THE ROLE OF WEAK FISHERIES SCIENCE IN THE NORTHERN COD STOCK COLLAPSE OFF NEWFOUNDLAND AND ITS USEFULNESS IN LEGITIMIZING FEDERAL GOVERNMENT POLICY OBJECTIVES

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By

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ABSTRACT

The July 2, 1992 announcement of a cod moratorium signaled the end of a long history of the commercial cod fishery in Newfoundland. The burden of blame for the collapse of the Northern cod stock was placed on the fishery science division of the federal Department of Fisheries and Oceans. This blame, however, was misplaced. This report analyzes how the inherent weakness in fisheries science and its subsequent strategic failures, facilitated the promotion of economic and political policies that led to overexploitation of the Northern cod resource. Further to this, the report examines the view that globally there is a common pattern of marine exploitation that inevitably leads to stock collapse. The Newfoundland fishery of the late 1990s adheres to such a pattern where the social and economic value of the resource subordinates the interests of science.

ACKNOWLEDGMENTS

Undertaking a Masters program as a mother and spouse requires support from many quarters, but most importantly support from within. The ongoing interest, help and input from my husband, Jim and our three teenagers, Leah, Jill and Nicholas made all the difference in completing this report and ultimately my program of study.

In addition to my family's commitment, I cannot underestimate the importance of the professors in the Masters of Marine Studies program in the success of my studies. They were true pioneers in undertaking teaching in a multi-disciplinary masters level program. They are Dr.George Rose, Dr. Paul Snelgrove, Dr. Joe Wroblewski, Dr. Y. Chen, Dr. Raoul Andersen, the late Dr. Susan McCorquodale, (who initiated my study of the Harris Report), Dr. Michael Wernerheim, Mr. Glenn Blackwood, Ms. Donna Stapleton and Mr. Eric Dunne. The opportunity to learn from these "masters" made the program particularly valuable. The encouragement from Dr. Peter Fisher was instrumental in completion of this paper. Finally, the sincerity of purpose in the writings of Cabot Martin and Dr. Leslie Harris on the Newfoundland fishery inspired this paper and left me wishing that I could impart just a fraction of their eloquence to this topic. In this I may have failed. Yet, I sincerely hope that the seriousness of this subject suffers nonetheless for this inability.

DEDICATION

To my mother, the late Estelle V. Fagan, whose own educational aspirations inspired her daughters to seek and value theirs.

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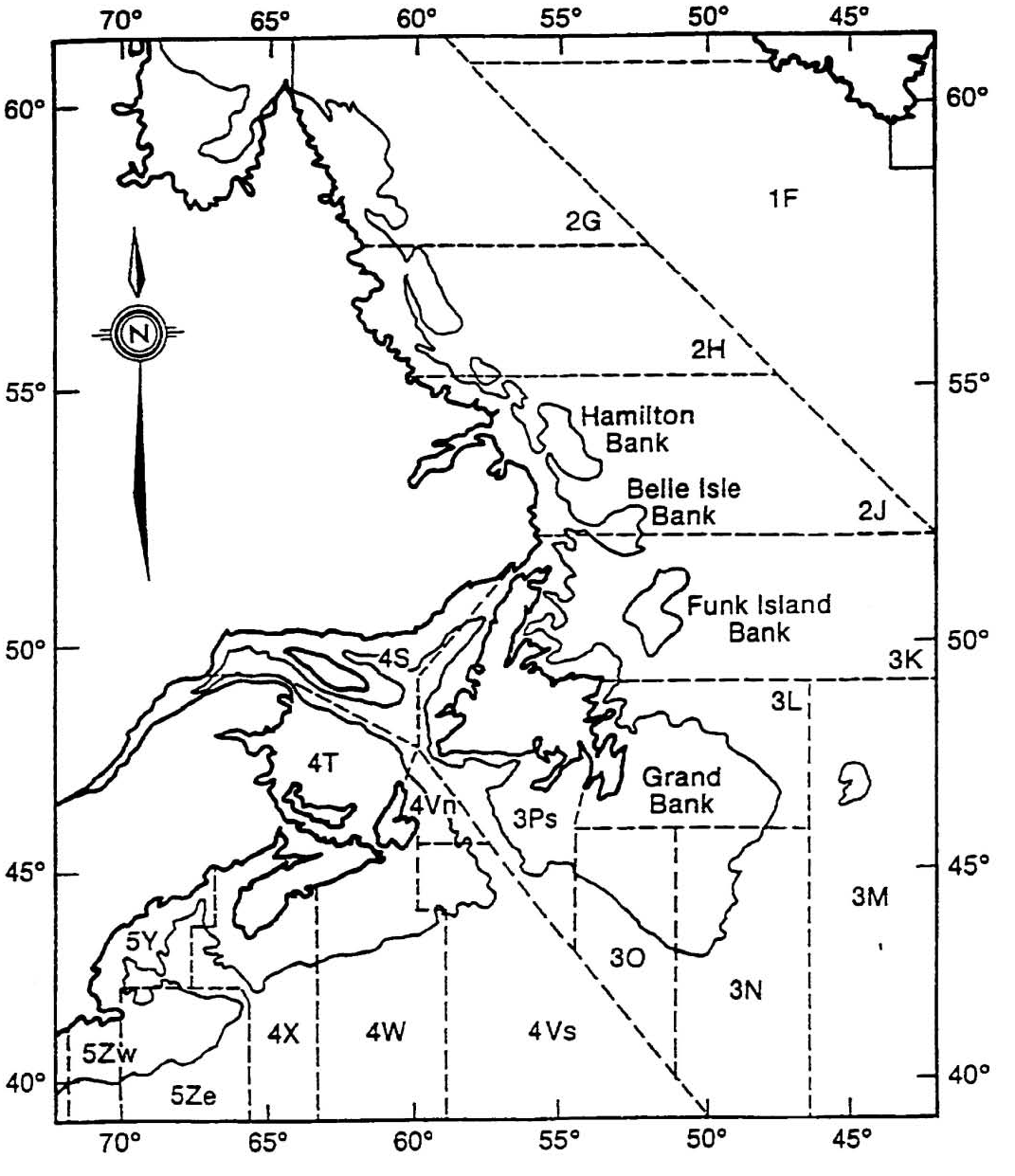
LIST OF ABBREVIATIONS

AFAP	**Atlantic Fisheries Adjustment Program**
CAFSAC	**Canadian Atlantic Fisheries Scientific Advisory Committee**
CPUE	**Catch Per Unit Effort**
DFO	**Department of Fisheries and Oceans**
EC	**European Community**
EEZ	**Exclusive Economic Zone**
FPI	**Fishery Products International**
ICNAF	**International Commission for Northwest Atlantic Fisheries**
MSY	**Maximum Sustainable Yield**
Mt	**Metric Tonnes**
NAFO	**North Atlantic Fisheries Organization**
NIFA	**Newfoundland Inshore Fisheries Association**
RV	**Research Vessel**
TGNIF	**Task Group on Newfoundland Inshore Fisheries**
TAC	**Total Allowable Catch**
UI	**Unemployment Insurance**
UNCLOS	**United Nations Convention of the Law of the Sea**
VPA	**Virtual Population Analysis**



Map showing 2J3KL divisions

Figure 1: Cod Landings 2J3KL 1850-1987

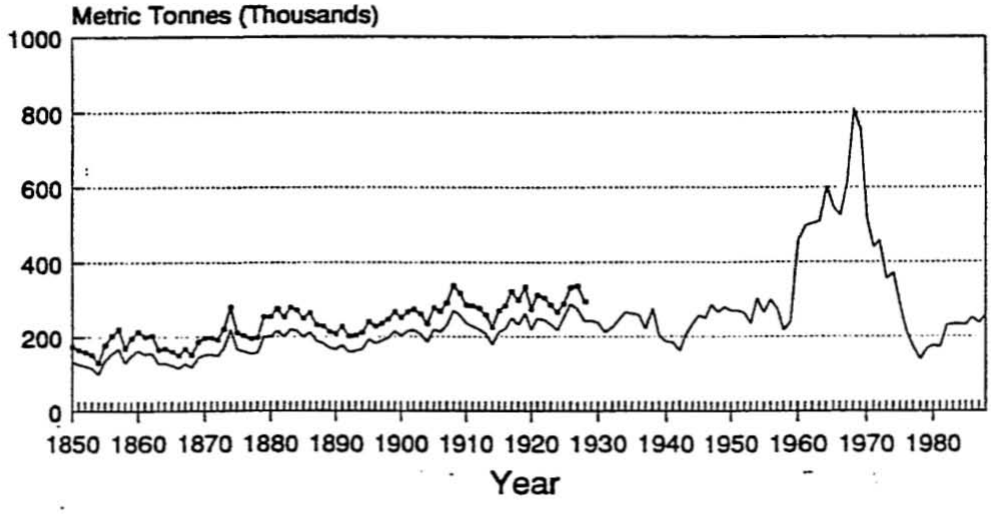


Figure 2: Historical Catches of Cod
Division 2J3KL

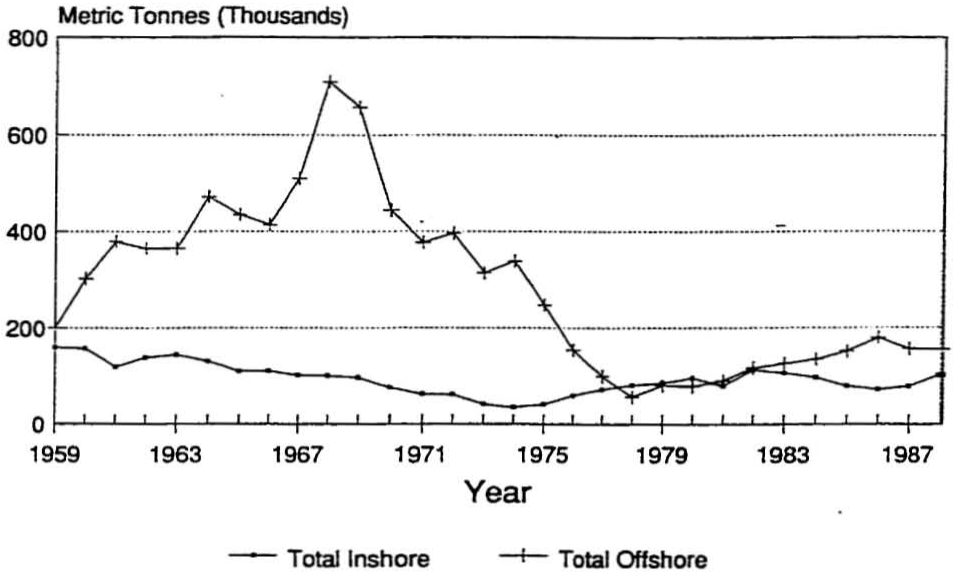


Table 1. 2J3KL Cod Quotas and Catches, 1978-1992

Year	Canadian Quota	Catches in the Canadian Zone	Catches in the NAFO Regulatory Area	Total Catches
1978	100,000	102,095	36,182	138,277
1979	130,000	131,386	36,120	167,506
1980	155,000	146,574	28,200	174,774
1981	185,000	132,644	23,677	156,321
1982	215,000	211,355	22,268	233,623
1983	240,000	214,422	17,893	232,315
1984	246,000	207,745	25,054	232,799
1985	249,700	192,828	44,958	237,786
1986	249,700	207,162	64,213	271,375
1987	246,500	208,857	35,653	244,510
1988	266,000	245,081	26,693	271,774
1989	235,000	215,318	38,799	254,117
1990	197,000	188,238	25,489	213,727
1991	187,860	132,980	23,806 (48,950)[1]	156,786
1992	120,000	20,732	9,532[2] (14,300)[1]	30,264

[1] estimated catches for 1991 and 1992

[2] provisional catches as reported to NAFO.

PURPOSE OF THE REPORT

The purpose of this paper is to analyze the role of weak fisheries science in the Northern cod collapse, to determine how weak fisheries science was manipulated by policy-makers in the use of the fishery to meet other objectives, and to consider if improved fisheries science would prevent the pattern of exploitation that leads to stock collapse.

