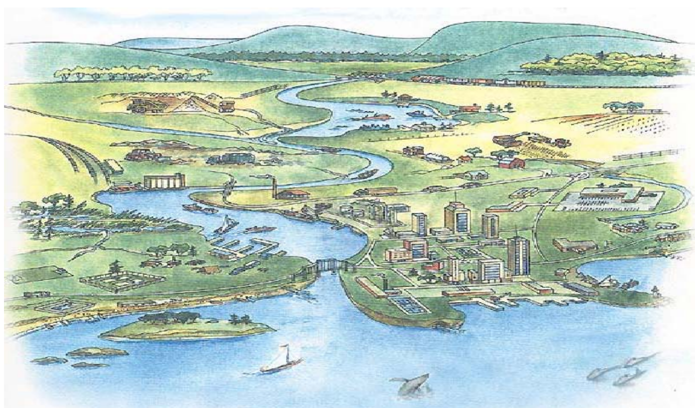
MANAGEMENT OF WASTES FROM ATLANTIC SEAFOOD PROCESSING OPERATIONS



Final Report

Submitted to:
NATIONAL PROGRAMME OF ACTION
ATLANTIC REGIONAL TEAM
Environment Canada Atlantic Region
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Submitted by:
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December 5, 2003

TE23016

December 05, 2003

TE23016

Jeffrey Corkum
Head Pollution Control
Environment Canada Atlantic Region
16th Floor Queen Square, 45 Alderney Drive
Dartmouth, Nova Scotia B2Y 2N6

Dear Mr. Corkum:

Re: FINAL REPORT - Management of Wastes from Atlantic Seafood Processing Operations National Programme of Action – Atlantic Regional Team

AMEC Earth & Environmental is pleased to provide you with our final report of the above noted project. The final report has addressed the objectives of the Project and your comments on the various draft reports, within the constraints of the available data. Where data was not available, these areas were noted and recommendations were suggested that would address these issues.

Should you have any questions regarding the report, please do not hesitate to contact either Peter Lund or the undersigned at (902) 468-2848. Thank you for the opportunity to be of service to Environment Canada.

Sincerely,

AMEC Earth & Environmental Limited,

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ACKNOWLEDGEMENTS

The National Programme of Action Atlantic Regional Team would like to acknowledge and thank those whose efforts assisted in the completion of this report, prepared on behalf of the team by AMEC Earth and Environmental Limited.

Member organisations on the team (representative departments and agencies of the federal and provincial governments) contributed their time, data and information to this exercise and without their co-operation, this publication would not exist.

Individual members of the NPA Atlantic Regional Team dedicated many hours to the review and critique of early drafts of the report, and their assistance is gratefully acknowledged and is reflected in the quality of the final product.

Finally, although the final report was delivered to the Team in print ready condition, editorial changes were necessary to complete the job of preparing the report for distribution. Special thanks are given to M. T. Grant and Jeffrey Corkum of Environment Canada, and to Chris Morry of Fisheries and Oceans for carrying out this work on behalf of the Team.

EXECUTIVE SUMMARY

Canada's National Programme of Action for the Protection of the Marine Environment from Land Based Activities (NPA) responds to an international call to protect the marine environment through co-ordinated actions at local, regional, national and international levels. It also responds to Canadians who expect clean oceans and sustainable development.

In the Atlantic Region, nutrient enrichment from land-based activities has been identified as a priority area for action. Sources of excess nutrients include food processing, municipal and industrial wastewater, agricultural fertilizer runoff, nutrient enriched groundwater, aquaculture operations, and soil erosion from agricultural and forestry practices.

Given the substantial growth that has occurred in the seafood processing industry, almost doubling since 1969, the NPA – Atlantic Regional Team chose to focus a project on seafood processing; the purpose being to gain a better understanding of the waste discharges and potential impacts to the environment from seafood processing operations.

The objectives of this Project are to identify and obtain currently available seafood processing data and to develop a database to facilitate the assessment of the environmental impacts from the seafood processing industry. On the basis of the information gathered, recommendations are provided for eliminating data gaps, as well as for follow up work to refine the sector profiles, and analyze potential impacts.

Literature review and regulatory review

The purpose of the regulatory review was to identify data, directly or indirectly relating to waste discharge, that processors were required to submit and the responsible agency. Therefore, a review of all applicable federal and provincial regulatory requirements relating to licensing/permitting of seafood processing facilities was conducted.

An extensive literature search was also conducted to identify sources of regional or local data on seafood processing and discharges from these facilities. Local and regional libraries were searched through web based search engines and government publications were searched using web-based means. More than 130 documents were examined that relate directly to seafood processing effluent.

Data gathering and compiling

Project staff conducted a thorough search of all available data sources for industry information as well as conducting a consultation program with responsible government agencies from each Atlantic province.

After obtaining all available reports and databases and making relevant government agency contacts, this information was compiled and reviewed for completeness. As part of this review, data from the various sources for the seafood facilities was reviewed for areas of data overlap and also evaluated to determine if some data sources were more current/complete than others.

Analysis

Upon completion of the data entry literature review phases, the newly created database and gathered industry information was reviewed and analyzed. Topics that were considered and summarized included:

- Species and Products
- Types of Seafood Processing
- Details on Production
- Discharge Profiles
- Waste Management
- Receiving Environment

The following objectives of this report have been achieved:

- Federal and Provincial regulatory requirements relating to processing plant licensing/permitting, liquid and solid waste discharges, and chemical usage have been reviewed and summarized;
- available baseline data has been compiled and validated for:
  - number and location of Atlantic Province seafood processing plants;
  - the type of seafood processed in Atlantic facilities, including an assessment of the potential for introduction of invasive organisms (i.e. through larva or pathogen discharge).
  - physical and chemical characteristics, toxicity, volume of discharge, and discharge frequency of effluents from Atlantic seafood processing plants;
- a database of available seafood processing data has been developed for Atlantic Canada (presented in a digital file on the CD-ROM that accompanies this report).

Conclusions and Recommendations

When this project was initiated, it was assumed that the database would contain enough information to provide guidance on which industry sectors created the most waste or the greatest environmental effect. This has not proven to be the case. It was not possible to make any recommendations for specific monitoring of any sector or category of Atlantic seafood processors based on a consideration of the extremely limited data. While some generally applicable data has been offered for the subjects that are lacking site specific data (i.e. data from other regions of Canada), it was not possible to analyze seafood processing plant waste discharge profiles, correlate with species, processing method, season, or finished product. However, based on the various references from other regions of Canada (mainly those of the Fraser River Action Plan (FRAP)) and the limited available data for Atlantic Canada, it was possible to make suggestions for prioritizing targeted site audits or site inspections.

There are inconsistencies in the format of basic data collection between EC the CFIA and the various Provincial departments, which made it difficult to assemble an accurate list of seafood processors. Differences in style and detail of basic information cause uncertainty over the separate identity of each processor listed by each organization. Furthermore, the variety of incompatible digital databases used and the apparent inability of many of these databases to generate data except in hard copy make it extremely difficult to share data easily. There are critical data gaps in the following information:

- data on site specific effluent characteristics;
- plans and specifications for existing seafood processing operations;
- information on detailed production capacity, sequence or seasonality of processing, quantity, and source of raw material;
- site specific data on receiving environments; and
- site specific impacts linked directly to seafood processing waste.

To address these data gaps, the following major recommendations for obtaining necessary data have been put forth:

- regulators review reporting requirements and determine if changes in the types/format of information or data submitted can be standardized. It would be greatly beneficial for the various agencies involved to store information in a common template with the ability to generate data in a commonly accessible digital format.

- *more consistent incorporation of the guideline requirements into permits issued by regional and local regulators, requiring submission of seafood processing plans and specifications to central agency for review and storage in a database. This will provide necessary information for future management of this industry*

- *key data regularly be forwarded by regional regulators to a central agency, as keeper of the data, regarding site specific seafood processing operations for inclusion in a permanently maintained database (such as that which accompanies this report).*

- use of the CFIA QMP as a standard data collection tool for each region, regarding site specific seafood processing operations for inclusion in the database.

- gather preliminary site data through slight modifications in the Shellfish Sanitation Surveys.

- all Atlantic provinces consider implementing effluent water quality testing as a condition of the industrial approval permit following the New Brunswick model.

- design and implement a program of targeted site audits or site inspections to evaluate plant processes and waste handling. The priority for such efforts should reflect the available literature and the limited regional data provided in this report but is mainly based on potential for high volume effluent and high contaminant loading.

- Review potential for invasive organisms to be imported to the Atlantic region through seafood processing activities.

It its anticipated that future work in this sector will include the review of processes and waste discharges at several processing operations, which will in turn lead to the identification of pollution prevention opportunities, and the recommendations for best management practices, sector wide.

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1.0 INTRODUCTION

1.1 Background

This report has been initiated as part of Canada's National Programme of Action (NPA) for the Protection of the Marine Environment from Land-based Activities. The major threats to the health, productivity and biodiversity of the marine environment result from human activities on land including municipal, industrial and agricultural wastes and run-off, as well as, atmospheric deposition. It has been estimated that 80% of the pollution load in the oceans originates from these sources. The NPA responds to an international call to protect the marine environment through coordinated actions at local, regional, national and global levels. Canada's goals under the NPA are to:

- protect human health;
- reduce the degradation of the marine environment;
- remediate damaged areas;
- promote the conservation and sustainable use of marine resources; and
- maintain the productive capacity and biodiversity of the marine environment.

Pursuant to these national goals, the NPA Atlantic Regional Team has undertaken to assess the current state and potential effects of the seafood processing industry in Atlantic Canada. The number of seafood processing plants has increased dramatically in the region since the late 1960's. In 2001, 800,000 tonnes of seafood were landed representing 1.5 billion dollars and direct employment for approximately 30,000 processing workers. This industry is a major contributor of waste effluent into marine waters, however, there is a lack of data relating directly to seafood processing plant waste products. Several studies were completed in the 1970s however little has been done to assess the significance of the environmental impact of seafood processing solid and liquid wastes in the Atlantic Region. Following the example of the Fraser River Action Plan, this project will adopt a sector approach leading to:

- Developing and maintaining an accurate processing plant inventory;
- Characterization of solid and liquid waste discharges;
- Characterization of receiving environment impacts resulting from seafood effluent discharges;
- Cost benefit analysis of promising pollution prevention strategies and pollution control technologies;
- Engaging industry to increase their awareness of the issues, and gain their cooperation to take voluntary corrective action;
- Cooperative inspection and enforcement activities;
- Development of appropriate effluent quality criteria; and
- Revision of existing guidelines (if appropriate).

AMEC Earth & Environmental was awarded the contract to begin this multiphase approach through the development of a comprehensive database for existing seafood processing facilities in the Atlantic region, and to gain a better understanding of the waste discharges from these facilities and the receiving environments.

The focus of this study will be on collecting, compiling, and validating available data on seafood processing facilities. Where relevant data is not available due to time or budget constraints, recommendations will be made for accessing the data. Where relevant data does not currently exist, recommendations will be made for collecting such data. Emphasis will be placed on using existing regulatory information gathering systems to provide available and required data.

1.2 Project Objectives

The objectives of this Project are to identify and obtain currently available seafood processing data and develop a database that will facilitate assessments of the significance of environmental impacts in the Atlantic Region with respect to point source discharges from the seafood processing industry. On the basis of the information gathered, recommendations are to be provided for addressing data gaps, refining the sector profiles, and analyzing potential impacts.

1.3 Project Scope

The tasks that were required to complete this Project were outlined in the NPA Atlantic Regional Team *Statement of Work – Management of Wastes from Atlantic Seafood Processing Operations* (Feb. 6, 2003), and the corresponding AMEC Earth & Environmental proposal (Feb. 13, 2003). They include:

- Review and summarize available Federal and Provincial regulatory requirements relating to processing plant licensing/permitting, liquid and solid waste discharges, and chemical usage;

- Compile and validate available baseline data for:
  - all existing Atlantic Province seafood processing plants and their receiving environments;
  - the type, quantity, and source of seafood processed in Atlantic facilities, including an assessment of the potential for introduction of invasive organisms (i.e. through larva or pathogen discharge);
  - production capacity, as well as sequence of processing, if applicable;
  - physical and chemical characteristics, toxicity, volume of discharge, and discharge frequency of effluents from Atlantic seafood processing plants;
  - sediment quality data at processing plant locations, and the potential for sediment enrichment with organochlorines, metals, or other chemicals from the processing waste;
  - general characterization of receiving environment; and

  - receiving environment impacts linked to seafood processing waste, including available monitoring data for fish waste ocean disposal sites.

- Develop a database of available Atlantic Province seafood processing data;

- Develop Seafood Processing Plant waste discharge profiles, correlated with species, processing method, season, finished product, and other factors (such as receiving environment) that may be found relevant during the course of the project;

- Provide recommendations for filling data gaps; and

- Propose locations for detailed site assessments and effluent sampling for use in validating waste discharge profiles and assessing impacts on receiving environment.

1.4 Approach and Methodology

The primary goal of this project is to establish the current state of the industry with respect to potential environmental impact, and the need for action. In order to achieve this goal, we require a better understanding of processors, processing inputs (raw materials and chemicals) and outputs (including both solid and liquid waste), and receiving environments. The creation of a comprehensive database to address the lack of centralized data related to Atlantic seafood processing plant effluents will facilitate the assessment of the significance of environmental impacts and the development of appropriate waste management and remediation strategies.

The following sections provide an overview of our approach and methodology to carry out the Project and meet the objectives stated in Sections 1.2 and 1.3.

1.4.1 Regulatory Review and Literature Search

The purpose of the regulatory review was to identify the type of data required to be reported by processors to regulatory agencies and to identify the data directly or indirectly relating to waste discharge and the regulatory agencies that are responsible for collecting such data.

Specific data types included:

- number, identity and location of seafood processors;
- species used and products;
- production capacity and schedule of processing activities; and
- site specific effluent characteristics.

The accuracy and completeness of these records was examined to determine if the regulatory databases were current and complete. This exercise also helped to identify major gaps in data required to assess the potential environmental effects of seafood processing waste discharges. As part of this review, all applicable federal and provincial regulatory requirements relating to licensing/permitting of seafood processing facilities were examined. Details of this review of the current regulatory regime of the Atlantic region seafood processing industry are provided in Section 2.0 of this report.

An extensive literature search was conducted to identify sources of regional or local data on the following:

- typical seafood processing effluent characteristics;
- details about the receiving environment (habitat type, sediment and water quality);
- effects of effluent on the environment; and
- potential for seafood processing practices that may cause the introduction of invasive species.

Local and regional libraries and government records were searched through the internet. Many documents and data sets were supplied by the NPA Atlantic Regional Team and other Regulatory agencies. A large number of documents relating directly to seafood processing effluent were examined (See References). Most of these references focused on areas outside Canada and discuss treatment methods for a specific process. Only four documents contained effluent data from the Atlantic region but several more publications contained generally relevant information for other regions of Canada and the northeastern United States.

1.4.2 Data Collection and Agency Consultation

The most critical task associated with this Project was the collection of existing data and information of the seafood processing facilities in the region from the various agencies that regulate the industry. Sources of organized data were identified including digital databases and hard copy files. Environment Canada facilitated collection of data from other government departments through NPA Atlantic team members. AMEC was provided with existing industry reports and information, and contacts for relevant government agencies.

AMEC Project staff conducted a thorough search of all available data sources for industry information as well as conducted a consultation program with the responsible government agencies in each Atlantic Province. The details of these agency consultations are outlined in Table 1.1.

1.4.3 Compilation, Review and Validation of Existing Data

After obtaining all available reports and databases and making relevant contacts as outlined in Section 1.1, this information was compiled and reviewed for completeness by AMEC staff. As part of this review, data from the various sources for the seafood facilities was reviewed for areas of data overlap and also evaluated to determine if some data sources were more current/complete than others. This data validation process is critical to determine the accuracy of the data and the levels of confidence that can be applied to each database.

Table 1.1: Agency Consultation

Organization	Subject / Regulation	Data Provided
Environment Canada	**Shellfish Sanitation Program, Maritime Region / Management of Contaminated Fisheries Regulations (Fisheries Act)**	**Shellfish Sanitation Survey Data for 271 sites in NB, NS, and PEI. No data available for NL**
	Ocean disposal permits / Canadian Environmental Protection Act, 1999 (Part 7, Division3, Disposal at Sea)	**Data on Ocean Disposal permits for fish processing sites in Atlantic Canada**
Canadian Food Inspection Agency	**Quality Management Plans**	**No site specific data available**
Fisheries and Oceans Canada	**HADD issues from fish processing effluent / Fisheries Act**	**No site specific data available**
Health Canada	**Chemical additives in seafood processing**	**Chemicals approved as additives in seafood processing**
Transport Canada	**Marine Pollution Prevention / Fisheries Act**	**Not applicable – only relates to spills from vessels at sea**
NL Department of Environment	**Industrial compliance Certificate of Approval / Environment Act**	**Data for fish meal plants and seal processing facility only**
	Water quality monitoring / Environment Act	**None available**
NL Department of Government Services and Lands	**Fish processing plant effluent discharge approval / No specific regulation**	**Not Applicable**
NL Department of Fisheries and Aquaculture	**Fish Processing plant licenses / Fish Inspection Regulations (Fish Inspection Act)**	**NL Fish Processor license data**
PEI Department of Fisheries, Aquaculture and Environment	**Fish Processing plant licenses / Fish Inspection Act**	**PEI Fish Processor directory data (includes all licensed operators)**
	Pollution Prevention Program / Environmental Protection Act	**None available**
	Water Resources Program / Environmental Protection Act	**None available**
NB Department of Agriculture, Fisheries and Aquaculture	**Fish Processing plant licenses / Fish Processing Act (General Regulation)**	**NB Fish Processor license data**
	Fish Processing plant inspections / Fish Inspection Act (General Regulation)	**Not Applicable**
NB Department of the Environment and Local Government	**NBDELG GIS database / No specific regulation**	**NB water quality GIS records**
	Water Quality Approval / Water Quality Regulation (Clean Environment Act)	**NB water quality approval permit data**

Organization	Subject / Regulation	Data Provided
NB Department of Health and Wellness	**Buyers license inspection program / Fish Inspection Act (General Regulation)**	**None available**
NS Department of Fisheries and Agriculture	**Fish Processing plant licenses / Fish Inspection Regulation (Fisheries and Coastal Resources Act)**	**NS Fish Processor license data**
NS Department of Fisheries and Agriculture	**NS Fish Processor Directory / No specific regulation**	**NS Fish Processor directory data**
NS Department of the Environment & Labour	**NS Industrial Plant /Facilities Approval / Activities Designation Regulation**	**Data on approvals issued to processors discharging into inland waters**
Fisheries Association of Newfoundland and Labrador	**Industry standards /Best Management Practices**	**No site specific data available**
Nova Scotia Fish Packers Association	**Industry standards /Best Management Practices**	**No site specific data available**
PEI Seafood Processors Association	**Industry standards /Best Management Practices**	**No site specific data available**
National Seafood Sector Council	**Waste water management Best Management Practices**	**No site specific data available**

Up to six separate listings of seafood processors was obtained for each province as follows:

- Provincial processor license list (all provinces);
- Provincial water quality permit list (NB)
- Provincial business directory (NB, NS, PEI);
- Federal import/export registry (all provinces);
- Shellfish sanitation program (SSP) survey observations (271 sites); and
- Environment Canada list (369 sites).

There are differences in the number of processors in each list for several reasons. While many differences are due to the nature of each database, many processors are identified somewhat differently in each list. For example, the proper title of the processor has been changed slightly in several lists and some entries do not reflect recent changes in ownership. Some processors appear with English titles in one list but French titles in another list. Some lists identify each plant owned by a single company while other lists only identify each company once. Several lists contain companies that are not seafood processors but only buy or sell seafood.

Data formats within each listing are not consistent. The locations given for each processor sometimes represents the plant location but may instead represent the address of the owner. Geographic co-ordinates were not identified for all sites and several co-ordinates have been derived from the location named in the list, which may not be the actual plant location.

Also, it is possible that many sites that are currently listed in the various data sets are not operating at present. The operating status of many plants changes annually based on changes in both the market conditions and the fishery but plant owners are still licensed.

1.4.4 Information Assembly and Data Entry

This compiled and validated information was then assembled and entered into the Project electronic data template. This data template was provided as part of the original Environment Canada Statement of Work. This data template was re-created in Microsoft Excel spreadsheets to provide a versatile database for the future inventory of facility information as well as providing a tool for the evaluation of industry data. This data entry system allows the Project data collected by the AMEC to be summarized and interpreted on a macro and micro scale. The compiled data is presented in a digital file on the CD-ROM that accompanies this report.

1.4.5 Database Review and Interpretation

Upon completion of the data entry phase, the newly created database was reviewed and analyzed. Analysis of the data was conducted with the intent to achieve the objectives of the Project as outlined in Section 1.1. Where significant data gaps existed that precluded this level of analysis, these data gaps were highlighted and recommendations were then put forward on how these data gaps should be addressed in the future to complete the database. These recommendations are outlined in detail in later sections of this report.

The database template is presented in Appendix A, which includes notes on information sources, data gaps. Recommendations for resolving data gaps are provided in Section 5.

2.0 REGULATORY REVIEW

The following section describes the regulatory environment for seafood processing effluent discharges into the environment. Regulatory control of wastewater discharges relies mainly on federal and provincial statutes, which require specific authorization for discharges of this type (see Table 2.1). There are an unknown number of plants operating under long-term agreements, which predate current legislation. In general, provincial approvals are primarily based on the federal Fish Processing Operations Liquid Effluent Guidelines (1975) when issuing approvals.

2.1 Federal Acts and Regulations

2.1.1 *Fisheries Act*

The federal Minister of Fisheries and Oceans has the legislative responsibility for the administration and enforcement of the *Fisheries Act*, which contains provisions dealing with the effects of seafood processing facility effluents in the environment; the Habitat Provisions (Section 35) and the Pollution Prevention Provisions (Section 36). Environment Canada has been assigned responsibility for administration and enforcement of the pollution prevention provisions of the Act that deal with the deposit of deleterious substances into water frequented by fish. In 1985 a *Memorandum of Understanding* between the Department of Fisheries and Oceans (DFO) and the Department of the Environment (DOE) was signed, outlining the responsibilities of DFO and DOE for the administration and enforcement of the pollution prevention provisions of the *Fisheries Act*. Environment Canada (EC) has the lead responsibility for advancing pollution prevention technologies; promoting the development of preventative solutions; developing and evaluating the effectiveness of regulations and other instruments, and for the pollution prevention initiatives that support compliance with the *Act*. EC is also responsible for liaising with the provinces, territories, industry, other government departments and the public on issues relating to the pollution prevention provisions of the *Fisheries Act*, and must consult with DFO on matters relating to the development of regulations concerning the administration of the pollution prevention provisions.

Section 36(3), of the *Fisheries Act,* which prohibits the deposit of deleterious substances into waters frequented by fish, has traditionally been utilized as a first defense against pollution impacting the marine environment, and therefore would relate to effluent from seafood processing facilities. Subsection 36(5) includes the provision for Federal regulations to authorize certain discharges, however no such regulations exist for the seafood processing sector. Also, Section 36 (1) (b) prohibits the deposit of the remains or offal of fish on the shore between high and low water marks, which could have implications for some processors.

Where pollution impacting the marine environment can clearly be demonstrated to have caused a harmful alteration, disruption or destruction of fish habitat (HADD), Section 35 of the Act can be invoked. This Provision of the Fisheries Act is administered by DFO.

Table 2.1: Summary of Regulations Directly Related to Fish Processing Plants

Jurisdiction	Department / Agency	Act	Regulation	Required Approvals / Prohibitions	Data submission requirements	Contact	Comments
Federal (all fish bearing waters)	Canadian Food Inspection Agency (CFIA)	Fish Inspection Act	Fish Inspection Regulations	Registration Certificate (Renewed annually)	Contact data Physical description of the plant: ▪ Location ▪ Dimensions ▪ Equipment Type of fish species and products production schedule	CFIA Regional Offices (NL)(709)722-4424 (PEI)(902)566-7290 (NB)(506)452-4057 (NS)(902)742-0862 (NS)(902)426-4567	Processors are required to implement a Quality Management Plan (QMP) that meets standards set out in the CFIA Inspection Manuals / Codes of Practice. The QMPs are reviewed annually by CFIA for approval but are not filed or recorded. The QMPs are returned to each processor.
	Fisheries and Oceans (DFO) And Environment Canada (EC)	Fisheries Act (General Prohibitions)		Subsection 36(3) prohibits the deposit of deleterious substances into waters frequented by fish, Subsection 36(5) provides for authorization to discharge deleterious substances in specified quantities or under specified circumstances	The Fish Processing Operations Liquid Effluent Guidelines suggest detailed map and plans of new or expanded plants be submitted to EC for review prior to construction including the location of drains and sewers, and details of the liquid effluent treatment system, operating capacity, water usage, and sources of contaminated and clean process water.	DFO Gulf Region, Assessment Section (506)851-2978	No set limits are provided for possible pollutants from fish processing, however, Fish Processing Operations Liquid Effluent Guidelines have been developed under the Fisheries Act. The Guidelines indicate the minimum level of effluent controls considered necessary to the federal government. Generally, screening and discharging through an outfall below low tide has been acceptable.
	DFO	Fisheries Act			Processors are required to submit annual data on fish purchases and total production. Production data is divided by species and product type.	DFO Gulf Region, Statistics Division (506)851-7822	Data for fish purchases is stored in a separate database than total production. Production data can only be output as hardcopy.
		Oceans Act	MEQ guidelines, criteria and standards to protect marine ecosystem health within an Integrated Management Plan	Targets, limits and corrective actions will be specified in the management plan for each integrated management area	Could be specified in management plan		
	Environment Canada (EC)	Canadian Environmental Protection Act, 1999 (Part 7, Division 3, Disposal at Sea)		Ocean Disposal Permit	Type and amount of waste	EC Atlantic Region, Waste Management & Remediation Section (902)426-8305 EC Atlantic Region, NL Provincial Office (709)772-4047	Ocean disposal sites are specified by EC based on environmental criteria and monitored to ensure that the permit conditions are met by the permit holder and that the assumptions made during the permit review and site selection process are correct and sufficient to protect the environment
		Canadian Environmental Protection Act (*CEPA*), 1999		Required implementation of a pollution prevention plan	Water quality for parameters identified in the *CEPA* List of Toxic Substances (Schedule 1)		EC can require a facility to prepare and implement a pollution prevention plan if effluent contains any chemicals identified in the *CEPA* List of Toxic Substances (Schedule 1)
	DFO, CFIA, EC (Shellfish Sanitation Program)	Fisheries Act	Management of Contaminated Fisheries Regulations	Shellfish harvesting is prohibited in contaminated areas	Site specific data on shoreline structures and visible contaminant sources	EC Atlantic Region, Shellfish Section (902)426-9003 EC Atlantic Region, NL Provincial Office (709)772-4269	Responsibility for the program is divided as follows: ▪ EC monitors water quality in shellfish growing areas ▪ CFIA monitors harvested shell fish for contaminants ▪ DFO enforces closures and controls harvesting EC is responsible for pollution prevention provisions of the Fisheries Act
	Canadian Environmental Assessment Agency	Canadian Environmental Assessment Act (CEAA)		Environmental screening required for new facilities which will discharge effluent into fish bearing waters			The potential for harmful alteration, disruption or destruction (HADD) of fish habitat triggers a federal screening under *CEAA*

Table 2.1: Summary of Regulations Directly Related to Fish Processing Plants

Jurisdiction	Department / Agency	Act	Regulation	Required Approvals / Prohibitions	Data submission requirements	Contact	Comments
Federal	Health Canada	Food and Drugs Act	Food and Drugs Regulations, Divisions 1, 16, and 21	Use of food additives restricted to those listed in Division 16.		Health Canada, Food Directorate (613)957-1700	Seafood products for export may include additives not approved in Canada provided the laws of the export country are not contravened. Chemicals may be in use as "processing aides" which are not regulated under the Food and Drugs Act. Processing aides are used to enable additives or processes but which do not leave residues in the seafood product.
New Brunswick	Agriculture, Fisheries and Aquaculture (NBDAFA)	Fish Processing Act	General Regulation	Fish Processing License (Renewed annually)	Contact data Workforce data Raw material source Physical description of the plant: ▪ Location ▪ Dimensions ▪ Fish species and processing type ▪ production capacity	Registrar, Fish Processing Section (506)453-2252 Fish Inspection (Regional Unit) (506)755-4000	
	Health and Wellness	Fish Inspection Act	General Regulation	Buyers License (Renewed annually)	Contact data Raw material source Fish species and processing type production capacity	Public Health (Regional Sub-office) (506)755-4022	The Fish Inspection Act is expected to be repealed soon with additions to the Public Health Act
	Environment and Local Government (NBDELG)	Clean Environment Act	Water Quality Regulation	Water Quality Approval Permit (Renewed every 5 years)	Effluent volume and chemistry data including: BOD, COD, SS, total Kjeldahl nitrogen-phosphorous-ammonia, pH, and grease.	Resource Sector (Section) (506)453-6532 Materials & Standards (Section) (506)453-3784	NBDELG is currently investigating methodologies for development of water quality guidelines for industrial effluent
Newfoundland & Labrador	Fisheries and Aquaculture (NLDFA)	Fish Inspection Act	Fish Inspection Regulations	Fish Processing License (Renewed annually)	Contact data Marketing data Raw material source Physical description of the plant: ▪ Location ▪ Dimensions ▪ Equipment ▪ production and storage capacity	Fisheries Branch (709)729-3719	No new applications for primary processors are being considered at this time. New licenses are considered for sole source aquaculture fish processing.
	Environment (NLDoE)	Environmental Protection Act		Certificate of Approval	Site specific data at the discretion of NLDoE staff	Pollution Prevention (709)729-5782	Applies only to Seal Processing Facilities and Fish Meal Plants
		Environmental Assessment Act	Environmental Assessment Regulations	Approval (Release)	Site specific data at the discretion of NLDoE staff	Environmental Assessment Division (709)729-2562	
Nova Scotia	Agriculture and Fisheries (NSDAF)	Fisheries and Coastal Resources Act	Fish Inspection Regulations	Fish Processors License (Renewed annually)	Contact data Proof of regulatory compliance Raw material source Physical description of the plant: ▪ Location ▪ Dimensions ▪ Type of fish species and products ▪ production capacity	Legislation And Compliance Services (902)424-0335	
	Environment and Labour (NSDEL)	Environment Act	Activities Designation Regulations	Industrial Plant / Facilities Approval (Renewed every 10 years)	Site specific data at the discretion of NSDEL staff	Environmental Monitoring And Compliance (902)679-6086	See below
			Environmental Assessment Regulation	Environmental Assessment Approval	Site specific data at the discretion of NSDEL staff	Environmental Monitoring And Compliance (902)679-6086	Some activities require an Environmental Assessment Approval prior to the issuance of an Industrial Plant / Facilities Approval

Table 2.1: Summary of Regulations Directly Related to Fish Processing Plants

Jurisdiction	Department / Agency	Act	Regulation	Required Approvals / Prohibitions	Data submission requirements	Contact	Comments
Prince Edward Island	Fisheries, Aquaculture and Environment (PEIFAE)	Fish Inspection Act		Fish Processors License (Renewed annually)	Contact data Process water source Raw material source Physical description of the plant: ▪ Location ▪ Dimensions ▪ Equipment ▪ production and storage capacity Workforce data	Fisheries & Aquaculture, Manager of Services (902)368-5259	
		Fisheries Act			Monthly Fishery Reports are required from fish and shellfish processors of species type and amount of products	Fisheries & Aquaculture, Program Statistics Officer (902)368-5248	Several processors are not consistent in reporting regularly. These reports include the source of raw material as local or "off island" but do not include the volume received.
	Environment & Energy (PEIDE&E)	Environmental Protection Act		▪ Approval to discharge into fresh water ▪ Environmental Assessment Approval	Site specific data at the discretion of PEIDE&E staff	Water Management Div. (902)368-5043	No existing seafood processing plants currently require provincial environmental approvals

2.1.2 *Oceans Act*

The *Oceans Act* (1997) contains provisions for the Minister of Fisheries and Oceans to lead the development and implementation of a national strategy for oceans management based on the principles of:

- sustainable development;
- integrated management of activities affecting estuaries, coastal and marine waters; and
- the precautionary approach.

