under this category.

Annex 5.

Final: December 4, 1996

Discussion Paper on a Framework for Evaluating Fisheries Management Measures
Marine Fish Division, Maritimes Region, Department of Fisheries and Oceans
December, 1996

Justification

Fisheries management measures, by design, affect the viability of both fish populations and the fishing industry. These measures cover a broad scope of activities from total allowable catches (TACs) to trip limits, from licensing policies to fishing seasons, from mesh size regulations to small fish protocols. Many management measures have specific conservation objectives including controlling the overall rate of exploitation, how exploitation is distributed among ages and sizes of fish, the protection of spawning components, and the protection of fish habitat. On the human side, management measures affect who has access to the resource, over what time period, the effectiveness of fishing technology, and the economic success of the operations. The imposition of management measures can also affect the quality and quantity of information available to assess fish stocks and the efficacy of the management itself. Research on the strengths and weaknesses of these measures is needed in order to make informed decisions about their application.

Marine Fish Division has identified the need to evaluate fisheries management measures and it is well positioned to carry out the needed research. Much of the necessary information is assembled in annual stock assessments. The Division has considerable expertise in the field, good collaboration with industry and researchers in other relevant disciplines, and several people are already evaluating components of the current management system. The profile and impact of this type of research will be enhanced by identifying it as a high priority and by taking a coordinated systems approach. Instead of looking at specific measures in isolation, the impact of that measure can be regarded in the context of a dynamic system.

This discussion paper was commissioned by the Manager, MFD, preparatory to Divisional program planning for 1997/98. It's intention is to lay a basis for an enhanced initiative within the Division on research on management systems.

Approach

This initiative would umbrella to cover existing work and would encourage new studies by providing a context and focus for discussion and review. There would be two main thrusts: the encouragement of rigorous evaluation of existing or proposed management measures in a wide range of case study projects; and the development of analytical techniques for evaluation of the performance of management measures and systems. The working hypothesis is that fisheries management can be improved by an approach which includes evaluation of objectives which are to be achieved, strategies by which to achieve them, and tactics to implement these strategies.

Ultimately, new knowledge and techniques that emerge from this project will be incorporated into regular fishery evaluations and translate into improved management plans.

It will be important to establish effective linkages with high priority projects within and outside the Division. Information on the effectiveness of management measures will be relevant to projects concerned with the collapse and recovery of cod fisheries. Linkages also need to be established with the Cod Mixing study and other stock identification work in the Division especially when evaluating the application of techniques.

The multi-disciplinary scope of this work includes biology, economics, sociology, and management science. Collaboration with experts outside the Division is required, especially to address the economic and social implications of management. Within the Maritimes Region, collaborations could occur with Science , Economics , Resource Allocation, and Enforcement. Of particular interest is the DFO initiative on Integrated Management Plans. Close contacts should be maintained with ICES, NAFO, NMFS, and other DFO Regions, as well as with Universities involved in similar work.

The Resource Advisory Process (RAP) may be expanded to include a Fishery Management Subcommittee for peer review and generation of advice on management-related issues. The fisheries management measures evaluation initiative could provide input to this new Subcommittee. The presently existing Fisheries Management Studies Working Group could provide peer review of technical aspects related to the proposed initiative and advise line management on research priorities, gaps in data, and techniques.

It is recommended that the WG meet in early January, prior to PREP document preparation. The primary purpose would be to prepare a categorized list of management issues of importance to the Maritimes Region, an inventory of ongoing research on fishery management systems and measures, and to identify program areas requiring additional attention.

Projects

A number of case studies should be undertaken to represent the scope of work currently underway in the Division as well as the full scope of management objectives, strategies, and tactics. Objectives may be any combination of biological (e.g. conservation of the resource), economic, and social. While it would be useful if the case studies reflected a range of objectives, difficulties in defining social and economic objectives in quantitative terms should not preclude evaluating whether or not conservation objectives have been achieved. Management strategies define a general approach for achieving objectives. Traditional examples include setting target fishing mortality rates for fully operational fisheries, minimum spawning biomass thresholds that are used to trigger drastic management actions (e.g. fishery closures), and spawning escapement targets. Management tactics are the specific tools used to implement strategies. These are numerous, diverse, and analysis of their effects is often intractable (e.g. closed areas, small fish protocols, trip limits, catch quotas). Nevertheless, these activities have the most direct and immediate effect on fishing operations and fish populations. Case studies should include

successes and failures and not be restricted to eastern Canada, but draw on international experience as well.

"Case studies" should be viewed as a broad term inclusive of all projects which document management measures, their effects and repercussions. Documentation of management measures currently applied in groundfish and pelagic fisheries throughout the Region, extending the work of Annand and Hansen (1995), is an essential element of this program activity, for example, as too are projects which quantify by-catch and discard problems.

Case studies should include the following elements.

Issue: What is the problem to be addressed by the management measure? This could a broad management approach (strategy) or a tactic.

Management Measure: A description of the specific measure, the context of its application (including management system, complimentary or conflicting measures, regulation and enforcement, etc.), and the range of its application.

Expected Result: Detail of the expected results of the management measure. How could one tell if the desired result was achieved, identify signs of effect, over what time frame?

Monitoring Activities: Identify data sources and monitoring activities that were required to follow results, enforcement and regulatory changes that were implemented, and the frequency of evaluation (including biological, economic, social, and enforcement).

Evaluation and Review: Analysis of relevant data, criteria used to judge effectiveness, recommendations for future use.

The following is a list of possible case studies and is not meant to be either exclusive nor final. Rather, the list would be modified regularly to reflect work in progress by the Division. Additions, deletions, and modifications are welcome.

Strategies: for example

The use of fishing mortality targets for fully operational fisheries and spawning stock biomass thresholds for closing and opening groundfish fisheries.

Management strategies for mixed species fisheries, yield per recruit, spawning stock biomass, and aggregate production considerations.

Evaluation of the implications of stock status uncertainty and stochastic recruitment on the yield per recruit benefits from a unilateral Canadian strategy of $F_{0.1}$ for Georges Bank haddock.

Evaluation of the benefits of an in-season management approach in the 4WX herring fishery.

Incorporating management science techniques into planning and decision making in the Scotia-Fundy herring fisheries.

Tactics: for example

An evaluation of whether ITQ management systems achieve capacity reduction and conservation objectives.

The effectiveness of in season evaluations of fishing plans such as in herring and salmon fisheries

Compare and contrast quota management vs. effort management in implementing a constant fishing effort management strategy.

Contrast the use of closed areas to enhance spawning success, enhance pre-recruit survival (avoid catching small fish), and to prolong fishing seasons.

Evaluation of tactics designed to limit the capture of small fish including mesh regulations, minimum fish size regulations, small fish protocols.

Evaluation of the implications of stock status uncertainty and stochastic recruitment and/or natural mortality on the achievement of target fishing mortality strategies when carry-over allocation is implemented as a tactic.

Development of Analytical Techniques

The following is a description of the type of analytical methods that may be used to evaluate management measures. This is not meant to be an all inclusive list, it will grow (or shrink) as the initiative progresses, any additions, deletions or modification are welcome. Regardless of the tool used, a common sense approach to framing alternative hypotheses will almost always save time.

New methods and approaches will be needed to evaluate current fisheries management measures in retrospect. It will be important to consider not only the specific measure and its implementation but also the dynamics of the system in which it was applied. It will be difficult to reach unequivocal conclusions since several factors will influence performance indicators in an uncontrolled manner. Techniques appropriate for identifying alternative hypotheses will be needed. Care should be taken to identify confounded designs, correlated explanatory variables, and autocorrelated time series.

Carefully designed computer simulations may be used to investigate alternatives. The ICES Working group on Long Term Management Measures (ICES CM 1994/Assess:11) described a simulation framework comprising a) an underlying system which defines the "true" biological, fishery and ecosystem dynamics, b) an observation process which generates stock

assessment and monitoring data, c) an assessment component which estimates the "perceived" state of the system, and d) a management component where pre-defined fishery control laws are used to define management measures. Simulations would include different levels of error, for example differences between how the "true" system functions and the assumptions used in stock assessments, errors in the implementation of tactics (e.g. misreporting of catches), measurement errors in the observation component. A principle objective of the simulations is to test the robustness of alternative management measures to uncertainties about the management system. The results may also be used to identify important areas of future research (Powers and Restrepo 1993).

While experimentation may be difficult, there may be cases where an experimental approach is possible and applying alternative management approaches may help to learn more about how the ecosystem is functioning. Adaptive or experimental management has been promoted by Hilborn and Walters (1992) and a successful experiment is described by Sainsbury 1991. The best candidate systems for experimentation may be developing fisheries with relatively sedentary species and several spawning components.

Inference about the effectiveness of management measures will have to be made from confounded experimental design in the majority of cases. There is a need to develop statistical tools appropriate for this task. (please suggest any)

There will be considerable uncertainty associated with any inference. Ultimately, information on the uncertainty of population estimates may be as important as the point estimates themselves. However, additional work is needed to define an efficient and effective manner to convey this information to decision makers and stakeholders. There is an emerging literature on the subject of incorporating uncertainty and this should be exploited to the fullest.

References

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Annex 6.

Age-Structured Production Models

by

A. Sinclair, MFD, GFC

Recent international agreements call for biological reference points which are related to maximum sustainable yield (see section xxx of this report). This will require using stock production models and the estimation of stock-recruitment relationships. Age-structured stock production models were applied to data from several north Atlantic fish stocks at the June 1996 ICES Comprehensive Fisheries Evaluation Working Group (ICES CM/Assess20:1996). The application of these models to Canadian fish stocks is encouraged. Relevant reference points, including B_{msy} and F_{msy}, are illustrated in Fig. 1. A third reference point of interest is F_{crash}, the unsustainable level of fishing mortality, defined by the slope at the origin of the stock/recruitment curve.

