Fish Waste Disposal Practices and Options for Eastern New Brunswick

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FISH WASTE DISPOSAL PRACTICES AND OPTIONS FOR EASTERN NEW BRUNSWICK

by

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ABSTRACT

Tidmarsh, W.G., J.H. Merritt, G. Bernier, J. Joza and S. Bastien-Daigle. 1986. Fish Waste Disposal Practices and Options for eastern New Brunswick. Can. Ind. Rep. Fish. Aquat. Sci. 176: 65p.

The study was commissioned by the Habitat Protection and Economic Development branches, Gulf Region, Department of Fisheries and Oceans. The objective was to prepare an inventory of fish waste disposal practices and processing methods in eastern New Brunswick, identify alternative options for beneficial uses of fish waste, assess the environmental and social implications of the waste disposal options, and establish research requirements to optimize the uses of this material. Current landings in eastern New Brunswick are about 65,000 mt. Groundfish and pelagic species each account for 28% of the catch. Shellfish comprise 44% of the landings. The fishery is not expected to change substantially in future. About 33,000 mt of waste are produced in eastern New Brunswick annually. Two-thirds is produced in northeastern New Brunswick north of Miramichi Bay. Processing is concentrated in the Caraquet-Shippegan-Lamèque area. One-third is produced in the southeastern sector, principally by shellfish processors in Kent and Westmorland counties.

On a regional basis, shellfish comprises half the waste volumes generated, pelagic species about 33%, and groundfish 17%. Shellfish waste is the dominant component of the waste in both sectors. Sixty percent of the waste is processed into fish meal and fish oil by four reduction facilities. The remainder is discarded in landfills, or is spread on agricultural land. A small but unknown proportion is dumped at sea. At present the single largest problem is the uncontrolled dumping of shellfish waste on private land near Caraquet. A former problem with shellfish and bloater wastes in Westmorland County was essentially solved by the establishment of a meal plant and disposal facility in the region in the early 1980's. The remaining waste disposal problems in eastern New Brunswick reflect the widely dispersed nature of the processing industry and the high cost of transporting raw material for processing. Currently, waste processors can sell all the material they process.

The review of potential alternative by-products indicated that production of chitin and chitosan from shellfish waste, and fish silage from finfish waste could alleviate the potential waste problem. Research and development work would be needed to optimize the chitin extraction method to maximize the economic return, while markets for fish silage should be investigated to determine the most suitable product. Manufacture of both products would benefit the region by significantly reducing a major social nuisance, and increasing the economic return from the fishery.

RÉSUMÉ

Tidmarsh, W.G., J.H. Merritt, G. Bernier, J. Joza, et S. Bastien-Daigle, Élimination des déchets de poisson dans l'est du Nouveau-Brunswick. Méthodes actuelles et proposées. Rapp. can. ind. sci. halieut. aquat. 176: 70p.

L'étude a été commandée par la Division de l'habitat du poisson et la Direction des ressources et du développement de la Région du Golfe, ministère des Pêches et des Océans. L'étude avait pour objet de répertorier les méthodes d'élimination et de traitement des déchets de poisson utilisées dans l'est du Nouveau-Brunswick, de désigner d'autres usages bénéfiques pour les déchets de poisson, d'évaluer les retombées sur le plan social et écologique des autres méthodes d'élimination des déchets de poisson et d'établir les besoins en matière de recherche pour maximiser l'usage des déchets de poisson. Dans l'est du Nouveau-Brunswick, les débarquements de poissons se chiffrent actuellement à environ 65 000 tonnes métriques (tm). Le poisson de fond et les espèces pélagiques représentent chacun environ 28 pour 100 des prises; les mollusques et les crustacés constituent 44 pour 100 des débarquements. On ne prévoit pas que l'industrie de la pêche changera de façon dramatique dans l'avenir. L'est du Nouveau-Brunswick produit chaque année environ 33 000 tm de déchets de poisson. Le nord-est de la province, au nord de la baie Miramichi est responsable des deux tiers de la production de déchets. Le traitement de ces déchets est surtout concentré dans la région de Caraquet-Shippagan-Lamèque. Le dernier tiers de la production de déchets revient au secteur du sud-est et il est surtout attribuable aux usines de traitement de mollusques et de crustacés des comtés de Kent et de Westmorland.

Dans la région, la moitié du volume des déchets est imputable aux mollusques et crustacés, 33 pour 100 provient des espèces pélagiques et 17 pour 100 du poisson de fond. Les déchets de mollusques et de crustacés composent la majeure partie des déchets dans les deux secteurs de la province. Quatre installations de transformation réduisent en farine de poisson et en huile de poisson 60 pour 100 des déchets. Le reste des déchets est mis en décharge ou sert d'engrais pour les terres agricoles. Une petite proportion indéterminée est rejetée à la mer. À l'heure actuelle, le plus grand problème demeure la décharge des déchets de mollusques et de crustacés sur les terres privées dans les environs de Caraquet. Dans le comté de Westmorland, on a résolu le problème que posaient les déchets de bouffis et de mollusques et crustacés par la création d'une installation d'élimination et d'une usine de préparation de farine de poisson dans la région au début des années 80. Le problème d'élimination des déchets qui persiste dans l'est du Nouveau-Brunswick illustre les disparités de l'industrie de la transformation et le coût élevé du transport des matières brutes en vue de la transformation. À l'heure actuelle, les transformateurs de déchets réussissent à vendre tout le matériel produit.

L'étude des autres sous-produits qu'il serait possible d'envisager a démontré que la production de chitine et de chitosane à partir des déchets de mollusques et de crustacés et que la production de poisson ensilé à partir des déchets de poissons osseux pourraient alléger quelque peu le problème que pose l'élimination des déchets. Il faudrait approfondir les travaux de recherche pour perfectionner la méthode d'extraction de la chitine en vue d'en maximiser le rendement économique et il faudrait aussi faire enquête auprès des marchés consommateurs de poisson ensilé afin de trouver le produit qui leur convient le mieux. La production de la chitine et du poisson ensilé profiterait à la région en augmentant le rendement économique de la pêche et en éliminant par la même occasion un "fléau social".

PREFACE

This study was commissioned by the Department of Supply and Services on behalf of the Fish Habitat Division and the Economic Development Branch, Gulf Region, Department of Fisheries and Oceans to review the current status of fish waste disposal and processing in Eastern New Brunswick, identify environmental and socio-economic problems associated with current practices in the region, and assess alternatives to make better and fuller use of these wastes for economic, environmental and social benefits to the region.

The study was based on a review of fisheries landings statistics supplied by the Department of Fisheries and Oceans, a literature review, discussions with officials in both the federal and New Brunswick governments, and interviews with selected plant operators and meal brokers.

The study had five separate components:

- Identify current fish waste disposal practices in the different areas of Eastern New Brunswick and any environmental or socio-economic effects associated with these activities;
- Identify current waste processing capacity and fish by-products produced in the region;
- Review alternatives that may be available to improve disposal practices or enhance the value of fish waste products;
- Determine market and economic considerations associated with these alternatives;
- Identify research needs to improve waste utilization or disposal practices.

The study was conducted by members of the following organizations:

Martec Limited
- Project Management and Social/Environmental Aspects

Monenco Maritimes Limited
- Regional Disposal Practices

Seatech Investigations Services Limited
- Fish Landings and Production Statistics

Canadian Institute of Fisheries Technology
- Fish Waste Processing Alternatives

DPA Group
- Marketing and Economic Considerations

The report is presented in nine parts. Part 1 introduces the study and describes the methodology used for the project. Part 2 describes the current status of the fisheries in Eastern New Brunswick while Part 3 identifies the current waste disposal practices in the region, government regulations controlling disposal and the social and environmental issues associated with disposal. Part 4 describes potential methods of waste processing which have been used elsewhere and the uses to which fish wastes can be put. In Part 5, research needs to improve waste utilization are identified, while in Part 6 the economic and marketing aspects of fish waste by-product are discussed. The environmental and social costs and benefits of alternative waste utilization strategies are described in Part 7. In Part 8, the disposal methods which are most acceptable from the environmental and socio-economic points of view are described. A summary and conclusions are contained in Part 9.

The terms of reference for the study and tables listing landings by month by fisheries district for groundfish, pelagic fish, as well as lobster, crab and other shellfish species are presented in the appendices.

1.0 INTRODUCTION

1.1 GENERAL

Fish waste utilization and disposal, and the environmental and socio-economic problems associated with improper practices, are inherent problems wherever large scale fish processing facilities are located. Between 5 and 65% of the raw fish goes to waste depending upon the processing method and the finished product.

Fish waste disposal can take two forms:

- Dumping of raw waste at sea, or on land in a controlled or uncontrolled manner;

- Processing of the waste into by-products using a variety of mechanical and chemical methods.

Both forms of disposal are practiced in eastern New Brunswick at the present time.

The Fish Habitat Division, Gulf Region of the Federal Department of Fisheries and Oceans, Moncton, in collaboration with the Economic Development Branch initiated this study to review present fish waste management practices in eastern New Brunswick to identify locations where environmental and socio-economic problems are being experienced and make recommendations on alternative methods of fish waste disposal or processing which may have future economic benefits for the region. The relatively low prices received for fish meal in past years make this review timely because processing alternatives may have to be found if fish meal production becomes economically unattractive.

The study area covered 5 counties and 12 fisheries statistical districts in northern and eastern New Brunswick administered by the Gulf Region of the Department of Fisheries and Oceans (see Figure 1). For the purpose of this review, the study area was divided into two sectors - northeastern and southeastern New Brunswick. The dividing line was the Miramichi estuary. This is not only a convenient geographic demarcation point, but also separates fisheries and fish processing activities which are distinctive and have different types of waste disposal problems.

In eastern New Brunswick the problem of fish waste management has been the subject of a number of investigations. Most of the effort has been directed toward the handling of liquid and solid wastes, and odour problems arising from fish processing and reduction plants in Caraquet, Lamèque, and Shippegan. Three studies (Canadian Plant and Process Engineering, 1970; Sheffner, 1970; Broderson, 1973) have considered the in-plant liquid waste management problems of the largest processing facilities operating in the region. Recommendations made included improved stickwater and blood water recovery practices, and correct in-house management practices to prevent wastes entering the environment. These studies did not review problems associated with solid waste management and disposal practices associated with fish processing.

The only studies in eastern New Brunswick oriented toward the management of solid fish waste have been carried out in the southeastern sector. A study of the waste disposal problems in Kent and Westmorland counties was undertaken by MacLaren Atlantic (1979). This investigation led to the establishment of a shellfish waste processing facility in the area which solved this waste problem. The problem of bloater (salt cured herring) waste in the region, however, has been of continuing concern and was further investigated by Co-Fish Consultants (1984). These two investigations have provided considerable background information for this study, particularly for the southeastern sector. The overall management of fish wastes in northeastern New Brunswick has not been considered previously.

The scope and approach for this review of fish waste disposal practices and options for eastern New Brunswick and the contents of the report are described in the following sections of the introduction.

1.2 SCOPE AND APPROACH

The terms of reference for the study are presented in Appendix A. Specifically, the objectives of the study were to:

1. Prepare an inventory of the current status of the fisheries and fish processing waste disposal practices and by-product processing, in the study area in order to define the general environmental and socio-economic considerations associated with fish waste disposal.

2. Consider alternatives for the beneficial disposal or processing of fish offal which might alleviate current fish waste management concerns including the identification of future research requirements.

3. Review the economic benefits which may be derived as well as the social and environmental concerns that should be addressed in order to minimize future difficulties.

To meet these objectives, the study was divided into three phases as shown in Figure 2. The first phase identified the current status of the fisheries and fish waste disposal and processing in the region, and the regulations covering waste disposal. The second phase covered alternative methods of fish waste disposal and processing which might be beneficially applied in eastern New Brunswick. The final phase included the preparation of a list of priorities for dealing with identified waste problems and research needs to exploit potential opportunities.

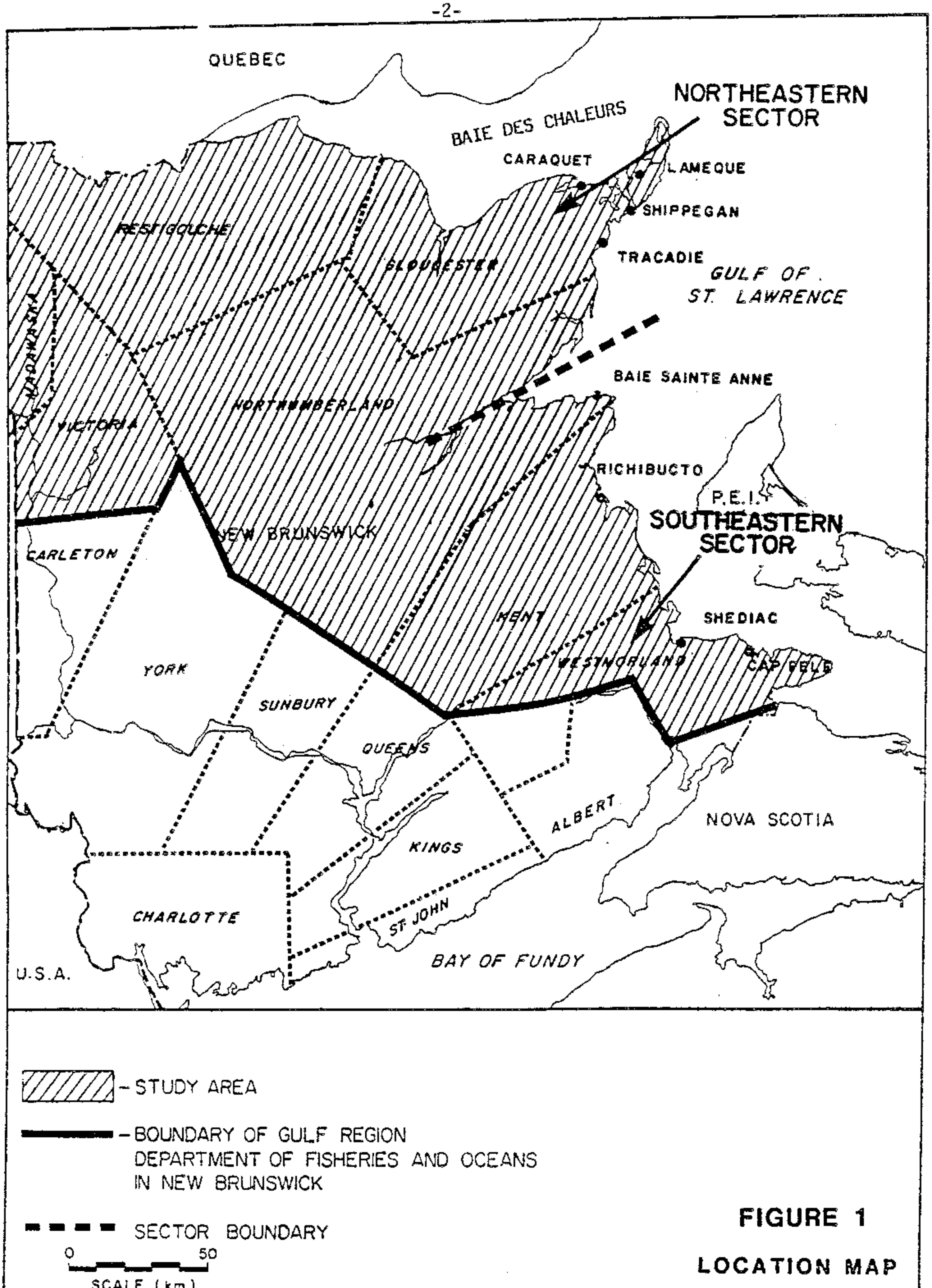


FIGURE 1

LOCATION MAP

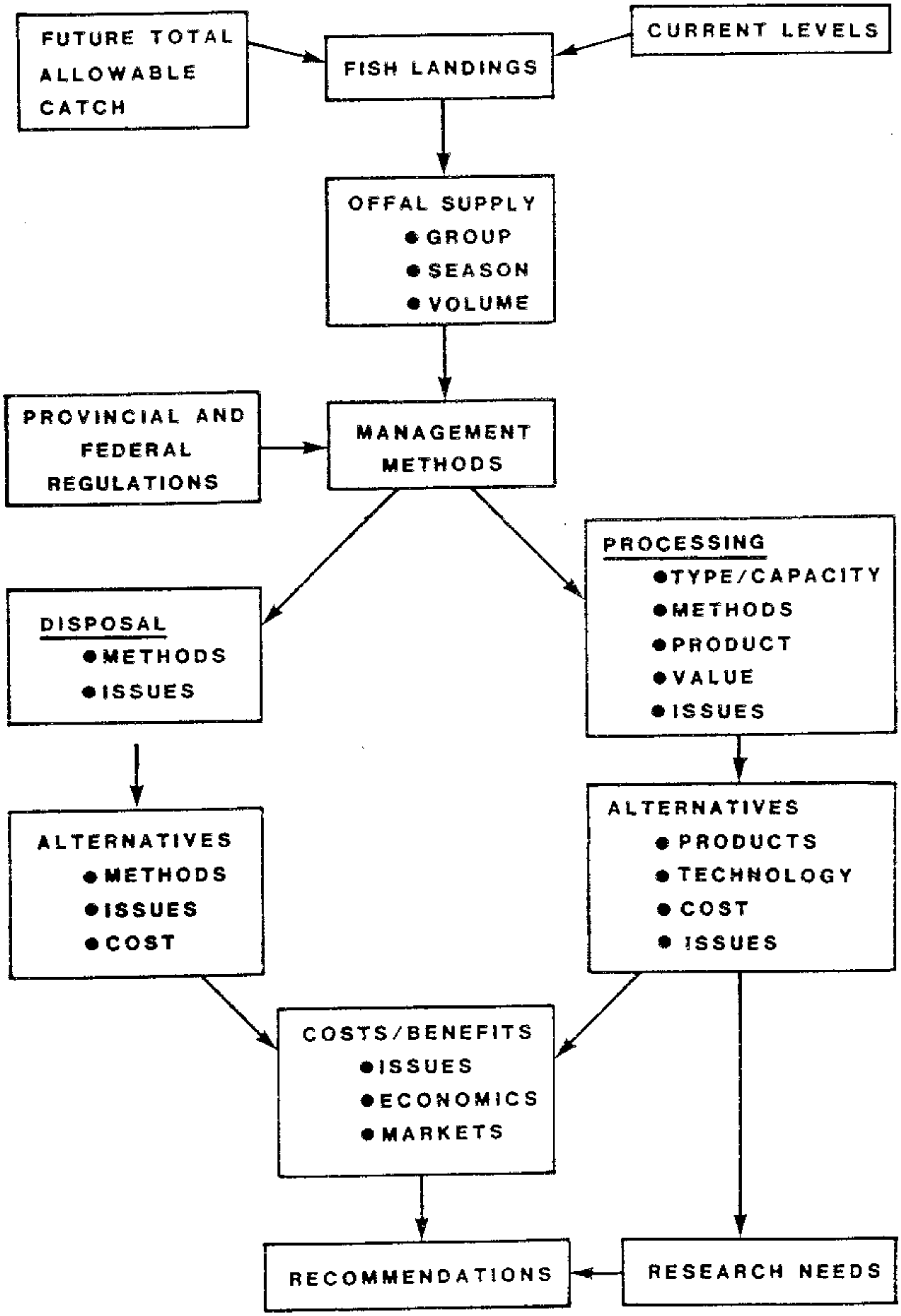


FIGURE 2
GENERAL APPROACH

This study is limited to the solid waste (i.e. fish offal, shellfish shell) problems in eastern New Brunswick. The liquid wastes, and odours from gaseous emissions, which have been a cause for concern in the past are identified but are not considered in detail. Aspects of these problems have been studied previously and can be managed using existing technology (Richard, pers. comm.). These situations are localized and readily identifiable. Federal and Provincial regulations and guidelines are in place for dealing with these wastes should a specific need arise.

Solid waste management and disposal, however, have received only limited attention to date. Traditionally much of the waste has been reduced to fish meal and fish oil, and the remainder has been placed on farmer's fields, or in landfills. Undoubtedly, some has also been dumped at sea. These methods have created local environmental and socio-economic problems in the past. The increasing environmental awareness and the recognition that the wastes represent a ready source of protein, has led to a need to review the present management and identify possible methods to optimize beneficial uses of the material. This study considers the solid waste problems in eastern New Brunswick in detail, and identifies the liquid waste and odour problems only in the context of the overall environmental and social issues associated with fish waste disposal in the study area.

The project involved a detailed review of fisheries statistics to determine the seasonal characteristics of the fisheries within the study area and the waste types and volumes generated. Direct contacts with regulatory personnel and plant operators were made to gain an appreciation of the magnitude of the fish waste disposal problem and to highlight specific issues, in the study area. At the same time, a literature review was conducted to obtain the latest information on various fish waste processes and disposal methods available to provide background for the assessment of alternative methods.

The marketing and economic analysis was based on a review of the current demand for fish waste products, namely fish and shellfish meal, and fish oil, and the identification of new products that brokers indicate are being requested. This analysis has considered both export opportunities, import substitution and new products. Import substitution considers products or markets, within New Brunswick, which could be supplied locally instead of being brought in from foreign or other Canadian sources.

A major proportion of the time during this study was devoted to determining the types, volumes and location of wastes in the study area. This effort was needed, because finfish and shellfish waste is low in value and relatively heavy which makes transportation of raw material costly, limiting the alternative usages available for consideration. This profile was developed using 1985 plant capacity and 1984 production data to determine the quantities of waste being created, and the present management techniques.

Using this general approach, it was possible to make an appraisal of the fish waste disposal situation in eastern New Brunswick and identify alternatives, which might increase the economic benefits and reduce or eliminate current or future environmental or social problems, associated with fish waste management in the study area.

1.3 CONTENTS

As indicated in the preface, the report contains nine parts; each addressing one aspect of the study. In each section, the methodology used, and comments on the quality of available data and the lack of appropriate information are presented. This has been done to keep the reader aware of limitations that should be applied to the interpretation of the data. In an attempt to keep the document as concise as possible, appendices have been used to present raw data not directly pertinent to the discussion in the main body of the report.

