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THE ECONOMICS OF THE CRAB FISHERY, NEWFOUNDLAND REGION, 1979-1985

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THE ECONOMICS OF THE CRAB FISHERY

NEWFOUNDLAND REGION, 1979-85

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ACKNOWLEDGEMENTS

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1. INTRODUCTION

Since the Newfoundland crab fishery began in the late 1960's, the Economics Branch of the Department of Fisheries and Oceans (DFO) has undertaken a number of economic assessments of the industry. Many of these analyses have been conducted internally within DFO in support of the ongoing management of the fishery. Two recent studies that have been widely circulated outside DFO include "An Economic Assessment of the Newfoundland Crab Fishery - 1979 -" and "The Economic Overview of the Newfoundland Crab Fishery" that was presented at the Crab Seminar in 1984.

This paper thereby is one of a series of economic assessments that are intended as a guide to management and industry as well as a more general audience. This particular economic assessment comes during a period of transition in the industry given the lower recent catches in NAFO Division 3L, the development of supplementary crab fisheries in 3K and 3Ps and the exploratory fishery in 2J.

Section 2 outlines the performance of the crab harvesting sector with an emphasis on the period 1979-85.

Section 3 utilizes a break-even model to analyse how fishing days, daily catch rates, landed crab prices and vessel costs determine the resource required to break even for a typical crab vessel. The results for a typical vessel are extended to an analysis of the resource requirements of the crab fleet in each NAFO Division.

Section 4 overviews the performance of the crab processing sector over the period 1979-85.

Section 5 outlines those aspects of the crab product markets that have relevance for the local crab industry.

The conclusions of the report are contained in Section 6 and three appendices provide a more detailed treatment of certain portions of the paper.

2. DESCRIPTION OF THE CRAB HARVESTING SECTOR

2.1 Resource Base Considerations:

A knowledge of the resource base should underlie an economic analysis of a fishery. There are four resource issues which are directly pertinent to an economic analysis of the crab fishery.

a. Exploitation Rates - Atlantic Canadian snow crab stocks have traditionally been managed at a target exploitation rate of 50-60 percent of the commercial biomass. The rationale for this policy is that the reproductive capacity of the stock would be protected by the minimum carapace size of 9.5 cm., although male crab off Newfoundland mature at approximately 6.0 cm. (females never attain legal size). The fishery is directed exclusively at larger males and the target exploitation rate is intended to stabilize landings and reduce the problem of harvesting soft-shell crab (the incidence of which is positively related to the exploitation rate).

There now appears to be considerable variability in the dynamics of different crab stocks and their capacity to maintain high levels of abundance under heavy exploitation of the commercial biomass. In many of the traditionally fished areas of the Newfoundland crab fishery, the yearly growth and recruitment has not been adequate to maintain catch rates at their traditional rates of exploitation. In areas of current low productivity, there have been high catch rates and landings in the early years of the fishery and, as the virgin biomass was fished out, both landings and catch rates sharply declined. The annual rate of exploitation must thereby be determined by the productivity of the local crab stock if stock levels are to be maintained. In many traditionally fished areas, the existing effort levels should be substantially reduced to stabilize landings at a lower level.

b. Soft Shell - Crustaceans grow by moulting or casting off their shell and replacing it with a larger shell which has formed under the old one. The new shell is initially soft and its larger internal space is filled with water. Soft-shell crab produce a lower product yield and suffer increased mortality during handling and transport. The abundance of soft shell is directly related to the intensity of fishing pressure and the reliance on new recruits. Moulting generally occurs during July and August, although the phenomenon is protracted in areas where excessive exploitation rates exist. The soft-shell problem is common in many areas of the Province, particularly Bonavista Bay, where 50% of the legal sized animals may be soft shelled in July and August. The crab fishery in any portion of the Newfoundland Region has never been closed because of an excessive incidence of soft-shell despite the high mortality among soft-shell crab that have been caught in the commercial fishery. The closure of a fishery for the 2-3 months required for soft-shell crab to 'harden up' would not significantly reduce the overall crab catch but it would affect when and by whom the crab was caught.

c. Lack of a Predictive Model - The biological assessment of the crab resource is hampered by the lack of an acceptable predictive model for resource assessment. Without a predictive model, fisheries managers are unable to assign reliable catch quotas and fishermen have less information on resource availability before the season begins. The lack of a predictive model and a biologically based Total Allowable Catch (TAC) has resulted in the total catch and effort in the crab fishery being managed using indirect measures such as limitations on vessel entry, shortened seasons, and trap limits. If a TAC is introduced in the crab fishery, it will not be based on a predictive biological model of the resource but rather in management's desire to reduce catch and effort so as to stabilize long term landings.

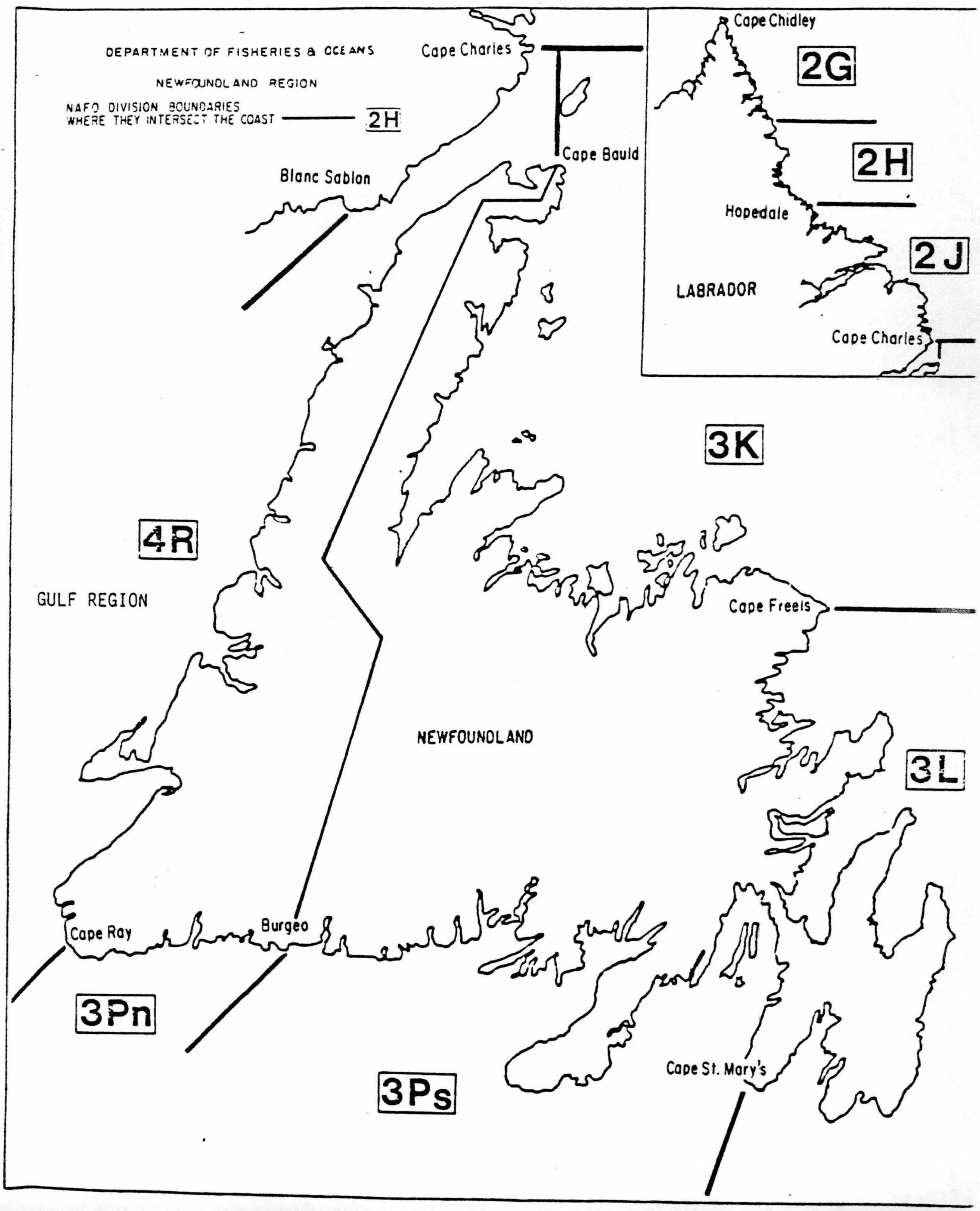
d. Uncertainty - The uncertainty and variability associated with landings and catch rates are factors endemic to a crab fishery that is catching a high percentage of the commercial biomass in each year. This uncertainty derives from the fact that if the exploitation rate is high, the catch is comprised of a disproportionate large number of new recruits to the biomass. It is the inability to predict future recruitment that is the greatest biological shortcoming and, since recruitment tends to be variable from year to year, catches are also subject to considerable variability. Crab is a renewable resource but the renewal process is not completely understood, predictable, or invariant. Both fisheries managers and investors should design their activities to reflect the existing knowledge of the resource base.

2.2 Crab Landings by NAFO Division

In this section, the crab fishery will be analyzed in terms of the NAFO Divisions in which the respective crab stocks are located. Figure 1 (p. 7) outlines the NAFO Divisions and Figure 2 (p. 8) describes the landings of the fishery since its inception in the late 1960's.

The Newfoundland crab fishery was initially concentrated in NAFO Division 3L, although a smaller fishery was conducted after 1970 in NAFO Division 3K. In the late 1970's, the 3L crab fishery grew

FIGURE 1 - NORTH ATLANTIC FISHERIES ORGANIZATION DIVISION BOUNDARIES, NEWFOUNDLAND AND LABRADOR



dramatically as fishermen began to exploit offshore crab stocks but landings and catch rates declined precipitously in the 1980's. Landings of 3L crab in 1985 were 2,636 tonnes (t), a 42 percent reduction from 1984 landings and an 80 percent reduction from the peak landings of 1981.

The crab fishery in NAFO Division 3K, after an initial decade of slow growth, grew considerably in the 1980's as new fishing areas were discovered and a number of new fishing licences issued. However, in 1985, there was a decline in 3K landings despite a substantial increase in the number of vessels fishing crab.

The crab fishery in NAFO Division 3Ps has been sporadic and relatively small throughout the years and the potential for a sustained fishery remains undefined. The crab stock in NAFO Division 2J was not fished until 1985 and the magnitude of the stock has not yet been fully delineated.

FIGURE 2 - NEWFOUNDLAND CRAB LANDINGS BY NAFO DIVISION, 1969-85

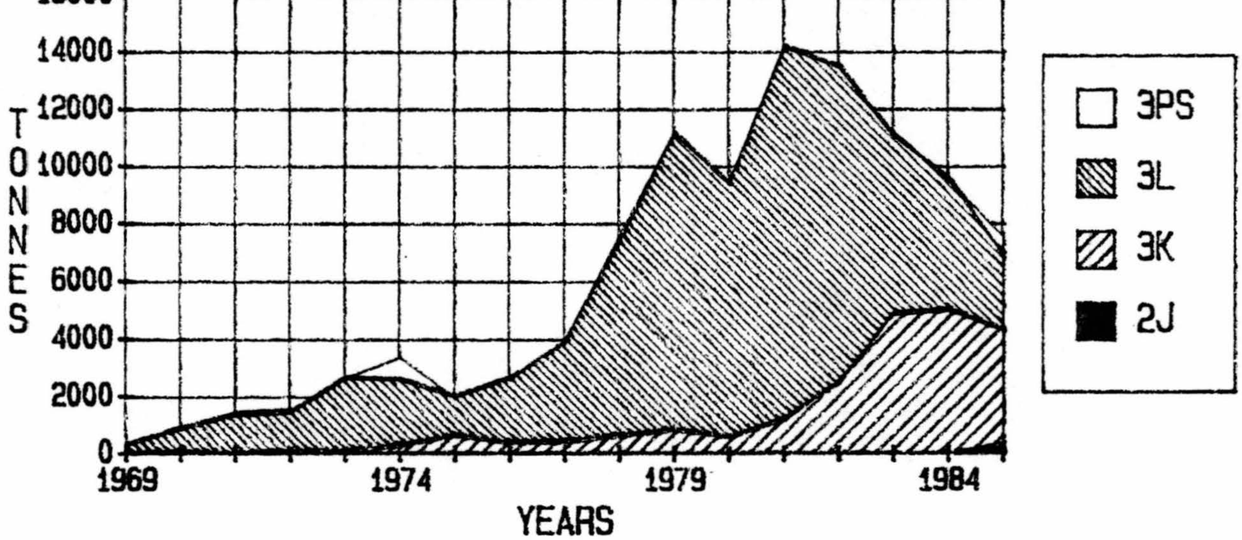
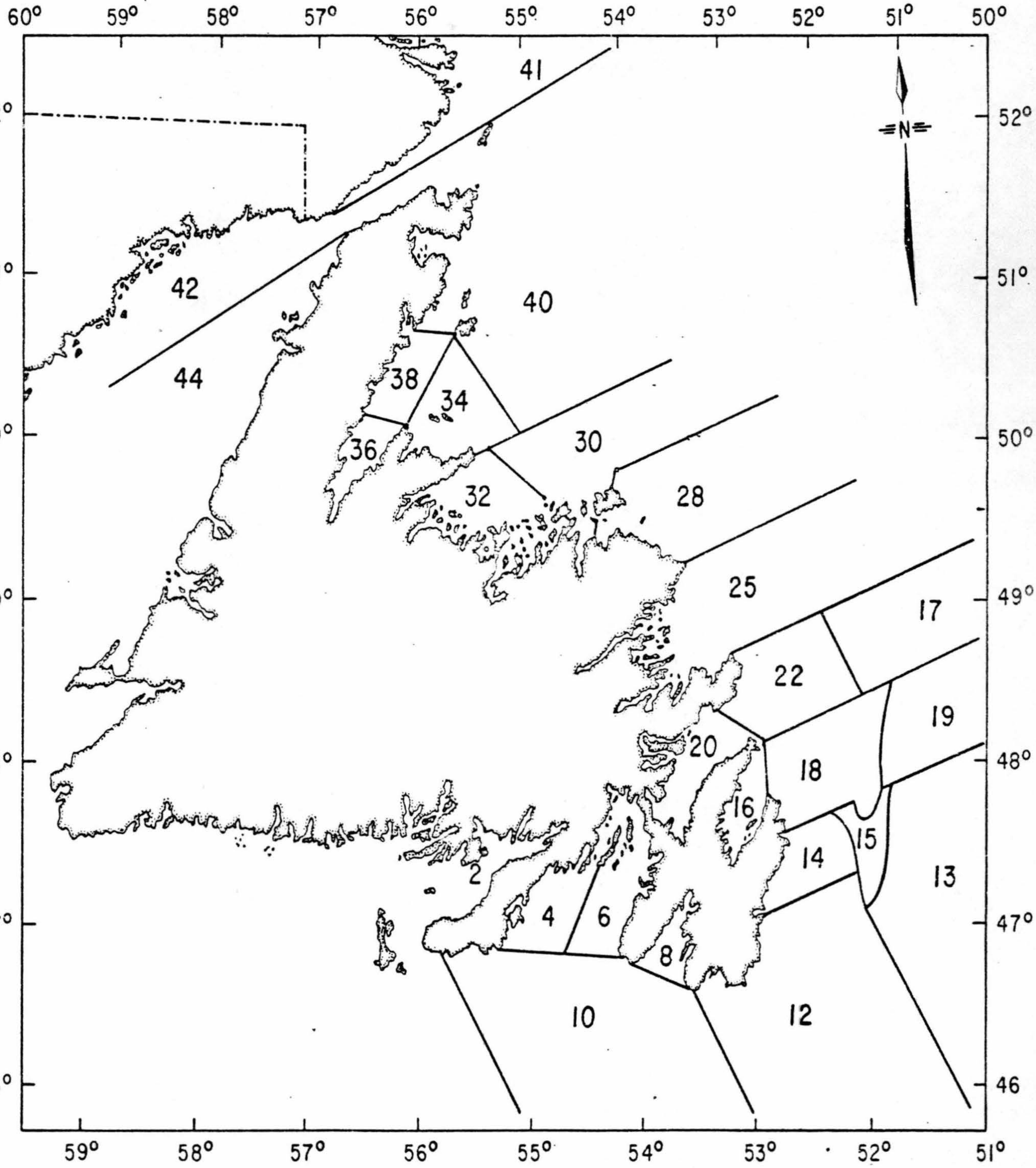


FIGURE 3 - SNOW CRAB MANAGEMENT AREAS, NEWFOUNDLAND

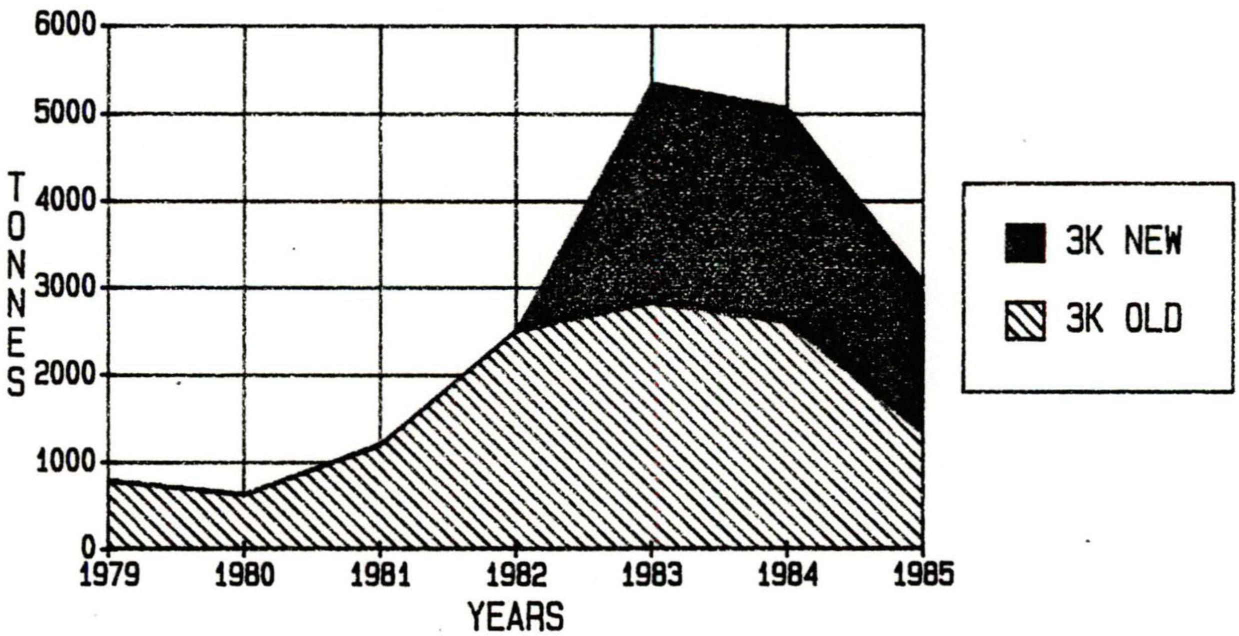


2.3 Landings by Crab Management Area

The NAFO Divisions are sub-divided into Crab Management Areas for purposes of resource assessment (Figure 3) and a history of the fishery can be revealed by considering the crab landings in such geographic detail.