Stock/Recruitment Relationships

It is tempting to discount possible relationships between stock size and recruitment given the scatter of data points in lengthy time series. However, an important underlying relationship may be masked by intrinsic variation in the system and by a reduced range of observations (Walters and Ludwig 1981, Hilborn and Walters 1992 chapt. 7). If environmental factors influence the survival rate of fish during the pre-recruit life history (eggs, larvae, juveniles), then a higher initial number of eggs will produce a higher number of recruits for any level of environmental mortality. If the environmental effect is strong, one would not expect to see a strong relationship between stock size and recruitment. Secondly, most assessment time series begin after stocks had been reduced by fishing and there has also been little variation in fishing mortality. Thus, the population age structure is truncated and the biomass is reduced relative to the potential range over which the stock/recruitment relationship could operate. Finally, the precision of our estimates of stock size and recruitment is relatively poor. All of these factors could potentially mask a relationship between stock size and recruitment.

These characteristics were shown with a simulation using a 4TVn cod-like population (same age range, weights at age, and partial recruitment) over a 40 year time period. A Ricker stock/recruitment relationship with multiplicative process error was used

$$R = aSe^{\sigma - bS}$$

where R is the number of recruits
S is the spawning stock size
a and b are the stock/recruitment parameters
σ is a normal variate with mean 0 and standard deviations of 0.1, 0.3, and 0.5

Natural mortality was constant at 0.2 for all ages and years. Fully recruited fishing mortality was held constant for the projection period, and 3 levels were used, 0.2, 0.4, and 0.6. No sampling error was included in the simulation. Ten replicates of each process error and F combination were run.

The effect of the process error in the stock/recruitment relationship and the level of fishing mortality is shown for one replicate of the simulation in Fig. 2. When the fishing mortality was 0.4, the range of spawning biomass was less than half that when F was 0.4. There was a considerable scatter of points whether the process error was low (0.1) or high (0.5). However, if the process error was high (0.5), there was a high degree of scatter. Only when F was low (0.2), and the process error was low (0.1), was there a relatively tight relationship between stock size and recruitment.

The incorrect rejection of stock/recruitment relationships could result in lower catches. In these simulations, average annual yields were highest for an F of 0.2 (Fig. 3). The average yields also increased with the magnitude of the process error.

Production

It is also possible that ignoring possible stock/recruitment relationships could lead to stock collapse. This is illustrated by a case study of southern Gulf of St. Lawrence cod (see ICES CM/Assess 20:1996 for details). Size at age and stock production declined from the late 1970s to the 1990s. Stock production refrence points were estimated for 4 time periods during this decline, 75-79, 80-84, 85-89, 90-95. F_{msy} declined from 0.40 to 0.23, Fcrash declined from 1.33 to 0.79, and MSY declined from 78,000 t to 31,000 t. Plotting the observed annual values of F and yield revealed that the stock may have been severely overfished throughout the 1980s, and that fishing mortalities in the final years before the fishery was closed were well above sustainable levels.

These are simply scenarios of what might happen if stock/recruitment relationships exist but are masked by system error and the fishing regime. This analysis was not meant to provide evidence that such relationships exist, this is done elsewhere (e.g. Hilborn and Walters 1992 chapt. 7). The point is that one should not reject such relationships simply because the basic data are scattered. There are many reasons why this may happen and the consequences of falsely rejecting stock/recruitment are potentially severe.

Further examination of mehtods for estimating biological reference points from production analyses is warranted, in particular methods that incorporate uncertainties.

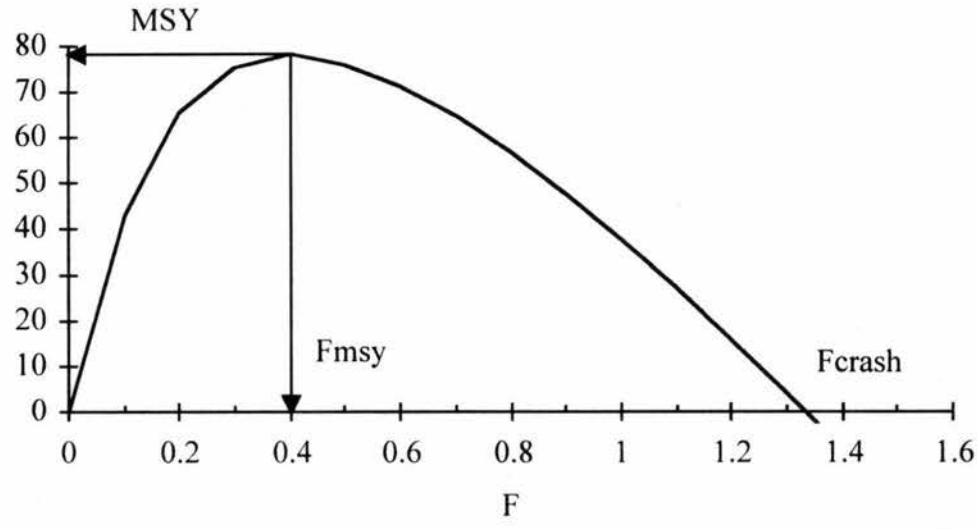

Fig. 1: Equilibrium yield/F curve from an age-structured production analysis illustrating biological reference points F_{msy}, and MSY. Fcrash is the limit of sustainable fishing mortality. This is defined as by the slope of the stock/recruitment curve at the origin.

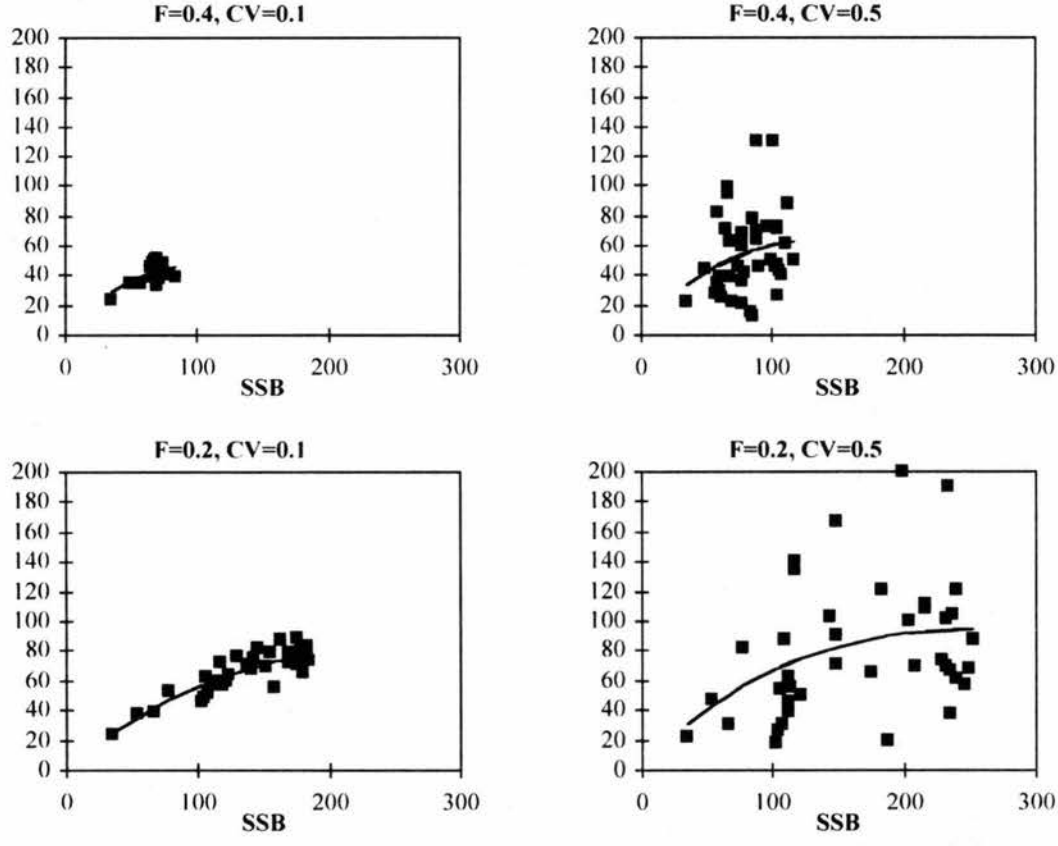

Fig. 2: Stock/recruitment scatter plots from simulations with different levels of process error in the stock/recruitment relationship (CV) and different levels of F. The underlying stock/recruitment relationship is masked by high process error and high Fs.

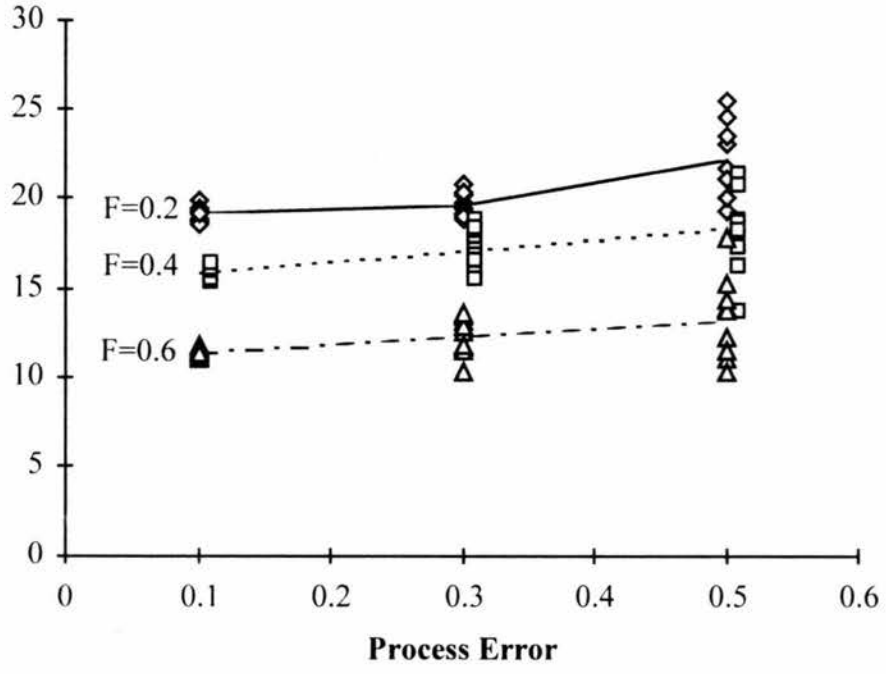

Fig. 3 Average annual yields from simulations with different process errors and fishing mortalities. Yields were higher at lower Fs. Yields increased with the level of process error.