2.0 CURRENT STATUS AND FUTURE TRENDS IN THE FISHERY

This part of the report describes the current status of the fishery in the study area including current fisheries management practices, and makes comments about possible future trends. It has been included to put the discussion of fish waste types and volumes within the region, into perspective.

The discussion of current trends is grouped into groundfish, pelagic fish, and shellfish. The groupings are consistent with those used by the Economics Branch of DFO in compiling landings statistics. Landings for each group are reported as "round weight", which is the total live weight of the organisms. This applies even for species such as scallops which are landed as a semi-processed product.

In the groundfish and pelagic fish groups, individual species are only mentioned in passing because the characteristics of wastes within each group are similar. Shellfish are described by species because the waste management problems associated with each type are unique either spatially or temporally.

Although the data for individual species are available, grouping makes it easier to define the annual distribution of waste generation.

Fisheries management practices are also identified including the regulations used to control fish landings in the study area. The implications of these on the seasonal variability in fish waste volumes and the amounts available for processing into by-products are considered.

2.1 GROUNDFISH

The first species group of concern is groundfish and includes only marine fish species. Species within this group include cod, haddock, redfish, halibut, flounder, sole, plaice, turbot, pollock, hake, cusk, and catfish. The landings of groundfish in 1983, 1984, and 1985 (preliminary) are shown in Tables 1 and 2. A comparison of these values with landings from the whole Canadian Atlantic Coast are shown in Table 3. The landings in Table 3 do not exactly conform with those in the previous tables but have been included to place the landings in eastern New Brunswick in perspective.

Landings by statistical district for the three years are shown in Appendix B. These data are derived from DFO landings statistics. The 1985 data are preliminary. The original 1984 and 1985 data are reported in kilograms but have been converted to metric tons in the appendices for the sake of consistency.

The data shows that landings in northeastern New Brunswick have varied between about 13,900 and 17,500 mt over the last three years, while, in southeastern New Brunswick, they varied between about 970 and 1,850 mt during the same period. In 1984, groundfish landings represented 29% of the catch in the northeastern sector, while only 13% in southeastern New Brunswick (see Figure 3). However, the landings in southeastern New Brunswick were only 12% of the regional total. The data in Tables 1 and 2 show the differences in the groundfish landings as a proportion of the total catch in each sector of the study area over the last three years. Considerable annual variation in groundfish landings is apparent in both sectors but the percentages of the total annual catch do not vary significantly.

Groundfish landings in eastern New Brunswick represent only 2 to 3% of the total for the whole Atlantic Coast (Table 3).

The dominant species is cod which represented 75% of the total landings in eastern New Brunswick in 1983. Redfish and small flatfish each represent 8 to 10% of the landings, respectively (DFO, 1983).

Seasonal trends in groundfish landings for 1983, 1984, and 1985 are shown in Figures 4, 5, and 6, respectively. The raw data (Appendix B) shows that groundfish are landed during every month, although landings are very small between December and March. Peak landings have occurred in May over the last three years but they varied by almost 100% between 1983 and 1985. Landings during May reached almost 6,000 mt in 1983, but declined to a little over 3,000 mt in 1985 (preliminary data). From June until November, the landings by month show a generally declining trend (Figures 4 to 6). Landings during these months vary between about 1,200 and 2,400 mt. They vary considerably between months from one year to the next.

Within the study area, there is considerable variation in landings between fisheries districts. Districts 65, 66, and 67 in northeastern New Brunswick account for about 85% of the total groundfish landings in the study area. These landings are made at Caraquet, Lamèque, and Shippegan (see Figure 1). In the remaining districts, the landings vary considerably from month to month and between years, although the bulk of the landings tend to occur from June until September (see Appendix B). Despite this variability, the groundfish landings as a proportion of the eastern New Brunswick catch remain relatively constant.

In summary, groundfish landings can be described as highly concentrated around Caraquet, Lamèque, and Shippegan. The remaining catch is widely dispersed throughout the study area. A review of the plant capacity data also indicates that much of the processing of groundfish landed in other districts is carried out in the Caraquet-Shippegan area. Landings and processing are concentrated within a small geographic area which would tend to simplify waste management.

2.2 PELAGIC FISH

The second species group is termed pelagic fish. For the purposes of this report, it includes both marine and anadromous species. Within this group are herring, mackerel, gaspereau, eel, Atlantic salmon, smelt, and capelin. The landings for the two sectors of the Province for 1983 to 1985 are shown in Tables 1 and 2. The 1985 data are preliminary. More detailed data are presented in Appendix C. The pelagic fish landings compared with the total Atlantic Coast pelagic's catch for the study area, are shown in Table 3.

Pelagic fish represent a considerably greater percentage of the total catch than groundfish in southeastern New Brunswick, but are similar in the northeast. In the southeast, they have accounted for from 45 to 69% of the catch (Table 2) over the last three years as compared with 25 to 35% in the northeast (Table 1). However, the total landings of pelagic species in the northeast is usually 2 to 3 times greater than in the southeast. A comparison of the 1984 pelagic landings in each sector is shown in Figure 3.

The landings of pelagic species in eastern New Brunswick represent about 10% of the total for Atlantic Canada (Table 3). Herring is the dominant species representing about 78% of the total catch. About half the herring catch is utilized in the roe fishery. Of the remaining species, gaspereau and mackerel each represent 8 to 9% of the total landings, respectively.

The monthly landings shown in Figures 4 to 6 suggest a bimodal annual distribution. The distributions are associated with two herring

Table 1. Landings in northeastern New Brunswick by species group 1983-1985 and the percentage of the total study area landings.

Year	Groundfish (mt)	%	Pelagic fish (mt)	%	Shellfish (mt)	%	Total (mt)	%
1983	17,474.0	33	12,926.0	25	22,308.0	42	52,708.0	82
1984	13,947.2	29	13,312.7	26	22,702.2	45	49,962.1	78
1985[1]	15,681.1	29	19,109.4	35	19,526.6	36	54,317.1	86

Source: DFO Annual Landings Statistics.

Note: 1. Preliminary data.

Table 2. Landings in southeastern New Brunswick by species group 1983-1985 and the percentage of the total study area landings.

Year	Groundfish (mt)	%	Pelagic fish (mt)	%	Shellfish (mt)	%	Total (mt)	%
1983	1,603.0	14	5,202.0	45	4,808.0	41	11,613.0	18
1984	1,849.6	13	7,365.1	51	5,076.3	36	14,291.0	22
1985[1]	972.8	11	5,917.4	69	1,710.4	20	8,600.6	14

Source: DFO Annual Landings Statistics.

Note: 1. Preliminary data.

Table 3. Landings by species group in eastern New Brunswick (northeastern and southeastern New Brunswick combined) compared with the Atlantic Coast.

	1982			1983		
	Atlantic Coast (mt)	Eastern New Brunswick (mt)	(%)	Atlantic Coast (mt)	Eastern New Brunswick (mt)	%
Groundfish	820,327	19,433	2	766,131	19,235	3
Pelagic fish	207,150	20,222	10	200,292	20,878	10
Shellfish	170,155	30,149	18	142,016	26,991	19

Source: Canadian Fisheries, Annual Statistical Review, Canada Department of Fisheries and Oceans, 1983

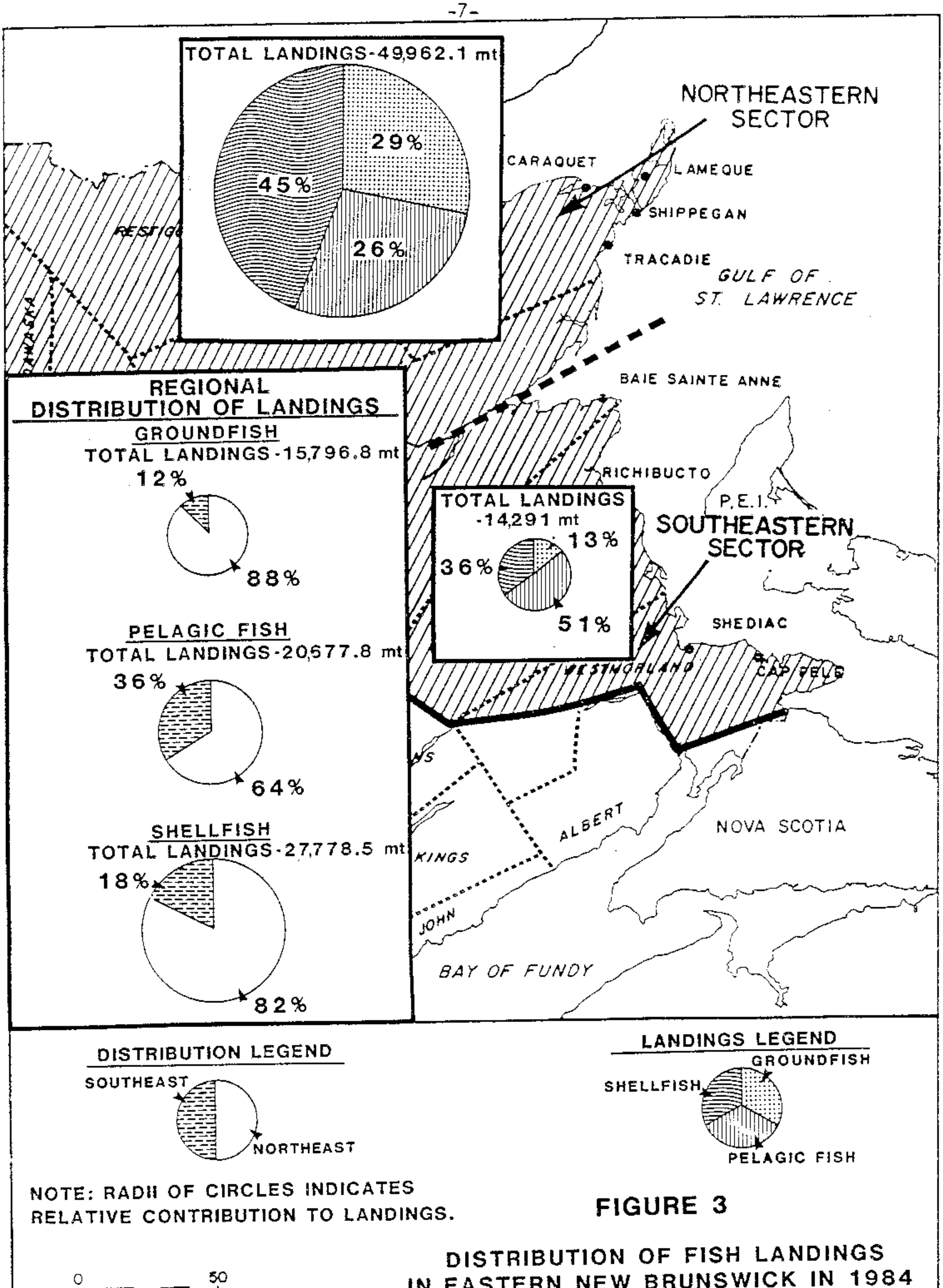


FIGURE 3

DISTRIBUTION OF FISH LANDINGS IN EASTERN NEW BRUNSWICK IN 1984

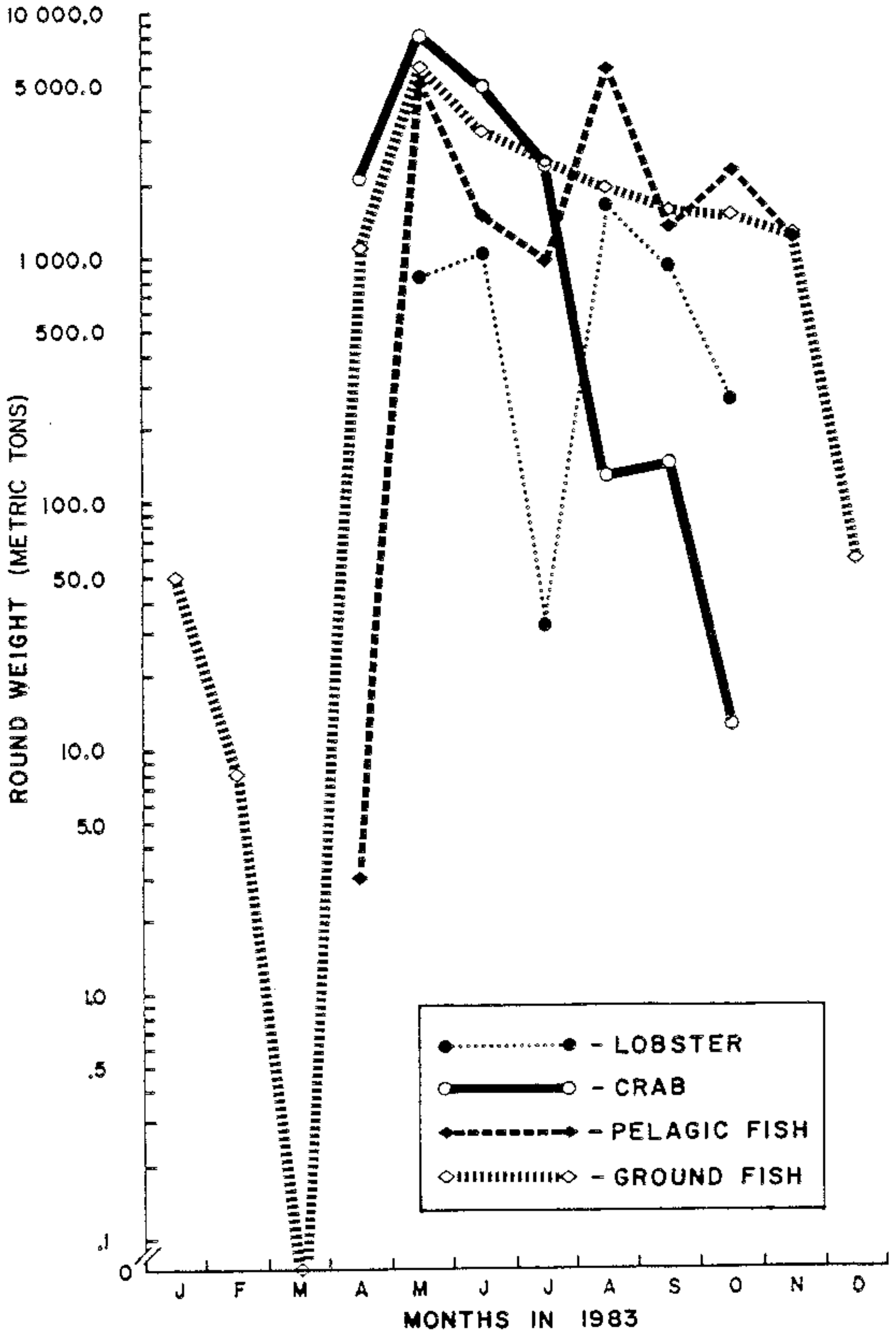


FIGURE 4

1983 LANDINGS BY SPECIES GROUP BY MONTH

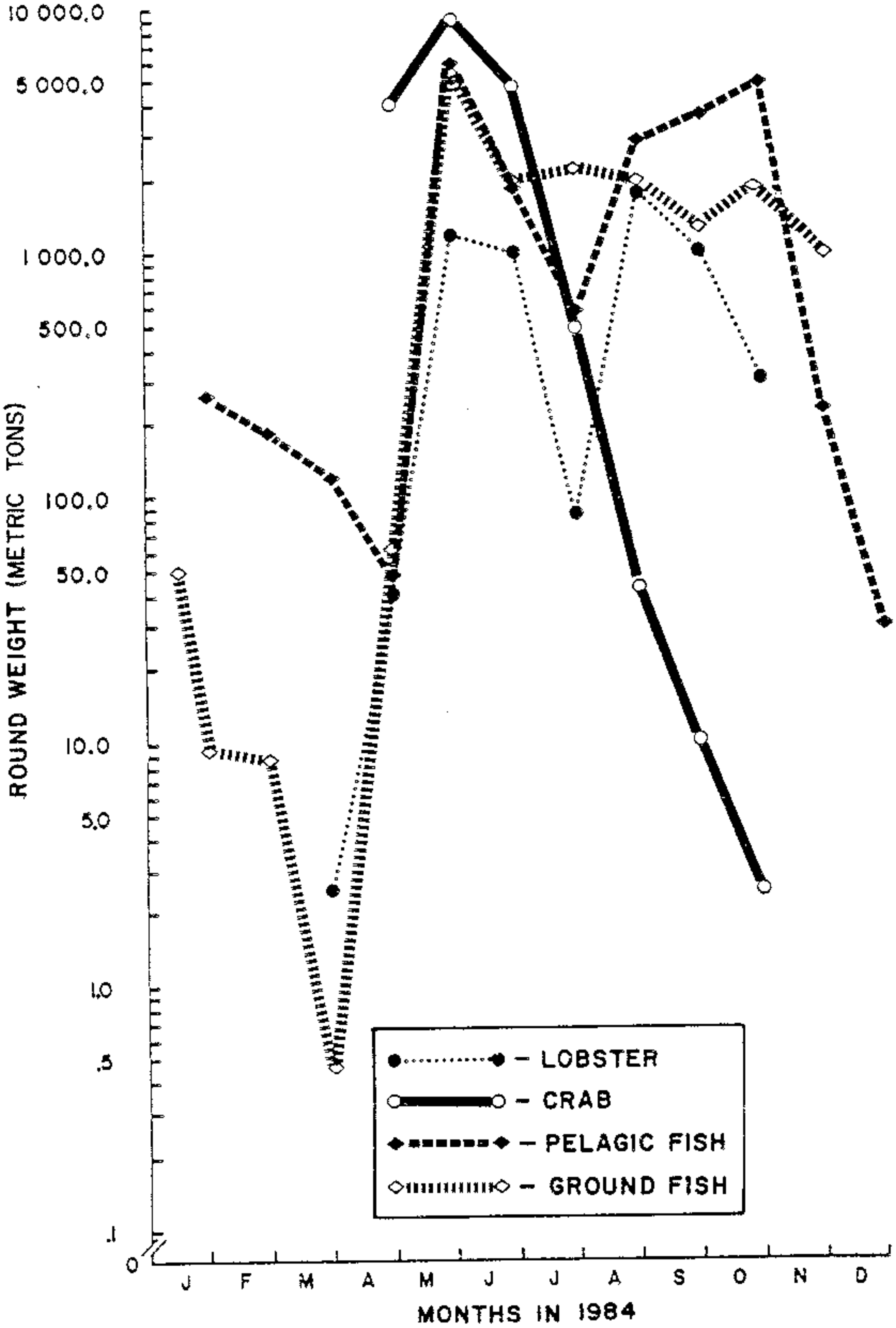


FIGURE 5

1984 LANDINGS BY SPECIES GROUP BY MONTH

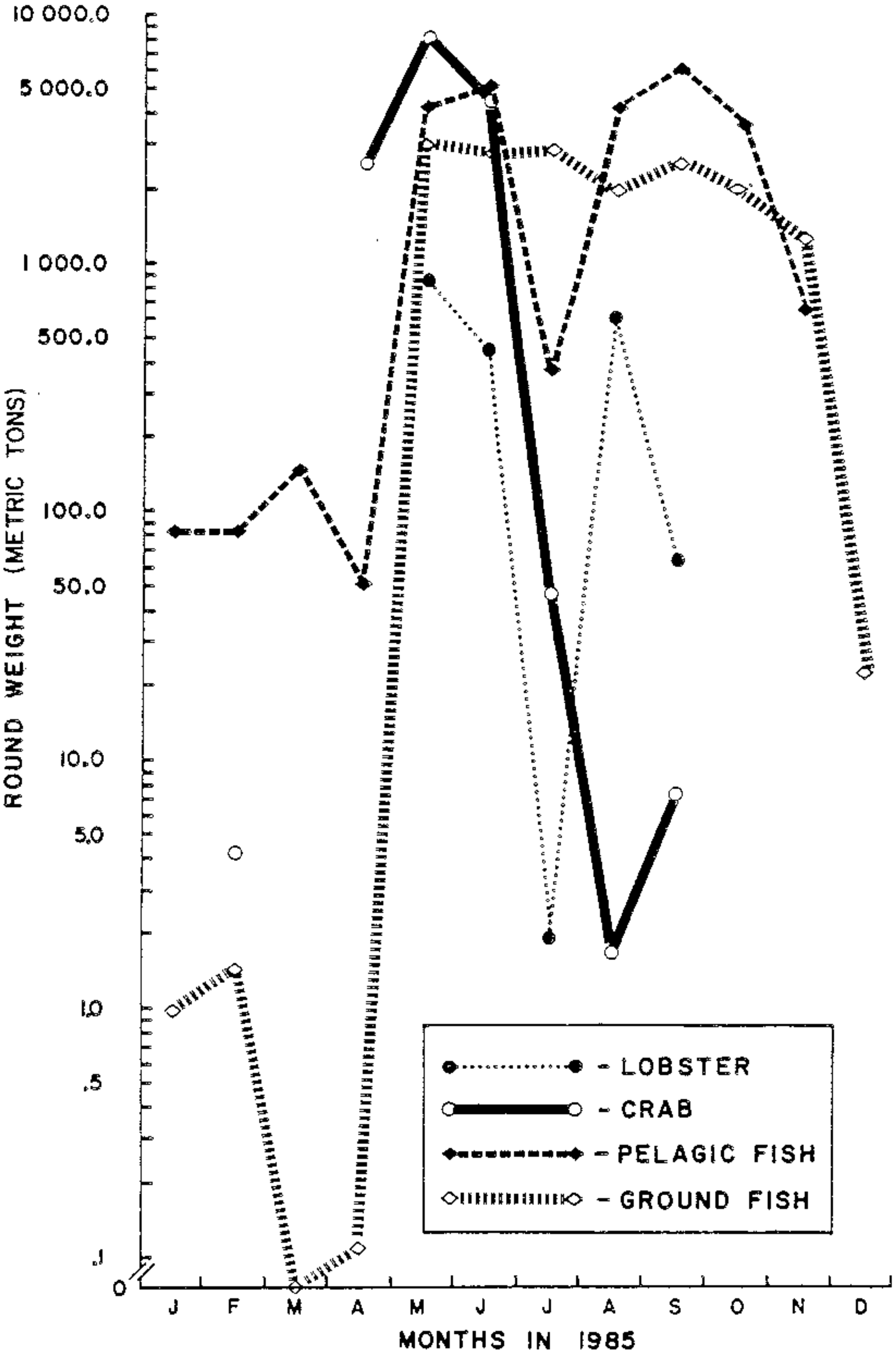


FIGURE 6

1985 LANDINGS BY SPECIES GROUP BY MONTH

fisheries. The first peak occurs in May or early June associated with the spring fishery while the second occurs in the August to October period associated with the autumn fishery. The principal landings in the spring herring fishery are recorded in Miramichi Bay and the Northumberland Strait. From 79 to 88% of the annual landings in southeastern New Brunswick occur during May. Beginning in July, the landings in northeastern New Brunswick become dominant. Over the last three years, between 55 and 70% of pelagic fish landings in the northeastern sector have been made in Districts 65, 66, and 67 - the Caraquet and Shippegan area (see Figure 1). District 65, alone has accounted for between 30 and 43% of the total annual pelagic fish landings in the study area. As shown in Appendix C, the landings in these districts tend to be concentrated but the timing of peak landings vary. For example, in 1984, 49% of the total pelagic landings in District 65 (Caraquet) occurred in October, while 41% of the total landings in District 66 (Lamèque) occurred in August. In other years, the landings have shown a more even distribution within the general bimodal annual pattern.