1. INTRODUCTION

The 1990s has seen one of the most spectacular declines in fish stocks in the world: the collapse of the once great Northern cod stock off the coast of Newfoundland. Much has been written about this decline and the reasons for it.

Fisheries science at the Department of Fisheries and Oceans (DFO) is considered by many to be at fault for this collapse. *The Independent Review Panel on the State of the Northern Cod Stock (1990),* known hereafter as The Harris Report, is one of the most comprehensive analysis conducted on the science of this stock collapse. It lays the blame for the collapse of the Northern cod fishery squarely on " weak" fisheries science. This paper considers how policy makers and politicians, in order to further objectives of a social and economic nature, manipulated weak science. It offers evidence of interference and deliberate misinterpretation of stock assessment to legitimize overcapitalization and to promote international trade relations. Further to this it is interesting to observe how Canadian fisheries science was promoted as the best fisheries science in the world and used to support a quota fishery. However, once this facade was removed by the "unraveling" events of 1985-1989, the DFO commissioned the Harris Panel led by Dr. Leslie Harris, to investigate fisheries science and review stock assessments at the Science

Branch, St. John's. This commissioning officially separated politicians from the responsibility of the Northern cod collapse. This report provides some background of events leading to the establishment of the Harris Panel, it reviews the Harris Report and confirms the strategic failures of science, discusses the structure of decision-making within the bureaucracy of the DFO, the objectives of the 1983 Kirby Report, upon which policy was designed, and then explains how fishery science was used to legitimize government policy in resource exploitation.

In order to draw conclusions about the realistic role of fisheries science in stock collapse, it is necessary to determine the influence of fisheries science in global marine exploitation. This is facilitated by an analysis of the views of eminent fisheries scientists Donald Ludwig, Ray Hilborn and Carl Walters. Their controversial view, that there is a pattern of exploitation that inevitably leads to stock collapse, independent of science, mirrors the process of stock collapse in Newfoundland. Supporting evidence for their viewpoint follows this analysis. The paper concludes that, contrary to Dr. Harris's view that science is our only hope in the prevention of overexploitation, it is the will of society that will ultimately determine appropriate marine exploitation. Good science can help to inform but the responsibility to ensure marine resource protection is with each one of us. It is our responsibility to manage our technology, curb our greed and protect our fish stocks.

2. BACKGROUND OF REPORT

Stock assessments of Northern cod came under attack in the mid-1980s due to a decline in the abundance of the Northern cod stock. Between 1962 and 1977, the biomass of Northern cod available for harvest had declined by 82 per cent from an

estimated 3 million tonnes to 526,000 tonnes (Hutchings, 1999). Of further importance, in the mid-1950s Newfoundland vessels landed 97 per cent of the fish caught in waters adjacent to the Northeast coast of the province. By 1975, their share had dropped to 8 per cent, as foreign vessels with factory freezer trawlers heavily exploited the resource offshore. In order to gain domestic control of the situation, the Canadian government, in 1977, declared a 200-mile exclusive economic zone (EEZ) (McCorquodale, 1994). The aim was to set in place an economically sound harvest annually and to allow the cod stocks to rebuild. The establishment of the DFO in 1979 (formerly the Department of Fisheries and Environment) was to satisfy this aim through its Science Branch. "The primary institutional functions of the Science Branch of the Northwest Atlantic Fisheries Center in St. John's is the provision of scientific advice for the rational management of commercial exploitation of regional biological marine resources" (Finlayson, 1994, p.1). The immediate consequence of the establishment of the 200-mile limit was a decrease in fishing mortality as the foreign fleets were evicted. As Canada had yet to develop its trawler fleet, this lull in trawler activity permitted a modest stock recovery between 1977 and 1985. In fact, the harvested biomass approximately doubled (Hutchings, 1999). However, it was unclear at the time whether this increase in landings was due to a real increase in resource abundance, a greater fishing effort, more efficient techniques, improved familiarity of the skippers and fleet managers with seasonal movements of the resource or some complex combination of these factors (Finlayson, 1994).

Although cod catch remained essentially static through 1987, the inshore catch declined while the offshore catch increased. This is important as it prompted inshore fishermen to question DFO stock estimates as early as 1985. This led to a paper by Dr.

George Winters of DFO in 1986 suggesting that DFO's abundance estimates were significantly wrong. This paper was filed away (Hutchings *et al.*,1997).

In 1986 the Newfoundland Inshore Fisheries Association (NIFA) responded to a growing discrepancy between its membership's perception of the stock's condition and that of DFO. Three biologists from Memorial University of Newfoundland were commissioned to conduct the first independent review of DFO stock assessments. This report, known as the Keats Report, was highly critical of DFO's data sources, statistical procedures and conclusions. It determined that since1977, instead of catching the target harvestable biomass of approximately 20 per cent or $F_{0.1}$ (see **Strategic Failures**), the annual catch had been somewhere between thirty and fifty per cent! This rate of exploitation gave some credibility to the inshore fishermen's perception that the stock was in decline. DFO dismissed the report as "superficial". However, in 1987, the persistence of criticism of DFO science and the growing public support in the media compelled the federal Minister of Fisheries, Tom Siddon, to create the Task Group on Newfoundland Inshore Fisheries (TGNIF), chaired by fisheries scientist Dr. D.L. Alverson. The Alverson Report conclusions, were not substantially different from those of the Keats Report. *"Chronic, overly optimistic interpretations of data of questionable validity had resulted in a persistent underestimation of fishing mortality and an overestimation of the growth of the biomass since 1977"* (Finlayson, 1994, p. 40).

The work of Alverson brought vigorous debate within DFO, particularly the Science Branch. This debate was to result in the radical reduction (by about one-third) of the 1989 estimate of the Northern cod biomass by the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC). It is through CAFSAC that scientific

information was communicated between fisheries scientists and the managers in the Science Branch of DFO. According to Finlayson this was the first reduction in current-year estimate since the advent of the 200-mile limit in 1977 (Finlayson, 1994). The atmosphere of growing skepticism of DFO's scientific knowledge spread from its origins in the inshore sector of the fishery to include influential members of the public and the media. The institutional authority of DFO was under siege. The importance of the authority of science is crucial in order to allow the Minister of Fisheries justification for quota allocations among competing user groups. Without the prestige and authority of science to legitimize these decisions, there is political crisis. *"In the spring of 1989, it became abundantly clear to the Minister of Fisheries, Tom Siddon, that his department's official construction of reality was passing beyond criticism and becoming the object of ridicule and contempt"* (Finlayson, 1994, p. 63).

This "unraveling" of authority called for a new action. The minister appointed Dr. Leslie Harris, then President of Memorial University of Newfoundland and a historian, as chair of the Independent Review Panel on the State of the Northern Cod Stock. It was against this background of crisis in authority and prestige at DFO that Dr. Harris and his panel went to work. The Harris Report confirms major problems in stock assessment and fisheries science. It is an integral part of this paper because it put responsibility for the Northern cod collapse on fisheries science at DFO, thus separating policy-makers and politicians from the tragedy. Therefore, this report will begin with a review of the Harris Report.

3. A Review of the Harris Report

On February 12, 1989, the DFO, under Minister Tom Siddon, established the seven member Northern Cod Review Panel headed by Memorial University President, Dr. Leslie Harris. It examined the history and complexity of the Northern cod stock, the data used in assessing and forecasting catches, the methodologies used in Canada and other countries and the calculations leading to the startling 1989 stock assessment. The Panel released an interim report in May 1989 and a final report in February 1990 to new Fisheries Minister Bernard Valcourt. This section provides some historical background of the Newfoundland fishery and summarizes the Panel's findings and recommendations.

The mandate of the Northern Cod Review Panel was to consider the scientific advice provided by the DFO since 1977 on the Northern cod stock, the current state and size of the stock, and make recommendations regarding stock assessment methods and means with a view to better forecasting the size, growth potential and behavior of the stock in future (Harris Report, 1990, p. 11). In fulfillment of its mandate, the Panel examined a number of issues, the key one being the explanation for the variance between current and earlier scientific advice on the state of the 2J, 3K, 3L stock.

3.1 Historical Background

The establishment in February 1989 of the seven-member Northern Cod Review Panel reflected grave concerns regarding the state of the Northern Cod stocks. It is important to consider the events prior to 1989 and include some historical background.

The abundance of marine resources and particularly of Northern cod, was the "raison d'etre" for the establishment of coastal settlement in Newfoundland and Labrador beginning around the 1500s. Until 1950, nature imposed management of the resource

through the inherent physical, seasonal and geographic limitations on fishing, thus providing sustainable resource usage (Harris Report, p.23). In the early 1950s, the introduction of new high seas technology, the factory freezer trawler, led to significant increases in Northern cod landings. This created the need for international management of high seas and foreign fishing. In 1949, the International Commission for Northwest Atlantic Fisheries (ICNAF) had been formed to provide the fishing industry of coastal states with scientific information and statistical data. The new era in high seas fishing required more of ICNAF than the mandate suggested. The Harris Report determines that "as an agency for conservation ICNAF was a total failure" (Harris Report, p. 7). The new high seas technology, and an unregulated harvest through the 1960s, led to a peak landing of Northern cod in 1968 of 810,000 tonnes (Harris Report, p.2). By the early 1970s the once abundant Northern cod stock was in decline as it dropped from average landings of 220,000 tonnes to 250,000 tonnes in the early 1900s to 172,000 tonnes by 1956 to a low of 35,000 tonnes in 1974 (Harris Report, p. 26).

In 1977, Canada declared a 200 nautical mile jurisdictional limit in an attempt, though belated, to regain control of its ailing marine resources. The social and economic impact that the decline of Northern cod landings visited upon coastal communities gave credence to Canada's claim before the United Nations International Law of the Sea Conference. In 1982, the United Nations Convention of the Law of the Sea (UNCLOS) extended the rights of all coastal states to a 200 mile jurisdiction of their marine resource.

With the declaration of the EEZ in 1977, Canada adopted a program of conservation and stock regeneration. As Northern cod was considered the species under most immediate and urgent threat, Canada established a strategy, a strategic objective

which they identified as $F_{0.1}$ strategy. This implied that they would limit the annual catch to approximately 20 per cent of the exploitable biomass. The DFO believed that if the fishing mortality rate was held at approximately 20 per cent and if their predictions about natural mortality and recruitment were correct, together these three elements would lead to a growth in the stock that would very quickly see it return to where an annual harvest of up to four hundred thousand tonnes could easily be taken (Harris Report 1990). However, the basic model for stock assesment that this implied was very seriously flawed (see **Findings**). By early 1989, it was clear that at least a short-term crisis was at hand.

The "red flag" was the January 1989 revision of the Canadian Atlantic Fishery Scientific Advisory Committee (CAFSAC) estimate of the status of Northern cod. (This is the scientific unit that recommends allowable catches.) The 1989 TAC for Northern cod had been set in late 1988 at 266,000 tonnes. The revision of the TAC in January 1989 by CAFSAC was a recommended decrease of 50 per cent from 266,000 to 125,000 tonnes. This sent shockwaves through the Atlantic fisheries system and shattered perceptions that the Northern cod stock was increasing and would continue to do so (Parsons, 1993). In spite of this recommendation the Minister set the TAC at 235,000 tonnes in February 1989. It is worth noting that the actual catch of Northern cod in 1989 was just 215,000 tonnes (Schrank *et al.* 1992, p. 285).

Due to the implications this had for Atlantic Canadian fishing communities, particularly Newfoundland, Fisheries Minister Tom Siddon established an Independent Review of the State of the Northern Cod Stock, headed by Dr. Leslie Harris, President of Memorial University (hereafter known as "The Panel") to explain the reasons for the differences between current and earlier scientific advice.