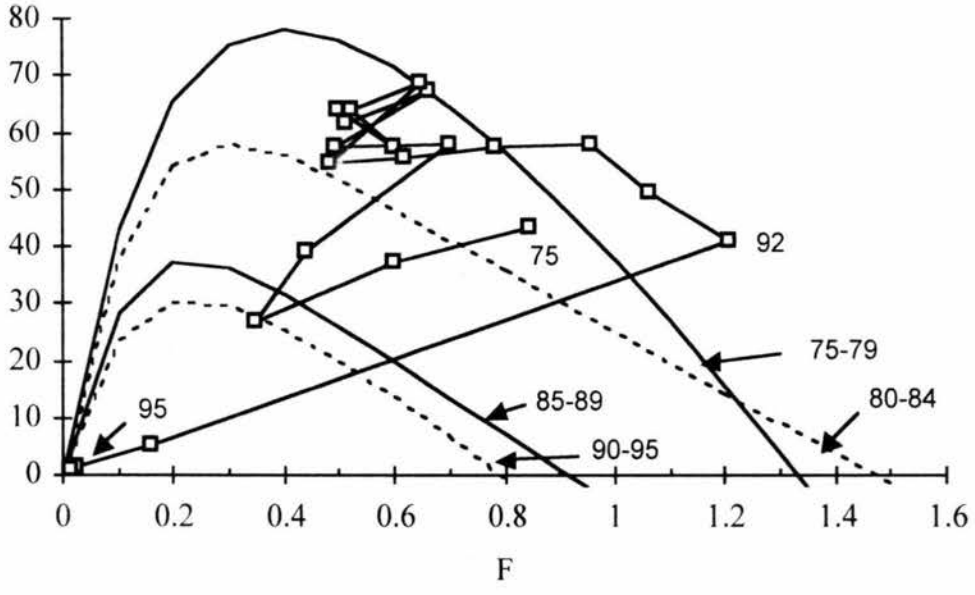

Fig. 4: Comparison of estimated equilibrium conditions of yield and F with observed annual values for southern Gulf of St. Lawrence cod. Four equilibrium curves are shown which correspond to conditions in the years indicated. MSY and Fmsy declined as the growth rates of cod decreased from high levels in the late 1970s to low levels in the 1990s. Annual Fs were above the equilibrium curves for most of the 1980s until 1992. They were above sustainable levels from 1990-1992.

References

Hilborn, R., and C.J. Walters. 1992. Quantitative fisheries stock assessment: choice, dynamics and uncertainty. Chapman and Hall, New York. 570 p.

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Final: 26 June, 1997

FISHERIES MANAGEMENT STUDIES WORKING GROUP
REPORT OF MEETING -- 27-28 MAY, 1997

1. Approval of Agenda

The meeting was held at the Bedford Institute of Oceanography, Dartmouth. The agenda is at Annex 1 and a list of participants at Annex 2.

2. Approval of Report of January, 1997 Meeting

The report of the 21-22 January meeting was approved with the addition of an entry under section A.5.b of Annex 4 (attached as Annex 3 to this report).

3. Working Relationships of the Working Group

The decision by the RAP Steering Committee to incorporate its Capacity and Economic Performance Trends Working Group into the FMS WG was noted as a useful broadening of the mandate of this group.

The last minute postponement of the inaugural meeting of the Fisheries Management Subcommittee (FMS) of RAP, scheduled for 29 May, because of the unavailability of the principals, was regretted. The importance of this subcommittee was again emphasized. One of the primary roles of this WG is to provide integrated multi-disciplinary advice on the technical aspects of the management of fisheries, and it is essential that it has a policy-making group to interface with if its work is to be influential with regard to how management is actually conducted in the Region. Failure to take a comprehensive approach to the management of Regional fisheries has been the primary limitation on the success of past management efforts, and the Fisheries Management Subcommittee of RAP offers an excellent vehicle through which to correct this. It was noted, nonetheless, that the FMS WG reports to the Steering Committee of RAP and can usefully continue to encourage cross-disciplinary research without the FMS. The Terms of Reference and the draft agenda for the first meeting of the Fisheries Management Subcommittee, now intended to occur in June, were tabled.

The Terms of Reference of FMS state that FMS WG reports will be published, along with FMS minutes, in the RAP Proceedings series. Although this series has a limited distribution, it is citeable, and it was agreed that this could prove to be a satisfactory way of preserving and distributing the record of the WG's work. RAP Research Document and Fishery Status Report series provide outlets for other types of material. It was further agreed that production of the meeting reports in Proceedings should occur as soon as possible after each meeting.

(ACTION: HALLIDAY)

4. Reports from Other Groups

4.1 Study Group on the Precautionary Approach to Fisheries Management, February 1997 (STEPHENSON)

An ICES Study Group on the Precautionary Approach to Fisheries Management met Feb. 5-11, 1997 to draft modifications to the form and format of ICES advice making it more consistent with the precautionary approach. The report (ICES CM 1997/Assess: 7) reviews the need for a precautionary approach (as outlined in various international conferences and agreements), and discusses the implications for ICES, fisheries management agencies and the fishing industry. The report contains several sections dealing with the need for, and calculation of, limit and target reference points, and presents a draft modified template of a form of advice. The draft report is being discussed by ICES working groups before being finalized in September 1997.

4.2 Study Group on the Management Performance of Individual Transferable Quota (ITQ) Systems, May 1997 (STEPHENSON, O'BOYLE)

The ICES Study Group on the Management Performance of ITQ Systems met in Woods Hole, May 6-8, 1997 with the tasks of developing a performance appraisal survey to measure the status of fisheries systems (including biological, economic, social, compliance, decision-making aspects), and the examination of a range of candidate ITQ case studies for future comparison. The performance evaluation of ITQ systems was seen as a specific case in the evaluation of fisheries management systems generally, and it was pointed out that there is no accepted methodology for such comparison. The Study Group drafted a framework for the evaluation of any change in management, as follows:

1) description of the pre-existing conditions in fishery (biological, economic, social, and administrative)

2) description of objectives / expectations of management action vs. what would have happened without it, e.g. description of status quo management situation vs. alternative scenarios for each element above (biological, economic, social, and administrative)

3) ex-post diagnosis/evaluation of what happened after implementation and why
   a) description (resulting structure)
   b) explanation.

A number of ITQ case studies, which differed considerably in fishery type and in ITQ regime, were discussed. From these, and other case studies, several appropriate candidates will be selected for more detailed comparison and evaluation.

The Study Group heard an interesting presentation on an OECD study on the "Economic aspects of management of marine living resources" which compared and evaluated a wide range

of fisheries management systems. The OECD study findings are expected to be published in June 1997.

The report from the Study Group will be available by the Annual Science Conference (September 1997).

4.3 Working Group on Fishing Technology and Fish Behaviour, April 1997 (HALLIDAY)

There were no Maritimes Region participants at the April 1997 meeting and the meeting report is not expected to be available until the end of June.

4.4 Workshops on Assessment and Management of Atlantic Herring, February and March 1997 (STEPHENSON)

A Regional meeting of science, management and industry occurred in Halifax on February 18-19, 1997. The meeting attempted to review and form consensus on 1) conservation objectives for regional herring fisheries, 2) strategic targets corresponding to conservation objectives, herring assessment and management units, 3) strategies for management of overwintering, summer feeding, and spawning aggregations, and 4) the form and approach of management generally.

An Atlantic Zonal workshop held in Moncton on March 24-27, 1997, reviewed assessments and developed Stock Status Reports for Div. 4T, Div. 4R, and Div. 4VWX herring (for this year replacing the Maritimes RAP), and discussed a number of biological aspects of herring management strategies, including:

- use of a "survey - assess - and fish" protocol in the management of spawning and non-spawning aggregations,
- decision rules for use in fishing overwintering aggregations,
- new/exploratory fishing for herring on the Scotian Shelf, and
- management strategies based on stock-recruit and environment-recruit relationships being developed in Newfoundland Region.

4.5 Krill Workshop, April 1997 (O'BOYLE)

In late 1995, DFO received a proposal to develop a 1000t experimental fishery for krill, a forage species, on the Scotian Shelf and in the Bay of Fundy. In 1996, this proposal was reviewed through the Regional Advisory Process (RAP), which commented that it would have a negligible effect on the ecosystem. Concerns were raised, however, in anticipation of future requests to expand this harvest. These concerns apply equally to any fishery directed at a forage species. Thus, in late 1996, the RAP Steering Committee decided to hold a workshop to consider the broader implications of fisheries on forage species. The broad objective of the workshop was to provide guidance for the future development of forage species fisheries in the DFO Maritimes Region.

The workshop was held in April 1997, to which both national and international experts were invited, as well as local interested parties. The workshop included a number of talks: some relating to general problems in applying ecosystem considerations to forage fisheries, a series describing the ecosystem approach to the management of the krill fishery in the Antarctic (the CCALMR approach), and three relating to existing or proposed krill fisheries within Canada. Two working groups then considered questions which comprised the central issues of the workshop. The conclusions of the workshop are summarized in the meeting's Proceedings which are soon to be released. The WG requested that copies be distributed to participants.