In the other fisheries districts, the monthly and annual pelagic landings are highly variable. This is particularly true in the late summer and autumn, and during the winter months.

The reasons for this variability are complex and reflect biological, regulatory and market influences. Nevertheless, the temporal and spatial variability within the study area is higher than for groundfish and would tend to indicate a more difficult waste management problem.

2.3 SHELLFISH

The third species group is shellfish and includes lobster, crab, shrimp, scallops, clams, and oysters. Lobster and crab are the dominant species in the group.

Landings statistics for this species group for the 1983 to 1985 (preliminary data) period in northeastern and southeastern New Brunswick are presented in Tables 1 and 2, respectively. Annual shellfish landings for the last 3 years are shown in Table 4. Monthly landings by district for lobster, crab, and other shellfish are shown separately in Appendix D. The lobster and crab data have been presented separately because the seasons are closely controlled and activity is intensive for 2 or 3 months each year. Other shellfish species have been grouped in Table 4 to indicate the relative proportions they represent of the total shellfish landings in each sector.

Shellfish tend to be the dominant component of the landings in northeastern New Brunswick. Over the last three years, shellfish have represented 36 to 45% of the catch. In southeastern New Brunswick, over the same period, the reported landings have varied between 20 and 41% of the total, although the 1985 lobster landing data are preliminary and are probably subject to adjustment. In 1984, landings in the southeast represented less than 20% of the shellfish catch in eastern New Brunswick (see Figure 3).

Total shellfish landings in the study area represent less than 20% of the total landings for the Atlantic Coast (Table 3). Queen crab landings in eastern New Brunswick, however, represent about 40% of the regional total, while lobster landings represent about 17% of the total Atlantic shellfish landings.

In eastern New Brunswick, crab landings representing about 65% of the total shellfish landings. Almost the entire catch (about 99%) is landed at Shippegan or Lamèque. Lobster landings are generally about 50% higher in southeastern New Brunswick than the northeastern sector (see Table 4). They are the dominant element of the shellfish landings in southeastern New Brunswick. The lobster landings shown in Table 4 indicate a decline in the 1985 catch in southeastern New Brunswick compared with 1984. These data were preliminary and Sirios (pers. comm.) has indicated that 1985 landings in fact exceeded the 1984 catch. Other shellfish landings in the study area include scallops, shrimp, and oysters in the northeast and scallops and clams in the southeast.

The seasonal distributions of catch shown in Figures 4 to 6 reveal the seasonality in the lobster and crab landings. The bimodality in the lobster catches reflects the fact that there are two fishing seasons in eastern New Brunswick - one in May and June, the other in August to early October. The crab landings are concentrated in April, May, and June with only insignificant landings from August until October. The raw landings data (Appendix D) reveal that lobster landings are relatively evenly distributed throughout the study area although the average landings are higher in the southeastern fisheries districts.

Landings of "other shellfish" are dominated by shrimp landings in Caraquet (District 65) (Figure 1) from May until October. They account for about 50% of the other shellfish catch in the study area. In the southeastern sector, scallop catches in May and June are responsible for the bulk of the landings.

In summary, the landings statistics reveal large seasonal variations in shellfish catches in eastern New Brunswick. The largest landings occur in May and June and are small from December until April. The patterns result from the seasons imposed on the lobster and, crab fisheries in the study area. From the point of view of this study these species are of prime concern because processing activities involving these species produce the majority of the shellfish wastes in eastern New Brunswick.

2.4 FISHERIES MANAGEMENT

The management of all commercial fish

Table 4. Shellfish landings in eastern New Brunswick 1983 - 1985.

Region	Lobster (mt)	Crab (mt)	Other (mt)
Northeast			
1983	1544.0	17525.0	3239.0
1984	1984.9	18150.3	2567.0
1985[1]	1015.6	16326.9	2184.7
Southeast			
1983	3196.0	237.0	1375.0
1984	3319.3	167.4	1589.6
1985[1]	977.2	157.3	575.3

Note: 1. 1981 landings data preliminary.

landings in eastern New Brunswick is the responsibility of the federal government. The fisheries are controlled by five mechanisms - quotas, seasons, area closures, fishing licenses, and specimen size limits (e.g. lobster carapace length). The landings of all the major species with the exception of clams are regulated.

Quotas for individual species are set annually. Seasons for fisheries can be specified (see Table 5) or they may be imposed at the discretion of the Minister. Areas may be specified as fully or partially closed to control the size of vessels or gear types used to exploit a stock, or protect a stock at a sensitive stage in its life cycle. Fishing licenses are used to control the number and size of vessels operating in specific fisheries, while specimen size limits are used to control the minimum size of organisms landed. Size control is particularly important in the lobster fishery.

All the groundfish activity, with the exception of the haddock fishery in Gulf waters adjacent to New Brunswick is controlled by annual quotas set for NAFO* divisions and subdivisions. These quotas are subdivided by gear type and can be adjusted depending on biological advice and management decisions. There are no seasonal closures.

French fleets, operating in the eastern Gulf and Cabot Strait area under treaty, have a groundfish quota. In 1985, it was set at 13,500 mt. These fisheries are, however, remote from eastern New Brunswick ports, and any reductions or reallocations of the foreign quotas are unlikely to result in increased groundfish landings in the study area.

Fisheries for pelagic species are controlled by seasons, quotas, and gear type. Herring, mackerel and tuna are controlled by quota and season. Capelin are controlled by annual quotas while the eel, gaspereau and shad fisheries are controlled by season. Seasons vary with location and gear type within eastern New Brunswick but general patterns are indicated in Table 5. The landings from fisheries controlled solely by season are relatively small and because of the processing methods used for these species, wastes volumes generated are small. Any changes in open seasons or implementation of alternative regulations would not significantly alter catch or affect waste volumes.

The herring fishery is controlled by two separate seasons and quotas: one covers the spring, while the second covers the fall fisheries. In 1984, total quotas for District 4T were used but these were subdivided into defined areas of the Gulf in 1985.

Manipulation of quotas or changes in policy towards the species has had a significant influence on this fishery in the past. In 1970, before changes were made in federal fisheries policy to discourage the practice of catching herring strictly for fish meal, landings in Districts 65, 66, and 67 alone exceeded 86,000 metric tons (Broderson, 1973). In 1983, the total landings for eastern New Brunswick were only 16,372 metric tons. The reduced catches have resulted in the closure of two meal plants in the Shippegan - Caraquet area.

Within the shellfish group, crab, shrimp, and scallops have generally been regulated by quota, although in 1986, a 10 week season was also imposed on the queen crab fishery. Lobster, and oysters, are controlled by season (see Table 5). Commercial mussel harvesting is banned except with special permits and local clam fisheries closures may be imposed for health reasons.

In addition to the regulations on the size and timing of landings, the fishery is controlled by limits imposed on licenses available for different fisheries. The fishing fleet is stable at present. Licenses have been frozen for the last four years and it is unlikely that fleet size, or the catching capacity in the various fisheries, will be allowed to drastically increase in the future.

2.5 PRESENT STATUS AND FUTURE TRENDS

This section summarizes the present status of the fisheries in eastern New Brunswick and contains a brief discussion of future trends. It has been included to indicate any possible changes in landings which may effect waste types and volumes in the future.

The eastern New Brunswick marine fisheries can be described as mature. Since 1983, total landings in eastern New Brunswick have ranged between 60 and 65,000 metric tons. Within the study area, the distribution of the landings has also remained relatively the same with about 80% of the totals occurring in northeastern New Brunswick, and the remainder in the southeast (Figure 3). Among the species groups, the landings also have remained fairly constant from year to year (see Tables 1 and 2).

There is little potential for significant increases in landings from existing fisheries because all available resources are exploited to their optimum yield. Some increases may arise as stocks rejuvenate but there are no significant underutilized species available which could cause landings to rise. It would not appear that reallocation of existing foreign fleet quotas would support increased activity by vessels based in eastern New Brunswick.

Increases in landings may occur if mussel, oyster or salmonid aquaculture are aggressively pursued in the study area. Eastern New Brunswick is not a favourable site for sea-reared salmonids because lethal winter temperatures are consistently encountered in the waters of the Gulf of St. Lawrence. Cultured mussel or oyster production could be increased. Both these species are, however, shipped live and any wastes associated with these operations would be small.

In considering future trends in the

* Northwest Atlantic Fisheries Organization (NAFO)

Table 5. Closed seasons for commercial fisheries in eastern New Brunswick in effect in 1985.

	Closed Season	Comments
Pelagic fish		
Mackerel	Jan. 1 - May 31	Closed to mobile gear
Striped Bass	None	Net fishing banned
Eels	Dec. 1 - July 31	Tabusintac River
	Sept. 1 - Nov. 15	Tidal estuaries
Gaspereau	July 1 - May 14	
Salmon	None	Commercial fishery closed
Shad	June 21 - May 14	
Smelt	mid-Oct. - mid-March	Slight variation in dates with different gear type
Shellfish		
Mussels	None	Special permits required
Oysters	Sept. 1 - April 30	General limits (specific limits in effect at other locations)
	Oct. 1 - Nov. 30	Richibucto area
	Oct. 1 - April 1	Caraquet area
Lobster	May 1 - June 30	Northeastern New Brunswick north of Miramichi Bay
	Aug. 10 - Oct. 10	Southeastern New Brunswick south of Miramichi Bay
Shrimp	Jan. 1 - March 31	

Source: DFO Schedule II - Closed Seasons.

Note: Snow Crab, Herring and Tuna fisheries have seasons with starting dates which vary with location and from year to year. These fisheries are also controlled by quota.

eastern New Brunswick fisheries, it is apparent that sizes of available fish stocks will determine the landings. There are unlikely to be any regulatory changes that would cause a significant increase in the total landings in the fishery. Policy changes could, however, significantly reduce the landings as was evident in the mid-1970s when the herring fishery was changed from a meal to a food fishery. Given these probable trends, it is not expected that waste types and volumes would change substantially unless market forces dictated a major change.

Some reduction in shellfish wastes may be experienced if the present trend from crab meat to crab sections and clusters continues (Michaud, pers. comm.). A lower demand for herring roe in the Japanese market may lead to smaller volumes of waste associated with this fishery. However, given the diverse nature of the fish processing industry in eastern New Brunswick, waste volumes should not change substantially in the future. Quantities of waste types may fluctuate, but the present amounts would appear to be good estimates of maxima to use in assessing the overall fish waste management situation in the region at present, and in the foreseeable future.

3.0 CURRENT WASTE DISPOSAL PRACTICES

Fish processors in eastern New Brunswick produce a variety of fish products from the various finfish and shellfish species landed in the region. Processing leads to fresh and pickled fish wastes that must be discarded either by dumping or processing into a useable by-product.

In 1984 there were 117 registered processors and fish dealers operating in eastern New Brunswick. Their distribution within the region is shown in Figure 7. Of these, 13 facilities deal in oysters or live lobsters and have no appreciable waste. No data for six plants were available from the DFO plant capacity statistics, but these are small facilities and are thought to deal mainly in fresh and live seafoods, again resulting in little appreciable waste. This leaves 98 fish processing facilities from which wastes are produced.

With the exception of landed fish which have been deemed unfit for processing into human food and condemned, there are no specific data on fish wastes by volume or type available from eastern New Brunswick. To obtain an estimate of current waste volumes and information about waste management practices in the study area, two sources of information were used. The primary source was the plant capacity statistics available from the Economics Branch, DFO, Gulf Region. The second source was anecdotal information obtained from the Inspection Branch of DFO, Gulf Region as well as plant operators and personnel associated with the New Brunswick Department of Municipal Affairs and Environment.

To estimate the types and volumes of fish waste, the 1984 plant production or 1985 capacity figures available from the Plant Capacity Statistics were converted into waste volumes using the conversion factors shown in Table 6. These factors represent the fraction of the original round weight of an organism used in the finished product. The remainder of the organism is waste. They were derived from the literature (Waterman, 1979) and Mr. John Merritt (pers. comm.). These represent what are considered to be reasonable averages of utilization of different species groups upon which to estimate waste volumes. The calculated volumes, however, are subject to several sources of error.

1. Material discarded prior to processing including any mortalities among live shellfish after landing could not be determined.

2. Variations in processing practices with fresh fish at different plants may lead to variations in the amount of waste for a similar product.

3. Groundfish offal dumped at sea prior to landing cannot be determined.

4. Seasonal changes in the condition of finfish and shellfish may lead to smaller or larger proportions of waste.

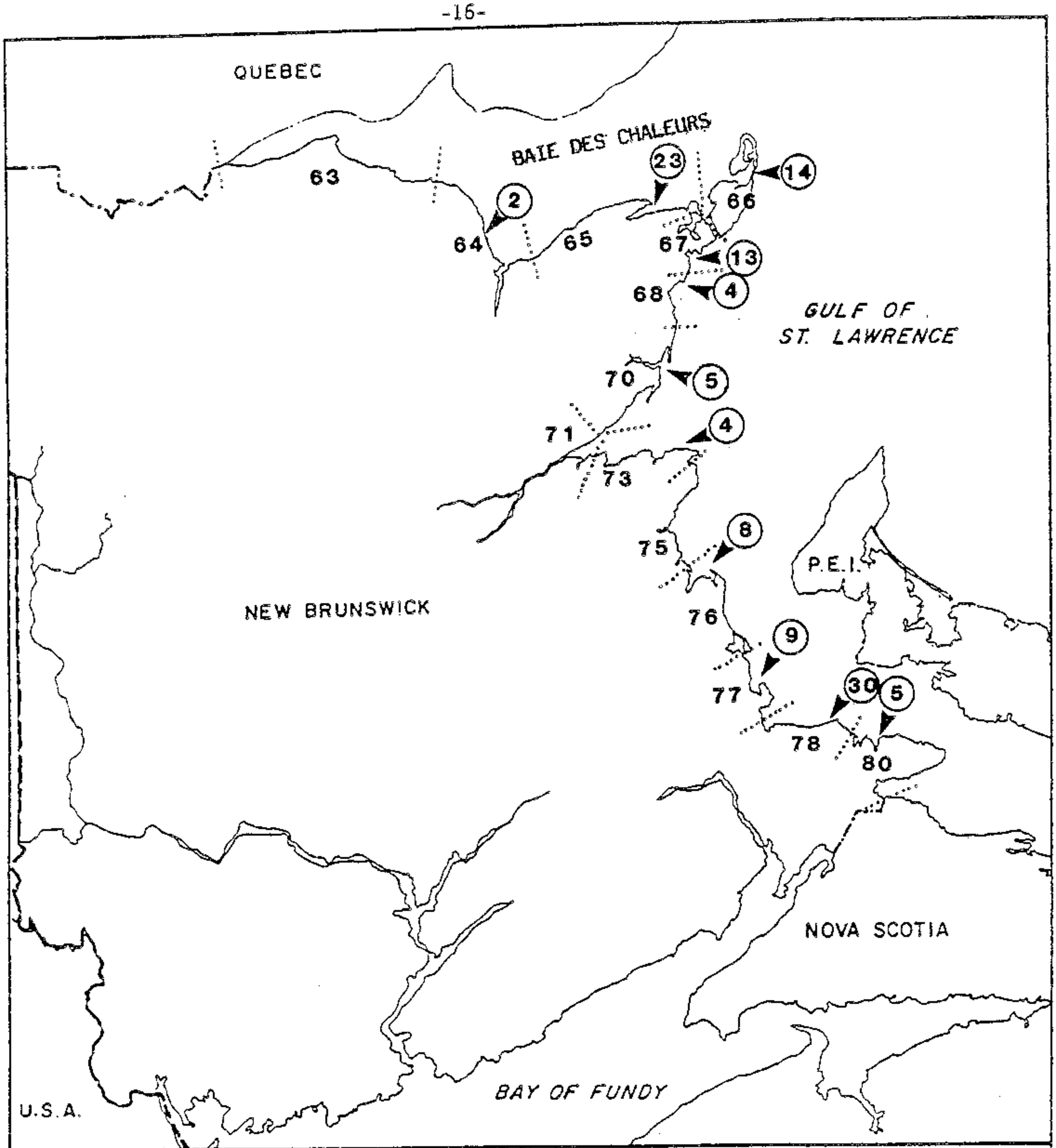
5. At 13 facilities, more than one method of waste disposal was identified i.e. landfilling versus processing. This resulted in having to allocate how each waste was handled. Based on local practices, in most cases it was apparent how this allocation could be made but in others, it was not, and the allocation was arbitrary.

6. Inaccuracies in plant record keeping may result in underestimates of wastes generated.

Specific facilities could not be identified in the plant capacity data as supplied by Fisheries and Oceans because of proprietary rights. Therefore, it was not possible to eliminate some of these sources of error.

As a result, the figures presented in the following subsections can be considered representative of the waste volumes and types in eastern New Brunswick, but care should be taken in their use. This is considered acceptable because the waste types and volumes will fluctuate in the future depending upon quotas, landings, and market conditions for the various species exploited in the fishery.

In the following sections the fish waste figures generated from the individual plant capacity and production data are presented by fisheries district. These figures have been further grouped to show waste characteristics in northeastern and southeastern New Brunswick separately.



LEGEND:

80 NUMBER AND BOUNDARY OF FISHERY STATISTICAL DISTRICT

(3) NUMBER OF FISH PROCESSING PLANTS PRODUCING WASTES BY DISTRICT

0 50
SCALE (km)

FIGURE 7

LOCATION OF FISHERIES DISTRICTS AND PROCESSING PLANTS

Table 6. Proportion of round weight utilized in fish processing.

Groundfish	Dressed (with head)	0.82
	Dressed	0.63
	Filleted (skin removed)	0.42
	Salted	0.60
Pelagic fish	Pickled	0.95
	Smoked	0.95
	Filleted (fresh smoked)	0.53
	Roe	0.06
Shellfish	Lobster	0.43
	Crab - meat	0.32
	- sections	0.50
	Shrimp	0.35
	Clams/mussels	0.15
	Oyster	0.14
	Scallop	0.12
Meal	Groundfish offal	0.21
	Pelagic fish	0.21
	Shellfish offal	0.35
Oil[1]	Pelagic fish	0.12

Note: 1. Highly variable with season.

Source: Waterman, 1979.
MacLaren Atlantic Limited, 1979.

3.1 WASTE VOLUMES AND TYPES

The estimated fish waste by species group and by volume, from fisheries districts in northeastern and southeastern New Brunswick are shown in Tables 7 and 8, respectively. The calculated waste volumes in northeastern New Brunswick are about twice as large as those in the southeastern sector. The total calculated waste volume for both sectors is about 33,000 mt or about 51% of the total landings in 1984. The estimated fish waste production by sector and species group in 1984 is shown in Figure 8.

These volumes represent 41% of the landings in the northeastern sector and about 83% in southeastern New Brunswick. The percentage volumes for southeastern New Brunswick are higher because plants in this region import large amounts of crab and lobster for processing.

In northeastern New Brunswick, an estimated 21,500 mt of fish waste are generated annually. About 85% of this material comes from districts 65 and 67. Groundfish account for 23% of the waste, pelagic fish 36%, and shellfish 41% (Figure 8). In southeastern New Brunswick, about 11,700 mt of fish waste is generated annually (Table 8). Of this total, 68% is shellfish waste, 27% is from pelagic species, and only 5% comes from groundfish (Figure 8). In calculating the waste volumes, it is uncertain exactly how much of the herring taken in the roe fishing is actually sent to waste, and how much is sent to other processors for bait, marinating, or smoking.

The calculation of waste from herring roe production is based on figures from the plant capacity statistics and is shown in Table 9. Waste is assumed to be the difference between the raw herring required for the amount of roe produced and other herring products produced by one plant. The excess herring must be transported to other processors, or discarded. The calculations suggest that there is a significant variation in secondary production of herring products associated with the roe fishery. Calculations shown in Table 9 suggest that the in-plant percentage of secondary utilization varies widely. This variation is apparently related mainly to lobster bait requirements.

In northeastern New Brunswick, the most significant amounts of waste in each species category are produced in districts 65 and 67 (Figure 7). With the exception of pelagic fish wastes generated in District 70 (Figure 7), the remaining districts in this sector produce wastes of less than 520 mt within each group. Total wastes generated in each of these districts is estimated to be less than 1,000 mt annually.

Based on D.F.O. 1985 preliminary landings statistics for northeastern New Brunswick, groundfish discarded at the wharf comprised less than 1% of the total landings, while 3% of the pelagic species landings were judged to be unfit for human consumption.

Waste volumes as a percentage of landings are significantly higher in southeastern New Brunswick. In 1984, wastes comprised in excess of 80% of the total landings. This anomaly arises for two reasons:

1. A significant amount of crab, lobster and herring is imported from northeastern New Brunswick, Nova Scotia, and Prince Edward Island, for processing in District 78 (Figure 7).

