ENVIRONMENTAL PERCEPTION IN TWO LOCAL FISHERIES: A CASE STUDY FROM EASTERN NEWFOUNDLAND

DAVID SHORTALL

ENVIRONMENTAL PERCEPTION IN TWO LOCAL FISHERIES:
A CASE STUDY FROM EASTERN NEWFOUNDLAND

by

© David Shortall

Thesis submitted to the Faculty of Arts
in partial fulfillment of the requirements
for the degree of Master of Arts,

Department of Geography
Memorial University of Newfoundland
March, 1973.

ABSTRACT

Few attempts have been made to examine the role of perception by fishermen in marine environments, although the invisibility of the prey and the uncertainty of the elements require that fishermen be aware of the effects of the environment. It was the purpose of the present study to examine how two groups of Newfoundland fishermen, the Petty Harbour trap and handline fishermen and the St. John's longliner gillnet fishermen, perceived their natural environment, and to establish how their adaptations were influenced by these perceptions.

The fieldwork was carried out between May and December, 1971. Structured and unstructured interviewing techniques were used to question the fishermen in both communities, while several trips were made to the fishing grounds to observe the fishing operation. Recorded environmental data were collected from official sources and were used to compare the fishermen's perception of the environment with actual conditions.

It was found from an analysis of the data that both groups of fishermen expressed an awareness of only certain elements of the natural environment. These elements were selected according to their effects upon fish behaviour and upon the catching operation. In this

way, the fishermen formed a mental image or model of the environment which enabled them to simplify their understanding of its complexity. Each group of fishermen was found to form a distinct image of the environment which varied according to the size of the fishing area, the extent of the fishing season, the variety of species sought, and the kind of technology utilized. The fishermen tended to express how they would act in a given situation according to the effects of specific elements. Actual adaptations, however, were influenced from day to day by the unpredictable occurrence of wind, tide, fog, and fish behaviour, as well as by the differing investments in the fishery.

ACKNOWLEDGEMENTS

The research and compilation of the present study were expedited by the services and goodwill of a varied group of individuals and institutions at all stages of its development.

At Memorial University of Newfoundland's Department of Geography, Dr. W.S.W. Nowak supervised the study, while Dr. A.G. MacPherson and Dr. J. Mannion acted as advisers. Mr. G. Learning executed the finished figures included in the text, and Mrs. M. Rose typed the manuscript. The Institute of Social and Economic Research provided financial support for field research.

In Petty Harbour, the following fishermen gave freely of their time, knowledge and hospitality: Messrs. L. Bidgood, D. Chafe, Jacob Chafe, John Chafe, R. Chafe, T. Clarke, J. Hearn, J. Kieley, J. Stack, William B. Stack, William M. Stack, D. Weir, and C. Whitten.

In St. John's, the following fishermen matched the kindness of their Petty Harbour counterparts: Messrs. H. Alcock, E. Dean, F. Flight, C. Garland, F. Hutchings, C. Johnson, W. Rowe, J. Simms, W. Slade, R. Stanford, B. Wareham, H. Wareham, C. Wells, and J. Wells.

Various departments of the Federal Government of Canada and the Provincial Government of Newfoundland and

Labrador provided information and statistical data.

To all the above mentioned, I would like to express my sincere gratitude, as I do with apologies to any I may inadvertently have omitted.

My special thanks go to Patricia Thornton whose constant criticism and encouragement were invaluable.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

Fishing is classified as a hunting occupation, in which the fishermen seek, pursue, and capture mobile animals in patterns of exploitation which are strongly influenced by the natural environment. Unlike terrestrial hunting, the prey sought by fishermen are difficult to observe directly and the operation takes place in an environment affected by hydrographic as well as by meteorological conditions. The fishermen attempt to adapt to these conditions, and in this process develop an awareness of, and a relationship with, the natural environment that differs markedly from that encountered among terrestrial hunters.

No previous attempts have been made to provide a comprehensive examination of how fishermen perceive and adapt to the natural environment. Of the works which have appeared on various aspects of human behaviour in a marine setting since 1960, environmental perception has generally been neglected.

The most important contributions to the study of the adaptation of fishermen in marine environments have been made by anthropologists such as Faris, Morrill, Fraser, Davenport, Andersen and Wadel. Faris[1] provided an ethnographic study of a rural Newfoundland fishing community in which the perception or cognition of the people about their physical, social, and economic environments was the main focus. He noted the importance of the sea as the basic determinant of life in the community and found that fishermen tended to develop an elaborate terminology about it, based upon different environmental conditions. He was more interested, however, in examining how these observations about the sea were expressed in the language of the community than in how fishermen applied them to the prosecution of the fishery.

Morrill[2] examined how some Virgin Island fishermen assimilated through direct observation and acquired by folk belief, an elaborate knowledge of the taxonomy, behaviour, and ecology of the organisms within their marine environment. He also noted briefly how fishermen adapted to their knowledge of fish behaviour by using different catching methods and to the influence of current and wind conditions upon the fishing operation. He omitted to describe the effects of these environmental elements in detail, however. His most important contribution was to provide an understanding of some kinds of observations that fishermen make about fish behaviour. However, he tended to be more concerned with discussing fish behaviour per se without identifying those aspects which were important in enabling the fishermen to adapt their fishing operation. Morrill, like Faris, examined the observations themselves rather than adaptations to them.

Fraser,[3] in his study of the Malay fishermen, noted the high value that the fishermen placed upon the ability to locate fish schools. He established that the fishermen determine the presence of their prey by detecting sounds made by fish, or by observing organisms that the fish stir up in the water. Fraser's main contribution was his observation that the Malay fishermen have a comprehensive view of their environment that demands knowledge not only of fish behaviour and the conditions which affect it but also of wind and sea conditions which influence the catching operation. He did not describe, however, the particular weather and sea conditions which were important to the catching operation or how the Malay fishermen adapted to them.

Davenport[4] followed a different approach in discussing the problem of adapting the fishing operation to uncertain environmental conditions. By using a game theoretical approach,[5] he described how Jamaican fishermen overcame the hazardous effects of water currents upon fishing gear by devising a number of strategies aimed at minimizing the effect of the hazard while at the same time maximizing fish catches. He described this as a minimax strategy. The strategies developed by the fishermen over a long period of trial and error were found to be similar to those predicted by Game Theory, showing that the fishermen applied their accumulated knowledge of the fishing environment through strategies which achieved the theoretically optimum usage. Davenport's game theoretical approach, however, was based upon one variable. The findings of Faris, Morrill, and Fraser would suggest that in other circumstances, several variables may be equally significant.

Andersen and Wadel[6] discussed the problem of information management in fishing and suggested that decisions are rarely taken on the basis of detailed or predetermined information. The authors noted that the fishermen must cope with the uncertain and uncontrollable natural movements of fish and with environmental conditions which are constantly changing and are only observable at the fishing grounds. While making an important generalization about the uncertain conditions of knowledge under which fishermen operate, they did not isolate the specific kinds of environmental information upon which fishing decisions are based. An understanding of this information is necessary to ascertain which elements of the environment the fishermen perceive to be significant and how they respond to these elements in their decision making. This is a necessary prerequisite to an understanding of how fishermen adapt to their environment.

The aforementioned review suggests that fishermen tend to have a special awareness of their environment and tend to develop a unique relationship with that environment but that no study has yet attempted to identify all the key elements of the marine environment and to examine how fishermen perceive and adapt to each of them. The purpose of this thesis is to present such a study by providing a comprehensive analysis of the perception of and adaptation to those biological, hydrographical, and meteorological elements deemed by the fishermen to be fundamental to the operation of the fishery.

Most studies by geographers of the man-environment relationship have tended to examine this relationship without explicit elaboration of the role of perception as an intervening variable in comprehending how man adapts to his environment. The perception factor seems to be important in any discussion of fishing adaptations because of the intimate involvement that fishermen have with their environment and because of the selective awareness of elements of the environment. An approach which focuses on perception should therefore provide meaningful insights into the way fishermen adapt to the environment. Any attempt to assess the role of perception in the man-environment relationship must cope with two main problems - (1) the lack of a well-developed theory upon which a scientific treatment of perception can be based, and

(2) the lack of a defined methodology. The first problem is referred to in reviews by Saarinen,[7] and Wood[8] and is generally attributed to the infancy of environmental perception as a field of enquiry. Saarinen suggested that more empirical studies must be completed before the stage of theory building will be reached.

The second problem is partially derived from the first. It relates to the apparently unique and complex way in which each individual perceives and responds to his environment and the consequent difficulty of reducing perception to measurable form or generalization. Environmental perception is held to be an essentially subjective process in which an individual forms a distinct "image"[9] of the environment in order to deal with it.

The notion of the image incorporates the concept of "bounded rationality" which suggests that man does not possess omniscient reasoning powers about his environment nor the ability to predict perfectly; instead, he possesses only limited information, and behaves rationally only in terms of the information at his disposal. Simon argues that

> ... the first consequence of the principle of bounded rationality is that the intended rationality of the actor requires him to construct a simplified model of the real situation in order to deal with it. He behaves rationally with respect to this model and such behaviour is not even approximately optimal with respect to the real world. To predict his behaviour we must understand the way in which

> this simplified model is constructed and its construction will certainly be related to his psychological properties as a perceiving, thinking, and learning animal.[10]

Man therefore makes decisions, evaluations, and preferences on the basis of the image or model of the environment rather than upon the environment as it is known to exist in any real or objective sense.

From this process is derived the distinction between the perceived environment of the image and the real environment of nature.[11] The former is said to contain each individual's awareness resulting from his experience, learning, or physical sensitivity, while the latter, although not clearly defined, is assumed to consist of the whole environment which is external to man but from which the perceived environment is abstracted. Doherty[12] noted the importance of relating the perceived and real environments as a means of determining which attributes of reality are important to man in his image-making role while Downs,[13] assuming a finite capacity for the storage of relevant information about the environment, similarly suggested a need to determine what factors people consider important about their environment, and how, after the relative importance of these factors are estimated, they are employed by them in decision-making. Lowenthal[14] discussed the uniqueness of each person's perceived environment while Wood[15] and Brookfield[16] noted the difficulty of measuring the subjective variables that comprise that environment.

Certain aspects of the perceived environment are known to be shared, and hence conditioned, by the groups of which each individual is a member. Lowenthal suggested that "each culture screens perception of the milieu in harmony with its own particular style and techniques".[17] Doherty, noting that the concept of group images is basic to geographical research, stated that while each individual's image of reality is in its entirety highly personal, there are aspects of that image which are shared with others. "There are underlying similarities in the way people of similar backgrounds view their environment."[18] In a similar vein, Brookfield discussed the difficulty of separating the perceived environment of the individual from that of the group. He states that "both exist inextricably in the perceived environment of the individual".[19] Burton and Kates,[20] examining the perception of environmental hazards in relation to the use of natural resources, speculated on the tendency for users of the same resource to have different perceptions. They suggest, however, that these differences may become blurred over time, leading to little variation in hazard perception. This is held to be particularly true for those hazards which have a high frequency of occurrence. One can logically infer that in environments where hazards and other conditions tend to be both regular and frequent, individual perceptions would tend to become similar.

Most studies of environmental perception in relation to the use of natural resources have been concerned with examining adjustment to specific and relatively infrequent natural hazards, such as floods and drought, and the role of perception in this adjustment. These studies were generally made at the macro level. A review of this hazard literature is contained in the works of Saarinen[21] and of Sewell, Kates, and Phillips.[22] The latter provided the most comprehensive survey of the contributions made by geographers to the study of the influence of weather and climate upon different activities and upon the decision-making process. They noted the existing lack of understanding of the relationship between the perception of atmospheric variables and adjustment to them and suggest two general research priorities. These are (1) the study of the sensitivity of different economic activities to various weather parameters and (2) the study of the relationship between the perception of atmospheric variables and actions to accommodate them. These suggestions are directed mainly towards an analysis of critical or extreme conditions which are normally studied at the macro level. Saarinen noted the lack of attention given to small-scale studies by geographers and suggests that more attention be given to perception of normal or everyday weather, climate, and physical processes.[23]

From a review of the geographical literature using perception theory and methodology, several conclusions can be made which are of importance to the present study. Small-scale studies focusing upon the perception of normal or regularly occurring natural events should provide an increased understanding of the role of perception in the man-environment relationship. Within such studies it is important to identify the components of the perceived environment, to examine how groups adapt to these components, and to establish the relationship between these components and the real or objective environment from which they are abstracted.

The purpose of the present research is to identify the components of the natural environment which two different groups of fishermen perceive to be significant and to establish to what extent the perception of these elements influence the conduct of the fishery. The basic hypotheses developed for testing were - that fishermen, exposed to a complex natural environment, select from it those elements that they believe to have the most important effects upon the fishery; that the fishing operation is largely a response to the natural environment, and as such it is a response to an image of that environment.

The data were derived from case studies of two fishing systems, the Petty Harbour trap and handline fisheries, and the St. John's longliner gillnet fishery.

These fisheries were chosen on the basis of two related criteria (a) contiguity, and (b) fishing methods. These fisheries function in an area off the northeastern Avalon Peninsula of Newfoundland for which recorded environmental data are available. Within this area, each fishery occupies a particular zone which varies in extent according to the different fishing methods employed. The latter determine variations in the duration of the fishing season and in the types of species sought. In this way it is possible to identify how the size of the area, the season, and the type of fishing methods employed influence the way in which fishermen perceive and respond to the environment.

The field work was carried out between May and December of 1971. Field data was collected by personal interviews using both structured and unstructured questioning techniques, as well as by personal observations made during several visits to the fishing grounds. Objective data on the natural environment were obtained from an analysis of available recorded information.

Crew skippers were the only fishermen interviewed because it was decided that as owners of fishing equipment and as decision-makers, they would express a more detailed awareness of the natural environment than would crew members. Thirteen of the trap and handline skippers were interviewed in Petty Harbour, this number representing some 33% of the population of skippers. In St. John's, fourteen of the longliner operators were interviewed, this number accounting for 82% of those using that port in 1971. As many interviews as possible were conducted given that field time was limited by the availability of informants during an intense fishing season. It was also found that as the number of people interviewed increased, responses became repetitive and little new information was expressed.

Each fisherman was interviewed for an average of two hours using the structured and unstructured approaches. The format of the structured portion of the interview provided a means of identifying the major elements of the marine environment held to influence the fishery, their variability and frequency of occurrence, the preference for fishing locations, and the seasonal pattern of the fishery. This format, however, provided limited insight into the ways in which the fishermen perceived and adapted to the environment. This problem was approached by using the unstructured technique. In this format, verbal cues concerning specific types of wind, tide, or fish behaviour were used to encourage the informants to express their awareness of the environment. Simple questions which enticed the fishermen to talk about their experiences on the fishing grounds when influenced by specific environmental conditions were also posed. The latter approach helped establish many adaptations as responses to particular stimuli. Many of the questions asked of the fishermen were formulated with reference to the behaviour of other fishermen in a similar situation. This served both as a check on the reliability of the data and as a means of distinguishing between group responses and idiosyncratic behaviour.

The informants often couched their responses in a manner that suggests that the fishermen as a group hold similar general attitudes about critical factors operating in their environment. Moreover, responses were often expressed in hearsay fashion, such as "they use to always claim you'd have a breeze of wind before the caplin came" or in terms of group identification, such as "everybody knows the best winds for fishing". Most of the perception data were collected in verbal form and are recorded herein as personal communications. Only personal value judgments and long quotes about specific adaptations are attributed to their authors. Short, common expressions are not footnoted. The informants were invariably unable to attach any ranking significance to individual environmental phenomena. This precluded the use of statistical tests involving even simple ordinal data. It was therefore impossible to state how many or what percentage of the fishermen perceived or adapted in a particular way. The format of the responses to the questions did, however, permit a qualitative assessment of how individualistic or group-oriented such response was. Such statements in the text as "many" or "some" of the fishermen must therefore be read in this context.

Both groups of fishermen identified wind, tide, and fish behaviour as the most important group of environmental elements influencing the fishery. Actual wind and fog conditions prevailing in the two fishing zones were established from meteorological data recorded at the St. John's Weather Office, Department of the Environment. These data are considered to be more indicative of the actual weather conditions prevailing in the area of the St. John's and Petty Harbour fisheries than are the sporadically collected data used in compiling Marine Weather Forecasts.[24] The tidal cycle recorded at Bay Bulls shows no significant variations from that recorded at St. John's. Since Petty Harbour is located between the two recording sites, negligible variations between the tidal cycle of St. John's and Petty Harbour can be expected. Biological information on the behaviour of fish resources within the two fishing zones is sketchy, but generalizations can be made from the body of literature concerning the large-scale seasonal movement and feeding behaviour of the cod in Newfoundland waters. The availability of daily fish landings for the 1971 Petty Harbour fishery also gives some understanding of the relationship between fish catches and the occurrence of various environmental conditions.

The study is divided into two parts. Part I examines the Petty Harbour trap and handline fisheries and Part II, the St. John's longliner gillnet fishery. The first chapter in each part gives a general background study to each fishery, by describing the human and physical setting in which the fishery takes place. This includes the organization of the fishery, and a description of fishing grounds and methods. The second chapter in each part examines perception and adaptation to selected elements of the marine environment. This chapter is divided into three sections according to the major component of the environment in which each element is examined in terms of its perceived effects upon fish behaviour and the catching operation. A concluding chapter summarizes the findings from both parts.

NOTES TO CHAPTER I

1. James C. Faris, Cat Harbour: A Newfoundland Fishing Settlement (St. John's: Institute of Social and Economic Research, Memorial University of Newfoundland, 1966).
2. Warren T. Morrill, "Ethnoichthyology of The Cha-Cha," Ethnology, VI, No. 4 (1967), pp. 405-416.
3. Thomas M. Fraser Jr., Fishermen of South Thailand (New York: Holt, Rinehart and Winston Inc.), 1966, pp. 8-9.
4. William Davenport, "Jamaican Fishing: A Game Theory Analysis," Yale University Publications in Anthropology, LIX (1960), pp. 3-11.
5. Game Theory is described by Peter Gould (q.v.) as "dealing, in essence, with the question of making rational decisions in the face of uncertain conditions by choosing certain strategies to outwit an opponent, or, at the very least, to maintain a position superior to others."
6. Raoul Andersen and Cato Wadel, "Comparative Problems in Fishing Adaptations" in North Atlantic Fishermen, edited by Raoul Andersen and Cato Wadel (St. John's: Institute

of Social and Economic Research, Memorial University of Newfoundland, 1972), pp. 153-154.

7. Thomas F. Saarinen, Perception of Environment, Resource Paper No. 5 (Washington, D.C.: Association of American Geographers, 1969), p. 3.

8. L.J. Wood, "Perception Studies in Geography," Transactions Institute of British Geographers, L (July, 1970), p. 136.

9. The concept of the "image" was first advanced by Kenneth Boulding in The Image (Ann Arbor: University of Michigan Press, 1956), p. 115. Lundeen refers to the "image" as "the individual's mental construction of his environment." See Richard Lundeen, "The Semantic Differential Technique and Personal Construct Theory in Image Measurement," Discussion Paper No. 5, Department of Geography, York University, 1972.

10. Herbert H. Simon, Models of Man: Social and Rational (New York: Wiley and Son), 1957, p. 240.

11. The distinction between perceived and real environments was first made in 1952 and restated in 1963 by William Kirk. He argued that the major division in geography should be between the phenomenal (real) and behavioural (perceived) environments. The terms "perceived" and "real" are now the most widely used in the geographical literature.

12. J.M. Doherty, "Developments in Behavioural Geography," Graduate Geography Department London School of Economics and Political Science, Discussion Paper No. 35 (November 1969), p. 7.
13. Roger Downs, Progress in Geography II, 1970, p. 80.
14. David Lowenthal, "Geography, Experience and Imagination: Towards a Geographical Epistemology," Annals of the Association of American Geographers, LI, No. 3 (September, 1961), p. 251.
15. Wood, op. cit., p. 136.
16. Harold Brookfield, "On the Environment as Perceived," Progress in Geography I, 1969, p. 73.
17. Lowenthal, op cit., p. 252.
18. Doherty, op cit., p. 4.
19. Brookfield, op cit., p. 68.
20. Ian Burton and Robert W. Kates, "The Perception of Natural Hazards in Resource Management," Natural Resources Journal, III, No. 3 (January, 1964), pp. 412-441.
21. Saarinen, op cit., pp. 29-37.
22. W.R. Derrick Sewell, Robert W. Kates and Lee E. Phillips, "Human Response to Weather and Climate: Geographical Contributions," The Geographical Review, LVIII, No. 2 (1968), pp. 212-280.
23. Saarinen, op. cit., p. 27.
24. Personal Communication, Richard Nelis, Officer-in-Charge, Gander Weather Office, September 14, 1971.

PART I

PETTY HARBOUR

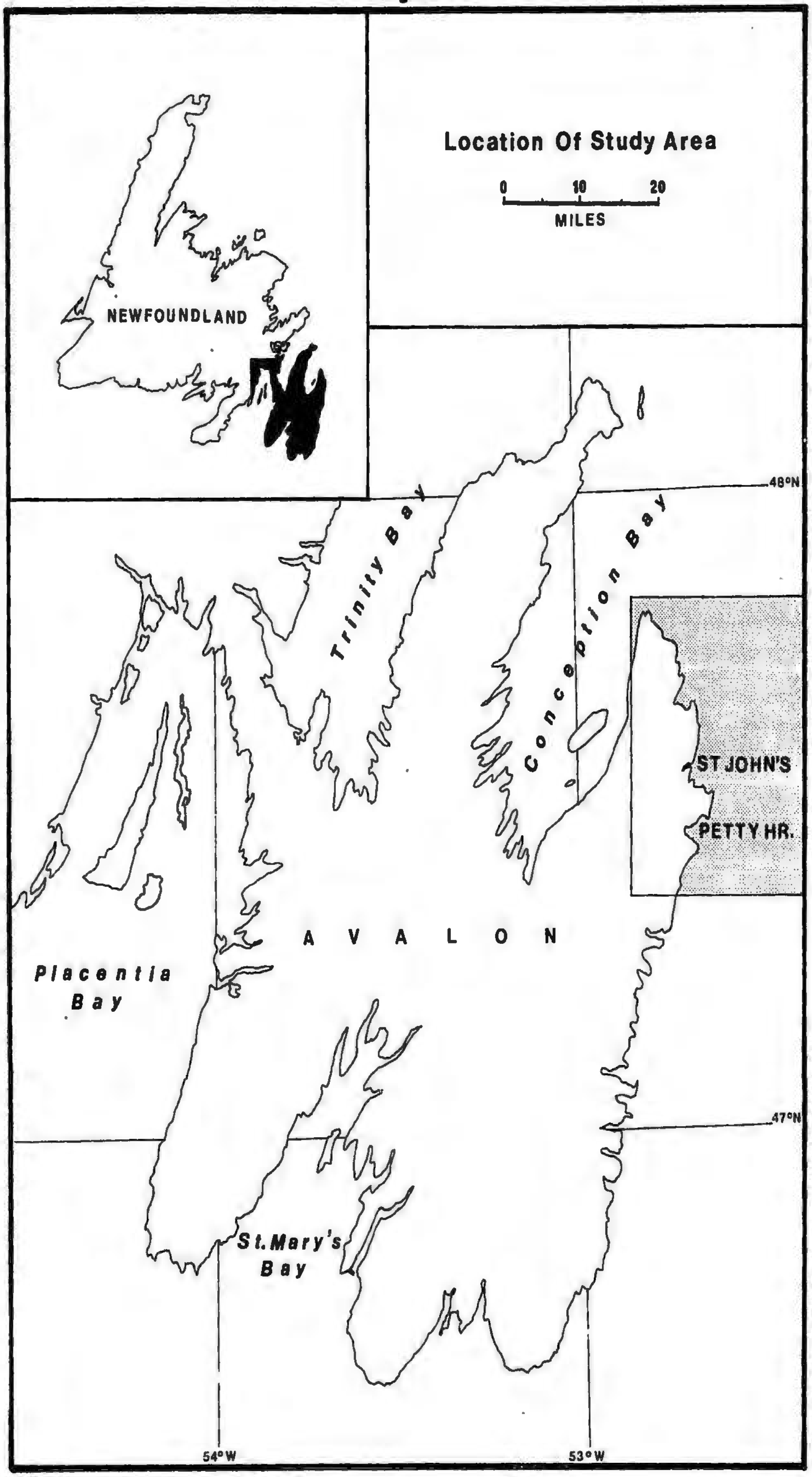
CHAPTER II

THE TRAP AND HANDLINE FISHERIES OF PETTY HARBOUR

Petty Harbour is a small village of some 1000 inhabitants located at the head of Motion Bay, nine miles south of St. John's (Figure 1). The community lacks any notable land amenities and was originally settled to exploit the rich cod resources in the adjacent coastal waters. The Official List of Electors shows that in 1971, 29% of the labour force were engaged in fishing with the remainder employed in other activities, mainly in nearby St. John's. Almost the entire labour force of Petty Harbour was employed in fishing until the beginning of World War II, when large numbers began to be attracted by the growing employment opportunities in the nearby city.

The Petty Harbour fishery is based upon the prolific cod (*Gadus callarias*) stocks that follow spawning caplin (*Mallotus villosus*) to the shoreline in June and remain within the coastal area until November. During this period the fish are caught by men operating from small boats using two technologically distinct, relatively passive, but complementary fishing gears, the cod-trap and the handline. The handline represents one of the oldest catching methods brought to the New World while

Figure 1


NEWFOUNDLAND
Location Of Study Area
0
10
20
MILES
48°N
Trinity Bay
Conception Bay
ST JOHN'S
PETTY HR.
AVALON
Placentia Bay
47°N
St.Mary's Bay
54°W
53°W

the Newfoundland Census of 1884 records the use of the cod trap in Petty Harbour for the first time. These two fishing gears have therefore been used for a long time in Petty Harbour and have resulted in a system of exploitation that has remained unchanged and has strongly resisted innovation. Their use has also divided the fishing grounds into two sectors, a trapping zone and a handlining zone, and the fishing population into two groups, those that handline exclusively from June to November, and those that operate traps from June to August and handline from August to November.

It is important to describe the human and physical background of the Petty Harbour fishery in order to appreciate fully the way in which the Petty Harbour fishermen perceive and adapt to their environment. This will be done by discussing the composition of the fishing labour force, the nature of the fishing area and the organization of the fishery, and the boats and gears employed in the fishery.

Manpower

The precise number of fishermen engaged in the Petty Harbour fishery and the numbers employed respectively in trapping and handlining is difficult to determine. The records of the Economics Branch Fisheries Service of the

Department of the Environment classify fishermen according to the number of months they are employed in fishing and according to the type of species caught. There is, however, no record of the number employed according to the type of fishing method used. These statistics show that in 1971 there were 81 fishermen in Petty Harbour: 57 part-time and 24 casual.[1] Of the total of 81, all were engaged in catching cod and 40 of these were also employed in catching salmon. Although almost half the fishermen sought salmon as well as cod, the salmon fishery is considered to be of only secondary importance to the cod fishery. It provides an alternative for trap fishermen before the commencement of the trap fishery, and lasts for only about five weeks, from the fifteenth of May when the salmon season opens until the third week in June, by which time all the fishermen will have turned to trapping. Salmon catches also tend to fluctuate markedly from year to year and to be considerably smaller than cod. In 1971, 10,000 pounds of salmon, with a landed value of $7,215.00, were caught in Petty Harbour as compared to 2,546,000 pounds of cod, with a landed value of $144,944.00.[2]

Surveys conducted among the fishermen provide an estimate of the number of trap and handline crews, the numbers in each crew, and the status of the fishermen as part-time or casual. It was found that in Petty Harbour in

1971, there were 25 handlining crews most commonly composed of two men per crew, and 18 trap crews most commonly composed of three men per crew. The labour force tends to be somewhat fluid, but handliners represent the largest segment of the "part-time" fishermen. They may, however, move from one fishery to another so that if the handline fishery is unsuccessful at the beginning of the season, many elect to serve on trap crews. Their fishing skill and their proficiency in "gutting" fish are highly valued assets. The trap crews tend to be composed largely of casual fishermen including seasonal and shift workers and vacationing high school students. The number of these workers may fluctuate markedly from year to year, but appears to be larger than the twenty-four casual fishermen indicated by the Department of the Environment for 1971. Because of the mobility of the trap crews between fishing and other activities, only the crew skippers, the owners of the boat and fishing gear, can be considered to be permanently employed in the fishery.

The Fishing Area

The Petty Harbour cod fishery takes place in "The Petty Harbour Area", the area defined by the Newfoundland Fishery Regulations as extending from "The North Head of Petty Harbour on the north to Long Point on the south", and to the fifty fathom contour, the limit at which handlines can be employed. (Figure 2). Local regulations contained within the above regulations divide the fishing area into two distinct sectors, one for trap fishermen and the other for handliners. These formal rules as well as other informal rules also govern access to the resource by individual fishermen. The establishment of these regulations derives from the nature of fish as a common-property resource and the consequent need to control access to the resource by allocating rights to each group of fishermen and to ensure entry into the fishery by each fisherman.