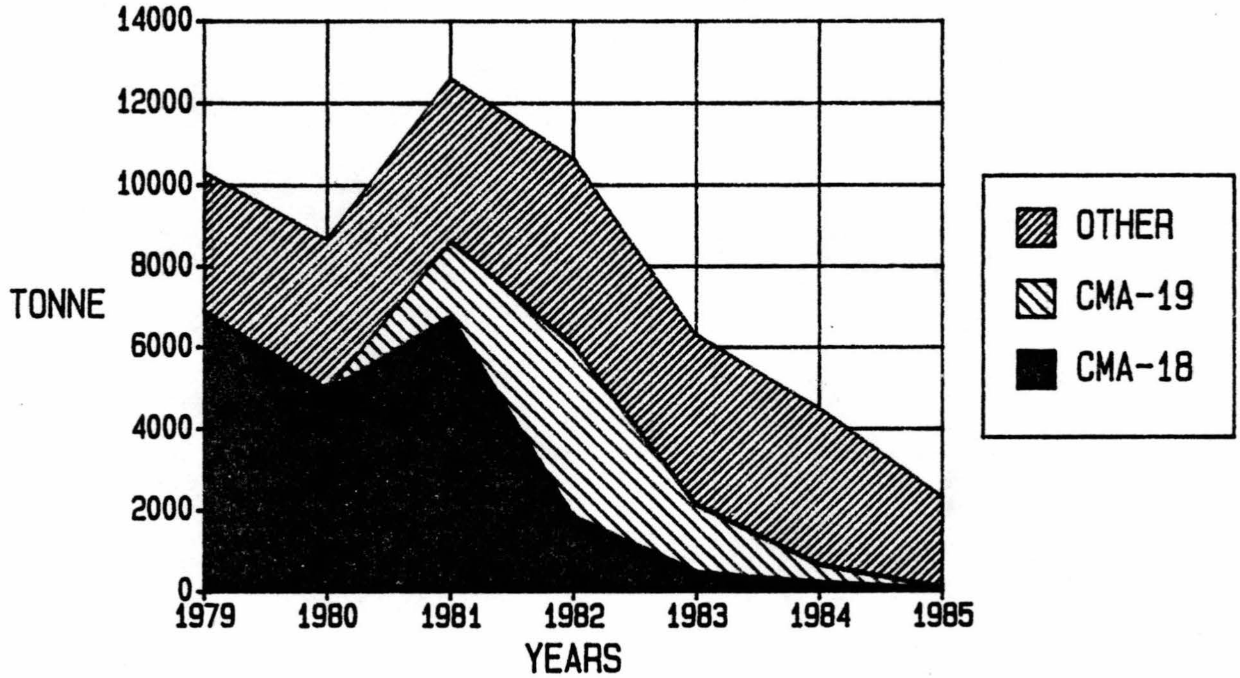
For NAFO Division 3K, the pattern in landings is illustrated (Figure 4) by a comparison of the catch from traditional and newly-fished areas. Prior to 1983, all the crab landed in NAFO Division 3K was caught in crab management areas 32, 34, and 36. The growth in landings after 1982 resulted from the exploitation of new grounds as well as the issue of additional licences in 1983, 1984, and 1985.

FIGURE 4 - 3K CRAB LANDINGS BY NEW AND TRADITIONALLY FISHED MANAGEMENT AREAS, 1979-85



For NAFO Division 3L, the decline in overall landings in 1980's was largely caused by the decline in landings from the offshore stocks in Crab Management Areas 18 and 19 (See Figure 5). At their respective peaks, these areas generated high landings both in total and on a pot haul basis. The catch from these areas, in particular Area 18, greatly exceeds the landings from any other area in 3K or 3L. The large decline in overall landings, effort and catch-per-pot haul from these areas are symptomatic of the decline of much of the 3L crab resource.

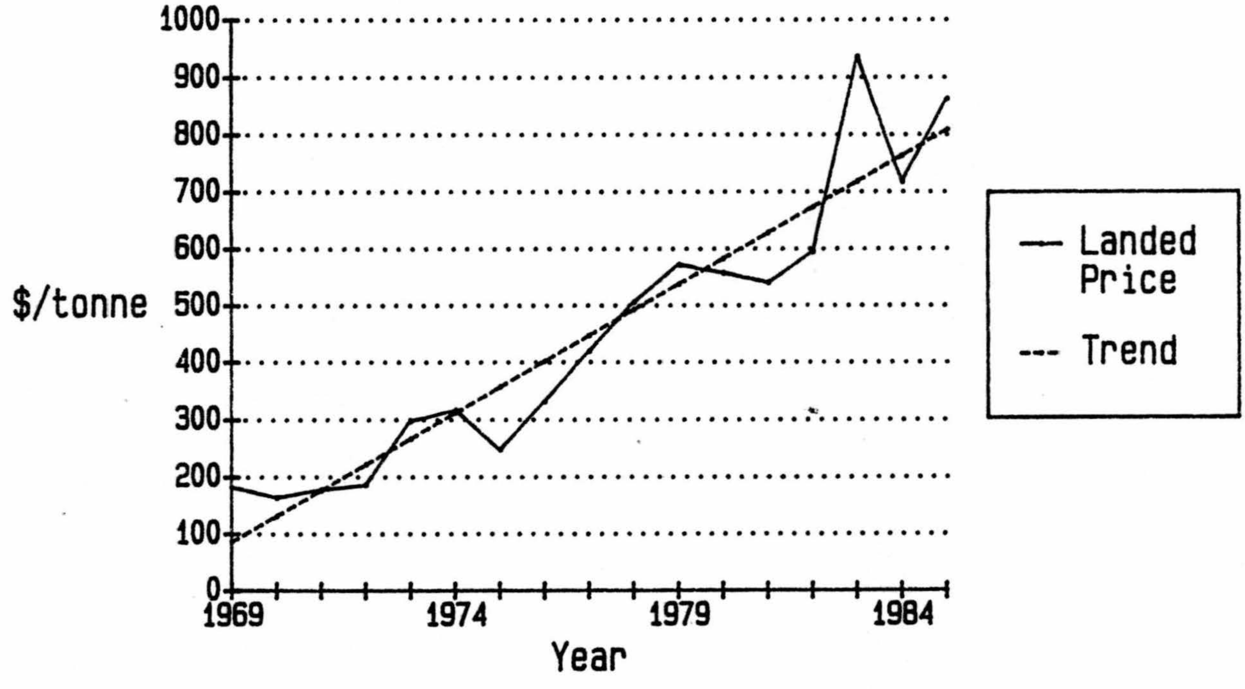
FIGURE 5 - 3L CRAB LANDINGS BY MANAGEMENT AREA, 1979-85



2.4 Value of Crab Landings

The value of crab landings naturally follows the trend in the volume of landings altered only by variations in the price paid for landed crab. Figure 6 illustrates that the average price of landed crab grew steadily between 1969 and 1982 followed by a leap in 1983 stemming from the collapse of the Alaskan crab fishery. In 1984 and 1985, the price of landed crab remained above its pre-1983 level, but it has shown some volatility. Over the sixteen year period, 1969-1985, the average annual increase in the price of landed crab has been $43.30/t or approximately 2¢/lb.

FIGURE 6 - NEWFOUNDLAND LANDED CRAB PRICES, 1969-85



2.5 Management of the Crab Fishery

The initial management of the local crab fishery emphasized the conservation of the resource via minimum carapace size and minimum mesh regulations. The collapse of the snow crab market in 1975 was the catalyst for the introduction of the economic principle of limited entry to the management of the Newfoundland crab industry. In 1976, entry into the crab fishery was limited to those fishermen holding licences in 1975. A requirement that the crab licence be utilized reduced the number of crab licences from 160 in 1974 to 64 by the end of 1976. Furthermore, in 1977, a licence utilization clause required individual fishermen to land specific quantities of crab in order to maintain their licence privilege. During 1977, vessels less than 50 feet were required to land a minimum of 50,000 lbs. and vessels 50 feet or greater, 70,000 pounds. In 1979, the landing requirement was raised to 75,000 pounds and 100,000 pounds for each fleet sector, respectively. The overall impact of the utilization requirement was to decrease the fleet from 64 licences in 1976 to 52 by the end of 1978 with a corresponding increase of landings from 2,668t to 7,582t during the same period. Since 1978, there have been no licences cancelled because of non-utilization. Throughout the 1976-1981 period, existing enterprises were permitted to replace vessels up to 64'11". Since 1977, a Crab Advisory Committee consisting of federal and provincial government officials, fishermen, processors, and union members, has met on a regular basis to review development in the industry and provide advice to fisheries management.

In 1979, crab licences were limited to fishing a maximum of 800 pots so as to discourage excessive effort being deployed against the resource. A further initiative to balance effort with the available resource was the introduction of a zonal management approach in 1982 whereby the existing fleet was confined to the areas in which they normally fished - the so-called "southern zone", NAFO Division 3L, from Bonavista Bay to St. Mary's Bay; the "northern zone", NAFO Division 3K, from White Bay to Notre Dame Bay; and an overlap area comprised of Bonavista, Notre Dame, and White Bays for the three vessels fishing from Valleyfield.

In 1983, a total of nine experimental permits were issued for a two-year period to fishermen in the Canada Bay, Twillingate and Fogo Island areas. Fishermen receiving these permits were excluded from the traditionally fished areas and were intended to exploit virgin stocks. In 1984, a further four experimental permits were issued to fishermen on the Baie Verte Peninsula. These thirteen permits have subsequently been renewed on an annual basis.

A significant development in the 1985 fishery was the introduction of supplementary crab fisheries in NAFO Divisions 2J, 3K, and 3Ps. The supplementary crab fisheries allowed eligible fishermen to pursue crab to supplement their earnings from other species and reduce the risk of catch failure from relying on a fixed gear groundfishery. The supplementary crab licences were issued after a decade of limiting entry to the crab fishery, a policy that resulted in a fleet of vessels that specialized on crab. In NAFO Division 3K the development of a supplementary fishery occurred alongside the on-going operation of the established crab fleet. However, in Divisions 3Ps and 2J the issue of supplementary crab licences was not complicated by the existence of a fleet of established crab vessels.

To qualify for a supplementary crab licence, it was necessary to be a full-time licenced groundfish fisherman, possessing a vessel greater than 35 feet in length overall and be a resident of the respective area. A limited number of fishermen were therefore eligible to receive the supplementary licence and fishermen were required to gear up before the licence was issued. Supplementary crab fishermen were limited to fishing 150 traps. The season was originally scheduled as April 1 to September 30 in 2J, August 15 to October 15 in 3K and September 1 to November 1 in 3Ps; however, the season for the supplementary crab fishery was extended to November 8 in all areas as many fishermen encountered difficulties acquiring the necessary gear. These fishermen encountered further difficulties given their inexperience in the fishery; a common problem was that crab pot haulers lacked the appropriate power or speed.

The following sub-sections report on the 1985 crab fishery in each NAFO Division. The primary focus is on the supplementary fisheries, as the economics of the established fishery will be extensively reviewed in later sections. A more detailed assessment of the 1985 fisheries must await the compilation of 1985 enterprise costs and earnings data.

2J Crab Fishery

The 1985 crab fishery in NAFO Division 2J was initiated after exploratory surveys by DFO's Development Branch in 1983 and 1984 revealed significant potential for a crab fishery offshore Labrador.

Five of the forty-five eligible Labrador-based longliners were licenced to fish crab on a supplementary basis in 2J. These five licenced vessels generally experienced a number of problems stemming primarily from their lack of experience in fishing crab. Only one of the five vessels fished crab throughout the season and the overall catch amounted to only 12.9 t (approximately).

The supplementary licences issued were basically intended to fish inshore crab stocks. There were, however, prospects for an offshore fishery in 2J. Two crab vessels originating from 3L conducted an experimental fishery between August 15 and October 15 about 70 miles east of Battle Harbour. The 3L vessels were used in 2J as local fishermen lacked both the expertise and the vessels required to harvest this offshore stock. The crab was landed and processed (to the cooked section stage) in Mary's Harbour, transported on ice by boat to Cook's Harbour and from there trucked to Witless Bay for final processing. The two vessels landed approximately 322 t of crab during their fishery off Labrador.

3K Crab Fishery

The supplementary fishery in NAFO Division 3K commenced on August 15, 1985 but many fishermen were prevented from fishing crab by the non-availability of gear. The supplementary crab fishermen were restricted originally to fishing outside a geographical line bounded by 50°N and 55°W. This area defined 'new' grounds and attempted, to the extent possible, to prevent an increase in effort on grounds fished traditionally by established crab fishermen. The supplementary crab fishermen subsequently argued they could not economically fish outside the line given the trap limit and the line was thereafter revised inward to run from Partridge Point to Eastern Head (Cat Arm, White Bay) and Cape St. John to North Head (Green Bay). In 1985, a total of 96 fishermen were licenced to fish crab on a supplementary basis, of which 82 were active. Supplementary crab fishermen landed 856 t of crab, having a total landed value of $804,000. The average active supplementary crab fishermen thereby landed 10.4t of crab with an average landed value of approximately $9800 per enterprise. The net income to the enterprises from participating in the supplementary crab fishery equalled the value of crab landings minus the costs of fishing crab and the income that would have been derived from fishing other species. The introduction of a supplementary crab fishery in 1985 did not prevent an overall reduction of 20 percent in the landings of 3K crab. The reduction was particularly felt by the established 3K crab fleet that existed prior to 1985 as these vessels experienced a 38 percent reduction from their 1984 landings from 5037 t to 3,110t.

3L Crab Fishery

The 3L crab fishery continued to decline in 1985 as landings dropped a further 42 percent from 1984. Although most licenced fishermen fished crab to some degree, in 1985 fishermen responded to the low catch rates by further reducing the effort expended in the crab fishery and began fishing other species. A number of fishermen also experienced difficulties in meeting their financial commitments. The most prominent examples of 3L crab fishermen diversifying their fishing effort were the four 3L crab vessels that were longlining in NAFO Divisions 3LNO; the two 3L crab vessels that conducted an experimental crab fishery in 2J; and the single vessel that fished scallop experimentally on the St. Pierre Bank.

3Ps Supplementary Crab Fishery

In 3Ps, 64 supplementary crab licences were issued in 1985, of which 51 actively fished crab. Fishing activity was concentrated in Placentia Bay, in the area of Merasheen, Red and Long Islands and Cross Point with a small fishery on the western side of Placentia Bay. There was also a minimal crab fishery in Fortune Bay. The total 3Ps crab catch in 1985 was 662 t with a landed value of approximately $625,000. The average active supplementary crab vessel in 3Ps landed 12.9t of crab with a value of $13,732.

The next five subsections describe the economic performance of the established or non-supplementary crab vessels over the period 1979-84 in the traditionally fished areas of 3K and 3L.