2. A substantial clam processing industry in District 77 (Figure 7) results in the generation of a disproportionately large volume of waste, relative to the product produced.

Two districts, 77 and 78, account for over 80% of the wastes generated in the southeastern sector. Groundfish wastes account for about 5%, pelagic fish about 27% and shellfish about 68% of the wastes (see Figure 8). In southeastern New Brunswick, a much smaller proportion of herring taken in the roe fishery is apparently utilized for secondary products (Table 9). If, as indicated in Table 9, herring identified as surplus to a processor's needs are not discarded but are in fact used by other processors, the pelagic fish waste is reduced by over 50%, and shellfish wastes reach in excess of 75% of the sector total. Michaud (pers. comm.) indicated that a few of the roe producers in District 73 (Figure 7) are now selling some or all of the fish carcasses for bloater (hard smoked herring) production, so the waste volumes may have been significantly reduced since 1984.

Bloater production waste management has been a continuing concern to provincial environment officials (Richard, pers. comm.) since 1980. Bloater production in 1984 is shown in Table 10. Using 5% wastage for round bloaters and 47% for filleted fish, the total estimated waste volume is about 800 mt (see Table 10). The 5% figure has been adopted based on the results of the Co-Fish Consultants (1984) report which indicated that a wastage figure of 10% (MacLaren, 1979) would appear to be exaggerated.

Most bloater wastes are associated with filleting operations. In 1984, it has been estimated that approximately 75% of the wastes arise from this source despite the fact that only 18% of total production is devoted to fillets.

Table 11 shows the number of processors producing wastes of each type in each fisheries district in eastern New Brunswick. Analysis of the plant capacity statistics reveal that 35 processors produce groundfish wastes, 80 produce pelagic fish wastes, and 45 produce shellfish wastes. About one-half of the processors produce more than one type of waste. The volume of wastes generated by producers show a wide variation within and between districts for all species groups. Median waste volumes have

Table 7. Annual average estimated waste volumes by species group from producers in northeastern New Brunswick.

District	Groundfish (mt)	Pelagic fish (mt)	Shellfish (mt)	By District Total (mt)	By District Percent
64	493	5	429	927	4
65	2,865	4,248 (1,089)[1]	2,808	9,945	46
66	339	84	518	941	4
67	1,131	2,241 (1,781)[1]	4,992	8,364	39
68	260	87	86	434	2
70	6	853	37	896	4
By Group Total	4,888	7,723 (2,870)[1]	8,870	21,507	
Percent	23	36	41		

Figures based on DFO Plant Capacity Statistics from 1984 and 1985 (preliminary).

Note: 1. Estimated waste from herring roe production in Districts 65 and 67.

2. District totals include fish landed which were judged to be unfit for human consumption.

Table 8. Estimated annual average waste volumes by species group from producers in southeastern New Brunswick.

District	Groundfish (mt)	Pelagic fish (mt)	Shellfish (mt)	By district Total (mt)	%
73	66	1,552 (1,542)[1]	5	1,623	14
76	143	60	658	861	7
77	67	502	4,452	5,021	43
78	345	969	2,872	4,186	36
80	-	29	-	29	1
By Group					
Total	621	3,112	7,987	11,720	
Percent	5	27	68		

Figures based on DFO Plant Capacity Statistics from 1984 and 1985 (preliminary).

Note: 1. Estimated waste from herring roe production in District 73.

Table 9. Estimated annual herring roe production in eastern New Brunswick.

	District	Production Roe (mt)	Milt (mt)	Total (mt)	Herring required for production (mt)	In-plant utilization for other products[2] (mt)	%	Non-utilization Amount (mt)	%
Northeastern Sector	65	133.6	16.8	151.1	2518.3	1429.0	57	1089.3	43
	67	68.0	56.7	124.7	2082.5	301.4	14	1781.1	86
Southeastern Sector	73	98.4	-	98.4	1640.2	108.0	7	1532.2	93
	78	5.8	12.1	17.9	300.4	415.1		-	-

Figures generated from DFO Plant Capacity Statistics from 1984 and 1985 (preliminary).

Notes: 1. Based on a roe to round weight ratio of 0.06.

2. Amount of utilization of herring for other products, including bait, in the same facility.

Table 10. Estimated annual bloater production and estimated bloater waste volumes in eastern New Brunswick.

Fisheries District	Round Production (mt)	Round Waste (mt)	Filleted Production (mt)	Filleted Waste (mt)	Total Waste (mt)
65	45	2	-	-	2
76	-	-	525	467	467
77	66	3	30	27	30
78	3,341	167	108	96	262
80	334	17	15	13	30
	3,786	189	678	603	791

Figures generated from DFO Plant Capacity Statistics from 1984 and 1985 (preliminary).

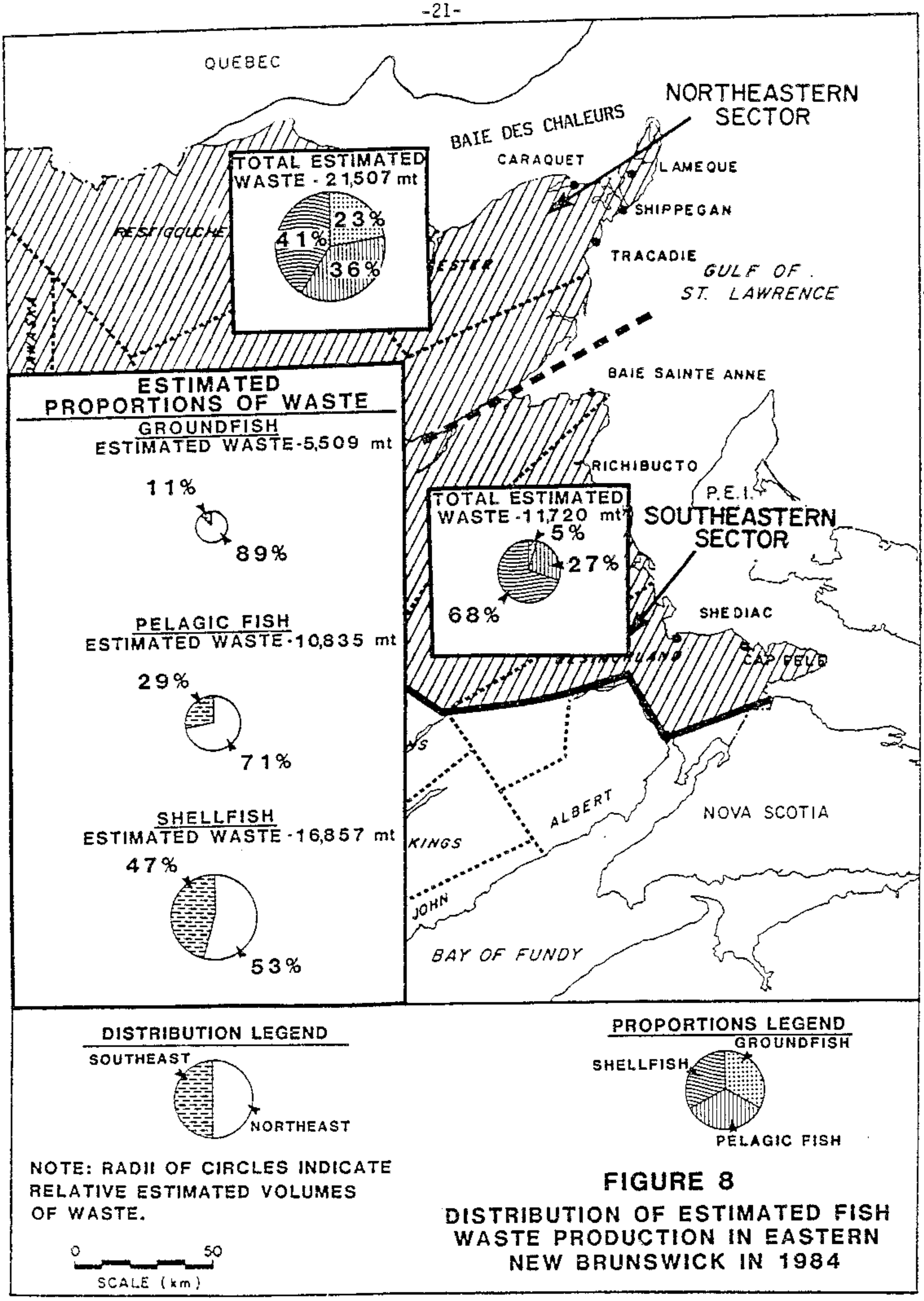


FIGURE 8

DISTRIBUTION OF ESTIMATED FISH WASTE PRODUCTION IN EASTERN NEW BRUNSWICK IN 1984

Table 11. Numbers of producers of fish waste by species group and estimate of waste volumes generated in fisheries districts in eastern New Brunswick.

District	Groundfish			Pelagic fish			Shellfish		
	No.	Range (mt)	Median (mt)	No.	Range (mt)	Median (mt)	No.	Range (mt)	Median (mt)
64	2	73 - 268	-	2	15 - 268	-	2	68 - 376	-
65	8	3 - 860	183	17	0 - 927	170	9	3 - 683	277
66	6	1 - 170	31	3	1 - 80.7	2	6	0 - 517	0
67	4	23 - 657	223	5	20 - 263	96	7	0 - 1,687	633
68	3	6 - 227	27	3	15 - 52	20	2	0 - 86	-
70	2	1 - 5	-	3	9 - 817	27	3	8 - 15	14
73	3	1 - 56	9	3	2 - 5	3	2	0 - 8.6	-
76	3	10 - 77	74	5	2 - 482	7	6	2 - 850	41
77	3	7 - 51	9	5	3 - 39	13	5	2 - 1,934	389
78	1	345	-	22	0 - 302	17	7	182 - 831	382
80	-	-	-	5	1 - 20	3	-	-	-
TOTAL	35	1 - 860		73	0 - 927		49	0 - 1,934	

Figures based on DFO Plant Capacity Statistics from 1984 and 1985 (preliminary data).

been used to show at which end of the scale the bulk of producer wastes occur in each group within each district. This indicates whether the wastes are produced by a number of smaller operators or by just a few larger ones. For example, in District 66, six shellfish processors produce 517 mt of waste but almost all of it is produced by one processor.

The figures in Table 11 reveal the number of processors and diversity of sizes of facilities producing fish wastes in eastern New Brunswick. They provide some appreciation of the complexity of the fish waste management issue in the study area.

3.2 DISPOSAL PRACTICES

Fish waste disposal practices in eastern New Brunswick have been determined from information available in the plant capacity statistics, and anecdotal sources. Table 12 shows the number of producers using different disposal methods for different types of wastes in each fisheries district. Distances travelled to dispose of the wastes are also indicated. Table 12, however, does not show any wastes disposed of by fishermen before landing or transportation to a processing facility (i.e. heading and gutting at sea, illegal dumping at wharves).

Anecdotal reports about methods used by individual processors were reported by Daneault (pers. comm.) and Sirois (pers. comm.). This information (see Table 13) cannot be directly compared with the Plant Capacity Statistics because the numbers of plants identified are not identical. However, this information has been invaluable in determining any geographic trends in disposal methods which might be of assistance in planning future disposal strategies.

Each of the disposal methods used in the study area are described below.

3.2.1 Landfill

Landfill is a collective term used to describe fish wastes which are dumped in municipal or private dumpsites, or are spread on farmers' fields or abandoned agricultural land.

Land-based disposal of fish waste is practiced in every fisheries district in eastern New Brunswick where processors are located. The data indicate that 52 or about half the processors, landfill all or part of their wastes (Table 12). As shown in Table 13, land disposal is much more prevalent among the processors in southeastern New Brunswick. In three districts, 64, 76, and 77 (Figure 7), all processors landfill their wastes. The volumes in these districts ranged from about 900 to about 5,000 metric tons. Of the 5,000 metric tons discarded, in District 77, over 80% of the wastes are mollusc shells.

In the remaining districts, the percentage of wastes landfilled range from 3 to 41%. Although the relative percentages landfilled in Districts 65 and 67 are lower, the volumes 3,528 mt and 1,850 mt, respectively, are high and represent about 40% of the total waste landfilled in the study area.

Hauling distances for land-based disposal of wastes reached 50 km in some cases, but distances beyond 20 km from plant to disposal site are the exception.

In eastern New Brunswick, solid fish wastes are currently dumped:

- At designated municipal or provincial government dumps;
- At private dumpsites;
- On agricultural land;
- Over the wharf.

Municipal or Department of Transportation dumps used by fish processors are described in Table 14. The five sites were identified based on the information supplied by G. Sirois (pers. comm.) and L. Daneault (pers. comm.). One is located in northeastern New Brunswick, while four are located in the southeastern area. A total of 23 processors dump at these facilities.

These designated dumping facilities are not closely monitored by the operators and they have been the cause of odour and vermin problems in the past. In 1985, a processor located in District 64 came under considerable pressure from provincial authorities. The company was discarding fish wastes, first at a municipal dump, and later in a rock quarry designated as a dump site, in an unacceptable manner. Odour and aesthetic considerations forced the operator to cease dumping at the municipal facility. Problems with uncontrolled dumping in the rock quarry continued until the operator went out of business.

A longer standing problem which still remains only partially solved is the disposal of shellfish and bloater wastes at a former dump site operated by the Department of Transportation at St. André in District 78. In the late 1970's, odour and aesthetic considerations caused considerable public protest and an investigation was launched in 1979 to evaluate the problem. A report (MacLaren, 1979) considered a number of alternative solutions and recommended that:

- A processing facility be established in the immediate area for shellfish waste; and
- A chilled temporary storage facility be established to hold finfish wastes until they could be economically transported to processing facilities in the north.

Ultimately, the St. André dump was closed and a facility to process shellfish wastes was established at Botsford Portage.

Table 12. Disposal methods and volumes of fish wastes in fisheries districts in eastern New Brunswick, by numbers of producers.

District	Landfill				Fish Reduction				Total Waste (mt)	Sea No.	Bait No.
	No.	Distance (km)	Volume (mt)	Percent	No.	Distance	Volume	Percent			
64	2	1.5	927	100	–	–	–	–	927	–	–
65	6	0 – 5	3,585	37	15	1 – 25	6,279	63	9,864	1	5
66	3	1 – 35	399	41	6	1 – 10	561	59	941	–	1
67	5	1 – 50	1,850	21	9	0.5 – 3.0	6,514	79	8,364	–	3
68	1	10	52	12	3	22 – 60	382	88	434	–	1
70	4	1 – 7	79	9	1	70	817	91	896	–	–
73	4	3 – 7	85	5	2	75 – 100	1,542	95	1,627	–	2
76	8	5 – 25	861	100	–	–	–	–	861	–	–
77	9	2 – 8	5,021	100	–	–	–	–	5,021	–	–
78	9	5 – 35	722	17	21	5 – 20	3,464	83	4,186	–	20
80	1	0	1	3	3	5	28	97	29	–	4
TOTAL	52		13,537	41	60		19,587	59	33,124	1	36

Figures based on DFO Plant Capacity Statistics from 1984 and 1985 (preliminary data).

Table 13. Waste disposal practices at fish processing facilities producing wastes in eastern New Brunswick.

DISTRICT	WASTE TYPES	DISPOSAL METHOD			
			Land Filled		
		Processing	Public	Private	Other
64	Groundfish		1		
	Pelagic fish		1		
	Shellfish		1		
65	Groundfish	4	2	1	
	Pelagic fish	9	6	1	
	Shellfish	5	5	1	
	Shrimp	1			Dumped at sea
66	Groundfish	4			
	Pelagic fish	2			
	Shellfish	1			
67	Groundfish	4			
	Pelagic fish	4		4	Bait
	Shellfish	7			
68	Groundfish	2		1	
	Pelagic fish	2		1	
	Shellfish	2		1	
70	Groundfish	1		3	
	Pelagic fish	1		2	
	Shellfish	1		4	
73	Groundfish		3		
	Pelagic fish		4		
	Shellfish		1		1
76	Groundfish		7		
	Pelagic fish		5		
	Shellfish		3	2	
77	Groundfish		1		
	Pelagic fish		1		
78	Groundfish		3	2	
	Pelagic fish	4	3	24	
	Shellfish	6	1		
80	Pelagic fish			2	
	Shellfish	1			

Source: G. Sirois, pers. comm.
L. Daneault, pers. comm.

Table 14. Public dumpsites currently used for fish waste disposal in eastern New Brunswick.

District	Users	Location
65	5	St. Leolin
73	3	Between Baie Ste. Anne and Pointe Sapin
76	7	St. Ignace
77	7	Buctouche
	1	Cocagne

Source: G. Sirois - pers. comm.
L. Daneault - pers. comm.

An entirely satisfactory solution to the bloater waste problem has never been achieved despite considerable effort on the part of the province (Richard, pers. comm.). At present, most of the bloater waste is accepted at a common disposal site for a fee and is spread over abandoned agricultural land, but some producers refuse to pay the fee and dump at private sites elsewhere (Richard, pers. comm.).

The locations and actual numbers of private dumps used for fish waste disposal in eastern New Brunswick are not known. According to Sirois and Daneault (pers. comm.) approximately 18 private dumps are used in the study area including the privately operated common disposal site at Botsford Portage. Permits are not required to dump fish wastes.

In northeastern New Brunswick, significant volumes of shellfish wastes, particularly from producers in District 65, are dumped on private land, buried and left to rot. The problem appears to be related to cost. D'Entremont (pers. comm.) suggested that the cost of processing ($66/mt) was a factor contributing to the shellfish waste disposal problem. These costs led to the plant at Lamèque processing about 300 to 350 mt of shellfish wastes in 1985 to ease the waste problem and selling the product, essentially to cover the costs of handling and processing the waste material.

In northeastern New Brunswick dumping herring waste on farmers' fields has been a long standing practice. Herring makes excellent fertilizer provided the application rate is kept to a reasonable level. At present, the main difficulty is that piles of fish as much as 1 m deep are left in the fields. This practice makes it difficult to properly plough in the carcasses to prevent major odour problems and vermin attraction (Daneault, pers. comm.).

Landfilling of fish wastes is wide-spread in eastern New Brunswick at present. Approximately 40% of the fish processing wastes are land disposed, divided almost equally between dump sites and private land. The volumes of wastes discarded by processors varies from about 1 to over 1,900 metric tons per year. The most concentrated land-based disposal of wastes is around Caraquet and Shippegan.

Landfilled fish waste has caused a number of local problems in the past. Currently, landfilling shellfish wastes in the northeast and bloater wastes in the southeast are the major concerns in the study area. Proper disposal of herring on agricultural land is not a serious environmental or social concern, but it seems that a more beneficial use could be made of this resource.

3.2.2 Dumping at Sea

Dumping fish waste at sea is not legally practiced by land-based processors in the study area although localized dumping by some processors may occur.

Wastes routinely, and legally, dumped at sea include shrimp waste, scallop shells, and viscera, and some groundfish offal. Between 75 and 90 metric tons of shrimp wastes are discarded at sea as a result of on-board processing by a vessel operating out of Caraquet. These wastes are discarded in the central and northern Gulf, and off Cape Breton where the shrimp fishery is concentrated. Based on 1984 scallop landings of 1,049 mt it is estimated that about 920 mt of shell and viscera were discarded in the southern Gulf of St. Lawrence but the disposal locations are not known. The locations and volumes of groundfish offal disposal in the waters off eastern New Brunswick are not known.

Kresta (pers. comm.) has indicated that some processors have expressed an interest in ocean dumping fish wastes but to date none has occurred on a routine basis. No requests for ocean dumping of fish wastes have been received (McIver, pers. comm.).

The Fish Habitat Division of the Gulf Region DFO, has indicated a concern about ocean dumping of fish waste. In a 1985 memorandum, Mr. P. LeBlanc identified a procedure for consideration of such applications should they be received in the future.

Undoubtedly, there is some illicit disposal of wastes off public or private wharves by individual fishermen during gutting and filleting activities, before sale to buyers. The extent of this practice cannot be accurately determined. Although the volume of material dumped in this manner at any one location would be relatively small, it can cause localized aesthetic and water quality problems.

3.2.3 Processing

Currently, there are 60 processors in eastern New Brunswick transporting fish wastes to fish reduction facilities for processing into meal and oil (Table 12). In districts where processing plants are close, the percentage of wastes processed ranges from 59 to 97% of the total waste volume. Material is transported as much as 100 km for processing but the median is about 20 km. Operators in Districts 70, and 73 (Figure 7) travel the greatest distance to dispose of their wastes. About 65% of wastes sent to fish reduction facilities in the study area are generated in Districts 65 and 67 (Figure 7).

A greater percentage of the wastes produced in northeastern New Brunswick go to fish reduction plants than in the southeastern section. None of the processors in Districts 76 or 77 (Figure 7) send their waste for processing. This reflects not only the concentration of the industry in the northeast, but also the smaller scale of the processing operations in the southeast. Trucking wastes to a processor can be expensive particularly when a charge per metric ton is also levied to handle the material.

Currently, four companies are processing fish wastes in eastern New Brunswick. One in each of Districts 65, 67, 68 and 78 (Figure 7).

The plants operate from April until November. Their capacities to produce meal and oil, and their product types are shown in Table 15. The produced capacities of the plants vary from 13.6 to 40.9 mt/day for meal and 3.4 to 9.1 mt/day for oil. Two plants process groundfish waste, three process pelagic fish waste, and three process shellfish wastes. It is important to note that the fish meal plant in Caraquet does not have the facilities to handle crab waste. The production from these facilities from 1982 to 1985 are shown in Table 16.

These data show that the greatest volume of fish meal are produced from pelagic fish. Shellfish meal production increased substantially in 1984 and approached pelagic fish meal production. This was in part, a result of the District 78 shellfish waste processing facility coming into production that year. Groundfish waste meal volumes have remained below 1,000 mt since 1982. Production figures for individual products in 1985 are not available but total production figures (Table 16) show a substantial increase over previous years. There is no apparent reason for this increase and discussions with operators did provide a clear answer.

The following is a brief description of the basic features of the waste processing facilities at each plant based on telephone conversations with the plant operators.

