Food Protection Services

fish processing plants

Guidelines for the Application of a Hazard Analysis Critical Control Point (HACCP) Program

Prepared by:
Food Protection Services
BC Centre for Disease Control

Contact:
604.707.2440

Revised: January 2011

BC Centre for Disease Control
AN AGENCY OF THE PROVINCIAL HEALTH SERVICES AUTHORITY

Fish Processing Plants (HACCP)

TABLE OF CONTENTS

INTRODUCTION 1

PART I: THE HACCP PROGRAM APPLICATION TO A FISH PROCESSING PLANT 2

What is a HACCP Program? 2

The HACCP Manual - A Step By Step Approach 2

1. Assess the Hazards in a Fish Processing Plant 2
2. Determine Critical Control Points (CCPs) 4
3. Establish Critical Limits for Each CCP 5
4. Implement Procedures to Monitor CCP and Record Data 6
5. Institute Corrective Action 7
6. Establish Record Keeping Systems to Document HACCP Plan 7
7. Verify that the HACCP Program is Working 8

Summary 8

PART II THE HACCP PROGRAM CRITICAL CONTROL POINTS IN A FISH PLANT 10

Introduction 10

1. FISH PROCESSING PLANTS - UNIVERSAL CONTROL POINTS 11
2. FRESH FISH PROCESSING 13
3. SMOKED FISH PROCESSING 17
4. COOKED DUNGENESS CRAB PROCESSING 27

APPENDIX A DEFINITIONS 33

APPENDIX B QUESTIONS TO BE CONSIDERED IN A HAZARD ANALYSIS 35

APPENDIX C DESCRIPTION OF DISEASE CAUSING ORGANISMS ASSOCIATED WITH FISH 38

APPENDIX D RECORDKEEPING 43

EXAMPLES OF HACCP RECORDS 43

Ingredients and Supplies Log and Inspection Report Sheet 44
Freezer Log Sheet 45
Refrigerator Log Sheet 46
Process Record for Smoked Products 47
Freezing Record for Parasite Control 48
Shellfish Receiving Record 49
HOUSEKEEPING REPORT 50

TABLE 1 Study Results Showing Major Factors of Outbreaks Associated with Foods from Food Processing Plants 51

TABLE 2 Bacteria Pathogens and the Most Sensitive Seafood 52

TABLE 3 Examples of Practices That Increase Potential Food Safety Hazards 53

Fish Processing Plants (HACCP)

INTRODUCTION

There are a variety of potential hazards for most foods, many of which can occur during the processing stage. Since most fish processing plants are capable of processing high volumes of products, foodborne outbreaks can potentially affect large sectors of the population.

A hazard may be an unacceptable level of disease-causing micro-organisms or products of microbial activity (i.e. toxins). Hazards may also be caused by chemical substances that reach food inadvertently through various environmental sources, or during food processing, preparation or storage. Hazards can result from food additives that are used in excess of functional or culinary needs; or from materials that leach into highly acidic food from containers, pipes or their toxic coatings. Physical hazards may also occur, for example, glass, metal fragments and insects.

Hazard Analysis Critical Control Point (HACCP) systems provide scientifically sound bases for demonstrating that all reasonable precautions have been taken to prevent a hazard from reaching the consumer. For the plant manager, the HACCP program simplifies fish product safety by identifying the critical operations and providing effective and efficient methods for monitoring and controlling them. A Critical Control Point (CCP) is a procedure or process that controls or eliminates a hazard at a specified point in a food production sequence. Failure of the CCP can result in a Critical Defect. The final outcome of a HACCP program is the highest assurance of food safety.

HACCP also indicates control of the entire process. For example, consider the situation a leading company recently found itself in. Glass was reported to be in one of their products. Since the company had used the HACCP approach to product safety, they readily were able to convince investigators that they had their process well in control. Also, the company was able to identify specific production lots that might have a similar problem. A recall of the specific lots was made quickly and the company was able to function as normal. Other companies did not have such a system, and were unable to isolate portions of their production. Widespread recalls, have brought havoc to a company's reputation, and have even caused some firms to cease to exist.

The purpose of this publication is threefold:

- introduce and explain HACCP principles
- illustrate and describe those critical control points (CCPs) commonly found in fish processing plants, and
- provide a schedule for monitoring those CCPs.

While many of the CCPs described in this manual will be found in your processing plant, differences in processes and procedures between plants will result in varying CCPs. As such, it must be stressed that this manual is intended to outline the steps in building a HACCP program. Because there is no **one** HACCP program, each plant must examine their own operation and develop a HACCP program, which is best tailored to their individual processing and distribution conditions. The example HACCP programs (Pages 17-36) should be used only as a guideline when developing your own HACCP document.

The benefits of a properly functioning HACCP program include:

- a reduced public health risk
- cost-effective method of assuring food safety
- fewer customer complaints and recalls as safety and overall quality improves
- facilitate recall of suspect product

PART I: THE HACCP PROGRAM APPLICATION TO A FISH PROCESSING PLANT

What is a HACCP Program?