2.6 Fishing Capacity

Table 1 documents the rise in crab fishing capacity since 1979. During the period 1979-1982, the number of licenced vessels remained constant at 52, although in 1982, a vessel residing on the boundary between 3K and 3L switched its primary fishing activity from 3L to 3K. The issuance of nine permits in 1983 and four more permits in 1984 increased the fishing capacity directed at the 3K crab resource. Over the period 1979-84, the average 3K and 3L crab vessels increased their gross registered tonnage by 70 and 35 percent, respectively. This increase in the average vessel's fishing capacity is the result of: the development of offshore crab stocks which required larger boats for effective exploitation; the natural inducements of competitive fishing whereby fishermen seek to maximize their total catch by acquiring more efficient vessels; and public sector subsidies (both expenditures and tax expenditures) which spur investment in fishing vessels.

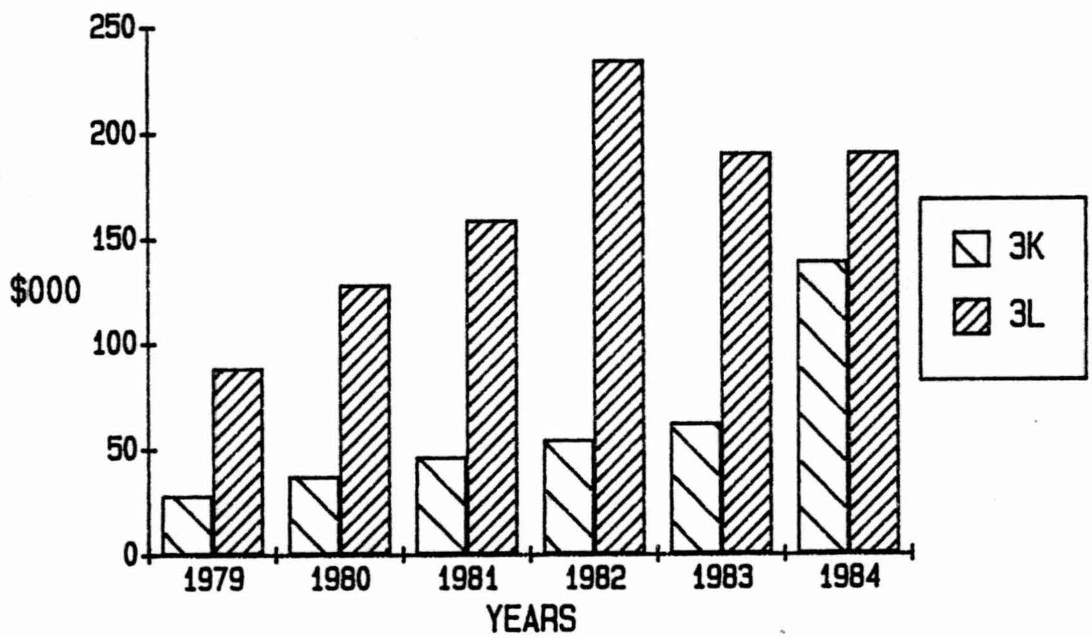
Figure 7 (p. 20), shows the net investment (gross investment less capital subsidies) per average vessel, providing a further indication of the relative trends in crab fishing capacity over the period 1979-1984.*

* The level of net investment in the average 3L crab vessel in 1982 may be over-estimated due to the variability associated with a small sample size for the costs and earnings surveys of the fleet in that year.

TABLE 1
NUMBER AND GROSS TONNAGE OF LICENCED CRAB VESSELS, 1979-84

	NUMBER OF LICENCED VESSELS	TOTAL GROSS REGISTERED TONNAGE (GRT)	AVERAGE GRT PER VESSEL
3K			
1979	13	260	20.0
1980	13	315	24.2
1981	13	315	24.2
1982	14	402	28.7
1983	23	721	31.3
1984	27	925	34.2
3L			
1979	39	1,894	45.1
1980	39	2,062	52.9
1981	39	2,064	52.9
1982	38	2,136	56.2
1983	38	2,321	61.0
1984	38	2,317	60.9

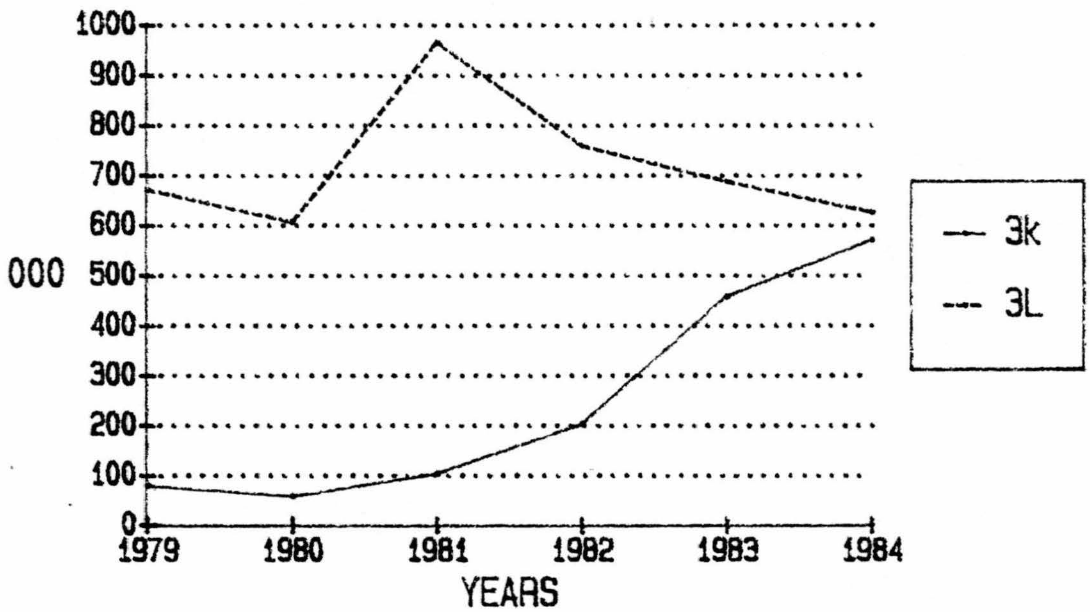
FIGURE 7-NET INVESTMENT PER AVERAGE CRAB ENTERPRISE, 1979-84



2.7 Fishing Effort

Figures 8, 9 and 10 (p. 22) outline the trends in fishing effort over the period 1979-1984. Figure 8 indicates a steady upward trend in total pot hauls in NAFO Division 3K, whereas in NAFO Division 3L, total pot hauls peaked in 1981, the same year landings also peaked.

FIGURE 8 - TOTAL CRAB POT HAULS, 1979-84



The days fished per vessel data shows a similar trend (Figure 9, p. 22) to total pot hauls. In 3K, the days fished per vessel grew steadily until 1982 and declined thereafter. In 3L in the latter 1970's, the average 3L crab vessel fished 80-90 days per year, but as catch rates declined in the early 1980's the average 3L crab fishermen responded by hauling their crab gear less frequently.

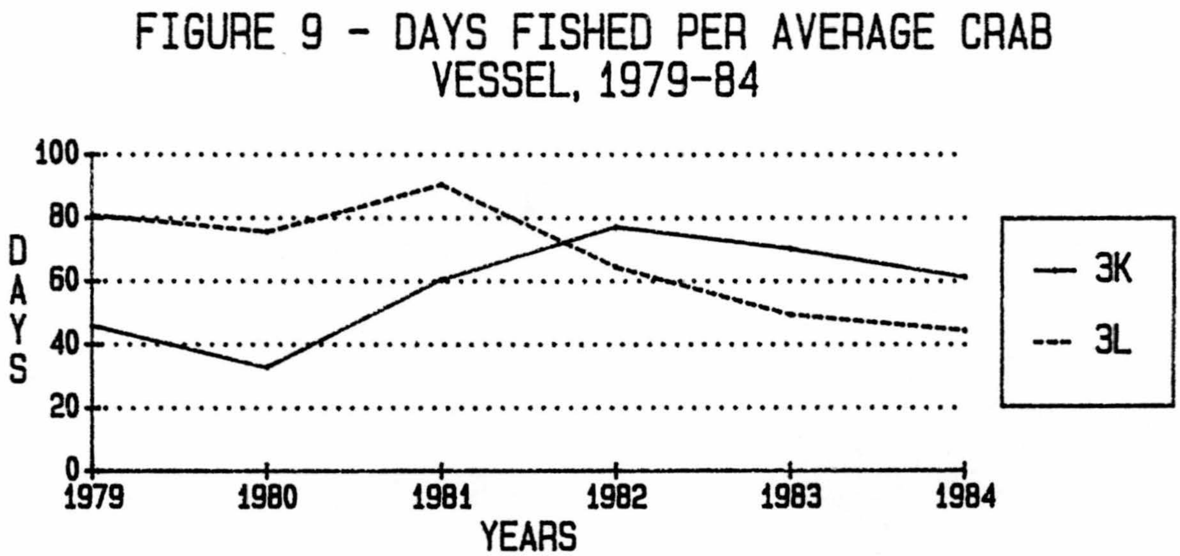
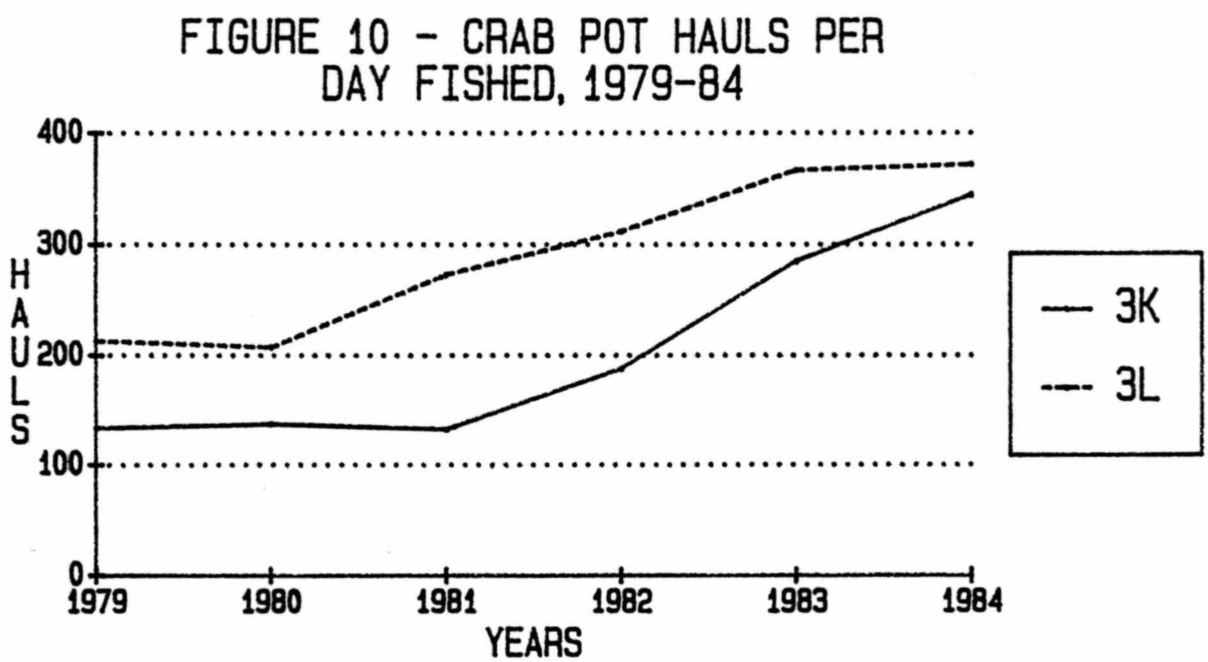


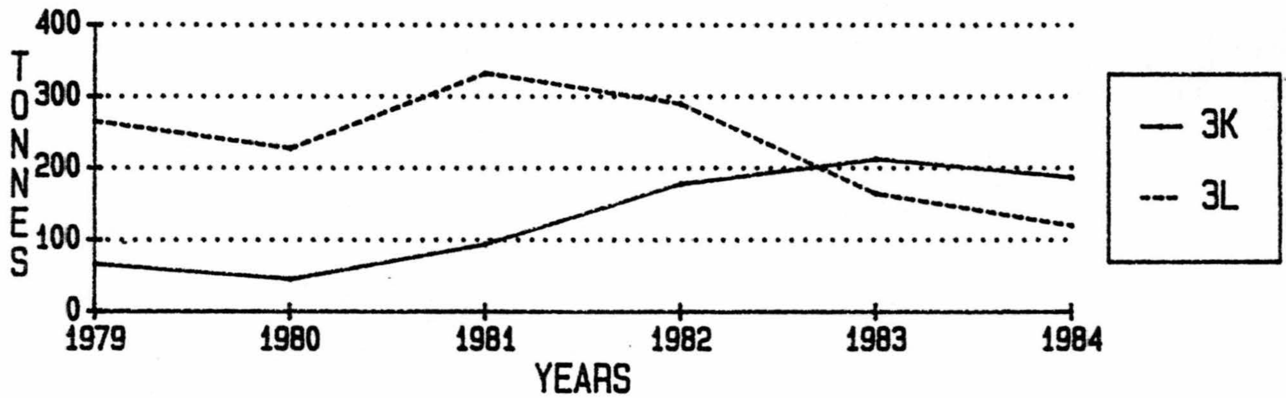
Figure 10 completes the overview of the effort expended by crab vessels in the years 1979-1984. In both 3K and 3L, the average vessel continuously increased the number of pots hauled per fishing day presumably in response to declining catch rates in 3L and the discovery of new grounds in 3K.



2.8 Vessel Productivity

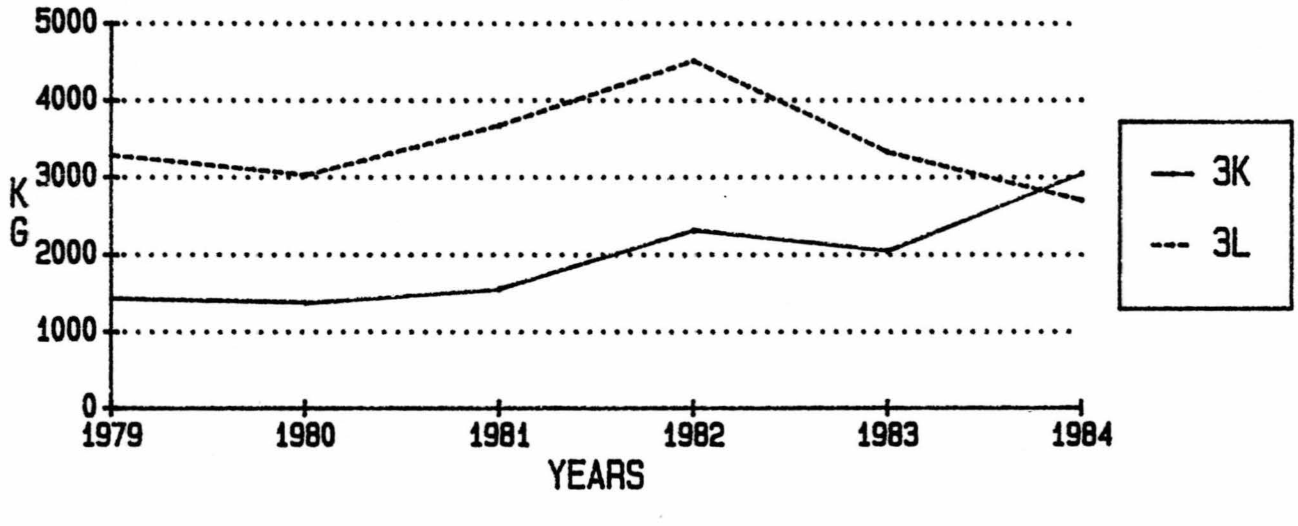
Figures 11 and 12 summarize the trends in vessel productivity 1979-1984. The reduction in the average catch by 3L vessels is clearly illustrated and, in fact, is more dramatic than the increase in the average catch by 3K vessels over the same period.

FIGURE 11 - AVERAGE CRAB LANDINGS PER VESSEL, 1979-84



The catch per day fished (Figure 12) has increased slightly in 3K but declined dramatically in 3L despite the fact the 3L fishing vessels reduced their fishing effort so as to stabilize their catch per day.

FIGURE 12 - CRAB VESSEL CATCH PER DAY FISHED, 1979-84



2.9 Financial Performance

The financial performance of the 3K and 3L crab fleet has been assessed from data collected for the annual survey of enterprise Costs and Earnings by the Program Coordination and Economics Branch, Newfoundland Region. Tables 2 and 3 (p. 25-26) outline the results of the annual survey from 1979-1984. The survey results are subject to sample variability but are generally compatible with other indicators of vessel performance. Tables 2 and 3 present the factor costs without adjustment for the opportunity costs of labour or capital.

3K Vessels:

The revenue of the average sampled 3K vessel grew steadily in the six year period, peaked in 1983 and declined thereafter. Increases in operating, repair and maintenance, and fixed costs (such as insurance and interest) reflect the increases in average net investment per enterprise. Increases in operating, and repair and maintenance costs also reflect the increased effort expended by the average vessel as well as the increases in unit prices on inputs such as fuel. Labour costs responded to variations in the value of vessel landings and the percentage of vessel revenue dedicated to the skipper and crew. Profit trends indicate the fluctuations in revenue and labour costs over the period as well as the continual rise in all costs other than labour.