(ACTION: O'BOYLE)

5. Research Planning

5.1 Results of PREP in relation to the WG's list of management issues for finfish

PREP documentation for Marine Fish Division for 1997-98 is not yet generally available, but it was pointed out that, in any case, the list of activities in Annex 4 of the WG's January report reflected much of what staff intended to pursue in the coming year. Thus, it is too soon to attempt to judge the influence of the WG's work.

5.2 Would a categorized list of management issues for invertebrate fisheries, and an inventory of current research relevant to these, comparable to those produced for finfish, be useful?

Science staff conducting research on invertebrate fisheries have been made aware of the intended role of the WG but have yet to identify how it can serve their needs. It was noted that the Developing Species Policy is under review and, if aspects of the debate on revisions were referred to the WG, this would be of common interest to invertebrate and finfish scientists.

5.3 Business arising from production of the Categorized List of finfish management issues :

5.3.1 Inventory of existing co-management /partnership agreements (ANNAND)

Terminological usage has yet to become standardized with regard to co-management and partnership arrangements but a chart was tabled which described one set of definitions (Annex 4). Integrated Fisheries Management Plans (IFMPs) are being negotiated for all Regional fisheries and several have been completed. These are agreed, but not legally binding, plans between DFO and industry representatives. However, these plans may incorporate a Joint Project Agreement (JPA) which commits the parties to specific actions, such as funding or conduct of particular research, monitoring and enforcement activities. JPAs can be viewed as co-management, or co-management like, arrangements. The term, partnering, is restricted to management agreements which meet the definition of such under the proposed new Fisheries Act. The authority to enter into partnering agreements is not available to DFO until the Act is passed. A glossary of terms now used would be very helpful to all those involved in some way with management planning and it was agreed that one would be produced.

(ACTION: PEACOCK & ANNAND)

It is the intention that every Regional fishery will operate under an IFMP this year. This was viewed as an encouraging development, and it was agreed that the WG should review such plans to ensure that all the necessary elements for a complete management plan are included in each and that plan provisions allow for measurement of performance in relation to objectives. It was decided that, initially, a couple of plans that could be classed as co-management plans should be made available to the WG so that procedures for evaluation can be established. That for Area 19 snow crab was distributed at the meeting and another, that for surf clams or Scotian Shelf shrimp, would be distributed as soon as available.

(ACTION: ANNAND)

5.3.2 Documentation of Resource Allocation Branch views on carry-over of annual allocations (ANNAND)

The meeting was informed that the Resource Allocation Branch was not prepared to consider implementation of an allocation carry-over system until the accuracy of catch statistics is established to be high and the effects of stock assessment uncertainty, and variability in recruitment and natural mortality, are better understood. It would be useful, therefore, if, in addition to the research already underway on the latter points, steps were taken to define the level of confidence needed in catch statistics to make carry-over of annual allocations implementable. This would then allow an evaluation of the measures needed, e.g. the level of observer coverage, to achieve the required statistical accuracy.

5.3.3 Reports on gear research conducted in the Gulf of St. Lawrence by Province of New Brunswick in cooperation with DFO Headquarters in 1996 (HALLIDAY)

According to Andrew Duthie, Chief, Fishing Operations, Program Planning and Coordination Directorate, Ottawa, the Province of New Brunswick, in collaboration with DFO Headquarters Region, conducted a number of commercial fishing gear trials in the Gulf of St. Lawrence in 1996. Twin trawling techniques for shrimp were tested, as too was a double separator grate system to reduce finfish by-catch and grade the shrimp according to size. Nets designed to fish selectively for cod and flounder species were tested on otter trawlers and Danish seiners. Nets with panels of different mesh size, intended to simultaneously optimize the net's size selection for cod and flounders, were also tested on these two vessel types. Reports have been obtained by the WG for several of these. That on twin trawling for shrimp is a final report which establishes the proper rigging of a twin trawl system, but no data on selection by the grate system was obtained. Two other reports, which are provisional pending further experimentation, concern release of cod by-catch by modified Scottish seine and otter trawl nets, the latter equipped also with a separator grate. Otter trawl selection curves are provided for winter flounder for four combinations of square mesh codends and grate sizes, and for cod for two of these, although data for cod are scant. Inquiries regarding further reports are continuing.

(ACTION: HALLIDAY)

5.3.4 Documentation of DMP implementation so that a course of action for further evaluation can be established (ANNAND)

A report is in preparation. It was noted also that an evaluation of the program by the Auditor-General's office was underway and that the A-G's report, due in the autumn, could be made available to the WG.

(ACTION: ANNAND)

5.3.5 Participation of enforcement staff in the work of the WG (HALLIDAY)

No action has yet been taken on this item. This will be raised in the FMS with the enforcement representative.

(ACTION: HALLIDAY)

6. Effort Regulation

6.1 FRCC Discussion Paper on Quota Controls and Effort Controls

The review of this document, prepared by members of the WG on behalf of the Regional Director of Science and submitted to Ottawa on 17 February 1997, was tabled (Annex 5). Also tabled was the Deputy Minister's response to the FRCC on behalf of the Department (Annex 6).The science component of the DM's response resembled the WG review quite closely. Although the DM's response overall was negative towards any suggestion that effort control supplant catch quota management, he indicated his support for exploring the benefits of adopting a combination of quota and effort controls.

6.2 Georges Bank pilot study in 1996 (GAVARIS)

Recommendation 4 of the Second Workshop on Scotia-Fundy Groundfish Management (Burke et al. 1996. Can. Tech. Rep. Fish. Aquat. Sci. 2000) was that a real-time, two-level monitoring system using catch and effort be explored for a selected fishery. Consistent with this recommendation, an estimate was made of the fishing effort required to take the 1996 cod and haddock catch allocations on Georges Bank for each of the three main gear sectors. There was a good correspondence between the utilization of catch quota, and of effort in relation to the target, for fixed gear but not for the mobile sectors.

This pilot identified several areas where further work is needed before regulation of fishing effort is considered. One area is in accounting methods for fishing effort that would make comprehensive records available, through the statistical system, to regulators in an appropriate time frame. The other area is in the technical aspects of defining fishery components and measuring directed and by-catch effort in relation to these, and in accounting for factors that influence catch rates such as areas and seasons fished and changes in fishing practices, e.g. in

gears. It was agreed that work could be most profitably concentrated on improving measurement of fishing effort, and the special issue of in-season monitoring should be deferred.

6.3 South West Fishermen's Rights Association proposal for days-at-sea regulation (CLARK)

A proposal by the South West Fishermen's Rights Association, Clark's Harbour, Shelburne Co., for regulation of fishing based on a system of equal numbers of days at sea per vessel was referred to the WG. An investigation of how many days at sea per active vessel would be required to catch allocations to the fixed gear sector in Div. 4X revealed a variety of technical questions that need resolution before an answer could be given. However, it was clear that the number of sea days per vessel would be very low.

As the referral to the WG was understood to have been withdrawn, it is not intended to pursue this question further.

6.4 Fishing effort trends -need for and form of an annual report (A. SINCLAIR, GAVARIS)

Two Stock Status Reports (96/52 and 96/65) which described fishing effort trends for mobile gear (fishing for groundfish) in Div. 4T, and for cod, haddock and pollock on the Scotian Shelf and Georges Bank, were produced last year. The preparatory work for these was done in support of the Second Workshop on Scotia-Fundy Groundfish Management (cited above) and it was subsequently decided that it would be useful to give the results wider circulation among the industry. An updated draft of the report on effort trends for the cod/haddock/pollock fisheries on the Scotian Shelf, Bay of Fundy and Georges Bank was tabled at this meeting. The WG noted that the necessary omission of effort by Newfoundland based vessels prior to 1987 distorted the effort trends, particularly on the eastern Scotian Shelf, and the presentation of "unstandardized" days fished for distinctly different fishery sectors made appreciation of overall fishery effort difficult. It was the view of the WG that these reports neither gave a comprehensive view of fleet activities or a satisfactory measure of effort that could be related to fishing mortality, and hence the results were difficult to interpret. While more comprehensive views could be produced, gaps in the statistical record would require proration and gear/ tonnage class standardization would be necessary. These matters need investigation before an improved report could be produced. The WG did not think that annual updates of the reports produced last year would be useful.

6.5 Development of a plan of work for evaluation of effort regulation

The important research questions were identified as relating to definition of the relationship between fishing effort and fishing mortality. The primary issues were identified as:

- the variation in fishing power between vessels (vessel types, tonnage classes),
- seasonal variation in catchability, and
- definition of distinct fisheries, i.e. the mixed fishery problem.

The WG decided that a specific plan of work would be best drafted by a small group and brought back to the WG.

(ACTION: A. SINCLAIR, GAVARIS, O'BOYLE)

7. Draft Plan of Work for Review and Recommendation of Appropriate Reference Points for Canadian Marine Fisheries in Light of new International Agreements (HALLIDAY, O'BOYLE and A. SINCLAIR)

The issues of the precautionary approach to fishery management and definition of reference points associated with it, have quickly become widely discussed topics. A planning meeting on a DFO High Priority Project proposal on these subjects is scheduled for June 8, and an element of that discussion is preparation for an inter-regional RAP meeting in January 1998 on assessment of cod stocks that have been closed to fishing, and on recovery strategies for them. Preparatory work for this January meeting, in the form of defining the calculations needed, is going on in the Regional assessment subcommittee of RAP. These topics are also under intensive discussion in the ICES Study Group on the Precautionary Approach to Fisheries Management (see above) and the Comprehensive Fisheries Evaluation Working Group, and are on the agenda of the NAFO Scientific Council meeting in June.

Despite the intense activity elsewhere, the WG felt it still had a role to play in the effective implementation and use of a precautionary approach in the fisheries of this Region. It is necessary to incorporate any conclusions about the precautionary approach into management plans in the form of operational procedures and decision making rules. It was agreed that the WG should hold a special session on this in the late autumn of this year. Preparatory work is required in development of an agenda and obtaining commitments from potential contributors, and R. O'Boyle agreed to take the lead in this.