The Hazard Analysis Critical Control Point (HACCP) program is a system which identifies and controls the critical steps in producing safe and wholesome fish products. HACCP is a system which designs and checks the process so that the final product is not contaminated -it does not rely on testing for contamination after it may have taken place. The ultimate goal of a HACCP program in the plant is to eliminate all public health risks.

The following seven (7) principles outline the basics of a HACCP program. These principles, properly applied in a processing plant, will result in minimizing the potential of a food borne illness outbreak:

1. Identify potential food safety hazards.
2. Determine Critical Control Points or CCPs (where and when hazards need to be controlled).
3. Establish critical limits for each CCP that will control potential problems.
4. Implement procedures to monitor CCPs and record data.
5. Identify corrective action to be taken when process controls are lost.
6. Establish record keeping systems to document the HACCP plan.
7. Verify that the HACCP program is working.

It may appear that the seven principles of the HACCP program, when applied to an entire plant, will be complicated and difficult to organize. However, when the plant is broken down into sections or processes, the number of CCPs becomes quite manageable.

The HACCP Manual - A Step By Step Approach

1. Assess the Hazards in a Fish Processing Plant

a) Construction of a *flow diagram* (or block diagrams) is recommended to assist the determination of CCPs for a particular process. All processing steps are included, whether they involve a CCP or not. (See the flow diagram for Smoking of Fish on page 21).

b) Identify all potential hazards associated with each step in the process. Hazard analysis is a general assessment of hazards involving processing, handling, storage/distribution, display and consumer abuse potential of a particular seafood. The product is considered hazardous when one or more of the following risk characteristics are involved:

- there are micro-organisms of concern likely to be present if this step is not controlled.
- there is a possibility of toxins.
- there is a possibility of chemical or physical contamination.
- there is a potential for consumer abuse.

In determining these risks, it is important to ask yourself these questions: can something go wrong here, and, if so, what is the risk to the consumer if this step is not controlled?

A good rule of thumb is that the risk of a consumer hazard increases for a particular product: (1) with more handling, (2) with higher storage temperatures, and (3) if the final product does not require cooking before eating.

The following chart highlights the types of hazards that could be part of any one processing step:

SEAFOOD-RELATED CONSUMER HAZARDS

MICROBIOLOGICAL	CHEMICAL	PHYSICAL
• pathogenic (disease causing) micro-organisms • cross-contamination • spoilage micro-organisms (a concern when histamine producing fish, i.e. tuna, mahi mahi, are involved) • parasites	• toxins • chemical cleaners/sanitizers • food additives • undeclared allergens	• foreign filth • bones (if labelled boneless) • packaging

NOTE: *The determination of microbiological hazards requires an understanding of the dangerous organism's profile, in particular, those factors that influence its survival in food. Growth temperature range, water activity requirements, and pH requirements are the main determining factors for the survival and growth of micro-organisms. Much of this information can be found in the Appendix.*

2. Determine Critical Control Points (CCPs)

- **Identify Critical Control Points**

a) Now it is time to determine the significance or importance of the hazards at each step in your operation. Most CCPs are located at any point in a food sequence where potential hazards need to be reduced or controlled. For example, a heat process (with a time and temperature specifically given to destroy a microbiological pathogen) is a possible CCP. Likewise, refrigeration required to prevent hazardous organisms from growing, or the adjustment of a food to a pH necessary to prevent microbial growth that could result in toxin formation is a possible CCP.

Sometimes more than one measure may be required to control a specific hazard and more than one hazard may be controlled by a specific measure. If a hazard has been identified for which no control measure exists, the product or process should be modified so that the hazard is eliminated or reduced to acceptable or minimal levels.

b) Once having identified a possible CCP, three questions will confirm whether or not a CCP exists. These questions are:

i) If this step is left uncontrolled, will it result in an unacceptable risk of a hazard to the consumer?

ii) Does a *preventive measure* exist further on in the process?

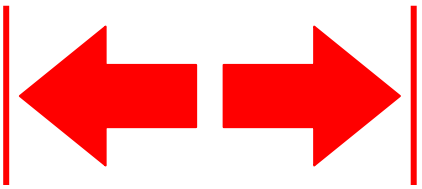
iii) Does this preventive step reduce the hazard to an acceptable level?

Diagram 1 (Page 12) illustrates how answers to each question will confirm the existence of a CCP. For the most part, Critical Control Points will involve:

- raw materials and ingredients,
- preservative factors (pH, water activity, etc.),
- time/temperature,
- sanitation,
- preventing cross-contamination,
- food handling/employee hygiene, and
- special controls.

c) Mark each CCP on your flow diagram and on a table format (see column one) as demonstrated in Part II. Remember to use HACCP for only direct hazards since non-essential monitoring may dilute out the detection of potential hazards.