Figure 3 shows the extent of the trap and handline grounds. The trap zone occupies the coastal frontage and is limited by regulation to a maximum distance of 170 fathoms[4] from the shore in Motion Bay where most of the important handline grounds are located.[5] The zone extends along three shores, the northshore, the southshore, and "on the shore" but does not include that part of the coast between Motion Head and Haye's Point where, by agreement between the trapmen and the handliners, traps are prohibited from being set because of the belief that they can intercept the movement of fish from the valuable handlining grounds located near the Motion Head to the shore.[6]

Figure 2

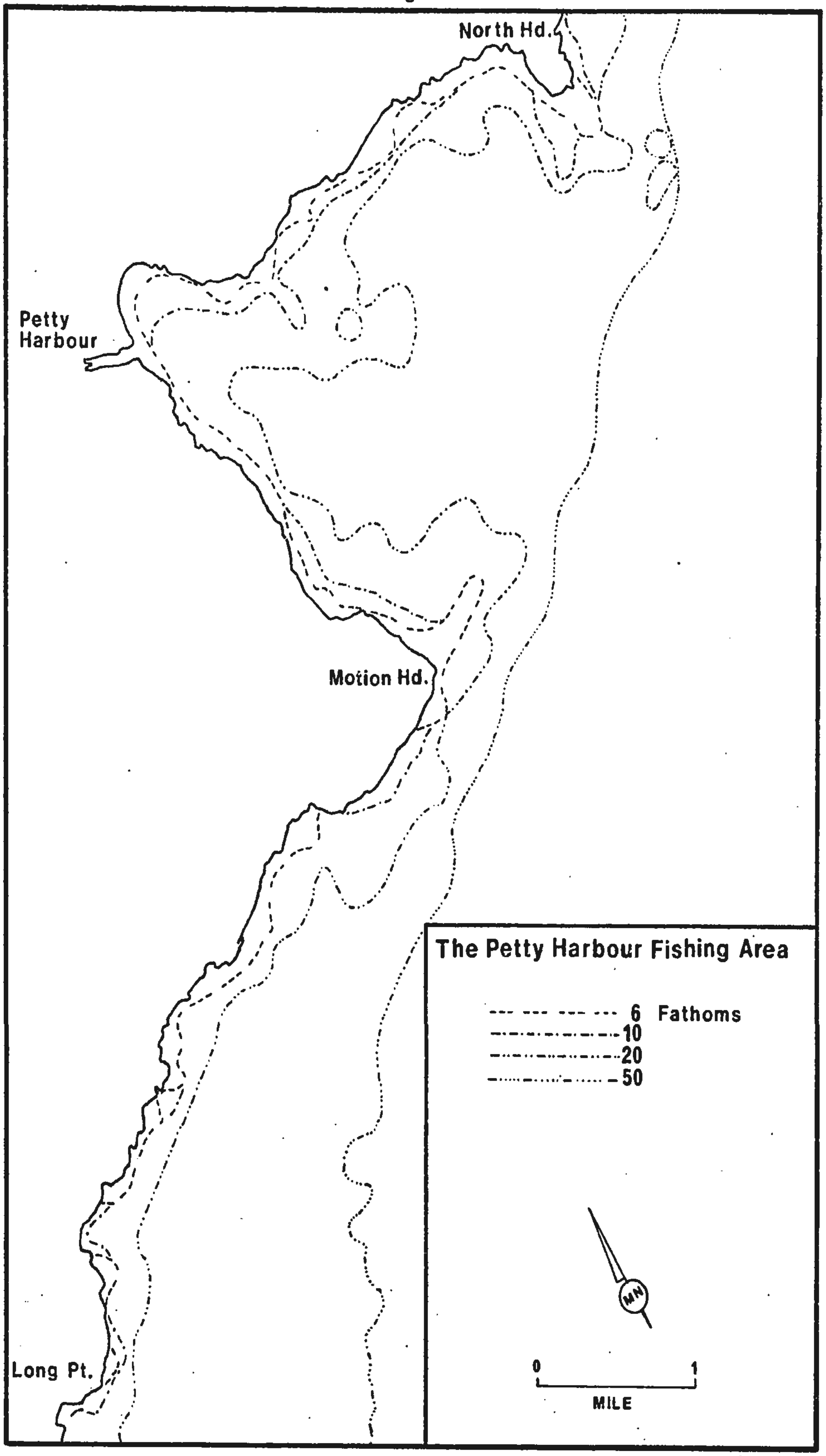
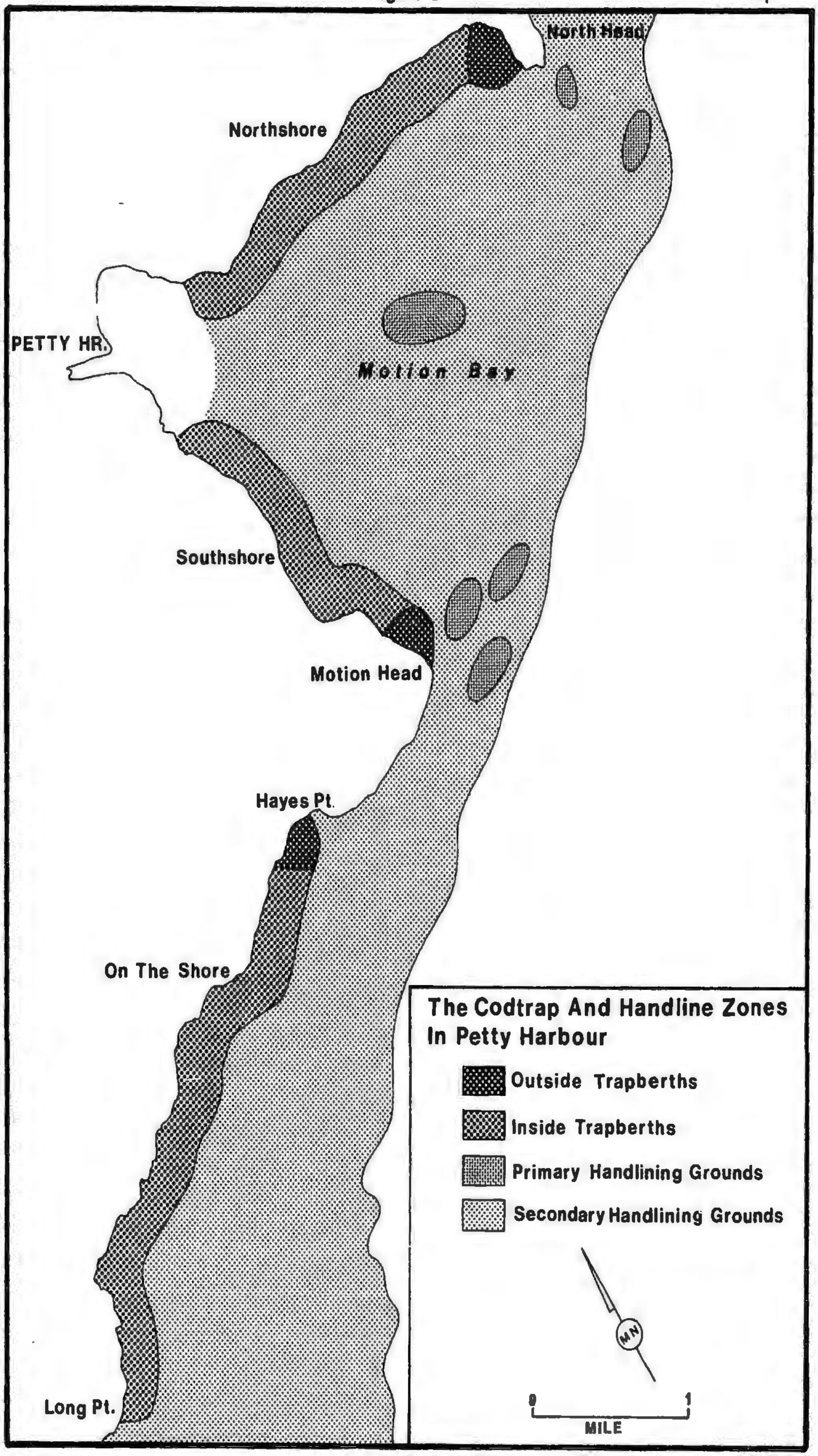

North Hd.
Petty
Harbour
Motion Hd.
Long Pt.
The Petty Harbour Fishing Area
6 Fathoms
10
20
50
MN
0
1
MILE

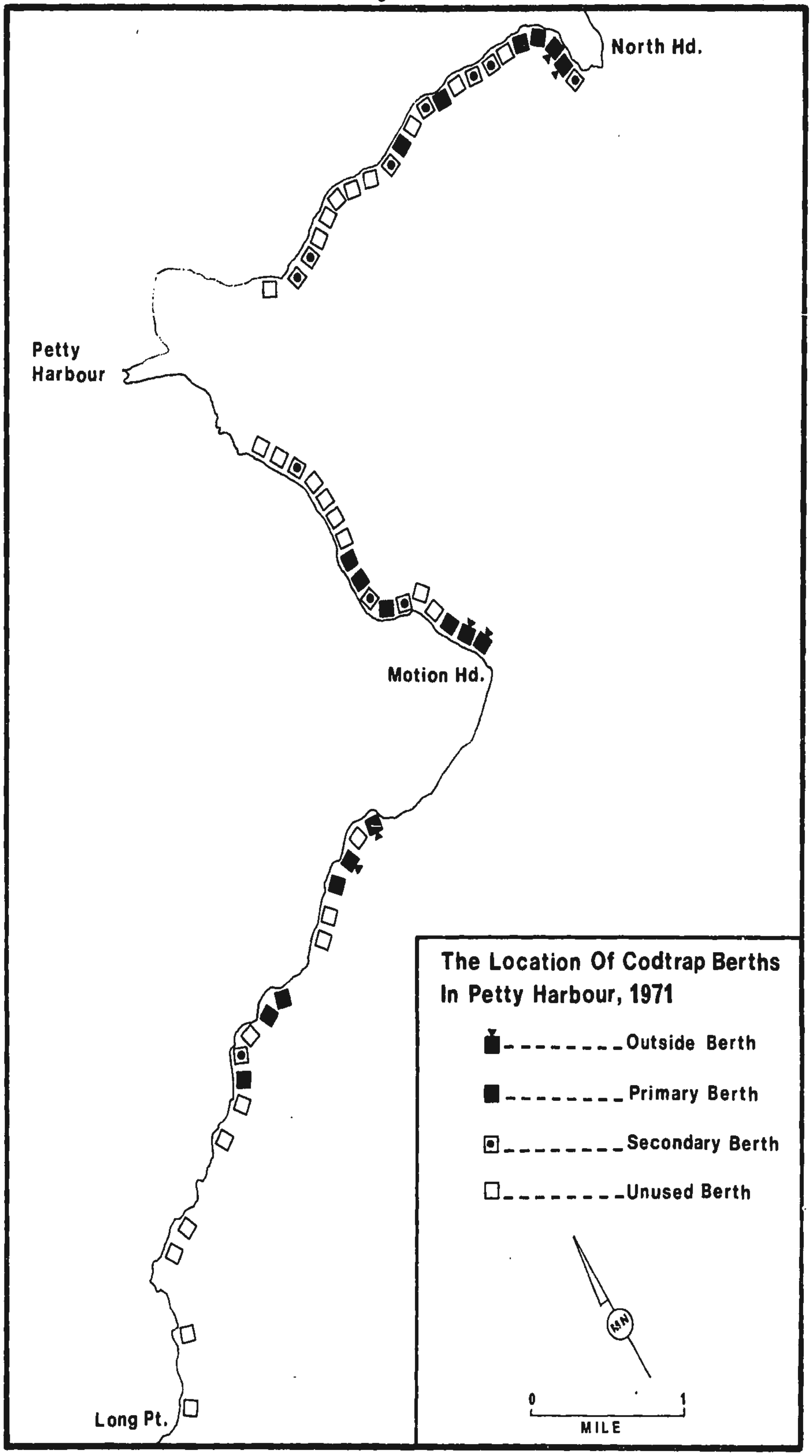
Figure 3


North Head
Northshore
PETTY HR.
Motion Bay
Southshore
Motion Head
Hayes Pt.
On The Shore
Long Pt.
The Codtrap And Handline Zones In Petty Harbour
Outside Trapberths
Inside Trapberths
Primary Handlining Grounds
Secondary Handlining Grounds
MN
0
1
MILE

The fishing zone is subdivided into a number of distinct fishing locations called trap berths, each of which is spaced seventy fathoms apart and is the setting place for one cod trap. This formalized spacing between trap berths provides an effective means for limiting conflict. Figure 4 shows that there are now fifty-six designated cod trap berths in Petty Harbour. Fifty-two of these berths were established in 1921, the first year of the trap berth lottery, but the overall decline in the number of fishermen since that date has reduced the number of berths actively fished to less than one half of the original number.

Some berths are known to be more productive than others. In order to achieve an equitable allocation of these berths, a lottery is held among the trap fishermen before the beginning of the fishery each year. This lottery is conducted by an elected body of fishermen known as "the Trap Berth Committee" and since most fishermen set two traps, it consists of two draws, one for the primary berths and the other for the remaining or secondary berths. Primary berths consist of the most productive "outside" berths which are located outside the other berths, on or near headlands where the fish are known to strike first during the onshore migration and in proximity to shoals which act as holding grounds for fish following this

Figure 4


North Hd.
Petty
Harbour
Motion Hd.
Long Pt.
The Location Of Codtrap Berths
In Petty Harbour, 1971
Outside Berth
Primary Berth
Secondary Berth
Unused Berth
MN
0
1
MILE

movement. The primary berths also include other berths which are known to be consistently good and are always included in the draw as primary berths. Other less consistently productive berths may be dropped or added according to the number of fishermen entering the draw. In this way every fisherman, regardless of the number of traps he intends to set, is ensured of obtaining a primary or more productive berth. The secondary berths appear to be either less productive than the primary berths or as productive as primary berths but located in exposed areas where rough seas make them hazardous places for setting traps. The number of secondary berths also tends to vary from year to year and depends upon the number of men entering a second trap in the draw. The remaining undrawn berths include those berths which are either less productive than the primary or secondary berths, more hazardous setting places than the secondary berths, or berths which are productive but which are considered by the majority of the trap fishermen to be too distant from Petty Harbour, when a sufficient number of other equally productive and closer berths can be used. Figure 4 shows the location of "outside" berths, primary berths, secondary berths, and undrawn berths in Petty Harbour in 1971. It indicates that the most productive "outside" berths are located on the headlands or as a comparison with Figure 3 will show, in proximity to primary handlining grounds. There is no apparent pattern in the distribution of the remaining primary or for the secondary berths, but the undrawn berths tend to be concentrated in areas which are either too far in the bay for the fish to reach during the onshore migration or too distant from Petty Harbour to be easily accessible to the fishermen. Figure 4 shows that one secondary berth is located outside the "outside" berths on the northshore. This berth is considered to be equally as productive as the latter berths but because of its exposed location is said to be "a hard place for tide and winds".[7] These conditions are often known to delay the setting of the cod trap at the beginning of the season, thus preventing the trap from maximizing the full productive potential of the berth.

The Petty Harbour handlining grounds include the shoals or "pieces of ground" that are located within the area enclosed by the limits of the cod trap zone and the boundary of the Petty Harbour area. These shoals are both numerous and scattered and extend in depth from about four to fifty fathoms. All of the informants refer to the large number of "pieces of ground" in the Petty Harbour area and some suggest that there may be as many as 100 such shoals. There are, however, three main concentrations of features. These are (1) the Northshore rocks and ledges

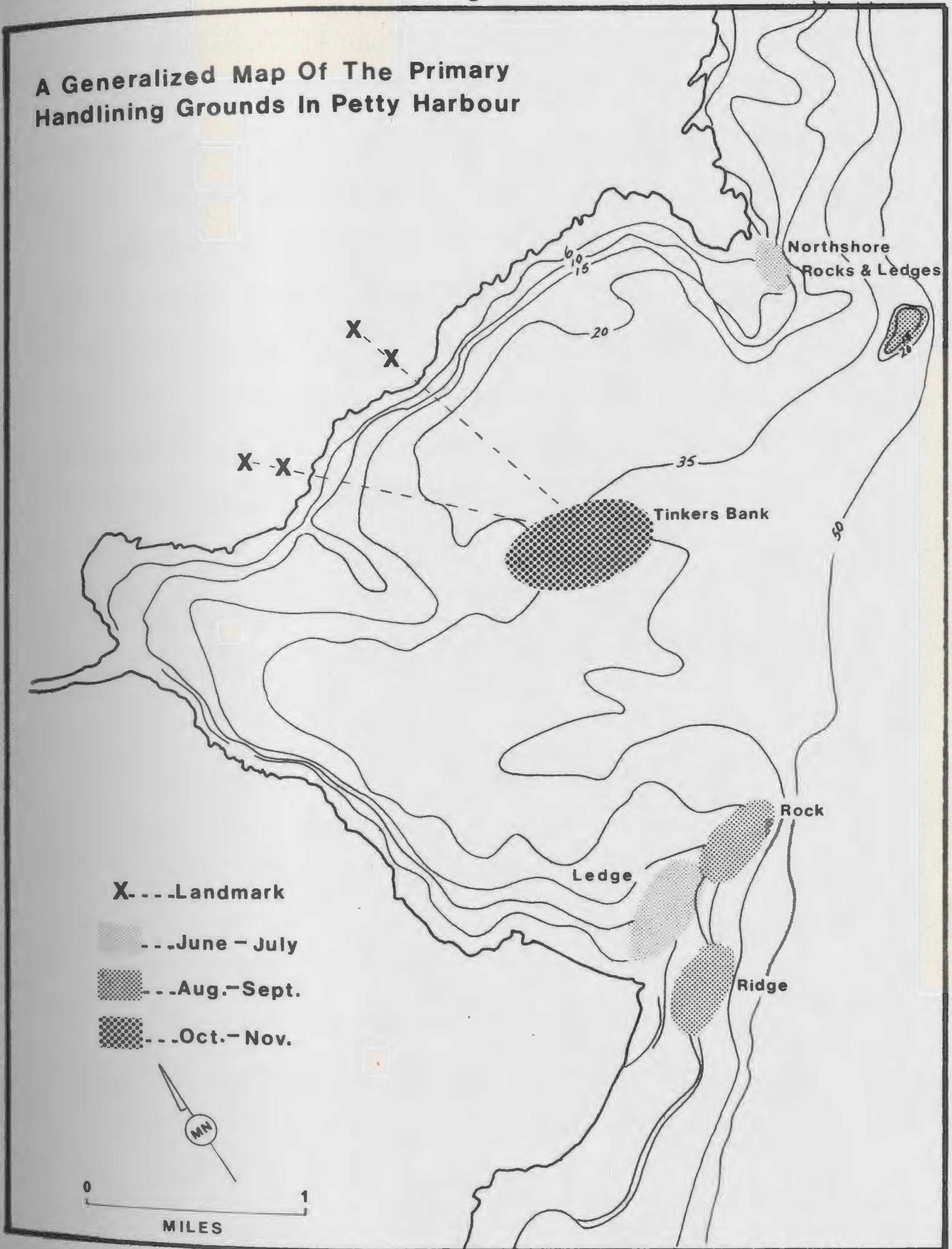
(2) the Ledge, the Rock, and the Ridge near the Motion Head, and (3) Tinkers Bank in the centre of the Motion Bay. Figure 5 shows the location, depth and seasonal importance of each of these features.

Each shoal may be subdivided into a number of spots or locations of various depths where the cod are known to be found in large concentrations at different times during the handlining season. These locations are referred to as "edges of ground". Fishing success depends upon:

(1) each fisherman's capacity for locating these spots which enables him to establish a "berth" on the grounds;
(2) each fisherman's capacity for adjusting his "berth" according to changing climatic, hydrographic, and biological conditions.

In Petty Harbour the locations of the major "pieces of ground" are known to all the fishermen. The location of each shoal is fixed in the following way (1) by using the known compass direction and travel time at a fixed engine speed to reach the general vicinity of the shoal and then (2) by using a generally known set of bearings or "marks" which are taken from the shoal onto prominent features on the land to fix a more specific location. In this latter process, four marks are used, two in each direction, with the marks for each feature being aligned, one behind the other to fix the location of a shoal. (Figure 5). This is called "lining up the marks".[8]

Figure 5


A Generalized Map Of The Primary Handlining Grounds In Petty Harbour
Northshore Rocks & Ledges
Tinkers Bank
Rock
Ledge
Ridge
6
10
15
20
35
50
X- - - -Landmark
- - -June – July
- - -Aug.–Sept.
- - -Oct.–Nov.
MN
0
1
MILES

During periods of darkness, prominent lights are used as bearings. When visibility is reduced by fog, the general location of the shoal is found by timing the boat and specific depths by sounding with a cod jigger.[9]

More precise landmarks are used to locate the "edges of ground" where the largest fish concentrations are said to be found. Not all of the fishermen, however, possess the knowledge necessary to locate these spots. Those that do tend to keep this information secret.[10] One informant noting this tendency, states that

> The fishermen out of Petty Harbour all know the grounds out there pretty well. But some are keener than others. They know marks that someone else don't know ... They'd anchor and get a load of fish and I wouldn't get enough for my breakfast.[11]

The ability to fix these spots of specific depth by means of landmarks is attributed to two factors:(1) a greater familiarity with the fishing grounds, normally attributed to the older and more experienced fishermen and (2) the transmission of secret information on the location of these spots from father to son.

After the spot is located, the size of the spot determines the number of boats that can fish on it. Once any boat has established a berth, by implicit agreement no other boat can come within forty to fifty fathoms of it for the length of time that the boat remains on the berth.

This is said to represent the minimum distance over which handlines can function effectively without becoming entangled. When the fish first enter shallow water, however, shorter lines can be used, permitting the boats to fish closer together and enabling a greater number of fishermen to fish the same shoal. The use of an agreed spacing procedure tends to reduce interboat conflict and, at the same time, allows individual boats at any particular time to establish temporary property rights over a favoured spot by excluding all others who are bound by conformity to observe the spacing procedure.

The division of the fishing territory into trap and handline zones and the establishment of spacing mechanisms through formal and informal rules limit stress between trapmen and handliners as well as among the fishermen in each group. They therefore seem to have established a means for providing a stable solution to the problem of areal competition in the Petty Harbour fishery.

Boats and Gears

The Petty Harbour cod fishermen employ boats and fishing gears which have not changed significantly in this century. Therefore, it is reasonable to assume that this technology represents a successful adaptation to the environment. The use of the trap boat is well suited to the weather and sea conditions that influence the conduct of the trapping and handlining operation, while the complementarity of the trap and handline respresents an adaptation to the movements of fish which are alternately concentrated and scattered during the fishing season. Also, by using either handlines or cod traps, a large number of fishermen can exploit the resource during the same period without incurring conflict. The Petty Harbour fishermen, in fact, seem to recognize the practical value of their fishing technology as a time-tested ecological adaptation and resist attempts by innovators to alter established fishing practices.

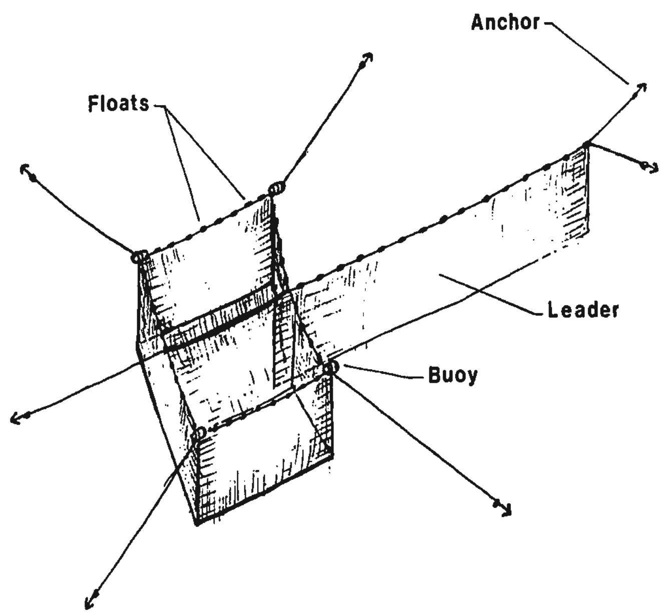
Fishing boats are both a vehicle to move fishermen from the harbour to the fishing grounds and a platform from which the catching operation is conducted. The boats should ideally combine the elements of speed, manoeuvrability and storage capacity with the facility to withstand changing conditions at sea. All of the boats used in Petty Harbour are of the trapboat design, the type most commonly used in the Newfoundland inshore fishery. The Economics Branch of the Fisheries Service does not classify boats according to design but only according to whether they are motorized or non-motorized. The records show that there were 36 motor boats in Petty Harbour in 1971. These boats were grouped by length with one boat under 20 feet, twenty boats in the 20-29.9 ft. range and 15 boats in the 30-39.9 ft. range. Only motorized boats were used in the fishery.

Most fishermen note the importance of having a stable fishing craft which will bear the weight of a trap during the trap hauling operation or provide a comfortable vehicle from which the handlining operation can be carried out. Beyond this general point, however, the fishermen said little about the characteristics of their craft or their adaptability.

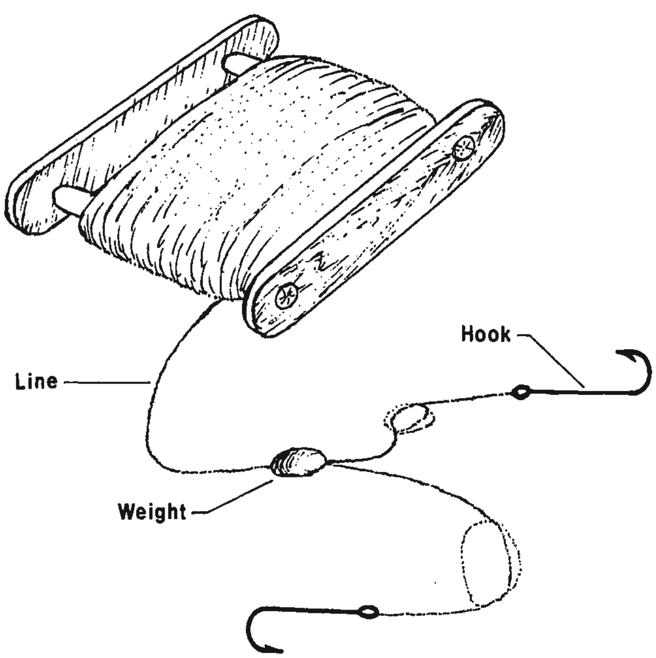
The Newfoundland cod trap, in terms of the quantity of fish caught, represents the most important fishing gear employed in the Petty Harbour fishery. This box-shaped device with attached leader has been designed for use in shallow water near the shore where it may intercept the onshore movement of large fish schools. Figure 6A shows a cod trap in a set position. Most cod traps currently in use in Newfoundland waters are made of nylon but they vary widely in their rectangular dimensions and depth. Ronayne noted that they range from 60 to 85 fathoms "on the round" and from about 6 to 14 fathoms in depth.[12] Most Petty Harbour cod traps are about 60 fathoms "on the round" and between 9 and 12 fathoms deep. The depth can be adjusted by "cutting" or "lowering" the trap according to the depth of the water in which the trap is set. The length of the trap leader also varies. In Petty Harbour it is restricted

Figure 6

A Codtrap



B Handline



by regulation to a maximum length of 60 fathoms to reduce the possibility of one trap "blocking the fish" from entering another.[13] The main well-known advantages of the cod trap are:

(1) the ease of construction enabling most fishermen to manufacture their own traps;

(2) the capacity for keeping the fish alive and in good condition should the trap owner be prevented from "hauling" during adverse sea conditions;

(3) the capacity to catch large quantities of cod during the relatively short period when the fish are available in the coastal zone;

(4) the relative ease of relocating the trap from one berth to another;

(5) a selective mesh-size which allows the escape of young, immature fish. The last is controlled by legislation.[14]

Some of the cod trap's disadvantages include:

(1) the initial high cost of construction materials;

(2) the cost of maintaining the trap in good working order;

(3) the trap's vulnerability to the effects of storm waves and tides in shallow water;

(4) the trap cannot be operated by one man; usually a three-man crew is needed to ensure the safe

and efficient handling of the gear.

The first factor is most often used to account for the fact that some fishermen have never become trap fishermen.

The cost of materials and accessories needed for the construction of a cod trap of the size used in Petty Harbour is approximately $2,000.00 at current market prices.[15] In addition, an average of fifty pounds of netting, costing about $67.00, must be replaced every year because of the damage caused during the normal day-to-day hauling operation. Many handliners have preferred not to risk investing in an enterprise that requires such high costs. The trap owner, however, feels that the financial risks involved in the purchase and maintenance of cod traps are more than offset by the increased earnings that result when the fish are available in quantity. One trapman notes that "you'd make as much in a week trapping as you would all summer long handlining".[16] The trap owner therefore bears a greater risk but also has a greater income potential than his handlining neighbour. If it is assumed that the average size of a trap crew is three men and a handline crew is two men, it is possible to compute the average catch per man during the period of the 1971 trap fishery from the second week in June till the third week in August. This was found to be 18,184 pounds for a trap fisherman and 5,876 pounds for a handliner. At an average price of five and one half cents per pound, this represents a return of $1,000.00 to a trapman and $323.00 to a handliner.

The handline is more important than the trap in terms of both the number of men permanently employed in its use and the length of the fishing period in which it is used. The handline represents one of the oldest and simplest forms of catching fish. It is still used effectively in the Petty Harbour fishery where it complements the passive cod trap by enabling a large number of handliners to engage in active exploitation of the cod before and during the trap fishery. It also provides the only fishing method used in Petty Harbour after the trap fishery has ended.

The handline is of simple construction consisting of a length of nylon line to which are attached two or three shorter lines bearing weights and hooks (Figure 6B). The length of the line is adjusted according to the depth in which fishing takes place while the type of weights or "flickers" used depends upon the position of the fish in the water and the strength of the tidal current. The closer the fish are to the water surface, the smaller are the weights used while the greater the intensity of the tidal current, the larger the weights needed to lower the handlines to within catching range of the fish.

The main advantages of the handline in the Petty Harbour fishery include the following:

(1) the low cost of the gear. A fifty fathom handline with attached weights and hooks costs only about $1.50.[17]

(2) its flexibility, allowing the fishermen to exploit the full range of fish schools moving throughout the Petty Harbour territory;

(3) the selectivity of the hooks which catch only the largest and more valuable members of the stock and permit the smaller fish to escape.

Some of the main disadvantages of the handline include the following:

(1) the tendency to catch a relatively small total quantity of fish in relation to the fishing effort;

(2) its complete dependency upon the feeding behaviour of the cod. (This factor will be considered later.)

Handline bait consists mainly of caplin (Mallotus villosus) and squid (Illex illecrebrosus). Caplin schools normally enter the Petty Harbour area in early June and provide the main source of bait till about the first week in August when they begin to move offshore. The caplin tend to enter Conception Bay before arriving in the Petty Harbour area and are trucked to the latter area to provide bait for the start of the handline fishery. The squid provide the main source of cod bait from about mid-August till the end of the fishing season in November. Squid schools normally appear in the Petty Harbour area after the caplin have migrated offshore. In recent years, however, the squid have been virtually absent from Newfoundland waters, and bait squid has had to be imported by the fish plant owners for resale to the fishermen.

The combination of the trap/handline system has become firmly established in the Petty Harbour fishery. The fishing practices inherent in this system are believed to control the rate of exploitation of scarce resources and at the same time to permit full participation by all those who wish to fish. Because of these beliefs, the Petty Harbour fishermen have prohibited the introduction of more sophisticated gears such as the line trawl and the gillnet, and have also shown an unwilling acceptance of the Japanese cod trap.[18] All of these gears have received wide acceptance in other Newfoundland inshore fishing communities. These gears are found to be unsuitable on ecological grounds and are also unpopular because they limit full participation by all fishermen.

Line trawls and gillnets are variously held to be responsible for the following:

(1) catching too many spawning or "mother fish", thus threatening the survival of the cod stock;

(2) attracting into the Petty Harbour area predators or scavengers which prey upon the cod;

(3) destroying the cod's natural habitat by "tearing up the bottom"; and

(4) interrupting the cod's natural migration to the shore by keeping the fish offshore where they are "caught up" by these and other gears.

Therefore, as one fisherman observes, "Petty Harbour is better off without gillnets and trawls. They make fish scarce in the long run." Similar objections are raised against the only Japanese cod trap used in Petty Harbour. One fisherman notes that "when the fish get in the trap, they can't get out ... The work (mesh-size) is too small and catches too many small fish." This opinion is held by many fishermen who have observed the Japanese trap to be considerably more effective than the Newfoundland trap, particularly during times of fish scarcity. Supporting these conservationist views is the notion that the use of such extensive fishing gears as the line trawl and the gillnet would allow a few fishermen to cover the whole of the fishing area, thus crowding out others from their favourite fishing spots; while the widespread adoption of the Japanese trap would allow a few trap fishermen to monopolize the fishery.

A sense of territorial identity prevails among the Petty Harbour fishermen and tends to reinforce these conservationist and egalitarian views by giving community sanction to the exclusion of line trawls and gillnets. The Petty Harbour area is represented as "our territory" engaging in an established "mode of fishing" according to "the book of rules".

NOTES TO CHAPTER II

1. Part time - those engaged in fishing from five to ten months; casual - those engaged in fishing for less than five months.
2. Source, Economics Branch, Fisheries Service, Department of the Environment.
3. Government of Canada, Department of Fisheries, Newfoundland Fishery Regulations: in the Canada Gazette, Part II, VIC, No. 11, 1960, Section 155.
4. One fathom equals six feet.
5. Newfoundland Fishery Regulations, Section 158(1).
6. Ibid., Section 158(2).
7. Interview, W.M. Stack, May 1971.
8. This process has been observed by several authors including Robert Paine, Coast Lapp Society I (Tromsø: The Tromsø Museum, 1957), pp. 101-102, James C. Faris, Cat Harbour: A Newfoundland Fishing Settlement (St. John's: Institute of Social and Economic Research, Memorial University of Newfoundland), p. 35, and Shepard Forman, "Cognition and the Catch: the Location of Fishing Spots in a Brazilian Coastal Village", Ethnology, VI, No. 4 (1967), p. 417.
9. A heavy lead device in which a hook is embedded, normally used for "jigging" cod fish.

10. Forman notes the importance of accumulating knowledge of secret fishing spots as a means of enabling Brazilian coastal fishermen to become independent producers. Forman, op. cit., p. 417.
11. Interview, T. Clarke, December 1971.
12. Ronayne, Mark, "The Newfoundland Cod Traps", _Trade News_, IX, No. 4 (1956), p. 5.
13. This regulation was established by concensus among the fishermen in 1965.
14. _Newfoundland Fishery Regulations_, Section 51(1).
15. This estimate is provided by John Leckie Limited, the largest supplier of fishing gears in Newfoundland.
16. Interview, T. Clarke, December 1971.
17. Source, John Leckie Limited.
18. A line trawl is a horizontal line of average length of 600 feet which is arranged either to float on the sea surface or lie on the seabed. Lines containing baited hooks are attached at intervals of about six feet along this line. The gillnet encloses a wall of netting 300 feet long and seven feet deep which is attached to the seabed. Figure 19.

    The Japanese cod trap differs in design from the Newfoundland cod trap in that it has two chambers, a roof net, a narrower entrance, a shorter leader, and is of smaller mesh size.

CHAPTER III

ENVIRONMENTAL PERCEPTION IN THE PETTY HARBOUR TRAP AND HANDLINE FISHERIES

This chapter will examine the Petty Harbour fishermen's perceptions of their marine environment and how these perceptions influence the ways in which they adapt to that environment. This purpose has three related objectives (1) to describe the fishermen's perceptions of wind, time, and fish behaviour, (2) to relate these perceptions to the real environment, and (3) to account for the patterns of exploitation that develop as a response to these perceptions.

The chapter is divided into three sections. The first section will examine the role of winds in influencing the availability of fish within the Petty Harbour area and in determining the conditions within which the trap and handline fisheries function. The second section will discuss the role of tidal conditions in affecting fish behaviour and the conduct of the trap and handline fisheries. The third section will examine the role of fish behaviour in affecting the organization and conduct of the fishery.