(ACTION: O'BOYLE)

8. Landed Values, Fishing Capacity Trends and Economic Performance (LIEW)

A Fisheries Status Report (96/2) was produced last year on landed values, fishing capacity trends and economic performance for Regional fisheries, and this apparently was found valuable by Regional management in communicating with clients. A draft report incorporating 1996 data was reviewed. Although similar in scope to FSR 96/2, a greater integration of Scotia-Fundy and Gulf data improves the presentation. There was some concern expressed about the low volume of price data in recent years, and this places some uncertainty on the accuracy of landed values. It was requested that, next year, information be presented to the WG on the amount of price data on which estimates of landed values are based and on the methods used to prorate for missing data.

It was recommended that the report should point out more clearly that the data represent landings in Regional ports no matter where the catches were made, i.e. that a varying proportion originate from waters outside the boundaries of this Region. Conversely, there are some catches

from Regional waters (although much lesser amounts) that are landed elsewhere. It was suggested also that, although the number of licences issued for particular fisheries was indicated in the text, it would be useful to incorporate this information in the figures as well.

Landed value gives a measure of gross revenue to the primary sector, but this alone does not adequately reflect the economic performance of fishing fleets. Nor does it provide an assessment of the importance of the fishery overall to the Regional economy. Value added through processing varies greatly among species and thus product values would give a different perspective on the relative importance of particular fisheries. Employment levels, incomes, and other factors are also essential indicators of system performance. Concern was expressed that data of this sort appears to be increasingly difficult to obtain. This is an issue that needs to be considered in evaluation of IFMPs in the context of industry contributions. For the moment, it is recommended that the preamble to this report makes clear what facet of fishery performance landed value represents, so that document users are aware of its limitations.

9. Conservation Harvesting Plans for 1997

Conservation Harvesting Plans were tabled for groundfish fisheries in 1997, in the Gulf of St. Lawrence (3 plans) and for the Subdiv. 3Ps cod fixed gear fleet, which were as limited in scope as in past years. It was noted, however, that these were now viewed as no more than the regulatory requirements for these fisheries and that it was the intention that these would be incorporated into IFMPs. (see item 5.3.1.)

10. Other Matters

10.1 Record of management measures

The WG was informed that the record of management measures produced for groundfish fisheries in Div. 4VWX+5 in recent years was being prepared for 1996 also. Those involved in invertebrate fisheries see no need for a comparable record.

10.2 Next meeting

It was proposed to hold the next meeting in November 1997. The agenda will include a special session on implementation and use of a precautionary approach in the management of fisheries of the Maritimes Region.

Chairman: R. G. Halliday

Annex 1

AGENDA
FMS WORKING GROUP
MEETING OF 27-28 MAY, 1997

1. Approval of agenda

2. Approval of report of January, 1997 meeting

3. Working relationships of the WG

- With the FM Subcommittee (Note: Terms of Reference of FMS)
- Publication of FMS WG reports (Note: Terms of Reference of FMS state these will be published, along with FMS minutes, in Proceedings series.)
- Incorporation of Capacity and Economic Performance Trends Working Group

4. Reports from other groups

- Study Group on the Precautionary Approach to Fisheries Management, February 1997 (STEPHENSON)
- Study Group on the Management Performance of Individual Transferable Quota (ITQ) Systems, May 1997 (STEPHENSON, O'BOYLE)
- Working Group on Fishing Technology and Fish Behaviour, April 1997 (HALLIDAY)
- Workshop on Assessment and Management of Atlantic Herring, March, 1997 (STEPHENSON, M. SINCLAIR)
- Others

5. Research planning

- Results of PREP in relation to the WG's list of management issues for finfish
- Would a categorized list of management issues for invertebrate fisheries, and an inventory of current research relevant to these, comparable to those produced for finfish, be useful? (SMITH)
- Business arising from production of the Categorized List of finfish management issues :
    1. Inventory of existing co-management /partnership agreements (ANNAND)
    2. Documentation of Resource Allocation Branch views on carry-over of annual allocations (ANNAND)
    3. Reports on gear research conducted in the Gulf of St. Lawrence by Province of New Brunswick in cooperation with DFO Headquarters in 1996 (HALLIDAY)
    4. Documentation of DMP implementation so that a course of action for further evaluation can be established (ANNAND)
    5. Participation of enforcement staff in the work of the WG (HALLIDAY)

6. Effort regulation

- FRCC Discussion Paper on Quota Controls and Effort Controls
    1. Regional Science Branch response (HALLIDAY)
    2. Departmental and industry responses
- Georges Bank pilot study in 1996 (GAVARIS)
- South West Fishermen's Rights Association proposal for days-at-sea regulation (CLARK)
- Fishing effort trends -need for and form of an annual report (A. SINCLAIR, GAVARIS)
- Development of a plan of work for evaluation of effort regulation

7. Biological reference points

- Draft plan of work for review and recommendation of appropriate reference points for Canadian marine fisheries in light of new international agreements (HALLIDAY, O'BOYLE and A. SINCLAIR)

8. Landed values, fishing capacity trends and economic performance (LIEW)

9. Conservation Harvesting Plans for 1997

- Gulf of St. Lawrence Groundfish and Subdiv. 3Ps Cod plans (A. SINCLAIR)

10. Other matters

Annex 2

LIST OF PARTICIPANTS

Christina Annand, Resource Allocation Branch, Halifax
Leo Brander, Policy and Economics Branch, Halifax
Donald Clark, Marine Fish Division, Science Branch, St. Andrews
Stratis Gavaris, Marine Fish Division, Science Branch, St. Andrews
Ralph Halliday, Marine Fish Division, Science Branch, Dartmouth
Peter Hurley, Marine Fish Division, Science Branch, Dartmouth
Doreen Liew, Policy and Economics Branch, Halifax
Robert Mohn, Marine Fish Division, Science Branch, Dartmouth
Robert O'Boyle, RAP Secretariat, Dartmouth
Gregory Peacock, Resource Allocation Branch, Halifax (27 May only)
Alan Sinclair, Marine Fish Division, Science Branch, Moncton
Stephen Smith, Invertebrates Division, Science Branch, Halifax
Robert Stephenson, Marine Fish Division, Science Branch, St. Andrews

Annex 3

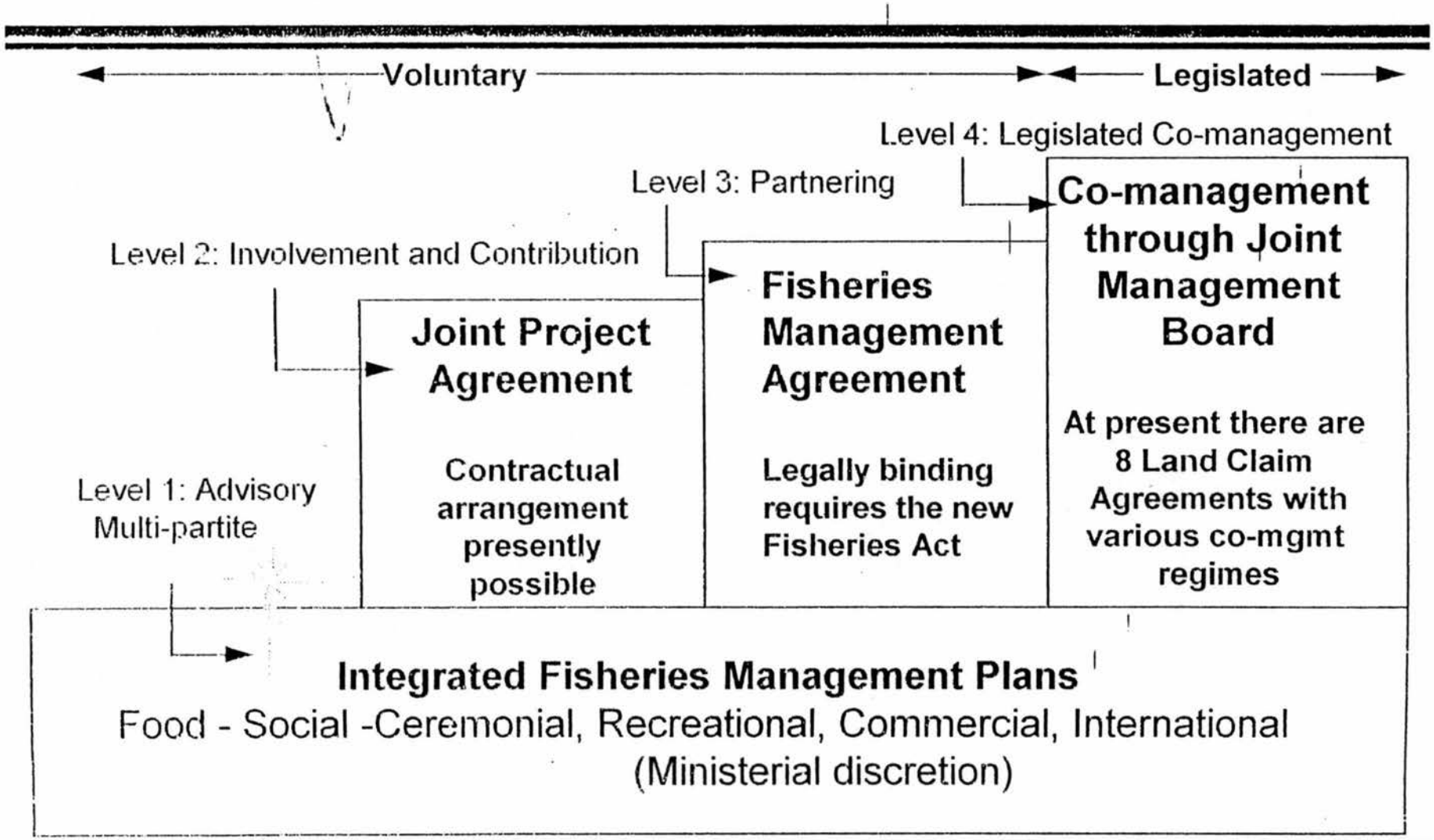
Addendum to FMSWG Report of 21-22 January 1997, Annex 4

A.5.b (MFD Project No. 1206)

Effectiveness of in-season evaluation of fishing plans such as in herring and salmon fisheries (CLAYTOR)

In-season forecasts and harvest allocations would have improved management of summer returning Atlantic salmon (*Salmo salar*) compared to pre-season forecasts and harvest allocations at 12 stock assessment sites in Southern Gulf of St. Lawrence rivers. Reducing under-harvest and increasing harvest variation were the greatest management effects. The relative effectiveness of making a single in-season allocation versus weekly sequential in-season allocations depended on the penalty associated with over-harvesting. Sequential allocations were always better when penalties for over-harvesting and under-harvesting were equal. When the penalty for over-harvesting was greater than under-harvesting, the management performance of single versus sequential allocations was site dependent. Sites with runs of shorter duration were better managed by single allocations. Sites with mean returns which were three times higher than the spawning escapement target were not improved by in-season management. A one or two week window exists for effective in-season management with single allocations. Defining the relative penalty to place on over-harvesting is the most important factor in determining how in-season management is implemented.