TABLE 2
COSTS AND EARNINGS OF THE AVERAGE 3K CRAB ENTERPRISE
1979 - 1984

	1979	1980[1]	1981[2]	1982[3]	1983[4]	1984[5]
A. **REVENUES**	45,176	31,339	54,108	94,552	259,006	156,529
- Crab	36,861	25,060	51,883	94,552	259,006	156,036
- Other	8,315	6,279	2,225	*	*	593
B. **OPERATING COSTS**	4,490	3,707	8,032	13,218	22,974	26,057
- Fuel/Oil/Grease	1,968	1,954	3,421	5,662	7,235	11,474
- Bait	1,137	732	1,515	2,609	8,358	11,300
- Provisions	916	703	1,061	1,592	1,946	1,870
- Other	469	318	2,035	3,355	5,435	1,413
C. **REPAIR AND MAINTENANCE COSTS**	6,126	5,544	6,533	7,591	22,527	20,657
- Vessel, etc.	1,761	1,183	1,603	2,209	15,509	8,591
- Gear[6]	4,365	4,361	4,930	5,389	7,018	12,066
D. **FIXED COSTS**	1,305	1,913	2,649	4,247	3,246	9,244
- Insurance	611	771	958	1,082	894	4,037
- Interest Charges	595	977	1,461	2,007	1,583	3,422
- Other	99	165	230	1,158	769	1,765
E. **SUBTOTAL (B+C+D)**	11,921	11,164	17,214	25,056	48,747	55,958
F. **GROSS RETURNS BEFORE LABOUR COSTS AND DEPRECIATION (A - E)**	33,255	20,175	36,894	69,496	210,259	100,571
LESS:						
Labour Cost	26,557	17,772	29,567	49,678	172,927	93,832
Depreciation	1,992	2,507	3,117	3,658	4,150	9,883
G. **NET PROFIT (LOSS)**	4,706	(104)	4,210	16,160	33,182	(3,144)

1 Cost data estimated from 1979 and 1981 data;
2 Based on survey of 4 crab enterprises;
3 Based on survey of 12 crab enterprises;
4 Based on survey of 3 crab enterprises;
5 Based on survey of 14 crab enterprises;
6 Includes gear repair and purchases;
* Not Significant

TABLE 3
COSTS AND EARNINGS OF THE AVERAGE 3L CRAB ENTERPRISE
1979 - 1984

	1979	1980[1]	1981[2]	1982[3]	1983[4]	1984[5]
A. **REVENUES**	175,991	133,696	182,883	176,176	164,100	90,247
- Crab	160,311	126,224	179,209	173,780	160,350	87,311
- Other	15,680	7,472	3,674	2,396	3,750	2,936
B. **OPERATING COSTS**	18,673	19,040	27,385	24,251	21,999	20,535
- Fuel/Oil/Grease	6,361	8,185	13,490	14,719	12,944	11,276
- Bait	5,387	6,395	10,105	6,620	6,810	7,310
- Provisions	204	640	1,360	1,188	863	518
- Other	6,721	3,820	2,430	1,724	1,382	1,431
C. **REPAIR AND MAINTENANCE COSTS**	21,834	18,365	14,883	17,338	12,626	12,633
- Vessel, etc.	7,700	7,600	7,486	7,174	7,607	4,909
- Gear	14,134	10,765	7,397	10,164	5,019	7,724
D. **FIXED COSTS**	5,329	8,505	11,680	17,525	14,169	13,200
- Insurance	2,351	2,770	3,189	3,661	5,402	5,403
- Interest Charges	1,525	2,530	3,533	9,378	6,991	6,820
- Other	1,453	3,205	4,958	4,486	1,776	977
E. **SUBTOTAL (B+C+D)**	45,836	45,910	53,948	59,114	48,794	46,368
F. **GROSS RETURNS BEFORE LABOUR COSTS AND DEPRECIATION (A - E)**	130,155	87,786	128,935	117,062	115,306	43,879
LESS:						
Labour Cost	105,108	78,385	105,213	89,748	90,850	49,085
Depreciation	6,154	8,380	10,602	12,549	12,334	13,428
G. **NET PROFIT (LOSS)**	18,893	1,021	13,120	14,765	12,122	(18,634)

1 Cost data estimated from 1979 and 1981 data;
2 Based on survey of 11 crab enterprises;
3 Based on survey of 10 crab enterprises;
4 Based on survey of 4 crab enterprises;
5 Based on survey of 14 crab enterprises;
6 Includes gear repair and purchases;

3L Vessels:

The costs and earnings data for the average sampled 3L vessel follow the trends in resource availability. Catch revenue and the associated labour costs have declined. Operating costs, and to a lesser extent, repair and maintenance costs, reflect the decline in the average number of days fished by the average vessel. Fixed costs increased in the period 1979-1982 inclusive, but thereafter levelled off. The profitability of vessels has also declined, notably in 1984.

2.10 Employment and Labour Income

Table 4 summarizes the labour market trends in the crab harvesting fleets over the period 1979-1984 as identified by the costs and earnings survey. In 3K total employment and the associated incomes generally increased over the period whereas in 3L employment in harvesting remained steady but incomes have declined.

TABLE 4
EMPLOYMENT AND AVERAGE EARNED INCOMES IN THE CRAB FISHERY BY MANAGEMENT ZONE, 1979 - 1984

	YEAR	CREWMEMBERS	TOTAL LABOUR INCOME ($,000)	AVG. EARNED INCOME/ FISHERMAN ($)
3K	1979	35.5[1]	345	9,725
	1980	39	331	5,925
	1981	40	384	9,610
	1982	42	645	15,375
	1983	99	3,946	39,906[2]
	1984	143	2,540	17,752
3L	1979	188	3,944	21,245
	1980	201	3,057	15,210
	1981	209	4,103	19,635
	1982	218	3,500	16,055
	1983	201	3,485	17,305
	1984	205	1,855	9,042

1 One enterprise had an extra crewmember for half the season.

2 The labour income for 3K crab fishermen in 1983 appears to be distorted by the sample variability associated with a small number of 3K crab vessels sampled in that year.

3. ANALYSIS OF THE ECONOMICS OF HARVESTING CRAB

3.1 An Appropriate Economic Model

The 1982 Task Force on Atlantic Fisheries identified the objectives of Atlantic Fisheries Policy as: economic viability on an ongoing basis; maximized employment subject to fishermen receiving a reasonable income from fisheries activities including fisheries-related transfer payments; and Canadianization of the fish harvesting and processing sectors. In instances of conflict between achieving these objectives, the objective of economic viability was to assume priority.

The objectives of the Task Force on Atlantic Fisheries differ somewhat from traditional economic theory whereby fisheries managers or individual investors seek to maximize the net present value of production at either the social or market discount rate, respectively. Economic theory dictates that an economic analysis of a fishery utilize a multi-year model to identify an appropriate strategy for investing in the resource (via allowing the stock to grow or decline) or in fish harvesting or processing capacity.

Economic theory also dictates that an economic analysis of a fishery consider the potential variation in landings, prices, costs or other factors that are vital to the industry. Such uncertainty implies that variability is associated with the potential future values of interest to fisheries managers or investors. Uncertainty is often reflected in an economic analysis by maximizing the expected net present value of landings with the expected value resulting from an analysis of the statistical probabilities associated with various possible outcomes.

The following analysis of the crab harvesting sector utilizes break-even analysis to address the issue of the number of vessels that can be utilized in the crab fishery while ensuring economic viability and a reasonable level of income. The primary purpose of the traditional break-even model (Fisher, 1980) was to identify the volume of fish required for an enterprise to cover its costs. Grandy (1984) extended the break-even model by explicitly introducing fishing days, daily catch rates and identifying operating costs as being either catch or days at sea related. Explicitly introducing effort variables into the model permits an investigation of the conditions under which an enterprise can break even. For example, if an enterprise fishes at low catch rates which are insufficient to cover its total costs, to break even it must either increase its daily catch rate, the number of days that it fishes or the unit catch value or else lower its fishing costs. The Grandy model thereby identifies the feasibility of the break-even solutions and indicates some of the constraints that must be overcome if an enterprise is to cover its costs. The easier (harder) it is to overcome the constraints the more (less) likely it is that the enterprise can break even.

The somewhat simplified version of the Grandy break-even model to be used in this paper suffers from a number of limitations in terms of analyzing the economics of a harvesting vessel. It is a single year model and does not address vessel performance over a number of years. The model also overlooks the risks and uncertainties which are inherent in landing fish and does not consider the operational aspects whereby a fishing enterprise must choose: an appropriate vessel, target species, fishing plan and gear. The analysis utilizes the concept of an "average" vessel as identified by the costs and earnings data and thereby assumes away the heterogeneity of fishing enterprises and fishing plans. The break-even model, by not maximizing the net present value of landings, also does not identify the least social cost at which the fish may be landed or the optimum amount of capital and labour that should be dedicated to harvesting fish. The break-even model therefore does not identify the potential economic rents that would be available if the fish were landed at the optimum efficiency. The advantages offered by the break-even model identified in Appendix 1 (p. 67) are its simplicity and its compatibility with the identified objectives for the Atlantic Fisheries of economic viability and maximized employed subject to fishermen receiving a reasonable income.

This section then utilizes a slightly modified version of the break-even model and the data from the 1984 Costs and Earnings Survey to identify the conditions under which a crab fishing enterprise may be economically viable. Relationships are specified between an enterprise's break-even catch requirements and such factors as daily catch rates and landed crab prices. The income of the average deckhand is used as a proxy for the crew's income under the various break-even scenarios. It is assumed throughout the analysis that an average 3K or 3L crab vessel can fish a maximum of 120 days, which may be an overly optimistic assumption in relation to the number of days in a season that a crab fisherman can actually land a worthwhile quantity of crab. The cost of capital is defined as 10% of the net investment (gross investment minus capital subsidies), a measure that includes no premium for the risk that is implicit in an investment in the fishery. Deducting capital subsidies essentially "writes off" such public expenditures and assumes that society will not receive a rate of return on such investments. The analysis that follows pertains solely to the regular vessels that fished crab in 1984 and does not relate to supplementary crab fleets.

3.2 Impact of Fishing Effort on Economic Performance

Days Fished and Enterprise Profitability

If the value of the vessel's catch per day exceeds its variable costs, then each fishing day will augment the vessel's profit or reduce its losses. This connection between the number of days a crab vessel fishes at a specified catch rate and the vessel's profitability is illustrated for the average 3K crab vessel (Figure 13) and the average 3L crab vessel (Figure 14). The information presented was compiled using the model outlined in Appendix 1.* The analysis uses the catch rates identified by the 1984 costs and earnings survey (2,661 kg. for 3K and 2,308 kg. for 3L), the negotiated price of 88¢ per kg., as well as two catch rates (2,000 kg. and 3,000 kg.) included for sensitivity analysis.

* The results are obtained by specifying the days fished and the daily catch rate and solving the model for total revenue and total cost.

FIGURE 13 - PROFIT FOR AN AVERAGE 3K CRAB VESSEL BY DAILY CATCH RATE AND DAYS FISHED

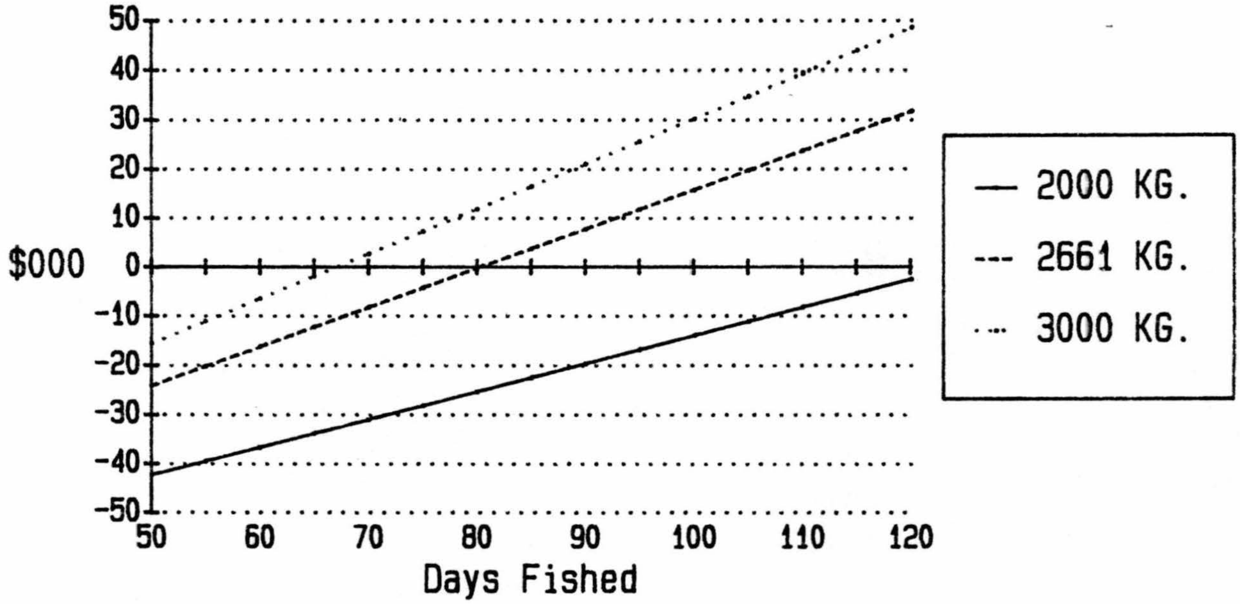
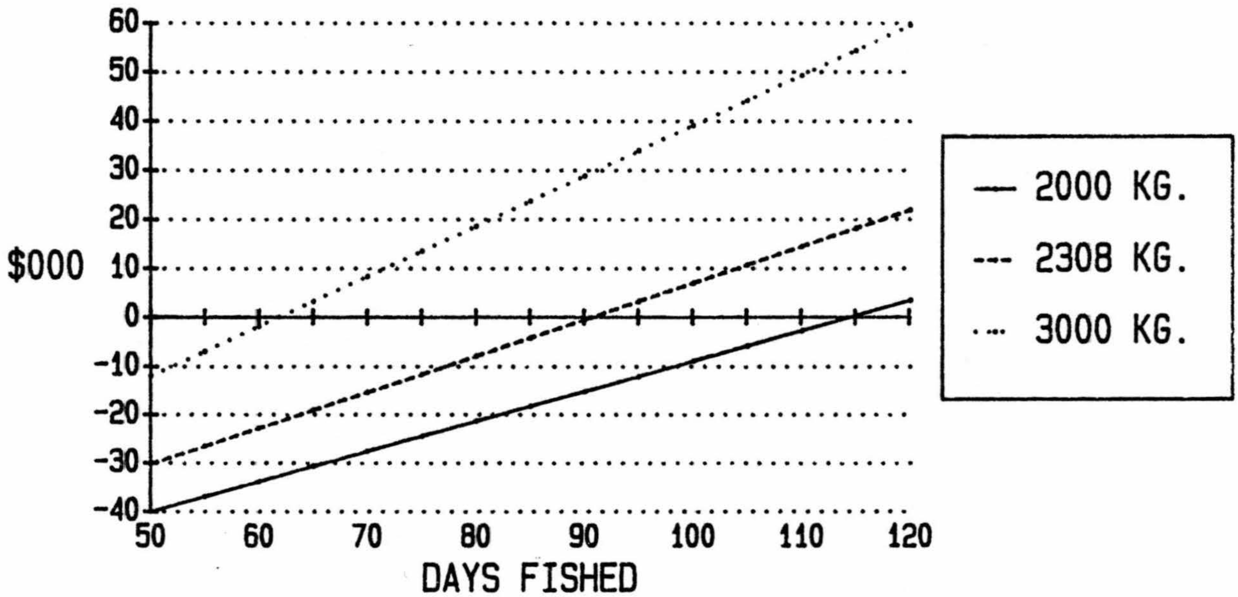


FIGURE 14 - PROFIT FOR AN AVERAGE 3L CRAB VESSEL BY DAILY CATCH RATE AND DAYS FISHED



It is not surprising that the higher the daily catch rate, the higher an enterprise's profitability or the lower its losses at any given level of fishing effort. The figures also indicate the break-even point or the number of days an enterprise must fish to cover its fixed and variable costs including labour and return on capital. It is important to note that Figures 13 and 14 specify:

a. The profitability of the average 3K or 3L crab enterprise if the enterprise fished a specified number of days at a specified catch rate. Different assumptions on prices and costs would result in different relationships being specified.

b. A linear relationship between each additional day fished and enterprise profitability implies that each fishing day makes an equal contribution to enterprise profitability. However, the complexity entailed in harvesting crab cannot be totally depicted on a linear two-dimensional basis. Firstly, as enterprises extend their season by fishing on the shoulders of the season, there is a decline in the marginal catch per fishing day. This decline in the marginal daily catch rate occurs to a certain extent because the marginal catch rate in each individual area declines as the season progresses and fishermen have limited potential to maintain their catch by switching to other areas*. The model outlined in Appendix 1 does not recognize the decline in the marginal, and to a lesser degree, the average daily catch as fishermen extend their season. Secondly, there is a positive relationship between the daily catch rate and the number of days it is economically feasible for an enterprise to tend its pots; in other words, the higher the catch rate, the more days a fixed gear fisherman will fish.