Meteorological Elements

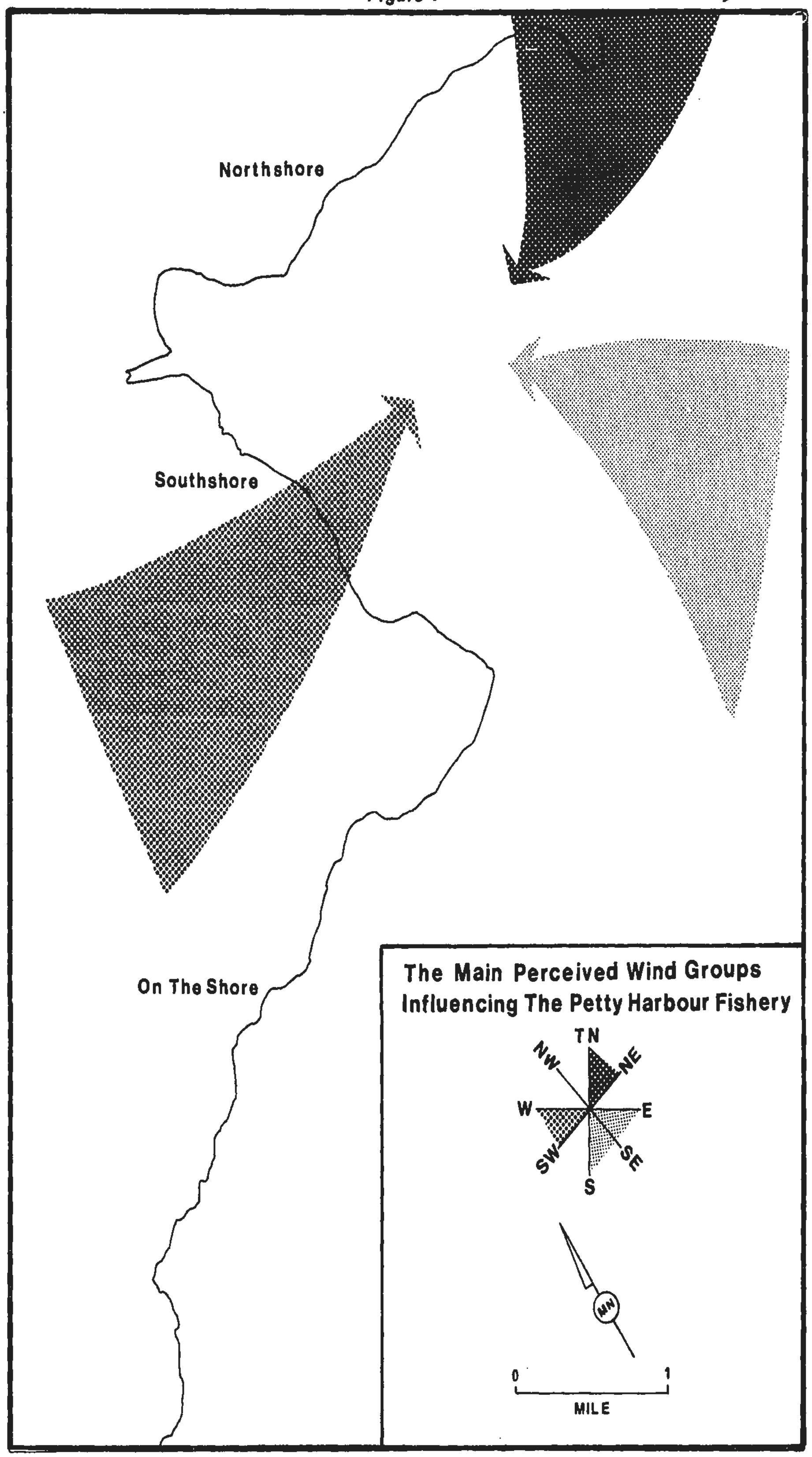
The Petty Harbour fishery takes place along a relatively exposed and unprotected coastline, operates from small boats using stationary or other passive fishing gears, and catches fish which are only seasonally available. The fishery is therefore strongly influenced by the elements of climate and weather. Although climate and weather are known to have favourable influences upon the fishery, these elements are most often alluded to as "hazards". The Petty Harbour fishermen tend to be more critically aware of the unfavourable influences acting upon their environment. This is indicated by the widely held and often repeated feelings of uncertainty that they articulate in association with the weather. One informant summarizes these views by noting that "there's very little that can put a man out of a voyage of fish weatherwise."

Winds are considered to be the most important meteorological elements influencing the Petty Harbour fishery while the influence of other elements such as air temperature, precipitation, and fog is said to be negligible. Winds are known to affect both the behaviour of fish and the functioning of the fishing operation, in both cases through their influence upon hydrographic conditions. In the Petty Harbour area, winds are held to be highly complex phenomena consisting of a variety of directions and speeds which vary in frequency of occurrence and duration. The fishermen attempt to cope with this complexity by isolating and grouping certain winds according to their believed effects on the availability of fish and on the catching operation. Winds are classified according to general direction as onshore, offshore, or northerly. Each is known to influence the behaviour of fish indirectly and in different ways according to its time of occurrence, frequency of occurrence, and duration. Figure 7 shows a generalization of the perceived groups of winds. Wind speeds are classified as "hard", "moderate", or "soft", and are mainly expressed in terms of resultant sea conditions which either permit or prohibit the fishing operation. The effects of wind speeds are said to vary according to the time of the season in which the wind occurs, and according to the size of the fetch over which the wind blows. By so classifying wind phenomena, the Petty Harbour fishermen simplify the task of comprehending, and thus adapting to, complex meteorological conditions.

Winds: Their Perceived Effects Upon Fish Behaviour

The Petty Harbour fishermen possess an extensive knowledge of the relationship between wind direction and fish behaviour. While this knowledge has been derived from

Figure 7

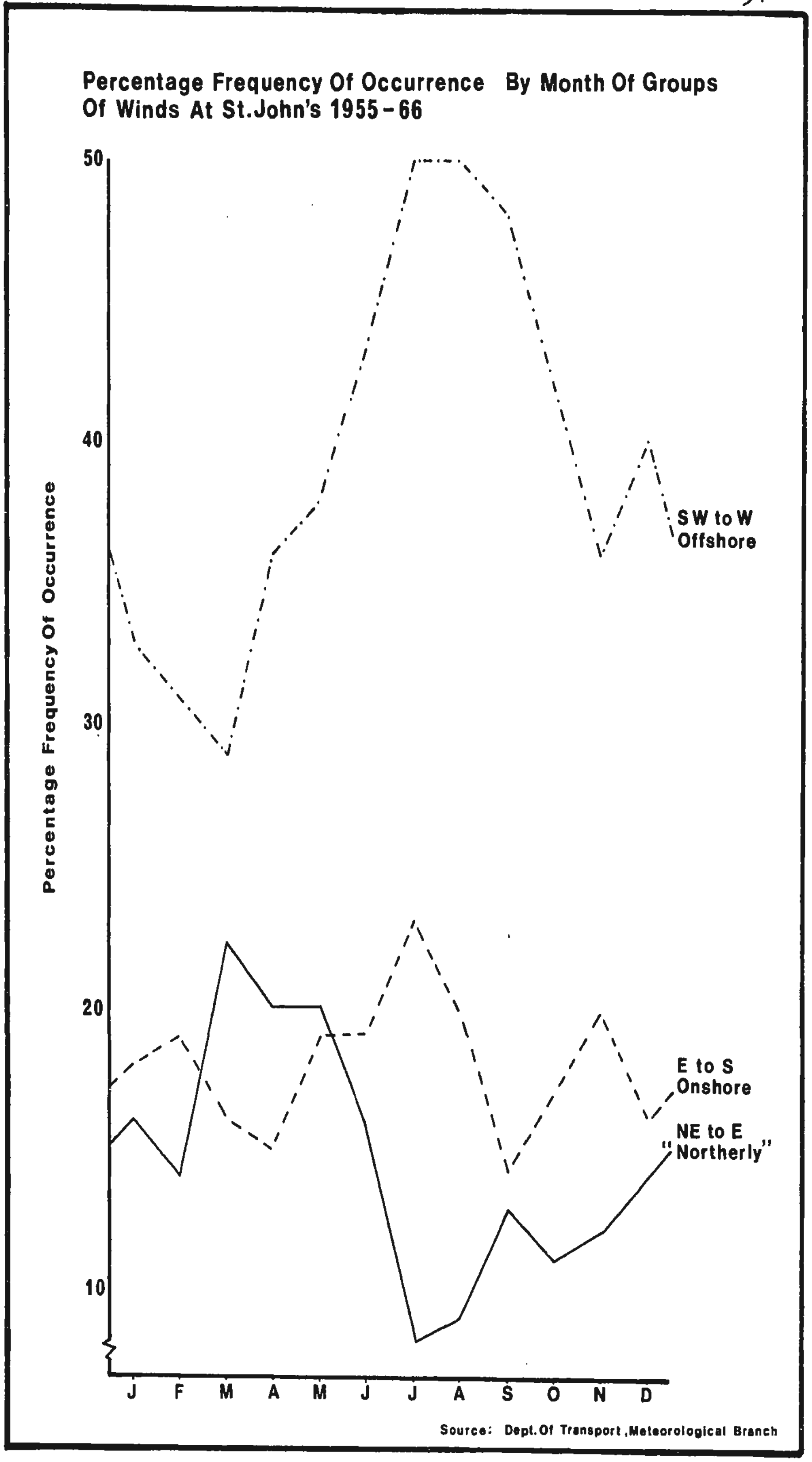

Northshore
Southshore
On The Shore
The Main Perceived Wind Groups
Influencing The Petty Harbour Fishery
TN
NW
NE
W
E
SW
SE
S
MN
0
1
MILE

observations taken over a long period of time and handed down from generation to generation, the actual mechanism of the relationship is not well explained. The effects of winds upon fish behaviour are expressed in terms of their influence upon the intervening variable, the sea. These relationships are explained as cause and effect but in reality are largely associations, the exact process not being clearly understood by the fishermen. Hela and Laevastu suggested that this is a common tendency among fishermen.[1] In the Petty Harbour fishery, wind directions are seen in terms of their effects upon seasonal onshore and offshore fish migrations, and upon periodic changes in the distribution and behaviour of fish within the inshore zone. The wind patterns are believed to determine the period that the fish are available in the Petty Harbour area as well as their relative availability to traps and hand-lines. This section will discuss the perceived effects of different wind patterns upon (1) the movement of fish into the Petty Harbour area at the commencement of the fishery, (2) periodic disruptions in fish availability throughout the season, and (3) the movement of the fish from the area at the end of the fishing period.

The Petty Harbour fishery normally commences in June after schools of cod pursuing caplin enter the coastal zone. This migration is associated with the occurrence of "soft" onshore winds varying from easterly to southerly in direction. These winds are known by the fishermen to have a relatively high frequency of occurrence in the spring and are believed to generate a mixing process which "thickens up the water" and increases its temperature. One informant notes that "when the water is warm, it's thick, when it's cold, it's clear." This seasonal warming process is not related to the direct experience of an increase in water temperature but is said to be indicated by the presence of fog in early June, a phenomenon which is often known to accompany onshore winds and which is referred to by the fishermen as "caplin scull weather". Most fishermen feel that it is changes in water temperature brought about by winds which cause the greatest effects upon fish behaviour. The fishermen have no understanding, however, of the actual mechanism which helps warm the inshore zone. This is explained by Templeman in terms of the differential effects of onshore and offshore winds of various speeds upon mixing the seasonally warm surface water with the colder subsurface water, creating uniform temperatures for the cod when they enter the inshore zone.[2] Figure 8 shows the increased frequency of occurrence of onshore winds between April and July, within which period the fish migrate into Petty Harbour.

Onshore winds are known sometimes to be accompanied by other sea conditions which are believed to affect the

Figure 8



Percentage Frequency Of Occurrence By Month Of Groups Of Winds At St.John's 1955-66
Percentage Frequency Of Occurrence
50
40
30
20
10
J
F
M
A
M
J
J
A
S
O
N
D
S W to W
Offshore
E to S
Onshore
NE to E
"Northerly"
Source: Dept. Of Transport, Meteorological Branch

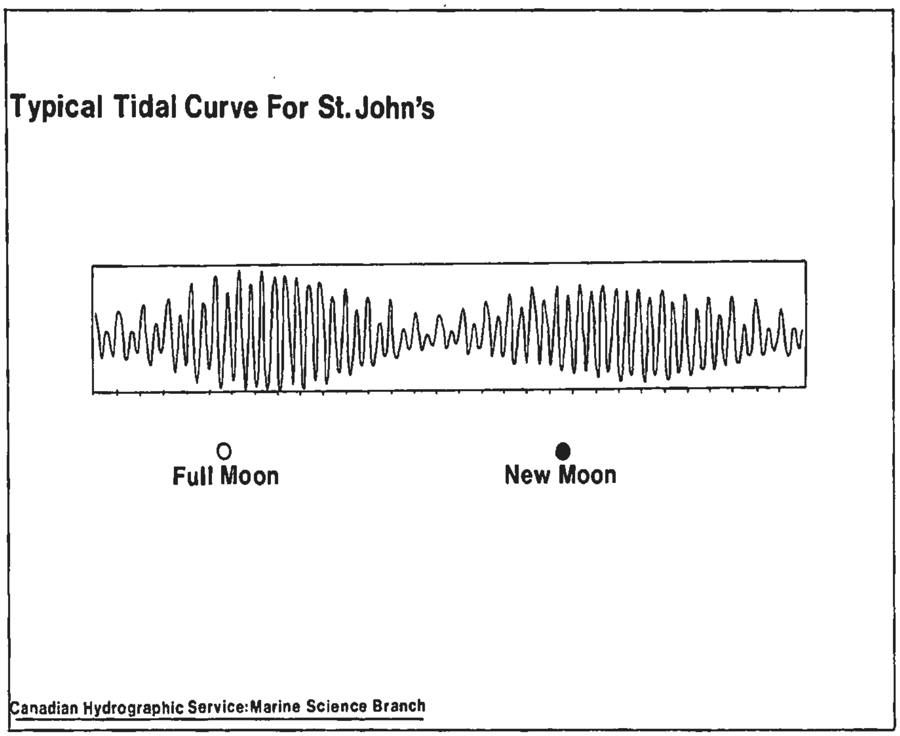
relative availability of the fish to traps and handlines once the fish have entered the coastal area. Onshore winds because of their source, are likely to have a large fetch and consequently to convey "big swells" into the Petty Harbour area, creating turbulence in shallow water. When this occurs, the caplin schools are said to be prevented from entering the trap zone and instead, become concentrated in the deeper and calmer waters of the nearshore shoals. Part of the caplin stock is said to remain on these shoals where the caplin spawn and attract feeding cod. The cod are then fished by handliners. The remainder of the caplin migration is believed to enter the trapping zone after the turbulence has subsided. This movement is related to the frequent occurrence of offshore winds from southwesterly to westerly in direction. These winds are known to have a shorter fetch than offshore winds and consequently "never throw home a sea". Because of the short fetch, however, it is considered necessary for offshore winds to last for longer periods than the onshore winds in order to reduce the effects of any existing turbulence. Figure 8 shows the high frequency of occurrence of offshore winds between May and August, and also the much greater frequency of occurrence of these winds relative to that of onshore winds. Of the group of offshore winds, the south-southwesterly is somewhat anomalous. It is said to reduce the water temperature, forcing the fish to lie on the seabed where they are believed to remain immobile and to refuse baited hooks.

Once the cod schools have become concentrated in the Petty Harbour area, their availability to traps and handlines throughout the season is held to be related in part to the relative occurrence of inshore and offshore winds and their effect upon the sea. The fishermen associate the best sea conditions with the "moderate" turbulence that results following frequent changes from onshore to offshore winds. This turbulence is thought to keep the fish in an active state in which condition they are said to digest their food quickly. The fish are then believed to seek more food, and accordingly, enter cod traps or take baited hooks. Some of the informants note that if offshore winds occur for an extended period without the alternate occurrence of onshore winds, very calm sea conditions can result, causing periodic disruptions in both the trap and handline fishery. When this happens, the cod are said to lie on the seabed in an immobile or "logy" condition. In this state the fish may be "glutted" with caplin and consequently unattracted to baited handlines or maybe concentrated around the cod trap leader without entering the trap. The fish are sometimes directly observed in the latter position. The occurrence of a brisk onshore wind at this time is said to "stir up the fish", making them "throw up their food", so that they again begin to seek food and become available to fishing gears. Templeman noted that fishermen in general and Newfoundland fishermen in particular recognize the importance of a "good breeze of wind" in reactivating the fishery.[3]

Winds emanating from a general northerly direction are said to have the most critical effects upon the fish, preventing their availability to traps and handlines for extended periods. These winds range from northeast to northerly and are collectively referred to as "northerlies" because their effects upon the behaviour of fish and their associations with other phenomena are believed to be similar. The northerly and northeasterly components of the "northerlies" group, however, are also distinguished by the fishermen according to the different effects that each has upon fish behaviour. Of the two winds, the northerly is known to be the more critical.

The occurrence of "northerlies" is associated with the occurrence of two related phenomena: (1) higher than normal tides (spring tides) and (2) turbulent sea conditions which are known to last for longer periods than for other wind directions. The association between "northerly" winds and spring tides is commonly said to occur "nine times out of ten". Spring tides are the highest and lowest water levels which occur approximately every 15 days near the times of the full moon and the new moon.[4] Figure 9 shows the period of occurrence of spring tides at St. John's.

Figure 9



"Northerly" winds have a large fetch and are said to be most frequent during a seven day-period extending from 3 days before the occurrence of the moon to 3 days after its occurrence. "Northerly" winds are relatively uncommon between June and November, the period of the fishery (Figure 7). Table 1 shows the number of days "northerly" winds predominate during this period for the years 1968 to 1971 according to their occurrence within the seven day period surrounding the spring tide or outside of this period. The Table shows that "northerly" winds have their greatest frequency of occurrence around the spring tide.

Table 1

The Correlation Between the Occurrence of

New and Full Moon and "Northerly" Winds

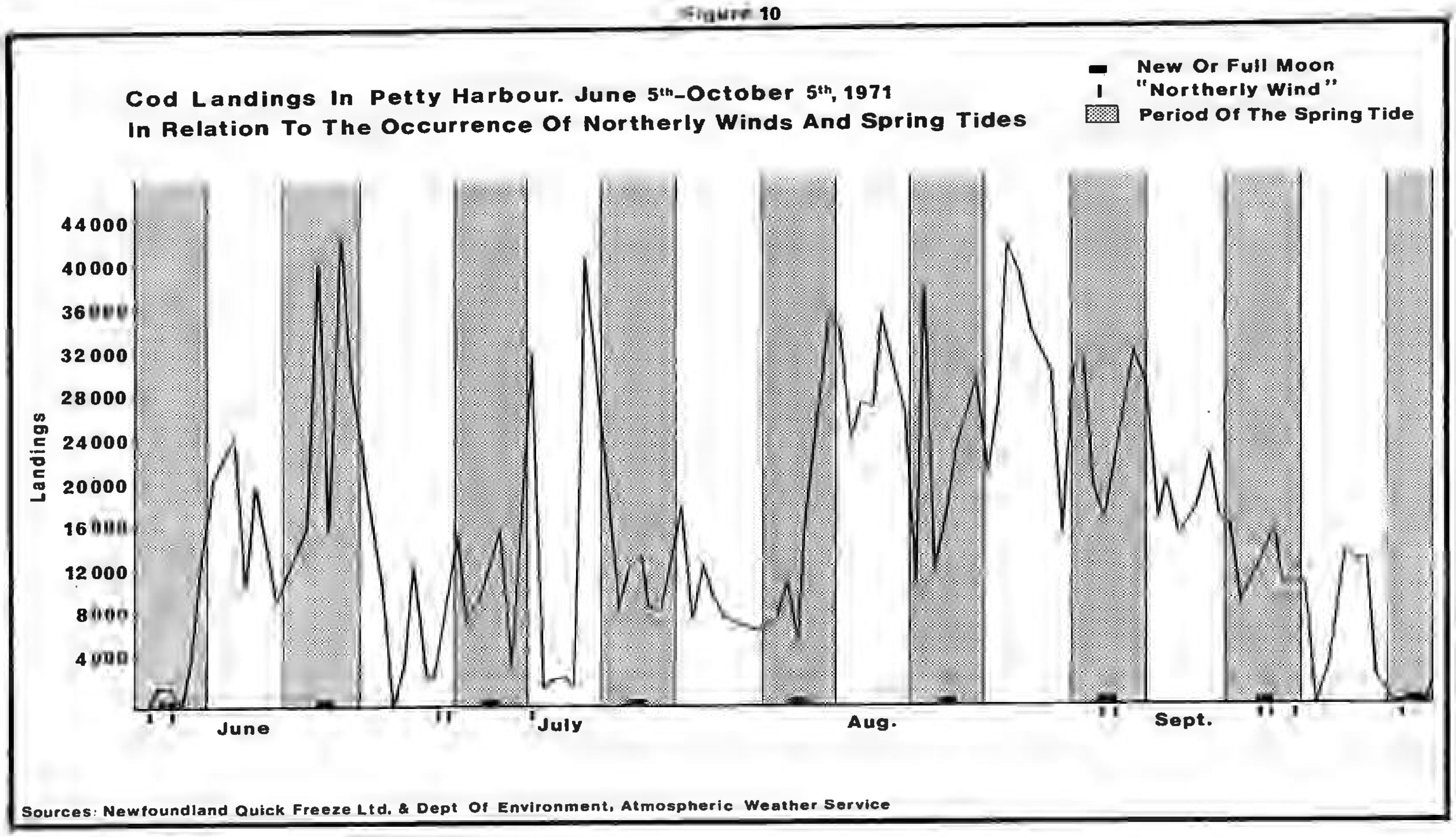
	1968	1969	1970	1971
No. of days northerly winds occurred during period of New or Full Moon	13 (72.3%)	11 (35.7%)	14 (57.7%)	13 (68.4%)
No. of days northerly winds occurred outside period of New and Full Moon	5 (27.7%)	17 (64.3%)	8 (42.9%)	6 (31.6%)
Total No. of Occurrences of northerly winds throughout whole period	18 (100%)	28 (100%)	22 (100%)	19 (100%)

Source: Atmospheric Weather Service
Department of the Environment.

When "northerly" winds occur during the period of the spring tide, the higher than normal water-level of the tide and the large fetch of the wind is said to result in "an extra big sea" which causes the fish to seek a calmer habitat in deep water outside the range of both traps and handlines. While these conditions are believed to cause periodic displacement of the fish schools during the season, the most critical disruptions in the fishery are said to result if the occurrence of "northerly" winds and the period of the spring tide coincide with the commencement of the cod and caplin migration to the shore in June. The excessive turbulence at this time is said to "throw the caplin back in the deep" where they may spawn and become preyed upon by the feeding cod. When this happens, most of the cod are thought to become filled with caplin on the deep water shoals and fail to enter the trap zone or to take baited hooks. Even after the turbulence ceases and favourable winds occur, the fish are said to remain in this sedentary condition. By mid-August the caplin will have retreated offshore and the fish, in the process of seeking other food, may be caught by handline on the shoals. The cod, however, are rarely known to enter the trap zone after this period.

The foregoing situation is claimed to be the major factor responsible for the failure of the trap fishery in Petty Harbour in 1971, and for the poor catches initially made by handliners. Because of the associated occurrence of a spring tide and "northerly" winds during the period of the caplin migration in the first week in June, the large cod trap catches which normally reach their peak in July, failed to materialize. Instead, the largest fish landings were made by handlines in August and September, after the fish had begun to feed again. Figure 10 shows that "northerly winds" and high tides coincided during the period of the cod and caplin migration in early June. It also shows that some of the lowest catches in the season were recorded in July, the time at which the trap catches are normally known to reach their peak. Trap catches usually far exceed handline catches making the low landings recorded in July particularly significant. In contrast to this the figure shows that the most consistently high catches were recorded in August after the end of the trap fishery. Figure 10, however, shows no apparent association between the occurrence of spring tides, "northerly" winds and significantly reduced fish catches. It appears, nevertheless, that the impact of the occurrence of "northerly" winds and spring tides upon the availability of fish at the beginning of the trap fishery has a strong influence upon the fishermen's perception of the relationship between these phenomena throughout the fishing season. This highlights the tendency of fishermen to impute causal relationships to

Figure 10


Cod Landings In Petty Harbour. June 5th–October 5th, 1971
In Relation To The Occurrence Of Northerly Winds And Spring Tides
New Or Full Moon
"Northerly Wind"
Period Of The Spring Tide
Landings
44000
40000
36000
32000
28000
24000
20000
16000
12000
8000
4000
June
July
Aug.
Sept.
Sources: Newfoundland Quick Freeze Ltd. & Dept Of Environment, Atmospheric Weather Service

phenomena which may be simply associations.

While the occurrence of spring tides with northerly winds is believed to restrict the availability of the fish to traps and handlines, these conditions are not known to limit access to fishing places or to prevent the hauling of cod traps. Disruptive weather is said not to occur generally until the late summer. Despite the reduced catches in 1971, all the trap fishermen preferred to leave their traps in the water at least until the first week in August since if the fish are scarce, each fisherman is guaranteed a sale for his entire catch which is not necessarily true if the fish are abundant.[5] In the handline fishery that followed after the removal of cod traps, the cod were found to contain a mixture of sand and caplin spawn, substantiating the trap fishermen's belief that the migrating caplin school had spawned on the sandy bottom offshore and had therefore distracted the cod schools from entering the trap zone.

The northerly and northeasterly components of "northerly" winds are held to produce different effects in the behaviour of fish when not associated with the occurrence of the spring tide. This difference stems from variations in their perceived influence upon the water temperature. The occurrence of a northerly wind is associated with a reduction in the water temperature, a process which is indicated to the fishermen by an increase in the water's clarity. One informant notes that "It makes the water cold and the water gets right clear, and the fish won't stay in clear water." Another informant states that "a northerly wind here in Petty Harbour cleans out the bay... If the wind comes to the north you won't get a cod here for two weeks."

The northeasterly component, however, is said to cause increased warming in the surface layer when it occurs during the summer, forcing the fish to move from this shore to the handlining grounds where they are thought to seek deeper and cooler water.[6] The northeasterly is consequently said to be "a good omen for hook and line men". With increased duration, however, the northeasterly is believed to convey part of the fish concentration out of the Motion Bay and "drive the fish up on the shore" where they may enter cod traps. Unlike the period following a northerly wind, however, the fish are said to return relatively quickly to the Motion Bay following the occurrence of onshore or offshore winds.

The "northerly" group of winds is said to increase in frequency of occurrence relative to that of other winds and to last for longer periods as the summer advances into fall. Prolonged periods of turbulence are consequently said to be common at this time of the year. These winds are also believed to be accompanied by a seasonal reduction in water temperature which makes the water denser, creating "heavier" swells which are more sluggish and hence produce turbulence which lasts for longer periods. The fishermen relate the increased buoyancy of their boats as the fall season progresses to the increase in water density. Figure 11 shows that "northerly" winds continue to increase in frequency of occurrence during the period of the fall handline fishery. This increased frequency together with a continual decline in the occurrence of onshore and offshore winds is thought to displace the fish from the handline zone for progressively longer periods. Eventually, by late November, the fish are said to remain offshore outside the range of handliners, indicating the end of the fishery for the year. One informant suggests that the duration of the fall fishery is directly related to the frequency of occurrence of onshore and offshore winds which tend to intervene between periods of "northerly" winds to return the fish to the grounds. He feels that if these winds were the only ones to occur in Petty Harbour, the fish would remain on the grounds and the fishermen could fish all winter.

Winds: Their Perceived Effects Upon the Fishing Operation

Wind patterns are further known to affect the seasonal and day-to-day conduct of the fishing operation through their influence upon the medium in which the

Figure 11

Mean Maximum Velocity Of Wind By Month At St. John's 1942-71

Source Dept. Of Transport, Meteorological Branch fishery functions. Winds of changing directions are said rarely to blow long enough or "hard" enough in any one direction to prevent the fishermen from going out or damaging their fishing gear. A "big sea", however, is said to result from the effects of specific winds of prolonged duration or of higher than normal wind speeds. The fishermen hold that these hazardous winds are most likely to occur at the commencement of or near the end of the trap fishing period when they are known to damage the fishing gear or towards the end of the handlining season at which time they are said to restrict access to the handlining grounds. These winds are also known to occur sporadically at different times throughout the fishing season, causing periodic and temporary interruptions in the day to day conduct of the fishery. This section will examine (1) how fishermen perceive the effect of hazardous winds upon the trapping operation and the handlining operation and how they adapt to these effects in their decisions and (2) the importance of weather forecasts in influencing fishing decisions.

The significance of hazardous wind conditions appears to differ relatively as between the trap and handlining fisheries. They are considered to be less important in restricting the handlining fishery since handlining operations are mobile and can be conducted in areas where the wind effects are minimal. The trapping operation, however, is restricted to specific locations and must be adjusted to the effects of various wind conditions acting upon these locations.

The trapmen, in an attempt to minimize the effects of winds must decide (1) when and where the traps will be set, (2) when the traps will be hauled, and (3) when they will be ultimately removed from the water. Cod traps are normally placed in their berths on the northshore, southshore, and "on the shore" between the first and fourth weeks in June.[7] The effects of seasonal wind patterns on each shore are considered to be different, and these perceived effects become one of the major determinants in deciding when the traps are set in their berths.

The cod traps are normally set earliest on the northshore or "on the shore" during periods of calm weather when the gear can be firmly anchored to the seabed. These traps are known to be damaged on occasion by swells that may accompany the onshore winds that are frequent during this period. They, nevertheless, are said to be located in the safest berths at this time. The southshore traps are rarely placed in their berths before the beginning of the fourth week in June because of the perceived possibility that dangerous "northerly" winds with associated spring tides might occur before then. The southshore is more exposed to the effects of "northerly" winds than any other part of the coastline. One informant refers to the conditions that influence the decision to set traps on the southshore in the following manner:

> There's always a breeze comes around the twentieth of June ... You always have a northerly wind and that brings a high tide with it and a big sea with it and everyone tears up their traps. This is why they don't set out their traps until after, probably, the twenty-fourth or twenty-fifth.[8]

Figure 8 showed that "northerly" winds have a higher frequency of occurrence in June than at any other time during the fishing season. Another informant notes that when "northerly" winds strike the southshore they "break right to the bottom and roll right up the shore" resulting in difficult setting conditions for cod traps. Another fisherman states that most fishermen prefer to wait until after "the second tide" (the second spring tide) before setting their traps.

After the traps have been firmly moored in their berths, the day-to-day hauling operation begins. The success of this operation is said to be restricted primarily by what are considered to be higher-than-normal or "hard" wind speeds. Responses by the fishermen to what minimum wind speeds constituted a hazard to the trap-hauling operation tended to vary from twenty to forty miles per hour. These differences appear to be related to the time of the year that the winds occur. A 40 m.p.h. wind may curtail fishing during the summer but only a 20 m.p.h. wind is necessary in the fall since it can be accompanied by strong gusts. These wind speeds are rarely considered to curtail safe access to cod traps or to prevent their hauling. If, however, a cod trap were to be hauled under these conditions, the trap netting is, in the fishermen's view, likely to be torn, reducing the catching effectiveness of the trap, and incurring the cost of replacing the netting. Since net damage occurs during the trap-hauling operation even in the calmest seas, the fishermen are particularly sensitive to the risk of hauling under the conditions created by high wind speeds.

"Hard" winds are thought to follow certain patterns of occurrence to which the fishermen can adjust. These winds are said (1) to be more frequent after sunrise than before, (2) to vary in direction and consequently in their effects upon each shore, and (3) to increase in frequency of occurrence and speed as the season progresses. Each cod trap is usually hauled twice a day, once in the morning and again in the afternoon. By hauling his trap as early as possible in the morning when wind speeds are believed to be at their lowest, the fishermen can ensure part of his day's catch even if disruptive winds occur in the afternoon. The fishermen are only aware of the association between low wind speeds and early morning but are unaware of the causes. This results from the fact that the temperature of the land and the sea are nearly equal before sunrise, restricting the formation of a pressure gradient over which winds can form. With the increase in solar intensity after sunrise, the land heats up much faster than the water resulting in the formation of a pressure gradient which instigates a circulation bringing cool air onto the land. This air movement, called a sea breeze, continues until late afternoon when the sun sinks lower in the sky. Eventually, the land and the sea temperatures again become similar and a calm period similar to that of the early morning follows.[9]

Despite their lack of understanding of the cause of the sea breeze the fishermen nevertheless respond to these winds. One fisherman who prefers to haul his trap between 4:00 a.m. and 5:00 a.m., notes the importance of

> Getting out before the wind. After daylight the wind breezes up and the earlier you can get to your trap and get in the better for yourself. Nine times out of ten its going to breeze up. It always do. If you're out early probably it won't breeze up before seven o'clock. You're in then.[10]

Most Petty Harbour trap fishermen follow this practice.

Those fishermen who have drawn two cod trap berths, located one on each shore, may accommodate the daily trap-hauling pattern to the variable effects of adverse winds on each shore. Strong onshore winds are found by the fishermen to be hazardous to the hauling operation on the northshore and "on the shore". The southshore, however, is known to be more protected from the effects of these winds and the cod traps can be tended with a minimum of risk. The opposite situation can occur during periods of high northerly winds.