1. Plant #1

This plant manufactures meal from lobster and crab. No oil is produced. The plant employs an indirect steam-heated dryer and can process 3 mt of raw material per hour. Usually the raw material is held for less than 24 hours; but occasionally it is held for up to 48 hours. A condenser is not used and, according to the owner, provided the raw material is fresh, there is no odour problem. Some offensive odour will arise in hot weather when raw material has to be stored over weekends.

The plant was constructed in the early 1980's but the equipment is old. The owner pointed out that the steam-heated dryer is in good condition.

2. Plant #2

This plant manufactures meal from crab waste as well as from groundfish and some herring wastes. One production line is used with a capacity of 10 mt/hour of raw material. There is a second line in the plant but it has not been used for seven years.

The plant was built in 1966 and has a direct-fired dryer with sea water condensers to remove odour and dust. The normal maximum holding period for raw material is 36 hours on weekends but raw material is usually processed within 24 hours. Blood liquor from raw material and stickwater are retained and processed.

3. Plant #3

This plant manufactures meal and oil from herring wastes. Some material produced originates in the province of Quebec. There are two 500 mt bins for storage of raw material.

The plant has one production line. It has a capacity of about 15 mt/hr of raw material and is reported to be in good condition. It dates from 1965 and the dryer is direct-fired. Sea water condensers are used but there is an odour problem. There has also been difficulty with disposal of stickwater and bloodwater, and repairs are now being made to the evaporator in order to reduce the pollution problem.

4. Plant #4

This plant produces fish meal from crab waste, herring waste and from groundfish offal generated from its own operations. The normal maximum period of storage of raw material is two days.

The plant can process 10 mt/hr of raw material. The equipment includes a Rotadisc dryer and stickwater evaporator. In the past there has been some problems associated with disposal of liquid effluent, including blood liquor.

The plant does not possess a hammer mill for processing shellfish waste. The Rotadisc dryer produces a very fine meal which limits its value for sale as a feed additive to the poultry industry.

3.3 GOVERNMENT REGULATION

Regulation of fish waste disposal falls under both federal and provincial jurisdiction. The general areas of responsibility and pertinent legislation and regulations are identified below.

3.3.1 Federal

With respect to fish waste disposal the federal government has four direct areas of responsibility under the provisions of the Fisheries Act. Under the Fish Inspection Regulations, inspection personnel can declare landed fish as offal prior to processing, if they are deemed unfit for human consumption. These fish must either be dumped at an approved site, or sent to a reduction facility for processing into meal.

The second covers the disposal of substances that are deleterious to fish in marine or fresh waters which is in contravention of Section 33 of the Fisheries Act. This section of the Act is administered by the Environmental Protection Service of Environment Canada.

The Environmental Protection Service

Table 15. Capacity to produce fish meal/fish oil in eastern New Brunswick by district.

District	Production Capacity		Type				
	Meal (mt/day)	Oil (mt/day)	Groundfish meal	Groundfish oil	Pelagic meal	Pelagic oil	Shellfish meal
65	40.9	3.4			x	x	
66	16.3	4.4	x		x	x	x
67	33.5	9.1	x	x	x	x	x
78	13.6	-					x

Source: DFO Plant Capacity Statistics.

Table 16. Meal and oil production in eastern New Brunswick.

	1982 (mt)	1983 (mt)	1984 (mt)	1985 (mt)
Groundfish	530	931	673	N/A
Pelagic fish	1,769	1,794	2,143	N/A
Shellfish	1,036	794	1,934	N/A
Total Meal	4,060	3,519	4,747	12,548
Oil	884	834	1,064	1,525

Source: DFO Plant Capacity Statistics.

(1975) have issued "Fish Processing Operations, Liquid Effluent Guidelines" under which the biochemical oxygen demand (BOD) and solids levels in effluents considered acceptable by the federal government are identified. The guidelines recommend screening all outfalls with a 25 mesh (0.71 mm) screen to trap solids. They also specify that bloodwater, press liquor and stickwater should not be discharged into the receiving water and that provision should be made for managing these wastes in the event of a plant shutdown.

Thirdly, under Section 31 of the Fisheries Act, action can be taken by the Department of Fisheries and Oceans where offal disposal may be shown to have altered, disrupted, or destroyed fish habitat.

Finally, under Section 43 of the Fisheries Act, DFO is impowered to designate gurry grounds; that is, a marine area remote from a fish plant where offal can be routinely discarded.

Marine disposal of fish waste is also covered under the Ocean Dumping Control Act, administered by the Environmental Protection Service. Under the Act, permits are required to dispose of solid wastes in an approved manner in the marine environment. Applications for ocean dumping of fish wastes have not been received in eastern New Brunswick although Lindsay (pers. comm.) and Kresta (pers. comm.) have indicated that it has been given some consideration in the past. If applications are received, McIver and Tay (pers. comm.) indicated they would be reviewed on a case by case basis. If the amounts to be dumped were small (about 500 mt), the local federal fisheries officer could designate a "gurry ground", pursuant to Section 43, but if the volumes were substantial, the Environmental Protection Service would review any application for marine disposal in conjunction with the Department of Fisheries and Oceans.

In deciding on the merits of an application, considerations would include:

- Potential impacts on larval fish and demersal fish eggs, e.g. herring spawning areas;

- Conflicts with fixed or mobile fishing gear;

- Potential contamination of adjacent beaches;

- Potential generation of anoxic sediments; and

- Possible bacterial contamination of adjacent shellfish beds.

If a disposal permit was issued under the Ocean Dumping Control Act, it would be for a maximum of one year and specify the location of the disposal site, the frequency of dumping permitted, the timing, the amount and the method of dumping. To date, no permits have been issued.

3.3.2 Provincial

The federal government does not have any direct responsibility for land-based fish waste disposal. Land disposal in eastern New Brunswick is the responsibility of the New Brunswick Department of Municipal Affairs and Environment.

Provincial authorities operate under three Acts as follows:

- The Clean Environment Act;

- The Provincial Water Act; and

- The Air Quality Act.

Under the provisions of these acts, operators failing to conform with regulatory requirements can have their licenses revoked.

To date, most of the attention of provincial environment officials has been focused on disposal of solid wastes in landfills. Under the Solid Waste Guidelines of the Clean Environment Act, specifications for approved landfills include the following:

- Provision of a clay base below the waste;

- The site be removed from domestic or municipal water supplies;

- The disposal area be remote from roads and houses to avoid aesthetic and odour problems.

Richard (pers. comm.) indicated that the waste is placed in a layer up to 1 m deep and has a soil cover of at least 0.3 m. The waste must be covered rapidly to avoid attracting vermin.

3.4 ENVIRONMENTAL AND SOCIAL EFFECTS

Problems with gaseous emissions, and the management of solid and liquid wastes, have been a general concern in different areas of eastern New Brunswick since the late 1960's. Much of this has been focused on the operation of fish reduction facilities, but more recently attention has also turned toward the wider problem of fish waste disposal at locations other than processing plants. The effects associated with both areas are described below.

3.4.1 Disposal

Disposal of fish waste on agricultural or vacant land has been a long standing practice in eastern New Brunswick. Traditionally, lobster and herring carcasses have been used to fertilize fields. If application rates were kept at reasonable levels, around 7 mt of herring per hectare per year, few problems were encountered, provided that the material was ploughed under.

This method became less attractive with the advent of chemical fertilizers, and the reduction in the amount of agricultural land in production adjacent to fish processing facilities.

The practice of discarding these wastes in private or public dumpsites became more prevalent as waste volumes increased. Concentration of the wastes led to local environmental problems, such as odour, fouling of adjacent watercourses, attraction of vermin, and general aesthetic degradation. An additional concern has been losses of fish offal and blood liquor from vehicles transporting the fish on public roads from processing plants to dump sites.

Documentation of all the recent problems associated with fish waste disposal in eastern New Brunswick is widely held but not easily accessible. However, a review of relevant reports and interviews with regulatory personnel have highlighted the following disposal situations where concerns have been identified:

- Uncontrolled disposal of fish wastes at a municipal dumpsite and a quarry at Petit Rocher;
- Disposal of shellfish wastes at a private dumpsite inland from Caraquet;
- Disposal of shellfish wastes at public and private dumps in Westmorland County; and
- Uncontrolled disposal of wastes from bloater operations in Westmorland County.

The common elements of these situations have been poor or essentially no management of waste disposal resulting in significant odour problems, attraction of vermin leading to public health concerns, and major aesthetic problems. Groundwater contamination problems, or significant fouling of watercourses have not been identified but are a potential concern.

In northeastern New Brunswick, the processing operation at Petit Rocher is now closed so the waste problems are no longer a concern. Crab waste disposal at dumpsites near Caraquet continues to be a problem but is one that is in part related to cost. Because shellfish wastes have relatively low value as a by-product (about $150/mt) the processor capable of handling shellfish waste in the region has been charging about $60/mt to process the material. Many of the primary processors are unwilling to pay this charge, and have opted for land-based disposal.

In southeastern New Brunswick, the shellfish and bloater wastes in Westmorland Country are now handled by one facility. The shellfish wastes are processed into meal and bloater wastes are spread on fallow agricultural land. Sludges from brine tanks are buried.

Operation of this facility has solved the problems experienced in the past (MacLaren, 1979; Richard, pers. comm.) but, as mentioned earlier, some processors refuse to pay the fees levied by the processor, and dump on private land or at public landfill sites. These include several bloater operators in Bas Cap Pélé and one shellfish processor. Despite the lack of full participation, fish waste disposal in Westmorland County is considerably better than in the past. Richard and Michaud (pers. comm.) indicate that it is only a matter of time before all the processors in this area will be using the designated processing and disposal facility.

The only difficulty foreseen is if the price for shellfish meal falls and processing becomes uneconomical. The processor could then no longer afford to process the waste without charging excessive user fees.

3.4.2 Processing

Fish waste processing in eastern New Brunswick is confined to the production of fish meal, shellfish meal, and fish oil. Some material is set aside for animal feeds by two processors in northeastern New Brunswick. This is unprocessed raw waste. It represents less than 2% of the volume of material used in fish meal - fish oil production. As shown in Table 12, a substantial number of processors set aside salt herring for lobster bait, but bait is not considered a fish by-product. Most of the herring processed for food products are marinated or smoked. Only 5 to 10% of the herring processed for food goes to waste. It is not suitable for lobster bait.

Fish meal and oil production, while solving one set of environmental and social problems associated with raw waste disposal, can produce others. These problems can be grouped into three categories:

- Blood liquor, and offal, being spilled during transportation from processor to the fish reduction facility;
- Odour arising from the fish reduction plant, particularly from those equipped with direct dryers; and
- Liquid wastes, principally blood liquor, stickwater, and press liquor from the plants which carry a high biochemical oxygen demand (BOD_5) and elevated levels of suspended solids.

Many of these problems still exist in the Caraquet-Shippegan-Lamèque area.

A major health consideration constantly present with fish meal production is the threat of <u>Salmonella</u> infection. The Inspection Division has a program to test samples of fish meal to insure the absence of <u>Salmonella</u>.

Each of the issues associated with waste processing in eastern New Brunswick is discussed briefly below.

1. Waste Transport

Traditionally, finfish and shellfish wastes have been transported to reduction facilities in open trucks improperly fitted to contain the contents. Blood liquor and some offal has escaped and created a nuisance for passing motorists and local residents. This problem is easily solved with good material management practices. Daneault (pers. comm.) indicated that many of the processors now use large plastic boxes for holdings wastes while the largest plants convey material directly to properly fitted trucks. If the material is moved quickly to the reduction facility, odour is not a problem, but if it is left for more than 24 hours in warm weather, an objectionable smell may develop.

2. Odour

Odour arises in fish reduction plants from three areas:

- Meal dryers fitted with or without scrubbers;
- Raw product; and
- Building ventilation.

The dryers are the greatest source of odour and plants have fitted scrubbers to deal with the problem. Direct-fired dryers where the product is exposed directly to gases of combustion, produce more odour than indirect steam or Rotadisc dryers where the fish does not come into contact with the heat source. The reduction plants in Bas-Caraquet and Shippegan are fitted with direct-fired dryers and odour has been a problem. Finn (pers. comm.) reported that the fish reduction plant in Shippegan generally operates at night to reduce the public complaints about odour in the town. The plant in Lamèque has a steam heated Rotadisc dryer and odour is not reported to be a concern. The facility in southeastern New Brunswick has a steam heated indirect dryer but is not fitted with a condenser. Odour is generally not a concern if the material to be processed is fresh (LeBlanc, pers. comm.).

Many methods for odour abatement in fish meal facilities have been proposed, including the use of ozone, activated charcoal filters, various chemical absorbers and plain and catalytic incinerators. Good housekeeping practices, combined with the use of incineration and sodium hypochlorite absorbers, can reduce odour to a manageable level.

Proper incineration of air completely eliminates fish meal odours. It is very costly to incinerate large quantities of air produced by direct-fired dryers to eliminate odour but it can be used to treat air from indirect dryers. Sodium hypochlorite can more economically treat larger volumes of air with lower concentrations of odorous substance, but use of absorbers does not completely eliminate odour.

Odour management systems are costly to install and operate. The depressed fish meal prices experienced in the recent past combined with increased costs of production and excessive capacity in the industry (DFO, 1985) has left operators with little incentive to upgrade their facilities. If faced with regulatory pressure to reduce odours, operators may choose to close their facility unless there is a considerable financial incentive to install the necessary equipment.

3. Liquid Wastes

Liquid wastes associated with finfish waste reduction are shown in Table 17. These values were derived from data collected at plants in Shippegan, Caraquet and Lamèque (Broderson, 1973). Liquid wastes are not a concern in shellfish waste reduction.

The data reveal that the levels of contaminants (BOD, suspended solids) are very high in blood liquor from offal storage, and separator sludge, stickwater, and solubles from the process. With pelagic fish waste, oil is an additional problem.

Information collected by Canadian Plant and Process Engineering (1970) revealed that many of the harbour contamination problems experienced at Shippegan and Caraquet were associated with blood liquor and stickwater disposal, and poor in-plant housekeeping practices. The liquid effluent guidelines introduced by the Environmental Protection Service in 1975 addressed these concerns and Richard (pers. comm.) indicated that these are used by Provincial officials in the assessment of identified contamination problems.

All three plants processing finfish wastes treat stickwater although difficulties with the evaporator at Caraquet have resulted in continuing contamination problems. Blood liquor disposal is also a concern at Lamèque.

In general, the liquid effluent contaminates tend to be confined to areas where limited circulation prevents adequate flushing and waste loadings are excessive. The liquid wastes are biodegradable, but odour, oil on the water surface, and solids present can be a considerable nuisance to residents who use adjacent areas for recreation or other purposes.

4.0 METHODS OF WASTE UTILIZATION

Before describing alternative methods of waste utilization, the characteristics of the waste available for processing in eastern New Brunswick are described.

4.1 WASTE CHARACTERISTICS

The waste available for processing can be classified into two basic groups - finfish waste

Table 17. Waste streams and characteristics for a typical finfish reduction plant.

Waste Stream	Average Concentrations		
	BOD_5 (mg/l)	Suspended Solids (mg/l)	Oil %
Pumpout Water	33,500	7,955	0.05
Blood Liquor	245,000	11,805	0.27
Separator Sludge	280,000	13,500	0.22
Stickwater	198,700	15,500	0.03
Solubles	184,250	41,163	0.13
Evaporator Condenser Water	1,132	58	0.01
Deodorizer Water	875	126	0

Source: Broderson, 1973.

and shellfish waste. Finfish waste consists of groundfish offal, and round fish or offal from pelagic species. The wastes include fins, tails, heads and guts. The composition of these wastes in their raw form and finished as meal are shown in Table 18.

The factors used to convert raw material volumes to finished product volumes are shown in Table 7. The finfish waste to meal ratio is about 5:1 while the shellfish (crab and lobster) ratios are about 2.9:1. The remainder is removed as water or suspended solids.

4.2 PROCESSING ALTERNATIVES

4.2.1 Fish Meal

Currently, finfish and shellfish waste processing in eastern New Brunswick is confined to the manufacture of meal and oil. The meal is used mainly for animal feeds while the oil is used in edible oils and oils for industrial applications. Generally, this is considered to be the best way to deal with fish processing wastes. However, problems associated with fish meal production may affect its long term viability. Competition from vegetable meals and oils has led to depressed meal and oil prices. Concerns about the environmental and social effects of reduction plant operations may make new meal plants expensive to build and operate. It may also be difficult to obtain public approval for the location of a reduction facility close to inhabited areas.

There are also particular processing difficulties with two of the waste types in eastern New Brunswick. These are the large proportion of shell and lack of protein in shellfish waste, and the high concentration of salt in bloater waste.

A typical flow diagram for fish meal production is shown in Figure 9. The numbers show production figures for a pelagic fish such as herring, but the general steps also apply to the production of meal from groundfish. Meal production involves four basic steps, with several intermediate activities to recover solids from the press liquor and stickwater. In some plants, however, stickwater is discarded resulting in significant waste loadings in receiving waters. Stickwater discharge and odours from the drying operation referred to previously are the principal sources of environmental problems associated with finfish reduction plants.

A simplified diagram for shellfish meal production is shown in Figure 10. The principal difference between finfish and shellfish waste processing is that cooking shellfish waste is optional and the amount of water removed from shellfish is substantially smaller.

In recent years, the market prices for fish meal and oil have remained low and fairly steady while the cost of production has risen. Thus, whereas the fish meal manufacturer would have paid about $40/mt for raw material ten years ago, primary fish processors now have to pay to have their wastes processed.

The price of fish meal is determined largely by the market price for soya meal which dominates the market for animal feeds. It is difficult to predict future trends in prices but recently there have been signs that the price of soya will rise. Therefore there are some grounds for suggesting that fish meal manufacture will become more profitable. This is discussed more fully in Section 5.

The outlook is somewhat brighter for fish oils. While there have been ample supplies of other competing oils, fish oils are now receiving increased attention because of their advantages in health and nutrition. Indications are that this emphasis on 'health' will increase the market for fish oils, not only edible oils for direct consumption by humans but also 'feed quality' oils for animal nutrition, notably for poultry. One particularly important area is in feed formulation for farmed trout and salmon. These fish have an absolute requirement for good quality fish oils in their diet.

Finfish meal is considered to be most valuable as a feed for farm animals because of the high protein content. It is about 95% digestible. Groundfish meal contains 63-65% protein, while herring meal contains 69-73%. Meal also contains phosphorous, calcium, manganese, iodine, Vitamin B_{12}, riboflavin, and niacin. Meal is not generally used as a fertilizer.

Shellfish waste is relatively low in protein and high in calcium. Meal made from shellfish is used to feed poultry but is roughly one-half the price of regular fish meal. As a fertilizer, it is only of value where lime is needed (Laughlin et al., 1973).

Bloater waste contains about 15 percent salt on a wet weight basis. This makes it unattractive as a raw material for fish meal manufacture and as a fertilizer. A substantial amount of salt in bloater or other salt fish waste could be removed by a simple water wash (Hotton and Merritt, 1985). There could be logistical problems collecting and transporting the waste, and the wash water would become contaminated by fat from the waste.

4.2.2 Fish Silage

Fish waste can be converted readily to fish silage, or liquid fish protein, by acidifying the material and allowing naturally present enzymes to decompose it (Windsor and Barlow, 1981). Formic or sulphuric acid are usually used to acidify the material. The process is simple and production costs are low, especially when silage is made from non-oily fish, eliminating the need for oil separation. The finished product is up to 15% protein but is heavy and therefore costly to transport. With fatty fish, oil separation, and the production of high quality oil, is a problem.

Table 18. Waste composition (typical values).

Component	Shellfish		Finfish			
	Raw	Processed[1]	Raw		Processed[1]	
	%	%	Groundfish %	Pelagic[2] %	Groundfish %	Pelagic %
Protein	12	27	13	15	66	71
Oil	1	2	3	12	4	8
Chitin	7	16			–	–
$CaCO_3$ and Other Minerals	20	46	4	3	21	12
Water	60	9	80	70	9	9

Source: Merritt, pers. comm.

Notes: 1. Processed as fish meal.
2. Values for raw material can vary with season.