3.2 Findings

To fulfill its mandate, the Harris Panel used the resources of the DFO: the library, data sources and expertise. The presence of panel members Dr. D.L. Alverson and Mr. John G. Pope brought stock assessment methodology expertise and back-up support of computer facilities (as well as their experience from the DFO-appointed Alverson Review in 1987). In completion of the final report, public hearings were held throughout Newfoundland and in Halifax. Inshore and offshore fishermen, major fishing companies, the fishermen's union and other special interest groups made presentations. (Harris Report, 1990, p. 13). The findings underscore Dr. Harris's statement that "we neither fully comprehend the complexities of the natural world that Northern cod inhabit nor realize the full impact of natural adjustments to human activity" (Harris Report, p. 129).

The findings are numerous and broad. Therefore, they are categorized here under four headings, and then summarized: (a) the state of the cod stocks, (b) fisheries management, (c) science: assessments and resources, and (d) overcapitalization. The "science" category receives a more in depth summary due to its role in the establishment of the Harris Panel.

3.3 The State of the Cod Stocks

The Harris Panel found that though Northern cod stocks did grow significantly in years immediately following the 200-mile extension in 1977, that pattern of growth reversed and stock declined. The Panel expressed concern that the decline in recruitment (the young of a population species enter into a fishery at a particular age; for Northern cod it is at ages 3, 4 and 5), coupled with the continued catch levels experienced during 1986, 1987, and 1988 had sharply eroded the gains that had been made in rebuilding the

Northern cod stocks during the late 1970s and early 1980s. The Northern cod stock complex exhibit a strong relationship between recruitment levels and size of the spawning biomass. (The population of cod that are sexually mature and involved in spawning.) The downturn in recruitment suggested that the catch level could not be maintained without causing a significant decline in the exploitable and spawning biomass (Harris Report, p. 64). In fact, the biomass had declined to 488,000 tonnes in late 1989 from 1,140,000 tonnes in 1985 (Hutchings *et al.* 1995).

The Panel found that there were no stock-specific management measures. Fish within statistical division 2J3KL had been managed as one stock unit over a period of 16 years. The assumption that it could, in fact, be managed as one stock, was never tested (Harris Report, 1990, p. 77).

Finally, the Panel found that there were enormous gaps in knowledge of Northern cod as fishery scientists concentrated resources on stock assessment. It is surprising that something of such fundamental importance was lacking in the information needed to generate scientific advice (Harris Report, p. 118). The mathematical models became more important than the species. *"We acted in substantial ignorance of the biology of the animals...and in almost total ignorance of the dynamics of the ecosystem in which they existed"* (Harris, in L. Hinds, 1995, p. 281).

3.4 Fisheries Management

The Panel analyzed the organization of management and science within DFO. They described these two groups, operating independent of each other, as the "segregation of science and management into watertight compartments." The Panel felt that the effectiveness of good strategies in the respective groups was undercut by a lack of

coordinated effort. As well, it was noted that there was not enough communication between the modeling group and the disciplines of fisheries oceanography and fish biology. The Panel felt that the lack of input from fisheries oceanography in stock assessment modeling had contributed to this crisis (Harris Report, pp. 41, 84 and 93).

The Panel found that the failure of coordination between federal and provincial jurisdictions lead to conflicts in goals and objectives. Reconciling socio-economic needs of fishing communities with the biological imperatives of the stock is a balancing act between goals of conservation and of socio-economic requirements of people and communities (Harris Report, pp. 42, 96, 108). It is important to note that among these conflicting jurisdictional goals is the issue of foreign fishing.

> *"It is difficult to make the average Newfoundland fisherman understand what interests of state compel the Canadian Government to permit a large foreign fleet to continue fishing within the two hundred mile economic zone...when inshore nets lie empty, and trawlers are tied up."* (Harris Report, p. 106).

The need for Newfoundland to maximize economic benefits of the fishery are in conflict with the Federal goal of using fishing concessions to further external relations objectives (Harris Report, p. 106).

Another source of conflict of interests addressed is that of the inshore and offshore interests. "In all of the presentations made to the Panel, whether in written or oral form, no single issue appeared more frequently than this and none evoked more passionate protestations." (Harris Report, p. 43). Inshore fishermen felt that their landings declined due to enormous technological effort followed by offshore fleets. This is not scientifically proven but anecdotal accounts support this claim, with concerns noted of the disturbance of spawning activity (Harris Report, p. 43).

The Panel found that $F_{0.1}$ (here constitutes an annual fishing mortality of about 20 per cent of the exploitable biomass) as a management strategy would have led to significant growth in the Northern cod stock if it had been followed. With management decisions based upon faulty advice, fishing rates soared to well over $F_{0.1}$ or more than double the desired level. Thus the spawning stock failed to grow as rapidly, lowering current yields (Harris Report, p. 103).

The Panel felt that there was room for improvement in the planning process with a need for greater measures of openness and better communications with interest/client groups and for input from such groups (Harris Report, p. 120).

3.5 Science - Assessments and Resources

It was the significant difference in scientific advice on setting Total Allowable Catch (TACs) in 1989 from that of earlier years that instigated the formation of the Harris Panel. Therefore, it is helpful to analyze the Panel's observations regarding the research methods and data used by DFO scientists.

Sound fisheries management requires a good knowledge of the dynamics of fish stocks and their interactions with environments. Mathematical models are commonly used to describe the dynamics of a fish stock and its ecosystem. These models are fitted to data collected from fisheries and scientific surveys. The Panel confirmed that earlier scientific advice had been overly optimistic. According to the Harris Panel

> "*...the basis for the significant difference in the 1989 scientific advice from that of earlier years results in part, from the addition of a new analytical method of handling the data inputs, in part from the changes in the state of the stock which have occurred since 1986; and in part from a significant adjustment in the 1986 research vessel (RV) survey, abundance estimates...*" (Harris Report, 1990, p. 73-74).

Why such variations? There were reasons for such numerous seemingly controllable variables. The Panel found that a number of stock assessment methods lacked the ability to measure changes in recruitment and abundance. The Panel determined that both the research vessel (RV) data and the commercial catch data were incorrect. This is crucial data used in stock assessment models. Also of interest, is the finding that scientists intentionally disregard ecological factors to avoid bias in their findings. For example, scientists disregard that cod seek out ideal conditions of water temperature, salinity, and availability of food. This exposes the research to error that may vary from less than 10 per cent to 50 per cent or more. They pointed out that $F_{0.1}$ formula was flawed because it did not recognize the need to maintain a sufficient number of older age spawning females.

Steele, Andersen and Green (1992) disagree with the Harris Panel's explanation for the difference in advice and note that the basic information that clearly showed the problem was available as early as 1986 (Steele *et al.*, 1992 p. 53). Cabot Martin felt that the Panel's attention to this difference of advice was not given enough prominence in the report. "Less than one page was spent on 'Explanation for the Difference Between the Current and Earlier Scientific Advice' " (Martin, 1994, p. 8).

The Harris Panel noted that the database of DFO science was not comprehensive enough for the complex task at hand. Such a database does not give any definitive answers with respect to the relationships among the several components of the Northern cod stock complex over time. The Panel found that historical catch per unit of effort (CPUE) data from the inshore fleets acoustic survey data and environmental indices of

availability and abundance should have played a larger role in developing abundance estimates and resource forecasting.

The independent estimates of population trends require much closer scrutiny. Finally, the two indices used to tune virtual population analysis (VPA) and/or cohort analysis to establish annual TACs are not completely reliable in that they are influenced by environment change, operational changes in the fishery and/or survey, and the introduction of new technology. In fact, technological advances in catchability were so rapid that the unit of effort as a measurement became meaningless (Harris Report, 1990, pp. 50, 60, 61 and 78).

The Panel found that the "discard mentality" in inshore and offshore fisheries was worrisome and contributed to underestimates of fishing mortality (Harris Report, 1990, p. 80). Also, the absence of an estimate of cod losses due to bycatch losses is not properly accounted for in tuning VPA (Harris Report, p. 60). "We failed to account adequately for misreporting, discarding, high-grading and bycatch" (Harris as quoted in Hinds, 1995, p. 281).

The Panel found that knowledge regarding predator and prey relationships should be used in developing finer stock assessment methodology. A better understanding of the relationships between seals and cod, cod and capelin, and capelin and seals are necessary for such incorporation.

Finally, the resources available to DFO scientists were lacking in some respects according to the Panel. The shortage of data processing capacity meant that scientists were unable to access computer facilities in a timely manner (Harris Report, 1990, p. 94). This inhibited, somewhat, the prioritizing of the use of observer data from offshore fleet

and smaller trawlers/gillnetters and longliner vessels. The Panel also found that there is a need for scientists to go to sea more often, and noted that RV cruises of four or five weeks are inadequate to observe appropriate detail over such a large territory. As well, the research vessels lacked state of the art electronic equipment. The Panel observed that resources for surveillance have not matched the changes that have taken place in the fishery over the years (Harris Report, pp. 94, 118, 125 and 126). In a 1992 address, Dr. Harris said, "We continued for too long to wear our rose tinted glasses and to interpret all data in the manner best calculated to support and confirm the model of growth upon which our hearts had been set."

3.6 Overcapitalization

The Panel found that the "euphoria attitude" following extension of the 200-mile limit in 1977 led to overcapitalization in both the harvesting and processing sectors. The bright prospects of open access to a larger resource base compounded with actual initial stock growth led to the large investments in boats and gear, as well as in new and improved plants and processing facilities. This placed heavier demands upon stocks. "As fish stocks decline, catches may still be maintained by increased fishing effort brought about through improved technology, the use of larger vessels, the deployment of more gear"...thereby suggesting interpretations of abundance that would justify high TACs as opposed to a policy of conservation (Harris Report, 1990, p. 42).

Overcapitalization in the processing sector put political and social pressures upon governments and encouraged them to "err on the side of overexploitation rather than on the side of conservation" (Harris Report, 1990). In concluding, the report addresses this resulting overcapacity and asks should the fishery become the preserve of professional

fishermen and plant workers, all of whom can earn an adequate living from it, or should it continue as at present a social relief mechanism? (Harris Report, 1990, p.150).

The Panel concluded its findings with the determination that current catch levels simply could not be maintained without causing a significant and potentially very serious decline in the exploitable and spawning biomass. As Michael Harris (1998) states, Dr. Harris pointed a damning yet compassionate finger at the Science Branch for disastrous advice given. Ultimately, a shadow was cast on the research methods and data used by DFO scientists. Would this tragedy have occurred without such disastrous scientific advice? This paper seeks to answer this question.

3.7 Recommendations

The Harris Panel felt that if the tragic decline of the Northern cod was to be stopped, immediate steps had to be taken to grow the size of the spawning biomass. In Harris's opinion, Ottawa's reduced 1990 TAC of 190,000 tonnes might not serve to reverse the trend of a declining spawning stock but could contribute to further decline (Harris Report, 1990, p. 136). To this end, the Harris Panel made twenty-nine recommendations for future management of this stock and for strengthening the scientific basis for management.

Twenty-six of the twenty-nine recommendations were accepted for further research and/or adopted. However, three key recommendations were not accepted. These were:

Recommendation # 1: further reduction in the 1990 TAC.

The Panel strongly recommended that "in respect of the Northern cod stock(s), as a matter of urgency, there should be an immediate reduction of fishing mortality to the

level of at least 0.30 and at the earliest feasible date, to the level of 0.20." (Harris Report, 1990, p. 151). The Federal government responded by stating:

> *"The TAC has already been reduced by 25 per cent since 1988 in order to conserve the resource. The lowering of the TAC is consistent with the government's long-term conservation goals. Future TACs will depend on scientific assessments and industry consultations, taking into account the socio-economic impact".*

This unleashed a wave of protest from scientists, academics and interest groups as it was the central recommendation of a comprehensive report;

Recommendation # 23: the establishment of a new fisheries management board or commission.

Recommendation # 5: unilateral action by Canada to acquire management rights for straddling stocks beyond the 200 mile limit.

In rejecting Recommendation # 23, the Federal government stated that a number of existing consultative methods provide Newfoundland with the opportunities to receive information and provide feedback and input. Recommendation # 5 was not accepted, as "this recommendation is incompatible with the international Law of the Sea".

In a later interview with Michael Harris, Dr. Harris conceded "you really didn't have to read very hard between the lines of our report to find that in making these recommendations, we were walking on the edge of a precipice." (M. Harris, 1998, p. 296).