The *Act* provides some basic authorities and management tools to be used within the context of integrated management plans, including the establishment and enforcement by regulation of Marine Environmental Quality (MEQ) guidelines, criteria and standards designed to conserve and protect ecosystem health. In this context, regulations under the *Oceans Act* could be used to prevent the degradation of marine environmental quality resulting from fish plant effluent and/or the cumulative impacts of industrial and municipal effluents, within an integrated management area.

Fish Processing Operations Liquid Effluent Guidelines (1975) for seafood processors were established in 1975. There are two stated objectives of the guidelines:

- To provide a basis for reviewing plans for liquid effluent control from new fish processing or fish meal operations and plans for alterations to or extensions of existing fish processing or fish meal operations as outlined in section 37 (1) of the *Fisheries Act*; and

- To be used for determining the requirements for existing fish processing or fishmeal operations to meet an acceptable level of liquid effluent control.

To meet the objectives, the guidelines intend for fish processing facilities to apply the principal of best practical treatment technology to their liquid effluents. The guidelines indicate that this includes screening the effluents for solids removal, well-designed outfall discharging below low tide, the recovery of certain high strength wastes associated with fish meal processing, and good housekeeping. Where the discharge of treated liquid effluents leads to a deterioration of the receiving water quality, the guidelines note that the fish processing operation may be required to install more advanced liquid effluent treatment.

While the guidelines recommend "a suitable method for metering the flow of contaminated process water should be available", there is no regulatory requirement for processors to record or submit such data to regulatory agencies and currently there is no such database. No other information about existing operations is required under the guidelines. Some information about plans and specifications including information on outfalls, drains and sewers, liquid effluent treatment is collected in the CFIA Quality Management Plans (See Section 2.1.3).

The guidelines suggest that plans and specifications for new facilities or alterations or extensions of existing seafood processing operations be submitted to Environment Canada for review and that they should include the following:

- A map showing the location of the operation and all outfalls in relation to the existing facilities and natural features.;
- A plan of operation layout showing the location of drains and sewers;
- The proposed liquid effluent treatment system including its location and size;
- Proposed operation capacity and anticipated water usage; and
- An indication of the sources of contaminated and clean process water.

While plans and specifications such as these have been submitted to provincial regulators as part of the provincial requirements for industrial approvals, there is no record of regular submissions to EC regional staff in this respect. Records were only available for four sites in Nova Scotia, which contained variable levels of detail and were somewhat deficient in addressing the last two bullets above.

2.1.3 The Canadian Environmental Protection Act

The *Canadian Environmental Protection Act*, 1999 (CEPA 1999) is an *Act* respecting pollution prevention and the protection of the environment and human health in order to contribute to sustainable development. The *Act* provides the federal government with new tools to protect the environment and human health, establishes strict timelines for managing toxic substances and requires the virtual elimination of releases to the environment from toxic substances, which are bioaccumulative, persistent, and result primarily from human activity.

For substances that are found "toxic" under CEPA 1999 and are added to the List of Toxic Substances in Schedule 1 of the *Act*, Environment Canada and Health Canada must propose an instrument to establish preventive or control actions for managing the substance and thereby reducing or eliminating risks to human health and the environment posed by its use and/or its release into the environment. Certain substances that may be found in seafood processing waste, such as chlorinated wastewater, inorganic chloramines, and ammonia dissolved in water, have been added to Schedule 1. A risk management strategy for these substances is under development, with initial focus on municipal wastewater effluents, the principal source of discharges containing these substances.

Protection of the Marine Environment from Land Based Sources of Pollution

Part 7 Division 2 of CEPA (1999) enables the Minister to issue environmental objectives, guidelines, and codes of practice to prevent and reduce marine pollution from land based sources. Canada's National Programme of Action for the Protection of the Marine Environment from Land-based Activities (NPA) establishes Canada's goals and priorities for protection of the marine environment. In 2001, the first report on implementing NPA was produced. The highest priority issues for the Atlantic region were identified as sewage and litter. Nutrients (other than sewage) were considered to be a medium to high priority. Food processing plant effluents, including fish plants contribute to the nutrient loadings in the region. The NPA objectives for nutrients are to encourage industries to switch to better management practices, monitor the effects of finfish aquaculture, and promote community-based solutions.

2.1.3.1 Canadian Environmental Assessment Act

Any new construction of seafood processing facilities that would discharge effluent into fish bearing waters would require an environmental screening under the *Canadian Environmental Assessment Act* (*CEAA*). The trigger would be federal jurisdiction over all fish bearing waters and the potential for deposit of deleterious substances into those waters. There may also be federal jurisdiction over aquatic species at risk and their critical habitat under the recent *Species at Risk Act*.

2.1.3.2 Ocean Disposal Program

Fish waste is an approved substance for disposal at sea ("the deliberate disposal at sea of approved substances from ships"). While in NB, NS and PE, ocean disposal is a last resort for the "management" of seafood processing waste, the practice still does continue in NL where isolated plants cannot feasibly transport extremely large volumes of fish plant waste to a fish meal plant or land-based waste disposal site. Environment Canada administers the Ocean Disposal Program by means of a permitting process under authority of the *Canadian Environmental Protection Act* (*CEPA*) 1999, Part 7, Division 3, Disposal at Sea. All proposed ocean disposal projects are reviewed under CEAA and are registered in an on-line public registry. Following public notification and review by Environment Canada, with advice from the Regional Ocean Disposal Advisory Committee, an ocean disposal permit is issued for the proposed project.

Ocean disposal sites are designated according to selection criteria established by CEPA 1999. The disposal site selection criteria include:

- location of fishery resources and habitat;
- interference with marine use in the area;
- evaluation of mixing and transport characteristics of the site; and
- feasibility of monitoring the disposal site.

Disposal site monitoring is part of the Ocean Disposal Control Program and serves to ensure that the permit conditions are met by the permit holder and that the assumptions made during the permit review and site selection process are correct and sufficient to protect the environment. Ocean disposal permits require that information on type and volume of waste disposed of by each permit holder be submitted on completion of the permitted disposal activity.

2.1.4 Shellfish Sanitation Program

Under the *Management of Contaminated Fisheries Regulations* (*Fisheries Act*), and *Fish Inspection Regulations* (*Fish Inspection Act*), the Canadian Shellfish Sanitation Program classifies shellfish growing areas for their suitability for shellfish harvesting on the basis of sanitary quality and public health safety. Many seafood processing plants include coastal structures such as wharves and visible outfalls. At all locations where such structures are near potential shellfish growing areas, a shellfish closure of at least 125 m radius is ordered due to potential contamination from industrial effluent and from vessels and wharf activities. In this program, DFO may issue orders prohibiting harvesting of fish (finfish and shellfish) from areas where any kind of contamination or toxicity is present to an extent to be of public health significance. Typically, seafood plants discharge within harbor areas where larger shellfish closures already exist. Environment Canada administers the pollution abatement section 36(3) of the Fisheries Act and conducts coastal surveys and water quality monitoring as part of this program. Surveys are conducted semi-annually and currently are not focused on identifying the types of industrial outfalls, however, incidental observations have identified visible outfalls from seafood processing plants at approximately 250 sites in the Maritime Provinces. No survey observations in Newfoundland & Labrador can be definitely linked to seafood processing. Water quality monitoring data has not been collected for any of the positively identified seafood processor locations.

2.1.5 Canadian Fish Inspection Act

The Canadian Food Inspection Agency (CFIA) administers a registration program under the federal *Fish Inspection Act* for processors that import or export fish products nationally (between provinces) or internationally. The Fish Inspection Act and regulations provide process standards including detailed definitions of processed fish products. The purpose is to ensure acceptable standards in product quality, safety and identity of fish and seafood products. Seafood processors are required to adhere to the CFIA Codes of Practice in order to obtain a registration certificate. The codes of practice include manuals of standards and methods for processing of fish and fish products, packaging and labeling, use of chemicals, bacteriological analysis, and inspection of fish and fish processing facilities. The following documents form the core of the CFIA guidance for seafood processors:

- Fish Products Standards and Methods Manual
- Fish Products Inspection Manual - Policies and Procedures
- Facilities Inspection Manual
- Canadian Shellfish Sanitation Program - Manual of Operations
- Chemical Methods Manual
- Flexible Retort Pouch Defects Manual
- Metal Can Defects Manual
- Standard Procedures for Bacteriological Analysis Manual
- Canada's National Fish and Fish Products Inspection and Control System
- Label Inspection Guide for Fish and Fish Products
- List of Canadian Acceptable Common Names for Fish and Seafood

The Quality Management Program (QMP) requires all federally registered seafood processors to develop and implement an in-plant quality control program. Canada's Quality Management Program (QMP) began in February 1992 and a re-engineered QMP format became mandatory in 1997. Each processor is required to develop and maintain a QMP, following the "QMP Reference Standard"; submit it to the CFIA for review and acceptance; and apply it to their processing operations. All operating processing plants have an approved QMP and are inspected every three to six months depending on the risk of product contamination. The QMP is composed of three major sections as follows:

- All plants must meet basic requirements for plant sanitation and hygiene and have effective recall procedures. An effective method of achieving this is through the Prerequisite Plan. The Prerequisite Plan focuses on cleaning agents, sanitizers and lubricants, construction and equipment, operation and sanitation, storage, and recall procedures.
- The Regulatory Action Point (RAP) Plan will also be common to all plants, but will differ according to the processing operation and product. The RAP Plan focuses on incoming fish, ingredients, packaging material, labeling, and final product.
- The Hazard Analysis Critical Control Point (HACCP) Plan will apply only to process operations that have identified "significant hazards" in their process and/or products. Each HACCP plan will be unique to each operation and will focus on process controls and employee qualifications.

The approved QMPs are returned to the processors and are not kept by the CFIA, nor is there a database of this information. There is no environmental protection mandate within this legislation and no information is required from the processors regarding liquid or solid waste except where waste storage/treatment facilities are located within the plant and may come in contact with the product.

2.1.6 Canadian Food and Drugs Act

The additives used by seafood processors are regulated by Health Canada under the Canadian *Food and Drugs Act*. The Health Protection Branch of Health Canada maintains a list of approved additives and the maximum level of use for each food type. The CFIA Fish Products Standards and Methods Manual (1995) includes a summary of 216 additives approved for use in fish processing (See Appendix B). Unlisted additives must be approved first by Health Canada under Division 16 of the Food and Drugs Act and added to the tables in Section B.16.100 of the Act. Only one new additive, ascorbyl palmitate (a preservative), has been approved for seafood processing since 1995. Many chemicals are not given specific maximum level of use but are required to adhere to good manufacturing practices meaning that use of the additive should be limited to the smallest amount necessary to achieve the processing effect.

Seafood products that are for export only may include the use of additives that are not approved in Canada provided that the laws of the export country are not contravened. The procedure for processing food for export only is regulated under Section 37 of the Food and Drugs Act but there is no requirement to identify additives used. Also, a number of chemicals may be in use as "processing aides" which are not regulated under the Food and Drugs Act. Processing aides include chemicals that are used to enable additives or processes but which do not leave residues in the seafood product. Data on use of non-approved additives or processing aides was not available for this report but these chemicals may be identified in the QMPs (See Section 2.1.4). The CFIA maintains a Reference Listing of Accepted Construction Materials, Packaging Materials and Non-Food Chemical Products, which identifies thousands of trade chemicals that have been found acceptable for use in establishments operating under the authority of the CFIA. These chemicals include:

- Barrier Creams:
- Cleaners such as general cleaners, hand cleaners, cleaners for non-food handling areas and for personal hygiene, and drain cleaners;
- Decharacterizing agents;
- Denaturing agents;
- Deodorizers;
- Disinfectants;
- Lubricants such as hydraulic and protective oils;
- Maintenance aid products such as floor drying compounds, and anti-freeze;
- Microbial control agents for use in fish process water & can cooling:
- Pesticides:
- Processing aids such as bleaches/scalding/compound, desiccants, filters and filtration agents, antifoam agents, and descaling;
- Refrigerants / heat exchanger agents: and
- Sanitizers.

Use of veterinary drugs in aquaculture is also regulated under the Food and Drugs Act where drugs are administered to fish species orally through feed or other mechanisms. Dosages and withdrawal times for veterinary drugs must be followed as indicated in the veterinary prescription or, if a prescription is not required, in the Compendium of Medicating Ingredient Brochures published and maintained by the CFIA. Ten drugs are currently approved by Health Canada for use in aquaculture. The CFIA Fish Products Standards and Methods Manual (1995) includes a bulletin (No. 8) summarizing these drugs and their approved usage (See Appendix B). Typically fish have been withdrawn from drug therapy long enough prior to processing when all drugs have passed through their systems. When fish have not been isolated for an appropriate amount of time, samples are required to assess if the drug levels in fish are acceptable prior to processing.

2.2 Provincial Acts and Regulations

The regulatory framework for industrial effluent discharges is unique for each of the Maritime Provinces (refer to Table 2.1). Provincial environmental regulations controlling industrial effluent are generally focused on the freshwater environment and discharges into the coastal/marine environment are considered to be shared jurisdiction with emphasis on federal management. Due to the higher priority the Provinces place on fresh water resources, there has not been any monitoring of seafood plant discharges into marine waters with the exceptions noted in two provinces (see 2.2.1 and 2.2.2). Any new construction or major modifications of seafood processing plants would require some form of environmental assessment (EA) in each province except NL. Approval of an EA could necessitate the attachment of conditions including requirements for wastewater monitoring or treatment. Such projects have been rare in recent times with more emphasis on utilizing existing capacity.

All provinces require licensing to operate a fish processing plant (refer to Table 2.1), under some form of fish inspection legislation, in order to aid fishery resource management, ensure product quality, and help develop and maximize economic benefits. The provincial licensing processes are very similar and license applications/renewals require submission of general information on species and processes proposed and the general estimates of production volume and schedule. Each province maintains a database containing contact information, location (for most sites) and species approved for use by seafood processors, but other information is only stored in paper files. It should be noted that the actual species being processed does not necessarily include all species identified in provincial permits. Processors will only use species (within those permitted) that can be feasibly obtained and marketed. Since raw fish prices and product market prices are constantly fluctuating, processors frequently process only some of the species permitted. While all the provinces require processors to submit production estimates as part of the license application, only Prince Edward Island requires processors to submit a monthly statement of actual production. No information is required from the processors regarding liquid or solid waste.

2.2.1 New Brunswick

The NB Department of Agriculture, Fisheries, and Aquaculture (NBDAFA) requires seafood processors to obtain a Fish Processing License under the *Fish Processing Act* (*General Regulations*). The license must be renewed annually and includes submission of process data including type and volume of production. Processors are subject to inspection by NBDAFA staff.

The *Environmental Impact Assessment Regulation* under the *Clean Environment Act* requires that certain undertakings (listed in a schedule to the *Regulation*) be registered with the NBDELG to determine if a formal environmental impact assessment (EIA) is necessary to assess the nature and significance of the potential impacts through further study. Construction or significant modifications of seafood processing plants could trigger a provincial EIA, depending on the daily water use.

The NB *Clean Environment Act* requires anyone discharging a contaminant to obtain approval from the NBDELG. A contaminant is very broadly defined and essentially includes anything, which is in excess of the natural constituents of the environment. All seafood processing plants that discharge effluent into fresh or coastal waters are required to obtain a water quality approval permit under the *Water Quality Regulation* of the *Clean Environment Act*. This regulation makes no distinction between sources of contamination and includes any industries and activities. Permits are granted following an environmental review conducted by staff of NBDELG and are accompanied by conditions, which control the quality and quantity of contaminants that may be discharged from each facility. These permits must be renewed every five years. There are a number of specific requirements for seafood processing plants under this approval system based on the class of contamination source represented by each site. The classification system and associated requirements are presented in Table 2.2.

Table 2.2: NB Seafood Processing Plant Requirements

Class	Effluent Discharge (m^3/day)	BOD (tonnes/year)	TSS (tonnes/year)	Minimum Required Screen Size	Additional Requirements
1A	> 20 000	> 2000	> 2000	25 mesh (0.71 mm)	-log book -alarm system in pump pit -3 mm (1/8 inch) screen prior to final discharge -outfall of effluent pipe below low water level
1B	10 001 – 20 000	401 - 2000	401 – 2000	25 mesh (0.71 mm)	same as above
2	1001 – 10 000	41 - 400	41 – 400	25 mesh (0.71 mm)	same as above
3	101 – 1000	1 – 40	1 – 40	3 mm (1/8 inch) or 25 mesh (0.71 mm) in the discretion of the Department	-outfall of effluent pipe below low water level -other requirements at the discretion of the Department
4	< 100	0 – 1	0 – 1	3 mm (1/8 inch)	-outfall of effluent pipe below low water level -other requirements at the discretion of the Department

In the past, NBDELG generally tested effluents from approximately 20 fish processing facilities per year. Under the new system, all facilities will be expected to do their own testing; however, NBDELG will continue to perform audits with their own testing. Beginning in 2003 and during each processing season thereafter, the Approval Holder shall obtain 3 grab samples of the Contaminated Process Water from the final effluent discharge location during the peak production periods and on non-consecutive days. The grab samples shall be submitted to a certified laboratory for testing. By November 30 of each year, the Approval Holder shall submit to NBDELG a Contaminated Process Water Report outlining the results of the sampling and testing of each grab sample obtained. The report shall contain as a minimum:

- the volumetric flow rate of the Contaminated Process Water in cubic metres per day (m3/day);

- the BOD loading in kilograms per day (kg/day);
- the COD loading in kilograms per day (kg/day);
- the SS loading in kilogram per day (kg/day);
- the Total Kjeldahl Nitrogen, Phosphorous and Ammonia in milligrams per litre (mg/L);
- the pH; and
- the grease concentration in parts per million (ppm).

The NB Department of Health and Wellness has taken responsibility for the human health and safety provisions of the *Fish Inspection Act*. It is expected that soon this *Act* will be repealed and similar provisions will be added to the *Public Health Act*. These provisions require "provincial" processors (i.e., those who are not inspected by the CFIA) to obtain a Buyers License, under the *Fish Inspection Act* (*General Regulation*). There is no wildlife habitat protection mandate within these provisions and information that is required from seafood processors regarding liquid or solid waste is restricted to potential effects on humans.

2.2.2 Newfoundland & Labrador

The NL Department of Agriculture, Fisheries, and Aquaculture (NLDAFA) require seafood processors to obtain a Fish Processing License under the *Fish Processing Act* (*General Regulations*). The license must be renewed annually and requires submission of species and process proposed and estimated volume of production and schedule. Processors are subject to inspection by NLDAFA staff.

New construction or significant modifications of seafood processing plants would not trigger a provincial EA under the current Environmental Assessment Act, except in the case where large fuel storage is proposed in close proximity to the shore. Approval would not depend on effluent characteristics or waste profile.

The NL Department of Environment (NLDOE) requires seal processing plants (one site) and fish meal plants (two sites) to obtain a certificate of approval under the *Environmental Protection Act* due to the potentially toxic nature of effluent from these processes. Water quality at these sites is monitored by NLDOE and data is recorded in paper files. No other seafood processors are required to obtain approvals under this legislation, nor is any waste product data recorded for other seafood processors by any provincial organizations.

2.2.3 Nova Scotia

Nova Scotia Department of Fisheries, and Aquaculture (NSDFA) requires seafood processors to obtain a Fish Processors License under the *Fisheries and Coastal Resources Act* (*Fish Inspection Regulations*). The license must be renewed annually and includes submission of species and process proposed and estimated volume of production and schedule. Processors are subject to inspection by NSDFA staff.

An Environmental Assessment (EA), under the *Environment Act* (*Environmental Assessment Regulation*), may be triggered by an application for an Industrial Plant/Facilities Approval (see below). Approval of such an EA would be required prior to the issuance of an Industrial

Plant/Facilities Approval. There was no record of any EA conducted for an existing seafood processing plant in NS.

The Nova Scotia Department of Environment and Labour (NSDEL) requires seafood processors that discharge effluent into fresh water to obtain an Industrial Plant/Facilities Approval under the *Environment Act (Activities Designation Regulations*). These permits must be renewed every 10 years and require the processor to record effluent data. Monitoring parameters are specified by NSDEL on a site-specific basis and are conducted and recorded by the processor. Processors are subject to inspection by NSDEL staff.

2.2.4 Prince Edward Island

The Prince Edward Island Department of Fisheries, Aquaculture, and Environment (PEIDFAE) requires seafood processors to obtain a Fish Processor License under the *Fish Inspection Act.* The license must be renewed annually and includes submission of species and process proposed and estimated volume of production and schedule. Processors are subject to inspection by PEIDFAE staff.

Under the *Fisheries Act*, seafood processors are required to submit to PEIFAE, monthly statements of actual production including product type, size/grade, and amount by case/box and weight. Several processors are not consistent in submitting regularly. There is no indication of the amount of raw material consumed.

The construction or major modification of a seafood processing plant may be considered an undertaking (any construction, industry, operation or other project or any alteration or modification of any existing undertaking which will or may cause the emission or discharge of any contaminant into the environment), under the *Environmental Protection Act*. Where such a project triggers a provincial environmental impact assessment and conditions of approval include water quality monitoring or treatment, it would be the responsibility of the PEIDFAE, Water Resources Branch to ensure compliance. No existing seafood processing plants have undergone this process under the current legislation.

It is the current understanding by the PEIDFAE that industrial waste effluent discharges into coastal waters is entirely the jurisdiction of Environment Canada and that PEIDFAE is not responsible for monitoring or enforcing compliance with the pollution prevention provisions of the federal *Fisheries Act*. Where industrial effluent enters fresh waters, the PEIDFAE Water Resources Branch is responsible for approving such discharges under the *Environmental Protection Act*. Currently, PEIDFAE is unaware of any seafood processing plants discharging into fresh waters.

2.3 Municipal and Regional Bylaws

A small number of plants in New Brunswick and Nova Scotia are known to discharge to municipal sewage systems. There is no information of this type for the other provinces. The discharge of wastewater from fish processing plants to municipal sewer systems is generally regulated by municipal or regional sewer use bylaws. Typically, these bylaws do not refer to such effluents specifically, but include general restrictions such as particle-size, total suspended solids (TSS), oil and grease (O&G), and biochemical oxygen demand (BOD) limits which must be met by all discharges. There are no regulatory requirements for recording such data but it is assumed that general restrictions on waste inputs are being regularly monitored and adhered to by seafood processors according to the specific agreements or approvals that they are operating under. Also, an unknown volume of solid waste is disposed of in municipal and regional landfill sites but no records are available on the type or volume of such waste. This type of information may be available in the QMPs described in Section2.1.3. It is beyond the scope of this study to assess whether waste disposal facilities are being operated in compliance with applicable regulatory requirements.

3.0 SEAFOOD PROCESSING

3.1 General

The Canadian seafood and marine products industry is a major world exporter of such products. It provides hundreds of small communities with an important source of jobs and resources. A national socio-economic summary of the aquaculture industry, the commercial fishery, and the seafood processing industry is provided in Section 3.1.1. A summary of the socio-economic seafood processing data collected for the various Atlantic Provinces, as compiled by the respective seafood processing industries, provides an understanding of the size and distribution of the industry, its value, and importance to the Atlantic region. This information is provided in Section 3.1.2.

3.1.1 National Socio-Economic Comparison of the Seafood Industry

Canada is one of the foremost maritime nations on the planet, boasting the world's longest coastline (244,000 km), representing 25 per cent of all the coastline in the world. Canada has one of the world's most valuable commercial fishing industries, worth more than $5 billion a year and providing more than 120,000 jobs to Canadians (Agriculture and Agri-Food Canada (AAFC) website, 2003). The capture fishing industry operates in three broad regions (Atlantic, Pacific and freshwater). Canada's growing aquaculture industry is also active across these three regions.

Marine Landings information for 2000 show that total landings from capture fisheries on the Atlantic and Pacific coasts reached 958,744 tonnes with a landed value of $1.97 billion (Table 3.1).

- The Atlantic fishery accounted for 85% of total landings with top production in herring, shrimp, snow crab, scallops, cod and lobster. Value leaders were lobster, crab, shrimp and cod. Lobster continues to be Canada's most valuable seafood product, worth almost $639 million in 2001.
- The Pacific fishery accounted for 14% of total landings with top production in hake, Pacific herring, rockfish and salmon. Value leaders were clams, crabs, shrimp and salmon.
- The freshwater fishery accounted the remainder of total Canadian landings in 2001. Species landed included pickerel, yellow perch, whitefish, northern pike and lake trout.

Table 3.1: Summary of Canadian Commercial Catches and Values

Quantity (Q) in tonnes, live weight, Value (V) in thousand dollars

	1996		1997		1998		1999		2000	
	Q	V	Q	V	Q	V	Q	V	Q	V
Atlantic – Total	686,439	1,148,885	740,502	1,211,390	785,403	1,287,206	813,818	1,589,596	819,361	1,689,365
Nova Scotia	279,331	466,225	299,877	511,817	297,848	542,508	305,192	629,429	306,473	647,718
New Brunswick	107,346	157,907	111,006	147,179	114,807	143,265	118,176	164,162	118,509	169,712
PEI	53,725	100,955	58,177	112,667	59,093	121,115	58,877	131,167	62,922	131,698
Quebec	50,692	134,038	51,156	114,198	51,513	103,056	55,117	131,794	58,209	158,889
Newfoundland	195,347	289,759	220,287	325,530	262,142	377,261	276,456	533,044	273,248	581,348
Pacific – Total	246,739	416,757	244,771	422,894	231,134	314,479	218,708	315,793	139,383	283,707
Seafisheries – Total	933,178	1,565,642	985,273	1,634,284	1,016,537	1,601,685	1,032,526	1,905,389	958,744	1,973,072
Freshwater fish - Total	38,295	69,249	38,798	70,505	40,744	83,092	40,566	82,505	-	-
New Brunswick	1,072	657	1,432	982	1,611	691	1,611	691	-	-
Quebec	1,429	4,178	1,515	4,872	1,606	5,681	1,606	5,681	-	-
Ontario	17,003	41,249	19,463	43,151	20,078	48,200	17,965	45,057	-	-
Manitoba	11,593	15,966	10,125	14,955	10,884	20,602	13,209	24,205	-	-
Saskatchewan	3,615	3,546	3,157	3,375	3,402	4,266	3,146	3,695	-	-
Alberta	1,716	1,642	1,695	1,702	1,854	2,196	1,757	1,850	-	-
NWT	1,867	2,011	1,411	1,468	1,309	1,456	1,273	1,326	-	-
Canada – Total	971,473	1,634,891	1,024,071	1,704,789	1,057,281	1,684,777	1,073,092	1,987,894	958,744	1,973,072

Aquaculture production in Canada reached 152,523 tonnes in 2001 worth $597 million (Table 3.2). Aquaculture provides jobs for more than 7,000 Canadians, and in 2001, accounted for almost 14% of the total Canadian production of fish and shellfish (AAFC, 2003).

- Canada is one of the world's key suppliers of farmed salmon, produced almost entirely in British Columbia and New Brunswick. Atlantic salmon predominates with Chinook and Coho also produced. The total value of finfish aquaculture in 2001 was $538 million or 90% of the total value of aquaculture production (Table 3.2).
- Shellfish farming is an increasingly important contributor to Canada's expanding aquaculture industry. Prince Edward Island leads the industry in mussel culture and are world renowned for the technology that develops them. Oysters (Atlantic, Pacific and European), manila clams and scallops are growing aquaculture industries. In 2001, cultured shellfish represented 22% of total aquaculture production worth $58 million or 10% of total value (Table 3.2).

Canada exports over 75% of its fish and seafood production to more than 80 countries. In 2002, exports (620,231 tonnes) were valued at $4.67 billion, up more than 10% in value from 2001 (AAFC, 2003). The United States is Canada's largest export market (70% of Canada's seafood trade is with the U.S.), followed by Japan and the European Union (AAFC, 2003).

Canada's fish and seafood imports in 2002 were $2.18 billion, resulting in a trade surplus of almost $2.5 billion (AAFC, 2003). Almost 35 % of the volume (and about 4% of the value) of imports were products not for human consumption; most of this was meal used in the manufacture of livestock and fish feed (AAFC, 2003).

3.1.2 Provincial Industry Size and Distribution Summaries

It is import to note that the data sources varied for the national, regional, and provincial socio-economic data mining exercise. The trends are consistent, however, the actual data values may vary.

- **New Brunswick**

Based on the data provided in the 2002 New Brunswick Seafood Processors directory, fish processing in the province occurs in 148 facilities around the coast and generates an estimated 12,000 jobs. The processing value is over $818 millions per annum and the most valued species are lobster, and snow crab. Exports of New Brunswick seafood products totaled 89,012 tons in 2000, of which 85.6 percent went to the U.S.A., 8.5 percent went to Japan and 2.7 percent to European Union and 1.3 percent went to the Dominican Republic (Table 3.3). The major export products were: lobster with 15,029 tons valued at 386.3 million dollars, Atlantic salmon with 17,606 tons, valued at 138.2 million dollars, herring with 22,907 tons valued at 48.7 million dollars, crab with 7,952 tons valued at 108.7 million dollars, and shrimp with 1,647 tons valued at 17.9 million dollars (Table 3.4). The commercial landings for many of these export species for New Brunswick are provided in Table 3.5.