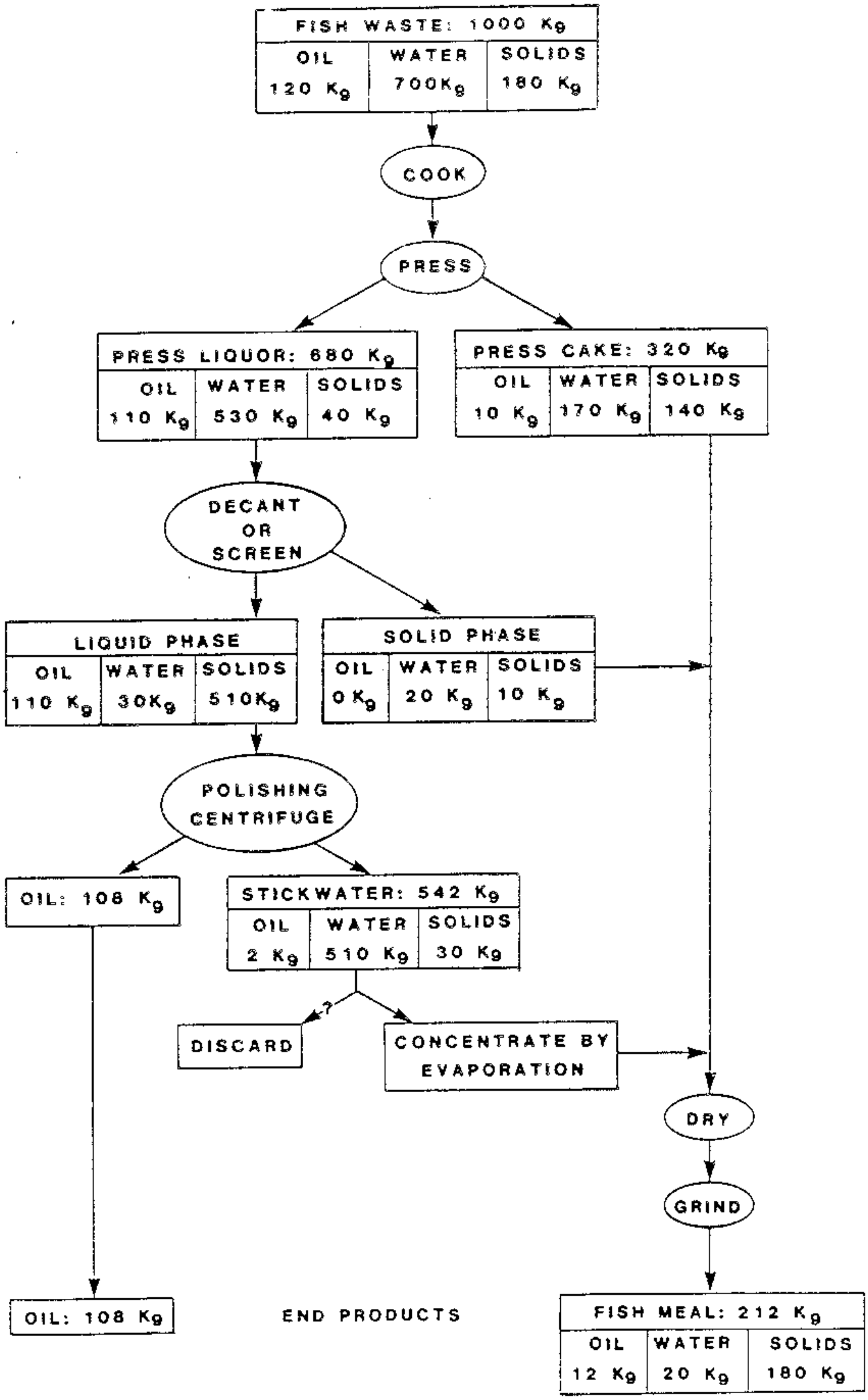
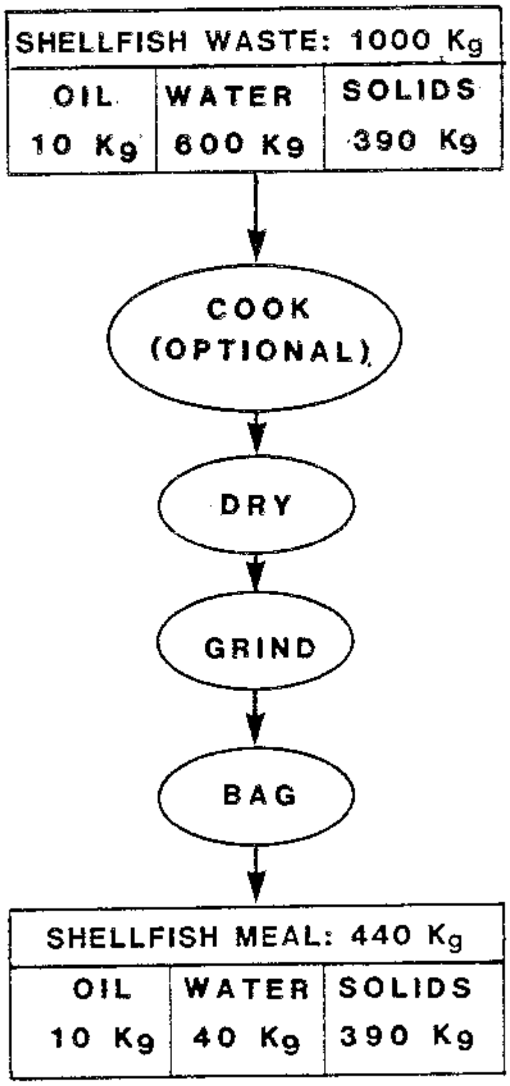


FIGURE 9

TYPICAL FISH MEAL PRODUCTION FLOW DIAGRAM

Modified from Windsor and Barlow, 1981



Source: Merritt , pers. comm.

FIGURE 10

SHELLFISH MEAL PRODUCTION FLOW DIAGRAM

Fish silage has been used satisfactorily on a commercial basis, notably in Denmark and Poland, as a liquid feed for hogs. Acceptability as a feed for other animals has been low. Silage is most likely to be successful where lean fish waste is available near hog farms, so that processing and transport costs can be kept to a minimum.

The production of silage from fish waste is carried out under conditions amenable to producing undesirable free fatty acids, resulting in the loss of whatever quality characteristics the oil in the waste had originally. A free fatty acid content above 3% (measured as oleic acid) makes any oil produced suitable only as an industrial oil similar to oil from cod.

Fatty fish produce a superior quality oil since most of the free acids are derived from the flesh phospholipids. The leaner the fish, the higher the free fatty acids. If peroxide values are not too high (less than 50 mg/kg) and free fatty acids are 3% or less, the oil could probably be used as an ingredient in animal feeds. Otherwise it could be added to cod oil for export, or burned for the energy content which is close to that of distillate heating fuels.

Fish silage can also be made by the addition of lactic acid bacteria. Since fish is rich in protein and lipids but low in sugars available for fermentation by bacteria, carbohydrate is needed to allow fermentation. The lactic acid produced decreases the pH and thus renders the medium unsuitable for the growth of most other microorganisms. Removal of oil is practically impossible, but, its presence in this form of silage seems to be more acceptable in animal rations than in silage produced using formic or sulphuric acid.

Preservation of fish waste by lactic acid fermentation on trawlers has been proposed but there has been little application of the method at sea or on shore.

4.2.3 Fish Protein Hydrolysate

Fish protein hydrolysate is made by heating fish waste to 45 to 60°C to kill bacteria and then hydrolysing it by means of added enzymes (Windsor and Barlow, 1981). After 2-3 hours, the temperature of the mixture is increased to 100°C to inactivate the enzymes. The material produced has more soluable fractions than fish silage.

Spray-dried hydrolysate, a concentrate of high solubility, has been produced commercially in France, since 1968. It was marketed as a milk replacer for the feeding of calves and other farm animals. According to recent (unsubstantiated) reports, production has ceased. It may be because there is a large surplus of milk and milk powder due to the milk subsidy within the European economic community.

There has been some interest in the production of hydrolysate in other countries including the United States and the United Kingdom.

4.2.4 Fish Protein Concentrate

Fish protein concentrate (FPC) is any stable fish preparation intended for human consumption, in which the protein is more concentrated than in the original fish. By international agreement, the finished product is greater than 75% protein.

The Food and Agriculture Organization of the United Nations (FAO) defines three types of FPC:

Type A: a virtually odourless and tasteless powder having a maximum total fat content of 0.75 percent.

Type B: a powder having no specific limits as to odour and flavour, but definitely having a fishy flavour and a maximum fat content of 3 percent.

Type C: normal fish meal produced under satisfactory hygenic conditions.

There are other protein concentrates which are made by hydrolysing fish protein using enzymes or other chemicals and then concentrating the product. An example of hydrolysed protein is fish sauce, popular in some Asian countries.

Fish meal is a cheap FPC but it is not normally intended for human consumption. It is usually produced under conditions that are not sufficiently hygienic and may include some rancid fat. Some fish meal for human consumption has been produced by the Norwegian fish meal industry.

The manufacture of FPC involves removal of most of the water and some or all of the fat from the waste. The waste is ground and chemical solvents (ethanol, etc.) are used to extract the water, fat and other components. Distillation or centrifuging is used to recover the solvent and produce the dry solid. Although FPC Types A and B have been made at pilot scale facilities in a number of countries, it has not been produced in commercially significant quantities. The process is too complex and the product not sufficiently economical to make production of FPC attractive.

4.2.5 Surimi

Surimi is a protein recovered after minced fish flesh is washed in fresh water and pressed to remove most of the soluble protein. The fish used may be fresh or frozen. The by-product contains about 80% of the original flesh and is used in the manufacture of kamanboko and similar products which are essentially protein gels. The protein gels are then reformed and additives included to produce other materials such as artificial crab and scallops, and fish sausage which have become increasingly evident in the North American consumer market over the last five years.

The process was originally developed by the Japanese. Conventional surimi production involves the use of freshly caught groundfish in order to obtain high quality material. Freezing and thawing raw material can degrade the quality of surimi produced.

Surimi produced from groundfish waste has an undesirable colour, because of the blood present. If fish waste is used, it must be very fresh. Production of surimi from pelagic species with a high oil content is not feasible at present, but research is continuing at the Canadian Institute of Fisheries Technology in Halifax. The oil interferes with the gelling process and the dark muscle present produces an undesirable colour.

Tavel Limited (1984) concluded that surimi production does not appear attractive for Atlantic Canada at present because of high costs of production, and low prices.

4.3 OTHER USES

A number of additional uses for fish by-products have been identified. The market for specialty by-products is small and, because of economic factors, appears to have diminished in recent years.

4.3.1 Aquaculture Feeds

Salmonids are being farmed on a large scale in Norway and Scotland. Development work is continuing in Atlantic Canada. Once the industry becomes firmly established, it is likely to expand. Aquaculture production is expected to expand rapidly over the next ten years. A major cost of production, estimated at 50 percent, is feed. According to recent developments in Norway, a good feeding system can be based on mixtures of fish meal and silage. The meal and silage, both stable and easily stored in silos and readily mixed with the necessary binder, vitamins, etc., can be supplied automatically to the fish enclosures.

The feed required for salmonid production is at least 5 metric tons per metric ton of salmon produced (wet weight); accordingly, 20,000 to 30,000 mt of feed per year could be required to meet the feed requirements for forecast aquaculture production in Atlantic Canada.

Capelin, mackerel, herring and a number of other species which are not fully utilized at present could be a source of suitable raw material. Fatty fish are preferred as a feed source because salmon and trout require oil in their diet. The protein level in the feed should be about 68% and the ash level no higher than 12%. Corey (pers. comm.) has noted that direct-dried fish meal is less nutritious than that dried using indirect methods, and is therefore less suitable as a raw material.

Care must be taken with feed storage in order to prevent the development of rancidity in the oils which can be harmful to or affect tissue quality in the cultured fish.

Some shrimp waste is also suitable for inclusion in feed for farmed salmonids because of the presence of carotenoids which impart a desirable, slightly red coloration to the flesh. Crab and lobster shell is considered to be too hard for this application.

4.3.2 Agriculture Feeds

In addition to the use of fish by-products for constituents in hog, cattle, and poultry feeds described in Section 4.2, finfish wastes can be used directly as a fresh or frozen wet feed. Whole fish or processed waste are used as a wet feed in mink ranching. Fat content is, however, a concern and groundfish waste is preferred. Up to 40 percent of the diet can be fish provided it has not spoiled (i.e. low bacteria count) or become rancid.

4.3.3 Zoo and Pet Food

The pet food industry uses substantial amounts of whole or waste fish, expecially in cat foods. Excessive ash can be a problem with fish waste. Much research has been done but not published by the companies concerned. Almost all fish for pet food is canned. The capital cost of a canning plant is high and the production and marketing process is complex.

Frozen groundfish is also becoming attractive as a feed in zoos. It is frozen in 23 kg blocks for shipment.

4.3.4 Glue and Gelatin

Fish glue from fish skins was at one time an important product. Since the introduction of new types of adhesives, the use of fish skins for glue is no longer important. Fish skins and bones can also be utilized to produce gelatin used in photographic processes and the chemical etching of metals. However, gelatin from other animal sources is considered superior for these applications.

4.3.5 Insulin and Other Biochemical and Pharmaceutical Products

There are a few products of a biochemical and pharmaceutical nature that can be derived from fish. Insulin can be prepared from the gall bladder and bile duct of fish and this has some advantages over the normal preparation from the pancreas of cattle (Soderquist et al., 1970). However, there has been little production of such substances from fish because raw material is not readily available close to markets.

4.3.6 Pearl Essence

Essence of pearl can be produced from the scales of most pelagic fish. It can be used to make imitation pearls and in the decoration of various articles but the requirements are small.

4.3.7 Marine Animal Leather

Fish skins and marine mammal hides, have been used to produce leather in much the same way as leathers from land animals. The market for leather from fish skins is small but there is some manufacturing in British Columbia from the larger (over 50 cm in length) cod and other species.

4.3.8 Chitin and Chitosan

Disposal of shellfish waste particularly crab and lobster is problematical. It has little use as an animal feed and, except where liming is needed, little value as a fertilizer.

One component of shellfish waste is chitin, a polysaccharide widely present in nature and found in the hard shell of crustacean shells. About 16% of the finished shellfish waste by-product is chitin. The isolation of chitin and its derivative chitosan, particularly from krill, has been of some interest in New Brunswick (Brown, pers. comm.). Possible uses of chitin and chitosan are:

- Wound healing accelerators;
- Stabilizers, thickeners and emulsifiers in foods, pharmaceuticals and cosmetics;
- Fibres and films;
- Binders for dyes, fabrics, adhesives and paper sizing and strengthening;
- Seed and food preservatives;
- Coagulants and flocculants for recovery of aqueous processing wastes and water purification; and
- Ion exchange resins and membranes for chromatography and electrodialysis.

The most important use is as a flocculant in industrial waste treatment and in health care.

4.3.9 Non-Edible Uses of Fish Oils

There was formerly a small but significant use of fish oils in non-edible products including paints, leather, lubricants, putty and caulking compounds, ore beneficiation, greases, fuel, and water repellents.

The synthetic replacements for all of these uses, except possibly sulphonated cod oil for fine leather dressing, have proven superior in quality and are competitive economically.

4.3.10 Bait

Fish waste is used as bait in the lobster fishery and for longlinering. In eastern New Brunswick, salt herring is preferred by lobster fishermen over other types but this appears to be based more on tradition and not on fact. Thirty-six processors currently supply about 1,500 mt of bait to fishermen in eastern New Brunswick. The supply is evenly divided between the northeast and southeast sectors of the study area.

The only opportunity for increased waste utilization as bait is to encourage its use over fish caught specifically by individual fishermen. This is not thought to be economical.

4.3.11 Fertilizer

Although fish meal and shellfish meal can be used as fertilizers, they are not necessarily competitive with chemical types. Work has been done in northeastern New Brunswick on mixing fish waste, sawdust, and peat moss to produce a fertilizer. This was studied by a French Company and a local entrepreneur, but was abandoned because the local market was too small, and the product could not compete with other organic fertilizers in outside markets.

4.4 SUMMARY

This review has identified five potential processing alternatives for converting fish wastes into usable by-products. Of these, only one, fish meal and fish oil, processing is currently practiced in eastern New Brunswick. A very limited amount of the fish processing by-product is sold raw, frozen for bait, or as animal feed.

Most of the fish processing by-products identified are as feeds or feed supplements for animals. Only a limited number of uses in human foodstuffs or in industrial applications exist. Where finfish by-products are used for feeds, they suffer severe competition from other protein sources such as soya. This competition has depressed prices for fish waste commodities world-wide and made production only marginally economical in recent years.

This review of waste utilization alternatives has also shown that the uses of shellfish waste are more limited than those for finfish waste. The high calcium carbonate content makes them suitable only for use in poultry feeds or where lime is required as a soil conditioner. As a soil conditioner it cannot compete with quarried limestone which is abundant in southern New Brunswick.

Any alternatives to the production of fish meal and fish oil that may be considered will require substantial capital investment and a considerable marketing effort. The marketing opportunities for fish waste by-products are considered in the next section of this document.

5.0 MARKET ANALYSIS

5.1 GENERAL

This section presents a summary of the market information data obtained by telephone interviews with fish waste producers, users and brokers in New Brunswick, Atlantic Canada and New England. In the time available for conducting this market assessment, it was not possible to attempt to quantify the size of the market opportunities outside of New Brunswick. Consequently, most of the market information provided in this section is anecdotal, based on the comments of the informants previously mentioned. Quantification of the specific opportunities identified would require a detailed marketing study.

Fish meal is a commodity. Typical of commodities, it has no product identity. It competes in world-wide markets, and the market is subject to a variety of uncontrollable circumstances (weather, climate, availability of competing products, etc.).

At the time of this survey in early 1986, the world-wide market for fish meal was characterized as one of short supply and good prices. Very few fish were caught in some of the traditional supply areas, such as South America. As a result, fish meal was in short supply and market demand and prices were high. This is in direct contrast to the situation reported in a study of the Atlantic Fish Meal Industry (DFO, 1985) undertaken a year earlier in which it was suggested that there was a "glut of fish meal, and low prices". More than 15 interviews conducted during the course of this study supported exactly the opposite findings. All informants were unanimous in their observations that prices were high and quantities limited at present .

The analysis of individual markets identified are considered under the following topics:

- Import Substitution;
- Export Markets; and
- New Products.

5.2 IMPORT SUBSTITUTION

Import substitution is the replacement of products now purchased by New Brunswick fish meal users from processors outside of New Brunswick. The term "import" includes other provinces in Canada as well as other countries.

5.2.1 Finfish Meal

The main opportunities for import substitution are in the area of finfish meal. The three major users of groundfish waste products in New Brunswick buy almost 100% of their fish meal from outside the province, primarily from Nova Scotia and Newfoundland.

The total volume of finfish meal purchased by the three users amounts to approximately 3,900 mt per year broken down as follows:

- Maritime Co-op 2,500 mt/yr
- Canada Packers 1,100 mt/yr
- Corey's Feed Mill 300 mt/yr

Current finfish meal production in eastern New Brunswick would only satisfy about 70% of this requirement.

All three producers indicated that they would like to buy more fish meal from New Brunswick. However, they find that the prices of the New Brunswick product are higher than meal from the other provinces. It was suggested that the reason for this was primarily because most of the New Brunswick groundfish meal is sold to brokers in Ontario and the mills using the feed must purchase it from the brokers there rather than directly from the source.

A second consideration is the availability and quality of supply. The users need material supplied on a regular basis year round but eastern New Brunswick cannot provide a regular source of supply. Because of the seasonal fishery, most of the New Brunswick product is sold out by November and new meal is not produced until fishing resumes the following spring.

The quality of the fish meal product from plants in eastern New Brunswick is generally rated as good. However, users stated that the direct-fired drying process produces meal of lower nutritional value compared with that produced using indirect heat dryers.

The supply of meal to the existing feed suppliers in the Province remains a constant market opportunity for plants in eastern New Brunswick. The concern is not lack of markets for New Brunswick producers, but rather a lack of supply in the Province to meet all the demand. In the future, the demand by New Brunswick feed suppliers for fish meal is expected to increase. This will be driven by the future growth of the aquaculture industry and its demand for feed supplies.

5.2.2 Shellfish Meal

There are no import replacement opportunities for shellfish meal in the province. New Brunswick firms do not appear to be using much of this product at the present time.

5.3 EXPORTS

As indicated earlier, fish meal is currently enjoying high market demand due to world shortages. This has clearly given eastern New Brunswick producers an advantage in terms of identification of potential new markets. Most of the product is still being shipped to the traditional market areas such as Quebec, Ontario and the United States but new markets overseas have been identified. There is no lack of market opportunities at the present time. In fact, the situation is exactly the opposite. All fish meal processors indicated that if they could produce more fish meal either through increased plant capacity or through increased supply of fish waste, they would have no trouble selling all of their production.

5.3.1 Finfish Meal

At the present time, roughly one-half of the New Brunswick production is sold in the rest of Canada, forty percent to the U.S., and ten percent to Japan. Among the nine brokers contacted during the study:

- Seven sold approximately equal amounts in Canada and the U.S.;

- One sold approximately ten percent of his total volume to Japan; and

- One sold one hundred percent of his total volume to Japan.

Quality is a very important consideration in developing new markets. Buyers in all market areas are prepared to pay a premium price to insure uniformly high standards. Once new customers have been identified and provided with good quality products on a regular basis, they can remain very loyal to their suppliers, assuming that the original standards are maintained. For example, Taiwan is a major fish meal user and represents a significant market opportunity. The Taiwanese are seeking very specific products, which have the following characteristics:

- Ash content (18-21%);

- Grayish white color;

- Steam dried; and

- Finely ground.

Top quality herring meal should be a consistent 69-73% protein. Other by-product meal should have a protein content in the range of 63-65%.

The consistent message from brokers and from producers during the study was that Canada has only "scratched the surface" of many of the export markets. Because almost all of the product traditionally has been sold in North America, it has not been necessary to attempt to serve the export markets. Additional sales to foreign countries would be a possibility for any increased finfish meal production in New Brunswick.

5.3.2 Shellfish Meal

Presently, all of the New Brunswick export shellfish meal sales are made to Japan. The market for shellfish meal in Japan is reportedly very large, with a major proportion being used in the production of chitin. To obtain top prices in Japan the meal should have a twenty percent plus chitin content. The chitin content of shellfish waste from eastern New Brunswick is about 16% (see Table 18).

Lobster and crabmeal is not a product handled by many brokers in eastern North America. Of the nine that were interviewed during the study, none handled this product. All of the marketing is currently done directly by the meal manufacturers (LeBlanc, pers. comm.; D'Entremont, pers. comm.).

5.4 NEW PRODUCTS

Five new product opportunities, or areas where there is likely to be growth in traditional market areas were identified during the study.

5.4.1 Aquaculture Feeds

Culture of caged salmonids in New Brunswick and Eastern Canada is expected to experience a period of rapid growth and expansion in the near future. In the past, most aquaculture was carried out on an experimental or pilot project basis but many operators are now operating large scale commercial facilities.

A protein source such as fish meal or silage is a major ingredient in the feed used. At present, all the raw material for the production of fish feed is purchased from outside the province, so significant opportunities for New Brunswick meal producers could exist from this one source alone.

Clearly, supply of feed to the aquaculture industry offers one of the most significant opportunities for increased utilization of finfish wastes from eastern New Brunswick.

5.4.2 Chitin

Chitin is a product which is still highly experimental with many potential new uses emerging. Currently, Japan has a monopoly on the technology for the production of chitin, so New Brunswick shellfish waste processors would have to rely on the Japanese as their primary source of production technology, and as a market for produced chitin, in the short term.

Canadian sales would be assured, if chitin production were to take place in Canada. Some recent market studies have reportedly found that there is a sufficient market for chitin to make the production of this product in Canada potentially attractive. This would have to be done through some form of joint venture between a Canadian firm and the Japanese in order to use the Japanese production technology and the Canadian shellfish waste supply.