Among the findings that were accepted for further research and study and/or adopted were:

- a reduction/stoppage of fishing during spawning season;
- new gear regulations to prevent harvesting of juvenile fish;

- a redistribution of fishing effort in 2J, 3K, 3L upon relative distributition of the exploitable biomass;
- DFO to develop means to estimate stock and stock trends beyond current RV and large trawler CPUE data;
- to attain a clearer understanding of rebuilding spawning stocks;
- to increase observer coverage in order to address bycatch concerns;
- research and incorporation into appropriate data predator-prey relationships;
- expanded data collection to include more input from and contact with fishermen;
- an increase in surveillance and enforcement with substantial penalties for violations to fisheries regulations;
- a re-examination of balancing biological, ecological and socio-economic goals with respect to fisheries;
- a more coordinated management approach to include more open communications among interest groups;
- new agreements and arrangements with universities and foreign colleagues, revised licensing practices to consider part-time fishing regulations
- expansion of the knowledge base for developing new stock assessment models, such as integrating other disciplines in stock assessment;
- implementation of a process whereby scientific advice is developed utilizing state of the stock analysis more efficiently
- that stock assessment be subject to rigorous peer review.

Most importantly, the Harris Panel emphasized that fisheries science and management should always proceed with caution (Harris Report, 1990, pp. 151-154). Following the release of the Harris Report, an Implementation Task Force on Northern Cod (also known as the Dunne Task Force) was given the mandate to carry out the necessary consultation with *"fishermen, fishermen's organizations, processors, municipal leaders and provincial government officials in order to work out an acceptable implementation plan"* (Emery, p. 19).

In May 1990, a five-year $584 million Atlantic Fisheries Adjustment Program (AFAP) was announced. It was designed to address the major challenges facing the Atlantic fishery such as rebuilding the fish stocks, adjusting to current realities and economic diversification (Hinds, 1995). At the same time, the Northern Cod program was announced: over five years $40 million would be spent on twenty-five projects designed to learn more about the basic biology and environment of Northern cod as a response to recommendations of the Harris Panel. "The necessity of such a crash program on cod biology underscores the decline in biological studies on cod and other ground fish that had occurred in recent years" (Steele *et al.*, 1992, p. 53). .

In February 1992, DFO introduced a conservation ceiling on Northern cod and reduced the original TAC by 35 per cent - this ended the winter offshore trawler fishery. Other restrictive measures were also included. On July 2, 1992, new fisheries minister John Crosbie announced a two-year moratorium on the Northern cod fishery. Today, almost eight years later, there is still a moratorium on the Northern cod fishery.

In spite of the urgent findings and detailed recommendations of the Harris report, DFO was slow to acknowledge a disaster in the making. This is an important point and

central to this paper. If the social and political will is lacking, no amount of scientific information or good advice can initiate change.

3.8 The Harris Report and Fisheries Policy

The changes in fisheries that occurred following the release of the Harris Report were basically management changes: the licensing process was modified; the capelin fishery is now subject to a TAC that is 10 per cent of the total biomass; there is increased surveillance, enforcement, and penalties for violators of fisheries regulations; there are new gear restrictions, among others. These are important changes yet the significance of the Harris Report lies in the fact that it was communicated so fully and credibly to the public. The highly regarded Dr. Harris accomplished what Derek Keats and D. Lee Alverson were denied in their respective reports in 1986 and 1987. According to Michael Harris:

> *"[with the Harris Report] attacking the messenger wasn't as easy as it had been when the Keats Report was dismissed as the work of a scientist still wet behind the ears. Harris was too highly respected and the evidence produced by his panel too overwhelming, to be talked away by even the most silver-tongued bureaucrat".* (Michael Harris, 1998, p. 121).

The findings of all three reports were "remarkably similar" (Finlayson, 1994, p. 80). Yet, Harris was heeded. DFO scientist Jake Rice in Finlayson (1994) says that Harris was listened to because "events had led the political system to need to discredit our advice rather than share some of the responsibility for any of their own poor use of our advice" (Finlayson, 1994, p. 31). This point underlines the separation of decision-makers from science once scientific authority is challenged. The wrath of the public can be unleashed on science as the decision-maker assumes the role of victim.

4. STRATEGIC FAILURES IN FISHERIES SCIENCE

The Harris Report confirms the problems with stock assessment that the inshore fishermen had raised in 1985 and were subsequently elaborated on in the Keats and Alverson reports. The Harris Report pinpoints four areas of failure in fisheries science and stock assessment for Northern cod. They are summarized here to underline the reason for such poor stock assessments. The failures are the $F_{0.1}$ strategy, data collection, stock assessment models, and understanding of the life history of the Northern cod. Together these failures permitted decision-makers to interpret stock assessment advice broadly and then base decisions on objectives that had little to do with science. Ecologist Robert Costanza writes that uncertainty in science and environmental issues can often be manipulated by political and economic interest groups.(Costanza,1993). Therefore a brief analysis of these failures is in order.

4.1 $F_{0.1}$

In 1976 ICNAF adopted an exploitation strategy of $F_{0.1}$ as the basis for recommending TACs to member governments. When NAFO took over from ICNAF in 1979 the use of $F_{0.1}$ continued. The management strategy of DFO from 1977 to 1992 was based on $F_{0.1}$ - a level of fishing mortality that would allow approximately 20 per cent of the harvestable biomass to be caught by commercial fishing every year. To maintain harvest rates at the 20 per cent target, the stock was regulated on the basis of catch quotas or total allowable catch (TAC). In contrast, changes in harvesting capacity were not monitored (Hutchings, 1999). History shows that this was an inappropriate level of harvest as is evident in the Harris Report.

The success of a catch-quota management system depends on the reliability of the estimate of stock size and on the accuracy of the reported statistics on catches, the cornerstone of the TAC strategy. Errors in these will become manifest as errors in the setting of TACs at $F_{0.1}$ levels. This leads to the next two strategic failures: data collection and stock assessment methods.

4.2 Data Collection

Between 1978 and 1988, catch rates from Canadian trawlers and the research surveys were used to describe trends in Northern cod abundance. Catch rate was assumed to be directly proportional to abundance i.e. a given increase in catch rate reflected a given increase in stock size, an assumption that now appears unjustified. The use of data on the commercial catch rate to describe trends in fish abundance contributed to the overestimation of stock size in the 1980s (Hutchings, 1999). "The size of their jobs and the relative scarcity of their fiscal resources have forced fisheries scientists to rely heavily on catch and effort data from harvesters in their stock assessments." (Sinclair, 1988, p. 88). In fact the largest single data source was the offshore fishery. This has led to a distortion of scientific data by misreporting and not reporting catches, high grading and illegal use of small mesh sizes and of nets.

Before his death in 1995, fisheries scientist Ray Beverton wrote (paper published in 1998) that management by quota allows build-up of fishing pressure held in check by mesh and gear regulations, which are difficult if not impossible to enforce. 'Technical measures' are then used by industry to escape effort control. Beverton gives five reasons why TAC quotas have been a total disaster. He says many fisheries catch mixed species; it is impossible to forecast incoming recruitment accurately; landing limits have been

widely disregarded; underreporting has degraded the database and confidence between fishermen and scientists has been destroyed (Beverton, 1998). Inshore data, even though it accounted for one-third to one-half of all Northern cod landings, was routinely ignored as a data source. The misreporting, common in the offshore database weakens and threatens the authority and credibility of science. Little wonder that industry has such poor regard for fisheries scientists. They knowingly supply scientists with skewed data and then feel justified in ignoring scientists' assessments. There is good reason then, in Dr. Harris's statement that the entire fish community, including harvesters, processors and corporations was disenchanted with the quality of DFO's scientific advice (M. Harris, 1998, p. 122). Also, it is important to understand why catch rates increase even with a declining resource. Trawlers have the ability to maintain high catch rates because the catchability of cod increases as abundance declines. Cod congregate to spawn, feed and migrate. Such a relationship is expected in fisheries where search is highly efficient, effort is concentrated in areas in which fish are most abundant and remain concentrated as abundance declines (Hilborn and Walters, 1992). Technology provides efficient catch and find operations. This contributed to the overestimation of the stock.

The high probability of overestimating stock size should have been clear, given that commercial fishing fleets do not sample the population at random and that increases in catch rate can be largely due to increases in harvesting efficiency. "The main consequence of this overestimation of stock size was that from 1978 to 1983, realized fishing mortality rates exceeded the targeted $F_{0.1}$ level by more than two-fold and between 1984 and 1989 by more than three-fold." (Hutchings et al., 1995). Continued reliance upon commercial catch rate data reflected management's prediction of rapid growth for

the stock during the late 1970s and early 1980s. The overly optimistic growth rate assumptions led to markedly increased industrial and government investment, including a financial restructuring of the offshore trawler industry. This activity fuelled a socioeconomic and political optimism in the fishery that possessed considerable momentum. It is interesting to watch how this momentum drove the decline of the stocks in spite of what the scientists discovered in the late 1980s (see **Overcapitalization**).

Research surveys are another primary means of estimating commercially fished stock. They have been conducted through the entire management unit of the Northern cod stock since 1981. Annually, these surveys have consisted of 300 to 500 thirty-minute tows by a stern-hauled bottom trawl at randomly selected locations within each of 75-80 sampling areas or strata. The data from these surveys provide the only available independent estimates of stock abundances and are typically reported as a mean biomass or number per tow (Hutchings, 1999).

Sidney Holt (1998) believes that there must be some realization that necessary estimates of stock abundance must come from direct research surveys and not from performance of commercial operations. Between 1978 and 1985 when the commercial catch data suggested the Northern cod stock had more than tripled in size, the survey data indicated a 50 per cent increase at best. It is interesting to note that an arbitrary decision was made to use the mid-point of the two catch rate trends in the stock assessment (Hutchings, 1999 and Finlayson, 1993).

In a 1992 address Dr. Leslie Harris says that we did not have the courage to rely upon the best scientific data - that derived from the scientific survey. It was not perfect but gave results that were reasonably good and scientifically accurate, within definable

limits. It also gave results that in early years (1985) showed that the strategic plan was not working *"...the desire to believe the model, to believe that the stock was growing at an appropriate level, outweighed the desire to accept the results of the survey"* (M. Harris, 1998). There was no room for low stock assessment results in the massive fishery investment scheme that was underway.

Before concluding this section on data collection, it is useful to consider the data Canadian federal fisheries received from ICNAF upon assuming management of the 200-mile limit in 1977. This was data on stock growth and abundance. Dr. L. Harris believes that this was "faulty" data or "inflated" data. ICNAF prepared the first management plan following Canada's 200-mile extension. This set the pattern for all subsequent management plans. The goal was to rebuild the spawning biomass at the new reference point $F_{0.1}$. This set the TAC for 1977 at 160,000 tonnes. Dr. Harris felt that it was in ICNAF's best interests to set it high considering the advantages this would mean for its member states. Under the terms of the Law of the Sea Convention, any stock surplus to a state's own need could be fished by foreign nations within the 200-mile limit. Therefore ICNAF was under no great constraint to be conservative in estimating the size of the biomass in terms of the figures it was giving to the Canadian Department of Fisheries and Environment (forerunner to DFO) in 1977 (L. Harris, 1992). This crucial data input for stock assessment had serious problems. It would appear that Canada started management of the 200-mile limit with inflated data and thereafter, received flawed data from its prime data source, the offshore fleet.

4.3 Mathematical Models for Stock Assessment

One of the primary means of estimating the size of a commercially fished stock is virtual population analysis (VPA) or cohort analysis.

> *"VPA involves tracking and estimating the annual mortality of each year-class of fish. Each age group is referred to as a 'year-class' of fish and is identified by the spawning season from which it arose. For example, the 1986-year class will be four years old in 1990. By counting the number of 1982 year-class fish caught in each successive year until no more of these fish are caught and adding to this the estimated number of 1982 fish that died of natural causes, one can, by 1995 or so, know approximately how many fish were in the 1982 year class"* (Finlayson, 1994, p. 33).