Table 3.2: 2001 Canadian Aquaculture Statistics (tonnes)

	Nfld	PEI	NS	NB	Que	Ont	Man	Sask	Alta	BC	CANADA	
Finfish												
Salmon	1,092	x	2,614	33,900	-	-	-	-	-	67,700	105,306	(2)
Trout	-	x	-	550	875	4,100	16	875	x	100	6,516	(2)
Steelhead	1,719	-	2,986	-	-	-	-	-	-	-	4,705	(2)
Other (1)											1,558	(1)
Total Finfish (3)	**2,811**	**76**	**5,600**	**34,450**	**875**	**4,100**	**16**	**875**	x	**67,800**	**118,161**	
Clams	-	-	-	-	-	-	-	-	-	1,400	1,400	
Oysters	-	2,731	438	744	-	-	-	-	-	6,800	10,713	
Mussels	1,452	17,506	1,619	750	339	-	-	-	-	-	21,666	(2)
Scallops	-	-	8	-	-	-	-	-	-	120	128	(2)
Other	-	-	402	-	53	-	-	-	-	-	455	
Total Shellfish	**1,452**	**20,237**	**2,467**	**1,494**	**392**	-	-	-	-	**8,320**	**34,362**	
Total	**4,263**	**20,313**	**8,067**	**35,944**	**1,267**	**4,100**	**16**	**875**	x	**76,120**	**152,523**	

2001 Canadian Aquaculture Production Statistics (' $000)

	Nfld	PEI	NS	NB	Que	Ont	Man	Sask	Alta	BC	CANADA	
Finfish												
Salmon	5,200	x	14,361	180,010	-	-	-	-	-	269,400	468,971	(2)
Trout	-	x	-	6,100	4,674	16,900	62	3,859	x	500	32,095	(2)
Steelhead	9,752	-	9,777	-	-	-	-	-	-	-	19,529	(2)
Other (1)											17,659	(1)
Total Finfish (3)	**14,952**	**733**	**24,138**	**186,110**	**4,674**	**16,900**	**62**	**3,859**	x	**269,900**	**538,987**	
Shellfish												
Clams	-	-	-	-	-	-	-	-	-	7,700	7,700	
Oysters	-	6,324	1,327	2,040	-	-	-	-	-	7,300	16,991	
Mussels	3,929	23,200	2,002	825	543	-	-	-	-	-	30,499	(2)
Scallops	-	-	88	-	-	-	-	-	-	700	788	(2)
Other	-	-	2,096	-	82	-	-	-	-	-	2,178	
Total Shellfish	**3,929**	**29,524**	**5,513**	**2,865**	**625**	-	-	-	-	**15,700**	**58,156**	
Total	**18,881**	**30,257**	**29,651**	**188,975**	**5,299**	**16,900**	**62**	**3,859**	x	**285,600**	**597,143**	

(1) Includes Char, Other Finfish and Total Alberta Finfish.
(2) Excludes Confidential Data.
(3) Excludes "Other" for provinces.

The production and value of Aquaculture include the amount and value produced on sites and exclude hatcheries or value added products.
The data, collected from each of the provincial departments responsible for aquaculture, are considered accurate and reliable.
Statistics Canada – Cat. no. 23-603-UPE Agriculture Division

Table 3.3: New Brunswick Seafood Export Countries by Volume (MT) and Value ($ '000)

Country	Volume (MT)		Value ($ '000)	
	1999*	2000	1999	2000
United States	15	66451	560,921	701,009
Japan	5282	8341	57,847	69,778
Dominican Republic	7632	6936	13,848	11,048
France	1397	749	9,898	4,006
Belgium	556	1037	5,898	8,905
United Kingdom	756	744	6,121	5,911
Denmark	2	536	58	5,259
Other Caribbean	4199	1844	6,169	3,358
Other	2831	2379	20,357	9,392
Total	**80,770**	**89,012**	**$681,117**	**$818,666**

*Note: source data error in 1999 volume data.

Source: 2002 New Brunswick Seafood Processors Directory

Table 3.4: New Brunswick Seafood Exports by Species

Species	Volume (MT)		Value ($ '000)	
	1999	2000	1999	2000
Lobster	13659	15029	320,824	386,303
Salmon, Farmed	14126	17606	108,536	138,289
Crab	6624	7952	78,281	108,766
Herring	24839	22907	50,203	48,751
Sardine	5703	8485	29,144	36,968
Shrimp	1053	1647	12,224	17,987
Scallops	283	270	5,830	4,979
Sea Urchin	1658	1460	5,180	4,620
Other	12915	13756	70,895	72,003
Total Exports	**80,770**	**89,112**	**$681,117**	**$818,666**

Source: 2002 New Brunswick Seafood Processors Directory

Table 3.5: New Brunswick Commercial Landings

Species	Volume (MT)		Value ($ '000)	
	1999	2000	1999	2000
Lobster	7517	7538	85,584	80,852
Snow Crab	7550	8482	37,453	56,029
Herring	76255	78413	14,178	14,029
Shrimp	11457	5333	16,756	7,338
Scallops	2008	2300	4,879	5,021
Sea Urchin	1704	1408	4,090	3,693
Groundfish	1664	10114	2,496	9,221
Total	**108,155**	**113,588**	**$165,436**	**$176,183**

Source: 2002 New Brunswick Seafood Processors Directory

According to the 2002 New Brunswick Seafood Processors directory, the estimated production in the New Brunswick Salmon Aquaculture industry in 2000 was 25,000 tons valued at $190 million (Table 3.6). The industry generates 1,725 person-years of direct employment (hatchery, grow-out sites, processing plant, selling, administration & others) and an additional 775 person-years of indirect employment in supplier industries such as feed and packaging and in the retail sector. New Brunswick Aquaculture products also include mussels, oysters and trout (Table 3.7). In 2000, these species combined value was $7.7 million. New species initiatives and associated programs are presently in place (i.e. research and development). Inventories of new species initiatives for 2000 included halibut, haddock, cod, small flounders, Atlantic and short-nose sturgeon, bar clams, scallops and soft-shelled clams.

Table 3.6: New Brunswick Salmon Industry

Year	# of Farms	Volume (MT)	Value ($ '000)
1979	1	6	40.2
1984	5	255	2948
1989	49	3993	37332
1994	67	12727	97999
1998	78	14232	106678
1999	87	22000	150000
2000	96	25,000	$190,000

Source: 2002 New Brunswick Seafood Processors Directory

Table 3.7: New Brunswick Aquaculture Products

Species	Volume (MT)		Value ($ '000)	
	1999	2000	1999	2000
Mussels	665	750	798	900
Oysters	286	286	788	788
Salmon	22000	25000	150,000	190,000
Trout	550	550	6100	6100
Total	**23,501**	**28,586**	**$157,686**	**$197,788**

Source: 2002 New Brunswick Seafood Processors Directory

- **Nova Scotia**

The market value of seafood products in Nova Scotia during 2000 was over 1.2 billion dollars (NSDAF, 2000). Fish landings by species group are shown in Table 3.8. The total landing, including aquaculture, was 318,165 metric tones with a landed value of 698,142 million dollars. This represented over 31% of total Canadian fish landings by weight or value.

Table 3.8: Nova Scotia Landings and Value 2000, by Species Group

Group	Metric Tonnes		Value	
	2000	1999	2000	1999
Groundfish	70,688	70,883	86,204	88,164
Pelagics & Estuarial	84,372	96,617	33,445	33,890
Molluscs/Crustaceans	151,486	121,555	528,024	510,718
Miscellaneous	0	17,358	0	1,530
Subtotal	306,546	305,413	647,673	634,392
Aquaculture	11,619	7,838	50,469	33,851
Grand Total	**318,165**	**313,251**	**698,142**	**668,243**

Source: NSDAF, 2000

Fish products represented approximately 27% of all NS exports and approximately 27% of all Canadian seafood exports (NSDAF, 2000). The most valued species are lobster, and snow crab. Exports of seafood products totaled 1.09 million dollars in 2000, of which 68.3% went to the U.S.A., 12.7% went to Japan, 3.4% to Denmark, 2.3% to the United Kingdom, 1.7% to Germany, and 1.6% went to Belgium. The major export products were: lobster with 22,337 tons valued at 283.8 million dollars, scallop with 78,193 tons, valued at 106.5 million dollars, crab with 14,083 tons valued at 65.0 million dollars, shrimp with 23,049 tons valued at 57.5 million dollars, and haddock with 12,387 tons valued at 23.6 million dollars (Table 3.9). The types of products exported are shown in Table 3.10. Live, frozen, dried/salted, and fresh whole fish account for almost 68% of total exports.

The aquaculture industry increased the annual value ten fold between 1990 and 2000, from 5.4 million to over 50.4 million dollars (NSDAF, 2000). Aquaculture products include Atlantic salmon, trout, mussels, oysters, quahogs, and scallops.

Table 3.9: Nova Scotia Fish Exports - by Species 2000 (ranked by Dollar Value)

Species	**Actual Value**	**Quantity (Kgm)**
Lobster	$338,577,342	20,125,576
Scallops	$141,353,462	7,391,997
Crab	$107,516,003	8,028,683
Shrimp	$102,349,683	16,124,792
Cod	$77,626,634	10,668,707
Perch	$58,731,441	7,067,577
Haddock	$42,912,559	9,704,582
Clams	$42,054,554	3,986,888
Groundfish Nes	$31,754,747	6,267,807
Herring	$24,167,410	8,616,081
Pollock	$17,237,133	4,541,035
Hake	$16,187,861	6,829,183
Flounder	$11,673,483	3,221,295
Tuna	$11,554,670	819,524
Fish Nes	$10,440,881	8,121,090
Swordfish	$9,781,156	733,589
Halibut	$9,258,394	683,865
Seaweeds	$5,293,684	0
Turbot	$4,371,408	611,167
Shark/Dogfish	$3,381,325	1,220,220
Molluscs Nes	$3,322,647	380,079
Trout	$3,193,443	605,514
Sole	$3,054,357	720,011
Sea Urchin	$2,993,179	651,544
Salmon	$2,984,075	380,759
Flatfish	$2,734,886	447,562
Silver Hake	$1,610,144	650,945
Mussels	$1,372,537	329,652
Oysters	$1,179,878	173,473
Mackerel	$939,794	511,539
Cusk	$735,280	142,645
Capelin	$696,691	768,565
Eels	$471,603	104,849
Salmonidae Nes	$448,987	113,573
Smelt	$181,440	55,195
Alewife	$152,563	120,127
Snails	$146,026	18,069
Sardines	$144,069	32,978
Squid/Cuttlefish	$114,169	82,819
Other Nes	$102,883	89,279
Catfish (Ocean)	$85,775	16,210
Anchovies	$8,796	915
Crustaceans Nes	$3,538	349
SPECIES	**$1,092,900,770**	**131,160,309**

Source: NSDAF, 2000 (Nes = Not elsewhere specified)

Table 3.10: Nova Scotia Fish Exports - by Process 2000 (ranked by Dollar Value)

Process	Actual Value	Quantity (Kgm)
Live	$416,931,124	25,415,307
Frozen	$214,227,202	24,128,696
Dried/Salt	$104,584,747	15,090,834
Fresh Whole	$96,934,789	24,170,986
Fillets Frozen	$70,177,831	10,841,710
Frozen Meat	$67,920,399	3,449,977
Prepared/Preserved	$45,780,888	5,404.719
Fillets Fresh	$26,859,097	3,832,017
Fresh	$14,752,040	2,062,536
Livers/Roes	$13,439,931	2,095,005
Frozen Whole	$9,906,065	5,610,459
Bait	$3,191,793	6,583,547
Smoked	$2,939,824	1,031,471
Fresh Meat	$2,337,066	270,979
Brined/Cured	$1,636,043	496,924
Blocks & Slabs Frozen	$1,209,128	566,142
Meal	$72,083	109,000
PROCESS	**$1,092,900,770**	**131,160,309**

Source: NSDAF, 2000

- **Prince Edward Island**

The fish processing industry was a significant exporter with approximately 90% of its output being sold outside the Province (Canmac Economics Ltd. *et. al*., 2002). Fish products represented approximately 20% of PEI total manufacturing shipments (both on-island and off-island) in 1998. This proportion has remained fairly stable over the last decade ranging from a high of 28% in 1991 to a low of 19% in 1996. Early estimates for 1999 indicated a return to the 28% level (Canmac Economics Ltd. *et. al*., 2002).

According to the 2001 PEI Department of Fishery, Aquaculture and Environment *Seafood Product Director*y, the Province has over 60 seafood processing plants located throughout the coastal communities of the Island (Canmac Economics Ltd. *et. al*., 2002).

The fish processing industry, with the primary processing species in PEI being shellfish (mainly lobster) shows significant and growing contribution to PEI's economy over many years. The value of shipments increased from $14.5 million in 1971 to $189.6 million in 1998 and was estimated to be $317.3 million in 1999 (Canmac Economics Ltd. *et. al*., 2002). This large increase was partially due to the increased catch, the amount of on-island processing and the higher price paid for the commodity. However, the fact that the 1999 figure represented a 67% increase in the value of shipments over the previous year raises concerns about the accuracy of the data (Canmac Economics Ltd. *et. al*., 2002).

Employment and income in the fish processing sector also increased significantly over the years (Table 3.11). By 1998 the sector was employing 1,285 persons (full-time equivalent) and contributing $24.6 million of employment income to the economy (Canmac Economics Ltd. *et. al*., 2002). Although the 1999 principal statistics are not yet available, it is estimated, based on the value of shipments, that the 1999 employment was 2,150 persons (full-time equivalent), with an income of $41.1 million (Canmac Economics Ltd. *et. al*., 2002). Recent statistics by the PEI Department of Fisheries, Aquaculture and Environment indicated that employment could peak at 3,000 persons over the course of the year.

Table 3.11: Key Economic Indicators

Year	1997	1998	1999	Mean
Sales (000 $	158700	189600	317300	221867
Exports (000 $)	142830	170640	285570	199680
Employment	1228	1285	2150	1554
Income (000 $)	19400	24600	41082	28361

Source: Statistics Canada Publication #31-203; Industry Canada; Canmac Economics Ltd.

- **Newfoundland and Labrador**

Based on 2002 data from Statistics Canada, Fisheries and Oceans Canada and the Department of Fisheries and Aquaculture, the fishing and aquaculture industry highlights are outlined in Table 3.12.

Table 3.12: Newfoundland & Labrador 2002 Fishing and Aquaculture Industry Highlights[1]

Landed Value (Millions $)		**Active Processing Licenses (By Type) (2002)**	
Groundfish	**64.2**	**Core**	**62**
Pelagics	**9.8**	**Non-Core**	**57**
Shellfish	**421.3**	**Secondary**	**7**
Sea Mammals	**20.0**	**Aquaculture**	**5**
Total	**$515.4**	**Total**	**131[2]**
Landed Volume (tonnes) - Preliminary		**Primary Markets (% of Total), Jan to Dec, 2002**	
Groundfish	**59,880**	**United States**	**47%**
Pelagics	**50,750**	**China**	**15%**
Shellfish	**156,840**	**Denmark**	**7%**
Total	**267,470**	**Japan**	**6%**
		Iceland	**5%**
Seals	**294,000**	**Other Countries**	**20%**
		Total Production Value	**$1 Billion**
Employment (Person Years)		**Aquaculture Production (tonnes) (2002)**	
Harvesting	**8300**	**Shellfish**	**1700**
Processing (persons)	**7900**	**Finfish**	**3100**
		Aquaculture Export Value	**$20.5 million**
GDP Indicators (%) (2001)			
Fishery as a percentage of the GDP (Goods Producing Sector)			**10.4%**
Fish Processing as a percentage of the GDP (Manufacturing Sector)			**29.6%**

Source: NLDFA website - http://www.gov.nf.ca/Fishaq/industry/fact_2002.stm

Note 1. It is not known if these numbers account for small-scale harvest and preparation facilities that exist for shellfish in numerous locations or the salmonid slaughtering operations associated with mariculture operations

Note 2. The number of active licenses in 2003 is 144.

3.2 Seafood and Marine Products in Atlantic Canada

The Canadian seafood and marine products industry is comprised of firms engaged primarily in the processing and marketing of fish, shellfish and marine plants and animals as well as by-products such as fish meal and fish oil (Nova Tec, 1994). Canadian fish products are harvested from oceans off Canada's Atlantic and Pacific coasts as well as from inland freshwater lakes. These three fisheries are based chiefly on groundfish, pelagics, salmonids, molluscs, crustaceans and freshwater fish.

3.2.1 Species and Products

Within the Atlantic Region, the commercial catches are consistently highest in Nova Scotia, followed by Newfoundland, New Brunswick, and Prince Edward Island (refer to Table 3.1, Table 3.13). Table 3.14 illustrates the similar trend in value of the commercial catches. According to Tables 3.13 and 3.14, the primary commercial catch species in Nova Scotia are as follows:

- Groundfish - hake, haddock, and redfish;
- Pelagic/Finfish – herring; and
- Shellfish – scallop, lobster, shrimp, and crab.

According to Table 3.13, the primary commercial catch species in Newfoundland are as follows:

- Groundfish - cod, flatfishes, and Greenland turbot;
- Pelagic/Finfish – capelin and herring;
- Shellfish – shrimp, crab, and clams/quauhaug; and
- Miscellaneous – lumpfish roe and seal.

According to Table 3.13, the primary commercial catch species in New Brunswick are as follows:

- Groundfish - cod;
- Pelagic/Finfish – herring;
- Shellfish – lobster, shrimp, and crab; and
- Miscellaneous – marine plants.

According to Table 3.13, the primary commercial catch species in Prince Edward Island are as follows:

- Groundfish - cod;
- Pelagic/Finfish – herring;
- Shellfish – mussel, lobster, and oyster; and
- Miscellaneous – marine plants.

Table 3.13: Year 2000 Quantity of Atlantic Coast Commercial Landings (metric tonnes, live weight)

	Nova Scotia			New Brunswick			PEI	Quebec	Nfld	Atlantic
	S-F	Gulf	Total	S-F	Gulf	Total	Total	Total	Region	Total
Groundfish										
Cod	8,251	1,197	9,448	188	1,070	1,258	968	4,028	30,013	45,714
Haddock	12,386	1	12,387	31	0	31	0	0	234	12,653
Redfish spp.	13,530	11	13,541	0	7	7	0	285	5,864	19,697
Halibut	701	13	714	5	13	18	9	211	263	1,215
Flatfishes	5,959	1,377	7,336	17	83	100	474	1,078	13,062	22,050
Greenland turbot	583	27	610	0	5	5	0	1,633	14,084	16,333
Pollock	5,674	2	5,676	115	0	115	0	1	722	6,514
Hake	14,927	111	15,038	36	15	51	176	14	1,090	16,368
Cusk	1,083	0	1,083	0	0	0	0	0	0	1,083
Catfish	189	1	190	0	0	0	0	12	474	675
Skate	479	0	479	0	0	0	0	6	1,581	2,066
Dogfish	2,364	44	2,408	97	0	97	6	149	0	2,660
Other	1,778	1	1,779	1	1	2	9	14	434	2,239
Total	67,904	2,784	70,688	490	1,194	1,684	1,642	7,431	67,822	149,268
Pelagic & other finfish										
Herring	71,589	5,575	77,164	37,425	40,718	78,143	22,923	7,369	16,654	202,253
Mackerel	4,020	306	4,326	0	1,998	1,998	4,167	1,711	4,454	16,656
Swordfish	741	0	741	0	0	0	0	0	227	968
Tuna	619	130	749	0	0	0	110	0	243	1,102
Alewife	78	275	353	0	2,090	2,090	78	0	0	2,521
Eel	0	5	5	0	45	45	73	11	29	164
Salmon	0	0	0	0	0	0	0	0	0	0
Smelt	2	12	14	0	24	24	156	39	3	236
Capelin	0	0	0	0	0	0	0	0	20,829	20,829
Other	1,002	19	1,021	1	2	3	309	4	76	1,413
Total	78,051	6,321	84,372	37,426	44,876	82,302	27,816	9,135	42,516	246,141
Shellfish										
Clams/quahaug	8,821	200	9,021	85	629	714	1,541	1,655	15,113	28,044
Oyster	0	236	236	0	241	241	3,653	0	0	4,130
Scallop	77,930	263	78,193	1,483	817	2,300	926	2,338	2,833	86,590
Squid	38	0	38	0	0	0	0	0	325	363
Mussel	0	94	94	0	266	266	14,069	0	0	14,429
Lobster	19,284	3,093	22,377	1,628	5,910	7,538	8,655	3,236	2,010	43,815
Shrimp	23,049	0	23,049	0	5,333	5,333	0	17,089	84,065	129,536
Crab, Queen	9,897	4,186	14,083	0	8,482	8,482	1,122	14,295	55,581	93,562
Crab, Other	1,918	1,034	2,952	441	2,170	2,611	2,696	1,409	866	10,532
Sea urchin	820	0	820	1,408	0	1,408	0	10	726	2,964
Other	625	0	625	709	0	709	0	1,575	347	3,256
Total	142,382	9,104	151,486	5,754	23,848	29,602	32,662	41,607	161,866	417,223
Seafish/Shellfish	**288,337**	**18,209**	**306,546**	**43,670**	**69,918**	**113,588**	**62,120**	**58,173**	**272,204**	**812,632**
Marine plants	0	0	0	7,886	101	7,987	6,803	0	0	14,790
Lumpfish roe	0	0	0	0	0	0	0	36	2,030	2,065
Miscellaneous	0	0	0	0	0	0	0	0	1,034	1,034
Total	0	0	0	7,886	101	7,987	6,803	36	3,064	17,890
GRAND TOTAL	**288,337**	**18,209**	**306,546**	**51,556**	**70,020**	**121,576**	**68,923**	**58,209**	**275,268**	**830,522**

Source: DFO website-http://www.dfo-mpo.gc.ca/communic/statistics/landings/S2000aqe.htm

Table 3.14: Year 2000 Value of Atlantic Coast Commercial Landings (thousand dollars)

	Nova Scotia			New Brunswick			PEI	Quebec	Nfld	Atlantic
	S-F	**Gulf**	**Total**	**S-F**	**Gulf**	**Total**	**Total**	**Total**	**Total**	**Total**
Groundfish										
Cod	15,301	1,527	16,828	347	1,213	1,560	1,254	5,290	47,000	71,932
Haddock	23,556	2	23,559	0	0	0	0	0	193	23,752
Redfish spp.	7,271	6	7,277	0	4	4	0	210	2,514	10,005
Halibut	6,120	109	6,229	49	64	114	55	1,074	1,554	9,026
Flatfishes	8,330	1,425	9,755	0	71	71	422	799	6,166	17,213
Greenland turbot	1,842	22	1,864	0	10	10	0	3,428	20,489	25,791
Pollock	4,793	1	4,794	212	0	212	0	1	395	5,402
Hake	10,990	88	11,078	0	21	21	193	8	380	11,680
Cusk	1,042	0	1,042	0	0	0	0	0	0	1,042
Catfish	99	0	100	0	0	0	0	4	125	229
Skate	147	0	147	0	0	0	0	1	454	603
Dogfish	786	24	810	43	0	43	3	88	0	944
Other	2,721	0	2,721	0	1	1	3	8	325	3,059
Total	83,000	3,204	86,204	651	1,384	2,035	1,931	10,911	79,596	180,676
Pelagic & other finfish										
Herring	10,848	1,258	12,106	5,743	8,286	14,029	4,768	1,383	2,596	34,882
Mackerel	1,737	241	1,978	0	1,403	1,403	2,587	840	1,446	8,254
Swordfish	6,058	0	6,058	0	0	0	0	0	1,260	7,318
Tuna	7,783	3,168	10,950	0	0	0	2,238	0	2,436	15,624
Alewife	0	122	122	0	451	451	46	0	0	620
Eel	0	22	22	0	192	192	295	47	147	703
Salmon	0	0	0	0	0	0	0	0	0	0
Smelt	0	29	29	0	31	31	197	34	3	295
Capelin	0	0	0	0	0	0	0	0	5,154	5,154
Other	2,153	27	2,180	1	1	2	237	14	103	2,536
Total	28,578	4,867	33,445	5,744	10,365	16,110	10,369	2,317	13,145	75,386
Shellfish										
Clams/quahaug	8,373	553	8,926	163	1,205	1,369	4,772	2,277	11,710	29,054
Oyster	0	610	610	0	753	753	8,803	0	0	10,166
Scallop	105,916	579	106,495	3,499	1,522	5,021	1,839	3,719	4,554	121,629
Squid	27	0	27	0	0	0	0	0	130	158
Mussel	0	114	114	0	268	268	17,372	0	0	17,753
Lobster	249,187	34,638	283,825	22,462	58,390	80,852	87,776	38,364	22,308	513,124
Shrimp	57,513	0	57,513	0	7,338	7,338	0	28,455	183,761	277,067
Crab, Queen	37,615	27,391	65,006	0	56,029	56,029	6,842	70,240	263,436	461,552
Crab, Other	2,201	946	3,146	694	1,790	2,484	2,063	1,180	758	9,631
Sea urchin	2,109	0	2,109	3,693	0	3,693	0	22	1,329	7,152
Other	252	0	252	231	0	231	0	1,326	252	2,061
Total	463,194	64,830	528,024	30,744	127,294	158,038	129,466	145,581	488,238	1,449,347
Seafish/Shellfish	**574,771**	**72,901**	**647,673**	**37,139**	**139,044**	**176,183**	**141,765**	**158,810**	**580,978**	**1,705,410**
Marine plants	0	0	0	764	20	784	1,266	0	0	2,050
Lumpfish roe	0	0	0	0	0	0	0	79	4,560	4,639
Miscellaneous	0	0	0	0	0	0	0	0	1,349	1,349
Total	0	0	0	764	20	784	1,266	79	5,909	8,038
GRAND TOTAL	**574,771**	**72,901**	**647,673**	**37,902**	**139,064**	**176,966**	**143,032**	**158,889**	**586,887**	**1,713,447**

Source: DFO website - http://www.dfo-mpo.gc.ca/communic/statistics/landings/S2000ave.htm

3.2.2 Sources of Seafood Catches Processed in Atlantic Canada

Essentially no site-specific data is available throughout the Atlantic Provinces that breaks down the processing plant sources by species (i.e. what comes from aquaculture, what is caught locally, what is moved about within the region, what is imported from outside the region). This information may be available through the CFIA QMP's, however; at this time there is no federal or provincial database that houses this information. The absence of information on the movement of product for processing could contribute to the problem of invasive species and disease dissemination.

3.3 Seafood Processing Plants in Atlantic Canada

There is very little site-specific data available and there are very few studies specific to the region. All known locations for seafood processors are shown in Figure 3.1. It should be noted that some plant coordinates are apparently not correct but are presented as they were received in the various federal and provincial databases.

Table 3.15 has been developed from the database and summarizes the number of plants in each province and of major species processed. No species or product data was available for 207 plants. The types of processors are fairly evenly distributed between the Atlantic Provinces. Most processors are licensed to use a wide range of species; just 68 processors are licensed for only one species. Approximately half of processors are specifically licensed for a range of selected individual species of groundfish, pelagics, and shellfish. Most of these plants process more than one major category, usually a combination of finfish and shellfish (over 400 plants). The least utilized species (ten or less processors) include lump fish, red fish, arctic char, sturgeon, perch, striped Bass and bloodworm. Ten processors are solely using fish byproducts; most of these are fishmeal plants. The majority of utilized species are "wild" but aquaculture source finfish and shellfish are licensed for a significant proportion of processors in NS and PEI. There are certainly some plants in NB and NL using aquaculture species but no site specific data was available.

3.3.1 Types of Seafood Processing

The five main categories of fish processing are as follows:

- Groundfish
- Herring
- Salmon
- Shellfish
- Fishmeal

Each of the five processing types mentioned above have unique processing characteristics and therefore unique effluent characteristics. Although variations of the processing techniques would be encountered on a site specific basis, the majority of the process features would be consistent. Some references for processing details are not current but processes are not anticipated to be much different today. If anything, current process standards are likely to be more efficient.

Figure 3.1 Seafood Processing Plant Locations in Atlantic Canada

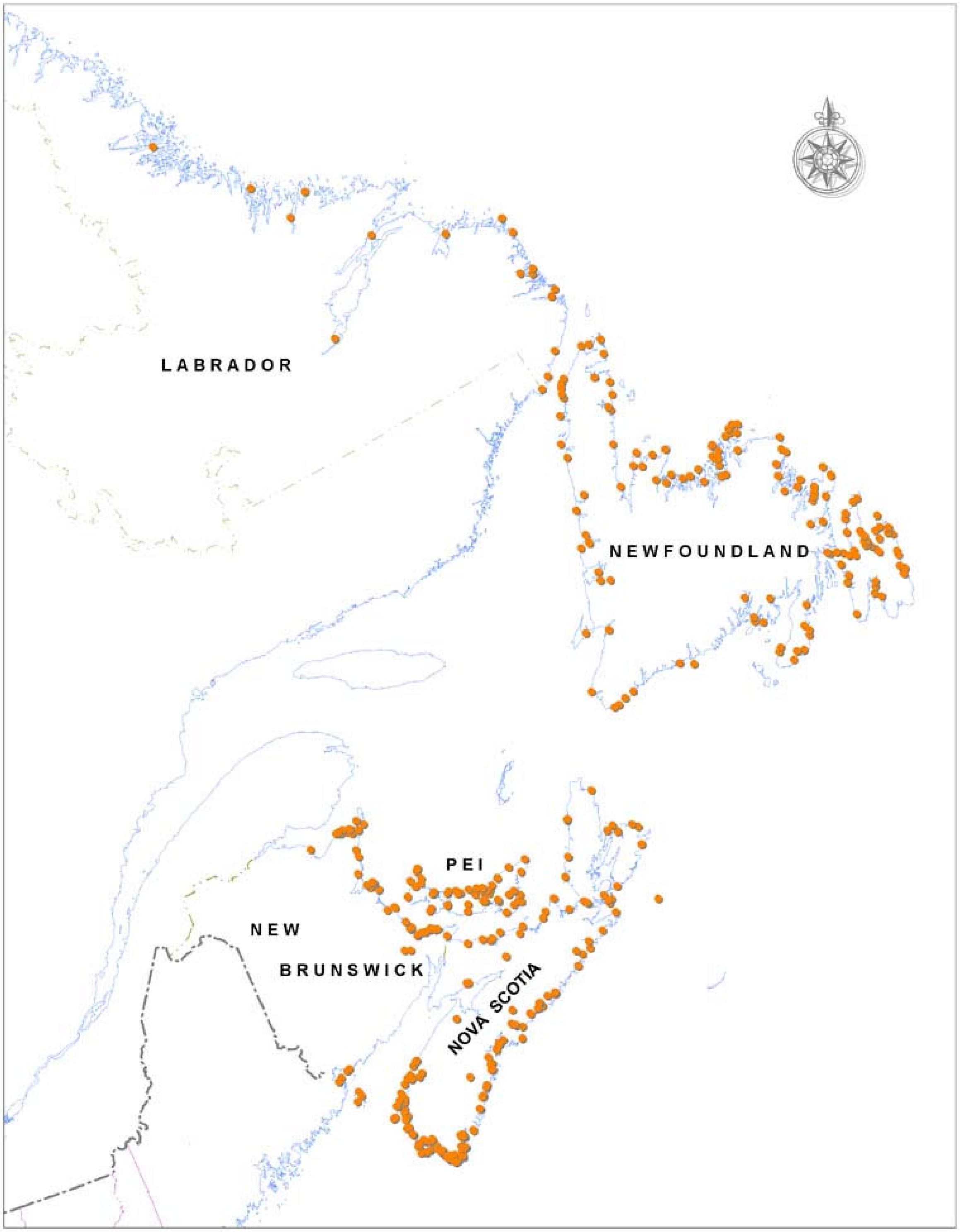


Table 3.15: Seafood Processing Distribution in Atlantic Canada

Species/Type Processed	Number of Processors
Any Processing by Province	
New Brunswick	178
Newfoundland & Labrador	281
Nova Scotia	292
Prince Edward Island	80
Species/Product Data Unavailable	207
Major Species Types	
All Species	4
All Species (except shrimp and snow crab)	64
All Groundfish	243
All Pelagic	173
All Shellfish	26
Crabs and mollusks	377
Marine Plants (Irish moss, rock weed, etc.)	75
Aquaculture finfish	94 (data only for NS & PEI)
Aquaculture shellfish	88 (data only for NS & PEI)
Byproducts (eg. blood, skins, offal)	10
Major Fin Fish Species	
Herring	158
Mackerel	106
Smelt	93
Gaspereau	85
Cod	88
Shad	83
Hagfish	73
Hake	70
Salmon	63
Shark (mainly blue, mako, & porbeagle)	45
Eel	42
Alewife	38
Trout	19

Species/Type Processed	Number of Processors
Major Shellfish Species	
Lobster	271
Scallop	223
Snow Crab	164
Rock Crab	150
Jonah Crab	120
Shrimp	115
Red Crab	115
Bar Clam	114
Quahog	108
Sea Urchin	105
Periwinkle	92
Marine Mammals	
Seal	26 (mostly NL – 18 of 26)
Other	
Squid	120
Sea Cucumber	82
Jellyfish	64

No recent studies have been conducted on industry standards in the Atlantic region. Such a study is required in order to gain a realistic understanding of current process standards. The above-mentioned processing types, as well as the standard vessel unloading process, are detailed below:

- **Vessel Unloading (NovaTec, 1994)**

Vessel unloading is common to all fish processing. It can be done with wet (siphon) or dry (vacuum) pumps, or with buckets or baskets. In Atlantic Canada, most groundfish are offloaded in plastic containers on ice. Based on available information, it is thought that dry pumps result in rough handling of the oily fish species like herring and salmon, and are generally only used for ground fish which are less susceptible to damage, but this needs to be verified. Wet pumps are much gentler and are used for freshly caught herring and salmon which are kept in water inside the holds of fishing boats and fish packer vessels during transport. The pumps use large diameter hoses to pump water and whole fish out of the vessels' holds. Water and fish are then discharged onto grating to allow the separation of fish and water. A certain amount of water is recirculated to the vessels to ensure sufficient water for the operation of the pumps and to be able to remove all fish. The water level in the vessel is continually lowered during the unloading operation and the vessel, generally, is almost completely empty when all fish have been unloaded.