Co-Management Approach



Annex 5

Comments on the FRCC Discussion Paper "Quota controls and effort controls: conservation considerations"

prepared by the Fisheries Management Studies Working Group

DFO Maritimes Region

Past experience indicates the catch-quota based management system used to control eastern Canadian groundfish fisheries resulted in fishing mortalities much higher than the $F_{0.1}$ target level. Benefits of more moderate exploitation (higher catch rates, lower costs) were not derived from the fishery and the industry was poorly positioned to cope with the downturns in the resources, and indeed stock collapses, observed in the late 1980s-early 1990s. There is clearly a need for open discussion of possible alternative approaches so that the industry may become more robust to fluctuations in the stocks and is able to withstand these variations without massive government support.

The FRCC paper "Quota controls and effort controls: conservation considerations" provides a useful starting point for such a discussion. It points out that the current system was designed to use TACs to control fishing mortality at pre-determined targets. This requires annual assessments of stock size and TACs vary with stock size. Past difficulties with quota management stemmed largely from problems of monitoring actual catches. Landings were misreported and catches were often discarded or dumped. There was considerable pressure to set quotas higher than the assessed levels, and that fishing was regulated by reported landings was an incentive to underreport. While some improvements have been made to the landings reporting system through dockside monitoring and stiffer penalties for non-compliance, there is still scope for smuggling landed fish and dumping at sea.

A suggested alternative approach is to determine how much fishing effort would be required to generate the desired amount of fishing mortality. This quantity would vary less from year to year since effective fishing effort and fishing mortality are proportional. The paper points out, however, that there are several uncertainties associated with the relationship between nominal fishing effort and effective fishing effort due to variations in vessel fishing power, seasonal and spatial variation in catchability, and the yet to be determined incentives to misreport effort to get around effort regulations.

The paper describes possible advantages of a dual system which would be designed to control both catch and effort. An advantage of such an approach is that these two sources of information could be complimentary. Recognizing the uncertainties associated with establishing both TACs and fishing effort targets, it might be prudent to use both to control fishing mortality. If the fisheries unfold according to predictions, both the TAC and the pre-determined amount of fishing effort should be used up at the same time. If not, this indicates a problem either with the stock size estimate or the catchability estimate and the situation should be investigated. If

resolved, the action would be clear. If not, then a conservative course of action would be to stop fishing. While this aspect of a dual management system was mentioned, the prescribed courses of action were not fully elaborated.

Another advantage of considering fishing effort controls, not highlighted in the discussion paper, is that they would provide the basis for future fishing effort targets in cases where it is clear that past levels of fishing effort were too high. For example, in the southern Gulf, the indications are that reductions of effort in the order of 75% will be needed to fish at $F_{0.1}$. Larger reductions will be needed to achieve lower Fs when fisheries reopen at fishing mortality levels below $F_{0.1}$. This focuses attention on finding ways to achieve these reductions.

There are many issues covered in the Discussion Paper but there are four points of overriding importance and our comments are restricted to these. The points are the relationship between nominal and effective effort, the mixed fishery problem, the use of ancillary measures, and the meaning of "control" of effort.

An essential element for success of direct effort control is the predictability of the relationship between nominal and effective fishing effort, namely catchability. If catchability is independent of stock size, then it would be correct to assume that effort targets would be relatively constant from years to year while TACs would vary with stock size. However, there is mounting evidence that groundfish stocks are susceptible to increasing catchability as stock size declines. In addition, there is evidence that environmental conditions may also affect catchability. Variability of catchability might obviate theoretical advantages of effort controls. This requires further research.

The FRCC paper suggests that effort controls in mixed species fisheries could be applied as a total amount regardless of the species towards which the effort is directed. It is unlikely that such measures would provide the necessary protection to individual stocks. There is a need for further research into the spatial and temporal aspects of individual species catchability in mixed fisheries. If the species composition is predictable at a spatial and temporal resolution suitable for management, then it might be possible to classify the fishing effort to specific "fishery" types and estimate catchability at this level.

Ancillary measures in the "how, when and where fishing can take place" category are advocated for many reasons but have, with the exception of size- at-capture regulations, usually been implemented for the purpose of effort control. These indirect measures cannot substitute for direct controls on the quantity of catch and effort and, indeed, it is doubtful that they have any appreciable effect on effort levels. They can have important implications, however, for both profitability of fishing and cost of enforcement.

The choice being faced is not so clear cut as implied by the Discussion Paper's concluding paragraph, which states "it is clear that controls over both catch levels and fishing effort must play a role....". The term "control" means a direct constraint on fishing effort. However, information on fishing effort could be utilized in the management of the fishery without imposing effort quotas on individual vessels or fleet sectors. Effort reference levels could

be established which would trigger a management plan review mechanism and allow for in-season or longer-term (tactical or strategic) adjustments in the regulatory elements of the plan. In other words, an effort monitoring, rather than control, system could perhaps deliver many of the same benefits without requiring such an extensive and expensive, ongoing, research program on fishing effort measurement, and minimize administrative costs and interference in the conduct of the fishery. It is important to recognize also that improvements to the catch quota system are possible, and the cost effectiveness of implementing these should be evaluated against that of implementing fishing effort controls.

In summary, like any good discussion paper, the FRCC's "Quota controls and effort controls: conservation considerations" poses several worthwhile questions. Clearly, more research is required before implementing a renewed management system based on effort controls, and imposing an additional level of control which would be costly and, would, with the present state of knowledge, have a high risk of being ineffective. Nonetheless, it would be worthwhile investigating how fishing effort could be monitored on a real time basis in certain test cases in order to further evaluate the utility of such an approach. New knowledge could then be applied on a broader basis if the results were positive. What is required now is not a yes or no decision on the imposition of effort controls but a stepwise approach to development of another tool that could provide the necessary improvement in control of exploitation levels.

Submitted: 17 February 1997

cc. R. Rumell
J. Hi...
R. Herbert
M. Boudreau
P. Steele
D. Rivard
R. Nowak

Annex 6

MAY - 8 1997

Mr. Fred Woodman
Chairman
Fisheries Resource Conservation Council
Ottawa, Ontario
K1A 0E6

Sylvain

Dear Mr. Woodman:

I am writing to provide you with comments on your discussion paper entitled Quota Controls and Effort Controls: Conservation Considerations.

It is clear that the Council has put considerable time and effort into developing this paper which should generate some interesting debate amongst stakeholders regarding the future management of groundfish resources. As you know, the Department of Fisheries and Oceans is promoting management approaches that emphasize partnering, rights-based management and fleet rationalization. The combination of these approaches have, in my view, great potential in promoting conservation objectives in an effective and efficient manner.

While I appreciate that the paper attempts to present a balanced view of effort and quota control systems, there are some that may perceive that effort controls are favoured over quota management controls. I am concerned that the benefits of effort control have been presented in a very positive manner, while minimizing the disadvantages, or difficulties of a sole reliance on effort controls to achieve conservation.

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As Council is aware, we currently employ a number of different effort controls in the fishery, such as seasons, types and numbers of gear, etc. The concept of effort control, as it pertains to days-at-sea however, is not a management method that we have favoured in the past. In recent years we have, instead, preferred to place emphasis on improving the existing measures and generating an awareness in the industry that fishing practices must change in order for the stocks to be sustainable in the long-term. Unfortunately, the discussion paper does not seem to reflect this new general approach.

The view by many seems to be that our management system has not worked, so we need to scrap it entirely and bring in something radically different. We have in fact made significant changes to our management regime and there are many fisheries that did not close that are benefiting from our current conservation measures. As an example, since the collapses we have implemented the Conservation Harvesting Plan (CHP) concept, small fish and by-catch protocols, improved mesh sizes, dockside monitoring programs, test fisheries and other measures.

While I support exploring the benefits of adopting a combination of quota management and effort controls, I would resist any suggestion that effort control supplant quota management. It must be realized that even under effort controls, there are still incentives to under-report and there is an enormous incentive for each fisherman to find ways of becoming more effective. As efficiency increases, as it will, more of the resource will inevitably be taken with ostensibly the same effort.

While this summarizes my general thoughts, I am also providing you with more detailed analysis of various sections of the report (attached).

Sincerely yours,

W.A. Rowat

Comments from DFO - Fisheries Management
on the FRCC Discussion Paper on Quota Controls and Effort Controls

Canada's groundfish management system is based primarily on output controls. Our problem in the past is that we have perhaps not put enough effort into ensuring that these controls work. The current strategy is to improve the various output controls so that they are much more effective.