The accuracy of VPA estimates of stock size depend on the validity of two primary assumptions - that commercial catch data are reported without error (see **Data Collection**) and that natural mortality is constant from one year to the next and does not vary with age (Hutchings 1999, p. 263). It is assumed to occur at an annual rate of 20 per cent for all year-classes. Yet, both of these sources have no acceptable levels of reliability. Dr. Leslie Harris in a 1992 address says that scientists "applied in the assessment of stock size the crudest of mathematical models that were so flawed they could not possibly produce answers that were even close to being right." (For a detailed explanation of stock assessment methods see Hutchings *et al.*, 1995 and Finlayson, 1994.)

4.4 Lack of Knowledge of the Biology of the Species

According to McCorquodale (1994), *"the biologists forgot that marine science is a very non-quantifiable science and lulled by false data signals coming from rising catch levels they failed to recognize the high risk involved with state-of- the stock assessments based on relatively short and unreliable data series."* It would appear that over-reliance

on the mathematical modeling of fish population dynamics was not counter-balanced with an adequate understanding of the interrelatedness of environmental factors, the life history and behavioral aspects of the Northern cod or the characteristics of the inshore and offshore fishing operations (McCorquodale, 1994, pp. 88-89).

Resource management regulations rely upon sound knowledge of the life history of the species under study. This information includes age- and size-specific schedules of survival and fecundity, population structure, predator and prey relationships, environmental influences affecting feeding, spawning and migrating strategies. In practice and according to L. Harris (1990) and Hutchings *et al.* (1995), the effort allocated to the collection of such biological data was limited. For example, scientists did not know whether there was one stock of Northern cod or many sub-stocks that make up a stock complex; they knew little about migratory patterns, little about what determined growth rates, why cod in some geographical parts of the region grew at a faster rate than others, scientists knew little about spawning behavior, fecundity, egg and larval survival rates and natural mortality. The resources within DFO were to be used on stock assessment modeling. The scientists worked under tight deadlines - deadlines that required information for setting the annual TAC. "Biology became subservient to math in both staffing and philosophy" (Beverton, 1998, p. 233).

Together these four strategic failures in fisheries science and stock assessment allowed for broad interpretations of the reality of resource abundance. This weak fisheries science was easy to manipulate as decision-makers sought to enforce policies that met other objectives. According to Wooster (1988), weakness in science is manipulated when management is willing to accept unfavorable outcomes to obtain some

other objective, for example to keep a fishery open for social and economic reasons. Secondly, it occurs when management selects an inappropriate measure for bringing a desired effect or by failing to utilize or enforce a measure that would otherwise have worked, for example when quota regulations are not enforced actual fishing effort is unknown and differs from that intended.

Suppose that each year the advice received by the fisheries minister did precisely reflect the state of each stock, and its current distribution at sea. In such an ideal situation, TACs for some stocks would vary significantly between years, perhaps by as much as 25-50 per cent. How could a modern industry geared up to capture and process the maximum catches react to years of low TACs? How could a politician survive having to bankrupt part of the industry, when a stock became unavailable? (Longhurst, 1999). Thus, the uncertainty inherent in fisheries science was most useful to a profit-driven industry and ambitious politicians.

The following section considers how the structure of decision-making and the policies formulated imposed pressures on scientists and finally how the weaknesses in science were manipulated in order to legitimize government policy, specifically overcapitalization.

5. FISHERIES SCIENCE AND POLICY WITHIN DFO

5.1 The Structure of Decision-Making

The Canadian states' sponsorship of fisheries science dates from the creation by Act of Parliament in 1895 of the Fisheries Research Board (FRB) (chaired by the Minister of Marine and Fisheries but staffed on a voluntary basis by scientists from the

nation's universities) and the establishment of a summer research station in St. Andrew's, New Brunswick. It was incorporated in 1973 within the structure of the Ministry of Environment, Fisheries and Marine Services. In 1979 it was renamed the Department of Fisheries and Oceans. Its creation allowed for the full integration of fisheries science within a political body. The duties, power, functions of the Minister of Fisheries are extensive. The establishment of DFO placed the responsibility for managing Eastern Canada's groundfish fisheries with the federal government. Within fourteen years, the commercial exploitation of Northern cod that DFO undertook to manage ended, due to a nearly one hundred-fold reduction in spawner biomass of what was once the largest cod fishery in the world (Hutchings *et al.*, 1997). According to Hutchings *et al.*:

> *"It is the role of the Minister and not of public servants to make policy decisions affecting the fishery. This direct consequence of the Act that established DFO has led to the assumption that science can be used in policy assessment without the necessity of having scientific questions stated explicitly in terms of precise and particular policy alternatives"* (Hutchings *et al.*, 1997, p. 1199).

The present system of fisheries management is structured on the premise that science is capable of providing the system with precise and reliable stock assessment and can project the consequences of alternative management strategies. Finlayson questions *"is it reasonable and responsible to predicate policy development, management strategies and exploitation on the assumption that science is capable of providing precise and certain knowledge?"* (Finlayson, 1994, p. 131).

There was a closed-shop attitude at DFO, and within its fisheries science DFO's CAFSAC was not known for being open to comment from outside, nor for making its papers available to others. Yet it was the sole originator of stock assessment advice to the minister, with which he had annually to set TACs for each sector of each fishery. The

assessment documents received by the minister were "smoothed and polished" by a number of internal sub-committees and finally reviewed by a government- industry forum. Small wonder that they were criticized as lacking in error terms or alternatives, and as being crafted so as to be palatable to the minister and acceptable to industry. The cardinal rule in the public service is only one set of advice goes forward to the minister (M. Harris, 1998). Regional managers see themselves as having considerable discretion in what they "should send, must send and can send to Ottawa" (Apostle *et al.*, 1998, p. 51). One suspects that the levels of scientific uncertainty and the reasons for them were not properly explained (Longhurst, 1999, Finlayson, 1994, M. Harris, 1998).

In Lament for an Ocean, Michael Harris reports on former DFO fisheries scientist, Jeff Hutchings' disgust at how scientific results are filtered up to the minister. *"We have someone well up in the bureaucracy in a position to alter scientific statements. Bureaucrats and scientists in that department have an overriding responsibility to defend the minister's position"* (M. Harris, 1998, p. 294). Presumably, defending the minister's position means legitimizing policies that are not necessarily compatible with "pessimistic" stock assessment. Therefore, "good" fisheries science may not make any difference to protection of the resource. Hutchings *et al.* argue "bureaucratic intervention has deleteriously influenced the ability of scientists to contribute effectively to fisheries management." (Hutchings *et al.*, 1997, p. 1204).

Strong disagreement at CAFSAC meetings does not make it into the reports to the minister. Papers of scientists with different conclusions are filed away and stay within the department. The scientific advice is then matched with the management objectives of the department (M. Harris, 1998). It is easy to understand how this "filtering" of

important stock information can lead to conflicts. Finlayson (1994) says that the relationship between science and the state has always been coloured by a struggle over their respective rights and duties and, in particular, control of the direction of scientific activities. The struggle is part of the state's desire to assert full control and science's maneuvering to preserve some measure of independence (Apostle *et al.*, 1998). An examination of the process in action follows.

5.2 Scientific Advice vs. Political Will

Despite evidence in 1986-1988 that Northern cod stocks were in trouble, Canada continued to fish hard and downplay negative scientific advice. In fact, it took at least two years before the managers at DFO recommended lowering the TAC. Despite the DFO-commissioned Alverson Report's recommendation that the 1988 TAC be pegged at 1987 levels (as a minimum management response), DFO raised the 1988 quota of Northern cod by 10,000 tonnes to 266,000 tonnes. In December, 1988, DFO scientists informed the minister that the 1989 TAC for Northern cod should be no more than 125,000 tonnes - a stunning reversal of advice but a necessary one as CAFSAC had in a retrospective analysis determined that from as early as 1981, east coast fishermen had been fishing at over twice the $F_{0.1}$ level for Northern cod. With this determination acknowledged, the TAC would now have to be slashed in half. In spite of this, Minister Siddon went with a TAC of 235,000 tonnes. He said that he could not possibly cut so many jobs overnight. The 235,000 tonnes were allowed regardless of biological consequences. According to Cabot Martin, the fishable biomass at the time was only 600,000 tonnes - catching 235,000 of it was madness! (M. Harris, 1998). It would appear that scientific advice deemed incompatible with the social and economic

objectives of the federal government was ignored. Consider another example of this. When the new fisheries minister, Bernard Valcourt, set the TAC for 1990 at 190,000 tonnes and established a policy of 'enterprise allocations', the fishery office in Port aux Basques was trashed, the 'rioters' thereby gaining an extra quota of redfish. Further to this, the 1991 TAC was set at 190,000 (later 197,000 due to a lobby by John Crosbie - see **Employment, Subsidies and Overcapitalization**). Yet, "fishing flat out with the deadliest gear on the water" fishermen were only able to catch 127,000 tonnes. Nature was now setting the TAC. The senior science bureaucrats smoothed out dissenting opinions and told the minister what he wanted to hear. The minister in turn continued to use science to justify what he needed to do politically. Hutchings *et al.* believe that inclusions of fisheries science within a political body can permit analysis presented by that body to be portrayed as being based on science, thereby legitimizing government policy and department objectives (Hutchings *et al.*, 1997, p. 1203). The question now arises how could fisheries science at DFO allow itself to be used in this political game of fisheries?

There is good reason to believe that science had a large hand in the creation of the unrealistic expectations that it later warned against. In order to justify and maintain authority internationally with the EEZ extension to 200 miles, DFO created a smokescreen that enabled it to enjoy a fine reputation from 1977-1989 in the international science community. DFO had boasted that its management of the resource would produce so much fish that there would be too much for the inshore to catch all by itself (Finlayson, 1994). Certainly this was not a milieu within which scientists could afford to question themselves - a prestigious reputation was at stake and the minister was relying

on them for scientific input to policy decisions. *"Having made large investments in the production of knowledge and having originally certified it as valid, the institution will not lightly decertify its validity"* (Finlayson, 1994).

An important argument for the Canadian case in negotiating the extended jurisdiction to 200 miles in 1977, was that Canada had the expertise to manage this zone so as to rebuild the depleted stock. This self-imposed superior scientific reputation convinced DFO fisheries science that it was so. The 200 mile extended jurisdiction put huge demands on science as the fishing industry expected to increase its presence. Since management decisions are usually justified by stock assessments, the role of science and scientists is "supposedly" crucial. Yet, there are problems in balancing scientific advice against the short-run interests of industry and the broader objectives of government (Apostle *et al.*, 1998). It is useful to consider some of the pressure and demands on fisheries scientists within DFO between 1977 and 1992.

5.3 Pressures and Demands on Fisheries Scientists

The demands listed here impact on all fisheries scientists in their work, and specifically upon, DFO scientists.

- The complexity and relative inaccessibility of the marine environment undermines certainty in the work of the fisheries scientist (see also **Ludwig, Hilborn and Walters**).
- Scientists work in a social environment where judgments may not be immune to political pressure. Also fisheries scientists work from assumptions that reflect a certain view on nature, people and society (Apostle *et al.*, 1998, Maguire, 1995).

- The context in which they must produce useful information is a year round capital intensive industry with year round search and kill technology - technology that can take huge amounts of fish and find them in their "hiding" places (Ommer, 1995).

- Policy makers demand certainty in order to formulate regulations. When no certainty exists political and economic interest groups can manipulate issues. This makes it difficult for fisheries scientists to defend their analysis (Apostle *et al.*, 1998).

- The entire scientific assessment process occurs within a highly politicized bureaucracy. Steele *et al.* (1992) see the role of scientists as in the "black box" of government decision-making, where they are imbedded, dependent upon and subservient to the state. McCorquodale (1994) says this dependence of government scientists lies at the root of much of the blame for fishery collapse.

-The management system based on restricting effort and catch through TACs means there is an incredible pressure to misreport by harvesters. This leads to incomplete and inaccurate data from industry when reporting CUPE (see also **Strategic Failures**). This weakens and threatens the credibility and authority of science from the point of view of industry, who know what they are doing, and policy-makers who question the validity of the stock assessments (Apostle *et al.*, 1998).