Some fishermen who were allocated two trap berths on the same shore, or one berth on the northshore, and the other berth "on the shore", often preferred to exchange one berth for another on a different shore. The exchange provided a means for those fishermen to minimize disruptions in the fishery by adjusting to the variable effects of hazardous winds on each shore. The exchanging of trap berths was abolished in 1971.[11] It is still possible, however, for a fisherman to adapt to these effects by setting in one of the many undrawn berths located on either shore (see Figure 4). Of the three shores in Petty Harbour, traps located in berths "on the shore" are said to be in the most hazardous location for hauling because of their complete exposure to the Atlantic Ocean gales. Fishermen with only small or "light crews" who have drawn a berth on this shore, often prefer not to set there but prefer instead to forfeit their berth, and to set in an undrawn berth on another shore.

The cod trap fishery normally ceases by mid-August. The decision to remove the traps from their berths is influenced by two interrelated factors: (1) the size of fish catches being taken by both traps and handlines at this time and (2) the believed tendency for hazardous wind conditions to increase in frequency of occurrence in August.

All wind speeds, and particularly "northerly" wind speeds, are thought to begin to increase at this time. Figure 11 showed the increase in the mean maximum velocity of all wind speeds and Figure 7 showed the relative increase in the average frequency of occurrence of "northerly" winds.

If the early summer trap fishery has been a success, then most fishermen prefer to leave their traps in the water until the fish have moved away from the shoreline. Although this means accepting the increased risk of damage from heavy seas, it is felt that "a load of fish will pay for the damage". However, if the summer trap fishery has been poor, and handlining catches tend to be increasing in early August, then most trap fishermen will abandon the trap fishery and take up handlining rather than risk damaging their gear. Because of poor catches, they may be unable to provide the costs of replacing torn netting. This practice was followed in 1971, when most of the cod traps were removed from the water by the end of the first week in August, following the failure of the trap fishery, rather than at the end of the third week in August which is the normal practice. One informant describes some of the factors that were considered in this decision in the following way:

> If you haven't had a hard breeze and the fish is scarce well you'll probably take in your twine because you're going to have them, you're going to have the August breeze anyway.[12]

When the trap fishery has been poor, some owners of two traps may decide to leave one trap in the more protected of the two berths in the water for an additional period. It is said that "a spurt" of fish sometimes appears briefly in the trap zone in late August if the fish have failed to enter the trap zone during the normal period of the fishery. The maintenance of only one trap at this time represents a means of minimizing the wind hazard and at the same time providing an opportunity to compensate for the failure of the early summer trap-fishery. A similar strategy was found by Davenport to be employed by Jamaican fishermen.[13] One informant who kept one trap in the water until August 24th in the 1971 fishery, had to replace the netting in one entire side of the trap after the trap was damaged by the turbulence resulting from hard northerly winds.

The handline fishery, in which all the fishermen participate after the trap-fishery has ended, takes place under less favourable wind conditions than the trap-fishery, but is less hazardously affected by them. The handlining grounds are well dispersed throughout the whole of the Petty Harbour area. Therefore, when it becomes difficult to fish on favourite shoals outside the headlands because of hazardous wind conditions, the handliners have the option of seeking more protected but often less productive grounds. Terada found such a strategy to be more economical.[14] The most protected grounds are said to be found "in the bay" along the northshore or "on the shore" depending upon which way the wind is blowing. The grounds "on the shore" are thought to be least important for handlining because of the distance that the fishermen must travel along an exposed shore before reaching the safety of the bay in the event of the sudden occurrence of high winds. One of the oldest fishermen explains the risk in fishing on this shore:

> We went outside the harbour yesterday morning... and we went upon the shore off Bay Bulls. The day before we were down the other way [northshore] and it blew like the devil.... As soon as we put our lines out, up she came and we had to leave it and go down across [to the northshore].[15]

Individual fishermen's perceptions of the minimum wind speeds necessary to curtail the handlining operation vary from twenty-five to fifty miles per hour. This higher range of tolerance for wind speeds by handliners compared to that of trap fishermen is the result of the mobility of the handlining boats enabling them to seek protected fishing areas and is evidenced by the fact that the peak handline period occurs between August and November when the mean wind speed is increasing.

Despite the increase in wind speed in the fall and the increased frequency of occurrence and duration of "northerly" winds, these conditions are said not to prevent access to the handlining grounds. Some of the most productive grounds during this period lie in deep water within the protective shelter of the bay (Figure 5). The fishermen tend to remain fishing in this area until the fish have moved offshore outside the range of the handlines.

The Petty Harbour fishermen's information about wind conditions, and consequently their response to them, is derived mainly from direct personal observation at sea, and to a lesser extent from weather forecasts. The latter, although listened to regularly, are said by the fishermen to provide insufficient information on their own because they do not indicate the time at which the winds will occur. It is difficult to ascertain to what extent the forecasts do influence their behaviour since they continue to listen to them regularly. If perceived hazardous winds are forcasted, the fishermen prefer to commence fishing until these winds begin to blow rather than risk the loss of a whole day's fishing. One fisherman referring to the predicted occurrence of a "northerly" wind states that "I knew that it was going to come, but I didn't think we'd have it till three or four o'clock in the evening."[16]

It is also noted by the fishermen that when forecasted wind conditions prevail in the Motion Bay, other conditions may occur outside the headlands. One respondent who places a low value on the reliability of weather forecasts states that "they call for a westerly wind on the radio but when you go outside the heads here, the wind is down southwesterly." Hela and Laevastu offer some substantiation for this distinction in their study.[17] Because of the unreliability of weather forecasts, it is therefore often necessary for the fishermen to "take a chance on going out" to determine the actual suitability of conditions for fishing. Andersen and Wadel also note the need for fishermen to experience conditions personally before making fishing decisions.[18]

Hydrographic Elements

The most important hydrographic factor influencing the Petty Harbour fishery is the periodic motion of the water of the sea defined by Bowditch as "the tide".[19] It was shown in the previous section that the fishermen expect disruptions to occur in the fishery when "northerly" winds accompanying the bi-monthly occurrence of the spring tide. Petty Harbour also experiences daily tidal changes which are said to influence both fish behaviour and the catching operation. The significance that the fishermen attach to the tidal factor, however, varies according to the fishing method used. Just as wind conditions are known to have the most important effects upon the operation of the trap fishery, tidal conditions are thought to have their greatest influence on the conduct of the handline fishery.

Bowditch notes that there are two components of the tide, a vertical one and a horizontal one. The vertical component consists of the rise and fall of water which results from variations in the attractive force between the earth, the sun, and the moon. The rise and fall of the tide is accompanied by a horizontal movement of water called "the tidal current". While receiving its initial energy from the tidal forces, the tidal current is greatly modified in its direction, intensity of flow, and duration by the contours of the sea bed and the shape of the coast upon which it is acting. Because of these modifications, the tidal current may appear to be acting separately from the rise and fall of the water. For a full discussion of the tidal phenomenon see Bowditch.[20]

The Petty Harbour fishermen recognize both the rise and fall of the tide and the tidal current but refer to them collectively as "the tide" and vaguely attribute them to lunar forces. They do, however, realize that the tidal current also operates independently of these forces and is influenced by the morphology of the sea bed over which it flows and by "the shape of the land which turns the water". More importantly, however, the changing water level and the tidal current are differentiated in terms of their effects upon the behaviour of the fish and the related aspects of the catching effectiveness of fishing gears.

Hydrographic tables show that the Petty Harbour area experiences two high and two low tides each day with a mean tidal range of 2.8 feet.[21] Each low tide is followed by a high tide at intervals of approximately six hours and twelve minutes, which means that the tides occur fifty minutes later each day. Figure 9 showed a typical tidal curve for St. John's, the closest station to Petty Harbour. The tidal current is said by the fishermen to vary in direction. Two predominant directions, however, are recognized, "up" (south) and "down" (north). The "up tide" is said to enter Motion Bay on the northshore and to proceed across the bay and along the shoreline, moving "up on the shore" while the "down tide" is believed to follow the same pattern but in the opposite direction. Of the two predominant directions, the "up tide" is found by the fishermen to be the prevailing one. This may be attributed to the southward moving Labrador Current which reinforces the "up tide".[22] The fishermen, however, express no knowledge of this phenomenon, and refer to all moving water as "tide".

The speed of the tidal current is found to increase with distance from the community so that the strongest currents occur outside the headlands where the most productive grounds are located. It is felt, however, that there may be large variations in tidal current speed since "in one week there may be no tide at all while in another week there may be strong tides every day". The strongest tidal current is related to the occurrence of the spring tide.

This section will examine together the perceived effects of the tide upon fish behaviour and upon the catching operation and how fishermen accommodate to these influences in the implementation of fishing strategies.

Tide: Its Perceived Effects Upon Fish Behaviour and Upon the Fishing Operation.

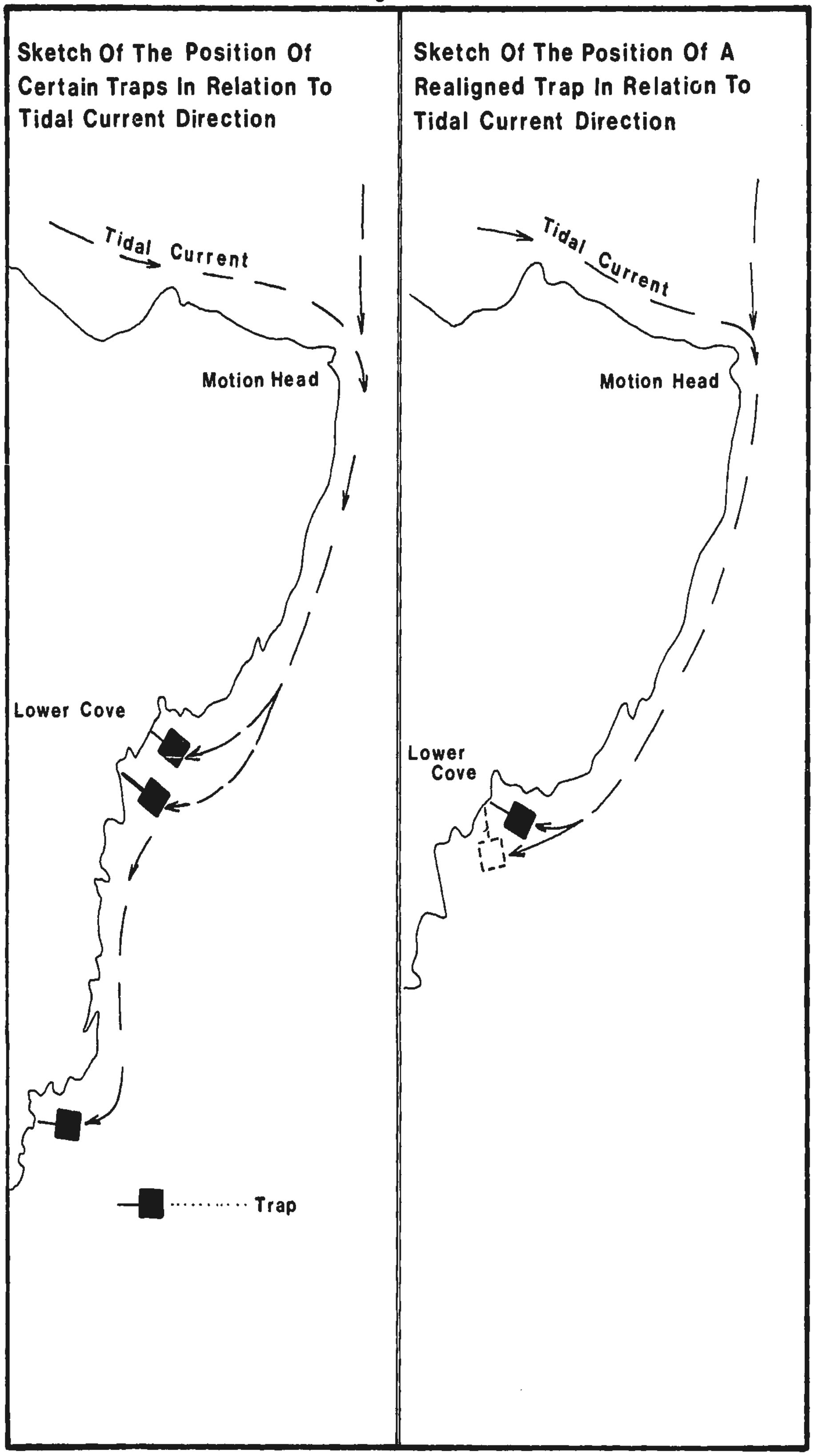
The fishermen state that the daily tidal oscillations and their associated tidal currents have important consequences for the fishery by influencing both the behaviour of the fish and the effectiveness of the fishing gears. In contrast to wind conditions, however, no clear distinction is made by the fishermen between those effects which influence fish behaviour and those which influence the catching operation. These effects are believed to be too closely related to be distinguishable. The rise and fall of the tide is most apparent along the shoreline and it is the tidal current which accompanies it that is believed to influence the trap fishery. On the other hand the tidal current, itself, is more readily apparent away from the shoreline and it is this factor regardless of the state of the tide which is believed to influence the handline fishery.

The trap fishermen generally agree that at low tide, the trap will have both its maximum catching effectiveness and will also be less difficult to haul than at any other time during the day. A rising tide is said to convey schooling cod into the surface water and towards the shoreline above the range of the traps. As the tide begins to fall, the fish are believed to retreat from the shoreline and to begin to follow the cod trap leader into the trap. Consequently, the best tide for trapping cod is said to be "the one which comes down off the land". Also at low-water level or "slack" tide, water movement is said to be at a minimum since "you don't get as much tide on your trap". On both accounts the low-water period is therefore thought to be the best time for hauling a trap.

The importance that the fishermen attribute to the low tide as a factor in the trap hauling decision appears to depend upon its time of occurrence in relation to other variables particularly winds. One low tide normally occurs in the morning followed by another sometime in the afternoon. The trap is usually hauled twice a day, once about dawn, and again in the afternoon. In the morning operation, the fishermen appear to be more concerned about reducing the risk of wind hazards than they are about maximizing the catching effectiveness of the gear or minimizing the strain in the gear. The tidal position is therefore considered to be of secondary importance at this time. If, however, the second low tide occurs in the early afternoon, the hauling operation may be timed to coincide with its occurrence. The daily trap-fishing strategy is therefore "a matter of beating the tides and the winds". This illustrates that a fishing decision may not be based upon any one single factor.

The tidal current alone is thought to have an adverse effect upon the stability of traps in certain locations and therefore on their capacity for catching fish. The netting in the back or "bunt" of the Newfoundland cod trap has a smaller mesh-size than that in the sides or front of the trap. Because of this, the fishermen believe that a strong tidal current striking the back of the trap can exert sufficient pressure upon it, to remove the trap from its moorings. When this happens, the trap is said to be rendered ineffective for catching fish. If the same current strikes the larger mesh of the front or sides, however, the water pressure is found to be greatly reduced, lessening the current's effect upon the trap's stability. Because of the shape of the coastline south of the Motion Head, the predominant south-trending tidal current is found by the fishermen to converge with the front of several traps located "on the shore". They consequently realign these traps in their berths to reduce the effects of the tidal current. Figure 12 shows the location of these traps relative to the path of the tidal current and the position of a representative trap following its realignment.

Figure 12



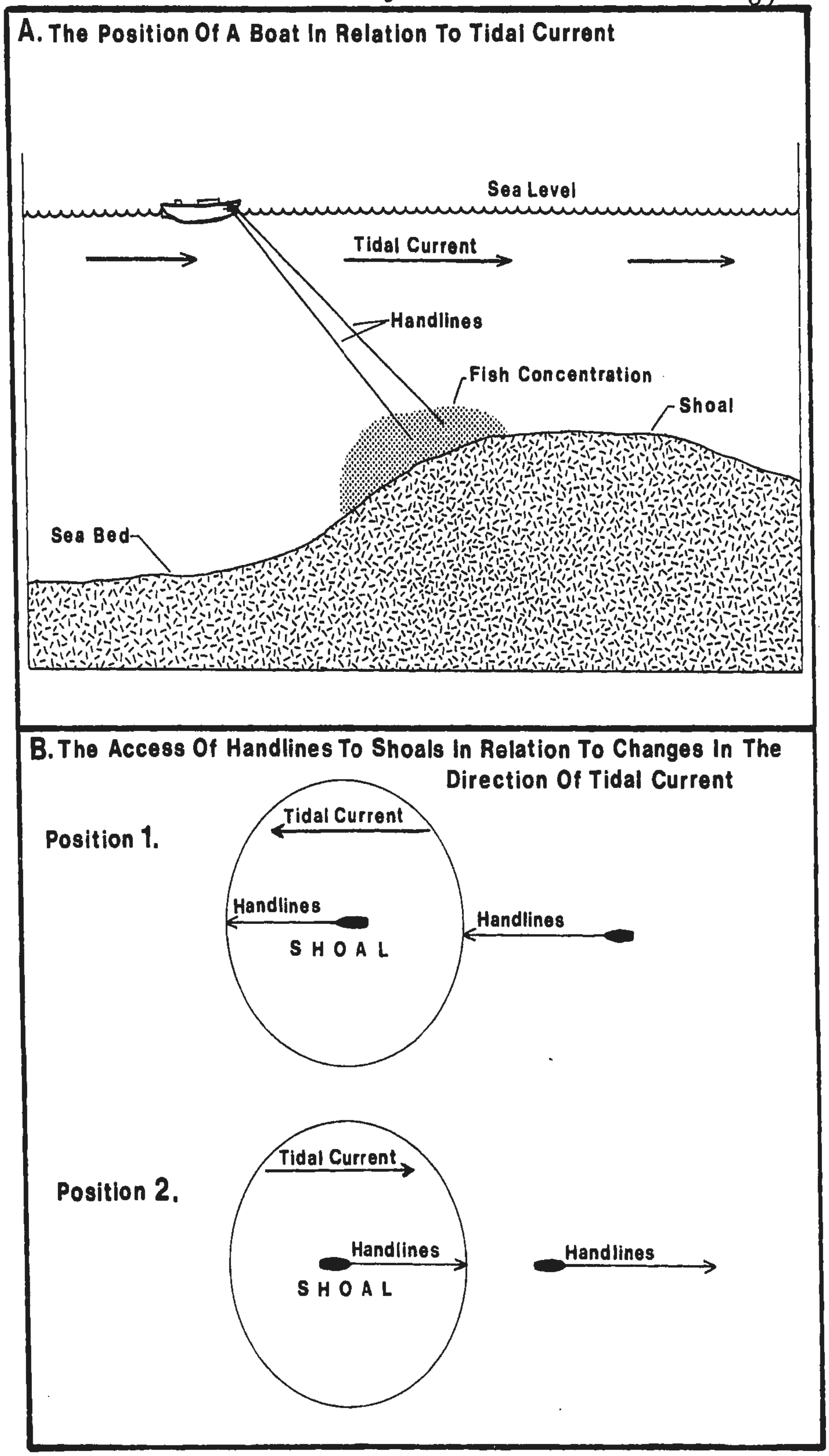
Sketch Of The Position Of Certain Traps In Relation To Tidal Current Direction
Tidal Current
Motion Head
Lower Cove
Trap
Sketch Of The Position Of A Realigned Trap In Relation To Tidal Current Direction
Tidal Current
Motion Head
Lower Cove

While tidal current may represent hazards in the operation of the trap fishery, in the handline fishery they are seen more in terms of providing advantageous fishing conditions. The fishermen believe that the movement of the water produced by the tidal current is essential to stimulate the fish to feed and is important in changing the location of fish concentrations from one "edge of ground" to another. Access to these concentrations is also said to vary according to the direction and speed of the tidal current. The implementation of successful fishing strategies depends upon identifying and adjusting to these variations.

The largest fish concentrations tend to be located on "the edges of the ground" where the best feeding conditions are believed to be found. The fishermen feel that the fish are maintained in these positions and stimulated to feed by the tidal current which runs against the edge of the shoal. The tide sweeps the fish up against the shoal ground and holds them there. In this position, they are said to be "stemming the tide" and feeding actively. Handlining fishermen attempt to maximize these perceived effects by positioning their boats so that the handlines are carried by the current against the edge of the shoal (Figure 13A).

Successful fishing strategies on the handlining grounds are said to depend upon the speed of the tidal

Figure 13


A. The Position Of A Boat In Relation To Tidal Current
Sea Level
Tidal Current
Handlines
Fish Concentration
Shoal
Sea Bed
B. The Access Of Handlines To Shoals In Relation To Changes In The Direction Of Tidal Current
Position 1.
Tidal Current
Handlines
SHOAL
Handlines
Position 2.
Tidal Current
Handlines
SHOAL
Handlines

current and upon the capacity for individual fishermen to recognize and adjust to changes in its direction. The fishermen suggest that the current speed may be "too slack" to stimulate the fish to feed so that they remain in a dormant position on the seabed, unattracted to the handline bait. When this happens the fishermen normally remain on the shoal until the current speed increases. An "extra strong tide", on the other hand, is said to restrict the lowering of handlines to the level at which the fish are concentrated. The tidal current is said to attain its greatest speed outside the headlands where the tides are said "to flow like a river" and where the most valuable fishing grounds are located. These conditions are said to occur most commonly during periods of spring tides. The fishermen note that this phenomenon may prevent the lowering of handlines to the seabed since "you can't put on a weight heavy enough" to keep the lines from floating. Fishing is said to be virtually impossible when wind and tide converge since "it can throw you out of the boat". Tidal speed is therefore not seen by the fishermen in isolation but only relative to its effects upon access to fish schools and its effects upon the feeding behaviour of the fish. The optional speed is said to be one which is "neither too slack nor too strong" although its actual speed may vary.

When the tidal current striking the edge of a shoal changes direction, the fish schooling on that edge are said to become more dispersed and therefore more difficult to catch. The fishermen ascribe great importance to the capacity to recognize what are almost imperceptible changes in tidal current direction and to know the lie of the shoals relative to the direction of the tidal current. With this information, a handliner can relocate to another "edge of ground" where the tide helps to school the fish. The best handliners are therefore ones who "know the grounds and know how to anchor for the tide". One informant notes that "some fellows go out today to throw out their anchor and that's where they're to all day. If the wind changed or the tide changed, they'd still stay there - just don't know the difference". These skills are therefore not universal among the fishermen.

When the tidal current is found to be frequently changing direction on a shoal, the fish are believed to remain concentrated around the edges. Access to the edge by handlines may be lost, however, when the tide changes direction. Some handliners when fishing off from the edge of a shoal attempt to overcome this by anchoring on the top of the shoal itself. In this way they can insure access to each or any edge of the shoal regardless of the direction of the tidal current. A boat anchored near the edge, however, may lose access to that edge when the tidal current changes direction. When this happens, the handlines of a boat located on top of the shoal will have access to the edge while those of a boat moored off from the shoal will be carried away from the edge. This boat will therefore have to move some distance to find fish since he may not come within an agreed distance in order to eliminate the possibility of the handlines becoming entangled (Figure 13B). Through this skill of detecting and adjusting to changes in tidal current direction, some fishermen are capable of reducing interruptions in the fishing operation thereby increasing their catching potential.

Biological Elements

In the two previous sections the behaviour of the fish has been discussed only as a dependent variable in terms of how it is influenced by the physical environment. The fishermen, however, also view fish behaviour as an independent variable affecting the successful prosecution of the fishery. Their knowledge of this behaviour is mainly concerned with the feeding habits of the cod and the related patterns of fish movement which affect the duration of the fishery as well as the varying accessibility of the fish to traps and handlines.

This section will examine (1) the perceived relationships between the cod and its main food organisms and how these relationships are seen to influence the onshore migration of the fish and the seasonal cycle of their movement within the Petty Harbour area, and (2) the effect of these perceptions on the operation of the trap and handline fisheries.

Feeding Behaviour and Fish Movement: Their Perceived Effects Upon the Fishing Operation.

The cod is a carnivorous species feeding upon a variety of food organisms. Of the items in its diet, the caplin and the squid are held by the fishermen to be most important. The caplin is said to be the cod's most important natural source of food, its availability determining the success of the early summer trap and handline fisheries. The feeding relationship between the cod and the squid is not as well explained as that between the cod and the caplin. The squid, however, is known to be an important source of bait for catching the cod in the late summer and in the fall when the caplin are no longer available in the inshore zone.

Winters states that the caplin performs two important functions in the inshore fishery (1) it attracts hungry, post-spawning cod into the inshore zone where they can be trapped and (2) it provides a cheap and easily procured supply of bait for handlining. He notes that "the productivity of the cod fishery is often concomitant with the abundance or scarcity of caplin."[23] The fishermen agree that the caplin is the best bait for cod and is responsible for attracting large quantities of fish into the trapping zone and providing bait for the start of the handline fishery. The cod are said to feed voraciously upon the caplin, producing large, dark, highly-valued cod called "caplin fish". The fish which feed upon the squid are called "squid fish" and are considered to be thinner, whiter, and generally less valuable than the "caplin fish".

The fishermen state that the caplin migrate into the Petty Harbour area during the first two weeks in June. The initial migration is said to occur normally during the period of a high tide which "brings the fish to the rocks". Small cod concentrations, however, are often known to be present in the inshore zone before the arrival of the caplin. These fish, called "herring fish", may be taken in salmon nets in late May and if suitable trap setting conditions prevail at this time, a few fishermen may set a trap on the relatively protected northshore, facilitating an early trap season. The handline fishery as a rule commences before the appearance of the caplin in Petty Harbour. At this time, the cod are taken either on artificial bait[24] or on caplin bait which has been trucked from nearby areas where the caplin have made an early appearance. The handliners, because they have a smaller catch per unit of effort than the trap fishermen, attempt to maximize every opportunity to catch fish.

The fishermen note general long-term changes in the time of arrival and in the pattern of the caplin/cod migration which have affected the commencement of the fishery. Some of the older fishermen recall that up to about twenty years ago, the fish always arrived later, sometimes not entering the inshore zone until the last week in June. During this earlier period, the fishermen would often "go to meet the fish" offshore where they were found "afloat", feeding upon the caplin. Here the fish were located by each boat lowering a cod jigger to different depths to determine at which level the fish were feeding. In this way, the handline fishery could commence before the cod began to occupy the shoals in the Petty Harbour area. When the fish arrived late, they were also said to come in an early run of small fish and a later run of larger and more valuable fish. Therefore, the fishermen considered that there was no need to risk setting traps earlier since one could be ensured of a "good voyage" from the later run of larger and more valuable fish.

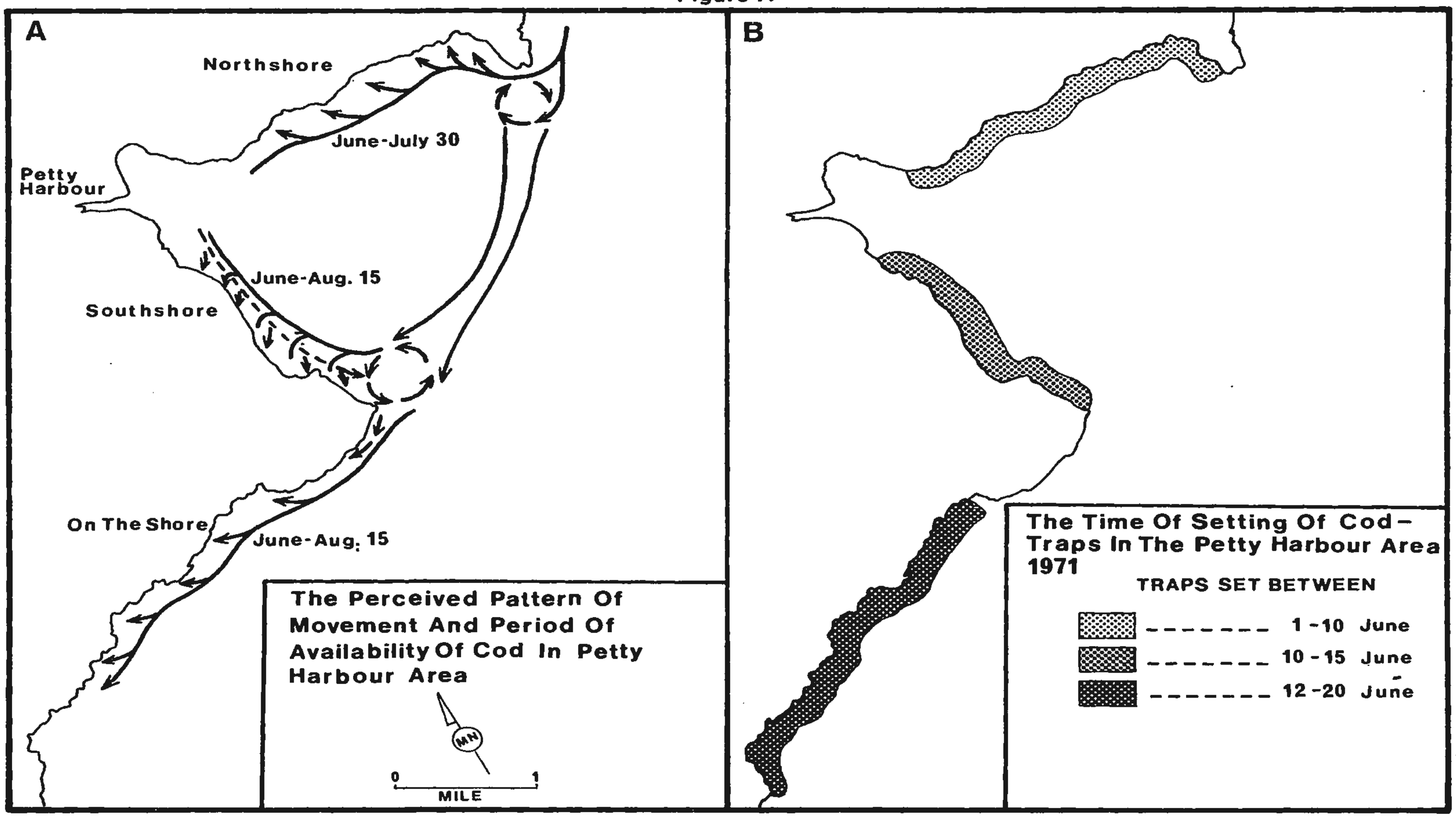
Since this earlier period, the main migration has been observed by the fishermen to enter the Petty Harbour area before mid-June and to consist of smaller fish schools and of fish of reduced average size. Most fishermen agree that "in the past twenty years, the fish are coming earlier", necessitating the setting of traps earlier than was the practice in the past. No attempts are made to explain this phenomenon. The smaller size of the fish schools and the reduced average size of the fish, however, are attributed to the growth of the offshore fishing fleets and to the introduction of gillnets in the inshore fishery elsewhere. The fishermen substantiate the latter claim by referring to the declining catches which are said to have followed the introduction of the gillnet to the St. John's handlining grounds. These grounds, located between the North Head of Petty Harbour and Cape Spear, had in the past provided a secondary source of fish for the Petty Harbour fishermen but are now considered by them to be poor fishing places. This observation serves to reinforce the Petty Harbour fishermen's attitudes favouring the continued prohibition of the gillnet in the Petty Harbour area.

The fishermen recall that, prior to 1950, the fish schools also followed a distinct migrational pattern within the Petty Harbour area. This pattern influenced the preferred location of cod traps at that time. When the fish entered the coastal area in late June they were said first to appear North of Petty Harbour and then to follow a general southward movement, "working up" and becoming concentrated along the Northshore. The "main body of fish" was said to remain on this shore for approximately three to four weeks, entering cod traps. At the end of this period the cod and caplin were then said to continue to move progressively southward to the southshore and "on the shore". Here the cod were taken in traps for about two weeks, after which time the fish were said to settle on the nearshore shoals. This perceived pattern of movement is shown in Figure 14. One informant describes this movement in the following way:

> The fish come in on the northshore and hang on the bottom for a certain period of time and then come up across the bay [Motion Bay] in deepwater on the southshore so the fish don't stay as long.[25]

Because of the tendency in the past for the fish to congregate first on the northshore and to remain there for longer periods than on the other shores, most fishermen preferred to have one trap berth on the northshore. One of the oldest fishermen recalls that "you'd have your voyage of fish down on the northshore before you'd get it on the southshore". For the fisherman owning two cod traps, the most favoured arrangement was to draw one trap-berth on the northshore and the other on the southshore or "on the shore". In this way he was more likely to realize the productive potential of each berth. This ideal arrangement rarely occurred in the trap berth draw but could be achieved by the exchange of berths which normally followed the draw or by setting in an unused berth.