Figures 13 and 14 therefore only illustrate the profitability of the average crab enterprise if the enterprise fishes a specified number of days at a specified average daily catch and does not imply that the enterprise can fish more days and maintain its catch rate.

* Leslie analysis, a resource assessment technique, focuses on the reduction in catch per unit of effort (catch per pot haul) with increases in the cumulative catch in an area. Of course, fishermen do not confine themselves to a single area but choose an area to fish so as to maintain their profitability. Sufficient data on catch rates per trip, and if necessary the Leslie analysis by area, may be available to model the decline in catch rates as the season progresses. The decline in the daily catch rate would of course vary between areas and between years.

c. Table 5 summarizes the information in Figures 13 and 14 by indicating the required fishing days to break even at various catch rates for the average vessel in the 3K and 3L crab fleets.

TABLE 5
FISHING DAYS REQUIRED FOR THE AVERAGE CRAB VESSEL TO BREAK-EVEN

Daily Catch Rate	FISHING DAYS	
	3K	3L
2,000	120+*	114
2,308	99	90
2,661	80	65
3,000	68	62

* The assumption has been made that 120 fishing days is the maximum length of the season.

The most relevant point in Table 5 is that if the average 3K and 3L vessel fished at the catch rates as determined by the 1984 costs and earnings survey (2,661 kg/day for 3K vessels and 2,308 kg/day for 3L vessels) and received the negotiated price for landed crab (88¢ per kg) then such 3K and 3L vessels would require 80 and 90 fishing days respectively, to cover their costs. In 1984, the average 3K and 3L crab vessel fished 61 and 44 days respectively, substantially below the number required to break even at the 1984 catch rates. It can be reasonably inferred that the daily catch rates in 1984 were too low for it to be worthwhile for fishermen to fish the number of days required to break even.

Table 5 also indicates a somewhat paradoxical result. The average 3K crab vessel, despite being physically smaller and less expensive, requires more fishing days to break even than the average 3L vessel if each vessel fished at an identical catch rate. In the context of the model identified in Appendix 1, Table 5 implies that the daily operating margin (the difference between revenue per fishing day and the daily operating and labour costs) is sufficient to allow the average 3L crab vessel to cover its fixed costs (including gear purchases and repair and maintenance) in fewer fishing days than the average 3K vessel would require at those catch rates.*

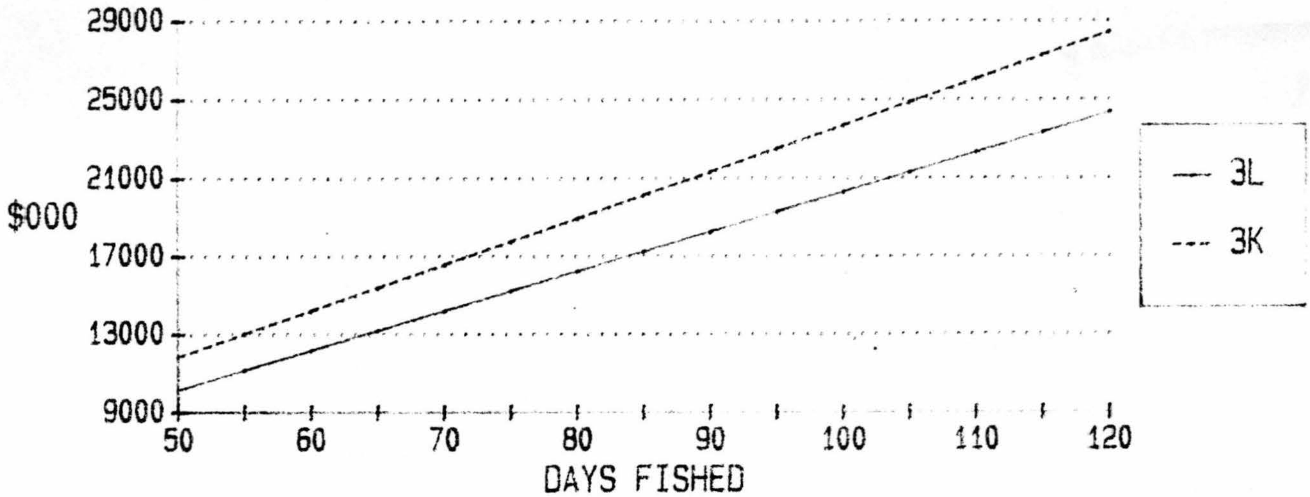
The perverse finding that a smaller, less expensive vessel requires more fishing days to break even emanates partially from the sensitivity of the results of a break-even model to variations in the share of gross revenue dedicated to the earnings of the skipper and deckhands. The 1984 costs and earnings survey indicated a higher crew share for the average 3K vessel than for the average 3L vessel and this discrepancy assumes a large weight in determining the daily operating margin and the fishing days required to break even. Appendix 2 (p. 69) elaborates on the sensitivity of the economic performance to variation in the crew share and concludes that if crew shares are equalized the smaller, less expensive average 3K crab vessel has a lower break-even requirement than the average 3L crab vessel.

* In comparing the break-even requirements of an average 3K and 3L crab vessel, it should be noted that these vessels are not fishing the same grounds. The analysis assumes that the vessels use fuel at the average daily consumption of such vessels as recorded by the costs and earnings survey.

Fishing Effort and Crew Incomes

Figure 15 indicates the earned incomes of an average deckhand that are associated with fishing at two of the catch rates depicted in Figures 13 and 14 (2,661 kg. for 3K crab vessels and 2,308 kg. for 3L crab vessels).* The higher earnings per day fished for the average deckhand on a 3K vessel compared to a 3L vessel is attributable solely to the higher catch rate for the average 3K vessel as detected by the costs and earnings survey.**

FIGURE 15 - DECKHAND'S INCOME ON AN AVERAGE CRAB VESSEL



* A crew is comprised of the skipper and deckhands. The 1984 crew share is higher for the average 3K crab vessel than 3L vessel. The difference in crew shares is caused by the average 3L skipper in 1984 taking a lower percentage than the average 3K skipper. The deckhands share is larger on the average 3L crab vessel than the average 3K vessel.

** Figure 15 does not include any provision for the Unemployment Insurance income received by fishermen. Qualifying fishermen are entitled to receive benefits for the week in which November 1 falls, to the week in which May 15 falls. Given that there is a two week waiting period, fishermen may be regularly entitled to receive 27 weeks of benefits and in 1985, the maximum weekly entitlement was $276. The UI benefit therefore offers fishermen a <u>potential</u> gross receipt of $7,452 over the non-fishing season which is often a significant portion of their total income.

3.3 Resource Requirements of the Crab Fleets

This section calculates the resource requirements to break even for crab fleets assuming a fleet of average vessels and various assumptions on daily catch rates and landed crab prices.

Resource Requirements of the 3K Crab Fleet

In Table 6 the 1984 conditions for the average 3K crab enterprise are compared with a number of break-even scenarios. Several observations relate to this comparison.

a. In 1985, the established fleet of 3K crab vessels landed 3,110 t of crab, a 38% reduction from the 1984 catch. This volume of crab is insufficient to support all of the existing 3K crab fleet at a break-even catch.

b. Table 6 also indicates that there is not a single absolute amount of effort or resource required to break even. The effort or resource requirements depend upon the basic parameters which affect vessel's operation. Any factor (such as an increase in the landed price or the catch rate) which increases the operating margin per fishing day, lowers the amount of effort and resource required to break even. The converse also applies. The operating margin per fishing day is defined as the operating revenue per day minus the operating and labour costs per day and represents the contribution of a fishing day to meeting a vessel's fixed,

TABLE 6
ALTERNATIVE CONDITIONS FOR THE AVERAGE 3K CRAB ENTERPRISE

		ALTERNATIVE BREAK-EVEN SCENARIOS*			
	ACTUAL 1984 CONDITIONS[1]	WITH 1984 CONDITIONS[1]	LOW PRICE AND CATCH RATE[2]	MODERATE PRICE AND CATCH RATE[3]	HIGH PRICE AND CATCH RATE[4]
VESSEL CATCH (KG)	210,539	277,666	240,000	213,439	170,811
Fishing Days	79.1	104	120	80	57
Daily Operating Margin ($)	490	490	249	638	898
Deckhand's Earned Income ($)	15,687	20,787	16,510	19,002	17,280
Optimal Fleet Size[6]	n.a.	11	13	14	18
ENTERPRISE PROFIT (LOSS)**	(14,764)	-	(21,272)[5]	-	-

* All figures relate to a vessel performing under break-even conditions as per the the model outlined in Appendix 1

** Includes an opportunity cost of net investment of 10 percent. A break-even profit equals zero.

1 As identified by the 1984 costs and earnings report, the catch rate for 3K crab vessels was 2,661 kg/day and the landed price equalled 74¢/kg. The survey data on vessel costs and earnings is not always consistent with the data obtained from purchase slips on fishing days per vessel and catch per day identified in Figures 9 and 12. Such discrepancies suggest the economics of a vessel should be assessed using a range of prices and catch rates.
2 Assumes a landed price of 68¢/kg. and a daily catch rate of 2,000 kg.
3 Assumes a landed price of 88¢/kg. and a daily catch rate of 2,661 kg.
4 Assumes a landed price of $1.00/kg. and a daily catch rate of 3,000 kg.
5 Under the low price and catch rate scenario, the enterprise is unable to break-even, given the assumption of a maximum of 120 fishing days.
6 The number of such vessels (rounded to the nearest integer) that could break-even with a 3000 t annual catch. At low price and catch rate conditions, the average vessel is unable to break even within the 120 maximum number of fishing days and in such cases, the vessels in the optimum fleet would incur an economic loss.

gear, and repair and maintenance costs . The greater the variability in the factors (prices, costs, catch rates) that affect the operating margin per day, the more variable the results of the break-even model.

c. The break-even scenarios presented in Table 6 are predicated on a range of landed price/catch rate conditions, some of which are more likely than others.

The price of landed crab is difficult to forecast but a variable that influences landed crab prices is the market for crab products, a market with a discernable variability and uncertainty (see Section 5). In choosing between the alternative break-even scenarios in Table 6, it may be prudent to assume a moderate price of 88¢ per kilogram for landed crab. In choosing between alternate catch rate scenarios, it would be imprudent to predict an increase in the catch rate for the 3K crab fishery given the uncertainty over recruitment, the current reliance on virgin stocks and the additional effort by the supplementary fishery. A moderate catch rate (2,661 kg./day) appears to be a reasonable estimate. A final variable that distinguishes the break-even scenarios in Table 6 is the number of fishing days.

The number of days to fish is a key decision for a fisherman but it is likely that the higher the margin between daily operating revenue and costs, the more days a fisherman will be willing to fish. In 1984, the 3K crab vessels likely fished the maximum number of days that they felt it to be economic given the environmental conditions, catch rates and alternative opportunities. It would be unduly speculative to predict a dramatic increase in either the operating margin per day on the fishing days for the average 3K crab vessel over those fished in 1984. Nevertheless, Table 6 indicates the number of days a vessel must fish to break even under the specified price, catch rate, and cost scenario on the assumption that the vessel owner fishes the number of days required to break even.

In summary, the break-even scenarios illustrated in Table 6 indicate the inadequacy of the resource to support the regular or non-supplementary 3K crab fleet under the existing arrangements.

The prospects for the 3K crab fleet are to perform below the break-even catch level with the associated impact on fleet viability and incomes.

d. Table 6 presents a range of break-even scenarios that assume a vessel covers all its fixed and variable, cash and non-cash costs. Of course, in the short run, it is only necessary for a vessel to cover its cash costs, leaving fixed non-cash costs to be covered in the long run. For example, interest expenses must be covered in the short run, whereas depreciation charges need not be covered in the short run. Another fixed cost that need not be covered in the short run is the 10% return on equity that represents an opportunity cost or the return available on other investments.

If a vessel only chooses to cover a percentage of its fixed costs in the short run then its break-even requirement will be reduced proportionately. For example, if the average 3K crab vessel chooses not to recover its depreciation expense in the short run, then the catch per vessel and fishing days required to break-even (at a particular price and catch rate) is reduced by 20%.

5. Table 6 indicates the rather perverse conclusion that if the price and catch rate increase from moderate to high levels, the deckhand's income declines at the break-even catch level. This result stems from the fact that the crew's income is a function of the gross value of the catch and an increase in the price and catch rate reduces the

value of the break-even catch and the deckhand's income. Break-even analysis assumes that a vessel only fishes until it covers its costs and thereby implicitly assumes that an increase in the operating margin per day (via an increase in landed prices, catch rates or whatever) will reduce the break-even requirements and thereby the crew's income at breakeven. Appendix 2 elaborates on the nature of the crew's income within break-even analysis.

Resource Requirements of the 3L Crab Fleet

Table 7 indicates the resource requirements of the 3L crab fleet and the same caveats that applied to the resource requirements of the 3K crab fleet are applicable. For example, it is unlikely that 3L crab vessels will find it worthwhile to fish the larger number of days that would be required to break-even under the low or moderate price and catch rate scenario. Nevertheless, the principal finding illustrated in Table 7 is obvious, the 3L crab fleet suffers a woeful amount of excess capacity given the resource available. The fleet will continue to experience difficulties meeting its financial commitments and generating reasonable incomes for its participants if it continues to operate as a specialized crab fleet. Much of the 3L crab fleet, having invested in vessels capable of fishing an offshore crab stock, must assess their alternatives to fishing crab such as longlining or otter trawling.

TABLE 7
ALTERNATIVE CONDITIONS FOR THE AVERAGE 3L CRAB ENTERPRISE

	ACTUAL 1984 CONDITIONS (1)	ALTERNATIVE BREAK-EVEN SCENARIOS*			
		WITH 1984 CONDITIONS (1)	LOW PRICE AND CATCH RATE (2)	MODERATE PRICE AND CATCH RATE (3)	HIGH PRICE AND CATCH RATE (4)
Catch (Kg.)	116,323	276,960	240,000	209,046	155,940
Fishing Days	50.6	120	120	91	52
Daily Operating Margin	448	448	289	595	1,037
Deckhand's Earned Income	9,022	20,481	16,309	18,384	15,583
Optimal fleet[6]	NA	11	13	14	19
ENTERPRISE** PROFIT (LOSS)	(33,849)	(170)	(19,217)[5]	-	-

* All figures relate to a vessel performing under break-even conditions as per the model outlined in Appendix 1

** Includes an opportunity cost of net investment of 10 percent. A break-even profit equals zero.

1 As identified by the 1984 costs and earnings report, the catch rate for 3K crab vessels was 2,308 kg/day and the landed price equalled 74¢/kg.

2 Assumes a landed price of 68¢/kg. and a daily catch rate of 2,000 kg.

3 Assumes a landed price of 88¢/kg. and a daily catch rate of 2,308 kg.

4 Assumes a landed price of $1.00/kg. and a daily catch rate of 3,000 kg.

5 Under the low price and catch rate scenario, the enterprise is unable to break-even given the assumption of a maximum of 120 fishing days.

6 Number of vessels (rounded to the nearest integer) that could break even with a 3000 t annual catch. At low price and catch rate conditions, the average vessel is unable to break even with the 120 maximum number of fishing days and in such cases, the vessels in the optimum fleet would incur an economic loss.

4. CRAB PROCESSING

Table 8 describes the main features of the crab processing sector within the province. The overall volume of crab production peaked in 1982 and declined thereafter while the value of crab products also declined but to a lesser extent. On a regional level, the 3K area has provided a steadily increasing share of local crab production. The production per plant data reflects the steady expansion in the capacity of 3K crab processors as well as the reduced landings in both areas. Plant production data does not always reflect the trend in landings as landed crab is transported between areas of the province (as well as across the Strait of Belle Isle from Quebec) prior to being processed.

TABLE 8
OVERVIEW OF THE CRAB PROCESSING SECTOR, 1979-85

	1979	1980	1981	1982	1983	1984	1985
NUMBER OF PLANTS:							
- Division 3K	3	3	4	4	6	8	8
- Division 3L	6	7	7	7	10	9	7
TOTAL	9	10	11	11	16	17	15
TOTAL PRODUCTION (t):							
- Division 3K	259	226	527	800	1220	1479	NA
- Division 3L	2220	1762	3105	3001	1971	1449	NA
TOTAL	2479	1988	3632	3801	3191	2928	2458
AVERAGE PLANT PRODUCTION (t):							
- Division 3K	86.3	75.3	131.7	200.0	203.3	184.8	NA
- Division 3L	370.0	251.7	443.6	428.7	197.1	161.0	NA
OVERALL	275	198.8	330.1	345.5	199.4	172.2	163.8
VALUE OF PRODUCTION PER PLANT ($M)	2.26	1.57	2.65	3.86	2.51	1.59	NA

Production by Product Type

Table 9 indicates crab production by product type of Newfoundland crab processors. The local industry in recent years has concentrated on frozen crab production as a result of a deterioration in the market for canned crab. A large percentage of the frozen crab is processed into meat rather than into less labour-intensive, higher yield crab sections. The Newfoundland industry does not have the flexibility to dedicate a large share of its production to satisfy the recently profitably Japanese market for raw sections greater than 8 ounces as Newfoundland crab is often smaller and does not have the aesthetic characteristics demanded by that market. In addition, the Newfoundland government, in the interest of preserving employment, does not allow semi-processed crab to comprise more than 15 percent of total processed crab. However, given the nature of the Newfoundland crab resource, the relative production of crab meat and meat sections has not become an issue within the local industry.*

* The relative production of crab meat and sections has recently become a major issue in New Brunswick where the provincial government has responded to weak markets for crab meat and strong Japanese and U.S. crab sections markets by allowing crab processors to reduce their meat/section ratio from 60/40 in 1984 to 30/70 in 1985. This reduction in the meat/section ratio reduces the employment generated in processing New Brunswick crab but gives processors greater flexibility to produce a more profitable product mix. It has also resulted in considerable labour unrest.