- There is pressure to submit analysis and results in a very short time frame. Larry Coady, Acting Director of the DFO Science Branch, in

Finlayson, suggests that the political demand to produce projections originated in the fishing industry's need for strategic financial planning. Industry and managers demanded long-range projections that were impossible to give and threatened that if scientists could not produce such projections the work would be handed over to economists (Finlayson, 1994).

- Task forces established to investigate problems in fisheries often use scientific research investigations as a delaying tactic. Scientists can spend valuable time with such task forces carrying out research and reviewing data. Since the establishment of a Federal fisheries department in 1860, well over one hundred reports have been commissioned and received but not one has been fully implemented (Parsons *et al.*, 1993).

- Finally, it is important to look closely at the very structure and promotion system within DFO. *"The root cause of the problems seems to be that the criteria governing the reward and promotion of individual scientists is not strongly linked to their production of useful, robust knowledge in support of their institutional mandate"* (Finlayson, 1994, p. 93). Scientists are rewarded and promoted based on their record of publications in scientific and academic journals. From the scientists' point of view there are no incentives for directing one's research toward problems of interest to the client groups e.g. fishermen and industry and service to the institution. It would seem logical therefore that stock assessments would not be given the priority that research publication would.

There were good solid reasons for the "weak" fisheries science that the Harris Panel exposed, - reasons both within the natural environment and within the bureaucratic environment. The creation of an "aura" of the superiority in Canadian fisheries science made it difficult for DFO scientists to dispel the myth. Their bureaucratic inclusion made it impossible to communicate directly to the public what to expect from science. It was never made clear that the scientific work was not foolproof. Maybe the scientists came to believe that it was. John Crosbie refers to this as their "collective mindset" (M. Harris, 1998). Ironically, it was the politicians themselves that set the "superior science" up on the international stage in 1977. In any event, this was their one true fault - they "oversold" their science and it eventually buried them when the inshore fishermen started questioning stock assessment estimates in 1985. At what level the science was oversold is debatable - presumably it occurred at all levels within DFO. Science accommodated the bureaucracy's demands for certified, unequivocal knowledge. "It is reasonable to suppose that the state would not long continue to sanction and support the activities of DFO science were it not responsive to the needs of the patron" (Finlayson, 1994, p. 146). Is it possible that DFO's commissioning of the Harris Report may very well have been indicative of the discontinuation of support for DFO science? Finlayson writes that:

> *"a knowledgeable, necessarily anonymous source claims (with first hand authority) that two internationally prominent fisheries scientists refused invitations to serve on the [Harris Panel] when it was made clear to them that certain politically-directed conclusions would be required. These were said to be that the Science Branch in Newfoundland must be publicly humiliated and thrown to the political wolves... After the release of the Harris report, members of the Science Branch were subjected to a sustained and unmitigated storm of very public and highly publicized abusive criticism. Whether or not the Minister of Fisheries (Tom Siddon) had indeed directed Harris to throw the Science Branch to the wolves, the scientists certainly had good reason to believe it was so, especially as the Minister and other powerful members of the government of the*

> *day - specifically, John Crosbie - declined to come to their defence"* (Finlayson, 1994, pp. 64-65).

Further strength for the argument that decision-makers and politicians commissioned the Harris Panel to discredit science in order to advance their own agendas can be found in a newspaper editorial quoting John Crosbie in Finlayson (1994, p 65). He said that the findings of the Harris Report were grounds for disregarding scientific advice on Northern cod management in favour of socio-economic and political considerations. Examples of this disregarding of scientific advice are listed in **Scientific Advice vs. Political Will.** The socio-economic and political considerations this advice was disregarded in favour of are included in a later section.

An internal report commissioned by Acting Director of the DFO Science Branch Larry Coady in March 1993 showed that some scientists believed that bureaucrats were distorting scientific findings to suit a political agenda prior to the cod moratorium. The report concluded, "scientific information, specifically the role of the environment, was gruesomely mangled and corrupted to meet political ends" (M. Harris, 1998, p. 300). Mac Mercer, then Director of DFO's Newfoundland Region Science Branch says that "the origins of the crisis were to be found in the social, economic and political decisions embedded within the policy and practice of management. The crisis had nothing to do with science" (Finlayson, 1994, p. 134).

In a 1997 interview with Michael Harris, John Crosbie concedes there were problems with science fitting into the government structure. This was an interesting comment considering his belief that *"we had to slavishly follow the opinions of marine biologists and I was not going to [as minister]. Their advice was given as guidance but*

the cabinet had to live with the social and economic consequences of the resource situation" (M. Harris, 1998, p. 116).

D.L. Alverson, a member of the Harris Panel, says we must expect that all members of the industry (fishers, processors, banks and unions) will always seek to maximize the economic opportunities within constraints imposed by the law. If these group pressures over-influence those responsible for fisheries policy and fisheries regulations and their enforcement, the fault lies with the policy and decision-makers, enforcement officials and their political masters (Alverson, 1993, p. 89). This would explain why DFO was unable to concede that massive overfishing was the primary reason for the collapse of the Northern cod stock. This reason was accepted in scientific circles (Steele *et al.*, (1992), L. Harris, (1993), Hutchings *et al.*, (1995), (1997), (1999), Alverson, (1993), McCorquodale, (1994), Sinclair, (1997)). Yet the DFO sanctioned publication of the 1993 book *The Management of Marine Fisheries in Canada* by Dr. Scott Parsons, Assistant Deputy Minister of Science, says that the Northern cod stock collapse was caused by "natural factors". According to Michael Harris, scientists were not allowed to speak out about the causes of the cod moratorium. "DFO spin doctors were at work telling the public that cold water and seals, not overfishing, had caused the collapse" (M. Harris, 1998, p. 301).

This section has discussed the structure of decision-making in DFO, explained specific incidents of bureaucrats and politicians disregarding scientific advice and considered the pressures and demands on scientists that led to their "exposure" in the Harris report. What, one asks, were the decision-makers using science, weak or

otherwise, to promote and legitimize? To answer this question it is necessary to go back to 1982 and meet Michael Kirby.

5.4 Objectives that Guided Fisheries Policies

In 1982 Prime Minister Trudeau and Cabinet created the Task Force on Atlantic Fisheries to study the growing financial problems in the fishing industry and to determine permanent solutions. Senior federal bureaucrat Michael Kirby was chosen to head this Task Force. His report, commonly known as the "Kirby Report" (1983), laid down new objectives to guide fisheries policy. It is useful to first consider three fundamental assumptions on which these objectives were based.

1) Fish is comparable to any other national resource and should be exploited accordingly in the most rational and efficient manner.

2) Efficiency can best be achieved through a strategy of industrialization.

(These two assumptions legitimized the modernization of the fishery.)

3) State intervention is necessary to rationalize fishing effort, given the common property nature of the resource (House, 1986). This assumption would have been the basic premise behind the introduction of limited entry - for reasons of economic efficiency as well as conservation of the resources.

One cannot help wondering how fish could be compared to other national resources. Fishing is such a complex activity - biologically, socially, and economically and based on open access or common property rights, belonging to all. To bring stability to the fishing industry the Kirby Report proposed three objectives. The first objective was sustained economic viability of the fishing industry. This objective was viewed in terms of controlling harvesting capacity and cutting costs, thereby reducing dependency

on government subsidies. This, of course, never happened (see **Employment, Subsidies and Overcapitalization**).

The second objective is the maximization of employment at reasonable income levels. This emphasizes the need for the fishery to employ as many people as possible, given that it is located in an economically disadvantaged region of Canada and that in a large part of that region the fishing industry is the only source of employment (Kirby, 1983, p. 187). This is key considering the massive overexploitation and overcapitalization that continued through the 1980s (see **Overcapitalization**).

The third objective stated in the Kirby Report, is the Canadianization of the fishery within the Canadian zone. The idea behind this objective is national control over the fisheries resources within the 200 mile EEZ, which should be harvested and processed by firms located in Canada and owned by Canadians. There are inherent conflicts between the first two objectives. Strengthening the economic efficiency of the industry will not always be compatible with a goal of maximizing employment opportunities. Trade-offs will be shaped by power relationships and institutional structures and reflected in policies of management. These goals are "mutually incompatible" (Apostle *et al.*, 1998).

Policy-makers must balance conflicting objectives. Economic efficiency in the fisheries must be reconciled with concerns such as social justice, regional development, resource conservation and environmental protection. They must also balance what needs urgent attention in the short run such as community support in crises and what is required in the long run, such as, strategies to enhance the viability of the stock. These concerns are rarely compatible. Another complicating factor for policy-making is that fisheries

policy is no longer the exclusive domain of national governments. Fisheries can be squeezed between domestic demands and international obligations. It appears that the Kirby Task Force thought of everything but the fish (M. Harris, 1998).

With these objectives, bureaucrats set out to devise a federal fisheries policy that was skewed by incompatible visions of what the industry should be: a social fishery. *"DFO became a specialized social welfare department in which the biology of the fish and conservation of the stocks were afterthoughts"* (M. Harris, 1998, p. 71). The Dunne Report acknowledged that policy positions on Northern cod gradually eroded so that by the late 1980s the policy was unclear (Dunne, 1990). Policies of employment based on unemployment insurance premiums, massive subsidies and overcapitalization became "business as usual" throughout the 1980s and early 1990s.

5.5 Employment, Subsidies and Overcapitalization

This report will show that the federal government used the authority of fisheries science to make policy decisions based on objectives that had little to do with marine resource capacity. What were these policy decisions that were pursued regardless of the scientific advice but promoted as if sanctioned by science? The fishery was used to absorb excess labour in rural Newfoundland. The federal government supported short-term fisheries employment augmented with unemployment insurance. The federal and provincial government subsidized the fishing industry to such an extent that it became massively overcapitalized. Additionally, the federal government used the marine resources in international trade arrangements and then jeopardized them by its inability to prevent foreign over-fishing. Scientists were expected to produce data that would support all of these policy initiatives.

According to Schrank (1995), the federal government permitted the industry to grow completely out of control until it was too late. Canada is still paying the price because of the resultant overfishing. Governments had always treated the fishery as the employer of last resort in Atlantic Canada. A confidential 1970 memorandum to the federal cabinet that sought to outline a plan for the economic rationalization of Canada's fisheries stated that the main objective of government policy has been to maximize employment in Canada's commercial fisheries. Both John Crosbie and Clyde Wells agreed on the usefulness of the Unemployment Insurance (UI) program (now called Employment Insurance) in keeping fishermen in the fishery. Wells said, *"To some degree both governments encouraged the use of the fisheries to create qualification for unemployment insurance."* (M. Harris, 1998, p. 67). It was the easiest way to cope with the political problems of unemployment. As confirmed by Crosbie "rural Newfoundland is completely dominated by the unemployment insurance system." (M. Harris, 1998, p. 176).

The incentive behind unemployment insurance, is that fishermen and plant workers were able to collect federal UI from November to May if they worked ten weeks in the inshore fishery. [By 1964, just seven years after UI was introduced and with no increase in the general population, there was a 33 per cent increase in the number of inshore fishermen - although the inshore catch of Northern cod fell by 50 per cent! (M. Harris, 1998, p. 67)]. In 1990, 66 per cent of all fish plant workers who qualified for UI did so on the basis of between ten and nineteen weeks of employment (Carter, 1993 p.162).

A shortage of fish between 1969 and 1975 led to a decrease in the number of fishermen in Newfoundland by one quarter to approximately 14,000. However, by 1980 the number was up to 33, 640 (Schrank, 1995 p. 291). In fact, overall the fishery accounted for 56 per cent of all employment growth in Newfoundland between 1977 and 1986. For every 100 persons employed in the fishery in 1977, there were about 200 persons employed in 1986 (McCorquodale, 1994, p.97). Income from UI for fishermen increased substantially over the years. In 1972-73, fishermen received 20.4 million dollars in UI payments, and by 1988-89, the figure was over 270 million dollars. To put this in another perspective, in 1981 self-employed fishermen received 96 cents in UI for every dollar earned. In 1990, they received $1.06 for every dollar earned (Schrank, 1995). How did this happen?