Figure 14


A
Northshore
June-July 30
Petty Harbour
June-Aug. 15
Southshore
On The Shore
June-Aug. 15
The Perceived Pattern Of Movement And Period Of Availability Of Cod In Petty Harbour Area
MN
0
1
MILE
B
The Time Of Setting Of Cod-Traps In The Petty Harbour Area 1971
TRAPS SET BETWEEN
1 - 10 June
10 - 15 June
12 - 20 June

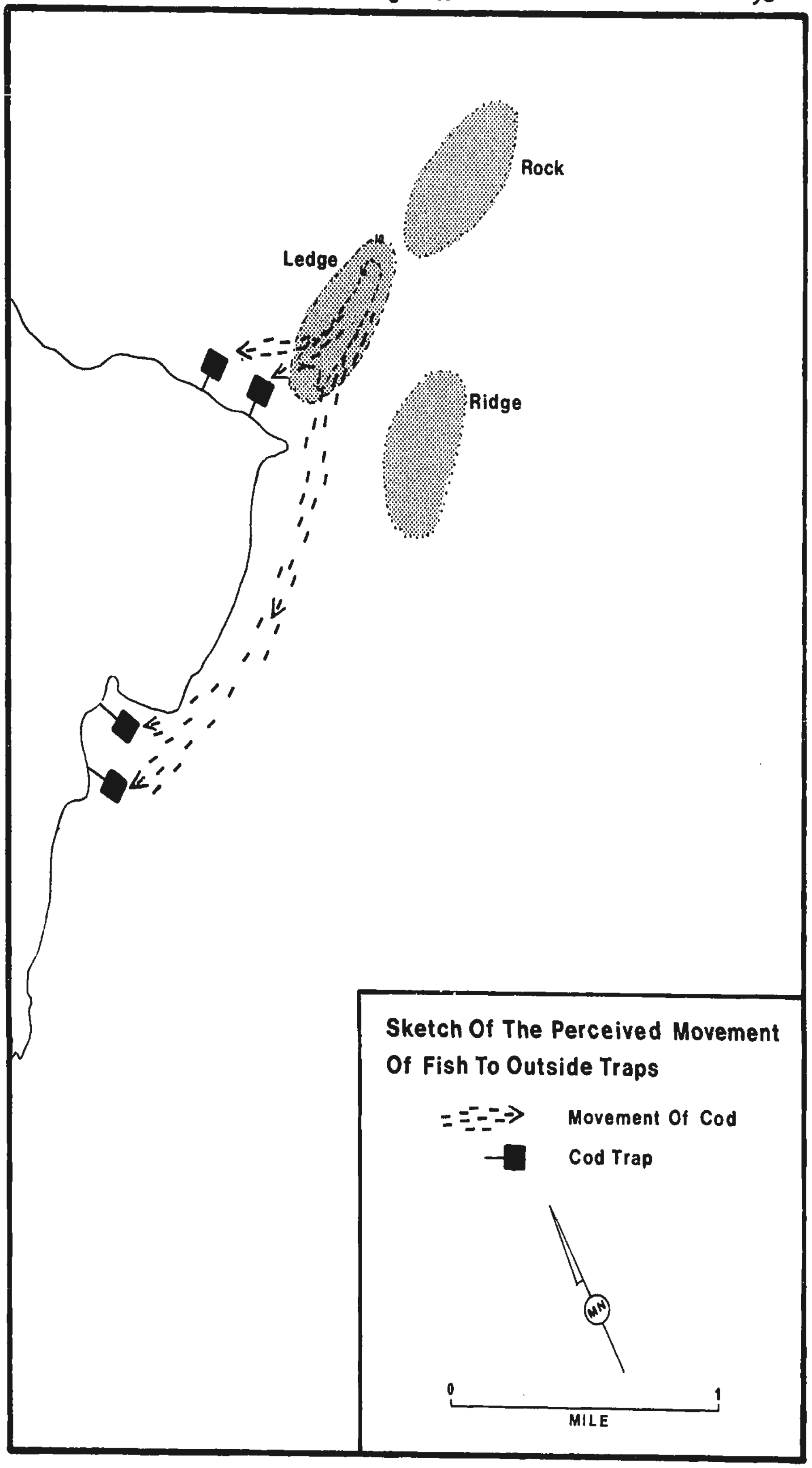
With the earlier arrival of the caplin in recent years, the fish are said to "come just as quick on either shore". The movement of the fish within the Petty Harbour area, however, is considered to be essentially the same. The fish are still believed to move from the northshore to the southshore and "on the shore", terminating the northshore trap fishery by about the end of July. It is therefore still considered important to set traps first on the northshore to realize the full potential of the shortened fishery on that shore. Figure 14A shows that the fishermen perceive that the cod move earlier from the northshore, and Figure 14B, that they accommodate to this by setting their traps earlier on this shore. Since traps located on either shore are now believed to have an equal opportunity of catching fish at the beginning of the fishery, the ownership of a cod trap berth on the northshore and one on another shore therefore appears to be less important than it was in the past. Other non-biological factors today seem to be more important in determining the locational preference for cod traps.

As the caplin migrate into the Petty Harbour area some of the fish are thought to become concentrated on the nearshore shoals which lie in the path of this migration. Here they are said to attract large numbers of predatory cod which provide a readily available source of fish for the early summer handline fishery. The cod are also held to be carried sporadically by favourable winds from these shoals into the shoreline where they can be taken in cod traps. The fishermen believe that the most important sources for handline and trap fish are found on the shoals outside the headlands.

Of all the shoals located outside the headlands of Petty Harbour, the Ledge has proved to be the most important source of fish during the period of the cod and caplin migration. In the fishermen's view, those fish that concentrate on the Ledge fulfil a dual purpose, providing the basis for the early summer handline fishery as well as increasing the productivity of "outside" traps located on both the southshore and "on the shore". Most handlining boats congregate on the shallow Ledge throughout June and July. During this period the fish schools are thought to be relatively evenly spaced, in shallow water, on the top of the shoal and along the edges. As a result, short handlines are used so that each boat can effectively function close together without the handlines becoming entangled. All the fulltime handliners can therefore establish a berth on the Ledge at this time, each fisherman having an equal opportunity of catching fish. All of the shoals outside the headlands of Petty Harbour are believed to intercept the caplin during its movement onshore and offshore and to hold the caplin and the cod for longer periods than do the shoals inside the Motion Bay. Because of these conditions, the handline fishery on the outside shoals and the "outside" traps located near them have the longest period of potential access to the migrating cod (Figure 3). Of particular significance to the trap fishery are the four outside traps located within range of the Ledge. These traps are said to benefit greatly from periodic fish movements from the Ledge to the shore. If the fish are concentrated on the inside part of the Ledge, they are said to be more available to the two traps located inside the Motion Head. If concentrated on the deeper outside part, the fish are believed to enter the "outside" traps located "on the shore". Figure 15 shows this perceived pattern of movement. As a consequence of the prolonged accessibility of the "outside" traps to periodic incursions of fish, these traps normally are the last to be removed from the water. Because of the complete failure of the 1971 cod trap fishery, however, all the traps were removed from their berths at about the same time.

The caplin are believed to begin moving away from the shoreline and the shallow shoals normally by the last week in July. By this time, the post-spawning caplin are said to develop a "slimy" or "worn out" condition and to float at the sea surface in small clusters. In such a state, they are found to be unsuitable as bait. Consequently the cod are also said to move offshore and to settle on deeper

Figure 15


Rock
Ledge
Ridge
Sketch Of The Perceived Movement Of Fish To Outside Traps
Movement Of Cod
Cod Trap
MN
0
1
MILE

shoals in search of other food. This process, and the consequent removal of the cod traps from the water, is normally completed by the end of the third week in August.

After the demise of the caplin, the cod is said to feed upon whatever food is most readily available. The stomach contents have revealed such organisms as tomcods, mackerel, sculpin, and crab. But these organisms are rarely thought to be found in sufficient quantities to provide all the cod's food requirements. Because of this, some fishermen feel that the cod may also derive sustenance from the nutrients stored in its liver since "fish caught in the summer have large livers ... fish caught in the fall have livers like a string".

The squid, when they are available, are normally said to enter the Petty Harbour area in late July before the caplin have moved offshore and to remain in the area throughout the late summer and early fall. Although the squid provides the main source of bait for the handline fishery which takes place during this period, few fishermen ascribe any importance to them in the cod's natural food chain. This notion is attributed to several factors including: (1) the highly variable occurrence of the squid in the Petty Harbour area, (2) the apparently different habitats occupied by the cod and the squid, and (3) the speed of the squid relative to that of the cod. The squid, unlike the caplin, are not known to follow a yearly cycle in the Petty Harbour area or to be available in large quantities. The species is said to have been virtually absent from the area during the five year period preceding 1971. During this time, quantities were imported from Japan or California to fulfil the bait requirements. When the squid do enter the coastal zone, in late July, they are believed to become concentrated on the shallow-water shoals near the shore. At this time, however, the cod are thought to have begun to settle on the deeper-water shoals away from the shore. The squid are also said to have "jet propulsion"[26] enabling them to move quickly in the water and thereby escape from the foraging of the more sluggish cod. These beliefs are substantiated by the commonly-held opinion that, unlike a caplin, a whole squid is rarely found in the cod's stomach.

Despite its seeming lack of importance in the cod's food chain, the squid is found to be an excellent source of bait for the late summer and fall handline fishery because of the shortage of other food organisms to satisfy the feeding requirements of the voracious cod. One fisherman expresses this notion by stating that "They really go after the squid bait ... The cod are hungry and take squid bait because there's no other food available." The squid are also considered to have a greater consistency than other types of bait, such as mackerel, and therefore becomes less easily detached from a handline hook when it is being hauled along the seabed.

The general absence of food organisms allows the fishermen to use the squid bait to attempt to concentrate the cod in favourite fishing spots so that they can be easily caught. This process, called "baiting the grounds", involves casting pieces of bait over the edge of a shoal at the beginning of the day's fishing, if the fish are found to be scarce. The tidal current is said to convey the bait against the edge of the ground where the fish can be attracted within catching range of the boat. Morrill notes that handline fishermen in the Virgin Islands follow a similar practice.[27] At the end of each day's fishing, the remaining bait is similarly deposited to "keep the fish on the grounds". By attracting the cod in this way, the Petty Harbour fishermen believe that they have some means of directly influencing the quantity of cod that is available for catching. This supply is said to increase in proportion to the number of boats "baiting the grounds". Such a pattern of exploitation is held to be impossible if other, more efficient catching devices, such as the line trawl and the gillnet were to be used in the fall fishery. The use of these gears is believed to prevent the fishermen from following the traditional practice of concentrating fish on favourite spots and to allow a few fishermen to usurp all the valuable fishing grounds.

The cod are believed to continue to retreat into deeper water as the fall advances, concentrating on the edges of progressively deeper shoals in the Motion Bay and "on the shore" (Figure 5). The fish are then said to be "spread out all over the place" in relatively smaller concentrations. The operation of the fall fishery is therefore characterized by a greater degree of boat movement between shoals and the utilization of more precise landmark knowledge than is required when the fish are found in shallower water. The cod are thought to move beyond the fifty-fathom contour and the range of handlines ultimately by late November. Fifty fathoms is felt to be the maximum depth from which a baited handline can be manually operated.

The Petty Harbour fishermen were found to perceive the marine environment in terms of the effects of certain key elements believed through first-hand experience and second-hand knowledge to influence fish behaviour and the fishing operation. These elements were viewed separately and expressed in the form of causal relationships enabling the fishermen to predict their effects, thereby simplifying their understanding of the complex marine environment, and allowing them to perfect the task of responding to it. In this way the fishermen constructed an image of the environment to which they referred in the formulation of decisions.

Wind and tide were expressed as independent variables causing favourable and hazardous effects upon both fish behaviour and the catching operation, while fish behaviour was seen as an independent variable influencing the catching operation. Water temperature was considered to be both an independent and a dependent variable, but because it was not directly experienced by the fishermen it tended to be associated with the more easily observable seasonal wind patterns.

The fishermen's perceptions of each element and its effects were influenced by the small size of the fishing area, the static nature of the fishing technology, and the relatively passive nature of the fishing operation. The relative significance attached to the effects of each element tended to vary between the trap and handline fisheries and this in turn was a consequence of the differing nature of the two fisheries. The trap-fishery is a capital-intensive operation taking place during a relatively short fishing season, and using costly fishing gear placed in a stationary position in shallow water along the shore. The handline fishery, in contrast, is labour-intensive, takes place during a longer fishing period, uses less expensive gear and is more mobile. In this fishery, the participants actively seek fish in an operation involving greater competition and skill than is apparent in the trap fishery.

Handliners and trapfishermen consequently differed in their assessment of what aspects of the fish behaviour and the fishing operation are of most concern, and thus in the interpretation of the elements of the marine environment that they attempt to explain and predict.

The availability of fish in the trap zone was deemed to be critical to the trap fishery because of the shortness of the trapping season and the stationary nature of the cod traps. Conditions which restricted the setting of the traps at the beginning of the season, as well as their day-to-day hauling were of critical importance because of the location of the traps in shallow water where these conditions have their most pronounced effects, because of the high cost of the traps and because of their reduced catching effectiveness when damaged. The broad seasonal movements of fish from shore to shore were seen to influence the setting pattern for cod traps while the shorter movements along the shoals were more important in influencing the seasonal pattern of the more mobile handline fishery. These patterns were seen to result from the variable effects of wind, tide and fish behaviour.

The fishermen were found to share a common knowledge about the effects of specific elements on each aspect of the trap and handline fisheries, and their anticipation of the seasonal occurrence of the elements associated with these effects bore a strong similarity to actual recorded conditions where such data were known. While the fishermen tended to articulate how they would adapt to specific elements, their actual adaptations were influenced by all elements since the fishing operation took place under actual conditions in which these elements never occurred in isolation. The range of possible adaptations was restricted by formal and informal rules and by a number of personal factors that varied from fishermen to fisherman and that may take precedence over environmental factors in the formulation of decisions.

In the trap fishery only four major decisions were identified: (1) where to set the trap, (2) when to set the trap for the season, (3) when to haul the trap on a day to day basis, and (4) when finally to remove the trap from its berth. These decisions were influenced by the variable effects of wind, tide, and fish behaviour on each shore but were also affected by other factors. For instance, it was found that all fishermen indicated that the outside berths were the most productive. Where they actually set their traps, however, was influenced by other factors including (a) the size of the crew, since some drawn berths needed a larger trap crew for hauling because of the hazards peculiar to those berths, (b) the distance of a drawn berth from Petty Harbour, since some trap owners preferred to have a berth as close as possible to the community to minimize travel, and (c) the difficulty of altering a trap to fit the berth drawn for it. Most decisions respecting the trap fishery, however, tended to be based upon the fishermen's responses to their perceptions of the effects of wind, tide, and fish behaviour.

In the handline fishery decisions were less clearly defined and less rigid than those employed in the trap fishery, and were made while in the course of fishing in response to conditions as they occurred. In this context the handline fishery was more competitive and there was a greater opportunity for individuals to maximize their returns. This was based upon individual differences in the knowledge of the fishing grounds and in the ability to adjust to changes in the location of fish and to changes in tide. Handliners were also found to experience fewer interruptions in the fishery because they could always move to more protected, if less productive, areas.

The conduct of the Petty Harbour fishery was found to be strongly influenced by the physical environment. Because of the inflexible nature of the fishery, it was important for the fishermen to develop an awareness of the effects of the environment and to learn to accommodate to these effects in the implementation of fishing strategies. It seems therefore that the fishermen conduct their activities within the context of an empirically derived image or model of the environment.

NOTES TO CHAPTER III

1. Hela and Laevastu noted that "every fisherman is convinced about the existence of direct and indirect correlations between the climate and weather and the fish. However, the true causes of correlations are not clearly understood": see Ilmo Hela and Taivo Laevastu, <u>Fisheries Hydrography</u> (London: Fishing News Books, 1961), p. 67.
2. Wilfred Templeman, <u>Marine Resources of Newfoundland</u>, Bulletin No. 154 Fisheries Research Board of Canada (Ottawa: The Queen's Printer, 1966), pp. 47-50.
3. Wilfred Templeman, "Some Instances of Cod and Haddock Behaviour and Concentrations in the Newfoundland and Labrador Areas in Relation to Food", <u>International Commission for the Northwest Atlantic Fisheries</u>, Special Publication No. 6, 1965, p. 456.
4. For a discussion of spring tides see Nathaniel Bowditch, <u>The American Practical Navigator</u> (Washington: United States Government Printing Office, 1966), pp. 703-717.
5. This is due to the limited processing capacity of the fish plant that purchases all of the trap fish caught in Petty Harbour. During "glut" periods, the plant may set a limit on the quantity of fish purchased from each fisherman.

6. The prolonged occurrence of northeasterly winds is associated with the presence of an abundance of salmon (Salmo salar) in the Petty Harbour area. The increased surface water temperature is believed to provide suitable conditions for the inshore migration of the pelagic salmon, but to be too warm for the cod which is considered to be a "cold water fish".
7. Cod traps placed in drawn berths must be set on or before June 25th. See Newfoundland Fishery Regulations, Section 157.
8. Interview, T. Clarke, December 1971.
9. Howard J. Critchfield, General Climatology (2nd ed.; Englewood Cliffs: Prentice Hall, Inc., 1966), p. 97.
10. Interview, T. Clarke, December 1971.
11. The "swapping" of trap berths was abolished by consensus in 1970 because the fishermen believed it enabled casual fishermen to acquire some of the best berths but only use them for a short period.
12. Interview, D. Chafe, December 1971.
13. This strategy was called a "minimax strategy". See Introduction, p. 3.
14. K. Terada, Fishermen and Weather, Fisheries Technical Paper No. 71 (Rome: The Food and Agricultural Organization of the United Nations, 1968), p. 1.
15. Interview, J. Stack, June 1971.
16. Interview, J. Stack, June 1971.

17. Ilmo Hela and Taivo Laevastu, op. cit., p. 94.

18. See Introduction, p. 6.

19. Bowditch, op. cit., p. 703.

20. *Ibid.*, pp. 703-717.

21. Source: Canadian Hydrographic Service, Marine Sciences Branch.

22. Templeman notes that a branch of the Labrador Current moves along the east coast of the Avalon Peninsula. See Templeman, op. cit., 1966, p. 23.

23. G.H. Winters, "Contributions to the Life History of the Caplin (*Mallotus villosus*) in Newfoundland Waters" (B.Sc. dissertation, Memorial University of Newfoundland, Department of Biology, 1966), p. 2.

24. Lengths of coloured cotton or plastic which are attached to hooks.

25. Interview, T. Clarke, December 1971.

26. The term "jet propulsion" refers to the manner in which the squid swims by rapidly expelling water from the body cavity. The squid is known by biologists to attain the greatest speed of any aquatic invertebrate. See Robert D. Barnes, *Invertebrate Zoology* (Philadelphia: W.B. Saunders Company, 1965), pp. 307-309.

27. Morrill describes a similar method of attracting fish used by the handline fishermen of St. Thomas in the Virgin Islands. A crushed mixture of sand and fish bait

called "chum" is placed in the water at the head of a current which runs along the edge of a shoal, attracting fish schools to the edge. Handlines are then baited and played out into the current where fish are taken rapidly and in large numbers. See Warren T. Morrill, "Ethnoichthyology of the Cha-Cha," *Ethnology*, VI, No. 4 (1967), p. 406.

PART II

ST. JOHN'S

CHAPTER IV

THE LONGLINER GILLNET FISHERY OF ST. JOHN'S

The St. John's longliner fishery developed from the traditional inshore fishery and grew from the desire by certain fishermen, following repeatedly poor catches in the summer trap fishery, to extend the duration of the fishery. This necessitated an extension of the range of operation into the offshore zone. The first longliner was introduced in St. John's in 1962 and by 1971, the fleet consisted of ten boats employing some thirty-four men - one-third of the St. John's fishermen.

The longliner fishery provides a marked contrast to the traditional trap and handline fisheries of Petty Harbour. This dissimilarity manifests itself in the following ways: (1) a more extensive and deeper fishing area, (2) a longer fishing season, (3) the utilization of larger and more mobile boats, of different catching methods, and of fishing and navigational aids and (4) the exploitation of a greater variety of species which are found in more dispersed concentrations. This dissimilarity is reflected in the different interpretations that longliner fishermen place upon the elements of the marine environment and consequently on the manner in which they adapt to the environment.

The Fishing Area

The fishery takes place in an extensive area off the northeastern Avalon Peninsula. This area consists of two relatively distinct fishing zones, an inshore zone and an offshore zone. The inshore zone extends from Cape St. Francis to the North Head of Petty Harbour up to depths of eighty fathoms and provides the most important cod fishing grounds between June and December. The offshore zone is bounded by lines running east and southeast from St. John's extending to a distance of about thirty miles offshore, over depths between about seventy-five and one hundred fathoms. It represents the main cod fishing grounds from February to June as well as the most important fishing grounds for greysole (*Glyptocephalus cynoglossus*) and flounder (*Hippoglossoides platessoides*) throughout the year. Figure 16 shows the general topography of the St. John's fishing grounds and Figure 17, the extent of the inshore and offshore zones.

Figure 17 also shows that the fishing area is divided into zones according to the range of operation of the longliners. By this criteria three distinct groups of vessels can be identified, Type A, Type B, and Type C. Type A has a range that extends to a maximum distance of thirty miles offshore and tend to fish within an area between twenty and thirty miles, where they sometimes remain

Figure 16

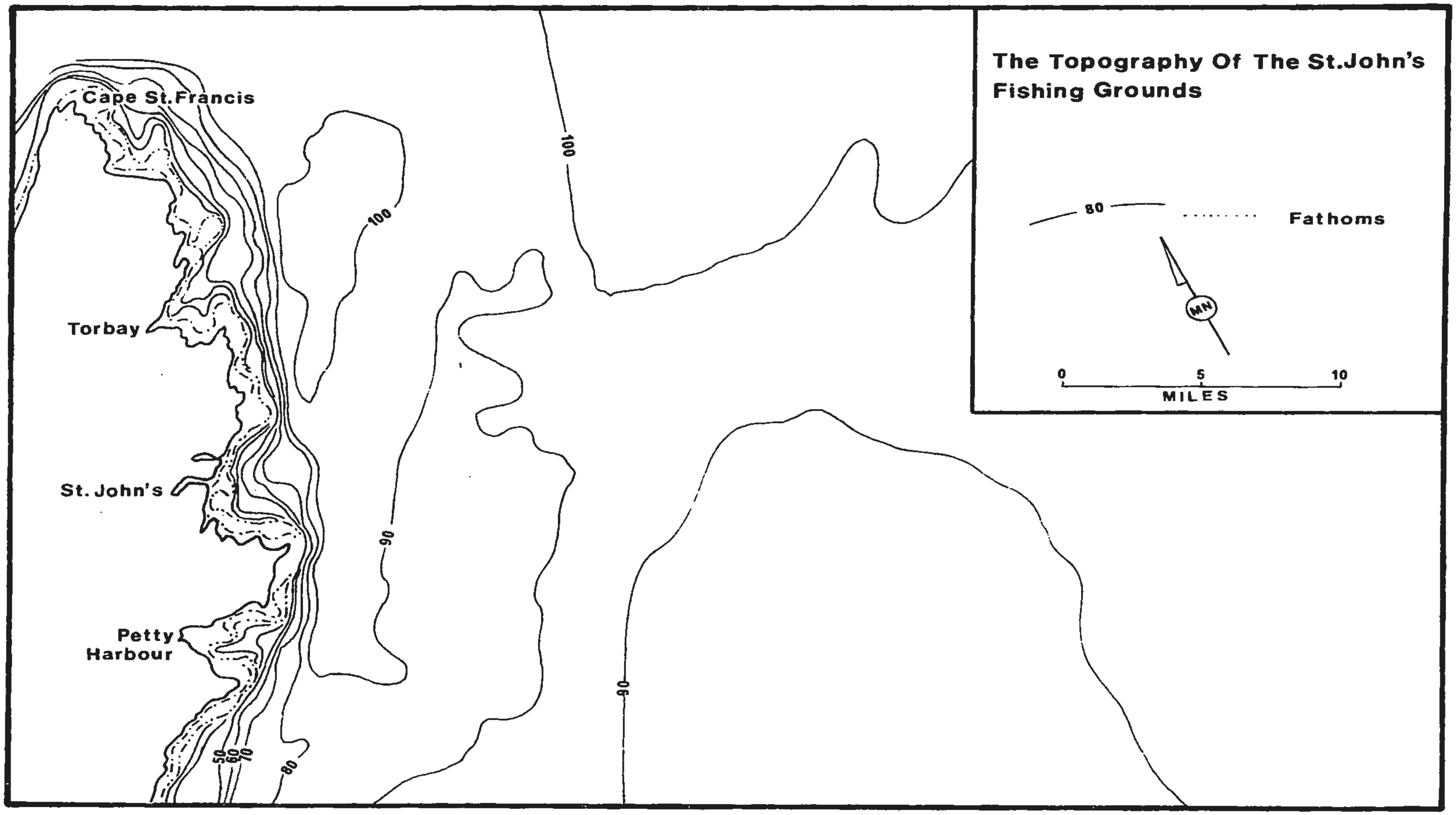
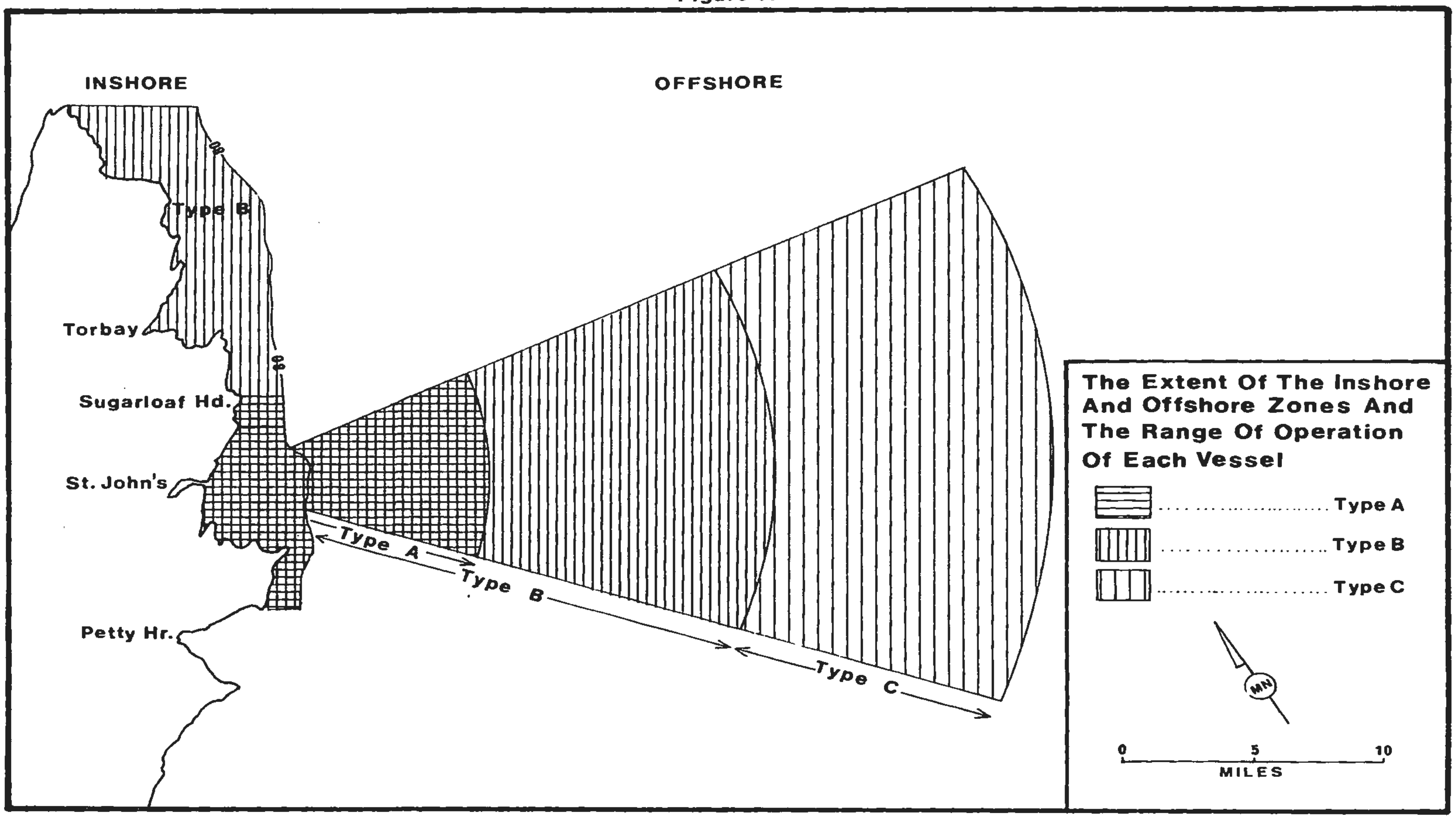

The Topography Of The St.John's Fishing Grounds
80
Fathoms
MN
0
5
10
MILES
Cape St.Francis
Torbay
St. John's
Petty Harbour
100
100
90
90
50
60
70
80

Figure 17



INSHORE
OFFSHORE
Type B
Torbay
Sugarloaf Hd.
St. John's
Petty Hr.
Type A
Type B
Type C
The Extent Of The Inshore And Offshore Zones And The Range Of Operation Of Each Vessel
Type A
Type B
Type C
MN
0
5
10
MILES

overnight. Type B has a range that extends up to twenty miles offshore and up to eighteen miles north of St. John's in the inshore zone. The limit of the offshore zone is arbitrarily defined and appears to be based upon two considerations: (1) the increased likelihood of interference from other trawlers beyond this distance and (2) the possibility of having to carry an excessive quantity of fish, making the vessel ride low and increasing the prospect of the vessel taking in water. Type C has a range that extends up to ten miles offshore and up to three miles north and south of St. John's in the inshore zone between Sugarloaf Head and the North Head of Petty Harbour.[1] The offshore limit is defined by the maximum distance at which landmarks can be fixed on a clear day since all type-C vessels lack radars. Both type-B and type-C craft make only daily trips to the fishing grounds.

Table 2 shows that each type of vessel can also be classified according to the size of the craft, number of gillnets possessed by each, complement of fishing and navigational aids, and type of species sought by each. Type A has an average length of 53.3 feet, uses an average of 132 nets per boat and has a similarly large complement of fishing and navigational aids. These craft seek only greysole and flounder and unlike the others, normally operate from ports in either Conception or Notre Dame Bays, but used St. John's as their base during the period between June and

Table 2

Classification of St. John's Longliners by Type of Vessel

	Vessel Name	Type	Length	Crew Size	Number of Gillnets	Gurdy	Radio Telephone	Radar	Echo Sounder	Main Species Caught
Type A	R.J. Douglas	L	56 ft.	5	120	X	X	X	X	GF
	Conception Bride	L	58 ft.	5	140	X	X	X	X	GF
	Margie C.	L	56 ft.	5	130	X	X		X	GF
	Johnny Bonita	L	51 ft.	6	190	X	X	X	X	GF
	Cape Kennedy	T	45 ft.	5	80	X	X		X	GF
Type B	Miss Garland	L	48.1 ft.	5	120	X	X	X	X	C
	Wells Brothers	L	45 ft.	3	80	X	X	X	X	C
	Elaine and Gwendolyn	L	42.5 ft.	5	140	X	X	X	X	C
	Miss Jaqueline	L	38 ft.	5	130	X	X	X	X	C
	Evelyn & Muriel	L	38 ft.	4	70	X	X	X	X	C
	Donald and Kelly	L	38 ft.	3	90	X	X		X	C
Type C	Bonnie and Florence	L	38 ft.	2	30	X	X		X	C
	Elizabeth Wareham	T	36.6 ft.	2	45	X	X			C
	Elizabeth Jane	L	36.4 ft.	3	30	X				C
	Debbie C.	T	37.1 ft.	2	45	X				C

<u>Key</u>

L - longliner
T - trapboat longliner
C - cod
GF - greysole, flounder

Source: Largely from Fisheries Service Economics Branch Dept. of the Environment

September in 1971. Type B has an average length of 41.6 feet, uses an average of 107 nets per boat, and has the largest complement of fishing and navigational aids. These vessels fish only for cod. Type C has an average length of 37 feet, uses an average of 37 nets per boat and has the smallest complement of fishing and navigational aids. These vessels also fish only for cod.

Boats, Gears, Fishing and Navigational Aids

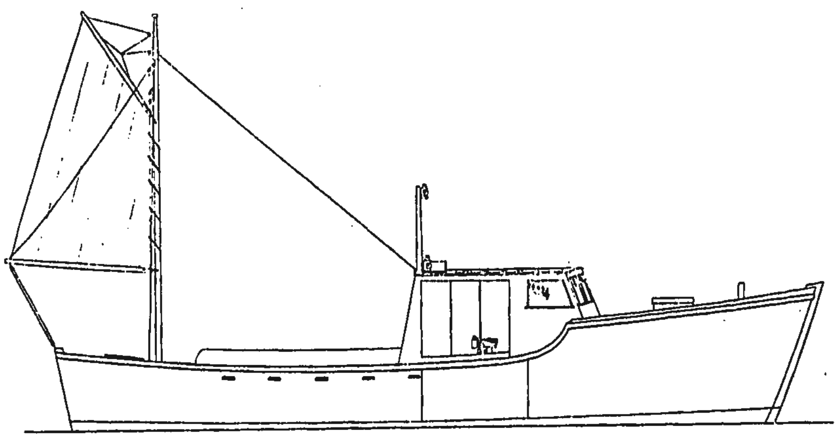
The expansion of the traditional inshore fishery into the offshore zone, the prolongation of the fishing season, and the exploitation of more dispersed fish concentrations have resulted in the development of boats and gears that are quite different from those which are used in the trap and handline fisheries of Petty Harbour and have also necessitated the adoption of fishing and navigational aids to facilitate the changed nature of the fishing operation.