The FRCC document makes reference to the quota management system of the early 1990s where the majority of systems to control the catch (particularly with the inshore) were through purchase slips with a very limited dockside monitoring program. Since closures of the major groundfish fisheries in 1993, a number of new management measures have been implemented as well as major improvements instituted on existing measures, i.e. CHPs, DMP, etc.

The complexity of measuring and monitoring effort controls should not be underestimated. Determination and measurement of the appropriate target level given a wide variety of gear types, soak times for various types of fixed gear, vessel sizes, areas, seasons, skill levels of fishermen, technology, etc. will be highly complex.
The document goes into much detail about the relative merits of quota and effort controls, but there is very little attention given to the practical aspects of implementing effort controls. The effort control systems being proposed do not seem to be consistent with the general trend in fisheries management these days, i.e. to move away from micro-management.

We have often been criticized for trying to micro-manage the fishery. We are therefore trying to get away from this style of management. We are trying to simplify things, but continuing to work within the existing system. To change direction in such a fundamental way as suggested in the paper would be to add a level of complexity that would be counter to our current thrust in management.

Instead of implementing a brand new system, which would entail considerable effort to monitor and enforce, would it not be better to continue improving on the existing measures?

Quota Controls

It is correct that a quota system requires precise annual assessment and at times there can be a high level of uncertainty. Under any effort system the present assessment process would still be required to come up with an estimate of fishing mortality and the same methodology would be used to generate appropriate effort levels, but since effort is not directly related to fishing mortality this would be more difficult to do. The variability

would still be present and there is no guarantee that an effort calculation would be any better.

The reference to the TACs set under a multi-year plan omits the process that allowed for a TAC reduction within the 3 year period if the advice warranted a reduction. The rules for reducing a 3 year TAC forms part of the basic principles section of the Atlantic Groundfish Management Plan.

A quota system does not inherently create an incentive to beat the quota nor does further subdivision of a fleet quota into IQs or smaller units. The incentive generally results from over-capacity and over-investment when the quota or effort level is too low for the available fishers to make ends meet or to avoid bankruptcy. There is no direct evidence that a move to ITQs has led to increased discarding and highgrading as trades and transfers between fishermen accommodate quota shortages. For example, the fact that the fixed gear groups in Scotia Fundy have moved to smaller community and gear groups have resulted in more quota being left in the water than in previous years which is also the case for many of the IQ vessels.

The argument that smaller quota groups result in only the valuable fish being landed is always a concern but has more to do with the market price being offered by the buyers than anything that can be controlled directly by DFO. When DFO introduced regulations to prohibit the landing of fish less than 17", fish were discarded because buyers did not pay very much for any fish less than 19". Indirectly DFO did influence the size of the fish captured by increasing the mesh size to eliminate the small fish yet the fixed gear, excluding gillnets, catch more small fish as hook size is not as selective as mesh size and in fact are more dependent on bait and bait size than actual hook size.

Mis-reporting, or non-reporting, would be inherent in both an effort and quota system provided either system prevented an individual from earning what they believed they needed to make a living.

A mixed species fishery poses a series of problems and DFO's current policy is to close a fishery for all species if a single quota species is reached. A fisher has more direct control in an IQ fishery than under a competitive fishery. An IQ fisher has more options as he can easily obtain additional quota to balance his individual quota mix. In 1996 the smaller fixed gear community quota groups in Nova Scotia were able to arrange transfers of one species from neighboring groups to extend their season. Under a strict competitive quota system this may not be possible even though quota reports alert most license holders of the remaining quota for a certain species. The IQ sector have advised DFO and the FRCC that their present method of fishing is very different from previous years as in recent years they chose to steam away from large concentrations of one species rather than depleting their quota for that species, even though they have the ability to transfer fish if necessary. This represents a change in thinking that allows more effective fishing patterns to emerge to accommodate changes in quota levels. The present catch rates are not necessarily indicative of their ability to catch fish but more a change in their fishing

patterns to adjust to the variable abundance of the different species. This indicates at least an ability to actively fish for different species and with the available technology there at least appears to be the ability to discriminate as opposed to blindly fishing for whatever comes up.

Effort Controls

The key issue in this section is that effort controls do not directly limit catches and there are many variables in an effort system that are impossible to regulate. The effort relationship between when, where and how to fish is often difficult to resolve and there are so many different views about the impact on biomass. Spawning or nursery areas are often cited as a non-effort measure yet the spawning closure on Brown's Bank was initially intended simply to reduce effort by limiting access when fish were aggregated for spawning purposes. Also, with days-at-sea, the fishing emphasis is put on the biggest schools, the biggest catch in the fastest time, which is a recipe for disaster.

The paper notes that "today, considerable interest in 'days-at-sea' controls has developed in both the U.S. and Europe." This leaves the impression that since these two are exploring this concept, then we should as well. Both the U.S. and Europe have a particularly dismal record of managing fisheries in the past and we have, on many occasions, been critical of their management style.

Lobster Fishery

The paper uses the lobster fishery as an example of an effort control fishery. Many of the effort measures that are reported for the lobster fishery are in effect for groundfish as well. Both fisheries have the ability to increase their effort through use of more gear and technology yet in groundfish the catch is restricted through the quota level whereas there is no similar mechanism in the lobster fishery.

The paper admits that "while effort controls in the lobster fishery are generally accepted, improvements are needed since over time, actual effort has increased enormously due to use of larger and more powerful boats, larger traps, increased numbers of pot hauls, improved navigation and so on." If effort controls have not worked particularly well for the lobster fishery, one has to question why such a system would work any better for groundfish, given the greater complexity of this fishery, i.e. so many different vessel classes, gear types, etc.

Lobster is a recruitment fishery where one can theoretically catch all of the animals over a minimum size. In this type of fishery effort controls do not have the same effect. In the lobster fishery the trap issue really is a revenue sharing issue and not a mechanism to protect the stock. The effort in the lobster fishery is so high at the beginning of the season which ultimately results in a significant reduction in catches in the weeks following any opening.

Days On ground

The report states that effort control over foreign vessels was lost when the 200 mile limit was implemented. This is not so. Since extension of jurisdiction in 1977 we have managed the foreign fishery in our zone through a combination of days on ground and quotas. Each country was then given a fishing plan with a quota and a number of days on ground associated with it. The theory was that when either the numbers of days were used up or the quota was caught, the fishery would close. In practice, the quota was usually caught before the days were used up.

We do not want to leave the impression, however, that because we had good control over foreign fleets in our zone through a combination of quota and effort controls that similar controls would work with domestic vessels. The foreign fishery was, and still is, managed quite differently than the domestic fishery. First, they are restricted as to where they can fish. Up until recently, when we had a considerable foreign presence in our zone, there were almost daily air surveillance flights and almost constant at-sea inspections. The relatively low number of vessels compared to the numbers of Canadian vessels of all sizes made them easy to monitor. The advent of 100% observer coverage on all foreign vessels about 10 years ago considerably improved our control over foreign fleets.

George's Bank and the U.S. Experience

The present sea days concept implemented in the US fishery has been unsuccessful in keeping the catch within the recommended levels. Currently they are operating under a strict days-at-sea measure with a target TAC. The resulting catch from the days-at-sea is exceeding the target TAC and the days-at-sea are then subsequently reduced the next year to stay within the target TAC. To date the assigned days have been far in excess of the desired fishing mortality and under this system the managers are constantly facing an uphill battle to limit exploitation to acceptable levels.

The Canadian experience on George's Bank last year took an opposite approach with strict TAC management and a target number of days-at-sea. While some sectors exceeded their days limitation, the overall catch was below the TACs. Comparing the two measures indicated that catch controls are more effective in limiting fishing mortality than effort controls.

Conservation Considerations

The suggestion that an effort system is less dependent on the accuracy of the biomass estimate may be misleading. It is assumed that under effort controls Science would still have to calculate the expected number of days that a fleet would need to keep fishing mortality within acceptable levels. Survey tools currently in use would continue to be relied on. Neither catch nor effort controls can be properly evaluated unless the relative abundance trends and exploitation rates can be measured and the need for this

information remains the same under either scenario. At least under a quota system high landings due to high local abundance can be counted. The suggestion that effort controls perform better when biomass estimates are uncertain is incorrect.

The 5 reasons that are listed as challenges in an effort system are valid but there are not enough comments allotted to demonstrate how difficult many of these measures are to monitor. In some instances these would be very difficult, if not impossible, to enforce. Monitoring the tonnage landed in comparison is far less complicated and under an effort system it is readily acknowledged that the actual landings must still be accounted for. Any new effort enforcement measures would mean an additional workload.

A quota system can limit the overall effort a fleet can inflict on a stock provided that the quota is enforced. In the past there was less effort directed to quota enforcement and this has been readily acknowledged by all industry groups as soon as catch history is considered for dividing up quotas. With the increased use of DMP, hail in, out and other recent measures the accuracy of onshore landings has increased significantly.

Silver Hake Box

The Silver hake box was initially designed as a small mesh gear line which restricted the use of small mesh to areas seaward of the line. While people now refer to this "line" as the silver hake box, its original name was the "small mesh gear line". Species to be caught in this area (i.e. silver hake, squid and argentine) were fished with 60 mm mesh. The line was put there to keep vessels from fishing with such small mesh on the more shallower landward banks where cod, haddock and pollock were more prolific.

Comparison of Conservation Impacts

There are no greater incentives to mis-report under a quota system than in an effort system and as noted a more detailed enforcement scheme for either system is required to ensure proper reporting. Practices at sea are more difficult to control under either system and the incentive to dump small fish due to the price offered by buyers remains the same. If there was a standard price per pound regardless of size or species there would be less dumping. That would ensure that a fisher still gets paid for the fish regardless of size and there would be little difference in subtracting a pound of small or large fish from a quota.