Between 1970 and 1981, the federal government subsidized the construction of replacement fishing vessels to the tune of 35 per cent of cost. This policy encouraged an aggressive expansion of the inshore sector. The provincial Department of Fisheries in Newfoundland offered a 30 per cent fishing gear subsidy to help small-boat fishermen acquire the latest technology. Coupled with the full tax exemptions for fuel and equipment used at sea, it was a powerful incentive for more Newfoundlanders to join the fish force. (DFO, 1993).

The number of fish plants in the Newfoundland fishery increased from 89 in 1975 to 138 in 1980 to 173 in 1992 (McCorquodale, 1994, p. 96). Regardless of how inefficient an operation might be, it was always a major political issue to close a plant in places where there was no alternative employment. Weak businesses were routinely saved from what would be a normal bankruptcy in any other industry. Subsidies were

paid to new plants and paid again whenever overexpansion threatened to close them. Yet in 1990 the average utilization rate of plants in Newfoundland was 22 per cent (M. Harris, 1998, p. 174). Consider this. The federal government used the public purse to provide subsidies to plants and fishermen and then accessed the public's marine resource of Northern cod to utilize these subsidies! Recall that Bernard Valcourt set the 1990 TAC at 190,000 tonnes. However, with intense lobbying from MP John Crosbie (Newfoundland's only representative in the federal cabinet and Minister of Trade and Industry) the quota was increased to 197,000 tonnes. The additional 7,000 tonnes was given in order to save two of Fishery Products International's (FPI's) offshore plants. In spite of this increased quota, the plants were closed anyway (M. Harris, 1998, p 118).

In the decade between 1981 and 1992, federal and provincial money to fishermen almost doubled from $211,300,000 to $408,700,000. During the same period the Northern cod resource was driven to collapse (McCorquodale, 1994). Subsidies send the wrong economic signal to fishermen in depleted fisheries because they create incentives for high levels of fishing. Subsidizing increases in fishing capacity has led to political pressures for higher quotas, well beyond the natural capacity of the resource (McGinn, 1998) (see also **The Views of Ludwig, Hilborn and Walters**). Shrank (1995) contends that there is a pattern of a grand start followed by rather meager results that characterizes nearly all efforts to reform Canada's fisheries policies (Schrank, 1995). A 1993 study commissioned by DFO found the degree of overcapacity in inshore and near-shore sectors ranged from 38 per cent to 56 per cent (DFO, 1993). There are many problems associated with overcapitalization that undermine the good intentions of a quota management system. *"It fosters underreporting, and illegal fishing, undermines gear*

regulations, stimulates buyer/seller arrangements to avoid regulations and encourages unsafe fishing practices. Better science cannot address many of the problems confronting an open access fishery" (Alverson, 1993, p. 85).

In the face of government employment/unemployment schemes, the call for better fisheries science is rather hollow. Overcapitalization makes the fishery artificially profitable. Because of this people remain in the industry and continue to over-invest to get a greater share of a dwindling resource. It is hard to identify any other business where capacity increases as productivity decreases! Yet, this has been a trend in most world fisheries. Overcapitalization creates a gap between promise and performance. Uncertainty, political pressures and social concerns make it difficult to accept measures that would adjust harvesting capacity to stock size or to a conservative level. There is a mismatch between harvesting capacity and stock size (Apostle *et al.*, 1998).

5.6 International Relations and Foreign Overfishing

The third and final policy issue to be considered here is Canada's use of the fisheries resource in international trade arrangements and its inability to control foreign overfishing. Better fisheries science would not have had any more influence on these trade arrangements than the existing weak fisheries science. In terms of Canada's trade and international concerns, for far too long the Atlantic fishery mattered very little in the federal scheme of things and could too easily become a pawn in a large game (McCorquodale, 1994). Certainly, scientific advice was not a consideration when the Canadian government generously gave the USSR a 266,320 tonne quota of offshore spawning capelin in 1978. Capelin are the key baitfish in the marine ecosystem and a major food source for Northern cod. Cod follow capelin inshore annually. This quota

was given after the USSR had severely restricted the capelin catch in Soviet waters because their stock had collapsed due to overfishing. (M. Harris, 1998).

Because the terms of the 200-mile EEZ extended jurisdiction allowed that any fish surplus to Canada's needs be offered to other countries, there was great pressure on Canada to provide this "surplus". Any surplus that Canada could offer to foreign countries provided a barganing chip in international trade relations. This put pressure on fisheries scientists encouraged to determine "optimistic" stock assessments even when they knew it could be detrimental for the health of the stock. Yet, it was determined that allowing such surpluses for Spain and Portugal was simply inviting disaster. Despite being members of and subject to the quotas laid down by the Northwest Atlantic Fisheries Organization (NAFO), the European Community (EC) permitted its national fleets to fish in international waters at levels far higher than NAFO quotas. Because cod migrate across international zones (outside the 200 mile limit on the "Nose" and "Tail" of the Grand Banks), these "higher" EC quotas are problematic. The EC totally ignored the 1990 NAFO quota of 15,377 tonnes on the Nose and Tail of the Grand Bank, setting its own quota of 60,000 tonnes. Yet, Spain and Portugal took 62,000 and 32,000 respectively. Michael Harris (1998:) questions how could Canada impose sanctions against the EC with its huge population of 325 million people - they purchased 20 per cent of Newfoundland's and 8 per cent of Canada's exports. Canada's position of using diplomatic channels to stop the foreign overfishing was a dismal failure. Surprisingly, Ottawa concluded in 1990 that the best chance of persuading the EC to stop overfishing was to offer underutilized species inside the Canadian zone.

Dr. Leslie Harris believes that the beginning of the collapse of the stock goes back to foreign fishing of the late 1960s.

> *"I think that the first great assault on the Northern cod, the one from which the stock has never really recovered, was almost totally a foreign assault. This was back in 1960, 1969 and 1970 when the Germans first appeared, then subsequently other East Europeans. They had developed the technology to allow them to fish in deep water and ice infested waters. This was the first assault on a pristine cod population, the Hamilton Bank stock. This was the first time it was fished during spawning"* (M. Harris, 1998, p. 6).

Foreign fishing with its generously "self-regulated" quotas imposed extraordinary pressure on the cod stocks. Ottawa's chosen measures of diplomacy did little in the face of the intent of the Spanish and Portuguese fleets to fish as they chose. Fisheries mattered relatively little on Canada's international agenda. However, with no regulations for these foreign fleets our valuable resource was stolen. It is difficult to imagine that good scientific advice would have made any difference to foreign overfishing through the 1980s.

To summarize, Canada's policy of using the fishery as a make-work project, subsidized by UI, inappropriate quotas, and massive subsidies led to an overcapacity of unrealistic proportions. Matching a limited resource to an unlimited desire was a sorry game. Not only was this industry out of control in Canadian waters; the unregulated situation in international waters inflicted the fatal wound. The role of the fisheries scientist in this massive overexploitation was a minor one. "Fisheries science is a façade that provides government with the authority of science for decisions made primarily on other grounds." (Finlayson, 1994, p. 3). The evidence presented here can confirm this. Further to this, the simplistic but commonly held presupposition that more ecological science leads to better fisheries management is erroneous. There are many obstacles in

the application of science to public policy (Scandol, 1998, p. 369). Such obstacles are logistical, economic, social and political in nature. Scandol's contention that more science does not lead to better fisheries management is true in the case of the Northern cod collapse. Dr. Harris's call for better science has merit and is well intended but not the answer. The question arises can this contention of Scandol's be applied as a rule in marine exploitation?

The final section of this paper considers this important question. The controversial 1993 paper by eminent fisheries scientists Donald Ludwig, Ray Hilborn and Carl Walters, "Uncertainty, Resource Exploitation and Conservation: Lessons from History", provides some useful insights.

ANALYSIS OF VIEWS OF LUDWIG, HILBORN AND WALTERS

6.1 The Views of Ludwig, Hilborn and Walters

Ludwig *et al.* (1993) challenge the idea that good science will prevent stock collapse. Fisheries policy founded upon scientific information reflects ignorance of the history of resource exploitation. The authors tell us that we should not be deluded into thinking that prevention of stock collapse is entirely or even primarily a scientific issue. Ludwig *et al.* list a number of consistent features of resource exploitation that inevitably lead to stock collapse.

First, wealth generates power, socially and politically and this promotes unlimited exploitation of resources - the more immediate the prospects for gain, the greater the political power that is used to facilitate unlimited exploitation.

Second, the lack of controls and replicates that are possible on large-scale ecosystem experiments hampers scientific understanding and consensus regarding past

events and predictions involving future events. This allows ample scope for differing interpretations. Some of the time-scales of marine ecosystem cycles are a decade or more. Therefore observational studies are unlikely to provide timely indications of required actions or the consequences of failing to take remedial measures.

Third, Ludwig *et al.* (1993) contend that the complexity of the underlying biological and physical systems means that optimum levels of exploitation must be determined by trial and error. The concept of maximum sustainable yield (MSY) has guided fisheries management for some time. It was conceived to maximize yield. However, fisheries scientists have been unable to control the technique, the distribution and amount of fishing effort and the data collected provided little information about the biological characteristics of the exploited fish stocks. As well, it is now determined that there is rarely steady abundance, but fluctuations levels and in concentration in fish stocks. This fact, together with societal priorities determined by political power led to what Ludwig *et al.* (1993) call the ratchet effect. This takes the form of an expansion of fishing when natural fluctuations lead to larger than average populations; then there are subsidies to preserve the higher levels of activity rather than cutback, to a lower level of activity, when natural fluctuations lead to smaller than average populations.

> *"Such levels are often excessive. Then a sequence of good years encourages additional investment in vessels or processing capacity. When conditions return to normal or below normal, the industry appeals to the government for help; often, substantial investments and many jobs are at stake. The governmental response typically is direct or indirect subsidies. These may be thought of initially as temporary, but their effect is to encourage over-harvesting. The ratchet effect is caused by the lack of inhibition on investments during good periods, but strong pressure not to disinvest during poor periods"* (Ludwig *et al.*, 1993, p. 17).

Finally, Ludwig *et al.* (1993) contend that high levels of natural variability mask effects of overexploitation. This is often not detectable until it is irreversible. Because of these influences and limits to fisheries science, Ludwig *et al.* (1993) feel that there will never be consensus among scientists and there will always be much uncertainty. Two examples are given to support this contention. One is the collapse of the California Sardine fishery. Government scientists recommended an annual quota for this fishery in order to prevent the species from being overfished. Yet, the fishing industry, in their opposition to quotas found scientists that supported their side and said that it was impossible to overfish a pelagic stock. The second case cited in support of their view was the collapse of the anchovy fishery off Peru. This was the most spectacular collapse in the history of fisheries exploitation - the yield decreased from a high of 10 million metric tonnes to near zero in a few years. This collapse has been extensively studied and there is still no agreement on what caused the collapse (Ludwig *et al.*, 1993, p. 36).

Lugwig *et al.* explain that there will always be major uncertainties in how ecological systems will respond to management actions and that society must make important decisions in the face of such uncertainty. "Society should not look to ecological research as the primary tool to tell them what to do" (Ludwig *et al.* 1993, p. 36). The authors concede that scientific certainty and consensus alone will not prevent overexploitation and destruction of resources. However, the limitations of science mean that we should take a much more cautious approach to resource management.

Ludwig *et al.* (1993) suggest five principles that resource managers should follow: consider human motivation and responses in planning. Human greed and shortsightedness may manifest themselves as biological problems of the stock under

exploitation; act in a timely manner - do not wait for consensus; consider the shortcomings of science, such as the influences that bear on scientific interpretations and accommodations of uncertainty as well as the need for interaction among disciplines such as economics, sociology and oceanography; distrust claims of sustainability as history tells us so. More basic research in the eco-system may serve only to make us more complacent and keep us from addressing real issues such as overpopulation and excessive use of resources; deal with uncertainty. Effective policies are still possible under conditions of uncertainty as long as such conditions are considered. Action should be robust to uncertainty, flexible and informed, considering many strategies (Ludwig *et al.*, 1993, p. 36).