Two basic boat designs are represented in the St. John's longliner fishery, the trapboat type and the longliner type. The former was introduced into the Newfoundland fishery in 1951 and was originally designed to provide a larger carrying capacity for codtrap catches and to enable the fishermen to work under more adverse conditions during the fall line trawler fishery. The latter was first introduced about 1955 and was originally designed for line trawling. Since the introduction of the nylon gillnet in 1962, both types have become adapted to fishing with gillnets throughout the year.

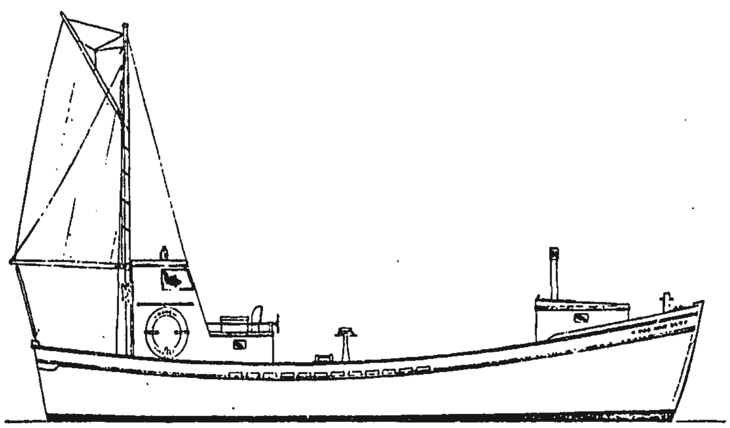
The major difference between longliners and trapboat longliners is that on the former the house and engine are usually up forward while on the latter type they are located aft (Figure 18). This arrangement makes for a relatively unprotected forward working space on the trapboat longliner restricting its adaptability to fishing in rough weather. Since the gear is placed in the water from the vessel's stern, there is also less space for "shooting" so that the gear may more easily become entangled. The longliner, however, with its sheltered, semi-enclosed working space behind the deck house is more suitable both for fishing in bad weather and for providing more space for "shooting" the gear. Trapboat longliners also tend to be smaller than longliners and to have a smaller complement of both crew and fishing gear. Table 2 shows that of the three trapboat longliners which operated from St. John's in 1971, only the largest vessel was of the Type A classification. This boat worked in the offshore zone and before its arrival in St. John's had been accustomed to fishing in waters up to fifty miles from its home port of Fogo. Table 2 also shows that the longliner was by far the most popular boat and operated in both the inshore and offshore zones.

Figure 18

A. Longliner



B. Trapboat Longliner



Courtesy Newfoundland Dept. Of Fisheries

The Newfoundland and Canadian governments provide subsidies for the construction of longliners.[2] These subsidies are normally applied to government-designed vessels. Most longlinermen feel that these designs are unsuited to fishing in the adverse weather and sea conditions experienced off the Eastern Avalon Peninsula. The longliners are said to be too high, to have too narrow a stern, and to have a rounded bottom, all of which are said to result in increased "rolling", causing a strain on the fishing gear during the hauling operation, increasing the possibility of damage to the nets. Dean made a similar appraisal.[3]

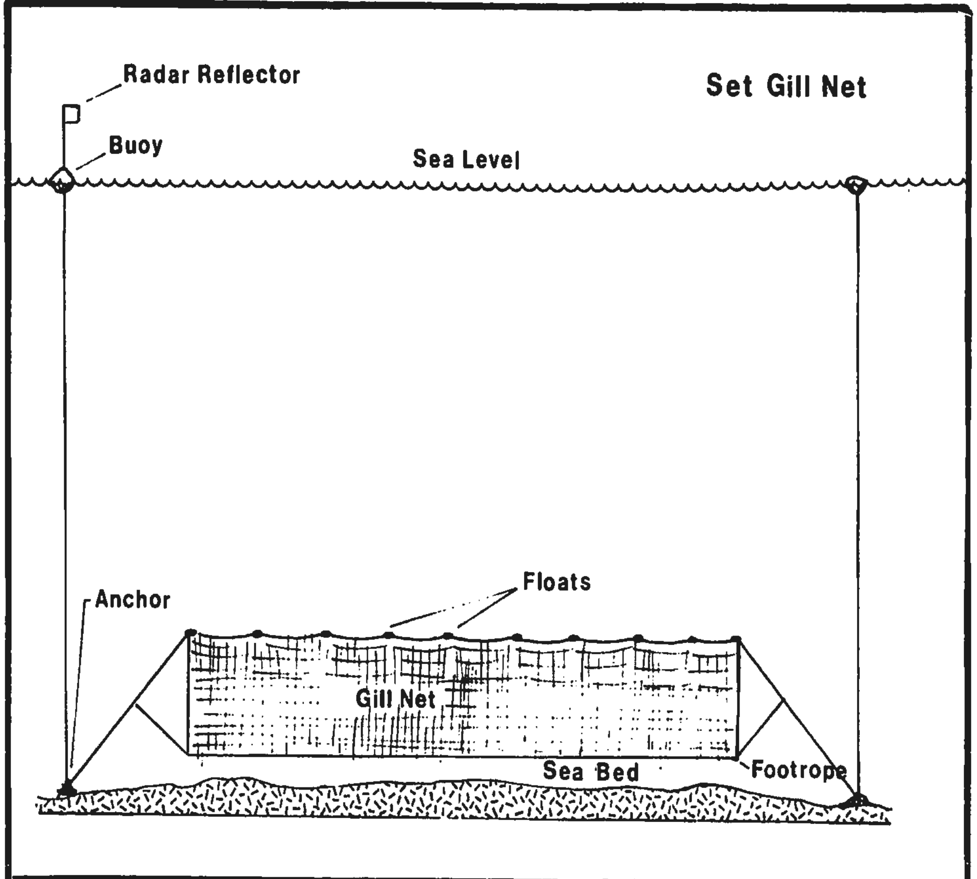
The ideal craft for fishing off the Avalon Peninsula is said to be one which combines length with a greater beam and a lower deck height. Although none of the longliners presently in use are considered to be entirely satisfactory, the overall dimensions of the fifty-foot longliner are generally thought to best meet these criteria. One owner of a fifty-eight-foot version, suggests that it is the safest and most comfortable craft in which to travel. However, because of its heavy weight and height, the craft is said to "roll like a barrel" when in a stationary position, often preventing the nets from being hauled without causing damage.

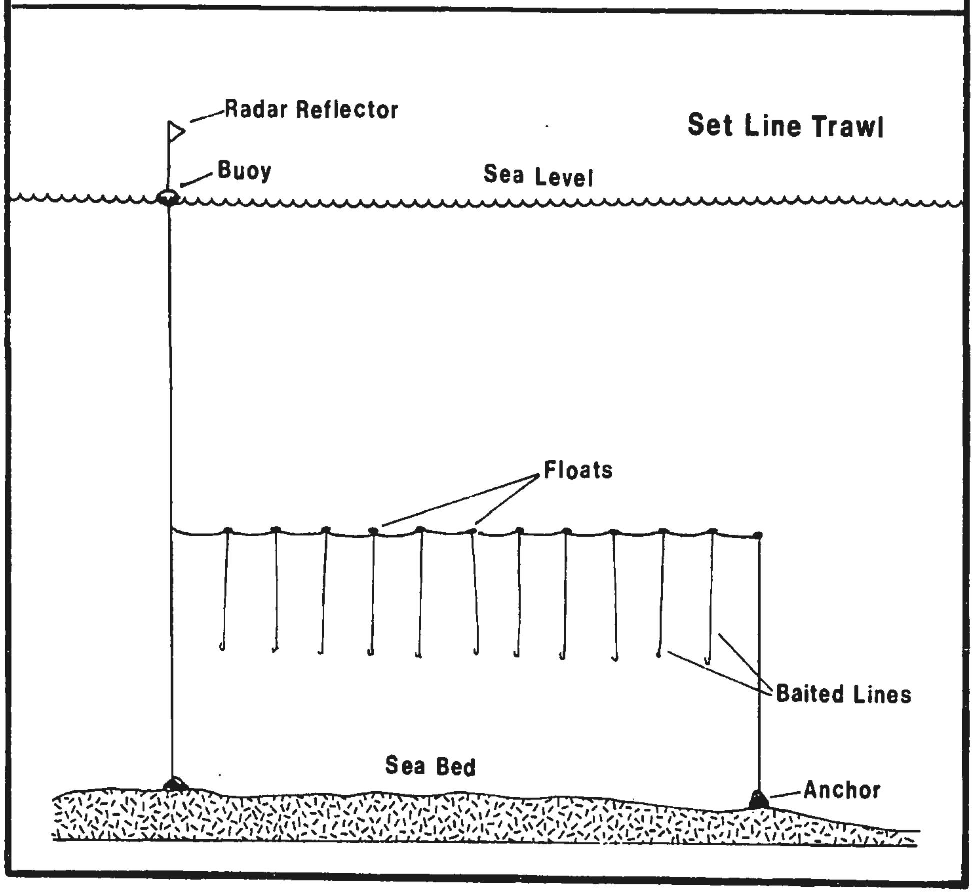
The gillnet and the line trawl, both stationary gears, are the only fishing gears used in the St. John's longliner fishery. The gillnet is attached to the seabed while the line trawl can be adjusted to catch fish at different depths (Figure 19). The gillnet is by far the most important type of gear and is used by all the boats. Trawls are used by most boats for the short period when the fish are above the range of gillnets.

All the gillnets used in the St. John's longliner fishery are made of monofilament twine[4] but their mesh size varies according to the species sought. Those craft seeking cod use a mesh-size of six to six-and-one-half inches while those fishing the shorter and broader flatfish species use a mesh-size of seven to eight-and-one-half inches (Table 2).

The number of gillnets used varies from one longliner to another and is related to several factors including the size of the vessel, the size of the crew, and the range of operations. It depends ultimately, however, upon the purchasing power of each boat owner. The cost of gillnets varies according to the form in which they are purchased. One completed gillnet consisting of netting, footrope, headrope and floats represents a retail cost of $75.00. Of this amount $50.00 is paid by the fishermen with the remaining $25.00 being paid by the Newfoundland government in the form of a subsidy.[5] In addition, the fishermen must purchase buoys, anchors, and radar reflectors. The cost of 100 completed nets and their attachments is estimated by one fisherman to be approximately $5,200.00. Longliner fishermen entering the fishery for the first time normally

Figure 19


Radar Reflector
Set Gill Net
Buoy
Sea Level
Floats
Anchor
Gill Net
Sea Bed
Footrope


Radar Reflector
Set Line Trawl
Buoy
Sea Level
Floats
Baited Lines
Sea Bed
Anchor

purchase nets with attached headropes and footropes. The nets need to be replaced every year because of damage to the netting incurred during day-to-day hauling operations. Those fishermen who have the facilities to "hang" or make their own nets prefer to replace only the netting each year to economize on the cost of gear. The netting costs $30.00 per net, $17.50 being paid by the fishermen and the remaining $12.50 by the Newfoundland government. Only three of the sixteen longliner operators who fished from St. John's in 1971 purchased their nets in this way. Every second or third year when the footropes and headropes need to be replaced, most fishermen prefer to buy a complete set of gear to obtain the subsidy rather than purchase footropes and headropes separately for which there is no subsidy. In addition to the normal wear and tear, nets may be lost in storms or destroyed by other trawlers[6] operating on the same fishing grounds. The cost of gillnets represents a large annual investment in the fishing operation.

In the extensive area of the offshore zone, gillnets are usually arranged in fleets of fifteen to twenty nets per fleet. Two fleets of nets are normally hauled and reset on each daily trip to the fishing grounds, a process which is said to take approximately three hours under good weather conditions. Each fleet of nets is left to fish for an average of three days and sometimes longer during periods of fish scarcity. It therefore takes three days to "clean up the gear". On the narrower inshore grounds, nets are arranged in fleets averaging two to five nets per fleet, the size of the fleets being determined by the dimensions of the places in which they are set. The number of fleets used by vessels operating in the inshore zone is limited by the longer time consumed in preparing, setting, and hauling small fleets of gillnets as well as by the restricted area for setting.

A variety of electronic navigational and fishing aids is used by St. John's longliner operators to facilitate movement between port and fishing grounds and to assist the fish-searching and fish-catching operations. The most important navigational aids are the medium range radar and the two-way marine band radio. The main fishing aid is the echo-sounder which is used both for locating fish concentrations and charting depth. It can also be used as a navigational aid by those vessels lacking a radar. All vessels carry a ship's compass, the most basic and mandatory navigational tool, as well as a powered winch or "gurdy", a device which hauls the nets aboard the vessel.

The radar is the most important navigational fixture carried on the boats. It is used to minimize travelling time between the port and the fishing gear by fixing the position of distant objects. The radar locates the fishing gear in the following way: a beam is transmitted by the radar and is reflected back to the vessel after striking a reflector buoy attached to the gear. This beam appears on a screen as a dot which indicates the direction and distance of the gear from the craft.[7] The radar is used during all types of weather but is most valuable during periods of fog when the gear becomes particularly difficult to locate.

St. John's longlinermen use the medium range radar which can clearly fix the position of an object at twenty miles. It costs approximately $3,300.00, making it the most expensive piece of equipment on the boat. Longliner operators who do not own a radar have major limitations placed upon the effective range of their vessels and upon the efficiency with which the fishing operation can be conducted. They can, however, attempt to counter these limitations by using other relatively satisfactory but less effective means of locating fishing gear. These will be examined in the next chapter.

With the marine-band radio-telephone the fishermen can engage in inter-boat communication. This medium plays several important roles in the St. John's fishery. In order of importance these include (1) providing a safety device in the event of an engine breakdown or other crisis, (2) assisting in conjunction with the radar, in the location of lost fishing gear, (3) furnishing the means of determining the relative catching success of other fishermen. The longliner skippers appear to be most frequently called upon to locate lost fishing gear. The radio-telephone is therefore of particular importance to those boats which lack a radar set. Most fishermen recognize the importance of the radio-telephone as a safety device in the event of an engine failure. Those fishing in the offshore zone are particularly sensitive to this danger and tend to operate within close contact with each other.

The echo-sounder records the shape of the seabed over which a vessel is passing and may also indicate the location of fish schools. It operates on the following principle: sound waves are transmitted through an instrument attached to the ship's hull. These waves are reflected off the seabed, received by the same instrument, and then recorded on graph paper, portraying the topography of the seabed. The primary function of the echo-sounder in the St. John's longliner is to locate fish concentrations and to determine the depth and shape of the seabed on which the nets are to be set. The secondary function is to assist navigation during fog between the fishing ground and the port for boats lacking a radar.

The echo-sounder finds its most important use as a fishing aid on the irregular seabed of the shallow inshore grounds. Here it can be used to fix the location of fish concentrations as well as to determine the depth and extent of the shoals on which these fish tend to concentrate. In this way the fishermen can determine precisely where the nets are to be placed and how many nets can be accommodated on each shoal. Those fishermen who lack echo-sounders can never be as certain about the location of fish concentrations and must depend upon their knowledge of the seabed topography to determine the most suitable net-setting patterns. In the deep water on the offshore grounds, the seabed is relatively flat over a large area. There are no perceptible shoals where the fish are known to become concentrated. In addition, the type of echo-sounder used by the St. John's longlinermen is unsuited to locating fish concentrations lying in a flat seabed.[8] The most important function of the echo-sounder in deep water is to chart the seabed to determine at which depth the nets are to be set. The vessels operating in deep water are highly mobile and may frequently relocate all or part of their gear from one area to another. The echo-sounder permits a quick reconnaisance of the new fishing area to determine its depth. This is necessary to ensure that the gear is firmly anchored to the seabed. After the nets have been set, the sounder may not be used again until the gear is relocated to another area.

The-echo sounder can serve as a navigational aid for craft lacking a radar or at times when the radar is not functioning. When a boat is off course and access to the port is restricted by low visibility, an operator can determine his location upon approaching the coast, by sounding for familiar shoals. A chart of the coastal area is generally used in conjunction with sounding to fix the direction of the port.

By using large vessels, extensive fishing gears, and a complement of fishing and navigational aids, the St. John's longliner fishermen develop an awareness of and adaptations to the natural environment that differ from those experienced by traditional inshore fishermen.

NOTES TO CHAPTER IV

1. This represents the limits of the St. John's fishing area as defined by the *Newfoundland Fishery Regulations*.
2. For longliners between 45 and 58 feet in length the Government of Canada provides a 50% subsidy and the Government of Newfoundland, a bounty of $200.00 per gross ton. For longliners under 35 feet in length, the grants are 35% and $200.00 per ton.
3. Leslie James Dean, *Diversification of Effort in the Newfoundland Longliner Fishery* (Honours B.A. Dissertation, Department of Geography, Memorial University of Newfoundland, 1971), p. 21.
4. Monofilament gillnets have gradually replaced the multifilament nylon type which were introduced in 1962. Quinlan notes that they have a greater catching effectiveness, are more durable, and become less entangled than the multifilament nylon nets. See Donald E. Quinlan, *The Longliner Industry in General With a Case Study* (B. Comm. Report, Department of Commerce, Memorial University of Newfoundland, 1966), p. 19.
5. Source: John Leckie Ltd.
6. Otter trawlers are the largest vessels operating in the Newfoundland fishery. They tow a large, bag-like net called the otter trawl which when moving along the seabed, can remove gillnets from their moorings.

7. For a description of the radar and the principles of radar detection, see Nathaniel Bowditch, The American Practical Navigator (Washington: The United States Government Printing Office, 1966), pp. 318-330.
8. The echo-sounders used by St. John's longlinermen provide no "white line" recording. The white line follows the dark seabed contour giving it a sharp contrast. If fish are present they will show up clearly on the echo recording as shady patches above the white line. The conventional echo-sounders used by the St. John's fishermen tend to show fish concentrations merging with the seabed and therefore indistinguishable from the bottom echo itself.

CHAPTER V

ENVIRONMENTAL PERCEPTION IN THE ST. JOHN'S LONGLINER GILLNET FISHERY

It was shown in Chapter III that the Petty Harbour fishermen identify wind, tide, and fish behaviour as the elements of the marine environment to which they adapt their catching operation. The St. John's longliner fishermen also recognize the importance of wind, tide, and fish behaviour upon the fishery. However, because of the larger area and deeper water in which the fishery takes place, the longer fishing season and the nature of the technology at their disposal, the longliner fishermen attach a different significance to the effects of these elements and develop a more varied set of adaptations to them. Unlike the Petty Harbour fishermen, the longliner fishermen emphasize the effects of fog upon the fishery. This chapter will (1) examine the St. John's fishermen's perception of wind, fog, tide and fish behaviour, (2) relate these perceptions to the real environment, and (3) account for the patterns of exploitation that develop as a response to these perceptions.

Meteorological Elements

Winds and fog are the dominant meteorological factors affecting the St. John's fishery. Unlike in the Petty Harbour fishery where wind conditions are measured in terms of their effects upon both the behaviour of fish and upon the functioning of the catching operation, in the St. John's longliner fishery they are viewed primarily in terms of their effects upon the catching operation alone. The St. John's fishermen express opinions similar to those of the Petty Harbour fishermen regarding the influence of winds upon the behaviour of the fish. These opinions relate only to fish behaviour on the inshore grounds, however, and are derived from the experience of the St. John's longliner operators as former trapmen and handliners. Wind conditions, however, are said to have negligible effects upon the availability of the cod and other species that are found in the deeper water on the offshore grounds. It is assumed by the fishermen that the effects of winds will be negligible at depths between seventy and one hundred fathoms where most of the fish sought by longliners are concentrated. As well as classifying winds as onshore, offshore, and "northerly", the St. John's fishermen also recognize another group of winds from westerly to northwesterly in direction. These winds are associated with rapid cooling in winter and are consequently unimportant to the Petty Harbour fishery, which is carried on in summer and fall.

Fog influences the conduct of the longliner fishery by restricting the effective range of vessels lacking radars and by impeding their movements between port and fishing grounds. This element is particularly critical because of the distance that longliners travel and the consequent difficulty of maintaining a true course.

This section will examine how the St. John's longliner fishermen perceive the effects of wind and fog upon the fishing operation and how they accommodate to these influences in the formulation of fishing strategies.

Winds: Their Perceived Effects Upon the Fishing Operation

Winds are primarily viewed as potentially hazardous events and are known to influence the fishing operation in two ways (1) restricting movement between the fishing grounds and the port, (2) preventing the net-hauling operation because of possible damage to the fishing gear. The hazards associated with vessel movement were not of major concern in Petty Harbour. Their importance in St. John's is related to the greater distances travelled and to the prosecution of the fishery during the fall and winter when these hazards are most pronounced. Damage to the fishing gear, however, was of equal concern in Petty Harbour. The influence of winds upon each of these activities is known to depend upon the season of occurrence, the source of the winds, and the wind speed. While vessel movement is rarely known to be impeded during the spring and summer, hauling operations may be curtailed by strong winds. During the fall and winter, however, winds more often restrict access.

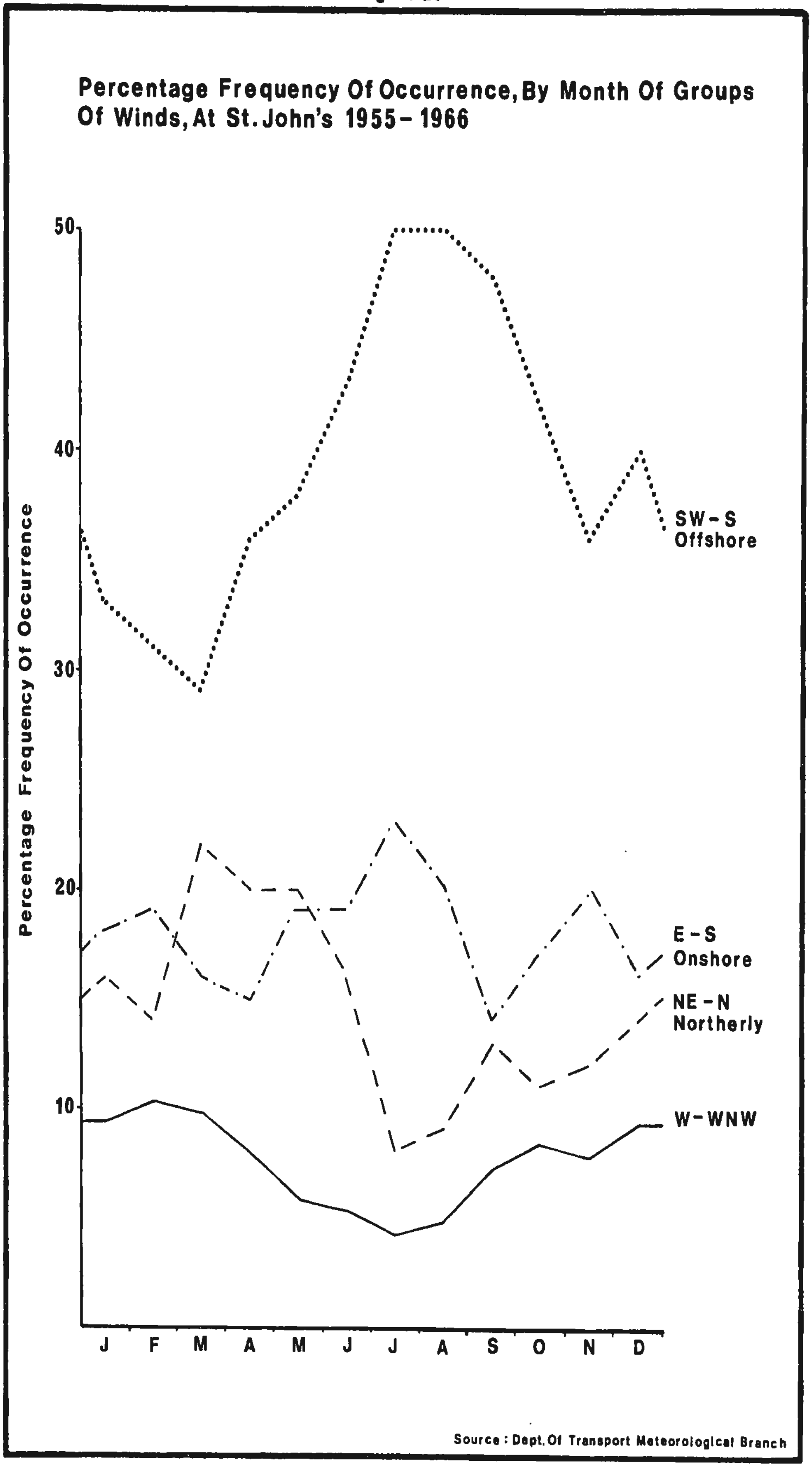
As in Petty Harbour, the greatest hazards during the fall are associated with an increase in the frequency of occurrence and duration of "northerly" winds, as well as a general seasonal increase in wind speed. The increased frequency of "northerly" winds is also associated with a reduction in water temperature which is said to make the water "heavier" or denser, and to generate swells which are larger and which last for longer periods than those which occur during the spring and summer. This condition is known to be further exacerbated by the occurrence of high wind speeds which can increase turbulence and help limit access to the fishing grounds. Many longliner skippers attempt to minimize disruptions in the fishery during the fall by placing part of their gear in an area which is accessible during periods of "northerly" winds. This strategy often means foregoing the possibility of reaping larger catches when the fish are known to be more plentiful in another but less accessible area. This type of adaptation was referred to by Davenport[1] and is described by one informant in the following way:

> You'd have so many down the shore [north] and so many up the shore [south]. We got 20 nets out to Cape Spear now and we got 30 down to Pouch Cove. When we can't get down there [Pouch Cove] we can get out there [Cape Spear] and haul. If there's any fish, we won't lose a day's fishing. Down to Pouch Cove is roughly 16 miles but if you got a lot of say northeast wind, you can't get down there, it's too rough. I'd rather have all the nets down to Pouch Cove, its a better place to fish. Summertime you can, you're getting in and out everyday with good weather.[2]

Another fisherman notes the protected conditions "back of Cape Spear (where) you can fish all day."

The greatest hazard to the fishing operation in the winter is that of "freezing spray" which is said at times to produce deposits of ice heavy enough to cause a vessel to capsize. Freezing spray conditions are predicted by the marine weather forecast to occur when the temperature falls below 28° Fahrenheit (the freezing point of sea water) and wind speeds exceed twenty-five miles per hour. The long-liner fishermen suggest that the lowest temperatures are experienced during periods of offshore winds, and are associated in particular with winds from westerly to north-westerly. They say that offshore winds, because of their origin, produce lower temperatures than onshore winds while winds from westerly to north-northwesterly are known to have a high frequency of occurrence during the period of the winter fishery in February and March[3] (Figure 20). The fishermen note that in winds exceeding twenty-five miles per hour, the boat can generate spray that will freeze to

Figure 20


Percentage Frequency Of Occurrence, By Month Of Groups Of Winds, At St. John's 1955-1966
Percentage Frequency Of Occurrence
50
40
30
20
10
SW-S Offshore
E-S Onshore
NE-N Northerly
W-WNW
J F M A M J J A S O N D
Source: Dept. Of Transport Meteorological Branch

its superstructure. One informant notes that

> she's [the vessel] driving water away from her and its blowing on her, then its making ice all the time. The harder it blows, the more water you're driving, the more ice you're making.[4]

The movements of the craft are therefore considered to be significant in the formation of hazardous freezing spray.

The threat of freezing spray is said to represent the greatest deterrent limiting the range of fishing operations during the winter. Because the danger of freezing spray is most associated with the occurrence of the colder offshore winds, the greatest risk to the fishing operation is said to occur during the return voyage to the port since the craft must "run against the wind." The turbulence produced by the wind is considered to be proportional to the winds' fetch, consequently, longliner operators prefer to restrict winter operations to a distance of about six miles from the coast, whence they can quickly return to port should the need arise. The most suitable winter fishing conditions are said to occur during periods of onshore winds since "the wind is behind the boat coming back", resulting in less spray being generated by the craft.

During the spring and summer wind conditions are believed to have a greater limiting effect upon the net-hauling operation. Swells occurring at this time are often known to be large enough to cause the craft to roll to such a degree that a severe strain is placed upon the nets during the hauling process. The gillnets are of considerable weight, being hauled from depths of up to 100 fathoms and often containing large rocks. They are therefore known to tear very easily. One fisherman notes that in the spring and summer,

> You could almost go out anytime. It would have to be a real hurricane where you wouldn't go out. But whats the sense of going out if you're going to tear up your nets for nothing.[5]

The largest swells during the spring and summer are associated with the occurrence of "northerly" and onshore winds with a large fetch that may or may not be accompanied by higher than normal wind speeds. Swells that can disrupt the hauling operation are often known to occur during periods of low wind speed preceding the movement of a storm into the fishing area. Faris similarly noted that even on calm days rough seas prevented the launching of fishing boats.[6] Offshore winds, even when they are accompanied by high wind speeds are believed to have insufficient fetch to produce large swells even in the most distant parts of the fishing area. One informant recalls hauling gillnets in a westerly wind of fifty-five miles per hour without incurring damage to the nets. Another who operates up to twenty-five miles from the shore notes the variable effects of high wind speeds from all directions:

> Thirty miles [per hour] of wind's plenty to take in nets... If you were getting that from the westerly or southwest, it wouldn't matter. But if you get say the northeast ["northerly"] or southeast [onshore] winds with that much [wind

> speed], you can't do much. The wind and lop all come the one time... Its all up in heaps... It don't be long getting hard on gear.[7]

Most fishermen feel that winds of thirty to thirty-five miles per hour are sufficient to curtail the hauling operation during periods of onshore or "northerly" winds. Dean found that Newfoundland longliner fishermen in general note that winds exceeding thirty miles per hour are critical in curtailing fishing operations.[8] In the spring and summer the longliner fishermen attach the most significance to the effects of high speed "northerly" winds since in addition to curtailing the hauling operation, these winds are also known to restrict access to the port. If a longliner is fishing south of the entrance to St. John's harbour and strong "northerly" winds occur, it may be necessary to move north of the harbour entrance so that the craft can "run with the wind" and safely enter the port. If the vessel proceeds against the wind, the operator risks taking in water and "swamping the boat". This can be especially critical when the boat is loaded with fish and consequently lower in the water.

Like the Petty Harbour fishermen, the St. John's fishermen pay scant attention to the information provided by weather forecasts. Most fishermen are regular listeners to marine forecasts but their fishing decisions appear to be influenced by them only during the late fall and winter when hazardous wind conditions or the threat of freezing spray are most likely to occur. They listen to forecasts at other times of the year only to be aware of the possibility of special wind warnings that may cause temporary interruptions in the fishery.[9] One informant expresses a widely held opinion about marine forecasts:

> I listen to them but I don't pay much heed to them - not this time of the year [August]. Sometimes they're alright and more times they're not. We never did depend on them.[10]

This notion is derived from the experience that the forecasts rarely provide precise information about the location of hazardous winds. The weather forecasts relevant to the St. John's fishery are given for the "east coast marine area" which extends from White Bay on the Great Northern Peninsula to Cape Race on the Avalon Peninsula, a distance of over 300 miles. Shewel noted the difficulty of providing accurate weather information for this large area.[11] Conditions which are predicted for the whole area may consequently bear little relationship to the actual conditions experienced where the nets are set off St. John's. The fishermen tend to be aware of these differences, noting that when predicted hazardous winds occur near the shoreline, calmer conditions are often found to prevail offshore and vice versa. The fishermen therefore prefer to experience conditions for themselves, and often attempt to "run out of the wind" rather than risk the loss of a day's fishing. One informant describes his experiences in the following way:

> ... We were inside... I'd say we had twenty or twenty-five miles [per hour of wind] ... We figured we'd go out so we kept moving and moving and by and by it was right calm. And when you were coming back in the day, you ran into that wind again but you didn't have it outside. Sometimes you came back and more times you say we'll take a chance and go. You often went and had to come back, you couldn't do nothing. Sometimes you go and steam out of it. Well then you're glad, you got your day's work done.[12]

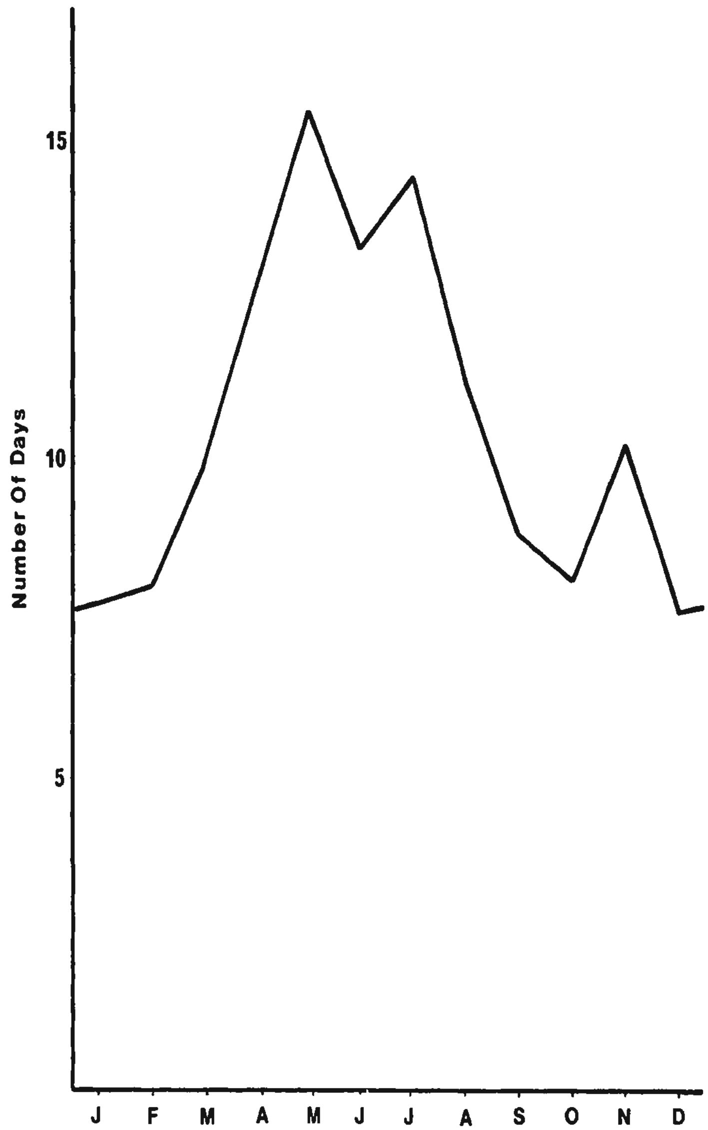
The St. John's longliner fishermen, like their counterparts in Petty Harbour, therefore prefer to use their own judgement in determining the suitability of the weather for fishing.