Long-term Implications

The over-capacity within the groundfish fleets remains the major problem and any system that is used to monitor and control the fleets must deal with the over-capacity in trying to ensure conservation. There has been little rationalization in the competitive fleets compared to the IQ or EA fleets. An ITQ plan allows a particular fleet to seek a proper size relative to the stocks. Invariably each new license holder (i.e. in license transfers) pays more for the license than the previous owner which results in additional pressure on

the resource as the new license holder must fish harder than the previous owner due to the increased debt

Conclusions

The drawbacks of each system are acknowledged in the discussion paper yet the "past package of management measures" are still reported with little time given to the more recent measures that are significantly different and improved. To suggest that the status quo did not offer adequate conservation protection is correct but at the same time it is implied in the discussion paper that the past management measures remain the status quo without any acknowledgment that significant changes from the status quo have occurred.

An effort system set up and managed by fishermen may work. Fishermen are being encouraged to take on more responsibility and to become more involved in managing their fleet quotas. In a competitive fishery, a fleet could decide to limit the numbers of days to be fished and then either distribute them evenly amongst fleet members, with some mechanism to keep track of used days, or could just set up a system to keep track of the days on an olympian basis. But this would be for the fishermen to manage themselves. For the Department to get into setting out the number of days for each stock, each mixed fishery, each vessel class and each area and then to monitor every vessel, is not realistic. Even under an industry system, there would still have to be a measuring system in place so that DFO could ensure that the measures were working. If there were no way to measure, then there would be no way we could know if the system was working or not.

Regardless of the measures employed, conservation will only be ensured if fishers support the measures adopted. The fishing industry must rethink their whole approach and become more responsible for the overall management of the resource. Past experience have shown us that fishers can find ways around any policy or circumvent any management system that they do not support. Industry must accept the challenge and responsibility to ensure that the resource is sustainable.

The effort control concept is that a fishery would be closed when either the TAC is reached or when the effort limit is reached, whichever comes first. In reality, it would be very unlikely that the Department would close a fishery when there is quota still remaining, simply because the effort control limit has been "triggered". The effort limits set by DFO would therefore be open to strong challenge by industry if there is an impact on profitability. In a situation where the effort limits were reached before the quota was taken, you can imagine the pressure that would be put on the Minister to allow the fishery to continue. In reality, what would happen in this situation is that the Department would allocate more fishing days or days on ground to enable the fleet to take the remainder of their quota.

Comments from DFO-Science on the FRCC Discussion Paper on Quota Controls and Effort Controls

Past experience indicates that the catch-quota based management system used to control eastern Canada groundfish fisheries resulted in fishing mortalities much higher that the $F_{0.1}$ target level. Benefits of more moderate exploitation (higher catch rates, lower costs) were not derived from the fishery and the industry was poorly positioned to cope with the downturns in the resources observed in the late 1980's-early 1990s. There is clearly a need for open discussion of possible alternative approaches so that the industry may become more robust to fluctuations in the stocks.

The overall message is that quota management was not successful and, therefore, we must come up with a more complicated management procedure (effort, area, season, small fish controls in addition to TAC control). The real problem may not be which tactic to use, but which strategy is to be adopted (is it a fixed harvest rate equivalent to $F_{0.1}$ or something even more conservative?). Another issue might be whether compliance and enforcement can be achieved or not. These were the real problems from a conservation point of view.

Groundfish stocks in Atlantic Canada did not collapse because of the $F_{0.1}$ strategy or because of quota management; departures from $F_{0.1}$, the lack of compliance, the limitations of enforcement, the changes in climatic conditions and changes in productivity were contributing factors. Past difficulties with quota management stemmed largely from problems of monitoring actual catches. Landings were misreported and catches were often discarded or dumped. There was considerable pressure to set quotas higher than the assessed levels and, as the fisheries were regulated by reported landings, there was an incentive to underreport. While there is still scope for smuggling landed fish and dumping at sea, it must be recognised that some improvements have been made to the landings reporting system through dockside monitoring and stiffer penalties for non-compliance.

The suggested alternative is to determine how much fishing effort would be required to generate the desired amount of fishing mortality. This quantity would vary less from year to year since effective fishing effort and fishing mortality are proportional. The paper points out, however, that there are several uncertainties associated with the relationship between nominal fishing effort and effective fishing effort due to variations in vessel fishing power, seasonal and spatial variation in catchability, and the yet to be determined incentives to misreport effort to get around effort regulations.

Effort controls are not necessarily more robust to uncertainty or more risk-averse than TAC controls. If effort is set too high, the stock will collapse just as quickly as it will if the TAC is set too high. Unless fishing effort is pegged at a very low level, equivalent to an artisanal level, effort control will require precise annual assessments to estimate the current q (or catchability). However, catchability for commercial fishing gears does not remain constant (because of changes in fishing power, density-independent variability and density-dependent variability) and therefore it would have to be estimated on a regular basis. These estimates would be subject to the same uncertainties associated with a TAC projection. The assessment would still require accurate data on the annual catches and an annual survey index to estimate q accurately, and to determine if the effort level needs to be decreased or increased to achieve the constant harvest rate strategy.

The answer to "What is the best approach to use?", quota or effort controls, also depends on which approach can achieve the greatest degree of compliance, which can best be enforced, and which is more socially, politically and economically acceptable.

The paper describes possible advantages of a dual-system which would be designed to control both catch and effort. An advantage of such an approach is that these two sources of information could be complimentary. Recognising the uncertainties associated with establishing both TACs and fishing effort targets, it might be prudent to use both to control fishing mortality. If the fisheries unfold according to predictions, both the TAC and the pre-determined amount of fishing effort should be used up at the same time. If not, this indicates a problem either with the stock size estimate or the catchability estimate and the situation should be investigated. If resolved, the action would be clear. If not, then a conservative course of action would be to stop fishing. While this aspect of a dual management system was mentioned, the prescribed courses of action were not fully elaborated.

Another advantage of considering fishing effort, not highlighted in the discussion paper, is that they would provide the basis for future fishing effort targets in cases where it is clear that past levels of fishing effort were too high. For example, in the southern Gulf, the indications are that reductions of effort in the order of 75% will be needed to fish at $F_{0.1}$. Larger reductions will be needed to achieve lower Fs when fisheries reopen at fishing mortality levels below $F_{0.1}$. This focuses attention on finding ways to achieve these reductions.

There are many issues covered in the Discussion Paper but there are four points of overriding importance on which we would like to provide detailed comments. These points are the relationship between nominal and effective effort, the mixed

fishery problem, the use of ancillary measures, and the meaning of "control" of effort.

Nominal and effective effort. An essential element for success of direct effort controls is the predictability of the relationship between nominal and effective fishing effort, namely catchability. It is suggested that effort control is somehow a more direct control than varying the TAC. Controlling the removals by varying the TAC to achieve a constant harvest rate could in fact correspond to a more direct approach because controlling effort requires an estimate for catchability. Furthermore, there is mounting evidence that groundfish stocks are susceptible to increasing catchability as stock size declines. In addition, there is evidence that environmental conditions may also affect catchability. Variability of catchability might obviate theoretical advantages of effort controls.

The Mixed fishery problem. The Discussion Paper suggests that effort controls in mixed species fisheries could be applied as a total amount regardless of the species towards which the effort is directed. It is unlikely that such measures would provide the necessary protection to individual stocks. There is a need for further research into the spatial and temporal aspects of individual species catchability in mixed fisheries. If the species composition is predictable at a spatial and temporal resolution suitable for management, then it might be possible to classify the fishing effort to specific "fishery" types and estimate catchability at this level. However, additional research would be required in that area before such a system could be implemented.

Ancillary measures. Ancillary measures in the "how, when and where fishing can take place" category are also advocated for many reasons. These indirect measures cannot substitute for direct controls on the quantity of catch and effort and, indeed, it is often doubtful that they have any appreciable effect on effort levels. Indirect controls of effort generally operate by reducing the catchability of fishing units. They can have important implications, however, both for the profitability of fishing and the costs of enforcement. For instance, the Discussion Paper suggests that additional tactics, such as gear limitations, closed seasons and closed areas, could be implemented for achieving "conservation considerations". These would be unnecessary if a clear strategy could be agreed on, such as fixed harvest rate of say 10%, and this was

adhered to, was achieved through compliance and was enforced. The additional tactics could just be interfering with the fishing operations for no real purpose from a conservation standpoint. If the estimated removals in keeping with the fixed harvest rate strategy cannot be controlled at the appropriate level because of various problems, then these additional tactics may be useful for conservation, but only if they are *more successful at limiting the removals*.

Meaning of "control" of effort. The choice being faced is not so clear cut as implied by the Discussion Paper's concluding paragraph, which states "it is clear that controls over both catch levels and fishing effort must play a role..." The term "control" seem to be used to mean a direct constraint on fishing effort. However, information on fishing effort could be utilised in the management of the fishery without imposing direct effort limitations on individual vessels or fleet sectors. Effort reference levels could be established which would trigger a management plan review mechanism and allow for in-season or longer-term (tactical or strategic) adjustments in the regulatory elements of the plan. In other words, an effort monitoring, rather than control, system could perhaps deliver many of the same benefits without requiring an independent effort management program, and could perhaps be implemented with minimum interference in the conduct of the fishery.

In summary, like any good discussion paper, the FRCC's "Quota controls and effort controls: conservation considerations" poses several worthwhile questions. Clearly, more research is required before implementing a renewed management system based on effort controls, and imposing an additional level of control which would be costly and would, with the present state of knowledge, have a high risk of being ineffective. Nonetheless, it would be worthwhile investigating how fishing effort could be monitored on a real time basis in certain test cases in order to evaluate further the utility of such an approach. New knowledge could then be applied on a broader basis if the results were positive. What is required now is not a "Yes or No" decision on the imposition of effort controls but a stepwise approach to development of another tool that could provide the necessary improvement for controlling of exploitation levels.