Conveyors pick up the fish after their separation from the vessel hold water and transport them to grading stations, where the fish are manually sorted according to their species. After sorting, fish are kept in chilled water or ice for intermediate storage until they can be further processed. Grading is not required for herring.

Baskets or buckets can also be used to unload vessels but are, generally, only used if small quantities of fish need to be unloaded, or to offload frozen fish. In these cases baskets are lowered into the vessels holds by a crane and filled with frozen fish.

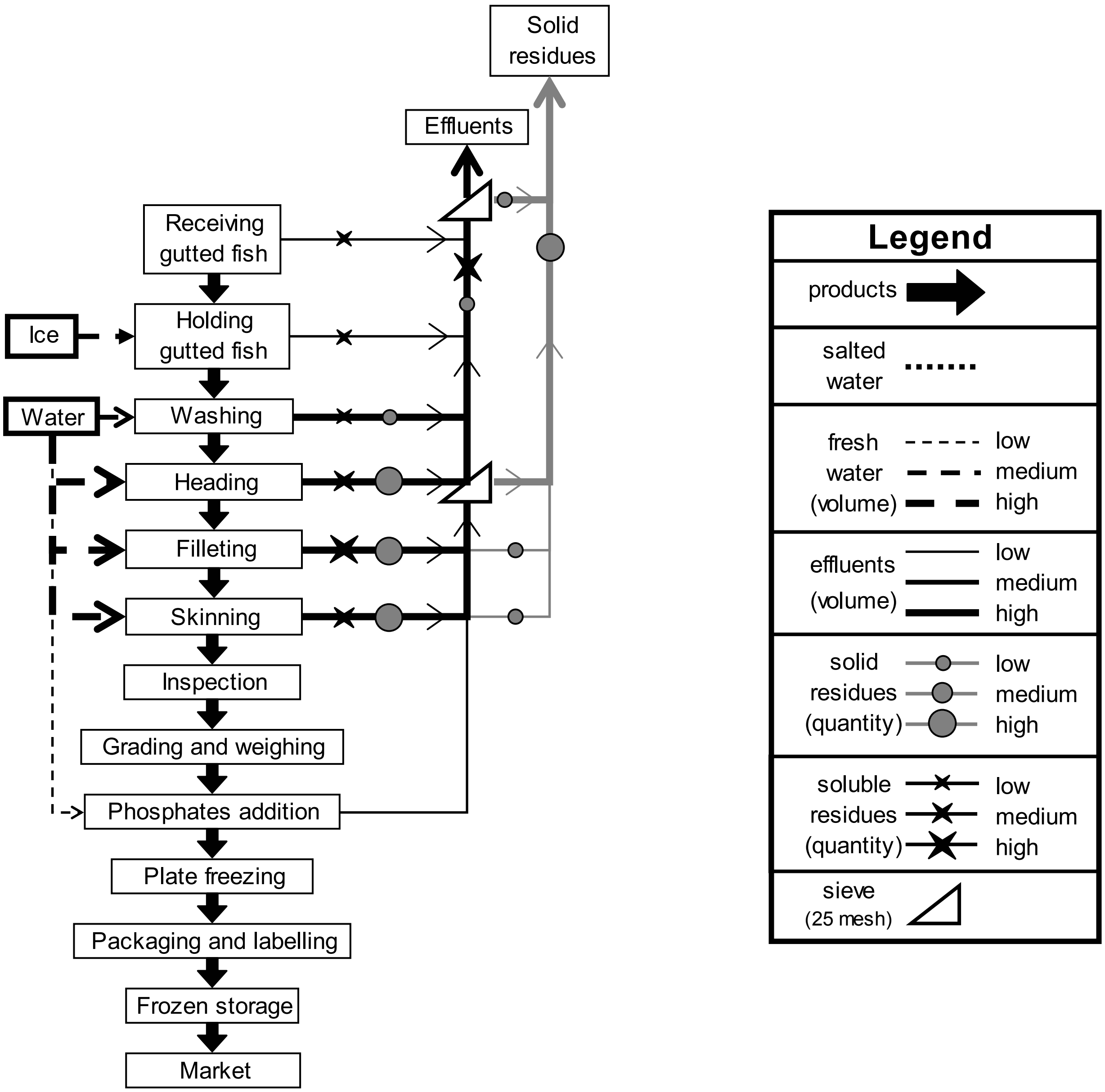
- **Groundfish (Riddle and Shikaze, 1973)**

With the exception of halibut, groundfish species are preprocessed in somewhat the same manner. The fish are either stored whole on the ship or are eviscerated prior to storage, the viscera and blood being washed overboard.

Most groundfish require no pretreatment prior to filleting. In small plants, the fish are processed by hand. The fillets are cut on a board, washed and immediately iced in boxes for distribution.

Most plants processing fillets use mechanized equipment. The fish are first washed in large wash tanks or by water sprays. Next, the fish pass to filleting machines or hand filleting tables. The skin is removed from fillet by hand or machines. The solid wastes from filleting, skinning and candling operations (inspection by shining light through fillets to detect and subsequently remove parasites) are usually rendered for pet food or animal meal. Figure 3.2 outlines a typical groundfish filleting operation.

Figure 3.2 Typical Groundfish Filleting Operation
(Coastal Zones Research Institute Inc. - Fisheries and Marine Products Division, 2003)



The skinned fillets are transported by conveyor belt through a washing tank and, in some cases, a dip tank. After inspection the fillets are packed into containers by hand or are frozen and then packed.

Halibut processing involves dressing by removing the viscera and cutting away the gills. The halibut are then packed in ice in the holds. If the fish are not processed immediately, they are re-iced in the fish processing plants. The majority of halibut are filleted and marketed frozen. Some halibut are frozen whole or sold fresh. Prior to whole freezing, a continuous belt washer sprays the fish. The fish are frozen with a glaze protection at approximately -250 C (Riddle and Shikaze, 1973). Halibut can be cut in fletches (boneless and skinless pieces). The fletches are either glazed or packaged in moisture-proof wrapping.

Groundfish are also sold salted. A typical salted groundfish operation is shown in Figure 3.3.

- **Herring (Riddle and Shikaze, 1973)**

Herring is processed into a number of products including fish oil, fishmeal, fillets, marinated herring, and herring roe.

- Fillets

As with groundfish, herring are trucked to the plant and stored in holding bins on ice. Herring are delivered to the plant round and in the filleting operation, the heads, tails, fins and viscera are removed by automatic machines.

Wastes from the herring filleting originate from the fluming of the round herring into the splitting machines, and from the water used in the machines themselves. Offal is removed prior to final discharge for further processing in the fishmeal operation.

- Marinated Herring

As with the filleting operation, herring are trucked to the plant and stored in holding bins on ice. Herring are delivered to the plant round and in the filleting operation, the heads, tails, fins and viscera are removed by automatic machines. The resulting splits fillets are then stored in barrels or vats in a solution of brine and acetic acid for a period of 5-9 days. After this period, the solution is dumped and the fillets are introduced to a second solution of brine and acetic acid and stored at a low temperature for two weeks. While in this stored solution, the fillets are called bismarks. After two weeks, the bismarks are dumped, skinned and repacked in barrels ready for distribution.

Wastes are produced during the splitting operation, clean up and acetic acid brine dumps. Offal is transported to fishmeal plants for further processing. With both the herring filleting and marinated herring processing, the waste is highly coloured from the blood loss during the splitting operation. Figure 3.4 shows the flow diagram for marinated herring processing. Sometimes marinated herring in barrels is further processed into bottled marinated herring as shown in Figure 3.5.

Figure 3.3 Typical Groundfish Salting Operation
(Coastal Zones Research Institute Inc. - Fisheries and Marine Products Division, 2003)

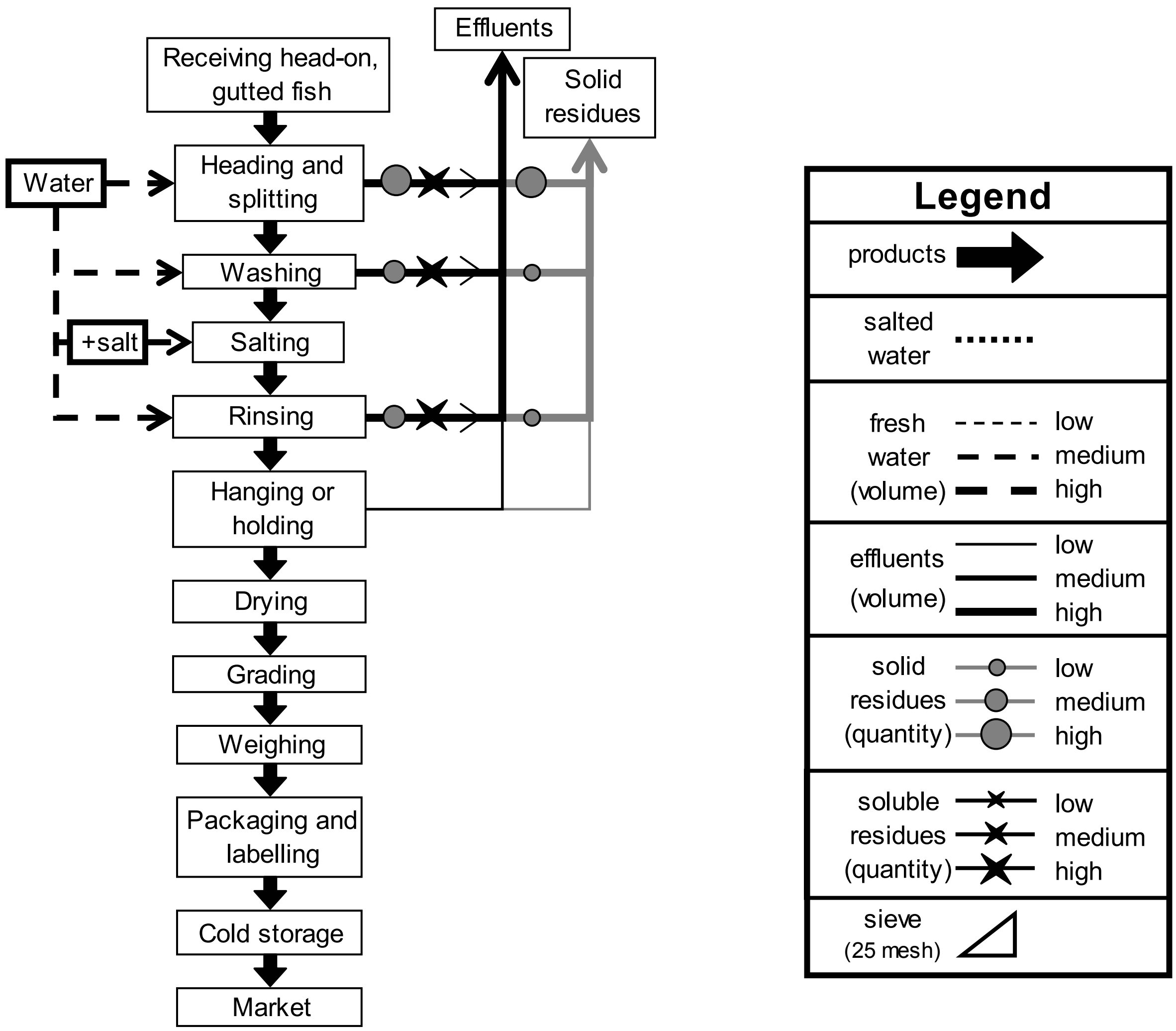


Figure 3.4 Process Flow Diagram for Marinated Herring (Barrels
(Coastal Zones Research Institute Inc. - Fisheries and Marine Products Division, 2003)

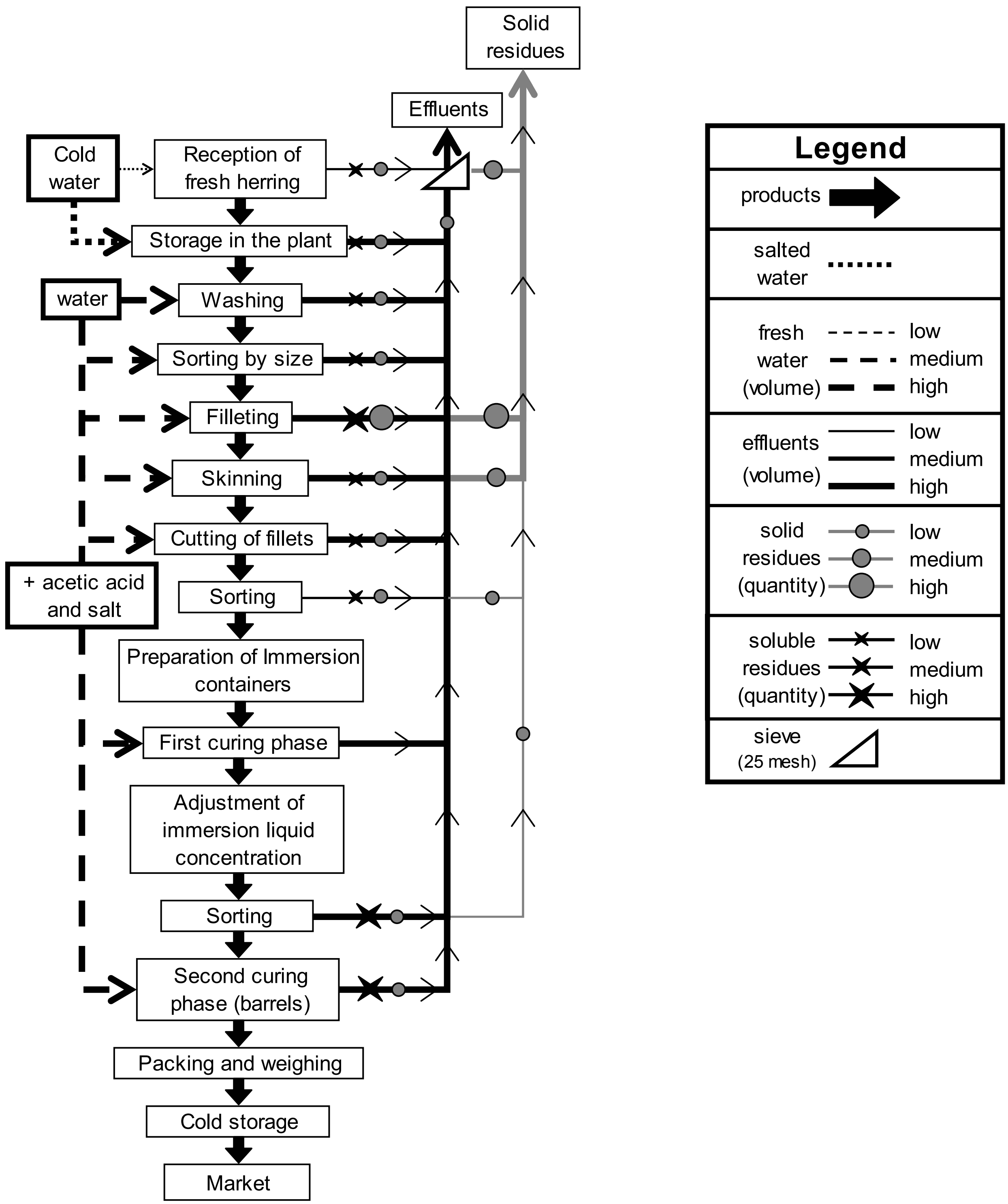
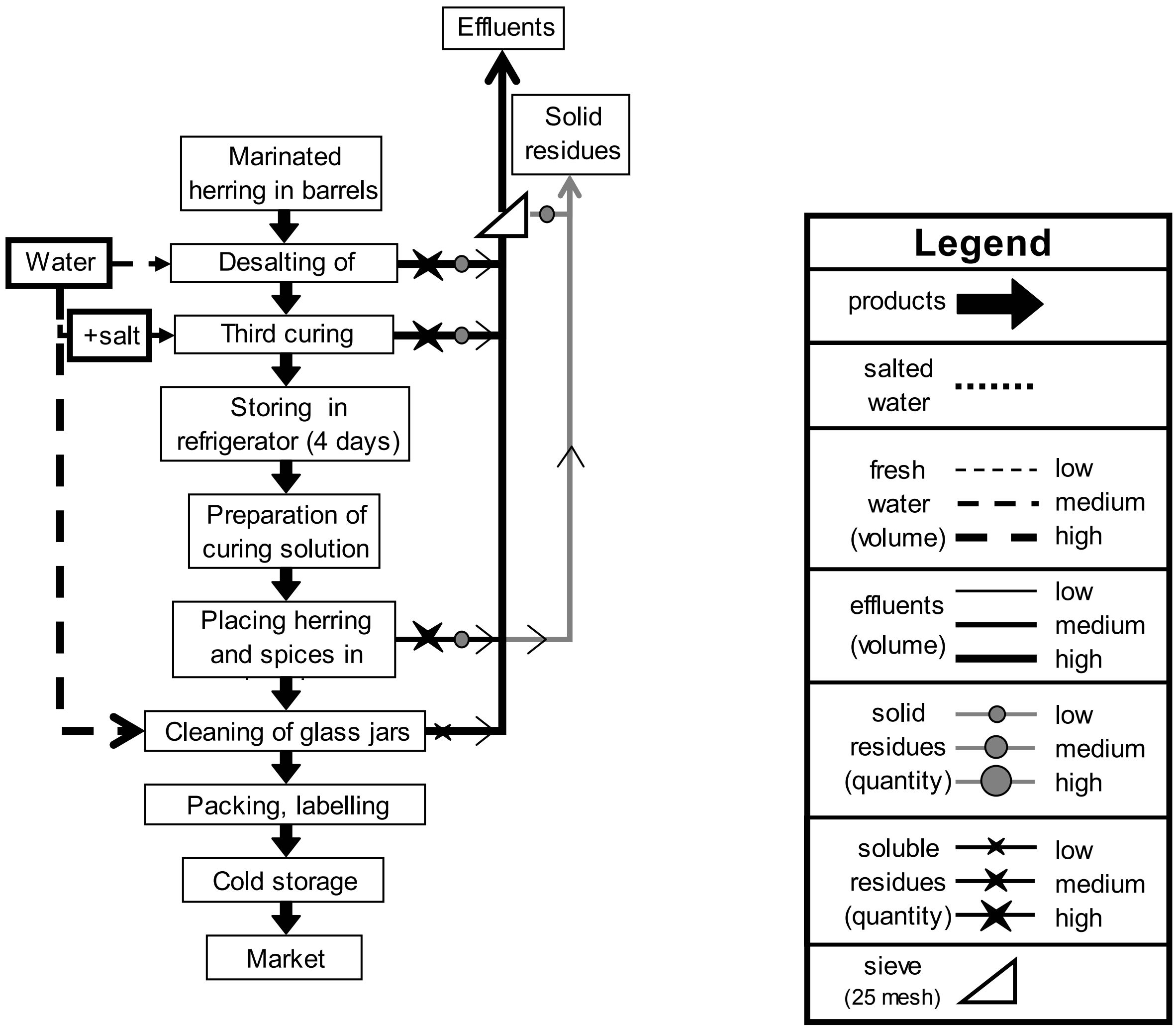


Figure 3.5 Process Flow Diagram for Marinated Herring (Bottled)
(Coastal Zones Research Institute Inc. - Fisheries and Marine Products Division, 2003)



- Smoked Herring

A typical herring smoking operation is diagrammed in Figure 3.6

- Herring Roe

The herring are stored on ice prior to processing to remove the roe. The herring are sorted by sex, males are removed, and females are then to tables where the roe are extracted and sorted. The roe are packaged and frozen prior to shipment. Following roe removal, the remaining herring flesh is sent to a reduction plant for processing into fishmeal or into pet food. A typical herring roe process is illustrated in Figure 3.7.

- **Salmon (NovaTec, 1994)**

The primary source of salmon in the Atlantic Provinces is farm raised. Typically, Atlantic salmon are reared in marine net-pen systems, harvested on site and immediately shipped to the processing plant. The industry hopes to develop the infrastructure for live haul harvesting where the fish would be killed at the processing plants rather than on site. This process would improve shelf life, appearance, and quality of the product. The various processes associated with the salmon industry are described below. It is important to note that typical harvesting practices from marine finfish farms in Atlantic Canada contain all bloodwater and deliver it along with the harvested product to the processing plants. All the salmon processing plants in NB are either using Heat Treatment as a means of disinfecting, or directing their effluent to a WW Treatment lagoon. It is not believed that any salmon plants in Atlantic Canada (outside New Brunswick) are treating for ISA disinfection (they may be directing effluent to lagoons). There is no available information about where wastewater from the processing plants is typically discharged.

- Butchering for Freezing

The equipment used for salmon butchering (also referred to as “dressing”) depends on the requirements for further processing. Dressing fish for freezing involves the removal of the head and gutting of the fish. The tails, fins and the collarbone immediately behind the head are not cut off. The eggs (or roe) of the female fish are removed for further processing, and the milt of the male is removed at this stage.

Butchering for freezing is done manually or with semiautomatic dressing lines. The manual dressing lines consist of a large table and fish cleaning station, where workers are responsible only for specific tasks, such as:

- head removal
- belly slitting
- removal of viscera and separation of milt and/or roe
- removal of the kidney
- cleaning of fish

Figure 3.6 Process Flow Diagram for Smoked Herring
(Coastal Zones Research Institute Inc. - Fisheries and Marine Products Division, 2003)

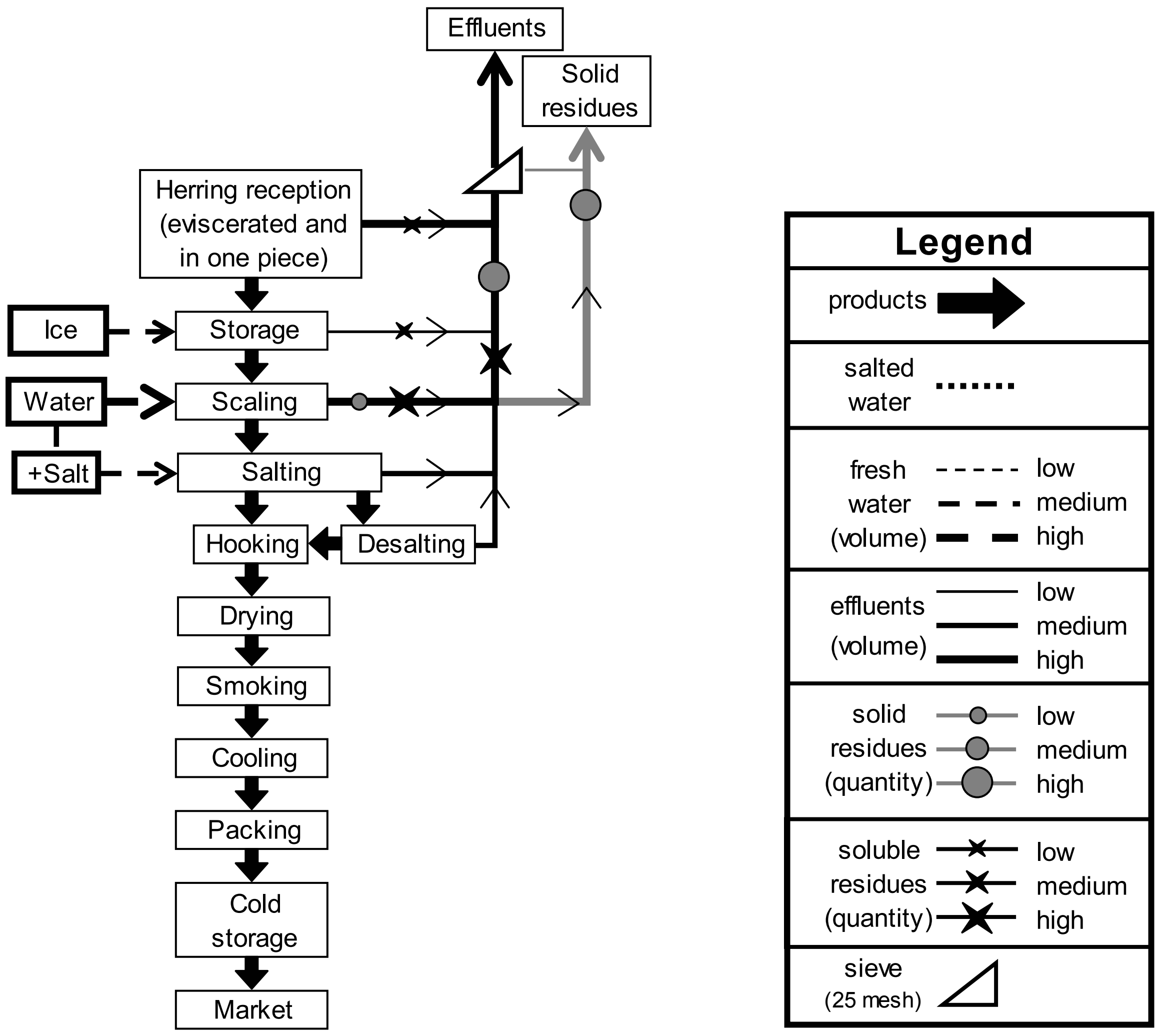
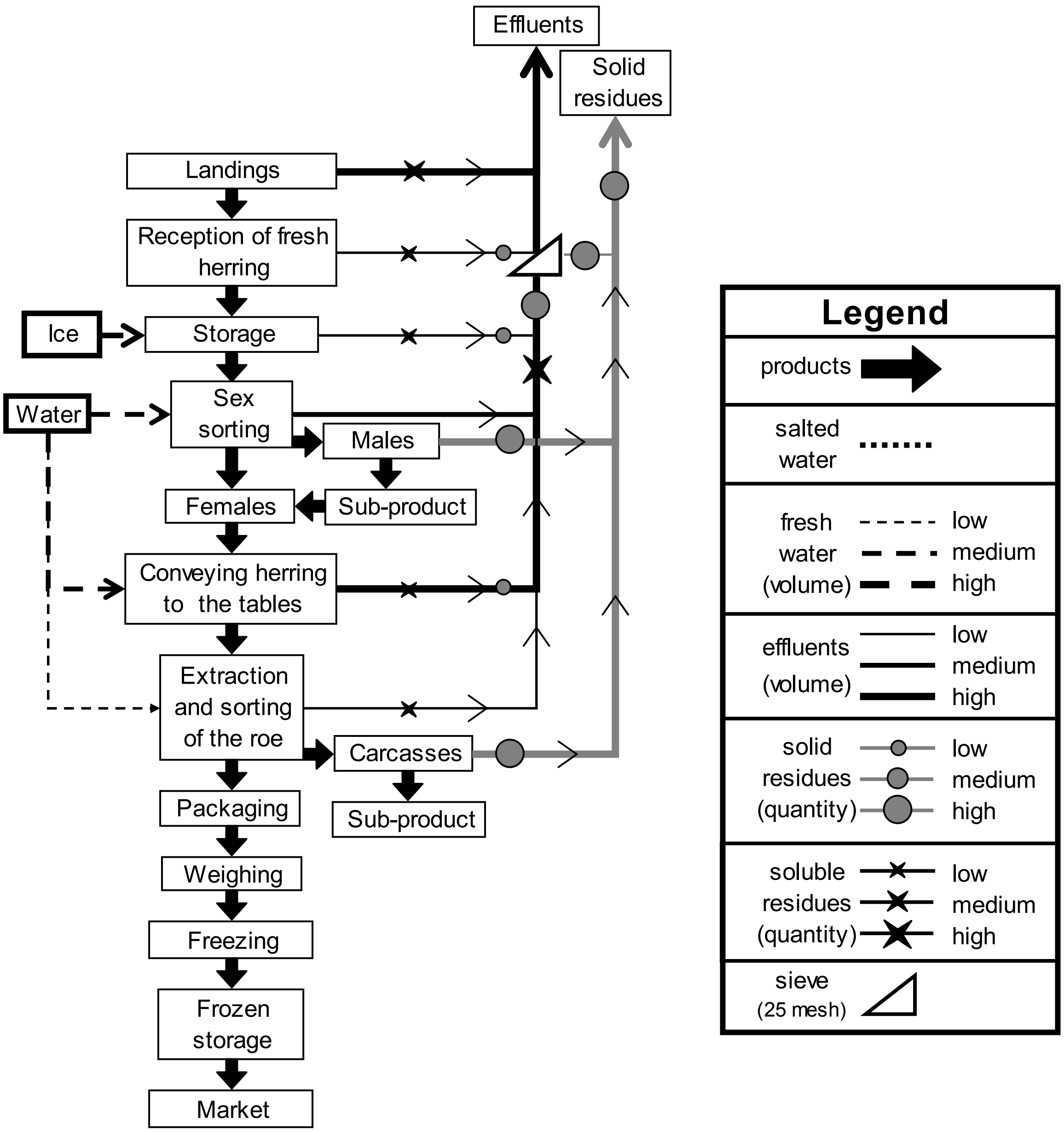


Figure 3.7 Process Flow Diagram for Herring Roe
(Coastal Zones Research Institute Inc. - Fisheries and Marine Products Division, 2003)



The final cleaning of the fish is done with a spoon that is directly attached to a water hose to both scrape and flush remaining viscera and blood away. Offal from dressing tables may be dropped on the floor, into totes for collection, or chutes that discharge to a flume or dedicated offal conveyance system.