TABLE 9
NEWFOUNDLAND CRAB PRODUCTION BY PRODUCT TYPE, 1979-85

	1979	1980	1981	1982	1983	1984	1985p
	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)
CANNED:							
Regular Pack	300,864	164,996	192,569	90,038	109,134	61,822	n.a.
Fancy & Salad	-	99,438	63,631	38,085	47,450	26,878	n.a.
Other	-	-	803	-	-	-	n.a.
Subtotal	300,864	364,434	257,003	128,123	156,584	88,700	22,780
(% of total)	(12.1%)	(18.3%)	(7.1%)	(3.3%)	(4.9%)	(3.0%)	(1.0%)
FROZEN CRAB:							
Meat	1,722,595	1,133,303	2,192,218	1,958,079	1,412,789	1,060,381	1,110,186
Claws	214,350	324,126	543,895	685,925	680,763	642,671	483,571
Legs	-	5,005	10,560	24,840	52,724	43,040	47,048
Sections	-	1,094	100,934	165,963	45,642	100,241	100,814
Au Gratin	25,481	53,365	109,986	118,855	128,485	58,256	102,586
In Shell	21,018	-	122,998	131,269	82,004	87,777	14,348
Other	122,231	60,574	67,193	269,820	299,915	546,435	387,747
Comminuted	72,912	46,407	227,605	318,425	332,763	300,665	189,133
Subtotal	2,178,587	1,623,874	3,375,389	3,673,176	3,035,085	2,839,467	2,435,433
(% of total)	(87.9%)	(81.7%)	(92.9%)	(96.7%)	(95.1%)	(97.0%)	(99%)
TOTAL	2,479,451	1,988,308	3,632,392	3,801,299	3,191,669	2,928,167	2,458,213

p- preliminary
n.a. = not available

Processing - Capacities & Utilization

The capacity of a plant is assumed to be equal to the shucking capacity of a processing operation and is denoted on an 8-hour shift basis. Although some plants may operate double shifts, this analysis assumes a single shift production capacity. A plant's utilization is equal to the plant's actual production divided by its capacity. Seasonal utilization extends from April to October. The highest month of production, usually June or July, is used to find peak utilization.

Table 10 gives the estimated utilizations of plant capacities for the period 1980-1984. In the period 1980-1984, total plant capacity increased by 63%. This increase is due to the addition of 7 new plants. In the 3K area, where 4 new plants have been built, plant capacity has increased by 269%. This was accompanied by an increase in utilization over the 1980-84 period; however, the decline in crab catching in 1985 is likely to have reduced utilization rates by at least 20%.

Table 10 indicates the existence of redundant crab processing capacity with an average seasonal utilization rate of only 41 percent and a peak monthly rate of only 67 percent on a single shift basis. Since most plants can effectively operate two shifts per day, the actual utilization rate is only one-third of available capacity in peak periods. The capacity developed in response to the opportunity to process a resource whose availability ultimately relied upon continued recruitment. The cost of such redundant capacity is a reduced (or indeed negative) economic surplus associated with processing crab and a reduced ability to pay higher wages to plant labour or higher prices to fishermen. The costs of redundant capital are shared within the industry but they do exist and are likely to be significant.

TABLE 10
ESTIMATED UTILIZATION OF CRAB PLANT CAPACITY
(1980-1984)

	PEAK MONTH									
	1980		1981		1982		1983		1984	
	Capacity (t)	Utilization (%)	Capacity (t)	Utilization (%)	Capacity (t)	Utilization (%)	Capacity (t)	Utilization (%)	Capacity (t)	Utilization (%)
North	1,065	47	1,585	48	1,585	67	4,160	49	4,602	84
South	4,785	72	5,615	92	5,615	91	6,890	63	6,526	56
TOTAL	5,850	67	7,200	82	7,200	86	11,050	58	11,128	67

	SEASONAL (APRIL TO OCTOBER)									
	1980		1981		1982		1983		1984	
	Capacity (t)	Utilization (%)	Capacity (t)	Utilization (%)	Capacity (t)	Utilization (%)	Capacity (t)	Utilization (%)	Capacity (t)	Utilization (%)
North	7,470	36	11,110	35	11,110	54	24,960	47	27,612	53
South	33,480	51	39,320	61	39,310	57	41,340	45	39,156	33
TOTAL	40,950	48	50,430	55	50,430	56	66,300	46	66,768	41

Landed Crab Prices

Newfoundland crab processors have been negatively affected by the decline in landings, the lower crab product prices and the expansion in crab processing capacity. However, one factor that has been to the advantage of Newfoundland crab processors is that the price paid for landed crab has been less than the price paid for landed crab in the Gulf of St. Lawrence Region. Table 11 compares the average price of landed crab in the Gulf region with the average price of landed crab received by Newfoundland Region fishermen (as derived from the DFO value and volume of landings data).

TABLE 11
AVERAGE VALUE OF CRAB LANDINGS, 1979-85
$/KG

YEAR	GULF REGION	NEWFOUNDLAND REGION	DIFFERENCE
1979	.76	.57	.19
1980	.57	.557	.013
1981	.58	.539	.04
1982	.95	.595	.355
1983	1.53	.936	.594
1984	1.30	.717	.583
1985	1.16	.838	.322

The factors that may have some bearing on such a price differential include: in the Gulf the price is determined by market forces whereas in Newfoundland it is determined by negotiations between the Fisheries Association of Newfoundland and Labrador (FANL) and the United Food and Commercial Workers International Union; the nature of the resource in the respective areas (for example, the constrained ability of local processors to avail of the lucrative sections market) and the existence of transport cost differences. It may be argued that the low capacity utilizations of crab plants depresses the price paid to local fishermen but conversely the overexpansion of the processing sector may cause processors to agressively compete amongst themselves so as to maintain their share of local crab production. This analysis is not meant to imply that the local price is somehow unfair but merely that it is lower than in a neighbouring region.

Processing Employment and Labour Income

The trends in processing employment and labour income reflect the rise and fall of crab landings within the province. Two patterns are evident within the industry. First, the increase in the number of crab processing plants has spread the employment and income associated with processing crab among a wider number of communities. The second pattern is a decline in the number of weeks of employment that can be obtained from processing crab. The dispersion of catches over a large number of plants has reduced the number of work weeks per employee. The trend to mechanizing the processing of crab has further reduced the employment in crab processing plants, a trend that has accentuated the employment losses associated with reduced landings.

5. CRAB MARKETING

The dominant factors in the current crab product markets from a Newfoundland perspective are the declining king and snow crab landings in the U.S., the continued success of surimi-based products and the continued stagnation of the markets for canned crab.

U.S. king and snow crab landings steadily fell from levels of 84.1 and 55.2 thousand tonnes, respectively, in 1980 to their estimated levels of 7.8 and 22 thousand tonnes in 1984. The collapse of U.S. crab landings in the early 1980's led to a dramatic rise in the U.S. price of Canadian frozen snow crab meat (Figure 16). U.S. snow crab prices peaked in the spring of 1983 followed thereafter by a downward trend despite the continued decline in U.S. crab landings. The improvement in U.S. crab product prices that occurred in 1985 was amplified by the depreciation of the Canadian dollar vis-a-vis the U.S. dollar. Whereas it is difficult to forecast U.S. crab landings, the U.S. king crab catch is expected to show only slow growth during the latter part of the decade while U.S. snow crab landings are expected to further decline. The projected low U.S. catches of king and snow crab create a U.S. demand for king crab from Russia and Chile and increase demand for snow crab from Canada and elsewhere. Low U.S. crab inventories and the continued stagnation of U.S. crab landings auger well for the demand for Canadian crab in the U.S. in 1986.

Despite the decline in U.S. crab landings, total U.S. consumption of crab has remained relatively stable. However, as is indicated in

Figure 17, a major change in U.S. crab markets has been the introduction of the lower priced surimi crab products that appears to have developed a market niche without reducing U.S. crab consumption. Surimi is derived from deboned fish that has been washed with fresh water to remove certain natural substances and to which phosphates and sugars are added to slow protein degeneration. Surimi is not an end product in itself, but is a food base for other products such as the surimi-based "crab sticks". In 1984, the U.S. doubled its importation of surimi-based crab to 27,000 t, or roughly twice its overall imports of end products such as sections, meat and canned crab. The impact of surimi production on crab markets remains to be established but to date, surimi-based crab products have created a new market niche with only partial replacement of lower end crab products.

A positive factor in the marketing of Canadian snow crab has been the strong Japanese market for crab sections which developed partially as a result of the failure of the Alaskan crab fishery.

The major buyers of Canadian fresh or frozen crab remains the U.S. and Japan, as other countries in 1984 purchased only 17 percent of Canadian crab exports. About 90% of Canadian crab products are exported.

The market for Canadian canned crab continues to suffer from the competition of low quality, low priced South Pacific crab.

FIGURE 16 - UNITED STATES PRICE PER POUND OF A 5 LB. CRAB BLOCK, 1979-85

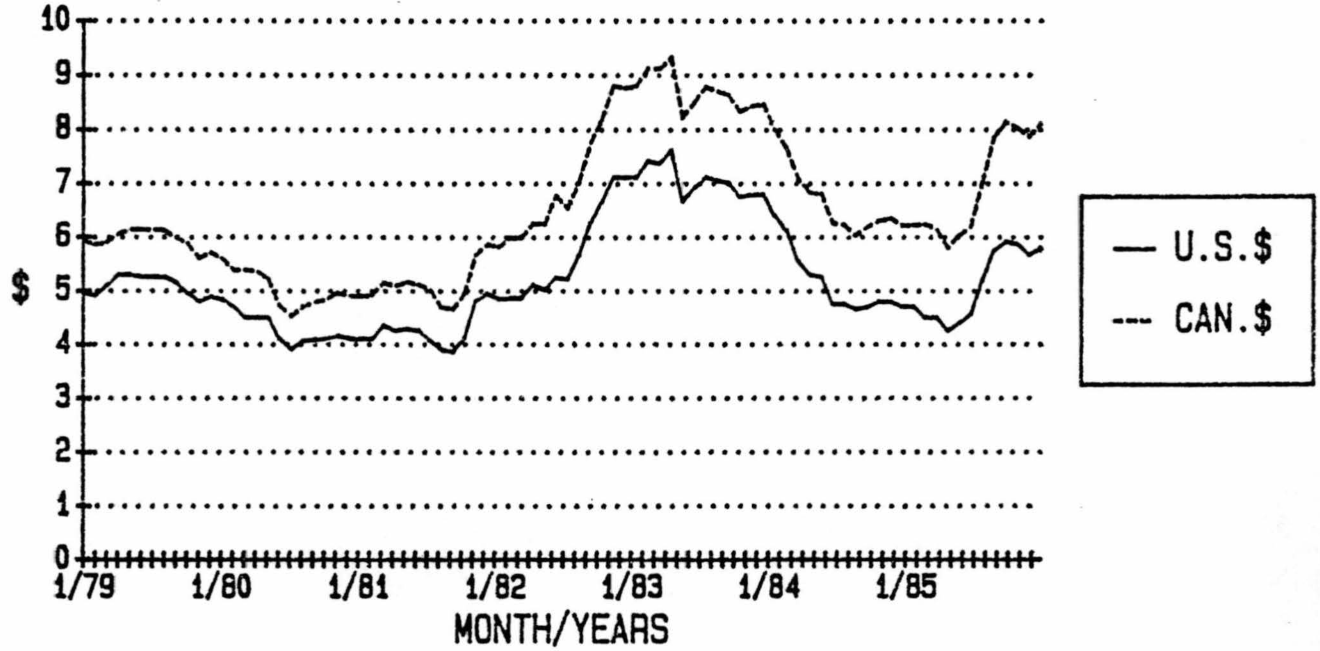
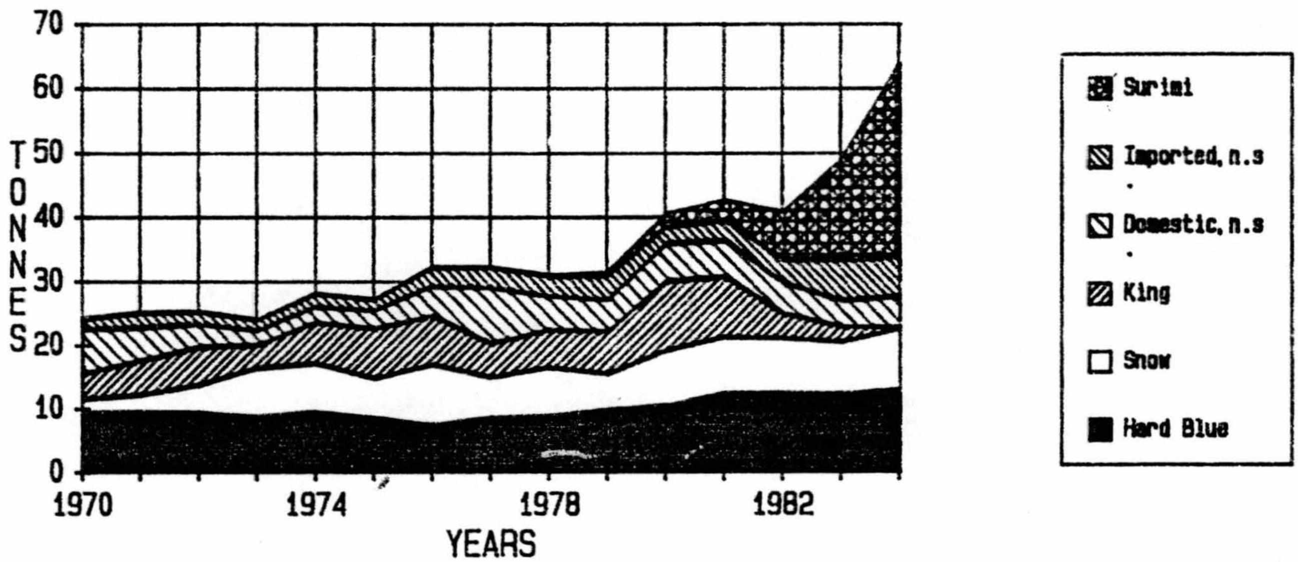


FIGURE 17 - UNITED STATES CRAB CONSUMPTION (000 TONNES), 1979-85



6. CONCLUSIONS

Resource

1. Reduce Effort: All Atlantic Canadian crab stocks have been managed at a target exploitation rate of 50-60% of the commercial biomass. However, there now appears to be considerable variability in the dynamics of different crab stocks and the capacity to maintain high levels of abundance under heavy levels of commercial biomass. The annual rate of exploitation must therefore be reduced in areas of low productivity if the crab stock levels are to be maintained.

   A decision to reduce the effort directed at a resource stock normally implies a reduction in the TAC but the crab fishery in the Newfoundland region has not traditionally been managed via TAC's. Other measures that may be used to reduce effort include restrictions in the number of vessels, trap limits, fishing zones, seasons, and enterprise allocations (which also require a TAC).

2. Soft Shell: The Newfoundland crab fishery in many areas suffered an excessive incidence of soft-shell crab in 1985 but the crab fishery in the Newfoundland Region has never been closed because of this condition. The closure of a fishery for the 2-3 months or less to allow soft-shell crab sufficient time to harden up would not reduce overall landings, but it would likely change the timing of catches and perhaps the group of fishermen who benefit.

3. Uncertainty: A fundamental characteristic of annually harvesting 50-60% of the commercial biomass is that there is a substantial reliance on annual recruitment. Individuals who invest in harvesting or processing crab would ideally tailor their investment to reflect the uncertainty associated with such variability in the recruitment of crab.

The resource management strategy should also facilitate fishermen participating in the crab fishery to the extent they deem to be prudent given the uncertainty over recruitment. The supplementary crab fishery is one example of a management initiative that will allow fishermen to reduce their reliance on a single species and thereby reduce the general uncertainty with which they operate. Other management tools that would facilitate fishermen participating in the crab fishery while limiting their financial exposure include:

a) enterprise allocations;
b) a predictable regulatory environment;
c) seasons that facilitate a fisherman participating in the crab fishery while participating in other fisheries.

However, it is easier to identify the ideal fisheries management tools than it is to implement such policies. Constraints on the management of fisheries in Newfoundland such as excess harvesting capacity, low incomes, and restrained geographical and occupational mobility often impede the implementation of an ideal strategy for resource management.

4. Development of the 2J Crab Fishery

It is both a costly and risky venture to develop a new fleet of vessels to harvest the offshore 2J crab stock. It is likely that the under-utilized crab vessels on the island will provide the nucleus of vessels to harvest the offshore 2J crab in the near future. The three variables that will affect the rate of development in Labrador are: the annual catch, the processing/transport capacity on the coast of Labrador, and the number of vessels that are licenced to catch crab. A conservative ceiling on the annual catch would be consistent with a go-slow approach to developing the resource and would give potential investors the necessary time and information to make harvesting and processing investments in the 2J crab fishery.