Ludwig *et al.* (1993) conclude by saying that scientists have perpetuated the illusion of sustainability through scientific and technological progress as governments continue to base their policies upon misguided views of the dynamics of resource exploitation. They remind us that resource problems are not really environmental problems - they are human problems that we have created.

Ludwig *et al.* are telling us that natural restraints inherent in the marine ecosystem do not auger well for strong fisheries science, that natural variability of levels of fish stocks leads to the ratchet effect, and that the prospects for gain and wealth in resource exploitation drive the political will to overexploit. The temptation to increase the yield at the expense of risk to the resource is irresistible. Economic pressures require maximum yield - a reflection of human desires.

> *"Resource management is a discipline whose history is replete with spectacular failures, but whose practitioners seldom change their policies in response to past experience. This is an institutional pattern of stereotypic response to repeated*

> *failure...This is the inevitable consequence of a contradiction between human desires and human capabilities, a magic theory that purports to satisfy unlimited consumption with limited resources...the miracle of the loaves and the fishes has become an objective of policy.* (D. Ludwig, 1993, p. 555).

Therefore scientific knowledge will not necessarily imply that fisheries management decisions will be taken that support such information. Putting our hope in good science, as Harris considers a goal, is merely a trap in providing false hope for the prevention of stock collapse and for a sustainable pattern of exploitation. The issue of stock collapse has less to do with scientific and environmental problems and more to do with human problems. It is about the exercise of political power where short-term priorities override long-term societal priorities.

6.2 Support for Ludwig, Hilborn and Walters

Ludwig *et al.* (1993) argue that the pattern that leads to stock collapse is the pattern that occurred in the overexploitation of the Northern cod stock. What other evidence exists to support their ideas? There are several examples to consider. The fact that over 90 per cent of the world's fish stocks have been overexploited underscores Ludwig *et al* (1993). Alverson (1995) says that the effects of fishing are consistently underestimated and poorly understood by managers. Considering that industrial fisheries globally now rely on 50 billion dollars (US) of subsidy per year, underlines the problems of the ratchet effect and overcapitalization (Pauly, 1999). Anthony Charles (1994) tells us that the fishery is used to absorb excess labour in order to sustain broader societal goals. This is evident in the Newfoundland fishery when the number of fishermen increased as the resource declined. The fishery was used to address the unemployment problems in rural areas. Charles says that this reduces sustainability of the fishery resource and the fishery

system as a whole. Another confirmation of Ludwig *et al.* (1993) assertions comes from Tony Pitcher. He says that: "stock assessment has been stuck for thirty years in a safe yield per recruit universe bounded by the comforting notion that fishers will stop fishing as economic returns diminish. We now know that this is not so as fishers improve gear, go further afield and switch to species further down the food web" (Pitcher, 1998, p. 369). In fact, this is now happening in Newfoundland (see **Conclusions**).

Economic ecologist Robert Costanza (1993) says that science is used by those in power to fulfill conflicting desires. Because of uncertainty in science, political and economic interest groups can often manipulate environmental issues. He is supported in this by Marc Mangel (1993) who says that the scientific community can be forced into negotiated agreement when it fails to differentiate between science and policy, when it fails to separate fact and value judgment. This is evident in the review of the Harris Report. "Social constraints on greed fail in natural resource exploitation" (Lee, 1993) and "social dynamics generally lead to overexploitation" (Ehrlich, 1993, p. 558). Cabot Martin reminds us that political choices are often framed as biological ones (Martin, 1992, p. 155). Thus "blame the scientists". William Schrank confirms the ratchet effect in action. He says that

> "*resource-based fluctuations of high magnitude (changes in catch of up to 90 per cent in a year) cause a steep and unusually unforeseen fall or rise in earnings and profits. Industry reaction to this form of uncertainty frequently has been to install sufficient catching and processing capacity to handle the peaks in supply, thereby inflating industrial overheads and reinforcing the inherent tendency towards over-expansion in the commercial fisheries*". (Schrank, 1994, p. 288).

McGinn (1998) confirms this as well. She says that in response to declining yields most fishers over-invest. Finally there are some important figures to consider: 11 of the

world's 15 most important fishing areas and 60 per cent of the major fish species are in decline due to excessive exploitation and other abuses. Whereas no fish stocks were in urgent need of management in 1950, today a majority of the world's fisheries qualify for that dubious distinction and require immediate action to reduce capacity and rehabilitate damaged resources (McGinn, 1998, p. 12). However technology may not allow for such rehabilitation. The increase in fleet size and the development of larger and safer vessels has resulted in significant excess fishing capacity, which can be rapidly transferred from one overfished stock or area to the next. As a consequence, the full exploitation and depletion of the remaining world resources, which in the 1950s would have taken 10 years or more to reach, can now be reached instantly (Garcia, 1994, p. 25).

So yes to Ludwig *et al.* (1993), there is a pattern of resource exploitation that inevitably leads to overexploitation, and the issues are not primarily scientific. Resource protection is not about science. It is an obligation of human responsibility, individual responsibility and collective responsibility. Good evidence exists that overfishing is pervasive on a global scale. Responsibility for natural resources management is vested in national and international governments. Those groups must bear the responsibility for the historical course of natural resource management. Industry maximizes its economic opportunities within a competitive environment, social attitudes and legal regimes. If industrial pressures over-influence those responsible for policy and regulations and their enforcement, the fault lies with policy and decision-makers, enforcement officials and their political masters (Alverson, 1995, p. 6).

An underlying assumption of fisheries management is that the control of nature is within the range of human capacity and that negative social impacts of policies can be

remedied through compensation schemes. Politics should be ruled out of the fishery. Politics have come to corrupt the management process and social concerns have loomed larger than bioeconomic imperatives (Scandol, 1998, p. 341).

CONCLUSIONS

The purpose of this report was to analyze the role that weak fisheries science played in the Northern cod collapse in Newfoundland and if better fisheries science would have prevented this collapse. It established the weakness in fisheries science through a review of the Harris Report, analyzed the strategic failures in science that allowed decision-makers to impose policies that had social and economic objectives and specifically, how these policies were actually imposed. It considered the pressures and demands on scientists and the objectives of federal policy that led to overexploitation. This report contends that it was the very weakness in science that facilitated such policy enforcement. Finally, this report considered the role of fisheries science in marine exploitation in general. It considered the viewpoints of three fisheries scientists who feel that there is a pattern of exploitation that inevitably leads to stock collapse and this pattern of exploitation is for reasons beyond fisheries science. There is much support for this view and the confirmation of its reality is in the huge subsidies for world fisheries and the fact that almost all major fisheries are overexploited. What can society do to change this pattern of exploitation? Before answering this question it is useful to revisit the Newfoundland fisheries in 1999. The Newfoundland fishery (as of December 1999) is worth nearly one billion dollars - the highest figure ever, by far. With groundfish depleted, the harvesters have found a new species - shellfish, and they are plentiful - for now. It appears that fishermen are following a familiar pattern of exploitation. Quotas have increased, capacity has increased, and effort has increased. According to Michael Harris,

> *"Ottawa has sanctioned a dramatic increase in harvesting capacity, set quotas in one place at 10 times the levels of just 6 years ago and unleashed the inshore and offshore sectors on this new dollar bonanza without even bothering to do a stock status report of Northern shrimp and snow crab in Newfoundland waters for the 1998 and 1999 fishing seasons. It is small wonder that the Auditor General concluded in his damning overview of the department [DFO] that quotas are heavily influenced by social and economic factors, rather than by ... conservation"* (M. Harris, 1999, p. 9).

It is important to understand this new fishery within the context of the marine environment. Daniel Pauly says that because larger species feed on species lower down on the food chain, overfishing top predators such as cod or tuna or shark triggers a slow-acting domino effect.

> *"At higher levels of the food chain, fish are bigger, but there are fewer of them than at lower levels, where species are smaller and more plentiful. Initially, the transition from high-level species to ones lower on the food chain brings new bounty. But unless the volume of fishing is reduced, the cycle of overfishing soon repeats itself with new prey: excessive fishing can trigger abrupt declines in these lower-level species, leaving fishers only steps away from the base of the food chain".* (Pauly, 1998, p. 861).

In a recent newspaper article, Dr. Leslie Harris was quoted as being concerned about the pressure now on shellfish stocks with huge quotas and observations by fishermen of small size shrimp - this is generally an early sign of overexploitation! Dr. Harris further expresses concerns about cutbacks to fisheries science this decade. "I think we ought to be doing a great deal more science and finding a much more substantial knowledge base for the decisions we are taking." (The Telegram, 1999, p.3) Yes, this is true but two points to be considered are: it is unlikely that governments will spend more money on fisheries science. Alverson (1993) says that there is an erosion of the quality of scientific endeavor in much of the developed world as governments see the cost of fisheries management as possibly exceeding the economic benefits of the fishery. The second

point is that perhaps Dr. Harris should redirect his focus to the bureaucratic institutions that manage fisheries science. Crutchfield in Steele *et al* .(1992) says that:

> *"given all the time and all the splendid research that has gone into expanding our knowledge of the sea, its living resources and the technical problems of harvesting them, the results are remarkably disappointing. The number of programs that have actually succeeded in checking depletion of ocean fish stocks can be counted on the fingers of one hand. And those that have protected stocks while providing some real improvement in earning stability of employment, and ability to withstand the usual economic jolts to which fisheries are subject, can be counted by someone with no hands at all".* (Crutchfield in Steele *et al.*, 1992, p. 62).

This statement was made in a 1980 address. Almost twenty years later, it sadly, still applies. It reflects what Ludwig *et al.* (1993) say: that issues of resource protection are not entirely or even primarily scientific.

This report has shown that science is one of many inputs considered in decision-making. This lucrative crab and shrimp fishery is very good for politicians. There is doubt that the best scientific information will adjust those huge quotas downward. "A better scientific understanding of the marine environment will be to no avail without the political will to implement the changes dictated by that understanding." (Meyer et al., 1993, p. 570). It is important that fisheries science recognize that continued calls for more research can be used as a delaying tactic by proponents of the status quo. This "new" fishery is following a familiar pattern (see **Ludwig, Hilborn and Walters**).

To return to the question, what can society do to prevent resource overexploitation? Daniel Pauly (1999) says that the public at large who ultimately owns the resource and whose taxes have so far been used to subsidize the carnage must become involved. Robert Costanza advises that there must be explicit stabilization at levels of resource exploitation that are limited by explicit choice rather than by technological

opportunity and greed. "Most social systems find both explicit choice and long run stability difficult as it requires institutional changes." Those who see benefits in the existing definitions will resist these (Costanza, 1993, p. 580).

Most of the failures in resource management can be traced to people thinking and acting as if overexploitation was someone else's problem or that costs could be borne by others - often future generations of people or less affluent sectors of society. Protecting our fish stocks is about human values and institutions and not just ecological functions. Dr. Leslie Harris says: "Of all the creatures that make up the living part of the ecosystem, man stands alone as the one that does not respond to the imperative of seeking equilibrium." (L. Harris, 1993, p. 8). Therefore, do not look to science, look to society, to our politicians and institutions and look to each other. We must create the scenarios that implore us to be ever vigilant. We must not be trapped into thinking that science will save us from our familiar pattern of overexploitation of marine resources. The kinds of information that science is ordinarily able to provide are fundamentally at odds with the types of decisions that are made. It is time to identify the obstacles to the use of scientific information in public policy development and create a means to remove them. Otherwise, government will continue to develop and impose policies that have little to do with marine resource capacity or with science.

The overwhelming findings of the Harris Report did not make a difference. We did not improve our fisheries science, in fact we imposed huge cuts to the fisheries science departments at DFO and did not change our pattern of exploitation - we just found another species further down the food chain. Until society takes collective ownership and stewardship of its resource and refuses to let it be squandered by the

subsidized few, the role of fisheries science may be relegated to simply predicting the next stock collapse. Thus, it will be the marine resource dictating the policy objectives, as did the cod when they disappeared from the nets off Newfoundland.

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