Fog: Its Perceived Effect Upon the Fishing Operation

Fog is said by the fishermen to have its greatest frequency of occurrence off St. John's during the spring and early summer. Figure 21 confirms this observation. Fog is known to exert several important influences upon the fishery. Fog is said to influence fish behaviour only on the inshore grounds where, as in Petty Harbour, the occurrence of foggy "caplin scull weather" is related to the availability of large quantities of fish during the period of the onshore caplin migration. The influence of fog upon the fishing operation, however, is known to be considerably more important particularly on the offshore grounds. Longliner owners lacking radars note the severe restrictions that fog imposes upon the range and efficiency of their operations in the offshore zone. The fishermen can normally locate

Figure 21

The Average Number Of Days Per Month With Fog At St. John's 1942-1971



Source Dept. Of Transport Meterological Branch their gear on the inshore grounds in fog by using the traditional method of following a compass bearing from the shore for an elapsed time at a fixed engine speed. As they move offshore outside the headlands, however, the craft are said to be easily displaced from their course by the tidal current, making it difficult to arrive at the precise location of the gear. One longliner owner who lacks a radar describes this problem in the following way:

> ... Say early in the spring of the year when you go off eight or nine miles. Well then if you get the foggy weather ... you're going to lose a heck of a lot of time because you only got your compass. Perhaps you're not able to see no more than twice or three times the length of the boat ... its no trouble to miss your buoy.[13]

Those vessels which lack radars tend to operate closer to the shore and attempt to overcome the obstacle of fog by arranging fleets of nets along a straight course. Each fleet is separated by a boat length, so that when the first fleet is located, the others can be found as well. If the nets cannot be located at the end of the elapsed travelling time, it may be necessary to return to the land and reset the course. This may cause long delays in hauling the gear and may result in the catch being spoiled and unsaleable. One informant recalls spending two foggy days searching for fishing gear that had been set seven miles off St. John's, only to find that the catch had become decomposed. There is consequently a strong inducement for vessels lacking radars to restrict their movements to near the shore. Several operators who lack radars, however, prefer to risk fishing in more distant waters where there is a greater opportunity of catching larger quantities of fish. These skippers adapt to the fog by setting their nets at a known distance and direction from that of another boat using a radar. This boat can then be called upon by radio telephone to find the gear should it be difficult to locate after "turning the course".

Longliners without radars are also known sometimes to have considerable difficulty in navigating the return voyage to the port during foggy weather. This becomes particularly critical when the tidal current changes direction, restricting the boat from maintaining a true course. One informant notes that on one occasion when these conditions occurred, his craft was displaced south of Cape Spear. The operator was forced to depend upon the echo sounder which could only indicate position after the vessel had entered shallow water. The radar gives an outline of the coastline, enabling those longliners that have them to alter their course before approaching the coast.

Hydrographic Elements

As in Petty Harbour, the St. John's longliner fishermen refer to all moving water as the "tide". Unlike the Petty Harbour fishermen, however, they only attribute significance to the tide as it affects the fishing operation and recognize only the influence of the tidal current component. The rise and fall of the tide is said to be experienced only along the shore and not to affect the setting or hauling of gillnets. The tidal current, as in Petty Harbour, is held to vary in direction inside the headlands but to predominate in a southward direction outside the headlands. Since the fishermen tend to operate further offshore it appears that the tidal current comes more strongly under the influence of the Labrador Current. The influence of this current is not recognized as such by the fishermen, however. This section will examine how the St. John's longliner fishermen adapt to the perceived effects of the tidal current.

Tide: Its Perceived Effects Upon the Fishing Operation

The tidal current affects three aspects of the fishing operation (1) the movement between the port and the fishing gear, (2) the net-setting operation, and (3) the net-hauling operation. The perceived influence of the tide on each of these aspects varies according to whether the operation takes place on the inshore grounds or in deeper water.

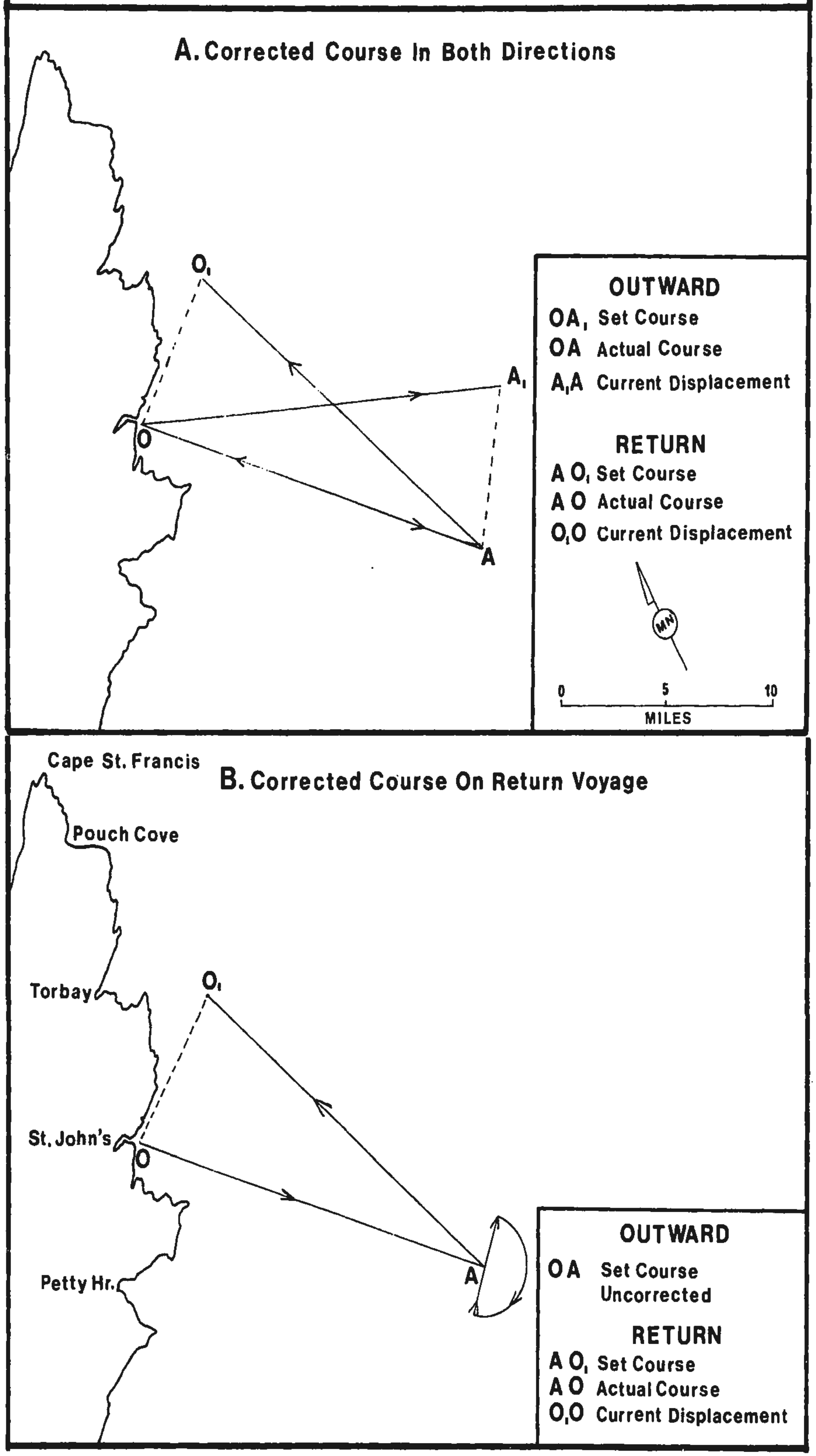
As a longliner moves offshore it is said to be progressively displaced to the south of its course by the predominating tidal current. Course corrections are normally made by altering direction according to the position of the gear indicated by the radar. If, however, its position is difficult to fix because of sea clutter[14] on the radar screen, then some fishermen prefer to make course corrections to facilitate the location of the gear. One informant who places his nets southeast of St. John's, prefers to locate them by following a more easterly course when radar reception is impaired by sea clutter. He describes this process in the following way:

> Anytime we go out now ... its real rough and we can't find our gear on the radar - big lop or something - we'll always haul down east-south-east in a long steam with tide going southern, you're going above the nets all the time. You don't realize it but in a three- or four-hour steam you'll probably end up about two miles above the net. The tide will do that... The stronger the tide, the further south you will go. So when you go out you haul down east-southeast, run down your time and course, and sure enough, there you'll find the gear.[15]

After the nets have been hauled and reset, it is said to be necessary to make another course correction to find the shortest distance back to the port. If the nets are located southeast of St. John's, the return voyage will follow a north-northwesterly rather than a northwesterly course. Figure 22A shows the corrected course and the tidal current displacement that results from vessel movement between St. John's and fishing gear located twenty miles southeast of St. John's when course corrections cannot be made by radar.

Figure 22

Movement Of Vessels To Counteract Tidal Current Displacement



In the offshore zone longliners tend to place their gear within two or three miles of each other. Some fishermen rather than making a course correction during periods of sea clutter, prefer instead to rely upon their knowledge of the relative location of all the fishing gear. These fishermen maintain the course on which the gear has been set and if at the end of the elapsed period of travel they cannot locate their gear, then they search for any gear from which the location of their own gear is known. One informant describes this method of adapting to tidal drift:

> We just go on our course and timing. Well there are so many net buoys around, you might hit a net buoy thats' above you - another fisherman He's up to the southern or southwest, well I got to go to the northeast. Or if you hit something to the northeast, you go to the southwest.[16]

In attempting to locate a net buoy from which a course can be fixed, the vessel follows a set searching pattern. The skipper steers for approximately two miles, 90° from the original course then makes a semi-circular or "half circle course" around his original position, and then steers back to that position. At relatively close range, the image of a buoy reflector is said to become more intense on the radar screen, and it is said that during the semi-circular traverse, someone's gear is invariably located. If gear is not located in this way, the vessel will at least have returned to its original position from which further course alterations can be made and the homeward course can be accurately fixed. As in the first method, the return voyage normally follows a corrected course. Figure 22B shows this pattern of movement.

All the fishermen follow the same practices in adapting the net setting operation to tidal current direction. The gillnets are set "across the tide", and in the same direction (northeast to southwest). Setting across the tide is believed to have distinct advantages for increasing fish catches while the general agreement to use the same direction for setting the gear is thought to provide for an equitable use of fishing space.[17] The fishermen place fleets of nets "across the tide" to ensure that the meshes of the gear are kept open, in a suitable condition to catch fish. It is felt, however, that if the nets were set "with the tide", they would become "bundled up on top of each other", and the meshes would become closed. The fishermen also note that when the nets are set "across the tide", they form a "bow" or an arc, which, unlike a straight line, is thought to prevent the fish from "running the net". The fish are said to be swept into the nets and to become concentrated in the centre of the fleet. One informant describes the perceived catching effectiveness of nets which form an arc in the following manner:

> When a body of fish nets ... its sure to block in the curve, and that's the most fish you'll get in your nets. You'll haul up the first one and you won't get much. According as you go along, the fish will be thicker and you come to the last net and he'll be the same as the first one... The fish goes in the bow, its' like its' too stunned to turn.[18]

If the tide reverses the fleet of nets is believed to maintain its shape and to catch fish moving with the tide.

The fishermen also note that during the setting operation the tidal current tends to displace the nets from their intended positions on the seabed. Displacement is said to increase with depth and is consequently greatest outside the inshore grounds. However, the need to adjust to this phenomenon is not considered to be as critical in the deep water as it is on the shallow water shoals. The area over which the fish are concentrated at any particular time is considered to be much larger in deep water so that tidal displacement is considered unlikely to move the nets outside the range of the fish. On the inshore grounds, the fish are found to be concentrated in a relatively small area, necessitating a more precise setting pattern to accommodate tidal displacement. This process is described by one fisherman in the following way:

> When you go to anchor on these places or you're setting gear there, you want to know what way the tide is going... If the tide was going off the land, you would have to go well in over the ground when you're setting your gear. By the time it sinks it will just reach the ground. If the tide was going in on the land, you have to go out over the ground. By the time it sinks down, it will be just down on the edge of the ground.[19]

The manner in which the fishermen determine the distance over which the net is displaced is said to be determined by "using judgment" which is developed over a period of time through facility with the operation.

The effect of the tidal current upon the net hauling operation is related to the direction and speed of the current. The fishermen prefer to haul their nets "with the tide" to minimize strain on the rather fragile monofilament gillnets. This process is made easy by setting the nets across the tide. Hauling the nets against the tide is said to put "a big strain on the gear".

Biological Elements

The marine fauna of the eastern Avalon Peninsula includes three species of fish that are of importance to the St. John's fishery: the cod, the greysole, and the flounder. Of these species, the ecology of the cod is best understood by the fishermen. Unlike their counterparts in Petty Harbour the St. John's fishermen have only a generalized understanding of the broad seasonal distribution and movement of the fish found in their area. The fauna also contains the queen or spider crab (Chronoecetes opilio) an animal which has little commercial value in the St. John's fishery, but which is found to constitute a hazard when it becomes entangled in the gillnets. This section will examine how the longliner fishermen perceive, and adapt the organization of the fishery to, the seasonal distribution and movement of the fish and in particular how they accommodate the net setting operation to further their understanding of fish behaviour.

Fish Behaviour: Its Perceived Effects Upon the Catching Operation

The cod are said by the fishermen to be found in two distinct seasonal and areal stocks, an inshore stock and an offshore stock. The former is found to enter the inshore grounds in June and to remain concentrated on the narrow shoal area until December, while the latter is believed to appear in deeper water outside the grounds between February and March where it is thought to remain until June. The fishermen's perception of the offshore stock is substantiated by Templeman who states that the cod are available in the deep water of the Avalon Channel off St. John's during the winter and spring but not during the summer.[20] The fishermen make no attempt to explain the reasons for this phenomenon. The fishermen say that the offshore stock is larger than the inshore stock, contains fish of larger average size, and vaguely follows a migrational pattern. That this migrational pattern is not well understood is a consequence of the larger, undifferentiated area over which the offshore stock is dispersed as well as the lack of identifiable indicators which demonstrate its presence. Unlike the inshore stock, the offshore stock is not known to be localized in seasonal-specific or depth-specific concentrations. The fish are believed to appear randomly in schools in different parts of the fishing area where they become accessible to gillnets for short periods, and to be found in larger concentrations with increased distance from the shore. One informant notes that "the fish don't stop at all on this level bottom, there's nothing to bring it up, there's no shoals." Another feels that "fish is on the move, if your gillnet is there, you'll be lucky to catch them" while another states that "If a good spot of fish come along, you might get a week or two of good fishing... We've struck it for three weeks sometimes out there." It would seem therefore that the fishermen understand little about the distribution and movement of the offshore stock that would allow them to employ exploitive strategies. Instead, they attach a strong element of luck on being able to locate and exploit fish concentrations for relatively short periods, and because of the high probability of the occurrence of periods when fish cannot be found, are uncertain in their expectations of a successful voyage.

The limited ecological knowledge that the fishermen have of the offshore stock seems to be derived from observations made about it over the relatively short period that the fishery has been in existence. This knowledge, such as it is, results from actively seeking out seemingly randomly distributed fish schools.

With the arrival of the offshore cod stock in February, the vessels tend to congregate close to the shoreline, gradually moving into more distant waters in the spring as the threat of freezing spray diminishes, reaching their maximum extent by June. The biggest boats, with the largest complement of gear and crew, fish the furthest off-shore in order to maximize their returns while the smaller vessels can normally catch sufficient fish to produce adequate returns while remaining closer to shore. The usual limit of operation may be extended if the fish are found to be concentrated beyond the prescribed limit. The St. John's longliner fishermen prefer to risk having their gear torn up by otter trawlers or their boats "swamped" by water given the possibility of reaping larger fish catches. Similar risks were often taken by Petty Harbour trap-fishermen when larger catches were foreseeable. By June the offshore cod stock begins to disappear from the range of gillnets and the longliners retreat to the inshore grounds to await the arrival of the inshore stock.

The fishermen believe that the inshore cod stock, because of the small size of the fish that comprise it, is distinct from the offshore stock. This inshore stock is the same one which enters the Petty Harbour coastal area in June and moves shoreward in pursuit of spawning caplin, ultimately becoming concentrated along the shoreline and on nearshore shoals where gillnet catches can be made.

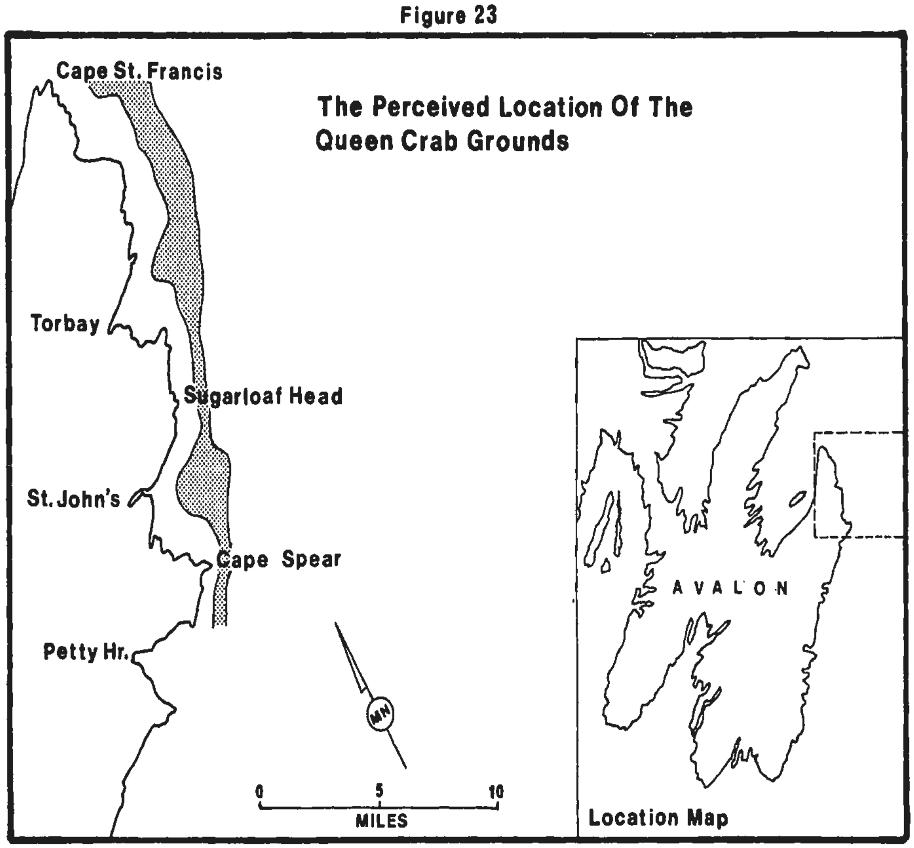
The caplin are known to retreat offshore and the cod are said to "come afloat" above the range of gillnets in search of other forms of bait. The cod are usually caught on line trawls until about the end of September when the fish begin to return to the seabed. They are then believed to respond to rapidly falling water temperature by moving along the edges of shoals of gradually increasing depths. As the fish move offshore, they are found to be caught by gillnets in progressively smaller quantities. By mid-December they are said to move beyond the eighty fathom contour into the deeper water offshore where, as one fishermen notes, "you're getting the same temperature all the time". The remainder of the stock are believed to become dispersed over the wide area offshore, indicating the end of the longliner fishery for the year.

During the period that the inshore cod stock is accessible, the longliners operate in that part of the area between the North Head of Petty Harbour and Cape St. Francis that extends from the shore to a depth of approximately eighty fathoms. In this area gillnets are set perpendicular to the shore and because the area is not very wide, it is necessary for those vessels having a large complement of gear to go north of the traditional inshore zone to find sufficient space for all the gillnets (Figure 17).

The flatfish species, flounder and greysole, together comprise the third major fish stock sought by the longliner operators. The fishermen who use the largest mesh gillnets find these species to be most densely concentrated in the area outside of approximately ten miles from the coastline and note a direct relationship between the distance from the shore and the size of the fish schools encountered. Unlike the cod, the flounder and the greysole are believed to maintain a true demersal existence by remaining on the seabed and undergoing little vertical or horizontal movement. They are also found to be available to gillnets in the offshore zone for longer periods than for cod, being found in the most distant waters at least until the end of September. Other than the broad distributional aspects, little is known by the fishermen about the ecology of these fish.

A major biological hazard present in the St. John's fishery is the queen or spider crab which is known to become entangled in the gillnets, preying upon enmeshed cod, thus reducing the catching effectiveness of the gear and causing long delays in the fishery because of the difficulty of removing them from the nets. The crab is said to be located mainly within an important cod fishing area that extends along the edge of the inshore grounds between about fifty and eighty fathoms (Figure 23). Both the cod and the crab are thought to be attracted to this area because of the availability of prolific amounts of food which are said to be "swept down over the grounds". The

Figure 23


Cape St. Francis
The Perceived Location Of The
Queen Crab Grounds
Torbay
Sugarloaf Head
St. John's
Cape Spear
Petty Hr.
MN
0
5
10
MILES
AVALON
Location Map

crab concentrations are believed to migrate within this zone but not to follow a seasonal or other cyclical pattern. Some fishermen prefer to set nets in this area only when the fish are found to be scarce in other areas. But given the difficulty of knowing the precise locations of the crab at any one time, some fishermen prefer to risk having their nets become entangled. One fisherman expresses this in the following manner:

> You don't know where they're going to be... Sometimes you can set and get neither one [none] and you're liable to set then and get your nets blocked... You've always got a big of fish there. You'll set there and you hope you don't get them [the crabs][21]

The quantity of crabs attracted to the nets is believed to be proportional to the period of time that the nets remain unattended. One fisherman recalls spending two days "picking" crabs from forty nets which, because of poor fishing weather, were left unattended for one week.

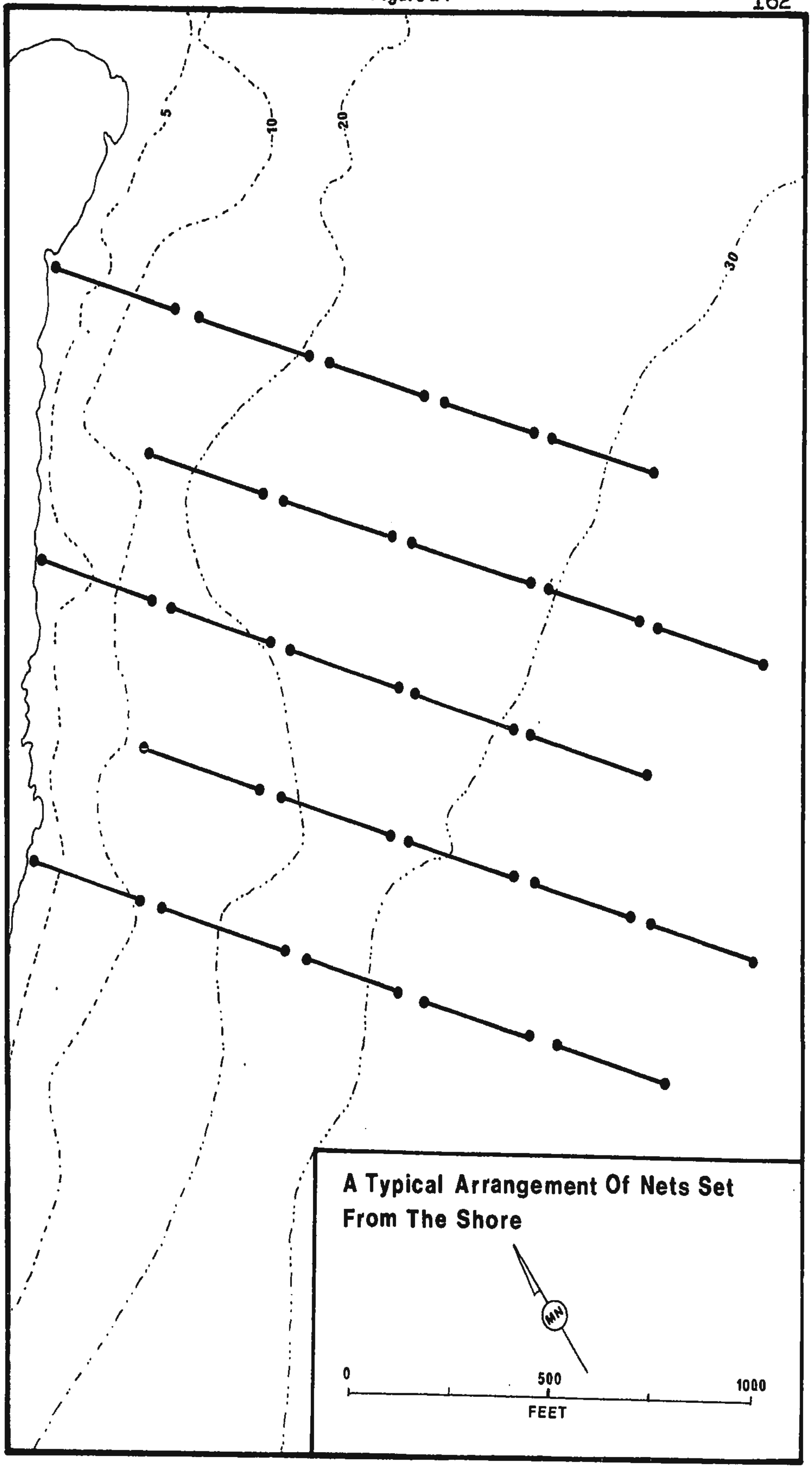
It would appear that the fishermen's present knowledge of fish behaviour, limited as it is, has been acquired through direct experience in the fishing operation. Given this present body of knowledge, they are now able to make some adaptations in their catching operation in response to these perceptions and to use the gear to further their knowledge. The longliner fishermen attempt to achieve two basic objectives in the conduct of the fishery: (1) to increase the catching effectiveness of their fishing gear and (2) to determine the location of the fish concentrations. These aims are expressed in the number of nets used in each fleet of gear, the geometric arrangement of the fleets, the distance between each fleet and the manner in which they are placed on the seabed. The kinds of net-setting practices used may vary according to whether the fish are caught inshore or offshore and according to the species caught.

When operating on the narrow inshore grounds, the longliner fishermen use fleets with a maximum number of five nets per fleet. The actual number of nets used in each fleet, the distance between them, and their geometric arrangement, however, all vary according to the location of the fish concentrations throughout the season. When the cod migrate as far as the coastline in June, the fleets are generally set in parallel rows off the shore in a northwesterly-southeasterly direction in unused codtrap berths. The number of nets used in each fleet varies according to the extent of the shoal on which they are placed. The fleets, however, are usually closely spaced at distances of between twenty and fifty fathoms at this time because of the tendency for the cod to become densely concentrated along the shoreline. The fishermen believe that when the cod are available in quantity, the largest catches can be realized by keeping the gear close together.

The parallel net arrangement also enables the fishermen to detect and respond to changes in the direction of movement and location of the fish resource. The gradual movement of the fish away from the shoreline to settle on the deeper parts of the grounds is said to be indicated by the increased tendency for the fish to concentrate at different places along the length of the gear. When this movement is first detected half the fleets may be reset in deeper water while the remainder are left set from the shore (Figure 24). This strategy is in response to the possibility that fish schools may still be near the shore but above the range of the gillnets or temporarily immobilized on the seabed. Consequently, as one informant notes "if you set a couple of nets outside and some inside, you still wouldn't be losing" since the fish can again become available near the shore. Eventually all the nets are relocated in deeper water as the fish are found to become more densely concentrated towards the outer ends of the nets.

When the fish "come afloat" in August, the longliner operators tend to adapt either by using line trawls which can be adjusted to catch the fish at different depths or by setting the nets outside the inshore grounds where marginal catches can always be obtained. The latter alternative is preferred by those fishermen who have relatively low costs in fishing gear and equipment and who can normally catch enough fish to cover the costs of their voyage. One fleet of gear is usually left on the inshore grounds during this

Figure 24


5
10
20
30
A Typical Arrangement Of Nets Set From The Shore
MN
0
500
1000
FEET

period, however, so that "when the fish strikes down you'd know it". The fishermen with large overhead costs must make full use of the fish wherever its available even to the extent of purchasing another type of gear and expensive bait which may only be used for a short period.

After the cod return to a benthic habitat and commence to move into deeper water in October, all the fishermen resume gillnetting. During this period when the fish become concentrated along the edges and in the depressions between shoals, different setting practices are followed. The fishermen then arrange their nets into fleets which vary in size according to the extent of the area in which the fish are found to be concentrated. This in turn is estimated from the time of travel taken at a fixed engine speed to traverse a depression traced by the depth-sounder or by using two sets of landmarks. A fleet of twenty nets is approximately one mile long, therefore a depression of one-tenth-of-a-mile in extent will require two nets. In late fall, larger fleets are set "down over the edge" of the inshore grounds where the fish may be caught "going off" until December.

When fishing on the offshore grounds, longliner fishermen tend to adjust their net setting arrangement to the larger area over which the nets can be placed by using fleets averaging twenty nets. They also prefer to set the fleets either end-to-end in a straight line, or in a series of parallel fleets spaced further apart than in the inshore zone. Some fishermen, including most of those who lack radars, always use the "straight line" technique. They suggest that it is the best means of both increasing the gear's catching effectiveness and detecting changes in the behaviour of the fish. Others believe that this method is best utilized to detect changes in fish behaviour during periods of scarcity while the parallel method is likely to result in increased catches when the fish are found to be concentrated in an area.