On the semi-automatic processing lines, fish are placed belly up in a pocket conveyor after their heads have been removed. Head removal can be achieved manually or automatically. The bellies are then slit manually; guts, and roe or milt are removed by hand and separated for waste disposal, or further processing, followed by the cutting of the kidney. The fish are then cleaned with nozzles attached to suction hoses that remove remaining guts and blood by vacuum, and with spoons attached to small water hoses as in the case of manual cleaning. The dressed fish are then washed, graded, and frozen. Figure 3.8 shows the typical process flow diagram for salmon freezing.

- Salmon Glazing

Frozen salmon generally receive a smooth coating of clear ice glaze prior to final packing and shipping. This glazing is accomplished by either spraying already frozen fish with a fine water spray, or by dipping the frozen fish into chilled water. After glazing the frozen fish are packed in plastic bags and placed in boxes for shipment.

- **Shellfish**
  - Lobster

Lobster are caught in large traps and kept alive until processing. The majority of lobsters are marketed in their shells either live or cooked (Riddle and Shikaze, 1973). A significant percentage of lobster processed in Atlantic Canada is of the form known as “green tails”, that is the uncooked tails are separated from the body and sold fresh or individually frozen (See Figure 3.9). The remainder are cooked, shucked, and canned (See Figure 3.10).

Lobsters are steam cooked in retorts and are water cooled after cooking to facilitate handling. If the lobsters are to be butchered, the backs are removed and the remaining viscera are washed free. The cooking, cooling and washing waters contain considerable quantities of solids and organic pollutants (Riddle and Shikaze, 1973).

- Shrimp (NovaTec, 1994)

The simplest of the shrimp processing operations is that of the packing plant which receives the shrimp either whole or deheaded, deheads them if necessary, weighs the catch and packs it in ice for shipment to another processor for breading, freezing or canning.

Raw shrimp are held on ice for about 2 days after catching to allow proteolytic enzymes and microorganisms the time to break down connective tissue between meat and shell to improve peelabilty. This deterioration also increases water-holding capacity and the holding period results in an increased bacterial load on the raw shrimp.

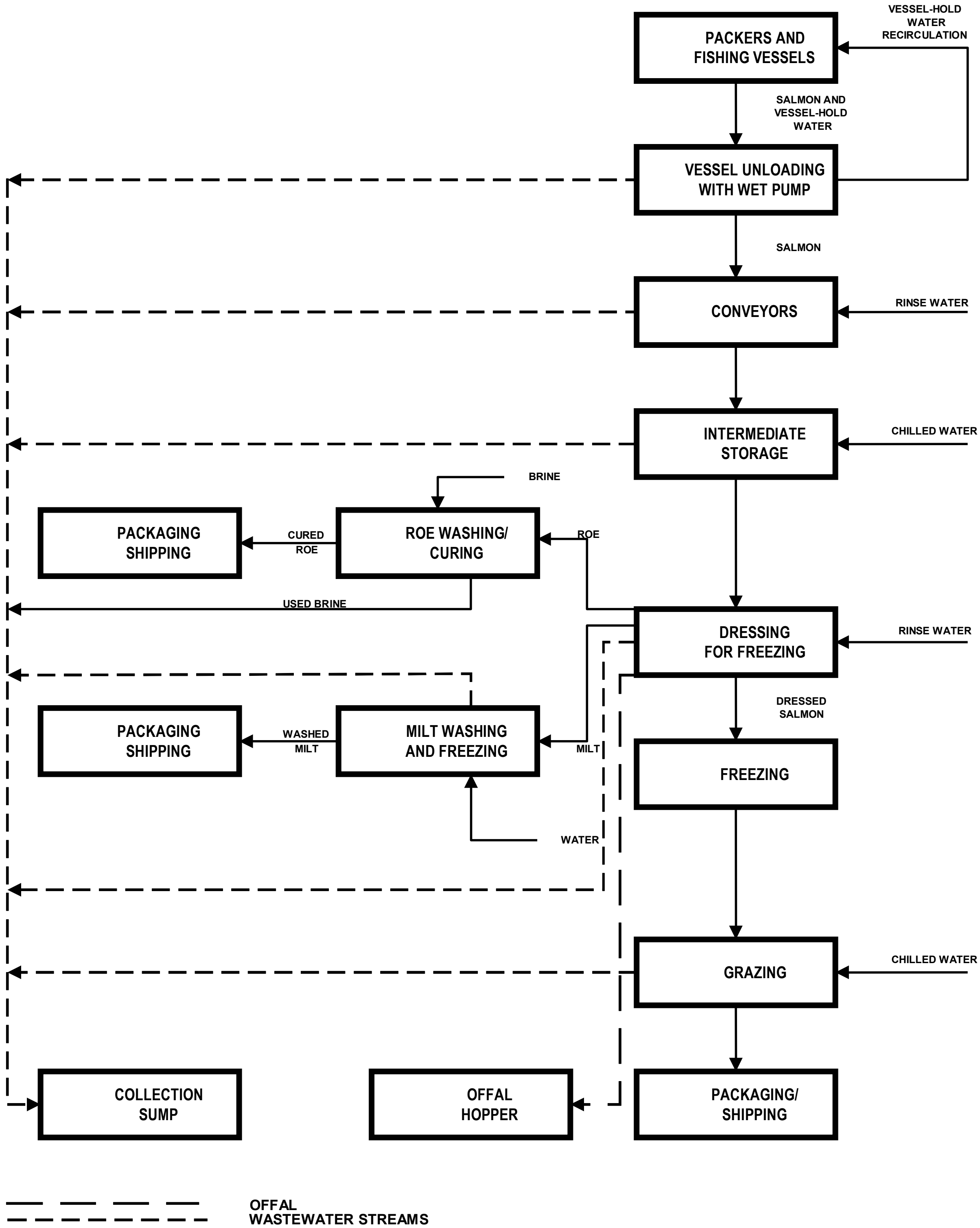


Figure 3.8 Typical Salmon Dressing for Freezing
(Source: NovaTec Consultants Inc., 1994)

Figure 3.9 Typical Lobster Processing (raw tails)
(Coastal Zones Research Institute Inc. - Fisheries and Marine Products Division, 2003)

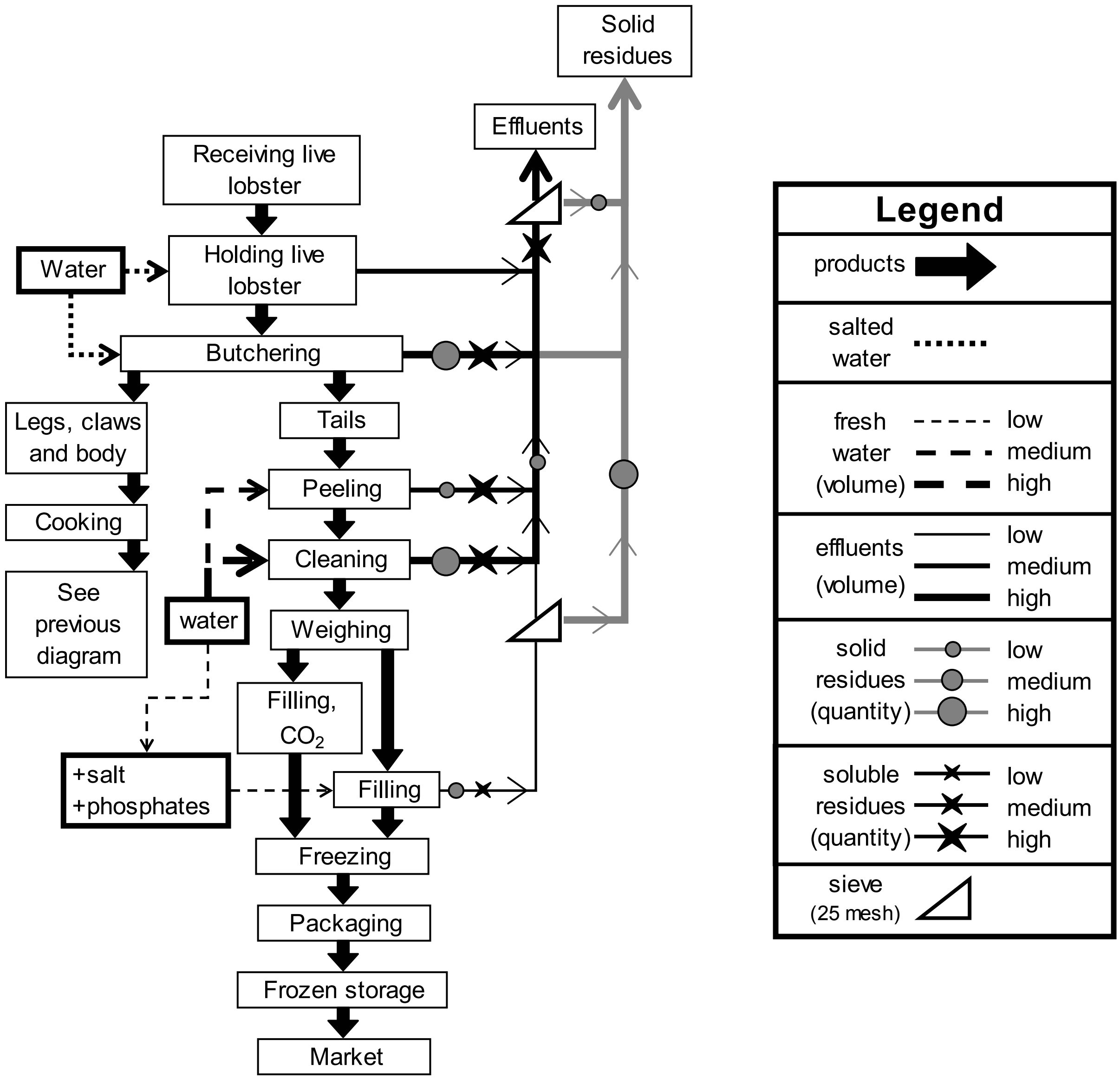
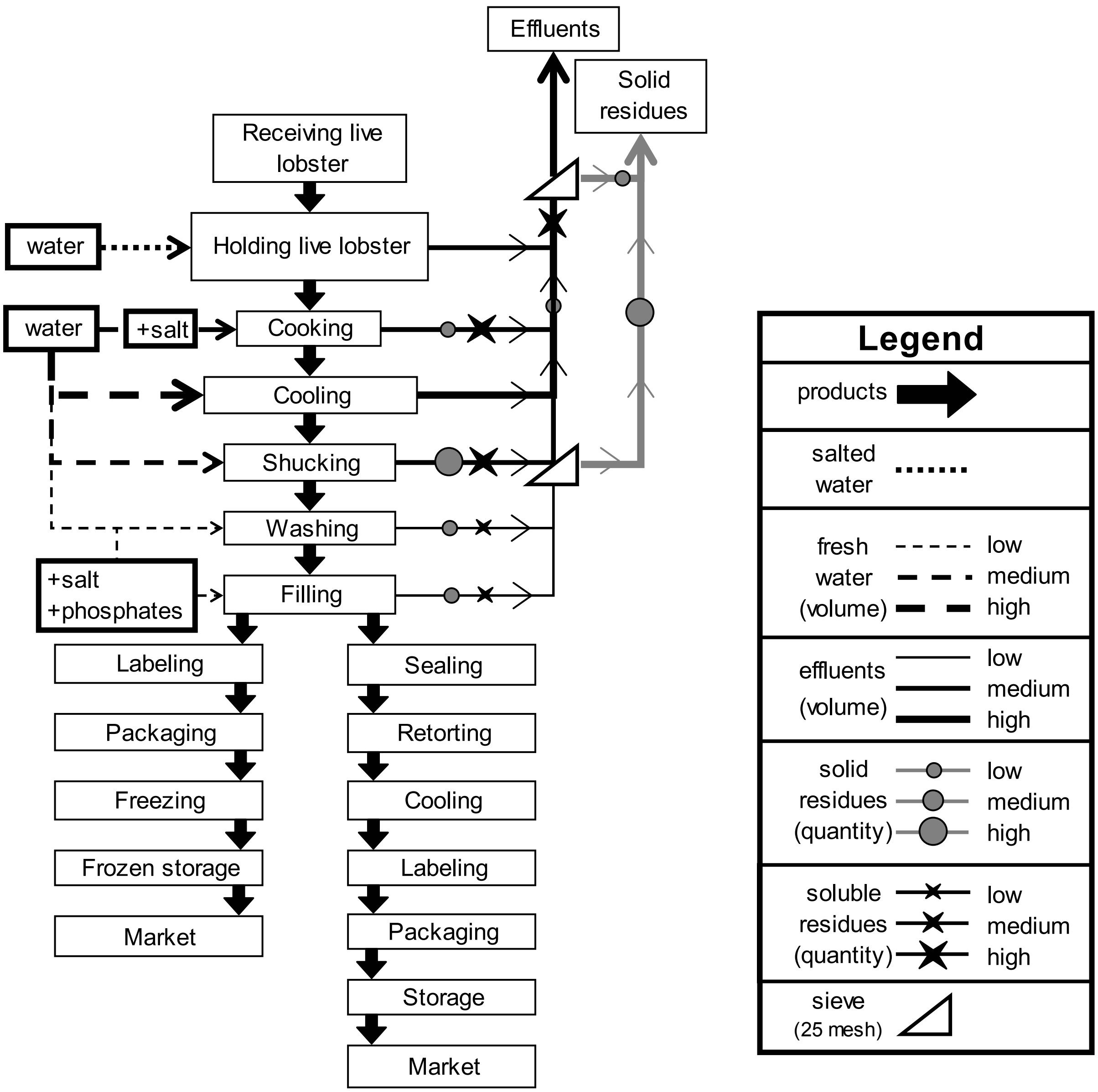


Figure 3.10 Typical Lobster Processing (cooked and canned)
(Coastal Zones Research Institute Inc. - Fisheries and Marine Products Division, 2003)



Iced shrimp are dumped into a melt/feed tank where potable water is continuously introduced to melt the ice and distribute the shrimp on the precooker conveyor. In the precooker, live steam is injected to provide optimum peeling and recovery of meat. In the precooker, the microbial load is reduced. The precooked shrimp fall onto the oscillating rollers of the peeler that pull extraneous parts from the meat. Water sprays loosen and wash away waste. Waste and the sprayed water are flumed away to a waste sump.

From the peeler the shrimp fall into the first of several flumes that lead to cleaning and separating steps. Mesh belt conveyors and elevators permit the flume water to pass through the mesh belt and onto the floor, from where it is discharged. After mechanical cleaning operations, the shrimp are flumed onto a table or "picking belt" where workers hand sort and clean the shrimp. Spraying with a salt solution or immersing it in a salt tank salts shrimp meat. Shrimps are often hand-packed into cans, vacuum sealed, and refrigerated or frozen. A typical flow diagram of shrimp processing is illustrated in Figure 3.11.

- Crab

In Atlantic Canada, the major crab species of economic importance is the snow crab and it grows in deep water. The crabs are then cooked with salted water. Then they are then removed from the cooker and cooled with fresh water. Cooked crabs are then sectioned and otherwise butchered before the crab meat is either manually or mechanically picked and placed in containers for shipment to market. Claws may be canned whole or the meat extracted and canned. The edible meat produced from the crab is only 10 to 15 **%** of the total live weight before cooking (NovaTec, 1994). A typical crab processing flow diagram is presented in Figure 3.12.

- Oyster (NovaTec, 1994)

Oyster processing involves cutting the muscles, which keep the shells closed, with a knife. Following this, the meat is taken out of the shells and washed in cold water. Oyster meat may then be stored on ice for sale on the fresh seafood market, or further processed (See Figure 3.13).

- Clam

Although some clams are harvested for processing (See Figure 3.13), however, most clams in Atlantic Canada are sold raw and unprocessed.

- Mussels

Upon receipt at processing facility, the mussels are immediately washed and put in irrigation for a minimum of 24 hours. This allows the animals to purge any silt that may be inside their shells. Following the irrigation, the mussels continue through a thorough cleaning process where they are polished, debearded and graded. Fresh mussels are generally packed in mesh bags to facilitate drainage and ventilation. Mussels are never sold frozen in Atlantic Canada.

- **Fishmeal (Riddle and Shikaze, 1973)**

It should be noted that this section presents a generalized national description of fishmeal production based on available references. A significant portion of the seafood plant waste sent to fishmeal plants in Atlantic Canada consists of the carapaces of lobster and crab, which is not fully reflected in the following discussion and represents a data gap which needs to be addressed.

Figure 3.11 Typical Shrimp Processing
(Coastal Zones Research Institute Inc. - Fisheries and Marine Products Division, 2003)

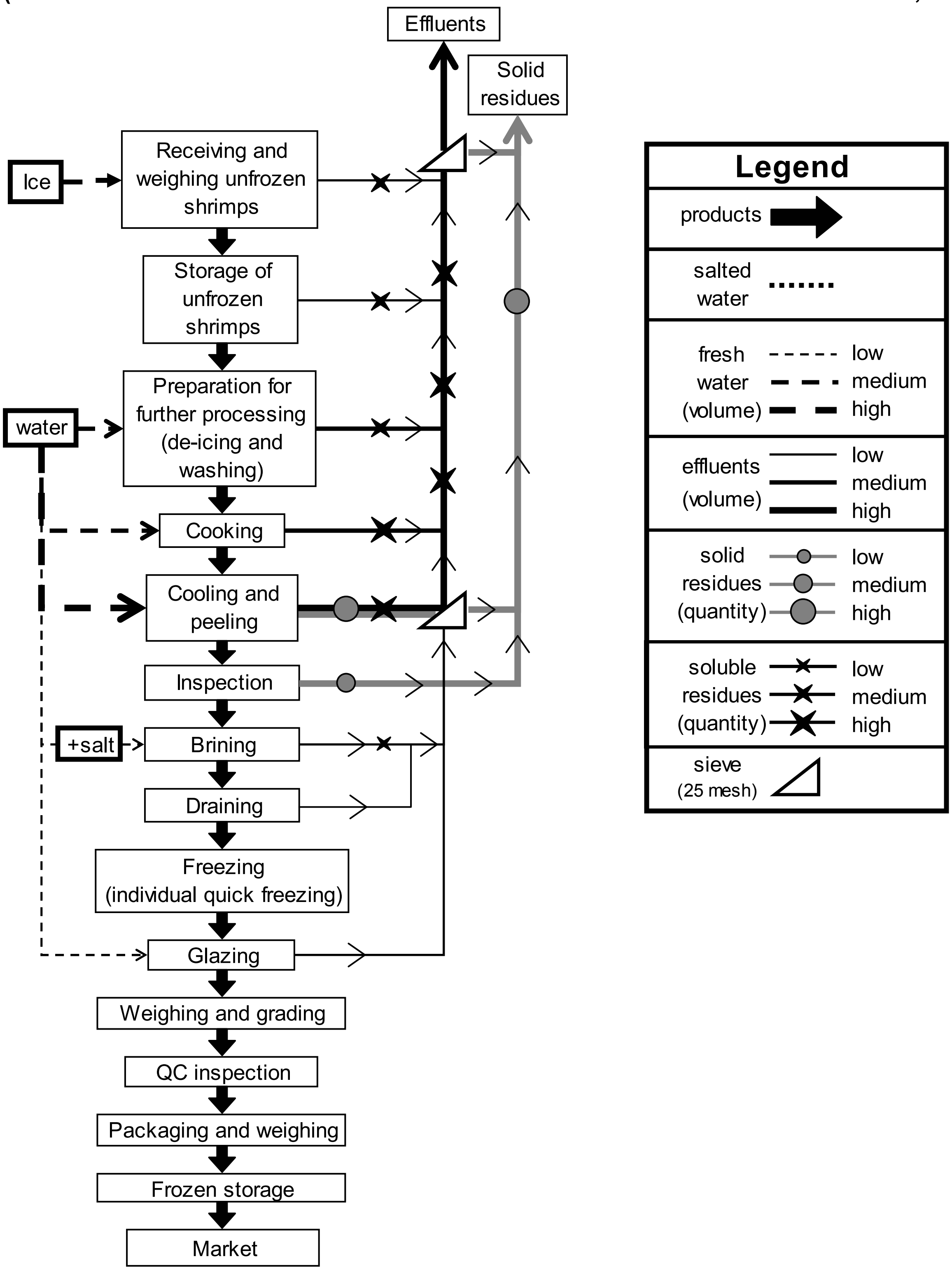


Figure 3.12 Typical Crab Processing
(Coastal Zones Research Institute Inc. - Fisheries and Marine Products Division, 2003)

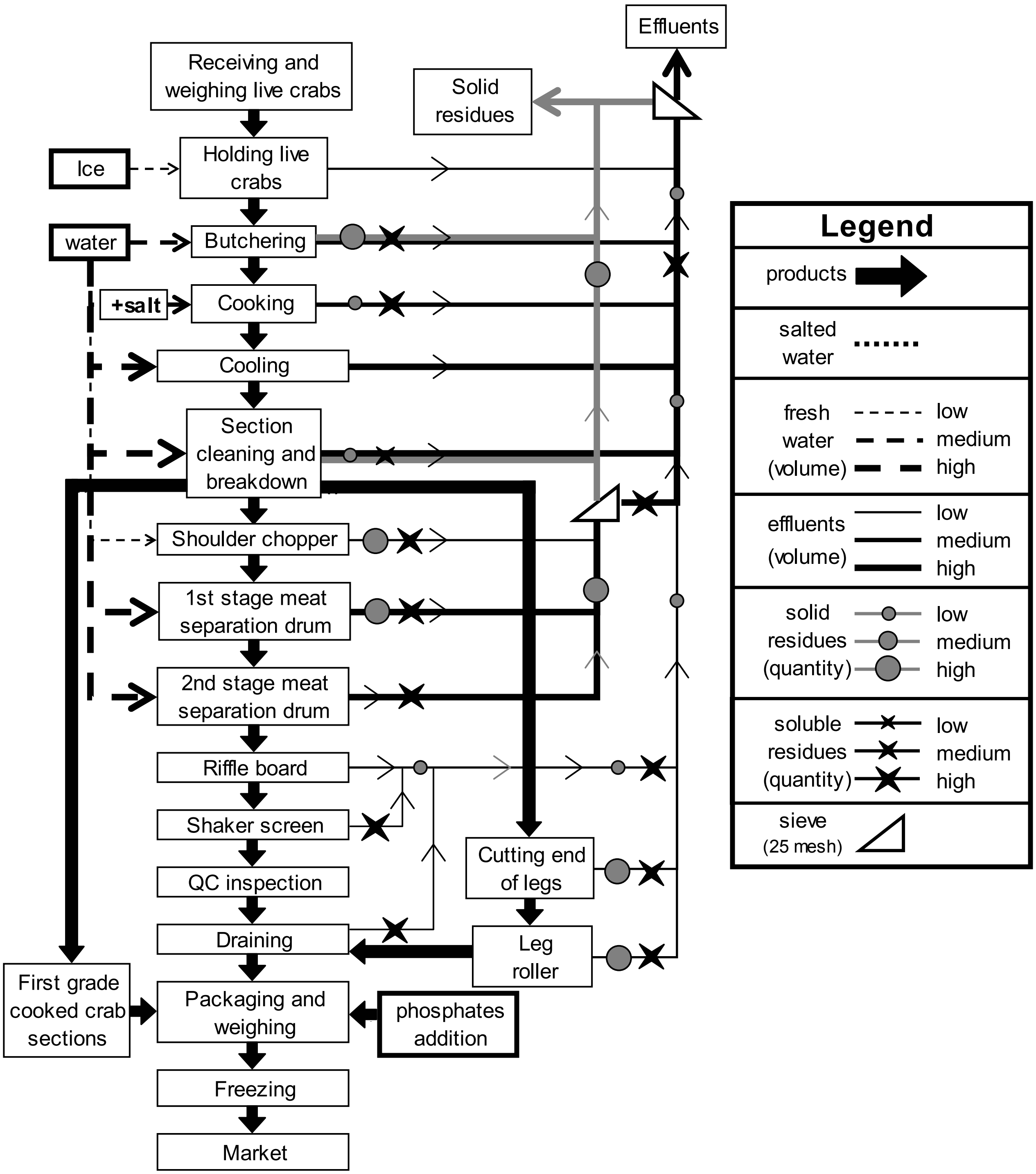
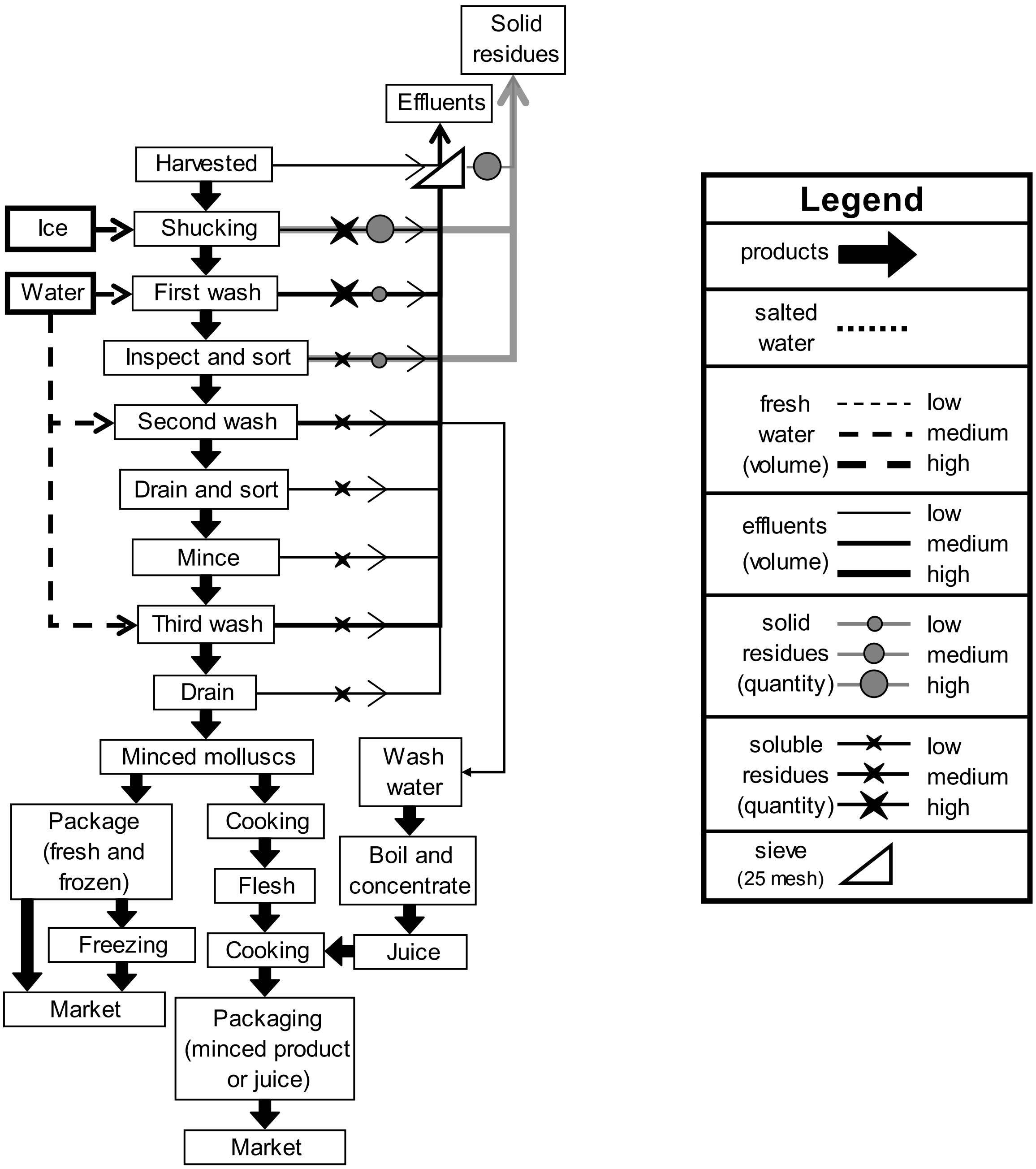


Figure 3.13 Typical Mollusk Processing
(Coastal Zones Research Institute Inc. - Fisheries and Marine Products Division, 2003)



In the processing of most species of fish for food purposes, typically 30-80% of the raw material is waste. Efforts are made by most plants to recover all edible portions, and the introduction of deboning machines has improved utilization. Still, much of the fish poses a disposal problem and one practice has been to produce a protein concentrate for animal feed. Oil may also be recovered from oily species.

The waste material, termed offal, is normally conveyed wet or dry to the fishmeal plant and stored in pits until enough is accumulated to warrant operation. Solids recovered by screening of off-loading and processing water are also sent to the fishmeal plant. During storage some liquid is drained or pressed from the offal. This stream is typically called bloodwater and is not large in volume but is very strong in terms of organic content. Some plants attempt to recover this, but most discharge the stream with the plant effluent.

The general flow for fishmeal production is shown in Figure 3.14. The offal is hashed by machine if large pieces are present, and then cooked in direct or indirect continuous steam cookers for up to 10 minutes. Non-oily offal may be added directly to driers, while oily species are pressed to expel most of the water and oil prior to entering the drier.