5.4.3 Silage

Silage is not a new market opportunity, although it is one where there is expected to be consistent market expansion. There is active research being undertaken into finding new uses of fish silage for different types of feed and fertilizer. One firm in the U.S. has been very successful in producing poultry feed from fish silage. Two experiments in Nova Scotia are currently being undertaken; one to develop a fish silage based feed for hog production, and a second to consider use of dried silage as an organic fertilizer for horticulture.

Silage technology for feed production is already well developed and actively used in Europe. Silage will be an area of market growth but this will depend on how rapidly the technology can be transferred to North America and adopted by feed producers and farmers. It does, however, suffer from high transportation costs because it is a bulky commodity. Silage production is most desirable adjacent to the end-user's premises.

5.4.4 Protein Concentrate

Protein concentrate and protein hydrolystate, liquid forms of protein, represent a potential growth market, particularly in the dairy industry. Experimentation and research is currently being undertaken in the use of liquid proteins as a feed, but a major barrier at present is the cost of transportation.

5.4.5 Frozen Fish

Frozen finfish waste is becoming a more and more popular product for zoo and pet foods. Groundfish waste is frozen into 23 kg blocks and sells for \$7.00-\$10.00/kg. Because of the oil content, pelagic fish wastes are not as suitable for these foods.

5.5 SUMMARY

Based on the findings of the interviews conducted with industry participants, there appears to be no shortage of market opportunities and every reason for increasing fish waste processing into saleable by-products. The industry is characterized by a demand for a high quality product, often custom produced to meet the specific requirements of a particular buyer or a group of buyers. Proper targeting of the market and provision of products meeting the specifications of the buyers within a number of different market niches would appear to be the most appropriate strategy for increasing and securing markets for eastern New Brunswick production.

If the current projections prove valid, the aquaculture industry in New Brunswick alone could well absorb a major share of any increase in waste processing, particularly, for pelagic fish wastes. The opportunities for increased utilization of the shellfish wastes produced in eastern New Brunswick are not as clear. Chitin production may become more attractive in the near future as new products are developed.

A key factor in considering these market opportunities is the highly seasonal nature of the finfish and shellfish waste supplies. Supplies to extend production runs would enable New Brunswick suppliers to be more reliable and more consistent in supplying their product.

6.0 RESEARCH AND DEVELOPMENT NEEDS

There are several avenues of research, or technology development, that could be profitably pursued in order to maximize fish waste utilization in eastern New Brunswick. The market analysis in Section 5.0 identified several opportunities where new products, or improvements in present technology, might have economic benefits for eastern New Brunswick. Secondarily, these opportunities or improvements could have significant environmental and social benefits for the study area.

6.1 TECHNOLOGICAL IMPROVEMENTS

6.1.1 Fish Meal and Oil

Fish meal and fish oil are the principal fish waste by-products produced in the fish processing industry. The technology is available and practices well known for efficient plant operation and good product quality assurance. Although there will be further development in the production and use of fish meal, most research requirements lie elsewhere.

As far as eastern New Brunswick is concerned, however, investigations into production requirements for fish meal used in aquaculture feeds would be beneficial in order to help supply a rapidly growing local demand. Corey (pers. comm.) has indicated that the use of indirect dryers improve the nutritional quality of fish meal, but other refinements in the meal production process, such as the adjustment of oil and water content, might improve product quality for aquaculture applications.

Fish oils are also receiving renewed attention because there is evidence that they are beneficial in the prevention of cardiovascular disease. The image of fish oil is poor and quality can vary. For this reason, attention should be paid to selective production from the best possible raw material to satisfy the demand of the speciality market.

6.1.2 Fish Silage

Fish silage has been used for many years as an agricultural feed, particularly in hog production. More recently it has been used in combination with fish meal as a feed for salmonid culture in Sweden. To date, however, there has been little use of fish silage in Atlantic Canada.

There are two aspects of silage production that have been studied to some extent, but require further attention if silage is to gain wider acceptance. These aspects are water removal and oil removal. Water removal would reduce the weight and bulk of silage per unit of protein thereby making product handling easier and reducing transportation costs. In some instances, it would make the silage more acceptable as a feed.

The amount of oil present in the silage will largely determine how much can be fed to hogs and other farm animals. The quantity of fish oil in these diets has to be restricted, however, energy-rich silage, high in oil, is acceptable in feeds for aquaculture and furbearers. Some work has been done on oil removal from silage made from fatty fish but, further study is required if its use in agriculture is to be expanded.

Oil from fish silage tends to be of inferior quality compared with oil from the fish meal production process. Further research into improving the quality of oil removed from silage would be desirable in view of the increased market demand for high quality oils. Depending on the methods employed, observations and trials will be required to determine the cheapest and best type of oil separation system, centrifuge or decanter, that should be used.

6.1.3 Chitin and Chitosan

At present, the most valuable by-product of shellfish waste is chitin. Research into chitin has been continuing at the Reseach and Productivity Council (RPC) in Fredericton for several years but it is recognized that technical leadership in the field of chitin extraction is held by the Japanese (Johnston and Peniston, 1982).

Johnson and Peniston (1982) have indicated that considerable economic benefit can be derived from chitin production if a process is used which removes and recovers the protein from the shell, before proceeding to demineralization. Protein removal also has a secondary benefit of removing a waste disposal problem and avoiding contamination of the process liquors. There would therefore appear to be definite economic and environmental benefits to using this approach for chitin extraction but this would have to be assessed relative to the available raw material. A major problem in chitin production is insuring that the raw waste has not degraded. Waste handling and holding procedures at the primary processors would have to be reviewed and assessed to insure that the highest quality chitin can be produced.

Michaud (pers. comm.) has indicated that proposals to upgrade the RPC extraction process, and develop a pilot plant, were not approved in the past. However, given the lobster and crab waste volumes discarded annually (about 7,000 mt) in eastern New Brunswick, and the environmental and social problems associated with their disposal, continued work and maintenance of contacts with Japanese interests is highly desirable.

The findings of this study indicate that shellfish waste is currently the most significant fish waste management problem in eastern New Brunswick. Pursuit of chitin related production technology would not only have economic benefits for the region, but also assist with solving a major environmental problem and social nuisance.

6.2 PRODUCT DEVELOPMENT

The market analysis demonstrated that there were several opportunities for fish by-product producers in eastern New Brunswick to expand their markets. Almost all of these relate to animal feeds. A new product that could be developed outside of animal feed is the use of shellfish waste in conjunction with peat moss, or sawdust, as an organic fertilizer.

Michaud (pers. comm.) has indicated that previous work on this subject has been pursued by a local entrepreneur and a French Company, supported by the Provincial Government's Department of Commerce and Technology. It was studied in detail but abandoned by the proponents because the potential market was too small at that time.

However, given the volumes of shellfish waste available for processing into useable by-products, this proposal should be reconsidered and research renewed on the proposed product. This would be a particularly attractive project for northeastern New Brunswick because the sources of peat moss and shellfish waste are very close to one another resulting in minimal raw material transportation costs.

7.0 ENVIRONMENTAL AND SOCIAL BENEFITS OF WASTE PROCESSING ALTERNATIVES

The market analysis has indicated that potential markets exist for fish waste by-products, both in New Brunswick and elsewhere. Research and development must be undertaken to fully exploit these opportunities. This will require a substantial investment some of which could be provided, directly or indirectly, by government. Not only would this investment have long term economic benefits to the study area, but it could also remove a social irritant and alleviate an environmental concern in eastern New Brunswick.

The study has indicated that substantial volumes of finfish and shellfish waste remain unprocessed and are discarded in landfills, or illegally, at sea. An analysis of the estimated waste volumes compared with the volumes of fish meal currently produced in eastern New Brunswick indicates that, in 1984, at least 2,300 mt of finfish waste was not processed. These volumes would produce about 460 mt of meal with a minimum market value of about $160,000. Processing these wastes would take 66 hours of additional operation utilizing the existing finfish meal production capacity within eastern New Brunswick. This would represent a 16% increase over 1984 meal production figures (Table 16).

A comparison of lobster and crab waste volumes with shellfish meal production in eastern New Brunswick indicates that only about 45% of the available waste is processed. If all this waste were processed, an additional 2,400 mt of meal could be produced with a value of \$300-\$350,000. Production of this shellfish waste would require an additional 408 hours of operation utilizing the existing capacity. This production would represent a production increase of 124% over 1984 shellfish meal production (Table 16).

Therefore, the estimated unrealized value of fish waste by-products in eastern New Brunswick is estimated to be \$460-\$510,000.

The environmental and social benefits of increasing fish waste processing in eastern New Brunswick extend beyond the immediate economic benefits. Increased fish waste processing will alleviate the odour, vermin and asethetic problems currently experienced at public and private dumpsites in the study era. This is becoming an increasingly important social issue in eastern New Brunswick. It will also reduce the environmental concerns associated with groundwater and surface water contamination at improperly operated landfills. Operation of fish waste processing facilities will result in concentrations of large volumes of wastes at specific locations. This will make it easier to manage the waste, and enforce emission and effluent standards. It may also lead to considerable protest by the local community which may not consider installation of a fish reduction plant in, or close to their community, in their local interest. Opposition to fish reduction facilities is based on the odour and water pollution problems associated with their operation. Although technology is available for effectively managing these problems, the reduction facilities in the study area are older and would require extensive upgrading and retrofilling to completely eliminate these problems. Hence, opposition to any new waste processing facilities may be experienced unless the waste management systems to be incorporated into the plant can be effectively demonstrated beforehand.

Each of the waste processing alternatives identified will alleviate the problems identified simply by processing material that, otherwise, would be dumped. However, careful planning will have to be incorporated into the planning and installation of any of these facilities to insure that they will not result in secondary social or environmental problems.

The social and environmental considerations associated with the production of the most attractive alternative products, of upgraded existing products, are identified in general terms below. Specific benefits or costs could only be identified when the size, location, and processing method for a potential facility are determined.

7.1 FINFISH WASTE

Based on the market assessment, it is evident that a substantial market for finfish meal exists in New Brunswick. The market is expected to grow as the aquaculture of caged salmonids expands in the province. There is only a limited volume of additional finfish waste available for processing so that the principle benefits will be derived from product enhancement. The principal method of product enhancement would be the replacement of direct-fired dryers with indirect steam or Rotadisc dryers which would improve the nutritional value of the finished meal. Indirect dryers cause fewer odour problems than the direct-fired type. Provided that the scrubbing equipment is properly maintained, odour problems from upgraded facilities should be minimal.

Recovery and processing of blood liquor from raw waste and stickwater, increases the protein content of the product and improves its market value. Discharge of these liquids into harbours resulting in a high BOD loading was a major environmental concern in the past (Brodersen, 1973). Again, technology is available for effectively managing these liquid wastes.

Production of conventional fish silage is a simple, low cost process that does not produce liquid wastes, or have a significant odour problem associated with it. Provided that the process is carefully monitored it should be possible to undertake fish silage production close to existing communities. If the end product is liquid silage, fish bones which comprise 5-8% of the mass would have to be removed and either discarded, or directed to a grinder. For some feeds, it may be possible to add the powdered bone back into the silage.

Consideration has been given to drying silage for uses other than animal feeds. Depending on the drying method, a high BOD in removed liquid, or odour in gaseous emissions could arise. The problems are similar to those associated with conventional meal production and could be managed using the same technology.

7.2 SHELLFISH WASTES

Shellfish waste is currently a much larger problem in eastern New Brunswick than finfish waste, in part, because there are fewer potential uses, and the by-product value is lower. The market analysis indicated that chitin production was the only realistic alternative to the production of shellfish meal. Chitin comprises about 7% of raw lobster and crab waste (Table 18) which leaves approximately 33% of the raw material comprised of proteins, calcium carbonate, and oil and 60% water.

During the production of chitin, protein can be extracted and recovered before the shell is demineralized using dilute acids (Johnson and Peniston, 1982). Therefore, the only waste product to consider is the demineralization brine which can be used as a neutralizing agent, or for road dust control programs. There are no gaseous emissions from chitin production.

The social and environmental benefits of chitin production from the existing shellfish waste are readily apparent. Not only would a major local problem in northeastern New Brunswick be rectified but some employment opportunities would be developed without undesirable side effects.

8.0 ACCEPTABLE DISPOSAL METHODS

Despite the unsatisfied demand for fish meal in New Brunswick and the unrealized value of the other waste by-products, there are several reasons why all the fish waste generated within the study area could not be processed, and must be discarded in a sound environmental manner. These reasons include:

- The location of any fish reduction facilities relative to many of the smaller processing facilities, particularly in southeastern New Brunswick, makes transportation costs very high;

- The seasonal distribution of the catch, particularly for crab and herring, would make investment in the large processing facilities to handle all the waste very expensive;

- The salt content of the marinated fish wastes make incorporation into conventional fish meal processing difficult; and

- Shells from clam, oyster, and mussel processing has little or no value other than for poultry feed.

Until these logistical and economic problems are solved, the only temporary solution for these unprocessed wastes is landbased, and possibly, marine disposal. These options are discussed in the following subsections.

8.1 LAND-BASED DISPOSAL

Land-based disposal of fish wastes in eastern New Brunswick is rather haphazard at present. The provincial government has developed guidelines for landfilling wastes (see Section 3.3.2) but these are not always adhered to, particularly at private dumpsites.

Proper land-based disposal practice has two elements. The first is selection of a suitable site, and the second is proper operation at the site.

Specifications for approved landfills in the Solid Waste Guidelines, issued by the provincial government, include provisions to isolate the waste from local groundwater supplies, and surface watercourses. The water table at the sites should be low. Sites should also be remote from local residences, recreation areas, public roads, and municipal drinking water supplies. Standards for fish waste disposal recently prescribed in Nova Scotia contain similar provisions. If the provisions are adhered to, fish waste disposal should not become a public nuisance or present a health hazard.

The second element involves proper disposal methods at the site. These will depend upon the method selected, i.e. burial in trenches, or spreading on fields. If burial in trenches is the selected option, the trench should not be greater than 2 metres deep. Wastes should be covered each day with a minimum soil cover of 0.3 m. After the trench is completely filled an additional 0.7 m of soil should be spread over the top of the trench and the surface leveled to the original grade. Periodic reworking may be required subsequent to final leveling to ensure that sink holes, that develop after the waste rots, are filled and do not pond water.

The second method is spreading the wastes on fields using a manure spreader and ploughing it under. This is more labour intensive and requires more careful planning, but under certain conditions it has advantages. LeBlanc (pers. comm.) has indicated burial of bloater wastes in pits makes the disposal site unuseable for other purposes, whereas spreading and ploughing fertilizes the soil and does not affect future use. No adverse effects from the high salt content of the bloaters was reported and odour and vermin were not apparent.

If spreading is deemed to be desirable, it is important to calculate the application rates per hectare to ensure that soils are not "poisoned" with excessive levels of nitrogen caused by protein decomposition. The rate should provide nutrients equivalent to those recommended for commercial fertilizer application. Lindsay (pers. comm.) indicated that an application rate for herring waste of up to 6.7 mt/ha/yr based on equivalent nitrogen content has been calculated for fields in the Shippegan area. Lindsay also indicated that agreement to proceed with spreading on the land was conditional upon satisfactory ploughing in.

Although shellfish wastes have also traditionally been spread on agricultural land in northeastern New Brunswick, they present a more difficult problem than finfish waste. Shellfish degrade much more slowly, they are substantially more difficult to plough under, and can cause a significant odour problem, even when buried (LeBlanc, pers. comm.).

Therefore, spreading shellfish wastes on agricultural land is not recommended. If land-based disposal is necessary, burial in properly managed landfills is needed.

8.2 MARINE DISPOSAL

Marine disposal of fish waste from processing plants is not routinely practiced in eastern New Brunswick at the present time (Lindsay, pers. comm.). Some wastes are dumped at sea by inshore fishermen cleaning their catch before landing, e.g. scallops, some groundfish. On occasion, some pelagic fish, particularly herring may be discarded if buyers cannot be found. The volumes are unknown but are thought to be small relative to the wastes produced by the shore-based processing plants.

Marine disposal has been given serious consideration by one or two plant operators in recent years (Kresta, pers. comm.) but applications for Ocean Dumping Permits were never processed. Nevertheless, the Fish Habitat Division of the Gulf Region (LeBlanc, 1985) has issued a memorandum to area directors identifying the procedures that should be followed in considering applications for the marine disposal of fish offal including designation of gurry grounds, should they be received.

Marine disposal of finfish waste at designated gurry grounds is widely practiced in Newfoundland where about 80 disposal locations have been identified (O.D.C. Scientific Ltd., 1983). Of these, problems such as offal on beaches, fouled nets, and detrimental effects on local lobster fisheries were identified at 15 locations. A study of one site in Fogo Harbour (LGL Limited, 1985) revealed that poor circulation at a gurry ground had led to the creation of an 1,800 m^2 anoxic area devoid of marine life. It was suggested that a new site with better circulation and more scavengers would reduce the effect of offal disposal on the local environment.

Marine disposal from shore-based processing plants does not take place routinely in the Maritimes. Applications for ocean dumping of herring offal at two locations in southwestern Nova Scotia were approved in 1985. A disposal limit of 2,000 mt was placed on the permits.

Guidelines for marine disposal of offal and dumpsite selection under the Ocean Dumping Control Act have not been issued, but McIver (pers. comm.) has indicated that the following concerns are considered when reviewing an application:

- Local circulation patterns;
- Potential impacts on demersal fish eggs and juvenile fish;
- Proximity of exploited shellfish beds and lobster habitat;
- Waste degradation on sediment quality;
- Conflicts with mobile and fixed fishing gear located in the area; and
- Contamination of shorelines.

Marine disposal of offal should take place in offshore areas with good circulation to promote degradation of the waste. Disposal by pumping rather than dumping is preferred to spread the wastes over a wider area, promote degradation, and avoid waste piles on the seabed. Sites must be chosen to avoid conflicts with fisheries that may not be active in the area during the disposal period, but which may be very intensively fished at other times.

The criteria listed above are pertinent to potential marine disposal of fish waste in eastern New Brunswick. Of particular concern in the study area is the possible bacterial contamination of shellfish beds. Filter feeders such as oysters, mussels and clams are harvested throughout eastern New Brunswick. Any local disruption of these fisheries caused by improper marine disposal site selection and practices could have a substantial economic effect.

8.3 PREFERRED ALTERNATIVE

Processing fish wastes into useable by-products is highly preferable to disposal either on land or at sea. However, in circumstances such as those identified above where waste processing is logistically and technically uneconomical, disposal is the only recourse.

For a number of reasons land-based disposal would appear to be preferable to marine disposal in eastern New Brunswick. Marine areas around the study area are shallow and support a number of intensive and concentrated fisheries, as well as recreational beaches. Unless marine disposal was very carefully planned and carried out, there is considerable potential for unwanted interference. In addition, shellfish waste would comprise the bulk of disposed material. The shell breaks down slowly and potentially could accumulate at the disposal site altering the habitat, and interferring with mobile fishing gear. Finally, marine disposal would be very much harder to regulate and manage if practiced on a larger scale.

With properly designed and operated landfills, fish waste disposal should present few environmental or social problems. Sites must be carefully selected and operated to avoid future land use conflicts or social concerns. They must be carefully monitored to insure compliance with landfill regulations.

Based on the history of land-based disposal in the province, it would be desirable to designate disposal sites at strategic locations in eastern New Brunswick and force processors to use these facilities on a cost recoverable basis. For example, a common disposal site could be designated in Kent County for controlled disposal of the large volumes of mollusc shell discarded by local processors. Common land-based disposal sites designated by the provincial government and operated and managed by a contractor would be the preferred method of dispsoal where waste processing is not practical. However, disposal should be discouraged wherever sufficient volumes of waste are available to warrant processing into useable by-products.

9.0 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

9.1 SUMMARY AND CONCLUSIONS

The fishery in eastern New Brunswick is dominated by activity in the Shippegan-Caraquet-Lamèque area. About 65,000 mt of fish are landed annually with shellfish accounting for 44% of the catch, and pelagic fish and groundfish about 28% each. The fishery is heavily regulated and is considered mature. It is not expected to grow significantly in the foreseeable future. It is highly seasonal with the bulk of the landings occurring between April and November.

Ninety-seven processors in the study area generate about 33,000 mt of waste annually. About 60% of the waste is processed into fish meal and oil at four plants in the study area, while the remainder is disposed of in landfills or is spread on agricultural land. Marine disposal of fish offal by shore-based processors is not routinely practiced in eastern New Brunswick at present.

Management of fish waste has been a continuing problem in eastern New Brunswick over the last several years. Originally, concerns were expressed about odours and liquid wastes associated with meal plants in the Caraquet-Shippegan area. Attention is now focussed on the environmental problems associated with land disposal of untreated finfish and shellfish wastes. These include odour, the presence of vermin, water supply contamination and aesthetic considerations.

Two problems - the disposal of bloater wastes on fields and at public dumpsites in southeastern new Brunswick, and shellfish wastes from processing in southeastern New Brunswick and around Caraquet - have attracted attention. The bloater waste problem has been essentially solved. The material is now accepted at one facility where it is spread over and ploughed into fallow agricultural land. However, a few operators refuse to pay the fee and continue to discard wastes in an uncontrolled manner.

Shellfish waste disposal particularly lobster and crab waste has been a long standing concern in the study area. The problem in southeastern New Brunswick was partially solved by the establishment of a meal plant in 1982. Established as a result of a recommendation in the McLaren (1979) report, this facility accepts wastes for a fee currently set at $45/mt. One operator refuses to participate in the program and continues to discard lobster and crab waste at a public dumpsite. Processors in Kent County also do not use the facility.

The problem in the northeast remains. In this region, shellfish wastes have traditionally been handled by the processor in Shippegan but, in recent years, low meal prices have forced them to charge processors $66/mt to handle the waste. This charge is not accepted by many who instead pay a trucker to discard the material at a private dumpsite near Caraquet. This has become a major social nuisance, and represents a significant loss of material that could be processed into a saleable by-product.