One consistent user of the straight-line method notes that:

> If you got them all in the one string, you get them [the fish] coming both ways all the time You're not barring off nothing... If you had a fleet of nets here and another fleet say a mile below that [parallel]... If the fish were coming up the shore you'd get them in this fleet, but you wouldn't get them in the other.[22]

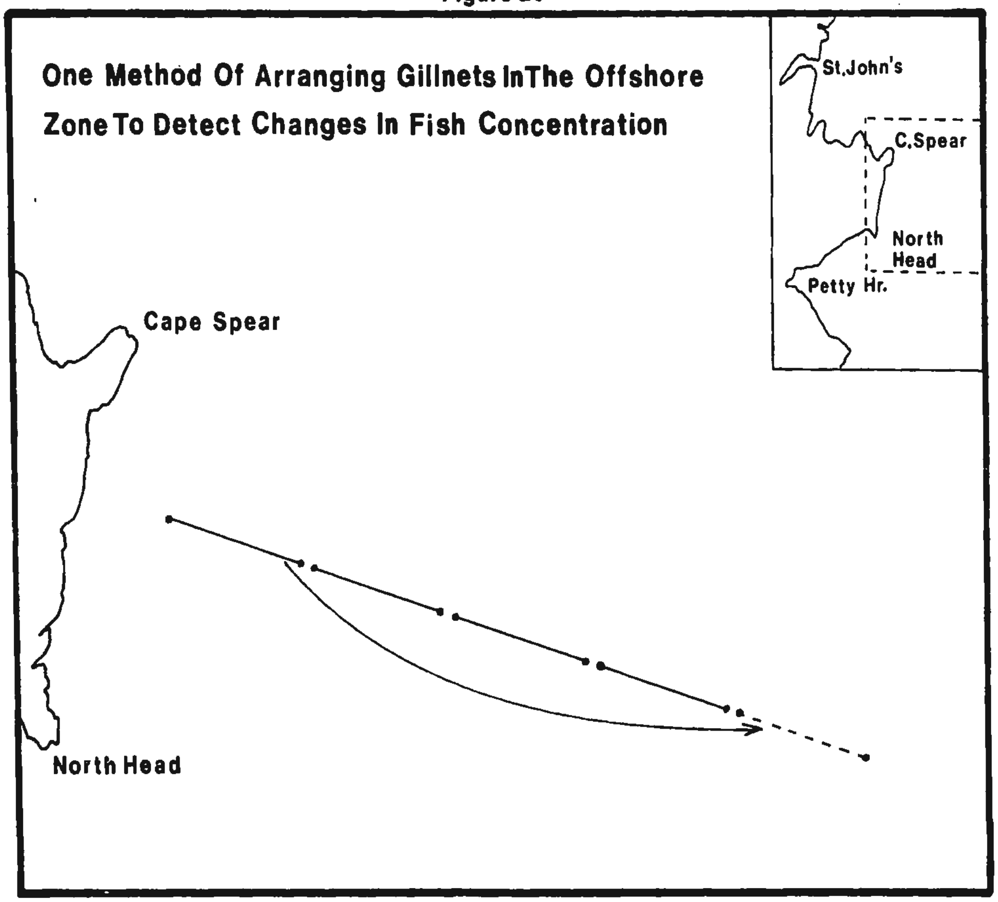
Another fisherman notes the experimental value of this method in determining where the fish are concentrated and in which direction they are moving at different times during the season. At the commencement of the winter fishery the fleets are set where the offshore stock is first found to be concentrated. When the nets are hauled, the fleet with the least fish is relocated to the outside end of the gear. Since the size of the fish catches is believed to be proportional to the distance from the land the gear is gradually placed further offshore as the season progresses.

By arranging their nets in a straight line, some longliner operators therefore believe that they can identify changing fish concentrations over a large area (Figure 25). They can also similarly relocate the nets day-by-day according to where the fish are found to be most plentiful.

There are other fishermen who believe that the fish are more effectively caught by arranging the fleets in parallel groups. This is based on the premise that the fish schools may be densely concentrated within a relatively small area so that the more of the netting to which the fish are exposed, the greater the quantity of fish caught. One informant notes the importance of "getting the fish between the nets" to reduce the possibility of escape. The distance between each fleet tends to vary according to the size of the area in which the fish are found to be concentrated and according to the number of vessels fishing in the area. Most fishermen prefer to keep the nets up to one mile apart but in practice they may be more closely spaced when a large number of boats are fishing in the same area in order "to give all hands a chance to set their gear". One informant who always sets his nets in parallel fleets, notes that:

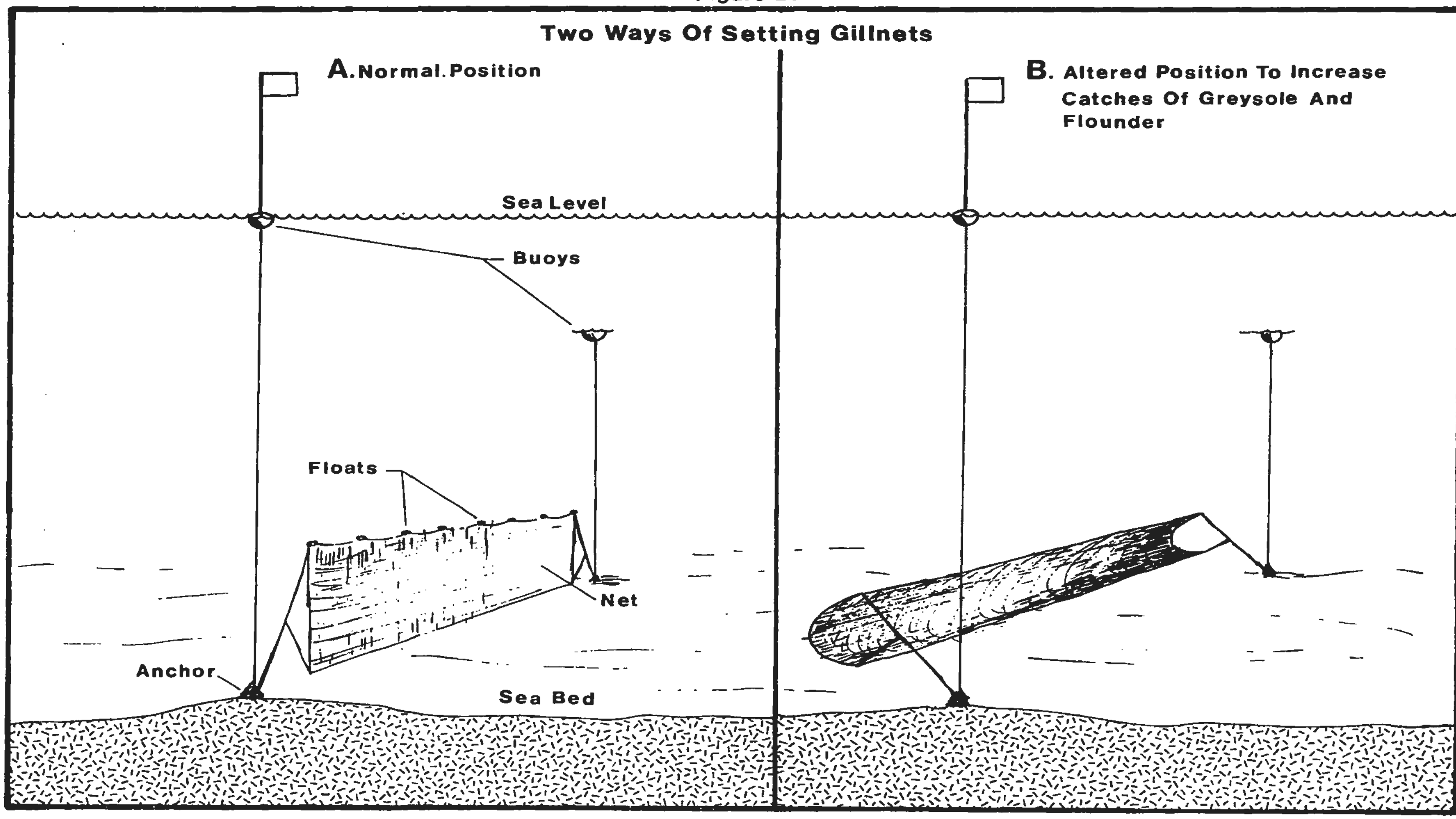
> We like to keep them [the fleets] about three quarters of a mile [apart]... If there's lots of gear around and you got some good fishing ground, you'll get your nets to within half a mile. We find that if you get them a little further apart, it seems like you'll get a little better fishing. I suppose you got that much more space.[23]

Figure 25


One Method Of Arranging Gillnets InThe Offshore Zone To Detect Changes In Fish Concentration
St.John's
C.Spear
North Head
Petty Hr.
Cape Spear
North Head

The longliner fishermen may also use different methods of arranging the gillnets on the seabed, according to the type of species sought. The cod are known to be caught over the full vertical range of the gillnet while the greysole and flounder, because of their more sedentary habits are found to be more commonly caught in the lower half of the net. The fishermen also suggest that these fish, because of their irregular shape, are not as easily enmeshed as the cod. The gillnet is consequently found to be relatively inefficient for the catching of greysole and flounder when set in its normal vertical position. The net's efficiency, however, is said to be increased by altering its vertical form to produce a trap-like device. This is accomplished by removing the supporting floats from the headrope. The latter is then believed to fall closer to the seabed and to form a pocket with the footrope. The greysole and flounder are then said to enter the pocket and to "roll up on the twine or lie up against the twine". When the net is hauled, the headrope and footrope come together, closing the pocket and preventing the fish from escaping (Figure 26). The fishermen who use this method on the most distant fishing grounds testify to the increased catches of greysole and flounder that result. However, other fishermen operating in the same area prefer to use the standard method of setting gillnets to allow full exploitation of the full range of species in the area.

Figure 26


Two Ways Of Setting Gillnets
A. Normal. Position
B. Altered Position To Increase Catches Of Greysole And Flounder
Sea Level
Buoys
Floats
Net
Anchor
Sea Bed

Therefore, if greysole and flounder are unavailable, the cod may still be caught. One such fisherman who follows this practice notes that

> Once the greysole and flounder comes and gets in this bottom part ... they're hauling the top part down... When the fish do get in, this [the top part] will sink anyway... If there's no greysole or flounder, the cod's getting in but if you got no floats on you won't get no cod.[24]

The decision to alter the shape of the gillnet consequently depends upon which species individual fishermen prefer to concentrate their effort.

Like the Petty Harbour fishermen, the St. John's longliner fishermen tended to perceive the marine environment in terms of the effects of key elements upon fish behaviour and upon the fishing operation. The St. John's fishermen, however, were aware of a wider range of elements than were the Petty Harbour fishermen, and they tended to express the effects of these elements more in terms of the catching operation than in terms of fish behaviour. Their image of the environment was, therefore, different from that of the Petty Harbour fishermen. It was an expression of the different selection, organization and meaning endowed by the St. John's fishermen to environmental elements, which can be largely attributed to the more active hunting nature of the St. John's fishery. The latter operated up to a greater distance from shore over a larger and more undifferentiated area, extended over a longer fishing season, used flexible fishing gear that did not depend upon bait, and employed fishing and navigational aids which helped the seeking out of fish and the movement to and from port.

Associations between fish behaviour and environmental influences were limited to the inshore zone and were derived from the longliner fishermen's experience as former trapmen and handliners. In the offshore zone, however, the fishermen did not formulate associations between fish behaviour and environmental conditions because of the lack of apparent indicators and the seemingly random distribution of fish over a large area. Furthermore, their gear could be used to locate fish concentrations and to detect changes in their movement over a large area. The effectiveness of the fishing gear was also less dependent upon the feeding behaviour of fish and their movement to the shore than were the traps and handlines in Petty Harbour. There was, therefore, less need than in Petty Haroour to establish causal relationships to predict fish behaviour.

The tendency for the fishermen to attach a more critical significance to the effects of the environment upon the actual conduct of the fishing operation was derived from their experience of the constraints imposed both upon the hauling of expensive fishing gear and upon the movement between the fishing grounds and the port. The sense of risk was found to increase with the greater distance travelled from the shore partly because of the exposure to a greater array of elements, and partly by the extension of the fishing season into winter when the most dangerous fishing conditions were known to occur. Perceptions of hazards tended to differ in degree of stress from one longliner to another according to the size of the craft and the complement of fishing and navigational aids possessed by each. These in turn influenced the range of operations of each vessel.

Like the Petty Harbour fishermen, the St. John's fishermen as a group tended to share similar perceptions about the effects of specific elements upon each aspect of the fishery, and their prediction of the seasonal occurrence of these elements bore a strong relationship to actual recorded conditions. The longliner fishermen were also found to respond to all of these elements since they occurred together in practice. The possible range of adaptations, however, tended to vary from one fisherman to another according to the variety of equipment possessed by each, and according to whether the fishing operation took place in the inshore or offshore zone.

Two broad fishing decisions were identified: (1) where to fish and (2) how to set the gear. These decisions were influenced by knowledge of the location and seasonal movements of fish, weather conditions, and tidal conditions which tended to vary between the inshore and offshore zones. In the inshore zone decisions concerning where to fish tended to be somewhat restricted because of the small size of the inshore fishing area, the relatively well known movement of fish within the area, the ease of fixing particular fish concentrations with the echo-sounder, and the relative ease of accommodating to hazardous wind and fog conditions. The manner in which the gear was set was also limited by the greater need to compensate for tidal conditions, while the size and arrangement of the fleets were determined by the shape and dimensions of the area in which the gear was set. The different ranges of the vessels on the inshore grounds tended to be based more upon the number of nets used by each rather than upon the complement of fishing and navigational aids or the size of the vessels.

In the offshore zone, decisions concerning where to fish and how to set the gear tended to be less restricted because of the larger size and undifferentiated nature of the area, the unknown distribution of fish within it and the difficulty of accommodating to wind, tide, and fog conditions when operating further off shore. Fishing decisions tended to be based more upon a consideration of the limitations imposed upon travel between port and fishing grounds rather than upon any compulsion to exploit the full range of possible fish concentrations. Differences in the size of vessels, the navigational aids possessed by each, and consequently their effective range, therefore loomed important in the offshore zone, as a result of differences in the capacity to cope with the effects of the offshore environment. The fishermen tended to adapt easily to the modern use of navigational equipment and to adopt standard procedures to facilitate movement. When the navigational equipment failed to provide easy access, however, more varied coping strategies emerged. The setting arrangement of the gear also tended to vary from one fisherman to another according to the particular needs of each. Since fish movements were perceived to be random in the offshore zone and since weather conditions were held to be variable, each fisherman set his nets so as to achieve a compromise between maximizing catch and minimizing risk of losing gear, which he perceived as being best suited to his particular needs.

The St. John's longliner fishery developed in response to a need to exploit fish resources in the more variable environment of the offshore zone. However, it appears that the process of exploiting the larger offshore area was impeded by the fishermen's apparent reluctance to realize the full potential of their new technology. It would also seem that while the Petty Harbour fishermen have a well defined image of their environment, some, and possibly the most innovative of the St. John's group, are currently in the process of building a new image of their fishing environment. Conversely, others tended to retain attitudes which in the longliner fishery represented a conservative ethos.

NOTES TO CHAPTER V

1. See Introduction, p. 4.
2. Interview, F. Hutchings, August 1971.
3. This is a result of the fact that land and sea surfaces demonstrate different properties in the absorption and reradiation of heat. In the winter, when solar radiation is reduced, land surfaces cool more rapidly and reach lower temperatures than water surfaces. Winds passing over the land in winter are consequently colder than those which are passing over the sea. The fishermen have a general understanding of this phenomenon.
4. Interview, J. Wells, November 12, 1971.
5. Interview, F. Hutchings, August 1971.
6. James C. Faris, Cat Harbour: A Newfoundland Fishing Settlement (St. John's: Institute of Social and Economic Research, Memorial University of Newfoundland, 1966), p. 28.
7. Interview, J. Wells, September 1971.
8. Leslie James Dean, "Diversification of Effort in the Newfoundland Longliner Fishery" (Honours B.A. dissertation, Department of Geography, Memorial University, 1971), p. 27.
9. These warnings are given as Gale Warnings (winds 34 to 47 knots), Storm Warnings (winds 48 to 63 knots) and Hurricane Warnings (winds over 63 knots).

10. Interview, C. Wells, December 1971.

11. Shewel noted that "a cold front, with its attendant weather and wind changes, moving from the northwest at 25 knots, would take over 12 hours to cross the present "east coast" marine area. This makes it difficult to write a short and accurate forecast for the east coast". See M. Shewel "Report on User Reaction to Marine Weather Services Provided by the Gander Weather Office", results of a questionnaire compiled by the Gander Weather Office, July 31, 1972, p. 22.

12. Interview, J. Wells, December 1971.

13. Interview, H. Wareham, June 10, 1971.

14. According to Bowditch, clutter results from the presence of unwanted signals from atmospheric noise, sea return, precipitation, etc. See Nathaniel Bowditch, The American Practical Navigator (Washington: United States Government Printing Office, 1966), p. 323.

15. Interview, F. Hutchings, August 1971.

16. Interview, J. Wells, September 8, 1971.

17. The longliner fishermen agree to set their nets in one direction only for two reasons: (1) to permit all the fishermen who wish to do so, to set their nets in an area where the fish are found to be concentrated, (2) to eliminate the possibility of having one net set across another, so preventing entanglement.

18. Interview, C. Wells, December 7, 1971.

19. Interview, H. Wareham, June 1971.

20. Templeman attributes this phenomenon to differences in bottom-water temperatures between the two periods. The highest temperatures, and those most suitable for the cod, were recorded during the winter. See Templeman, Marine Resources of Newfoundland, Bulletin No. 154 Fisheries Research Board of Canada (Ottawa: The Queen's Printer, 1966), p. 27.

21. Interview, B. Wareham, August 1971.

22. Interview, F. Hutchings, August 1971.

23. Interview, F. Flight, July 1971.

24. Interview, J. Simms, June 1971.

CHAPTER VI

CONCLUSION

Man's natural reaction, when faced with the complexity of the real world, is to formulate a simplified mental picture or model of that world in order to deal with it effectively. The marine environment involves interacting elements which are less predictable on a short term basis, less tangible, and less understood by science than most natural environments, and it is also generally more dangerous than other natural environments because of the higher frequency of hazards. The image that fishermen form of this environment is thus particularly significant, and must be capable of allowing them to respond to given situations with relative accuracy.

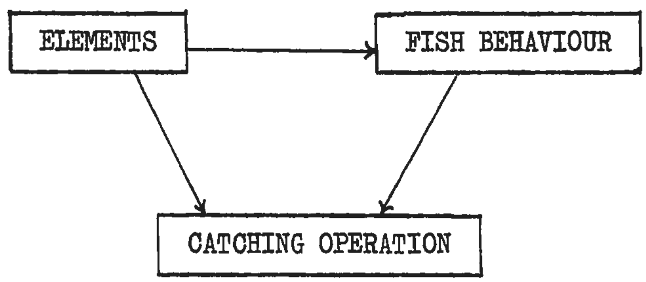
It was hypothesized that fishermen, exposed to a complex natural environment, select from it those elements that they believe to have the most important effects upon the fishery, and that the fishing operation is largely a response to the natural environment, and as such it is a response to an acquired image of that environment. Several conclusions can be made in relation to these hypotheses regarding how the Petty Harbour and St. John's fishermen formulate their environmental image, and how they use this image in making decisions about the environment.

The fishermen's mode of interpreting the complexity of their environment was to isolate a group of critical elements. The subsequent perception of these elements in terms of their effects constituted the environmental image or model within which context decisions were made. The key components of the image were found to be wind, fog, tide, and fish behaviour, and information pertaining to them and their effects was accrued empirically by the fishermen through experience and hearsay. Although each fisherman tended to manipulate a general image with reference to his own particular needs and capabilities, two distinct group or shared images became apparent.

The fishermen were found to make simple associations between the occurrence of certain elements and the occurrence of specific effects upon the fishery. In this way, they learned to predict the onset of these effects, thereby reducing the uncertainty of the environment. While the fishermen usually demonstrated an accurate assessment of the actual occurrence of such key elements, the mechanism of causality, as explained by them, could not always be scientifically substantiated because of the lack of relevant reliable data. This confirmed Hela and Laevastu's findings that fishermen are able to recognize the effects of the environment upon fish catches without necessarily knowing the real causes. What seemed to be relevant to the Petty Harbour and St. John's fishermen was not whether the causes of the observed relationship were real or correct, but that the observed effects were consistent with their image. These perceived effects were easily verifiable and seemed to substantiate the causal explanations offered to interpret them. Such was the case among the Petty Harbour fishermen, who having associated the failure of the caplin migration in 1971 with the occurrence of "northerly" winds and spring tides, which were said to keep the fish off the shore where they spawned, later reinforced this observation by discovering that the caplin had spawned on the nearshore shoals. The fishermen therefore tended to interpret their environment in pragmatic terms by associating the occurrence of a particular phenomenon with that of a particular verifiable effect, and as long as the effects follow consistently every time, the image of the environment remained intact.

With the exception of fog, which was significant only to the St. John's fishery, both groups of fishermen isolated the same natural elements. Wind and tide are the elements which are most directly experienced in the marine environment, while the behaviour of fish is of fundamental concern to those whose livelihood is derived from exploiting the living resources of the sea.

The fishermen tended to express their perceptions of the marine environment by categorizing wind and tide according to their effects upon fish behaviour and upon the catching operation, and fish behaviour according to its effects upon the catching operation. Winds, because



of the number of directions involved, were also functionally classified into groups to express generalized information about their effects. Water temperature was believed to have an important influence upon both fish behaviour and the prosecution of the fishing operation but was associated with seasonal wind patterns. The relative importance attached to each element, the knowledge of each, and the wind groups identified, was found to vary between the Petty Harbour and St. John's fisheries and resulted from differences in technology utilized, size of the fishing area, and length of fishing season.

The depth of environmental knowledge accumulated by the Petty Harbour fishermen was greater than that expressed by the St. John's fishermen. The former's understanding of environmental conditions and of fish behaviour and its environmental relationships was particularly substantial and constituted a corpus of information similar in scope to that found by Morrill among Virgin Island fishermen. The difference in the depth of information about the environment between the Petty Harbour and St. John's fishermen can be explained in two ways: (1) the degree of experience, and (2) the structural attributes of the fishery. Petty Harbour fishermen had a longer experience in the use of the same fishing methods, allowing them to build up detailed knowledge of fish behaviour. The St. John's fishermen, on the other hand, used relatively newer methods and were still in the process of learning about fish behaviour in the offshore zone. The Petty Harbour fishery also took place in a relatively small area, and displayed relatively passive fishing gear to exploit a seasonally available fish stock characterized by a cyclical pattern of movement in the inshore zone. The St. John's fishery, on the contrary, was dependent upon exploiting a fish stock randomly distributed over a large area, and applied fishing gear and electronic aids to locate fish concentrations. Because of the more exposed area in which they fished and the longer fishing period, however, the St. John's fishermen demonstrated a more critical awareness of the effects of the environment upon the actual fishing operation.

Both groups of fishermen tended to describe environmental influences upon fish behaviour and upon the catching operation in hazardous and non-hazardous terms but appeared to express a heightened awareness of hazards, indicating the frequency with which these disrupted the fishery. In the study areas, hindering winds, tides, and fog can occur at any time, singly or in combinations. The inherent danger of frequently occurring marine hazards heightens the need for immediate decision, and necessitates that the image upon which decisions are based be congruent with reality.

Each of the major elements of the perceived environment was expressed in terms of its distinct effects upon the fishery. The adaptations to these elements were also described by the fishermen in this way. In reality, however, decisions were made and strategies adopted under conditions where these elements occurred together. It would appear therefore that group behavioural responses can be identified. Actual behaviour in any given situation, however, depended upon weighting these elements which in reality occurred together. This was influenced by individual skills and by the technology at the disposal of each fishermen (e.g., the number of cod traps, the complement of electronic aids). The variance in behaviour was further influenced by variables which were not specifically environmental but which were intimately related to environmental decisions. These included economic and social factors. The greater the cost of the fishing equipment, the more need to maximize catches and hence the greater was the risk incurred. Rules were imposed by the fishermen which restricted behavioural options for both groups of fishermen, especially for the Petty Harbour fishermen. These also restricted the capacity for individual fishermen to maximize all of the possible range of adaptations.

While the fishermen tended to respond to their image of the environment in the formulation of fishing decisions, there was little indication of how the perceived environment of the image compared with the real natural environment from which it was abstracted. This comparison was difficult to assess because of the scarcity of comprehensive data relating to specific aspects of the environment. Where data were well-recorded (e.g. wind, tide, fog) the fishermen's recognition of their occurrence bore a strong relation to actual recorded conditions. The fishermen, however, were found to make different associations between the occurrence of these phenomena and that of other phenomena than did scientists. It was also found that the fishermen were generally unresponsive to scientific data that was readily available to them (e.g. weather forecasts), suggesting that this information was too unspecific, or not accurate enough, for making decisions from hour to hour. The fishermen may, in fact, possess more precise information about the effects of certain aspects of the real environment than is known by science. Some of the hypotheses generated by the fishermen could perhaps be usefully tested to determine their validity or non-validity. Templeman, in fact, drew upon the experience of fishermen to explain wind effects upon fish behaviour.

The fishing techniques employed in the Petty Harbour fishery tended to be more static and less affected by change than those employed in the St. John's longliner fishery. The image of the Petty Harbour fishermen, within which context decisions were made, restricted the range of options open to them. They were limited in these options by the passive nature of their catching gear, the limited range of their boats, and the refusal to adopt more innovative fishing methods. The relatively sophisticated fishing gear and electronic aids utilized in the St. John's fishery allowed the fishermen to pursue a wider range of fishing strategies than was possible in Petty Harbour, thereby making them less dependent upon the environment. Their technology plus the recent origin of the fishery allowed them to construct an image of the environment which is less complete and not as rigid as that in Petty Harbour. It would also appear that the St. John's fishermen have fewer reasons for constructing an exact image that incorporates detailed knowledge of fish behaviour and its environmental indicators.

Few studies which have focused upon man's economic relationship with the environment have examined the role of perception as an intervening variable. Studies by geographers of perception of the physical environment have generally failed to explain the everyday perception by man but have instead considered, in isolation, the perception of infrequently occurring and extremely hazardous events. Also these enquiries have only considered man as an exploiter of terrestrial environments and of resources, on a macro-scale. The present study examined man's adaptation to the marine environment as a totality perceived by its users, and has examined the role of perception in these adaptations. This approach recognizes the critical significance of events which are frequently experienced as compared to those which occur only sporadically over a long period of time. The existence of regularly occurring phenomena allows the perceiver to construct, over time, an image of the environment which will enable him to develop suitable coping strategies. Such is not the case for infrequently occurring phenomena. By using the micro-scale rather than the macro-scale, one is better able to identify all the meaningful variables, processes of decision-making, and adaptations.

The present study was an attempt to examine some aspects of how fishermen perceive their natural environment, and how these perceptions are expressed in the conduct of the fishery. It is felt that despite the difficulties inherent in the investigation of psychological processes, some attempt must be made to recognize the role of perception in explaining the relationship between man and his marine environment. Although geographers have, in the recent past, recognized this role, much work remains to be done relevant and applicable to the discipline. The present study suggests several possible directions that future research might take. These include the need to test the scientific accuracy of fishermen's perceptions of their environment, the need to examine the social, economic, and cultural variables that influence perception of the natural environment, and the need to determine the relative importance of these variables in affecting decision-making processes.

BIBLIOGRAPHY

Andersen, Raoul, and Wadel, Cato. "Comparative Problems in Fishing Adaptations," North Atlantic Fishermen, edited by Raoul Andersen and Cato Wadel, St. John's: Institute of Social and Economic Research, Memorial University of Newfoundland, 1972.

Barnes, Robert. Invertebrate Zoology, Philadelphia: W.B. Sanders Company, 1965.

Bocaud, A.A. Fishing Operations Off the Newfoundland Coast and Requirements for Weather Forecast Service, Government of Canada, Department of Transport, Meteorological Branch Circular 3358, Pub. 186.

Boulding, Kenneth E. The Image. Ann Arbor: University of Michigan Press, 1956.

Bowditch, Nathaniel. The American Practical Navigator, Washington: U.S. Government Printing Office, 1966.

Brookfield, Harold. "On the Environment As Perceived," Progress in Geography, I (1969), pp. 53-79.

Burton, Ian, and Kates, Robert W. "The Perception of Natural Hazards in Resource Management," Natural Resources Journal, III, No. 3 (Jan. 1964), pp. 412-441.

--------. "The Floodplain and the Seashore: A Comparative Analysis of Hazard-Zone Occupance," The Geographical Review, LIV, No. 3 (1964), pp. 366-385.

Burton, I., Kates, R.W., Mather, R., and Snead, R.E. The Shores of Megalopolis: Coastal Occupance and Human Adjustment to Flood Hazard, Elmer, New Jersey: Publications in Climatology, XVIII, No. 3, 1965.

Burton, Ian, Kates, Robert W., and Snead, Rodman. "The Human Ecology of Coastal Flood Hazard in Megalopolis," Department of Geography, Research Papers, No. 115, Chicago: The University of Chicago, Department of Geography, 1969.

Canada, Government of. Department of Fisheries, Newfoundland Fishery Regulations, The Canada Gazette, Part II, Vol. 94, June 8, 1960, No. 11.

Critchfield, Howard J. General Climatology, 2nd ed., Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1966.

Davenport, William. "Jamaican Fishing: A Game Theory Analysis," Yale University, Publications in Anthropology, LIX (1960), pp. 3-11.

Dean, Leslie J. "Diversification of Effort in the Newfoundland Longliner Fishery," Honours B.A. Dissertation, Memorial University of Newfoundland, Department of Geography, 1971.

Doherty, J.M. "Developments in Behavioural Geography," London School of Economics and Political Science, Graduate Geography Department, Discussion Paper, No. 35 (November, 1969), pp. 1-17.

Downs, Roger M. "Geographic Space Perception: Port Approaches and Future Prospects," Progress in Geography, II (1970), pp. 65-108.

Faris, James C. Cat Harbour: A Newfoundland Fishing Settlement, St. John's: Institute of Social and Economic Research, Memorial University of Newfoundland, 1966.

Forman, Shepard. "Cognition and the Catch: The Location of Fishing Spots in a Brazilian Coastal Village," Ethnology, VI, No. 4 (1967), pp. 417-426.

Fraser, Thomas M., Jr. Fishermen of South Thailand, New York: Holt, Rinehart and Winston Inc., 1966.

Gould, Peter R. "Man Against His Environment: A Game Theoretical Framework," Annals of the Association of American Geographers, LIII (1963), pp. 290-297.

Handcock, Gordon. "A Regional Geography of Petty Harbour, Newfoundland," B.A. Honours Dissertation, Memorial University of Newfoundland, Department of Geography, May 1967.

Hela, Ilmo, and Laevastu, Taivo. Fisheries Hydrography, London: Fishing News (Books) Ltd., 1961.

Kirk, W. "Problems of Geography," Geography, XLVII (1963), pp. 357-371.

Kristjonsson, Hilmar, ed. Modern Fishing Gear of the World, London: Fishing News (Books) Ltd., 1959.

Lowenthal, David. "Geography, Experience and Imagination: Towards a Geographical Epistemology," Annals of the Association of American Geographers, LI, No. 3 (September, 1961), pp. 241-260.

Lundeen, Richard. "The Semantic Differential Technique and Personal Construct Theory of Image Measurement," Department of Geography, Discussion Paper No. S, Toronto: York University, June 1972.

Matley, Ian M. "Perception of Environment: The Case of the Airman," The Professional Geographer, Vol. XXIV (February, 1972), pp. 23-25.

Morgan, Robert. World Sea Fisheries, London: Methuen and Co. Ltd., 1956.

Morrill, Warren T. "Ethnoichthyology of The Cha-Cha," Ethnology, VI, No. 4 (1967), pp. 405-416.

Paine, Robert. Coast Lapp Society, I, Tromsø: The Tromsø Museum, 1957.

Quinlan, Donald E. "The Longliner Industry in General with a Case Study," B. Comm. Report, Memorial University of Newfoundland, Department of Commerce, 1966.

Ronayne, Mark. "The Newfoundland Cod Traps," Trade News, IX, No. 4 (1956), pp. 3-6.

Saarinen, Thomas F. Perception of Environment, Resource Paper, No. 5, Washington, D.C.: Association of American Geographers, 1969.

Sewell, W.R. Derrick, Kates, Robert W., and Phillips, Lee E. "Human Responses to Weather and Climate: Geographical Contributions," The Geographical Review, LVIII, No. 2 (1968), pp. 262-280.

Shewel, M. "Report on User Reaction to Marine Weather Services Provided by the Gander Weather Office," Unpublished Report, Gander Weather Office, July 31, 1972.

Simon, Herbert H. Models of Man: Social and Rational, New York: Wiley and Son, 1957, p. 240.

Sonnenfeld, Joseph. "Geography, Perception and the Behavioural Environment," Man, Space and Environment, edited by Paul Ward English and Robert C. Mayfield, New York: Oxford University Press, 1972.

Templeman, Wilfred, and Fleming, A.M. Longliner Experiments for Cod Off the East Coast of Newfoundland and Southern Labrador, 1950-1955, Fisheries Research Board of Canada, Bulletin, No. 141, Ottawa: The Queen's Printer, 1963.

Templeman, Wilfred. "Some Instances of Cod and Haddock Behaviour and Concentrations in the Newfoundland and Labrador Areas in Relation to Food," International Commission for the Northwest Atlantic Fisheries, Special Publications, No. 6 (1965), pp. 449-462.

--------. Marine Resources of Newfoundland, Fisheries Research Board of Canada, Bulletin, No. 154, Ottawa: The Queen's Printer, 1966.

Terada, K. Fishermen and Weather, Fisheries Technical Paper, No. 71, Rome: The Food and Agricultural Organization of the United Nations, 1968.

Tunstall, Jeremy. The Fishermen, London: MacGibbon and Kee Ltd., 1962.

Winters, G.H. "Contributions to the Life History of the Caplin (Mallotus villosus) in Newfoundland Waters," B.Sc. Dissertation, Memorial University of Newfoundland, Department of Biology, 1966.

Wood, L.J. "Perception Studies in Geography," Transactions of the Institute of British Geographers, L (July, 1970), pp. 129-142.