In the latter case, the press liquor undergoes a fine solids separation using vibrating screens or decanting centrifuge followed by oil separation in nozzle centrifuges. The oil is further clarified in polishing centrifuges before sale as either an edible oil or animal oil. The aqueous phase may still contain up to five or six percent organic solids and is termed stickwater. At one time this was discarded, but now many plants employ multiple effect evaporators to concentrate these solids. The resultant product is termed condensed fish solubles and contains 30-50% solids. It is marketed as an animal feed, a specialty fertilizer, or is recycled back to the driers for incorporation in the meal. The condenser water used in the evaporators does pick up volatile solids and gases, the extent depending on the degree of freshness of the offal and the manner of operation of the evaporators. The fishmeal driers are usually rotary kilns, with heat being supplied by direct flame heating of the air, or by indirect heating using steam. The solids are dried to between 5-10% moisture content, ground to pass 10 mesh screens and sold in either 100 lb. bags or in bulk. The steam and odours generated during the drying of the meal can be very obnoxious and most plants employ some sort of direct water scrubbing to these vapours prior to release. Large volumes of water are employed for this, and the scrubber effluents will contain a significant quantity of organic material.

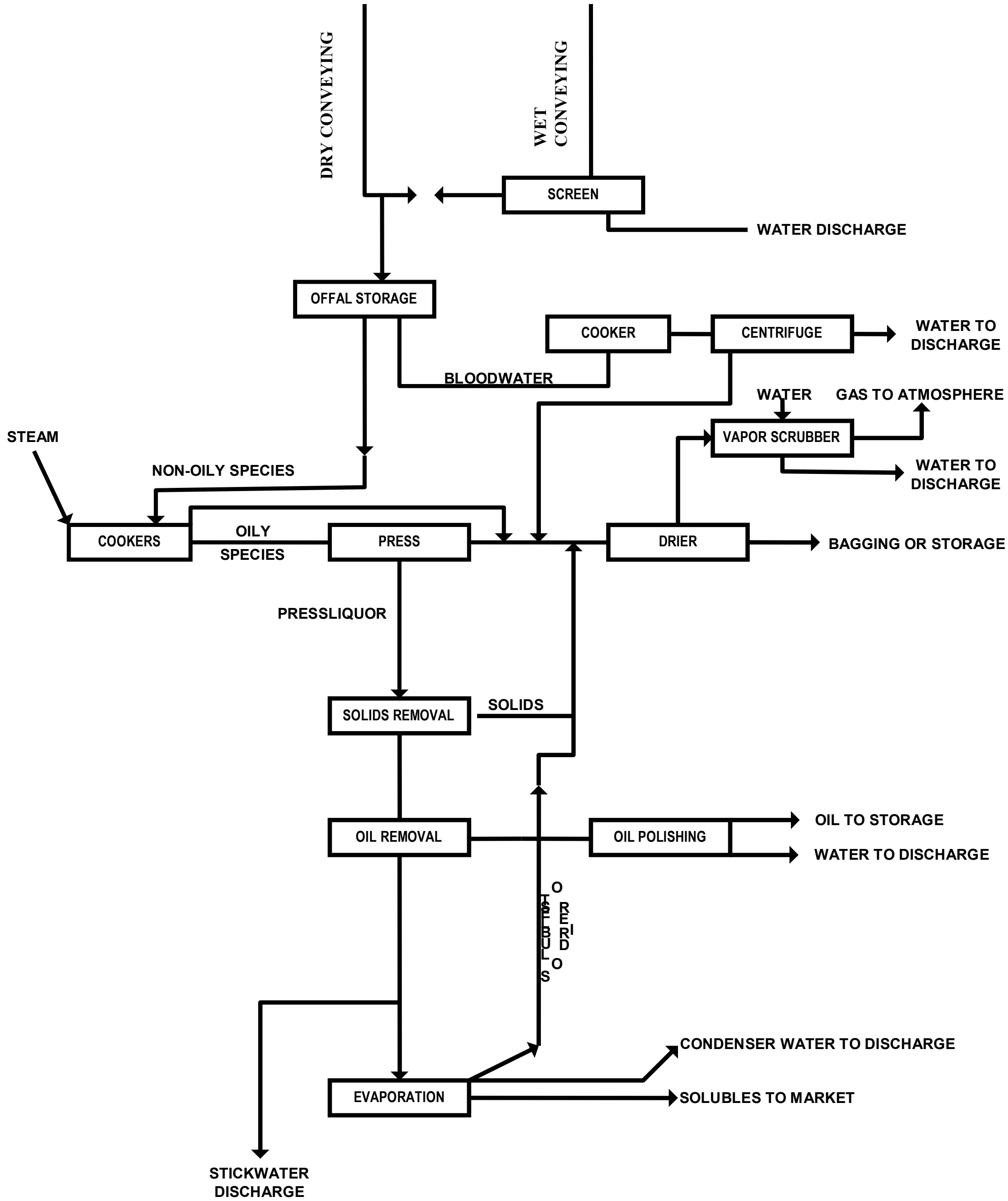
Many fish processing plants in Canada combine a number of the above-mentioned operations. For instance, plants may have the capability of processing both groundfish and salmon. These operations might also be linked to a fishmeal plant. The resulting wastes from the fish processing plant are usually flumed together and discharged as one effluent, after removal of the offal.

- **Sea Plants and Non-food Marine Products**

A few processors are licences to harvest , dry and process marine plants such as seaweed or irish moss to produce food ingredients, fertilizers and other specialized products. Other potential food and non-food products from fish waste include:

- Chitin and its multiple derivatives (carapace of crustaceans);

Figure 3.14 Flow Diagram for Fish Meal Production



(Source: Riddle and Shikaze, 1973)

- Pigments (carapace of crustaceans, algae, etc.);
- Enzymes (viscera and digestive system)
- Gelatine (the skins and carcasses of fishes);
- Omega-3 fatty acids (fish oil);
- Flavours; and
- Protamin (a functional protein found in the milt of herring).

There is no information on the type or amount of such products being produced in Atlantic Canada.

3.3.2 Production Capacity

Information about production capacity is required in order to accurately describe process efficiency in terms of waste ratios. The minimum data required for each plant includes the peak processing capacity, the volume of raw material processed in relation to volume of product, detailed process sequence, water consumption, recycling programs, waste treatment facilities, and the seasonal schedule for each plant. As mentioned in Section 3.2.2, there is no site specific data available that summarizes this data. While annual purchase data and production data is collected by DFO, this could not be used to make deductions about waste ratios without detailed process sequence information and the seasonal schedule for each plant. Much of this data will be available in the CFIA QMP's.

3.3.3 Processing Seasons

Seafood processing plants generally operate at peak levels during the fishing season for each species that they utilize. Most processors are permitted to use several species so the processing schedules overlap based on the fishing seasons allowing processors to extend the traditional operating season (Table 3.16). The increased availability of aquaculture fish (particularly salmon) and the ability to import raw material from other countries and to store local catch for short periods has made it possible for some processors to operate continuously.

The greatest fishing activity is during spring, summer and fall with only one major commercial fishery for smelt in winter. The actual operating schedule for each plant is extremely variable based on market conditions (i.e., fish and product prices) since processors will make the type and amount of fish products in response to market demand. The precise fishing seasons are also variable depending on regulatory management of fishery resources.

Processors are required to estimate their operating schedule when they make their provincial permit application/renewal but no data on the actual processing schedule is collected by any government agency. Prince Edward Island processors are required to submit monthly production volume to the PEI Department of Fisheries, Aquaculture and Environment from which seasonal production schedule could be deduced. Fisheries and Oceans Canada only collects information on annual production, which would not help in identifying production seasonality.

Table 3.16: General Fishing Seasons for Major Fish Species

Fish Type / Species	General Fishing season
Ground Fish	**Spring, Summer, Fall**
Pelagic & Estuarial Fish	
• **Eels**	**August to October**
• **Gaspereau**	**May to June**
• **Herring**	**Spring, Summer, Fall**
• **Mackerel**	**June to December**
• **Silversides**	**October to December**
• **Tuna**	**Summer, Fall**
• **Smelts**	**October to February**
Shellfish	
• **Clams and mussels**	**All year**
• **Crab**	**Spring/Summer, year-round in offshore areas**
• **Lobster**	**All Year**
• **Oysters and scallops**	**May to December**
Sea Plants	**Summer, Fall**

3.3.4 Estimating Total Waste Volumes

Given the available data, there is no way to relate the percent of raw materials that are processed into salable product with reasonable accuracy. Production data collected by DFO is restricted to bulk lots (i.e., cases, barrels, containers), and the weight of fish product may include small amounts of additive (i.e., storage medium, breading, filling). Estimates based on bulk weight could be extremely inaccurate. Also, without knowing which processors are recycling seafood byproducts, for example into fish meal, it is possible to greatly exaggerate the proportion of final waste. With considerable effort and time, regional numbers could be generated to relate the percent of raw materials that are processed into salable product, however, for the reasons identified above, such numbers would be wildly inaccurate; all the more so for the "regional" context since there is likely to be a wide range of processing standards between individual processors. Only a consideration of the site specific data will yield information that gives insight into process efficiency, seasonality, and potential environmental impacts, relative to each species.

For the purpose of illustrating the possible magnitude of waste effluent produced on a regional scale, a rough estimate has been obtained by comparing the production weights of finished products and the commercial landings on a province by province basis (See Table 3.17). It can be seen that the maximum possible amount of waste is very large and emphasizes the importance of monitoring this industry. The greatest possible waste ratio is approximately 51% of the landed weight in Atlantic Canada. Newfoundland & Labrador and Nova Scotia appear to produce the great majority of possible waste (over 87%) in the Atlantic region.

Table 3.17: Maximum Possible Waste Amount By Province

Province (Year)	Total Commercial Landing (Metric Tonnes)	Approximate Product Weight (Metric Tonnes)	Maximum Possible Waste (Metric Tonnes)
NB (2000)	113588	89012	24576
NL (2001)	267959	120999	146960
NS (2001)	366381	146708	219673
PEI (2001)	66046	39000	27046
TOTAL	813974	395719	418255

Sources: DFO website-http://www.dfo-mpo.gc.ca/communic/statistics/landings/S2000aqe.htm
NB Aquatic Products Directory 2002
NSDAF website – http://www.gov.ns.ca/nsaf/marketing/statistics/exports/01exportspec.htm
NL Fisheries and Aquaculture website – http://www.gov.nf.ca/fishaq/processing/reports/reportdec_01.stm
P.Trainor, Pers.Comm., 2003

4.0 WASTE CHARACTERISTICS

4.1 General

It is important to note that the fish and shellfish processing industry is faced with increasing problems of waste handling and disposal, plant sanitation, raw material availability and cost, production efficiency, increased competition (from other countries as well as other protein sources), and increasing labour and energy costs. As well, pollution prevention regulations applicable to this industry could become more stringent in coming years. Given these challenges, cost effective solutions for waste handling and operations must be found for plants to remain in business.

If pollution is viewed as an indication of an inefficient manufacturing process where both product and energy are wasted, then it maybe more cost effective to reduce pollution by improving the process rather than by adding expensive treatment facilities at the end of discharge pipes, which in turn produce sludge for later disposal (Nova Tec, 1994). The ideal food processing plant would take in raw materials, generate products, efficiently recycle water and energy, and recover by-products for internal use or for external markets (Nova Tec, 1994).

Both liquid (effluent) and solid wastes are generated by most seafood processing. Untreated effluents often contain varying amounts of solid matter including offal, skin, and bone. The almost universal screening of effluent removes most settleable solids from the effluent, which are collected for disposal or reprocessing into fishmeal. The remaining suspended and dissolved solids are discharged in the effluents. Although site specific data on solid and liquid wastes in Atlantic Canada is lacking, it is possible to discuss general waste characteristics based on experience from other regions.

4.1.1 Liquid Effluent

Summaries of contaminant concentrations in effluent from different seafood processing plants, as reported in the literature, are presented in Tables 4.1 and 4.2 (NovaTec, 1994). Although the information reported in Table 4.1 and 4.2 was developed for British Columbia, its use is relevant to this study given the complete absence of current site specific information of similar quality for the East Coast. The information can be viewed to indicate process and effluent contaminant trends and provide a guide for future studies on the East Coast.

Wastewater characteristics vary substantially with the type of species processed, applied processing technology and type of finished product. Overall, high BOD, oil and grease, and nitrogen content can be expected in effluents from fish processing facilities (Table 4.1). Most of the BOD and TSS and up to 60 % of oil and grease originates from the butchering process (NovaTec, 1994). The high nitrogen content is due to high blood and slime content in the wastewater streams. Generally, lower BOD and nitrogen concentrations can be expected from shellfish processing (Table 4.2) (NovaTec, 1994).

Table 4.1: Contaminant Concentrations of Fish Processing Plant Effluents

Species Processed	BOD (mg/L)	COD (mg/L)	TS (mg/L)	TSS (mg/L)	Oil & Grease (mg/L)	TKN (mg/L)	Other	Reference
Fish	1200	460			160			Sasaki et al., 1980
Fish cannery		2560		1360	603			Shitrin et al., 1972
Fish salting, smoking & cannery	1600-2000 (total)	500-5000		200-2000			(1)	Pesenon et al., 1974
Fish processing	3500	326-1432	4721	918-1000	1000	117		del Vale & Aguilera, 1990
Fish canning	1400	2900		1900	1200	82		Ziminska, 1985
Fish salting	2300	5400		6000	150	257		Ziminska, 1985
Fish smoking	1700			400	200	77		Ziminska, 1985
Oil rendering	11500	91000		25900	25000	268		Ziminska, 1985
Salmon cannery	2500	4000					(2)	Claggel, 1972
Salmon cannery	2490-2682	4462-5348		1330-1575	464-687	388-417	(3)	Stone et al., 1981
Salmon	397-3082		68-3422	40-1824				Riddle & Shikaze, 1973
Bottom fish	192-1726			300				Riddle & Shikaze, 1973
Halibut	64-150			66110				Riddle & Shikaze, 1973
Halibut	145-420			95-245				Riddle & Shikaze, 1973
Redfish	40-114			14-101				Riddle & Shikaze, 1973
Groundfish (dry line)	27-1775			7-1006	0-526			Riddle & Shikaze, 1973
Groundfish (wet line)	146-1205			30-1550	200-1500			Riddle & Shikaze, 1973
Herring (fileting)	3200-5600	6255	6966	1150-5310	200-3000			Riddle & Shikaze, 1973
Herring (pumpout wat)	33500			7955	500			Riddle & Shikaze, 1973
Tuna	695		17900	1091	500			Riddle & Shikaze, 1973
Surimi		6400-18000	5120-7790			740-1100		Green et al., 1984

Table 4.1: Contaminant Concentrations of Fish Processing Plant Effluents (Continued)

Species Processed	BOD (mg/L)	COD (mg/L)	TS (mg/L)	TSS (mg/L)	Oil & Grease (mg/L)	TKN (mg/L)	Other	Reference
Surimi	5000-5500	1600-2200		1500-2000				Okumura & Uetana, 1992
Surimi	6350-11600		3920-10800		106-1530			Oregon Dept. of Env. Quality, 1993
Fish meal	66400	191000		19000	12500	6400		Siminska, 1965
Fish meal: boilwater	4600	35200						del Vane & Aguilera, 1990
Fish meal: bloodwater		93000						del Vane & Aguilera, 1990

(from NovaTec Consultants Inc., 1994)

Table 4.2: Contaminant Concentrations of Shellfish Processing Plant Effluents

Species Processed	BOD (mg/L)	COD (mg/L)	TS (mg/L)	TSS (mg/L)	TKN (mg/L)	NH_3-N (mg/L)	Reference
Shellfish	290-380 (flt), 280-1075 (tot)	250-738 (flt) 485-1623 (tot)	776-2000	125-825 120-81 (VSS)	36-45	6-15	Hudson et al., 1976
Shrimp				2900			Tilsworth & Morgan, 1983
Shrimp canning	1070			550			del Vane & Aguilera, 1990
Shrimp		3400-6500	1900-2000				del Vane & Aguilera, 1990
Shrimp packing	112-340	131-360	50-500	22-200	22.4-59.4	1.8-13.8	Horn & Pohland, 1973
Shrimp processing	416-857			115-357			Horn & Pohland, 1973
Shrimp processing	530-1240 (tot.) 330-530 (sol.)			240-660			NovaTec, 1993
Crab processing	181-1281	320-2940	1040-1814	80-815, 11429 (VSS)	23-166	6-13.6	Horn & Pohand, 1973
Crab	4100	29000		95			Gates, 1991
Crab & crab sections				210			Tilsworth & Morgan, 1963
Crab meat				170			Tilsworth & Morgan, 1983
Blue crab	10000-14000	20000-25000	18000-25000	700-1000		200-250	Chao et al., 1960
Scallop	580-1250	544-3184		31-1905		15.5-37.5	Kroke et al., 1988
Scallop shucking		1965	9867	350	420		del Vane & Aguilera, 1990
Scallop shucking		1965	9887		420		Welsh & Zal, 1979
Clam washwater		637-3590	2528-3590		113-260		del Vane & Aguilera, 1990
Oyster	164-576	164-100	240-400	50-284	224-91	20-10	Horn & Pohland, 1973
Oyster canning	510			2280			del Vane & Aguilera, 1990
Oyster	310 (tot) 282 (flt)	407 (tot) 5-57 (flt)		12-11 (VSS)			Hudson et al., 1978

Flt - filtered; tot - total; sol - soluble; VSS - Volatile Suspended Solids

(Source: NovaTec Consultants Inc., 1994)

Table 4.3 is a presentation of the amount of contaminants discharged per unit weight of fish processed (contaminant mass loadings) (NovaTec, 1994). This type of data allows a more accurate evaluation of plant performance with respect to generating wastewater, as low contaminant concentrations are not necessarily due to "clean" processing but maybe the result of high water use. There was no data available on water usage for any site. Also, no data was available on the amount of chemical/additive usage for any site.

Variations in daily production, water use, and waste concentration values make it difficult to calculate the amount of waste discharged for each unit of production. A wide range of contaminant loadings per tonne of processed fish/shellfish indicates that loading also depends upon the species processed and applied processing technology (NovaTec, 1994).

4.1.2 Solid Waste

It has been estimated that in 1994, Atlantic Canada seafood processors produced at least 300, 000 tonnes of solid waste (EC, 1994). For some fish species, the solid waste accounts for a large proportion of the landed weight. Filleting plants can generate 30 to 60 % solid waste and crab processing can generate 75 to 80 % solid waste (ACAP, 1999). Solid waste in Atlantic Canada can be reused in secondary processes such as fishmeal and fertilizers (ACAP, 1999). Shellfish waste can be converted into lime, chitin and chitosan, which have many commercial and industrial uses. Where there is no opportunity to reuse waste products they are disposed of in landfills or if it is unfeasible to transport solid waste to a landfill due to remote location (such as in parts of Newfoundland) solid waste is disposed of in the ocean under permit from Environment Canada at approved locations. No monitoring reports were available for any ocean disposal sites where seafood processing waste was the main waste type, therefore, no site specific information is available on effects of ocean disposal.

4.1.3 Other waste components

There is no data available on the amount of chemical additives, process aides, or disinfectants/cleaners for any site. Any additive usage must be approved by Health Canada (See Section 2.1.4) but there are no specific regulations guiding the use of process aides or disinfectants/cleaners. Since there is no data available for amount or type of chemical additives, process aides, or disinfectants/cleaners that are being released in waste effluent, the significance environmental effects (if any) cannot be assessed. Chemical usage may be identified for each site in the QMPs (See Section 2.1.3).

4.1.4 Potential Contaminants Related to Seafood Processing Waste

There are no detailed studies of processing methods or waste profiles. All available data on site specific waste characteristics are included in Table 4.4. In addition to BOD, TSS, oil and grease, and nitrogen, some other possible contaminants include:

- Ammonia – present in the blood and slime of most fish and shellfish species and also used as a disinfecting agent in some plants. Ammonia waste can be acutely toxic (ACAP, 1999)

Table 4.3: Production Based Contaminant Discharge

Specie Processed	BOD (KG/1000 kg of product)	TSS (kg/1000 kg of product)	Oil & Grease (kg/1000 kg product)	Remarks	Reference
Salmon	1.8-2.9	1.2-2.3	0.1-7.4	per raw fish	Riddle & Shikaze, 1973
Salmon	20-50	16	3.5-7.4		Tavel Ltd., 1991
Salmon (hand butchered)		1.6	0.2		Tilsworth & Morgan, 1983
Salmon (mech. hutch.)		26	11		Tilsworth & Morgan, 1983
Groundfish (dry line)	1.3-8	1-22.5		per raw fish	Riddle & Shikaze, 1973
Groundfish (wet line)	15-20	7-34		per raw fish	Riddle & Shikaze, 1973
Groundfish	12-18	9-15	2.5		Tavel Ltd., 1991
Halibut (dry line)	2.6-4	1.6-7		per raw fish	Riddle & Shikaze, 1973
Redfish (dry line)	0.7	1.3	0.2	per raw fish	Riddle & Shikaze, 1973
Herring	22	21			Tavel Ltd., 1991
Shrimp (mechanical)	8	5			Horn & Pohland, 1973
Shrimp (hand)	4	2			Horn & Pohland, 1973
Shrimp	68	39			Mauldin & Szabo, 1974
Shrimp	84-130	54-210	17-42		Tavel Ltd., 1991
Crab	1.7-14	1.39-11		per raw crab	Horn & Pohland, 1973
Crab	4-9.2	13-73		per processed crab	Horn & Pohland, 1973
Crab	40	20			Tavel Ltd., 1991
Clam	19	6	0.5		Tavel Ltd., 1991
Fish Meal	3	1	0.6		Tavel Ltd., 1991

(Source: NovaTec Consultants Inc., 1994)

- Chlorine – usually from sanitation water but may also come from plants that use chlorinated municipal water sources. High chlorine concentrations can be acutely toxic but may also cause genetic damage at low concentrations (Payne et al, 1979)

- Chemical additives including 217 substances approved by Health Canada (See Section 2.1.4)

- Chemical process aides, disinfectants, cleaners

- Dockside waste (litter, petroleum leakage) – many plants have adjacent docking facilities to receive fish catches. Waste deposits from unloading operations have been observed in Atlantic Canada (Shaffner, 1970)

- Fecal coliform (from masses of seabirds attracted to outfall) – Shellfish Sanitation Program Surveys often identify large seabird concentrations (thousands) seeking food at processing outfalls as a potential source of fecal coliform. There is no indication in the literature that fecal coliforms occur in fish offal.

- PCBs – since they are so stable in the environment, PCBs accumulate in the environment through biomagnification. Small levels of PCBs have been found in fish in Atlantic Canada (EC, 1994). While the presence of PCBs in the food portion of fish is usually very low, the accumulation of fish waste at outfalls may cause elevated PCB levels (ACAP, 1999)

Under the London Convention, to which Canada is a signatory, the practice of dumping fish offal at sea is expressly prohibited. However, this practice is approved for processors in Newfoundland and Labrador who cannot feasibly send solid wastes to an approved land waste disposal facility or fish meal plant for recycling. Fourty-eight permits have been issued for NL in 2003 and one permit in NS that will result in the deposit of approximately 20000 –40000 tons of fish offal at approved sites (R. Wadman, Pers. Comm., 2003). No data was available on site specific effects of ocean disposal, however, disposal sites are selected with a preference for rocky bottoms with high energy sea conditions. Tests have been conducted at a number of dumping sites and it was shown that the offal was not dispersed or degraded as readily as had been thought.

4.1.5 Potential Effects of Waste Discharge

One product of contaminant loading is toxicity. A standard procedure for evaluating toxicity is to subject rainbow trout to effluent. Out of fourteen LT50 bioassays sampled in BC during 1996 and 1997 as part of the Fraser River Action Plan (FRAP), all 14 were found to be acutely toxic. A similar test has been conducted for Atlantic Canada in Newfoundland & Labrador, which was also found to be acutely toxic (L. Park, Pers.Comm., 2003).

Table 4.4: Discharge Profiles for Various Processes and Species

Process/species	BOD (mg/L)	COD (mg/L)	Suspended Solids (mg/L)	Total Solids (mg/L)	Discharge Volume (m^3/d)	Region (reference)
Shellfish	470-4640	720-13440	180-5260	1080-22300	N/A	New Brunswick (Shaffner, 1970)
Groundfish	180-4000	496-9450	210-438	14240-40000	N/A	
Fish meal	30-6470	1170-89800	250-15400	18530-50100	N/A	
Cleaning water (herring)	360-2440	960-4800	270-2150	264-1947	N/A	
Pickle water (herring)	17920	64000	5833	2300	N/A	
Stickwater	38000-110000	N/A	125000	N/A	N/A	All Canada (Riddle et al, 1973)
Bloodwater	55000-90000	N/A	40000-50000	N/A	N/A	
Bulk effluent	257-42500	N/A	1020-33500	N/A	N/A	
Groundfish (dry)	45-990	N/A	14.4-908	N/A	N/A	
Halibut	145-420	N/A	95-245	N/A	N/A	
Redfish	40-114	N/A	14.4-101.3	N/A	N/A	
Sole	45-990	N/A	32.6-908	N/A	N/A	
Groundfish (wet)	146-1205	N/A	30-1550	N/A	N/A	
Salmon	1.54-29.1	N/A	0.26-22.6	N/A	N/A	
Herring – filleted	3200-5800	N/A	200-3000	N/A	N/A	
Herring – marinated	6900-14000	N/A	800-5000	N/A	N/A	
Fish meal effluent	257-42500	N/A	1020-23910	N/A	N/A	
Blood water	120000	N/A	N/A	N/A	N/A	
Oily blood water	80000	N/A	15500	N/A	N/A	
Deoderizer water	20	N/A	100	N/A	N/A	
Condenser water	10	N/A	80	N/A	N/A	
Stickwater						
• Groundfish	120000	N/A	10000	N/A	N/A	
• Herring	70000	N/A	30000	N/A	N/A	
• Perch and smelt	160000	N/A	66000	N/A	N/A	
Pumpout water	34000	N/A	8000	N/A	N/A	
Tuna	895	N/A	1091	17900	N/A	
Sardine packing	100-2200	N/A	100-2100	N/A	N/A	
Stickwater (fish meal)	48000	140000	20000	N/A	N/A	Nova Scotia (J.H.McClure and Ass., 1987)
Canned and cured fish and seafood	3355.2	N/A	1677.6	N/A	N/A	Nova Scotia (NOAA, 1994)
Snow crab, herring	310	N/A	79	N/A	1291	New Brunswick (NBDELG, 2003)
Crab, lobster, mackerel, herring	330	N/A	100	N/A	1337	
Herring	440	N/A	500	N/A	138.9	
Shrimp, crab, herring	1700	N/A	1195	N/A	873	
Lobster	1500	N/A	980	N/A	568	

Also, one result of nitrogen contamination is increased nutrient loading causing eutrophication. Excessive phytoplankton and macroalgal growth is causing serious water and aquatic habitat problems in many PEI estuaries, promoted by the high availability of essential nutrients such as nitrogen and phosphorus (EC, 2000). The decay of massive quantities of plant material, particularly sea lettuce (Ulva lactuca), results in oxygen depletion and the production of toxic gases such as hydrogen sulphide and ammonia. This odour problem has caused many public complaints in Lameque, NB (T. Laroche, Pers.Comm., 2003).The high nutrient levels in surface waters may be a major contributing factor in harmful algal blooms (HABs), which appear to be increasing in frequency, severity, duration and geographic distribution. Toxic algal blooms cause shellfish to become contaminated, where human consumption results in illness and, in the worst-case scenario, death.

4.2 Discharge Profiles

Discharge profiles for seafood processing effluent are summarized in Table 4.4 based on available literature and a small number of measurements by NBDELG. No production data was available for any site, which could be correlated to waste volumes. While production volumes are available for regions and sectors (to some extent), there is no waste volume data for regions or sectors with which to make any correlations. Based on the limited available data (both historical and recent) for concentrations of BOD, COD, and suspended solids, the following observations can be made:

- BOD (mg/L) ranges from 10 to 110000
- COD (mg/L) ranges from 496 to 140000
- Suspended solids (mg/L) range from 0.26 to 125000
- Contaminant load is consistently highest in blood water, stick water and pickle water
- Contaminant load is generally lowest in ground fish process water
- Contaminant load is generally higher in shellfish processing than in finfish processing
- Contaminant load is generally higher in fish meal processing than either shellfish or finfish
- The lowest contaminant load by process/species is fresh salmon
- The highest contaminant load by process/species is marinated herring
- Contaminant loading is significantly lower in all recent measurements from NB compared with most of the historical data. This may or may not be attributed to the fact that the Province of NB regularly conducts inspections as a condition of the license to operate.

4.3 Potential for Introduction of Invasive Species

No known importation of an invasive species has occurred that is associated with a seafood product or raw material imported expressly for processing purposes. Imports of raw material by seafood processors is licensed and recorded by the CFIA on a regional basis. This information is currently being compiled into a national database but is not available at this time. Regulations regarding imports do not address the potential for importation of invasive species and no regional data is collected on this subject.

The appearance of infectious salmon anemia (ISA) in Atlantic Canada in the late 1990's has made it necessary to add heat or chemical treatment to some processes in order to kill the virus. This virus first appeared in Norway in the early 1980's and has mostly affected aquaculture salmon. There is no apparent linkage between seafood processing practices and the introduction of ISA into the Maritimes. All the salmon processing plants in NB are either using Heat Treatment as a means of disinfecting, or directing their effluent to a WW Treatment lagoon. It is not believed that any salmon plants in Atlantic Canada (outside New Brunswick) are treating for ISA disinfection (they maybe directing effluent to lagoons).

Other recently highly publicized considerations for the potential spread of invasive organisms are the nuisance club tunicate (*Styela clava*) biofoulant afflicting some mussel farms in PEI and the multi-nucleated sphere unknown (MSX) parasitic disease afflicting oyster farms in New Brunswick and Nova Scotia. These and other invasive organisms pose ongoing problems for commercial/aquaculture development and processing industries in the Atlantic Region. With the movement of these products to various seafood processing facilities within the region, there exists an increased potential for introduction of these organisms in previously uncontaminated areas. It is not possible to determine whether current seafood processing practices are adequate to address the potential introduction of invasive species due to the general lack of site specific data on process sequence.