Provincial legislation for ensuring the proper management of fish wastes both at fish reduction plants, and at landfills, is in place. However, because fish waste disposal is widely distributed throughout the region, enforcement, particularly at landfill operations is difficult. Many processors refuse to cooperate in attempts to solve local waste problems on economic grounds. The cost of participation is deemed to be too high.

Almost all of fish offal and shellfish waste processed in eastern New Brunswick is used for the manufacture of fish meal and fish oil. Processors can sell all they produce but in recent years prices have been low as a result of competition from other protein sources such as soya. A number of alternative processing finfish waste processing methods and uses were identified but with the exception of silage none appear to offer a significant alternative to meal. Chitin production could offer a potential use of the currently discarded shellfish wastes.

A market analysis revealed that there are a number of opportunities for selling increased amounts of fish meal in New Brunswick but the seasonal availability of the product, and to a lesser degree, product quality are limitations to increased exploitation of home markets.

New product opportunities include fish silage, and the manufacture of chitin from shellfish wastes. These would both require considerable capital investment and market development to successfully exploit potential markets. Some research and development is needed as part of a more detailed assessment of these opportunities. Both of these would have economic, as well as social and environmental, benefits for eastern New Brunswick.

Even if products are developed which would utilize all the unexploited waste, some land-based disposal would still continue in the study area. General considerations in selecting sites and operating facilities were identified. If these are followed, land disposal should not present an environmental problem or a social nuisance. Marine disposal is not considered desirable.

The study has revealed that the current fish waste management problem in the region is more a logistical and economic issue, than a technical problem. Many processors do not view proper waste disposal as their problem but rather one for government to deal with. A significant improvement in the present situation would be realized if all processors accepted the fact that establishing and maintaining good waste disposal practices are, at least in part, their responsibility.

9.2 RECOMMENDATIONS

Recommendations arising from the study can be broken down into two general categories; improvements in current waste management, and exploitation of new opportunities.

Recommended improvements in current waste management practices are presented in order of priority.

1. A substantial effort should be made to encourage shellfish processors in northeastern New Brunswick to have their wastes processed into shellfish meal. The current land disposal practices do not meet the solid waste guidelines of the provincial government and represent the largest single fish waste management problem in eastern New Brunswick. Operators must be made aware that improper disposal of wastes is illegal and that they will be liable to prosecution if they do not abide by the regulations.

   A concerted effort by both the federal and provincial governments will be required to insure that wastes do not continue to be dumped illegally. Direct subsidy to cover the cost of shellfish waste disposal is not recommended because the annual cost would be in the order of $500,000 and would not offer a permanent solution to the problem. A temporary solution may be the establishment of a waste collection program in the area funded by levies on processors to remove the wastes to processing facilities.

   In the longer term, an alternative shellfish meal or chitin extraction facility is needed to handle the shellfish waste.

2. Establishment of the waste dispsoal facilities in southeastern New Brunswick in the early 1980's solved a major fish waste management problem. Continuing efforts should be made by the New Brunswick Department of Municipal Affairs and Environment to have all operators use these facilities. Only a few operators do not use these facilities at present and legal action may be required to force non-participants to use these facilities.

3. Marine disposal should be discouraged because of potential contamination problems and interference with existing fisheries. Marine disposal would be difficult to manage and expensive to regulate. If processing alternatives do not exist, land-based disposal at properly operated landfills should be used. Application of fish waste on agricultural land should be limited to finfish waste at a designated application rate.

4. Where landfilling is used, the use of uncontrolled provincial, municipal or private dumps should be discouraged. Dumpsites should be designated by the Provincial Department of Municipal Affairs and Environment and operated by a qualified contractor. This would be particularly appropriate in southeastern New Brunswick where 15 operators in Fisheries Districts 76 and 77 are currently using existing public dumps. Much of this waste is mollusc shell which cannot be readily processed into saleable by-products.

5. To improve the utilization of the resource and obtain the highest economic return, herring roe processors and bloater operators should endeavour to coordinate their raw material requirements. After the roe is extracted, the carcasses could be sold for bloater production rather than being processed into fish meal or dumped in landfills or on agricultural land. Precautions would have to be taken to insure that the raw herring are not allowed to degrade before secondary processing.

   This could be considered when allocating quotas for herring to be used in bloater production.

New opportunities that should be considered for enhancing waste utilization and product enhancement are listed below in order of perceived priority.

1. A pilot project to extract chitin and chitosan from lobster and crab waste should be established in the Caraquet-Shippegan area. The number of industrial uses of high grade chitin and chitosan is increasing rapidly and it would appear to be timely to consider the installation of such a facility. The market analysis suggested that if commercial production was feasible, the Canadian market could absorb most of the product, particularly if a medical or food grade material is produced. A side benefit of chitin production could be pigment extraction for use in salmonid aquaculture feeds, and protein for use in agricultural feeds.

2. Aquaculture feed requirements should be further investigated because a major opportunity exists to displace imported material if a high quality product can be assured. Feeding systems that employ a combination of fish silage and fish meal to produce a pelletized feed should be investigated in detail. Requirements for systems such as this could expand rapidly as

the salmonid aquaculture industry expands in southwestern New Brunswick.

A jointly funded federal-provincial project should investigate all the elements of the aquaculture feed requirements to insure that fish reduction plant operators in eastern New Brunswick are fully aware of potential opportunities to expand their markets.

3. Fish silage offers some potential for processing smaller volumes of finfish waste than are required to economically operate a fish meal production facility. Liquid fish silage production has few environmental or social costs associated with it so it should be possible to locate production facilities close to potential markets. Potential applications of silage including use in agriculture and horticulture is attracting considerable attention in Nova Scotia. Some of this attention is devoted to dried forms of silage.

Markets for potential silage in eastern New Brunswick should be identified and assessed. If the studies identify potential markets, emphasis in assessing the feasibility of satisfying this market should be placed on the establishment of several small production facilities rather than one large installation. This would not only provide local finfish waste processing capabilities where presently none exist, but also reduce the raw material transportation costs which could make a larger facility economically unattractive.

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APPENDIX A

TERMS OF REFERENCE

The Department of Supply and Services on behalf of the Department of Fisheries and Oceans - Gulf Region has issued requests for proposals for "A Study of Fish Wastes in New Brunswick". The terms of reference are as follows:

The consultant will conduct a study which will cover but will not be restricted to the following topics:

1.1 Inventory of current disposal practices of fish offal and environmental and socio-economic impacts associated with this activity.

- Content and composition of the waste material;
- Tonnage, availability, peak flows and areas of high concentration;
- Actual disposal methods and actual location;
- Forecast of future tonnage;
- Review of fisheries management practices and their consequences on fish offal availability;
- Review of federal and provincial legislation affecting fish offal disposal; and
- Environmental and socio-economic impact of current disposal.

1.2 Inventory of current offal processing methods and environmental and socio-economic impacts associated with this activity.

- Identification and localization;
- Capacity;
- Type and composition of fish wastes processed;
- Productivity, output, profitability, stock and supplies;
- Review of federal and provincial legislation affecting fish offal disposal; and
- Environmental and socio-economic impact of current disposal methods.

1.3 Analysis of alternative options for the beneficial, environmentally safe and profitable use of fish wastes. The discussion should include the relative potential for environmental stress as a result of each process.

a) Feed supplement - Aquaculture
- Mink and Fox
- Cat and Dog
- Livestock
- Buffer in human dietary supplement
- Others (should be identified)

Processing - Silage
- Wet feed
- Dry feed
- Fish meal
- Others (should be identified)

Composition of feed

b) Composting - Method

c) Bait - Storage

d) Ocean Dumping in Corridors
- Site selection criteria
- Effects on exploited species

e) Others (should be identified)

1.4 - Cost-Benefit and advantage-disadvantage analysis of each option;
- Environmental and socio-economic impacts of each option;
- Research needs on available technology to implement options; and
- Potential market for each product.

1.5 Evaluation of past, present and future fish waste disposal methods with recommendations to prevent environmental and socio-economic constraints for their beneficial application.

1.6 Bibliography.

APPENDIX B

GROUNDFISH LANDINGS

Table B-1. 1983 Groundfish landings by district.
(in metric tons)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63								4		1			5
64					4	18	50	48	41	7	2		170
65	10			137	1,590	1,169	744	842	353	600	469		5,914
66				787	2,601	881	496	365	551	537	494	43	6,755
67				180	1,760	757	527	296	381	352	176		4,429
68		1			8	45	74	19	15	7			169
70	1	2			5	22	14	5	4		1		53
71	3									10	74	15	139
73	2	2			17	145	40	18	14	2			240
75					4	93	91	113	115	10			426
76					1	111	402	191	107				812
77						8	3	18	15				44
78						30	25						55
80							22	4					26
Total	50	8		1,104	5,990	3,279	2,488	1,923	1,596	1,526	1,216	58	19,237

Table B-2. 1984 Groundfish landings by district.
(in metric tons)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63						.1	1.0	.1	5.9				7.1
64		.7	.4	.6	6.7	16.3	13.3	20.8	122.7	164.7	34.7	.1	381.0
65					1,551.1	637.5	392.6	882.0	527.0	707.6	405.8	20.0	5,123.6
66				53.3	2335.6	694.3	378.4	457.3	297.5	781.2	361.0		5,358.6
67				7.2	1,562.7	345.4	279.0	359.4	134.7	85.7	62.0		2.836.1
68	.4				6.1	28.1	49.2	64.7	34.4	14.7			197.6
70		1.7			4.8	8.0	10.7	14.5	3.5				43.2
71	8.9	6.4								16.6	86.3	.2	118.4
73	.1				100.4	39.4	33.5	22.3	11.8				207.5
75					2.1	61.4	362.7	108.3	92.4	.1			627.0
76					.1	26.9	254.5	49.0	42.5	31.6	8.2	.3	413.1
77						2.0	74.2	1.0	2.5	2.7	2.8		85.2
78					1.6	17.6	3.3		2.2				24.7
80					1.3	69.8	285.6	16.5			.3		373.7
Total	9.4	8.8	.4	61.1	5,572.5	1,946.8	2,138.0	1,995.9	1,277.1	1.805.1	961.1	20.6	15,796.8

Table B-3. 1985 Groundfish landings by district (preliminary data).
(in metric tons)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63						.6	.1						0.7
64					1.6	9.3	20.6	23.9	7.5	27.2			90.1
65					749.9	908.7	125.7	1,068.3	1,155.0	858.3	251.2	22.8	6,239.9
66	1.0				1,365.6	960.7	542.2	571.6	782.3	968.0	741.0		5,932.4
67					812.6	864.6	397.6	192.9	537.6	206.6	289.0	.3	3,301.2
68					1.1	5.0	69.9	4.1	12.8	10.3	2.1	.1	105.4
70					.7	3.4	3.3	1.9	.7				10.0
71		1.4											1.4
73					32.4	16.1	41.4	21.1					111.0
75					63.2	14.0	130.4	78.9	64.5	9.8			360.8
76						18.4	289.2	29.4	28.6	4.2			369.6
77						30.1	16.9		4.8				51.8
78				.1	.1	7.5	12.4						20.1
80					.4	1.4	56.0	1.9					59.7
Total	1.0	1.4		.1	3,027.6	2,839.8	2,805.7	1,994.0	2,593.8	2,084.4	1,283.3	23.2	16,653.9

APPENDIX C

PELAGIC FISH LANDINGS

Table C-1. 1983 Pelagic fish landings by district.
(in metric tons)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63					92	23		1					116
64					174	53	45	15	13				300
65					593	361	153	1,597	872	1,641	936		6,153
66					123	124	191	2,680	306	2	354		3,780
67				1	48	58	160	1,089	80	516			1,952
68				2	31	70	145	172	90	18			528
70					36		5	49	7				97
71													
73					3,015	220	95	89	8				3,427
75					348	107	64	13	10				542
76					16	136	22	3					177
77					61	46	7	3					117
78					332	151	38						521
80					281	116	21						418
Total				3	5,150	1,465	946	5,711	1,386	2,177	1,290		18,128

Table C-2. 1984 Pelagic fish landings by district.
(in metric tons)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63					57.9	.1	1.4	.1	3.9				63.4
64	2.5	2.7	.9		26.0	32.4	12.9	5.6	11.7	1.8		1.3	97.8
65	10.2	3.0			34.1	172.4	27.5	1,075.9	1,871.5	3,134.9	76.8		6,406.3
66	13.0	10.4	.6	2.8	209.7	52.8	120.3	1,333.7	765.5	746.5			3,255.3
67	12.7	6.0	.5	1.4	61.7	175.3	12.1	181.4	421.5	695.7	106.9		1,675.2
68	46.9	33.7	14.9	41.5	84.1	182.7	108.5	142.7	128.5	94.2	14.5	4.0	896.2
70	39.7	19.2	9.8		61.6	.1	.1	1.5	3.5	9.6	.3	3.1	148.6
71	18.0	23.6	27.6		148.6	525.2	2.6		4.3	11.7	7.3	1.0	769.9
73	34.3	21.9	20.9		4,043.2	198.8	79.5	4.7	21.2	111.9		2.1	4,538.5
75	2.4	2.6	2.1	.8	566.0	238.3	91.0	4.4	4.2	7.5	4.2	11.7	935.2
76	47.9	37.3	24.0	1.6	480.6	147.1	43.5	5.8	17.0	15.7	12.5	7.5	840.4
77	28.3	19.7	10.9		6.1	142.1		34.5	349.0	81.4			672.0
78	5.5	1.4			47.4	85.4	38.5			1.4			179.6
80	3.2	3.0	10.4		137.0	10.4	29.9			1.9	3.6		119.4
Total	264.6	184.6	122.6	48.1	5,964.0	1,963.1	567.8	2,790.3	3,601.8	4,914.2	226.1	30.7	20,677.8

Table C-3. 1985 Pelagic fish landings by district (preliminary data).
(in metric tons)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63		.4	1.5			.1	.1						2.1
64		.8	1.1	11.1	137.6	64.7	7.3	2.1	2.6				227.3
65	1.3	1.0		17.4	291.4	1,860.2	36.3	1,665.2	3,036.9	3,410.2	527.8		10,847.7
66		.9	1.6		8.4	157.7	71.6	1,699.0	1,335.0	1.2			3,275.4
67		2.0	.7		147.0	290.9	9.9	952.3	1,635.7	305.4	120.6		3,464.5
68	7.0	17.1	8.9	.7	49.0	112.8	49.3	35.5	42.1	7.0	2.2		331.6
70	6.2	14.9	22.4	1.1	8.7	2.7	1.6	1.4					59.0
71	8.0	13.7	54.6		33.1	791.8	.7						901.9
73	15.0	15.2	34.3	2.3	1,958.1	354.6	56.9	1.5	1.0				2,438.9
75	1.9		.1	2.9	391.6	220.5	24.1	9.1	3.7				653.9
76	40.4	18.9	14.2	.3	411.7	1,053.0	60.2	2.3	.2		.2		1,601.4
77	.7		7.0	3.5	68.3	96.2	2.2	1.5		.3			179.7
78	1.9			5.9	363.6	134.2	48.4						554.0
80				7.0	418.4	60.1	1.7			2.2			489.4
Total	82.4	84.9	146.4	52.2	4,286.9	5,199.5	370.3	4,369.9	6,057.2	3,726.3	650.8		25,026.8

APPENDIX D

SHELLFISH LANDINGS

Table D-1. 1983 Lobster landings by district.
(in metric tons)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63					21	20							41
64					58	64	3						125
65					132	159	9						300
66					181	285	11						477
67					35	50	3						88
68					73	87	2						162
70					181	168	2						351
71													
73					139	176	3	1					319
75					32	8		314	226	57			637
76								350	134	24			508
77								251	76	20			347
78								232	161	67			460
80								473	356	96			925
Total					852	1,017	33	1,621	953	264			4,740

Table D-2. 1984 Lobster landings by district.
(in metric tons)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63					43.7	45.2	7.6						96.5
64					66.9	74.5	7.7						149.1
65					180.8	131.2	7.2						319.2
66				12.5	347.0	246.5	18.0						624.0
67				1.6	56.6	29.2	1.3						88.6
68					75.1	75.8	5.2						156.1
70			2.5		219.3	169.3	20.1						411.2
71					140.1	.1							140.2
73					31.9	126.7	9.0						167.6
75					6.3	31.1	2.1	318.6	246.9	52.7			657.7
76						3.5		325.2	194.3	39.9			562.9
77								178.7	94.1	20.8			293.6
78					31.9	59.9	6.2	316.0	137.0	73.7			624.7
80						6.2	1.0	611.6	277.8	116.1			1,012.8
Total			2.5	14.1	1,199.6	999.1	85.4	1,750.1	950.1	303.3			5,304.2

Table D-3. 1985 Lobster landings by district (preliminary data).
(in metric tons)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63					12.3	16.7	.1						29.1
64					53.3	28.4	.2						81.9
65					110.8	64.5							175.3
66					208.9	103.9							312.8
67					69.9	29.0							98.9
68					48.9	35.9	.3						85.1
70					163.5	68.5	.3						232.3
71						.1							.2
73					131.1	74.2		.9					206.2
75					48.7	30.9	1.1	183.0	59.9				323.7
76					.7	.1		160.0	5.6				166.4
77					6.3	2.3		48.3					56.9
78					1.0	1.7		97.0					99.7
80					.6	.1		123.6					124.3
Total					856.0	456.3	2.0	612.8	65.6				1,992.8

Table D-4. 1983 Crab landings by district.
(in metric tons)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63													
64													
65				425	1,443	820	234	22					2,944
66				414	2,308	1,530	921	40					5,213
67				1,241	4,104	2,795	1,223						9,363
68													
70					3	2							5
71													
73													
75								23	53	6			82
76				12				22	43	3			80
77								20	43	3			66
78								3					3
80								1	6	1			8
Total				2,092	7,858	5,147	2,378	131	145	13			17,764

Table D-5. 1984 Crab landings by district.
(in metric tons)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63													
64													
65				487.4	1,577.6	681.6	72.0						2,818.6
66				649.0	2,027.7	1,223.6	123.8						4,024.1
67				2,877.8	5,344.0	2,779.3	295.0		2.1				11,298.2
68													
70						9.4							9.4
71													
73													
75								23.6	35.9	8.3			67.8
76								18.0	22.5	6.5			47.0
77									19.9	9.5			29.4
78									5.4	.3			5.7
80							.3	.7	16.4	.1			17.5
Total				4,014.2	8,949.3	4,693.9	491.1	42.3	102.2	24.7			18,317.7

Table D-6. 1985 Crab landings by district (preliminary data).
(in metric tons)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63													
64					24.8								24.7
65				566.7	2,128.5	888.2	9.5						3,592.9
66				311.2	1,637.0	871.4							2,819.6
67		4.4		2,958.8	3,999.4	2,740.6	38.6						9,741.2
68					.3								.3
70					18.9	19.7							38.6
71					109.6								109.6
73													
75								1.7	4.6				6.3
76								1.8	3.0				4.8
77													
78				21.7	124.5								146.2
80													
Total		4.4		3,858.4	8,043.0	4,519.9	47.5	3.5	7.6				16,484.2

Table D-7. 1983 Other shellfish landings by district.
(in metric tons)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63							4	6	5	1			16
14	1	1	5	1		12	27	22	25	13	8		115
65					347	274	317	203	281	293	47	46	1,808
66				21	6	42	50	43	287	56	11	1	517
67					5	48	17	42	24	18			154
68				1	5	7	65	38	40	89	195		440
70					7	29	38	25	32	44	6	1	182
71									2	5			7
73						1	9	9	18	98	15		150
75	1		3	3	39	124	90	43	19	10	2		334
76	8				135	135	16	7	27	43	1		372
77				2	106	54	18	22	29	41	27	2	301
78					24	1		3	2				30
80				10	141	37							188
Total	10	1	8	38	815	764	651	463	791	711	312	50	4,614

Table D-8. 1984 Other shellfish landings by district.
(in metric tons)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63					3.4	26.8	41.9	52.4	30.7	47.3			202.5
64	.9	3.6	4.6	2.7		19.6	17.9	23.1	27.0	9.0	1.3		109.7
65					123.1	176.5	131.7	193.9	133.2	393.5	229.7	1.3	1,382.9
66					44.6	59.3	51.6	50.9	57.2	52.5	40.8		356.9
67							.7	12.8	20.1	27.2	3.8		64.6
68				.4	6.6	22.9	81.9	41.3	26.0	19.4	25.7	2.7	226.9
70					6.3	8.1	37.5	40.5	37.1	51.0	34.1	.5	215.1
71	.8								1.6	6.0			8.4
73						10.0	16.9	30.1	25.2	80.2	32.7		195.1
75				.3	67.9	117.1	54.0	22.2	12.4	3.7	1.4	9.6	288.6
76					150.5	96.3	10.2	6.9	2.0	.9			266.8
77					17.8	39.5	7.8	213.6	148.2	7.1	23.2	.4	457.6
78					4.4	3.3	1.1	.6					9.4
80		3.0			247.7	119.4	.2	1.8					372.1
Total	1.7	6.6	4.6	3.4	672.3	698.8	453.4	690.1	520.7	697.8	392.7	14.5	4,156.6

Table D-9. 1985 Other shellfish landings by district (preliminary data).
(in kilograms)

FISHERY DISTRICT	MONTH												TOTAL
	January	February	March	April	May	June	July	August	September	October	November	December	
63						2.9	18.5	6.7					28.1
64					2.4	33.7	30.9	35.2	22.4	.8			125.4
65					119.3	214.0	358.6	458.6	161.6	67.4	98.1		1,477.6
66					22.1	59.6	77.7	63.7	35.4	1.7			260.2
67				.6		15.3	69.0	9.0					93.9
68			.2		2.9	3.1	32.9	15.8	3.3	.5			58.7
70					29.2	32.9	47.6	19.7	11.4				140.8
71													
73					.6		8.3	10.3	5.7				24.9
75					24.2	42.7	5.1						72.0
76				.8	190.9	101.8	.8						294.3
77					21.4	18.4	9.9	8.8					58.5
78				1.4	29.5	10.7		.5					42.1
80				12.2	57.2	14.1							83.5
Total			.2	15.0	499.7	549.2	659.3	628.3	239.8	70.4	98.1		2,760.0