In 1985, there was also a supplementary crab fishery in Labrador fishing the inshore crab stocks. One difficulty with a 2J supplementary crab fishery is that the season is too short to permit a fisherman to fish crab and other species. Since a crab fishery will likely be a fairly specialized operation if there is to be a directed fishery at the inshore 2J crab stocks, the pot limits should be raised above 150 and the seasonal restrictions should be removed.

5. The 3K Crab Fishery

1) Crab landings in NAFO area 3K have declined despite a large expansion of the effort directed at the resource. The fleet has in the recent past fished virgin stocks and must subsequently rely to a greater degree on annual recruitment.

ii) The fishing capacity and net investment in the average 3K crab vessel has continually increased. The tendency toward larger, more expensive vessels increases the catch requirements of the fleet to cover its costs. Under the existing conditions, there is an insufficient resource for the 3K crab fleet to cover their costs by fishing crab. An increase in catch rates is unlikely and it is also unlikely that fishermen will find it worthwhile to fish a significant number of additional days in view of the low catch rates.

iii) The introduction of a supplementary crab fishery in 3K allows the 3K longliner fleet to diversify their catch and thereby reduces the risk associated with fixed gear fisheries for cod and turbot. The introduction of a supplementary fishery has re-distributed income from the regular crab fleet to supplementary crab fishermen. For example, the 856 t catch by the supplementary crab fishery in 1985 would be adequate to supply 3 - 4 average vessels in the established crab fleet with sufficient crab to break even under the conditions that existed in 1984.

iv) The introduction of a supplementary crab fishery has considerably increased the capacity that is available to harvest the 3K crab resource. An illustrative calculation may provide some insight into the amount of additional effort that has been licenced to fish 3K crab via the supplementary fishery. If the established fleet of 27 3K crab vessels fished 800 pots for 26 weeks, it would amount to 561,000 (27 X 800 X 26) crab pots weeks.

If 96 supplementary crab vessels are licenced to fish 150 pots for 10 weeks, it amounts to 144,000 (96 X 150 X 10) crab pot weeks. In 3K, some further measures may be required to limit the amount of effort that is deployed against the resource, in view of the large amount of licenced effort and the reductions in the 3K catch per unit effort. The management strategy in 1985 controlled effort via:

a) Trap Limits - Trap limits have a limited potential to promote economic viability especially given that approximately 300 3K longliners potentially qualify for supplementary crab licences. Trap limits are not an effective restraint on the total effort that is directed at the resource because of (1) the large number of longliners that could potentially enter the fishery and (2) the problems associated with identifying and enforcing such limits when traps are in the water. The trap limits on individual fishermen therefore are promoting an equitable distribution of the revenue from the supplementary crab fishery rather than restraining the total amount of effort. The trap limits must also be enforced if they are to effectively re-distribute the revenue from fishing crab.

b) Seasons - Season opening and closing dates have been used to ensure that the supplementary crab fishery remains a supplementary activity. However, it is important that the supplementary crab fishery be implemented in a manner that minimizes the necessity for fishermen to choose between fishing crab or fishing groundfish. There has been a traditional problem in taking the 2J3KL allowance for cod by fixed gear vessels less than 65 feet and it is highly desirable for fishermen to be able to fish supplementary crab without causing a dramatic reduction in their annual groundfish landings. In 1985, the supplementary fishery was conducted in the fall of the year when there is still potential for a groundfishery and the soft-shell crab problem can be significant. The catch of supplementary crab is affected by the timing of the season since the catch rate declines as the season progresses. Given the limited nature of the resource, the timing of the fishery has an obvious implication for the income distribution between the established and the supplementary crab fishermen.

c) The most effective mechanism for directly or indirectly limiting the effort by the crab fleet as well as the supplementary crab fleet would be by the application of quotas to fleet sectors or individual vessels. However, the imposition of vessel quotas on 3K crab is complicated by the lack of reliable predictable quotas on the resource.

d) In 1985, there was a soft-shell crab problem in many areas of 3K for certain portions of the year. The temporary closure of the 3K crab fishery due to soft-shell crab is complicated by the different seasons for 3K regular and supplementary crab fishermen. The different seasons implies that a closure may affect the sharing of revenues between regular and supplementary fishermen.

Status of 3L Crab Fishery

The 3L crab fleet remains mired in the problems of over-capacity caused by the decline in the offshore crab stocks. Much of the existing 3L crab fleet was created to fish an offshore stock that to a large degree cannot be currently fished at an economic catch rate. The future viability of these vessels will depend upon their ability to pursue other fisheries such as longlining, otter trawling, or scallop fishing. The potential success of 3L crab vessels in these other fisheries will be the topic of upcoming papers by the Program Coordination and Economics Branch, Newfoundland Region.

3Ps

The crab fishery in 3Ps provided an alternative fishery to those fishing enterprises that participated in the groundfish fishery in 1985. The introduction of a supplementary crab fishery in 3Ps has also been facilitated by the absence of an existing crab fleet. The future of the fishery will to a large extent, be determined by resource prospects in the area. The key management decisions are to determine the amount of effort that is to be directed at the fish stock, the season opening and closing dates and the extent to which management will utilize and enforce trap limits.

Break-Even Model

This paper has made extensive use of the break-even model outlined in Appendix I. Some of the significant limitations of the model were outlined in Section 3.1 A number of other observations can be made:

a. Break-even analysis is often used to calculate the resource requirements for a vessel to be economically viable. The model is a tool to consider the conditions under which a vessel breaks even. In particular, the core of this paper considered how landed prices, catch rates, fishing days, and certain factor costs interact in various break-even scenarios. Break-even analysis normally makes the unrealistic assumption that a vessel will fish the number of days required to cover its costs and as a consequence many break-even scenarios are unrealistic unless there is fundamental change in the fishery. A policy that is directed at ensuring a particular fleet break even should thereby specifically address the issue of how such a result is to be obtained.

b. This paper outlined a number of perversities in the response of the crew's income in break-even analysis. The break-even model indicates that the crew's income at the break-even level is highly dependent and perversely related to the conditions under which the vessel breaks even. Resource managers are therefore unable to avoid the issue of what is a "reasonable" income since it is a factor which must be explicitly incorporated into the analysis.

c. The crew share is set based upon prevailing attitudes toward reasonable labour incomes and risk-sharing. The analysis in Appendix II has indicated that the level of the crew share has a significant impact on the fishing effort required to break even and an even more significant impact on the deckhand's income that is implicit in the calculation of break-even landings. The sensitivity of break-even analysis to variations in the crew share further underlies the necessity for resource managers to consider the question of what is a reasonable level of earned income for fishermen in a seasonal or year-round fishery.

Processing

The processing sector has been revealed to suffer from excess capacity, a factor which increases the unit cost of processing crab and reduces (or eliminates) the economic surplus generated in that sector. Employment in crab processing is being reduced by the decline in landings, a trend to mechanize crab processing and the proliferation of plants which has spread employment more thinly.

Marketing

The local crab industry is a price taker on the world crab markets. The continued low level of U.S. crab landings and the current low inventories provides the local industry with a good opportunity for sales in the U.S. market. The local industry is constrained in its flexibility to produce crab sections for the lucrative Japanese market and surimi constitutes an uncertainty in the marketplace.

APPENDIX I

THE HARVESTING BREAK-EVEN MODEL

APPENDIX I

THE MODEL

The following equation represents one version of the current approach to calculating break-even vessel requirements (kg. per day fished). The model culminates, in Equation 5, in a calculation of the number of days a vessel must fish to break even at a fixed catch rate per day. It is notable that repair and maintenance (M) and gear costs (G) are fixed costs in the model as there is insufficient data to indicate the extent such costs vary with fishing effort.

1) $TR = TC$

2) $TR = p\beta d$

3) $TC = a_0 d + a_1 \beta d + (C+S) p\beta d + M + G + F$

4) $p\beta d = a_0 d + a_1 \beta d + (C+S)\ p\beta d + M + G + F$

$p\beta d - a_0 d - a_1 \beta d - (C+S)\ p\beta d = M + G + F$

$d(((1-C-S)p-a_1)\beta - a_0) = M + G + F$

5) $$d = \frac{M + G + F}{(((1-C-S)p-a_1)\beta - a_0)}$$

Where:

TR	=	Total Revenue
TC	=	Total Cost
p	=	Landed Crab Price (¢/kg.)
a_0	=	Unit Operating Cost Per Day Fished
d	=	Days Fished Required to Break-Even.
a_1	=	Unit Operating Cost Per kg. of Landed Crab
β	=	Daily Catch Rate (kg.)
C	=	Deckhand's Share of Landed Value of Catch
S	=	Skipper's Share of Landed Value of Catch
M	=	Repair and Maintenance Costs
G	=	Gear Costs
F	=	Fixed Costs Including Rate of Return on Invested Capital, Depreciation, as well as Other Fixed Costs.

In the model the denominator of equation 5 represents the operating margin defined as the difference between daily revenue and variable cost per day fishing. For the model to yield a positive estimate of the number of fishing days required for an enterprise to break even, the revenue per fishing day must exceed variable costs per fishing day. Furthermore, as the margin between revenue and variable costs per fishing day becomes very small in absolute terms, the model can generate explosive estimates of fishing days required to break even unless a ceiling is placed on the number of fishing days a vessel can fish.

APPENDIX II

SELECTED FEATURES OF BREAK-EVEN ANALYSIS

APPENDIX II

FISHING DAYS REQUIRED TO BREAK-EVEN

Section 3 indicated the relationship between days fished, daily catch rates and landed crab prices within break-even analysis. This Appendix will elaborate on those relationships and in the process, indicate several perversities in the results of the break-even model indicated in Appendix 1.

Impact of Daily Catch Rates

This section considers for a range of daily catch rates and landed crab prices, the number of days a typical crab vessel must fish to cover its costs. Figure 18 pertains to the average 3K crab vessel; Figure 19 applies to the average 3L crab vessel; and Figure 20 compares the two fleets. Naturally, the higher the price of landed crab and the daily catch rates, the fewer days an enterprise must fish to break even; the converse also applies. The crab prices represent the average negotiated price for landed crab in 1983 (74¢/kg.), 1984 (88¢/kg.) and a price provided for comparison purposes ($1.00¢/kg.) The figures indicate how crab availability (denominated in average daily catch) and market factors (denominated in landed crab prices) affect the number of days an enterprise must fish to cover its costs.

For example, in Figure 18, at an average price of 74¢ per kilogram, the average 3K crab vessel must catch 2,400 kg. of crab per day and fish the maximum available 120 days to cover its costs; at catch rates below 2,400 kg., the average vessel does not break even but fished the maximum number of available days and each increase in

FIGURE 18 - BREAK-EVEN FISHING EFFORT FOR AN AVERAGE 3K CRAB VESSEL

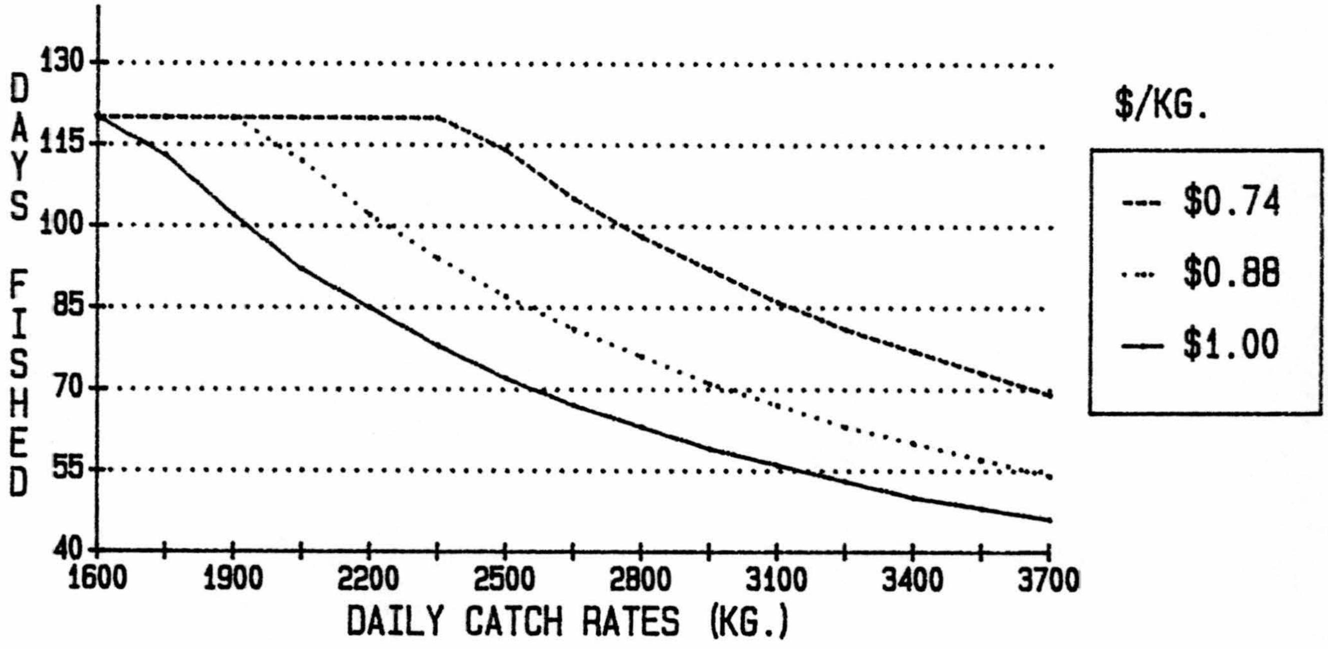
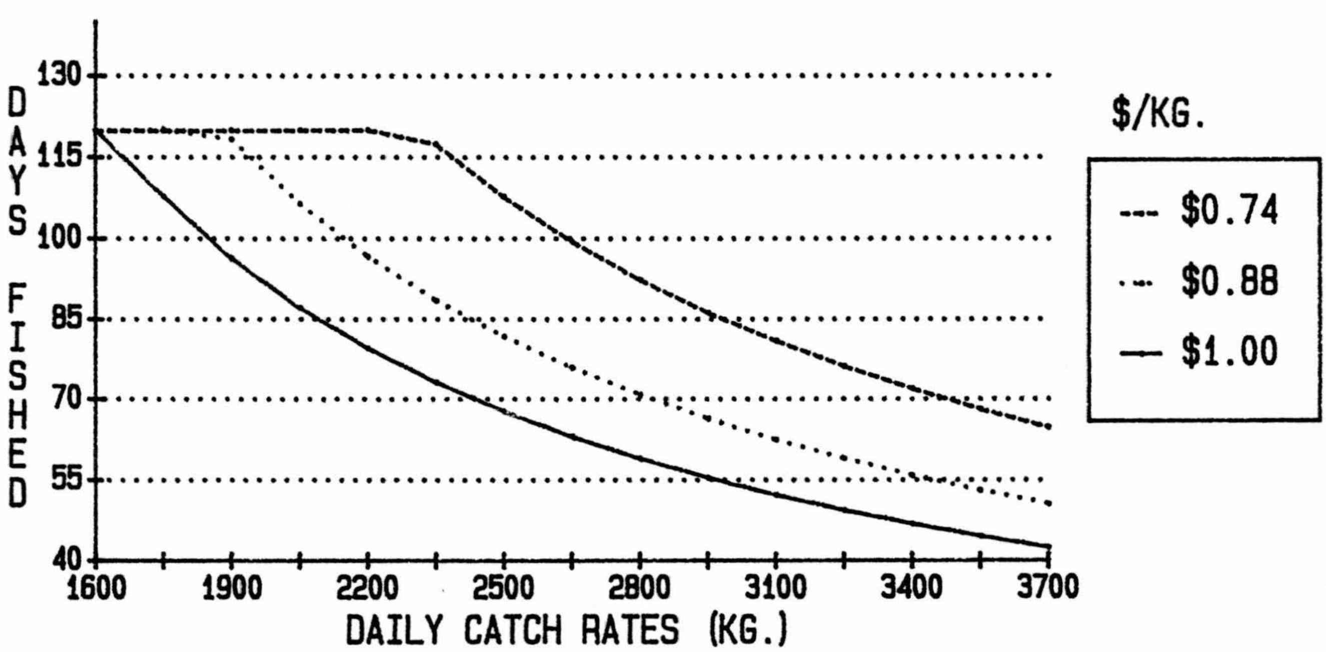