4.4 Waste Management

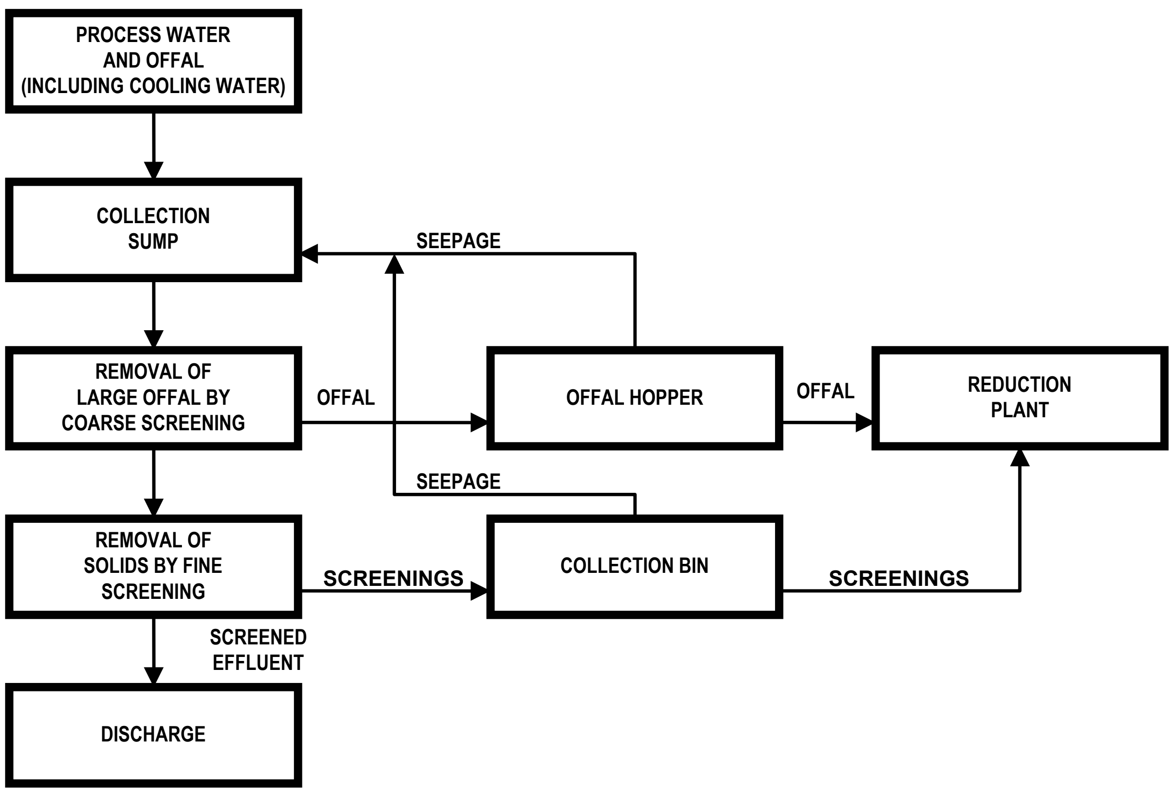
4.4.1 Current Practices in Atlantic Canada

It has been assumed that waste management practices observed in the fish processing facilities are typically very similar (depending on the throughput of the facility), they are described in the following sub-sections based on the limited and somewhat dated references available. The sub-sections also include a discussion of the principles of the waste management practices encountered and their advantages and disadvantages. The description of the practices is divided into offal transport methods, and screening, which is the typical form of treatment encountered at the facilities reviewed.

It is important to note that no regional or site specific data is available for waste management practices in the Atlantic Provinces, therefore regional differences could not be determined. Given that many smaller fish plants in Atlantic Canada operate without licenses, without any form of environmental inspection and may not have minimal screening on discharge pipes, much more solid particulate material gets into the environment in Atlantic Canada than would be a case if the minimum standards outlined in the 1975 Guidelines were being broadly practiced.

- **Offal Transport (NovaTec, 1994)**

A flow diagram of a typical waste treatment scenario is shown in Figure 4.1. Generally, fish processing facilities make use of water not only for fish cleaning, but also to flush offal and blood from equipment and floors, and to transport or flume the offal to floor drains and collection sumps. Automated processing equipment generally has permanently installed water sprays to keep the equipment clean and to flush offal away. Typically, large chunks of offal (heads, tails, fins, etc.) fall into chutes that direct the offal to flumes, or are washed into flumes, which transport the offal to a collection sump. However, a certain amount of offal generally falls onto the floor where it accumulates and must be removed manually. This is typically done by hosing the offal into a nearby drain or flume.



(Source: NovaTec Consultants Inc., 1994)

Figure 4.1 Typical Waste Treatment Scenario

Apart from resulting in high water consumption, this method of equipment cleaning and offal transport causes the mixing of the rinse water with offal and blood, which has two main disadvantages:

- Any soluble biological oxygen demand (BOD) components (i.e. blood) will be dissolved in the water. Dissolved BOD cannot be removed by physical treatment such as screening and is discharged unchanged by such treatment.

- In all facilities that used rotary sidehill screens, the wastewater had to be pumped to an elevated screen from where it was discharged by gravity. The pumping action is rough on offal chunks resulting in an increase of smaller particles that may pass through the following screen.

In addition, pumping is believed to increase the dissolved BOD by solubilizing suspended organic material. The shortcomings of offal fluming have been identified and addressed in many European fish processing facilities, and modifications have been and are being implemented at several fish processing facilities in the B.C. Lower Mainland.

The main processing principles include:

1) Use of suction to remove entrails and to clean fish.

This method represents a very effective means for reducing the contaminant loading, as well as the volume of wastewater discharged from fish processing facilities. However, to fully realize the potential of this processing method, the offal removed must be discharged directly into an offal hopper or bin. Discharging the offal into the wastewater collection system (including discharge directly to the screen) allows the mixing of the soluble fraction of the BOD with the effluent and will result in an increased contaminant loading.

The suction method for dressing fish is at present only practiced for freezer-dressed fish, as mechanized equipment available for cannery dressed fish has a higher throughput than can be achieved with the semiautomatic vacuum dressing lines.

2) Dry transport of offal and separation of offal from water prior to pumping.

These waste handling methods are very similar and can result in a major reduction in contaminant loading and water consumption. Dry offal transport refers to the use of conveyors for the transport of offal rather than fluming offal. As water sprays are generally still required, both for equipment cleaning, and because of Department of Fisheries and Oceans' requirements, the conveyors generally are constructed with a belt made of wire mesh which allows water to drain, but retains large chunks of offal.

- **Screening (NovaTec, 1994)**

Typically, the large processing facilities screen their effluent before discharge. Screening is a physical wastewater treatment process and removes solids that cannot pass through the openings of the screen. Solids removal is an important step in wastewater treatment, as solids of organic origin contribute to the BOD of a wastewater. However, a substantial fraction of the BOD of wastewaters is due to dissolved substances (such as blood), which together with particles smaller than the screen openings, cannot be removed by screening.

Dissolved BOD cannot be removed by simple physical means, but must be removed by a combination of chemical and/or biological treatment. Therefore, the separation of waste material from water, as outlined above, is an important means of reducing contaminant loadings if only physical treatment processes are employed.

Rotary screens are available in two configurations. In one configuration the untreated wastewater is delivered into a headbox that distributes the flow evenly across the rear, upper surface of a horizontal, rotating cylindrical screen. Effluent passes through the screen twice. Initially, through the top of the screen where the removal of solids takes place and finally, through the bottom of the screen in order to drain away. This second step also causes the screen to be backwashed as a result of the cascading action of the screened water. Retained particles are transported by the rotation of the screen to a doctor blade that scrapes off screenings. The screenings are generally collected in a bin or hopper. Internal high pressure sprays (spraying from the inside of the screen) may be installed for additional backwashing of the screen.

The second type of rotary screen receives influent through a headbox on one of the circular sides of a horizontal rotating screen drum. Effluent is screened as it drains through the drum. Retained particles are transported, by blades mounted on the inside, to the opposite end of the drum, where the screenings are discharged and collected. The drums are generally mounted at an incline, with the influent side being lower than the solids discharge end, to prevent influent from being discharged with the solids rather than draining through the screen.

A sidehill screen is an inclined flat screen that is curved at the bottom. Wastewater is delivered into a distribution chamber on the top of the screen from where it overflows onto the screen. Due to the inclination of the screen, water can drain through it while large size particles tumble down on the upper side. A brush moving back and forth on the front side of the screen removes any accumulated particles. The action of the wastewater as it flows over the screen also helps in cleaning the screen and transporting solids. Screenings are collected at the bottom of the screen.

4.5 Data on Receiving Environment

There is no site specific data on receiving environment for any site except for the observation of one NB outfall as being near a clam bed. The location of most seafood processing plants in Atlantic Canada is shown in Figure 3.1. It should be noted that the distributions of the plants are illustrated as per the geographical information gathered throughout the data mining process. The data has not been ground truthed and therefore the accuracy of the information could be problematic. The great majority of sites are coastal or estuarine. In the Maritime provinces (NB, NS, PEI) processors are distributed fairly evenly along the entire coast with concentrations at industrialized harbours. In NL, the majority of processors are in Newfoundland with only 11 sites in Labrador. There are some indications from the Shellfish Sanitation Program surveys that some sites are discharging into ponds or wetlands that are tidally influenced. Several sites in NS (up to 65) and at least 4 sites in NB are known to discharge into municipal waste water systems.

Preliminary data could be gathered through slight modifications in the Shellfish Sanitation Surveys. The surveys are conducted every two to three years and could collect georeferenced environmental data in the field using GPS during the course of the regular program. This would require that each seafood processing plant be located quite precisely (within 100 m) which could be done fairly easily using a standard NTS 1:50 000 scale map. The preliminary data would be used to identify areas with high risk of environmental effects on aquatic habitat. The measurement of actual effects on high risk sites could be initiated following a standardized approach for collecting sublethal toxicity and biological monitoring data in freshwater, estuarine, and marine receiving environments.

5.0 SUMMARY OF FINDINGS AND RECOMMENDATIONS

The following objectives of this report have been achieved:

- Federal and Provincial regulatory requirements relating to processing plant licensing/permitting, liquid and solid waste discharges, and chemical usage have been reviewed and summarized;
- available baseline data has been compiled and validated for:
  - number and location of Atlantic Province seafood processing plants;
  - the type of seafood processed in Atlantic facilities, including an assessment of the potential for introduction of invasive organisms (i.e. through larva or pathogen discharge).
  - physical and chemical characteristics, toxicity, volume of discharge, and discharge frequency of effluents from Atlantic seafood processing plants;
- a database of available seafood processing data has been developed for Atlantic Canada (presented in a digital file on the CD-ROM that accompanies this report).

The very limited data submission requirements of each regulatory agency under current regulations are being met. However, the various provincial and federal agencies that are collecting data have different reasons for their activities, which are unrelated to those of the others. It is no surprise then that each organization has identified industry members differently with considerable overlap but also with some processors uniquely recognized by each regulatory body. There are no regulations (provincial or federal) which require that information on outfalls be collected or stored by any agency. The Fish Processing Operations Liquid Effluent Guidelines (1975) are after all only guidelines and appear to have been applied inconsistently. Site specific data regarding seafood processing effluent, receiving environment, and actual effects of current contaminant loading is not required to be collected under any existing statutes. The NBDELG has initiated a policy to gather such data for seafood processors in NB (see Section 2.2.1), which will provide necessary baseline data in order to measure improvements and compliance. It would be of great value for all Atlantic Provinces to collect such data from seafood processors discharging into fish bearing waters but jurisdictional confusion over responsibility for the marine environment and the lack of a clear mandate in provincial regulations has caused most provinces to be reluctant to voluntarily shoulder the expense.

When this project was initiated, it was assumed that the database would contain enough information to provide guidance on which industry sectors created the most waste or the greatest environmental effect. This has not proven to be the case. It was not possible to make any recommendations for specific monitoring of any sector or category of Atlantic seafood processors based on a consideration of the extremely limited data. While some generally applicable data has been offered for the subjects that are lacking site specific data (i.e. data from other regions of Canada), it was not possible to analyze seafood processing plant waste discharge profiles, correlate with species, processing method, season, or finished product.

It is possible to make suggestions based on the results of other studies conducted in other regions (mainly those of the Fraser River Action Plan (FRAP)) but there is no meaningful way to support this with the data currently available for Atlantic Canada. Such recommendations would be further limited by the complete lack of site specific data on the receiving environment since the character of the receiving environment has a great influence on the actual environmental effects of seafood waste effluent. Finally, there is very little information on regional standards for processing and waste treatment, which would cause even greater uncertainty in using models from other regions (such as the FRAP reports). However, based on the various references from other regions of Canada and the limited available data for Atlantic Canada, the following observations are offered in order to give some rational for prioritizing targeted site audits or site inspections:

- Typically, there is considerable variability among processing plants in terms of water consumption, and effluent characteristics. It is unlikely that fish processing and waste management methods in Atlantic Canada are very similar to those in the rest of North America. Standards in the US are much more stringent than in Canada while the processes involved in producing fine product from very different raw materials in BC makes comparisons between the two coasts in Canada very uncertain. However, the entire industry is moving towards water conservation, and in-house modifications to improve the quality of the process effluent, driven by the desire to reduce water costs, to meet expected tougher regulatory requirements, and to avoid expensive end-of-pipe treatment. Some of the required modifications are advanced by the industry-wide necessity for further mechanization to reduce labour costs, such as the semi-automatic salmon dressing machines, and herring sex sorters, which both may result in a reduction of the water consumption and wastewater contaminant concentrations and loadings (NovaTec, 1994).

- Most of the BOD and dissolved organic carbon (DOC) usually originates from hold water and from the butchering process. Effluent total biochemical oxygen demand (BOD) to chemical oxygen demand (COD) ratios varied widely within and among processing plants. High BOD concentrations are generally associated with high ammonia concentrations.

- High ammonia concentrations are of potential concern with respect to toxicity. The degree of ammonia toxicity depends primarily on the total ammonia concentration, and pH. The pH level determines what proportion of that total ammonia present is in the toxic unionized form.

- Only a small fraction of TS is in total suspended solids (TSS) form. TSS usually accounts for approximately 10 to 30 % of TS. The TSS fraction is increased on days when ground fish or shrimp are processed together with salmon.

- Recorded effluent nitrate and nitrite (NOx) concentrations are generally low. Most of the nitrogen is in the ammonia form. High ammonia concentrations are due to high blood and slime content in the wastewater streams.

- The BOD, COD, TSS, and NH -N per 1000 kg of fish varies widely, from day to day within each facility, and are different between facilities. All facilities discharge less BOD, COD, TSS and NH -N per unit of production on high-production days than on low-production days. This is due to a high minimum base-line water usage and less efficient water use during low production days. Therefore, facilities with high daily production would have lower contaminant loading rates. Variations in daily production, water use and waste concentration make it difficult to calculate precisely the amount of waste generated per unit of production.

- The concentrations of fecal coliforms detected in effluent from all fish processing are generally low. In the absence of sources of sanitary sewage upstream of the sampling locations, fecal coliforms may be partly due to bird droppings in areas from which runoff is discharged together with process effluent (containment around wet pumps, yard drains connected to the main wastewater sump, etc.). It is possible that the majority of the organisms detected are non-sanitary sewage related.

- Effluent toxicity is demonstrated at all sites, and the range of toxicity observed at each site varies between processing days. The wide variation in toxic responses by several organisms to a single sample illustrates that the use of a single toxicity test is not recommended. Rather, the use of a number of tests with both chronic and acute endpoints is more predictive of the toxicity of the effluent from fish processing facilities. Reproduction is considered to be a more sensitive endpoint than survival in the chronic test and regulations based on chronic endpoints are generally accepted as being more protective of the environment.

- There is usually significant temporal variability in sample toxicity at a site reflecting changing effluent quality. Effluent quality is most likely altered by the nature and volume of fish being processed at the plant. One consistent factor in all effluent samples is high oxygen demand, seen as high BOD and COD in the analytical data, and apparent in low dissolved oxygen readings recorded during toxicity tests. Low dissolved oxygen was likely a factor in the toxicity observed in some samples. It is believed that effluents from all fish processing plants may be toxic during certain processing days. As low dissolved oxygen in the effluent samples is likely one of the factors in the toxicity, emphasis should be placed on reducing organic strength and loading.

To address the data gap issues, the following section outlines specific data gaps and recommendations for obtaining necessary data.

5.1 Data Gaps and Recommended Solutions

- There are inconsistencies in the format of basic data collection between EC the CFIA and the various Provincial departments, which made it difficult to assemble an accurate list of seafood processors. Differences in style and detail of basic information cause uncertainty over the separate identity of each processor listed by each organization. Furthermore, the variety of incompatible digital databases used and the apparent inability of many of these databases to generate data except in hard copy makes it extremely difficult to share data easily.

Recommend *regulators review reporting requirements and determine if changes in the types/format of information or data submitted can be standardized. There may be opportunities for eliminating considerable duplication of effort by adopting standard data formats, such as standardized address and location format for processing plants using the full proper title (including unique plant identifier where multiple plants are operated by one owner), plant address (not owner address – unless same) including Postal Code. Updated on an annual basis, the Provincial licensing programs would provide an excellent opportunity to collect data for multiple purposes. It would be greatly beneficial for the various agencies involved to store information in a common template. In addition, the ability to generate data in a commonly accessible digital format would enable the quick and easy sharing of data.*

- The available data on location of processing plants has been approximated for the great majority of sites based usually on the name of the nearest identifiable community. Also, there is confusion where separate place names are similar or identical, and in some cases the address of the owner has been given (not the plant address). Sites are georeferenced using longitude and latitude taken from the location of the identified community so often the map co-ordinates of some plants may actually be hundreds of metres or even kilometers from the given map co-ordinates (or completely wrong if the owners address has been used).

Recommend *sites be georeferenced using Global Positioning System (GPS) or at least are carefully identified on standard NTS 1:50 000 scale maps, which would yield accuracies within 100 metres. Traditional longitude/latitude measurements are the most widely understood and utilized format for identifying geographic location.*

- No data was available on how many or exactly which processors are operating under Agreements, which predate current legislation. These agreements may have implications on jurisdiction and enforcement capabilities.

Recommend *regulators identify exactly which plants are operating under Agreements which predate current legislation and when they expire.*

- The Fish Processing Operations Liquid Effluent Guidelines (1975) suggest that plans and specifications for new facilities or alterations or extensions of existing seafood processing operations be submitted to Environment Canada for review. There is no record of regular submissions to EC regional staff in this respect.

Recommend *more consistent incorporation of the guideline requirements into permits issued by regional and local regulators,, requiring submission of seafood processing plans and specifications to central agency for review and storage in a database. This will provide necessary information for future management of this industry.*

- There is a critical lack of data on site specific effluent characteristics which is necessary to assess the potential effects on the environment. Only New Brunswick has taken measures to begin collection and storage of such data (see Section 2.2.1) for all NB processors. There is no other likely source for this data in the Atlantic Provinces.

Recommend *that other Atlantic provinces consider implementing effluent water quality testing as a condition of the industrial approval permit. Although the federal Fisheries Act places the onus on DFO (through Environment Canada) to monitor waste effluent effects in fish bearing waters, the most practical and cost effective method is through the provincial industrial permits/approvals.*

- The critical lack of current process descriptions and effluent characteristics makes it impossible to characterize process or waste management standards in Atlantic Canada. In turn, it is not possible to estimate what the typical waste loadings are for each sector or region, based on the landed catches and products, since there is no data on typical waste loadings for each sector or region.

Recommend *design of a program to conduct targeted site audits or site inspections to evaluate plant processes and waste handling. These audits/inspections should initially target subsectors of the industry that have large waste discharge volumes, and potentially high levels of BOD and COD. Site audits of in-plant processes and effluent sampling for detailed lab analysis should also be conducted in a representative selection of plants from each sector to help confirm if process details described in the available literature from the 1970s and 80s is still applicable and to help characterize current regional or sectoral industry standards in waste management. The priority for such efforts should reflect the observations in the previous section from the available literature and the limited regional data provided in this report based on potential high volume effluent and high contaminant loading as follows:*

- *Nova Scotia processors utilizing groundfish (hake, redfish, haddock), pelagic finfish (herring), shellfish (scallop, shrimp, and lobster);*
- *Newfoundland & Labrador processors utilizing groundfish (cod, Greenland turbot, flatfishes), pelagic finfish (capelin, herring), shellfish (shrimp, queen crab, clams/quahaugs);*
- *New Brunswick processors utilizing groundfish (cod), pelagic finfish (herring, salmon), shellfish (snow crab, lobster, shrimp); and*
- *Prince Edward Island processors utilizing pelagic finfish (herring), shellfish (mussels, lobster)*

It is likely that no single processor will restrict species production to just one of these species above but will probably use multiple species simultaneously. Following an assessment of these major species, a representative selection of all other species should be targeted in no particular order.

- While some information on detailed production capacity, sequence or seasonality of processing, quantity, and source of raw material is available from provincial licenses, these were not available to the study team due to the competitive nature of the data. No site-specific data is available throughout the Atlantic Provinces that breaks down the raw material sources by species (i.e. what comes from aquaculture, what is caught locally, what is moved about within the region, what is imported from outside the region). This information may be available through the CFIA QMP's, however; at this time there is no federal or provincial database that houses this information.

***Recommend** key data regularly be forwarded by regional regulators to a central agency, as keeper of the data, regarding site specific seafood processing operations for inclusion in a permanently maintained database (such as that which accompanies this report). Although the creation of a centralized database has been initiated by the NPA Atlantic Regional Team, it should be noted that the Team has no regulatory or management mandate, therefore, the responsibility for maintenance of the database will have to be undertaken by some other regulatory or non-government organization. The minimum data required for each plant should include the peak processing capacity, the volume of raw material processed in relation to volume of product, detailed process sequence, water consumption, recycling programs, waste treatment facilities, and the seasonal schedule for each plant. The greatest potential source for this data will be the CFIA QMP's.*

***Recommend** use of the CFIA QMP as a standard data collection tool for each region. The QMPs are reviewed annually by DFO regional staff. For minimal additional effort, necessary information described above can be forwarded to the keeper of the data for input in the database.*

- There is a partial lack of data on standard production methods in Atlantic Canada. Some process flow diagrams from NB have been included and some information has been presented based on West Coast data, however, it is likely that processes and waste characteristics in Atlantic Canada differ somewhat since major species used and products are not the same in each region.

***Recommend** that data from Provincial licenses and QMPs on process standards be reviewed in order to identify regional and/or sectoral processing standards.*

- There is a critical lack of data on production of non-food products from marine species. Such processes may include unusual chemicals and waste types, which would need to be considered in the design of an auditing program as described above. Since these processes are not regulated by CFIA, there may be no QMP data to review.

***Recommend** that producers of non-food products be identified and contacted directly to acquire process details necessary to identify any unusual waste products.*

- There is a complete lack of site specific data on receiving environments at processing plant locations which makes it impossible to assess potential environmental effects from waste discharges, including the potential for sediment enrichment with organochlorines, metals, or other chemicals from the processing waste.

***Recommend** gathering preliminary data through slight modifications in the Shellfish Sanitation Surveys. The surveys are conducted every two to three years and could collect georeferenced environmental data in the field using GPS during the course of the regular program. This would require that each seafood processing plant be located quite precisely (within 100 m) which could be done fairly easily using a standard NTS 1:50 000 scale map. Information on the visible outfall configuration could be briefly described and general data on site specific environment at the outfall would make it possible to infer details of the local ecology and hydraulic energy.*

- There is a critical lack of data on site specific impacts linked directly to seafood processing waste.

***Recommend** standardized approach be developed for targeted research into site specific impacts (such as collecting sublethal toxicity and biological monitoring data) in freshwater, estuarine, and marine receiving environments, in order to ensure results can be interpreted and applied elsewhere and linked to efforts to characterize waste streams and receiving environments. It is beyond the scope of this report to design such a program appropriate to the Atlantic seafood industry but targeted site assessments should include as a minimum the following:*

- Document the process streams from raw materials handling to final product shipment at each facility.
- Provide an overview of waste management practices for pollution control at source, and comment on the relative effectiveness of the technologies employed.
- Describe waste treatment facilities including physical structures, design principles, controlling parameters, and overall system capacity.
- Identify and classify wastewater streams including process discharges and site runoff, potential contaminants, spill containment structures, and point(s) of release to the receiving environment.
- Review and describe (if present) the wastewater collection system.
- Identify relevant analytical parameters and adequacy of flow measurement techniques.
- Identify final effluent sample collection and flow measurement stations, and any specific field equipment needs.
- Describe any proposed changes to the wastewater treatment process, which may affect future effluent quality.
- Collect composite effluent samples during processing only (excluding washdowns after shifts). Measure flow volume, effluent temperature, DO, pH, and total residual chlorine concentration during the collection. Laboratory analyses of Acute and chronic toxicity of the effluent. A variety of organisms and endpoints should be used to assess the toxicity of each effluent sample. This is recognized as an effective

approach in testing for sensitivity of organisms to effluents containing a complex mixture of chemicals.

- Testing effluent conducted for the following parameters:
  - Alkalinity;
  - Ammonia;
  - Biochemical Oxygen Demand;
  - Chemical Oxygen Demand;
  - Conductivity;
  - Dissolved Organic Carbon;
  - Total Suspended Solids
  - Metals, dissolved;
  - Metals, total;
  - Nitrate and Nitrite; and
  - Oil and Grease.

- Invasive organisms pose an ongoing problem for commercial/aquaculture development and processing industries in the Atlantic Region. With the movement of these products to various seafood processing facilities within the region, there exists an increased potential for introduction of these organisms in previously uncontaminated areas. It is not possible to determine whether current seafood processing practices are adequate to address the potential introduction of invasive species due to the general lack of site specific data on process sequence.

Recommend *a review of potential invasive species and available measures for addressing potential import of such species through the seafood processing industry. Due to the apparent lack of published data on such species, consultation with regulators and the scientific community will be required. Accurate information on the source of raw material must be collected as well as the current industry awareness and preparedness of processors to deal with this possible threat.*

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APPENDIX A

Database Template

Appendix A: Database Templates

Seafood Processors

ID	Company Name	Plant Name	Location	Prov	Plant Activity	Plant Address 1	Plant Address 2	Plant Address 3	Contact	Contact Address 1	Contact Address 2	Contact Address 3	Area code	Phone	Fax	E mail	Prov. License
Unique number that links plant data in each table	Name of owner company	Unique plant name or identifier	Nearest community or geographic feature to the plant	Province (2 letter code)	Current status of plant operation	Street/Route and number	Municipality	Postal code	Person(s) in charge of plant operations	Street/Route and number (if different from plant)	Municipality (if different from plant)	Postal code (if different from plant)	Phone area code	Local phone No.	Local fax No.	E-mail address	Provincial Fish Processor License No.
	Possible Sources: • provincial license database • provincial business directory • CFIA Quality Management Plan (QMP)				Possible Sources: provincial license database	Possible Sources: • provincial license database • provincial business directory • QMP											Possible Sources: provincial license database

Seafood Processors (Continued)

Prov. WQ Permit	Federally Registered	SSP Site ID	Latitude	Longitude
Provincial Water Quality /"Industrial" Permit No.	Does the processor have approval from the CFIA for import or export of products (Yes/No)	Sanitary Shellfish Program (SSP) observations site No.	Latitude (Degrees/ Minutes/ Seconds)	Longitude (Degrees/ Minutes/ Seconds)
Possible Sources: • Provincial Water Quality /"Industrial" Permit database	Possible Sources: • CFIA website • QMP	Possible Sources: • DFO SSP surveys	Possible Sources: • provincial license database • DFO SSP surveys	

Process Details

ID	Species	Process Type	Product Types	Volume of Species Processed (Tonnes/yr)	Season	Sequence	Raw Product Source (if not local)	Plant Capacity	Offload Vessel Methods	Process Chemicals (>100kg/year)	Water Consumption (000's L/year)	Water Source	Comments
See Above	All species appearing on the Provincial processors license	All process types appearing on the provincial processing license	All product types appearing on the provincial processing license	Volume of fish material processed as tonnes per year that is proposed in the provincial processor license	Operating season appearing on the provincial processing license	Processing order of licensed species during the licensed operating season.	Source of non-local raw material as aquaculture, other province (by name), other country (by name)	Maximum possible volume of species which may be processed as Tonnes per year	Method of offloading raw fish material from fishing vessels into plant including flume (wet or dry), conveyor, or bucket lift	All chemicals used in seafood processing	Total water use as thousands of litres per year	All sources of process/cleanin g water including private well, municipal, surface water (i.e., fresh), salt water	
	Possible Sources: • provincial license database • provincial business directory • QMP					Possible Sources: • provincial license database • QMP			Possible Sources: • QMP	Possible Sources: • Provincial industrial water quality records • QMP			

Waste Treatment

ID	Wastewater Treatment	Sewage	Offal Transport Methods	Offal Fate	Ocean Disposal Permit	Permitted Volume	Effluent Screening Type	Comments
See Above	General description of waste water treatment design	Type of sanitary waste system utilized by the plant including municipal, septic, or other description.	Indicate if offal transport system is wet or dry	Identify destination of all fish waste from in-plant processes including reprocessing (eg. For fish meal), landfill, ocean disposal, or discharge into natural waters	Environment Canada - Ocean Disposal Permit No.	Maximum volume of material permitted to be disposed of under the Ocean Disposal Permit	Type and mesh size of screening used to filter effluent	
	Possible Sources: • QMP			Possible Sources: • QMP • DFO ocean disposal database	Possible Sources: • DFO ocean disposal database	Possible Sources: • DFO ocean disposal database	Possible Sources: • Provincial industrial water quality records • QMP	

Effluent Data

ID	Discharge Flow (m/s)	Discharge Volume (m3/day)	Effluent Dilution Approximation	BOD (mg/l)	TSS (mg/l)	pH	Comments
See Above	Maximum velocity of effluent discharge at peak operations	Maximum volume of effluent discharge at peak operations	Effluent concentration isopleths in aquatic receiving environment	Biological oxygen demand at peak operations as milligrams per litre	Total suspended solids at peak operations as milligrams per litre	Wastewater pH at peak operations	
	Possible Sources: • Provincial industrial water quality records		Possible Sources: • Plant records (i.e. EEM or discharge design)	Possible Sources: • Provincial industrial water quality records • DFO SSP surveys		Possible Sources: • Provincial industrial water quality records	

Outfall Data

ID	Outfall Design	Latitude	Longitude	Coastal Site	Receiving water body	Habitat Type	Depth @ Low Water (m)	Distance From Shore @ Low Water (m)	Pipe Diameter (m)	Pipe Material	Diffuser Configuration	Age of Outfall	Background DO	DO @ 15 m	Comments
See Above	General description of outfall construction and point of discharge	Latitude (Degrees/ Minutes/ Seconds)	Longitude (Degrees/ Minutes/ Seconds)	Site discharges to marine or estuarine water (True / False)	Name of receiving waterbody	Description of habitat at discharge point	Depth of end-of-pipe at low tide	Distance of end-of-pipe from shore at low tide	Diametre of outfall pipe(s)	Material that outfall pipe(s) are made of	Description of diffuser design		Background dissolved oxygen of receiving water body	Dissolved oxygen at 15 m (50 ft) from outfall	
	Possible Sources: • Provincial industrial water quality records • DFO SSP surveys	Possible Sources: • DFO SSP surveys		Possible Sources: • Provincial industrial water quality records • DFO SSP surveys					Possible Sources: • Provincial industrial water quality records • DFO SSP surveys • QMP			Possible Sources: • QMP	Possible Sources: • Provincial industrial water quality records • DFO SSP surveys		

APPENDIX B

Canadian Food Inspection Agency
-Bulletin No. 9 – (Approved Therapeutants for Aquaculture Use)
-Fish Products Standards and Methods Manual (Appendix 1)

TO: All Holders of the Fish Products Standards and Methods Manual

SUBJECT: APPROVED THERAPEUTANTS FOR AQUACULTURE USE

NOTE: **This bulletin supersedes and replaces Bulletin no. 8 Please remove Bulletin no. 8 from your manual.**

The purpose of this bulletin is to inform manual holders of the authorized use of drugs and pesticides in the aquaculture of fish and crustaceans.

A drug used in aquaculture must be:

1. approved by Health Canada specifically for use in fish or crustaceans;
2. authorized as an Emergency Drug Release (EDR) by Health Canada when the drug has not been approved in Canada (i.e., the drug has not been assigned a Drug Identification Number (DIN) by Health Canada);
3. authorized for testing purposes under an Experimental Studies Certificate, issued by Health Canada;
4. approved as an Investigational New Drug Submission by Health Canada for clinical trials; or
5. prescribed by a licensed veterinarian for "off-label" use (only products with an assigned Drug Identification Number).

Health Canada's Veterinary Drugs Program is responsible for the first four activities and sets the maximum residue limits (MRLs), administrative maximum residue limits (AMRLs) or interim tolerances for these drugs. MRLs are published in Division 26 of the Food and Drugs Regulations. AMRLs or interim tolerances are set by policy by the Veterinary Drugs Program of Health Canada. If levels of drug residues in excess of these limits are found in fish intended for human consumption, the fish will be considered "unwholesome", in accordance with Section 6.(1)(a) of the Fish Inspection Regualtions.

Dosages and withdrawal times for veterinary drugs must be followed as indicated in the veterinary prescription or, in those cases where a prescription is not required, in the Compendium of Medicating Ingredient Brochures (CMIB) published and maintained by the CFIA.

When an antiparasitic is orally administered to fish (via feed or another mechanism) it is deemed to be a drug and is therefore regulated by the Food and Drugs Act and Food and Drug Regulations.

When the same antiparasitic is applied externally to fish (not ingested) it is defined as a pesticide and is regulated by the Pest Control Products Act. The Pest Management Regulatory Agency within Health Canada approves or grants emergency release permits for pesticides under the Pest Control Products Act.

The Veterinary Drugs Program of Health Canada has approved, or temporarily authorized as an EDR, the use in aquaculture of the following veterinary drug products:

PRODUCT BRAND NAME	APPROVED SUBSTANCE	MRL*, AMRL** or interim residue tolerance*** (µg/g)	TISSUE	SPECIES
Terramycin-Aqua	Oxytetracycline	0.1***	Edible Tissue	Salmonids Lobster
Romet 30	Sulfadimethoxine	0.1**	Edible Tissue	Salmonids
	Ormetoprim	0.5**	Muscle	Salmonids
		1.0**	Skin	
Tribrissen 40%	Sulfadiazine	0.1*	Edible Tissue	Salmonids
	Trimethoprim	0.1*	Muscle	Salmonids
Aqua Life TMS	Tricaine methanesulfonate	0.02***	Edible Tissue	Salmonids
Aquaflor	Florfenicol	0.8*[1]	Muscle	Salmonids
Formalin-R Parasite-S	Formaldehyde	n/a[2]	n/a	Salmonid eggs
Perox-Aid	Hydrogen peroxide	n/a[2]	n/a	Salmonid eggs
Calicide	Teflubenzuron	0.3**	Muscle	Salmonids
		3.2**	Skin	
Slice	Emamectin benzoate	0.05***	Muscle	Salmonids

[1] MRL is specified for the metabolite florfenicol amine
[2] Regulated biological substance, ubiquitous in nature

Richard Zurbrigg

Director

Fish, Seafood and Production Division

APPENDIX 1
GUIDE TO ADDITIVES PERMITTED IN FISH AND FISH PRODUCTS

INTRODUCTION

The purpose of this document is to serve as a guide for DFO field personnel and to assist in answering inquiries from the fish-processing industry and fish importers concerning the use of additives in fish and fish products. The guide prescribes additives, and maximum levels permitted, in the various categories of fish and fish products sold in Canada. These categories of fish and fish products were developed to relate to the technological processes that are applied to fish/shellfish products.

Note: This document applies only to fish and fish products sold in Canada.

The guide is based on the following Divisions of the Food and Drug Regulations (FDR):

Division 1 Foods, General
Division 16 Food additives
Division 21 Marine and fresh water animal products

Note: The Fish Inspection Regulations include shellfish in the term fish, whereas in general, the Food and Drug Regulations refer to shellfish as "meat".

This material constitutes a guide only. The information summarized in this document was carefully selected and prepared but revisions to the FDR may have occurred after the production of this document. To obtain more information regarding the use of additives, contact:

Head, Additives and Contaminants Section
Chemical Evaluation Division
Bureau of Chemical Safety
Health Protection Branch
Health Canada
Address: Frederick G. Banting Building
Tunney's Pasture
Ottawa, K1A 0L2
Fax #: (613) 990-1543
Phone #: (613) 957-1827

The additives permitted for use in fish and fish products being sold in Canada, in accordance with Division 16 of the FDR, are selected and summarized in the attached eight tables. There are three categories of fish and fish products, namely: standardized food products, unstandardized food products, and unstandardized preparations of fish and meat products. The category to which a specific fish product belongs may be found in Division 21 of the FDR. The information in the tables applies only to fish products considered to be standardized, meaning the restrictions for the use of additives are more specific than for the category "unstandardized food products". The additives permitted for use in unstandardized fish products are identified at the end of this document. Standardized products are identified by [S]. The third category, "Unstandardized preparations of fish and meat products", includes products such as clam chowder, salmon spread, seafood salad, etc. Aside from fish, these products may contain various amounts of different ingredients. The additives contained in all ingredients of these preparations must be listed. As long as the additive is permitted in at least one ingredient then it is permitted for use in the preparation.

Example: Sorbic Acid is not permitted to be added to unstandardized fish products such as smoked salmon spread but is permitted in unstandardized salad dressings. Since smoked salmon spread contains both these ingredients, the presence of Sorbic Acid is permitted in the product but only if this additive originated from the dressing and the amount is proportional to the amount of dressing in the spread.

USING THE TABLES

The tables were organized using the classification of fish and fish products presented in this Manual. The first column of each table shows a name for the product and the number of the paragraph which applies to the product as identified in Division 21 of the FDR. The second column contains an alphabetical list of additives that are permitted in the product. The third column displays the purpose of use of this additive in the product. The last column shows the maximum permitted level of the additive in the final product. This level is often given as "Good Manufacturing Practice". Division 1 of the FDR identifies this term as follows: "the amount of food additive added to a food in manufacturing and processing shall not exceed the amount required to accomplish the purpose for which that additive is permitted to be added to this food".

In order to make proper use of the tables, it must be noted that in some cases not all permitted additives are listed in the table pertaining to that product. For example, if a canned (final) product was prepared from frozen fish (primary product), all additives permitted in the frozen fish would be permitted as carry-over additives in the canned product. These additives which were carried over from the primary product to the final product are listed in the tables for the frozen fish but are not repeated in the table for the canned product.

A similar situation applies to the specific species or product presentations. If some additives are permitted in all canned fish products, only additional additives permitted for the specific species are listed in the table.

Example: Canned flaked tuna may contain all additives permitted in frozen tuna, canned seafoods general and canned flaked tuna but only the additional additives permitted in canned flaked tuna are listed in the table for this product.

An Index of Additives is included after the tables, giving the number of the appropriate table where details on the specific additive can be found. When using this index, take note that, as per the above explanation, certain additives are not listed in the tables for all products in which they can be used.

APPROVAL OF NON-LISTED ADDITIVES

This document applies only to fish and fish products sold in Canada.

The fact that certain additives are not listed as permitted in some products does not necessarily mean that permission for their use cannot be obtained from Health Canada.

An applicant should provide the Bureau of Chemical Safety/ Health Protection Branch with information on the specific function of the requested additive for the particular product. All requests for permission to use new additives, or any changes in the use of additives, should be made in accordance with Division 16, Section B.16.002 of the Food and Drug Regulations.

PRODUCT FOR EXPORT ONLY

If a product processed in Canada is intended only for export and contains additives not permitted in Canada but permitted in the importing country, the product must comply with Section 37 of the Food and Drugs Act. This section states that the product is in compliance "if the package is marked in distinct overprinting with the word "Export" and a certificate that the package and its contents do not contravene any known requirement of the law of the country to which it is or is about to be consigned has been issued in respect thereof in prescribed form and manner."

CONTENTS

TABLE 1. ADDITIVES PERMITTED IN FROZEN FINFISH

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
FILLETS/ B.21.003	Ascorbic Acid	Preservative	Good Manufacturing Practice
	Erythorbic Acid	Preservative	Good Manufacturing Practice
	Iso-Ascorbic Acid	Preservative	Good Manufacturing Practice
	Sodium Acid Pyrophosphate	To reduce thaw drip	Used in combination with sodium tripolyphosphate and sodium pyrophosphate not to exceed 0.5 % calculated as sodium phosphate, dibasic.
	Sodium Ascorbate	Preservative	Good Manufacturing Practice
	Sodium Carbonate	To reduce thaw drip	15 % of the combination of sodium carbonate and sodium hexametaphosphate.
	Sodium Erythorbate	Preservative	Good Manufacturing Practice
	Sodium Hexameta-phosphate	To reduce thaw drip	0.5 % total added phosphate calculated as sodium phosphate, dibasic.
	Sodium Pyrophosphate Tetrabasic	To reduce thaw drip	Used in combination with sodium tripolyphosphate and sodium acid pyrophosphate, total added phosphate not to exceed 0.5 % calculated as sodium phosphate, dibasic.
	Sodium Tripolyphosphate	To reduce thaw drip	Used singly or in combination with sodium acid pyrophosphate and sodium pyrophosphate tetrabasic, total added phosphate not to exceed 0.5 % calculated as sodium phosphate, dibasic.

TABLE 1. ADDITIVES PERMITTED IN FROZEN FINFISH, cont.

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
GLAZED/ B.21.003	Acetylated Monoglycerides	Glazing agent	Good Manufacturing Practice
	Ascorbic Acid	Preservative	Good Manufacturing Practice
	Calcium Chloride	Firming agent	Good Manufacturing Practice
	Carboxymethyl Cellulose	Glazing agent	Good Manufacturing Practice
	Cellulose Gum	Glazing agent	Good Manufacturing Practice
	Erythorbic Acid	Preservative	Good Manufacturing Practice
	Iso-Ascorbic Acid	Preservative	Good Manufacturing Practice
	Sodium Alginate	Glazing agent	Good Manufacturing Practice
	Sodium Ascorbate	Preservative	Good Manufacturing Practice
	Sodium Carboxymethyl Cellulose	Glazing agent	Good Manufacturing Practice
	Sodium Erythorbate	Preservative	Good Manufacturing Practice
	Sodium Iso-Ascorbate	Preservative	Good Manufacturing Practice
	Sodium Phosphate, dibasic	Glazing agent (to prevent cracking)	Good Manufacturing Practice

TABLE 1. ADDITIVES PERMITTED IN FROZEN FINFISH, cont.

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
MINCED/ B.21.003	Ascorbic Acid	Preservative	Good Manufacturing Practice
	Erythorbic Acid	Preservative	Good Manufacturing Practice
	Iso-Ascorbic Acid	Preservative	Good Manufacturing Practice
	Sodium Acid Pyrophosphate	To reduce thaw drip	Used in combination with sodium tripolyphosphate and sodium pyrophosphate not to exceed 0.5 % calculated as sodium phosphate, dibasic.
	Sodium Ascorbate	Preservative	Good Manufacturing Practice
	Sodium Erythorbate	Preservative	Good Manufacturing Practice
	Sodium Hexametaphosphate	To reduce thaw drip	0.5 % total added phosphate calculated as sodium phosphate, dibasic.
	Sodium Iso-Ascorbate	Preservative	Good Manufacturing Practice
	Sodium Pyro- phosphate Tetrabasic	To reduce thaw drip	Used in combination with sodium tripolyphosphate and sodium acid pyrophosphate, total added phosphate not to exceed 0.5 % calculated as sodium phosphate, dibasic.
	Sodium Tripoly-phosphate	To reduce thaw drip	Used singly or in combination with sodium acid pyrophosphate and sodium pyrophosphate tetrabasic, total added phosphate not to exceed 0.5 % calculated as sodium phosphate, dibasic.

TABLE 2. ADDITIVES PERMITTED IN PREPARED CRUSTACEANS AND MOLLUSCS

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
CRUSTACEANS/ B.21.006(o)	Potassium Bisulphite	Preservative	Good Manufacturing Practice - Residues in edible portion of the uncooked product not to exceed 100 ppm, calculated as sulphur dioxide.
	Potassium Metabisulphite	Preservative	Good Manufacturing Practice - Residues in edible portion of the uncooked product not to exceed 100 ppm, calculated as sulphur dioxide.
	Sodium Bisulphite	Preservative	Good Manufacturing Practice - Residues in edible portion of uncooked product not to exceed 100 ppm, calculated as sulphur dioxide.
	Sodium Dithionite	Preservative	Good Manufacturing Practice - Residues in edible portion of the uncooked product not to exceed 100 ppm, calculated as sulphur dioxide.
	Sodium Metabisulphite	Preservative	Good Manufacturing Practice - Residues in edible portion of the uncooked product not to exceed 100 ppm, calculated as sulphur dioxide.
	Sodium Sulphite	Preservative	Good Manufacturing Practice - Residues in edible portion of the uncooked product not to exceed 100 ppm, calculated as sulphur dioxide.
	Sulphurous Acid	Preservative	Good Manufacturing Practice - Residues in edible portion of the uncooked product not to exceed 100 ppm, calculated as sulphur dioxide

TABLE 2. ADDITIVES PERMITTED IN PREPARED CRUSTACEANS AND MOLLUSCS, cont.

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
CRUSTACEANS FROZEN/ B.21.006(p)	Calcium Oxide	To facilitate the removal of extraneous matter and to reduce moisture loss during cooking.	When used in combination with sodium chloride and sodium hydroxide in solution, calcium oxide not to exceed 30 ppm
	Sodium Hydroxide	To facilitate the removal of extraneous matter and to reduce moisture loss during cooking.	When used in combination with sodium chloride and calcium oxide in solution, sodium hydroxide not to exceed 70 ppm
MOLLUSCS, FROZEN/ B.21.006(p)	Calcium Oxide	To facilitate the removal of extraneous matter and to reduce moisture loss during cooking.	When used in combination with sodium chloride and sodium hydroxide in solution, calcium oxide not to exceed 30 ppm
	Sodium Hydroxide	To facilitate the removal of extraneous matter and to reduce moisture loss during cooking.	When used in combination with sodium chloride and calcium oxide in solution, sodium hydroxide not to exceed 70 ppm
SHRIMP, COOKED, FROZEN/ B.21.006(b)	Citric Acid	pH adjusting agent	Good Manufacturing Practice

TABLE 3. ADDITIVES PERMITTED IN DRESSED FLESH OF FROZEN CLAMS, CRAB, LOBSTER, SHRIMP

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
CLAMS, FROZEN CRAB, FROZEN LOBSTER, FROZEN SHRIMP, FROZEN/ B.21.004	Sodium Acid Pyrophosphate	To reduce processing losses and to reduce thaw drip	Used in combination with sodium tripolyphosphate and sodium pyrophosphate not to exceed 0.5 % calculated as sodium phosphate, dibasic.
	Sodium Carbonate	To reduce thaw drip	Used in combination with sodium hexametaphosphate not to exceed 15 % of this combination.
	Sodium Hexametaphosphate	To reduce thaw drip	0.5 % total added phosphate calculated as sodium phosphate, dibasic.
	Sodium Pyrophosphate Tetrabasic	To reduce processing losses and to reduce thaw drip	Used in combination with sodium tripolyphosphate and sodium acid pyrophosphate not to exceed 0.5 % calculated as sodium phosphate, dibasic.
	Sodium Tripolyphosphate	To reduce processing losses and to reduce thaw drip	Used singly or in combination with sodium acid pyrophosphate and sodium pyrophosphate tetrabasic, total added phosphate not to exceed 0.5 % calculated as sodium phosphate, dibasic.

TABLE 4. ADDITIVES PERMITTED IN CANNED PRODUCTS

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
SEA FOODS GENERAL/ B.21.006 (f)(i)	Agar	Gelling agent	Good Manufacturing Practice
	Ammonium Carrageenan	Gelling agent	Good Manufacturing Practice
	Carrageenan	Gelling agent	Good Manufacturing Practice
	Gelatin	Gelling agent	Good Manufacturing Practice
	Irish Moss Gelose	Gelling agent	Good Manufacturing Practice
	Potassium Carrageenan	Gelling agent	Good Manufacturing Practice
	Sodium Acid Pyrophosphate	Sequestering agent	0.5 % total added phosphate calculated as sodium phosphate, dibasic.
	Sodium Carrageenan	Gelling agent	Good Manufacturing Practice
	Sodium Hexameta- phosphate	Sequestering agent	0.1 %
COOKED CLAMS/ B.21.006 (b)(k)	Calcium Disodium Ethylenediamine- tetraacetate	Sequestering agent	340 ppm
	Citric Acid	pH adjusting agent	Good Manufacturing Practice
CRAB MEAT/ B.21.006 (b)(d)	Aluminum Sulphate	Firming agent	Good Manufacturing Practice
	Calcium Disodium Ethylenediamine- tetraacetate	Sequestering agent	275 ppm
	Citric Acid	pH adjusting agent	Good Manufacturing Practice

TABLE 4. ADDITIVES PERMITTED IN CANNED PRODUCTS, cont.

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
FLAKED TUNA/ B.21.006 (d)(e)(l)	Aluminum Sulphate	Firming agent	Good Manufacturing Practice
	Ascorbic Acid	Preservative	Good Manufacturing Practice
	Calcium Ascorbate	Preservative	Good Manufacturing Practice
	Calcium Disodium Ethylenediamine- tetraacetate	Sequestering agent	250 ppm
	Sodium Sulphite	To prevent discolouration	300 ppm
LOBSTER/ B.21.006 (b)(d)	Aluminum Sulphate	Firming agent	Good Manufacturing Practice
	Calcium Disodium Ethylenediamine tetraacetate	Sequestering agent	275 ppm
	Citric Acid	pH adjusting agent	Good Manufacturing Practice
SALMON/ B.21.006(d)	Aluminum Sulphate	Firming agent	Good Manufacturing Practice
	Calcium Disodium Ethylenediamine tetraacetate	Sequestering agent	275 ppm
SHELLFISH/ B.21.006(b)	Citric Acid	pH adjusting agent	Good Manufacturing Practice
SHRIMP/ B.21.006(d)	Aluminum Sulphate	Firming agent	Good Manufacturing Practice
	Calcium Disodium Ethylenediamine tetraacetate	Sequestering agent	250 ppm
SPRING MACKEREL/ B.21.006(b)	Citric Acid	pH adjusting agent	Good Manufacturing Practice

TABLE 4. ADDITIVES PERMITTED IN CANNED PRODUCTS, cont.

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
TUNA/ B.21.006 (d)(e)	Aluminum Sulphate	Firming agent	Good Manufacturing Practice
	Ascorbic Acid	Preservative	Good Manufacturing Practice
	Calcium Ascorbate	Preservative	Good Manufacturing Practice
	Calcium Disodium Ethylenediamine tetraacetate	Sequestering agent	250 ppm

TABLE 5. ADDITIVES PERMITTED IN PICKLED, SPICED AND MARINATED PRODUCTS

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
FINFISH/ B.21.021 AND MOLLUSCS AND CRUSTACEANS/ B.21.021	Acetic Acid	Preservative	Good Manufacturing Practice
	Ascorbic Acid	Preservative	Good Manufacturing Practice
	Benzoic Acid	Preservative	1,000 ppm
	Calcium Ascorbate	Preservative	Good Manufacturing Practice
	Erythorbic Acid	Preservative	Good Manufacturing Practice
	Iso-Ascorbic Acid	Preservative	Good Manufacturing Practice
	Methyl-p-hydroxy Benzoate	Preservative	1,000 ppm
	Potassium Benzoate	Preservative	1,000 ppm calculated as benzoic acid
	Propyl-p-hydroxy Benzoate	Preservative	1,000 ppm
	Saunders Wood (Sandalwood)	Colouring agent	Good Manufacturing Practice
	Sodium Benzoate	Preservative	1,000 ppm calculated as benzoic acid
	Sodium Iso-Ascorbate	Preservative	Good Manufacturing Practice

TABLE 6. ADDITIVES PERMITTED IN SALTED AND/OR DRIED PRODUCTS

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
SALTED FISH/ B.21.021	Potassium Sorbate	Preservative	1,000 ppm
	Sorbic Acid	Preservative	1,000 ppm
	Sodium Sorbate	Preservative	1,000 ppm
FISH ROE (CAVIAR)/ B.21.006(a)	Colouring agents permitted in lobster paste		
LUMPFISH CAVIAR/ B.21.006(m)	Colouring agents permitted in lobster paste, and		
	Tragacanth Gum	Thickening agent	1.0 %

TABLE 7. ADDITIVES PERMITTED IN PREPARED/SECONDARY PRODUCTS

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
FISH PASTE/ B.21.021	Calcium Sorbate	Preservative	1,000 ppm
	Monoglycerides	Emulsifying agent	Good Manufacturing Practice
	Mono- and Diglycerides	Emulsifying agent	Good Manufacturing Practice
	Potassium Sorbate	Preservative	1,000 ppm
	Sorbic Acid	Preservative	1,000 ppm
	Sodium Sorbate	Preservative	1,000 ppm
LOBSTER PASTE/ B.21.006(a)	Allura Red	Colouring agents	300 ppm singly or in combination.
	Amaranth		
	Erythrosine		
	Indigotine		
	Sunset Yellow FCF		
	Tartrazine		
	Brilliant Blue FCF	Colouring agents	100 ppm singly or in combination.
	Fast Green FCF		
	B-apo-8'Carotenal	Colouring agents	35 ppm
	Ethyl B-apo-8' Carotenoate		

TABLE 7. ADDITIVES PERMITTED IN PREPARED/SECONDARY PRODUCTS, cont.

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
LOBSTER PASTE/ B.21.006(a)	Aluminum Metal	Colouring agents	Good Manufacturing Practice
	Alkanet		
	Annatto		
	Anthocyanine		
	Beet Red		
	Canthaxanthin		
	Caramel		
	Carbon Black		
	Carotene		
	Charcoal		
	Chlorophyll		
	Cochineal		
	Iron Oxide		
	Orchil		
	Paprika		
	Riboflavin		
	Saffron		
	Saunders Wood		
	Silver Metal		
	Titanium Dioxide		
	Turmeric		
	Xanthophyll		

TABLE 7. ADDITIVES PERMITTED IN PREPARED/SECONDARY PRODUCTS, cont.

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
SMOKED FISH/ B.21.021	Colouring agents permitted in lobster paste, and		
	Calcium Sorbate	Preservative	1,000 ppm
	Erythorbic Acid	Preservative	Good Manufacturing Practice
	Potassium Sorbate	Preservative	1,000 ppm
	Sodium Sorbate	Preservative	1,000 ppm
	Sorbic Acid	Preservative	1,000 ppm
	Wood Smoke	Preservative	Good Manufacturing Practice
SURIMI-BASED PRODUCTS/ B.21.006	Colouring agents permitted in lobster paste		
	Agar	Gelling agent	Good Manufacturing Practice
	Ammonium Carrageenan	Gelling agent	Good Manufacturing Practice
	Calcium Carbonate	Gelling agent	Good Manufacturing Practice
	Carrageenan	Gelling agent	Good Manufacturing Practice
	Gelatin	Gelling agent	Good Manufacturing practice
	Irish Moss Gelose	Gelling agent	Good Manufacturing Practice
	Potassium Carbonate	pH adjusting agent	Good Manufacturing Practice
	Potassium Carrageenan	Gelling agent	Good Manufacturing Practice
	Sodium Carrageenan	Gelling agent	Good Manufacturing Practice
	Sodium Hexametaphosphate	Texturizer	0.1 %
	Sodium Pyrophosphate, tetrabasic	Texturizer	0.1 %
	Sodium Tripolyphosphate	Texturizer	0.1 %
	Sorbitol	Texturizer	3.5 %

TABLE 8. ADDITIVES PERMITTED IN FISH PROTEINS

PRODUCT/ REFERENCE	ADDITIVES	PURPOSE OF USE	MAXIMUM LEVEL
FISH PROTEIN/ B.21.027	Isopropyl Alcohol	Extraction solvent	0.15 %
	Phosphoric Acid	PH adjusting agent	Good Manufacturing Practice

INDEX OF ADDITIVES PERMITTED IN STANDARDIZED FISH PRODUCTS

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ADDITIVES PERMITTED IN UNSTANDARDIZED FOOD PRODUCTS

COLOURING AGENTS:

1) **Good Manufacturing Practice**:
Aluminum Metal, Alkanet, Annatto, Anthocyanins, Beet Red, Canthaxanthin, Caramel, Carbon Black, Carotene, Charcoal, Chlorophyll, Cochineal, Iron Oxide, Orchil, Paprika, Riboflavin, Saffron, Saunderswood, Silver Metal, Titanium Dioxide, Turmeric, Xanthophyll

2) **Maximum level: 35 ppm**:
B-apo-8'-carotenal, Ethyl B-apo-carotenoate

3) **Maximum level: 300 ppm singly or in combination**:
Allura Red, Amaranth, Erythrosine, Indigotine, Sunset Yellow FCF, Tartrazine

4) **Maximum level: 100 ppm singly or in combination**:
Brilliant Blue FCF, Fast Green FCF

EMULSIFYING, GELLING, STABILIZING AND THICKENING AGENTS:

1) **Maximum level: 8% of the fat content**:
Lactylated Mono and Diglycerides

2) **Good Manufacturing Practice**:
Acacia Gum, Acetylate Monoglycerides, Acetylated Tatraric Acid, Esters of Mono and Diglycerides, Agar, Algin, Alginic Acid, Ammonium Alginate, Ammonium Carrageenan, Ammonium Furcelleran, Ammonium Salt of Phosphorylated Glycerides, Baker's Yeast Glycan, Calcium Alginate, Calcium Carbonate, Calcium Carrageenan, Calcium Citrate, Calcium Fulcelleran, Calcium Gluconate, Calcium Glycerophosphate, Calcium Hypophosphite, Calcium Phosphate-dibasic, Calcium Phosphate-tribasic, Calcium Sulphate, Calcium Tartrate, Carboxymethyl Cellulose, Carob Bean Gum, Carrageenan, Cellulose Gum, Furcelleran, Gelatin, Guar Gum, Gum Arabic, Hydroxylated Lecithin, Hydroxypropyl Cellulose, Hydroxypropyl Methylcellulose, Irish Moss Gelose, Karaya Gum, Lactic Esters of Fatty Acids, Lecithin, Locust Bean Gum, Methylcellulose, Methyl Ethyl Cellulose, Monoglycerides, Mono- and Diglycerides, Oat Gum, Pectin, Polyglycerol Esters of Fatty Acids, Potassium Alginate, Potassium Carrageenan, Potassium Chloride, Potassium Furcelleran, Propylene Glycol Alginate, Propylene Glycol Ether of Methylcellulose, Propylene Glycol mono Fatty Acid Esters, Sodium Alginate, Sodium Carboxymethyl Cellulose, Sodium Carrageenan, Sodium Cellulose Glycolate, Sodium Furcelleran, Sodium Hexametaphosphate, Sodium Phosphate-dibasic, Sodium Phosphate-monobasic, Sodium Phosphate-tribasic, Sodium Potassium Tartrate, Sodium Pyrophosphate-tetrabasic, Sodium Tripolyphosphate, Tragacanth Gum, Xanthan Gum.

FIRMING AGENTS:

1) **Good Manufacturing Practice**:
Aluminum Sulphate, Ammonium Aluminum Sulphate, Calcium Chloride, Calcium Citrate, Calcium Gluconate, Calcium Phosphate-monobasic, Calcium Phosphate-dibasic, Potassium Aluminum Sulphate, Sodium Aluminum Sulphate.

MISCELLANEOUS FOOD ADDITIVES:

1) **Good Manufacturing Practice**:
Acetylated Monoglycerides, Calcium Carbonate, Carbon Dioxide, Chloropentafluoroethane, Citric Acid, Glycerol, Lactylic Esters of Fatty Acids, Methyl Ethyl Cellulose, Mono- and Diglycerides, Nitrogen, Nitrous Oxide, Octafluorocyclobutane, Polydextrose, Propane, Propylene Glycol.

2) **Maximum level : 0.4 %**:
Beeswax

3) **Maximum level : 10 ppm**:
Dimethylpolysiloxane Formulations

PH-ADJUSTING, ACID-REACTING AND WATER-CORRECTING AGENTS:

1) **Good Manufacturing Practice:**
Acetic Acid, Adipic Acid, Ammonium Aluminum Sulphate, Ammonium Bicarbonate, Ammonium Carbonate, Ammonium Citrate-dibasic, Ammonium Citrate-monobasic, Ammonium Hydroxide, Calcium Acetate, Calcium Carbonate, Calcium Chloride, Calcium Citrate, Calcium Fumarate, Calcium Gluconate, Calcium Hydroxide, Calcium Lactate, Calcium Oxide, Calcium Phosphate-dibasic, Calcium Phosphate-monobasic, Calcium Phosphate-tribasic, Citric Acid, Cream of Tartar, Fumaric Acid, Gluconic Acid, Glucono-deltalactone, Lactic Acid, Magnesium Carbonate, Magnesium Fumarate, Malic Acid, Phosphoric Acid, Potassium Acid Tartrate, Potassium Aluminum Sulphate, Potassium Bicarbonate, Potassium Carbonate, Potassium Citrate, Potassium Fumarate, Potassium Hydroxide, Potassium Phosphate-dibasic, Sodium Acetate, Sodium Acid Pyrophosphate, Sodium Aluminum Phosphate, Sodium Aluminum Sulphate, Sodium Bicarbonate, Sodium Carbonate, Sodium Citrate, Sodium Fumarate, Sodium Gluconate, Sodium Hexametaphosphate, Sodium Hydroxide, Sodium Lactate, Sodium Phosphate-dibasic, Sodium Phosphate- monobasic, Sodium Phosphate-tribasic, Sodium Potassium Tartrate, Sodium pyrophosphate-tetrabasic, Sodium Tripolyphosphate, Tartaric Acid.

PRESERVATIVES:

1) **Good Manufacturing Practice**:
Acetic Acid, Ascorbic Acid, Calcium Ascorbate, Erythorbic Acid, Iso-Ascorbic Acid, Sodium Ascorbate, Sodium Erythorbate, Sodium Iso-Ascorbate, Wood Smoke.

SEQUESTERING AGENTS:

1) **Good Manufacturing Practice**:
Ammonium Citrate-dibasic, Ammonium Citrate-monobasic, Calcium Citrate, Citric Acid, Potassium Phosphate-monobasic, Sodium Acid Pyrophosphate, Sodium Citrate, Sodium Hexametaphosphate, Sodium Phosphate-dibasic, Sodium Phosphate-monobasic, Sodium Pyrophosphate-tetrabasic, Sodium Tripolyphosphate.