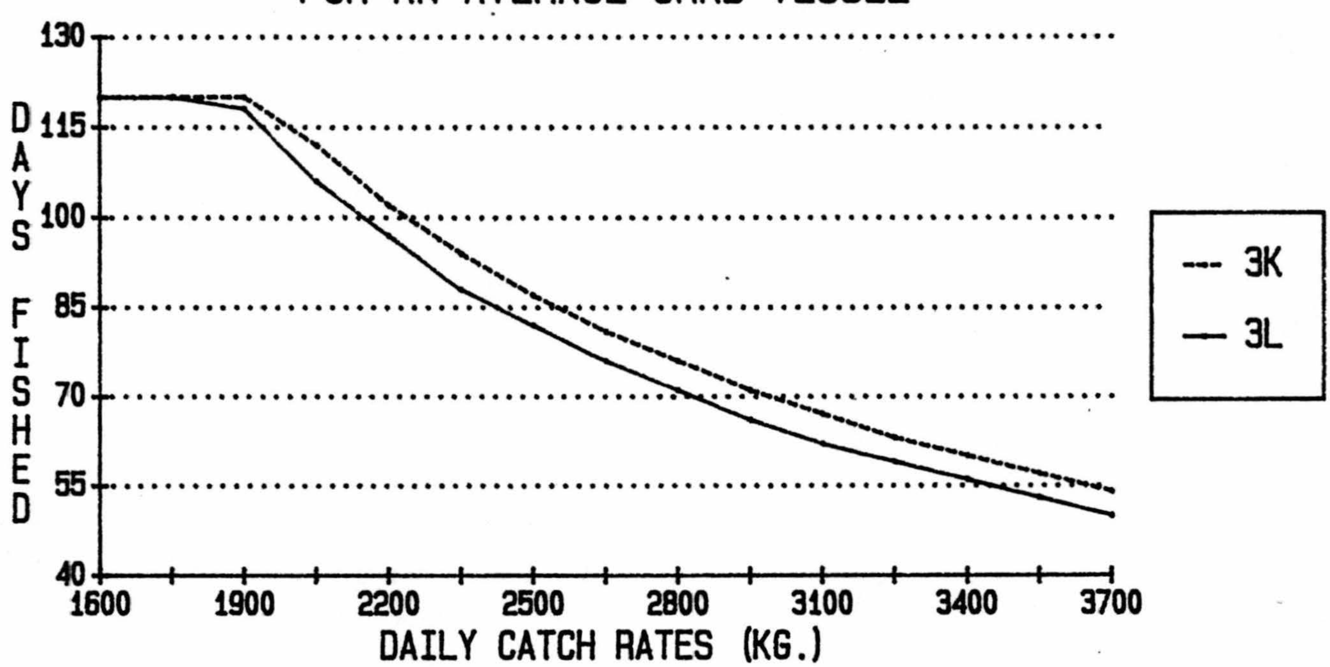
FIGURE 19 - BREAK-EVEN FISHING DAYS FOR AN AVERAGE 3L CRAB VESSEL



the catch rate reduced its financial losses. At catch rates above 2,400 kg. (at a price of 74¢ per kilogram), each increase in the catch rate reduced the number of days an average 3K crab vessel must fish to break-even. Naturally, the higher the price of crab, the lower the catch rate required for an enterprise to break-even.

The comparison in Figure 20 highlights a point that was made in Table 5. If the average 3K and 3L crab vessels are assumed to fish at the same catch rate (and receive the same price for their landed crab (88¢/kg), the less expensive and smaller 3K vessel requires a greater number of fishing days to cover its costs than the average 3L vessel. This oddity is primarily caused by the sensitivity of the break-even model to variations in the crew share and because the average 3L vessels in 1984 allocated a smaller share to the crew than the average 3K vessel.

FIGURE 20 - BREAK-EVEN FISHING EFFORT FOR AN AVERAGE CRAB VESSEL



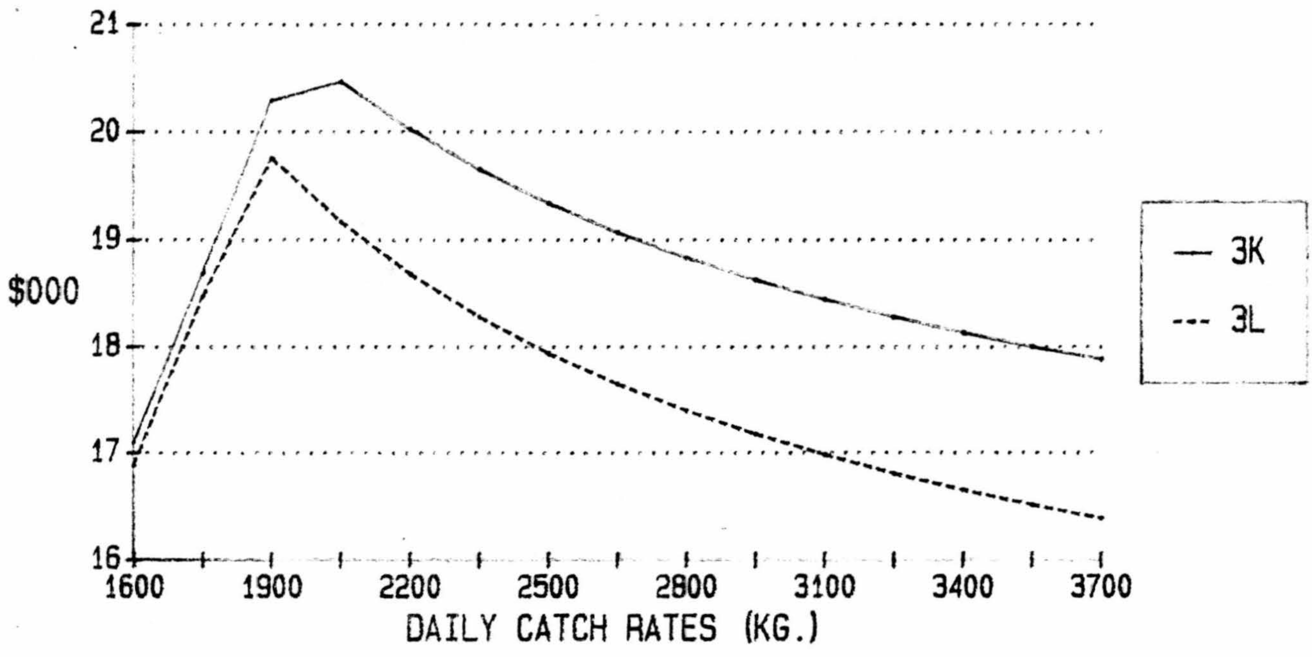
Impact of Catch Rates on Crew Incomes:

It would be anticipated that the higher the daily catch rates, the higher the crew's incomes, however, such is not always the case in the break-even model outlined in Appendix I. Figures 21 indicates the deckhand's incomes that are associated with the catch rates of the average vessel specified in Figure 20. The data indicate that an increase in the daily catch rate only increases the income of deckhands if the vessel is fishing the maximum number of available days, but still not breaking even. However, as indicated in Figure 21, if the catch rate is adequate for a vessel to cover its costs, further increases in the catch rate will reduce the income of deckhands as per the model outlined in Appendix I. The explanation for a decline in incomes at the break-even level as a result of a catch rate increase is that if a vessel is breaking even, as per the model in Appendix I, an increase in the catch rate reduces the number of days a vessel must fish to break even and lowers the total value of fish required to break even. A reduction in the total value of fish required to break even reduces the crew's income at break even since the crew is paid a percentage of gross revenue.

The response of the deckhand's income at the break-even level to variations in catch rates is not unique to catch rate variations. Any factor which increases (decreases) the operating margin per day will reduce (increase) the crew's income at the break-even level. An increase in the operating margin per day reduces the value of fish required to break even and lowers the crew's incomes at the break-even level. The crew's income in break-even analysis as per the Model in Appendix 1 is not a fixed amount, but is dependent on the price, catch rate, and cost scenario under which the vessel breaks even. Of course, fishermen in actuality continue to fish after they break even and a catch rate increase will therefore never in fact lead to a reduction in their incomes.

This section of Appendix 2 has elaborated on the degree that landed prices or resource availability (catch rates) affect the outcomes of a particular break-even model. Any factor which has a bearing on the vessel's operating margin per day would have an impact of similar nature.

FIGURE 21 - DECKHAND'S INCOME AS PER BREAK-EVEN ANALYSIS



Impact of Changes in the Crew Share

The share of gross revenue dedicated to the earnings of the skipper and crew is a significant component of a harvesting vessel's costs. This section considers the sensitivity of hypothetical changes in various factor prices on the number of fishing days required for an enterprise to break even.

Table 11 compares the economics for the average 3K and 3L crab vessel using the catch rates for the respective fleets that were identified by the 1984 costs and earnings survey. Since the average 3L crab vessel in 1984 landed less crab per fishing day than the average 3K vessel, using actual rather than a common catch rate widens the gap between the performance of the average 3K and 3L vessel.

Table 11 provides the basis for a number of comments:

a. The average deckhand's earned income at the break even catch is more sensitive to changes in the crew share than is the calculated number of fishing days required to break-even. For example, for the average 3K crab vessel, with a hypothetical change in the crew share from 49.6 to 52.4 percent of gross revenue (an absolute change of 2.8 points and a relative change of 5.6 percent), then the average 3K vessel would have to fish 8.6 percent more days (at its catch rate) to break even; however, the deckhand's income at the new break even catch would be 14.1 percent

TABLE 12
SELECTED IMPACTS OF HYPOTHETICAL CHANGES IN THE CREW SHARE AT THE BREAK-EVEN CATCH LEVEL FOR AN AVERAGE CRAB VESSEL*

	3K CRAB		3L CRAB	
CREW SHARE	FISHING DAYS REQUIRED TO BREAK-EVEN	AVERAGE DECKHAND'S EARNED INCOME ($)	FISHING DAYS REQUIRED TO BREAK-EVEN	AVERAGE DECKHAND'S EARNED INCOME ($)
44	51	9,047	67	10,120
46.8	54	10,285	72	11,581
49.6	58	11,706	78	13,282
52.4	63	13,353	85	15,287
55.2	68	15,286	93	17,687
58	75	17,587	103	20,609
60.8	83	20,369	116	24,246
63.6	92	23,804	120	26,243
66.4	105	28,151	120	27,398
69.2	120	33,612	120	28,554
PERCENTAGE CHANGE				
44	NA	NA	NA	NA
46.8	5.8	13.6	7.4	14.4
49.6	7.4	13.8	8.3	14.6
52.4	8.6	14.1	8.9	15.1
55.2	7.9	14.7	9.4	15.6
58	10.3	15.0	10.7	16.5
60.8	10.6	15.8	12.6	17.6
63.6	10.8	16.8	3.4	8.2
66.4	14.1	18.2	-	4.4
69.2	14.7	19.3	-	4.2

*It is assumed that the maximum number of available days is 120. A vessel fishing 120 days is likely not breaking-even but is minimizing its losses.

higher. <u>Changes in the crew share have a pronounced impact on the amount of effort a vessel must undertake to break even but the impact on the deckhand's income is substantially greater</u>. The sensitivity of the deckhand's income at the break-even catch level to changes in the crew share is readily explicable; an increase in the crew share increases the volume (and value) of the fish a vessel must land to break even and so the average deckhand gets a larger share of a larger amount of fish.

b. As indicated in Table 11, an increase in the crew share always increases the crew's income in the model outlined in Appendix 1. Furthermore an increase in the crew share, beyond the share at which the vessel must fish the maximum available number of fishing days, will increase the crew's income but also increase the enterprise's losses on a dollar for dollar basis.

c. As the crew share rises, the margin declines between revenue and variable costs (including labour) per fishing day. As the margin declines between revenue and variable costs per fishing day, each increase in the crew share has a greater marginal impact on: a) the number of days a vessel must fish to cover its fixed costs; and b) the deckhand's income at the break-even catch. The gap between revenue and variable costs per fishing day has a very significant impact in a model designated to calculate the number of days a vessel must fish to break even.** Any factor which affects the operating margin per fishing day will have a direct impact on the results of a break even model.

d. The crew share is of such significance within break-even analysis that fisheries managers, in calculating the resource requirements of a fleet, must ensure that the crew share arrangements are compensating fishermen to an "appropriate" level. Fisheries managers are thereby forced to address the question of what is the appropriate

** As the gap between revenue per day fished and variable costs of fishing decline with increases in the crew share, eventually the vessel will be forced to fish the maximum number of potential days but will be unable to break even.
There also exists a hypothetical level of crew share at which after deducting the share of gross revenue deducted from crew compensation, the remaining revenue is insufficient to cover the non-labour variable costs. If an enterprise in unable to cover its labour and non-labour variable costs then its optimal position is to not fish.

level of earned income for fishermen in a seasonal or year-round fishery. The model outlined in Appendix 1 is suitable for analysing the break-even requirements of an average vessel; however, the crew's income must be constrained to fall within certain bounds which are deemed to be "appropriate".

Since crew share is so intrinsic to the economics of a harvesting enterprise, it is important that it be fully understood. Outstanding questions on crew share are:

i) To what extent are crew shares more complicated than simply a portion of gross revenue? For example, to what extent are deckhands responsible for fuel provisions or ice? What is the variance in the types of crew sharing arrangements that are used in the fishery?

ii) The factors that determine crew share should be identified. Are crew shares based on traditional attitudes toward appropriate incomes and risk-sharing? Presumably a minimum share and "expected" income is necessary to attract a crew.

iii) To what degree does the crew share vary across fleets, species, gear types, and NAFO Divisions?

iv) Are crew shares stable across years? How much and how quickly do crew shares respond to changing conditions? Are mid-season adjustments made in sharing arrangements?

v) Is the crew share affected by the process whereby a fisherman's UI is based on earned income?

vi) If the skipper and vessel owner is the same individual, is the distinction between the skipper and vessel share artificial? The vessel share in break-even analysis is dedicated to paying the vessel's fixed and variable costs and is a very significant factor in break-even analysis.

APPENDIX 3

STATISTICAL APPENDIX

TABLE A
CRAB LANDINGS AND VALUE LANDED BY NAFO DIVISION, 1969-1985[1]

LANDINGS (t)	2J	3K	3L	3Ps	TOTAL
1969	-	-	319	-	319
1970	-	68	821	-	889
1971	-	-	1376	-	1376
1972	-	72	1412	-	1484
1973	-	89	2563	-	2652
1974	-	308	2309	809	3426
1975	-	651	1360	-	2011
1976	-	394	2259	15	2668
1977	-	435	3497	5	3937
1978	-	641	6765	176	7582
1979	-	849	10333	13	11195
1980	-	582	8846	-	9428
1981	-	1224	12976	4	14204
1982	-	2501	10990	16	13507
1983	-	4897	6220	4	11121
1984	-	5037	4529	-	9566
1985[2]	335	3967	2636	662	7596

VALUE LANDED ($,000)	2J	3K	3L	3Ps	TOTAL
1969	-	-	58	-	58
1970	-	5	140	-	145
1971	-	-	245	-	245
1972	-	14	263	-	277
1973	-	16	768	-	784
1974	-	69	744	273	1086
1975	-	158	339	-	497
1976	-	132	749	5	886
1977	-	187	1465	2	1654
1978	-	325	3423	89	3837
1979	-	493	5910	7	6410
1980	-	326	4931	-	5257
1981	-	674	6992	2	7668
1982	-	1565	6464	10	8039
1983	-	4629	5780	4	10413
1984	-	3657	3205	-	6862
1985[2]	297	3499	2130	625	6552

1 Data based on point of landings rather than point of capture.
2 1985 Data is preliminary.

TABLE B
MEASURES OF EFFORT EXPENDED BY CRAB VESSELS, 1979-1984

	NUMBER OF VESSELS	TOTAL POT HAULS	DAYS FISHED PER VESSEL	POT HAULS PER VESSEL	POT HAULS PER DAY FISHED
3K					
1979	13	79,311	45.9	6,100	133
1980	13	58,455	32.7	4,496	137
1981	13	104,297	60.5	8,022	132
1982	14	203,451	77.2	14,532	188
1983	23	459,321	70.0	19,970	285
1984	27	571,605	61.2	21,170	345
3L					
1979	39	671,277	80.8	17,212	213
1980	39	606,599	75.0	15,553	207
1981	39	966,271	90.6	24,776	273
1982	38	758,827	64.0	19,969	312
1983	38	687,407	49.3	18,089	367
1984	38	625,721	44.2	16,466	372

TABLE C
SELECTED MEASURES OF CRAB VESSEL PRODUCTIVITY, 1979-1984

	LANDINGS		CATCH PER			VALUE OF CATCH PER	
	(t)	$,000	VESSEL (t)	POT HAUL (KG.)	DAY FISHED (KG.)	VESSEL ($)	DAY FISHED ($)
3K							
- 1979	849	493	65.3	10.7	1,422	37,900	825
- 1980	582	326	44.7	9.9	1,369	25,100	767
- 1981	1,224	674	94.1	11.7	1,555	51,800	856
- 1982	2,501	1,565	178.6	12.3	2,313	111,800	1,447
- 1983	4,897	4,629	212.9	10.6	3,039	201,200	2,873
- 1984	5,037	3,657	186.5	8.8	3,047	135,400	2,212
3L							
- 1979	10,333	5,910	264.9	15.3	3,279	151,500	1,875
- 1980	8,846	4,931	226.8	14.5	3,024	126,400	1,685
- 1981	12,976	6,992	332.7	13.4	3,671	179,300	1,978
- 1982	10,990	6,464	289.2	14.5	4,518	170,100	2,660
- 1983	6,220	5,780	163.6	9.0	3,320	152,100	3,085
- 1984	4,529	3,205	119.2	7.3	2,695	84,300	1,907

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