3. Establish Critical Limits for Each CCP



- Establish conditions which must be met (Critical Limits) at each identified CCP
- Critical Limits are specifications or conditions to be met to ensure control of hazard or risk

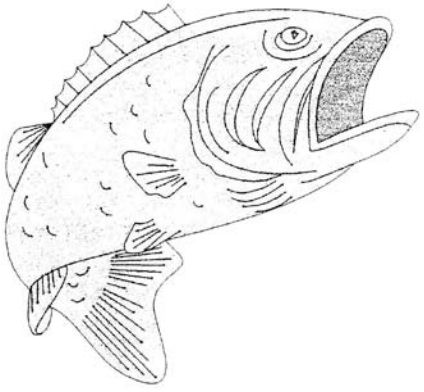
a) Critical limits are a set of tolerances or operating conditions for each CCP. These become the monitoring and testing limits that determine whether a CCP is within acceptable levels. Critical limits may be derived from a variety of sources, such as regulatory standards, literature surveys, experimental studies and/or expert advice.

b) In determining some critical limits, it is important to know the expected variation of the equipment to ensure that the critical control point is not exceeded. For example, destroying salmonella in fish cakes takes 65°C for one minute. The oven temperature will vary by two degrees either way; the minimum acceptable temperature (critical limit) should be 67°C.

c) There can be more than one CCP for a particular step. In the above situation there are actually three critical control points that need monitoring:

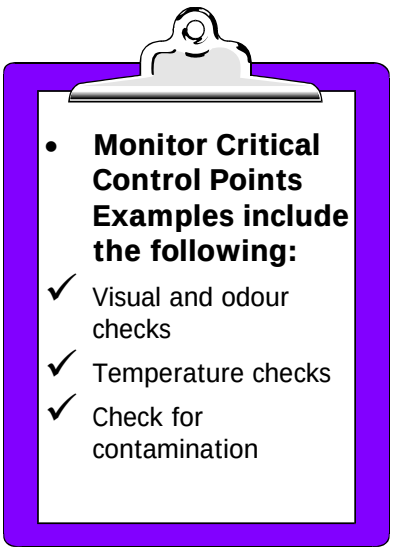
   1) Temperature = 67°C
   2) Time = one minute or more
   3) Fish Cake Thickness = Not to exceed 3cm thickness (as determined by testing)

d) In Part II, the third column in each table specifies the critical limits for each CCP. Strict adherence to tolerances or limits is important in maintaining a HACCP program. Product safety is not negotiable; there is no such thing as "almost risk free".



4. Implement Procedures to Monitor CCP and Record Data

a) *Monitoring* is the scheduled testing or observation of a CCP and its limits. Monitoring should be done at a frequency proportional to the degree of consumer risk involved. From the monitoring standpoint, failure to control a CCP is a critical defect. In addition to being able to detect a loss of control, a monitoring procedure should ideally provide this information in time for corrective action before there is a need to reject the product.

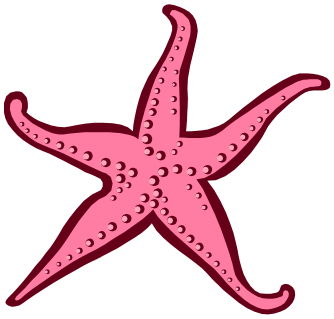


b) In most instances, monitoring of CCPs can best be accomplished through the use of physical and chemical tests (i.e. temperature recording charts or continuous pH tests in fluids), and through visual observations. The use of *microbiological testing* is seldom an effective means of monitoring CCPs because of the time required to obtain results. Microbiological criteria do, however, play a role in verifying that the overall HACCP system is working.

c) *Spot checks* are useful for supplementing the monitoring of certain CCPs and their respective limits. They may be used to check incoming pre-certified ingredients or to assess equipment and environmental sanitation. Supervision is a form of monitoring and is often a part of the spot check system.

d) It is also important to ensure that monitoring procedures are extremely *effective* and that their results will give useful and practical information. *Records* must be kept to ensure the CCPs are being monitored on a regular basis.

e) In Part II, the second and third columns in each table specify the required monitoring to be done and provides a timetable for monitoring the CCPs. Most, if not all, processing plants are unique and differ in their processes and plant conditions. For this reason the monitoring will vary from plant to plant, which again emphasizes the fact that the following tables are meant to be used only as a guideline.



5. Institute Corrective Action

a) In any HACCP program, a CCP may fail. As such, corrective action plans must be included to ensure that the operator knows exactly how to react to a detected problem and bring the critical control point back under control without delay. Action must include:

   i) Procedure for holding product pending completion of analysis to confirm product safety.
   ii) Disposition of the product if necessary.
   iii) Confirmation that the CCP has been brought under control.
   iv) Record of event (log tracking sheet).

b) If a product cannot be proven safe, then it must be disposed of, or if possible, safely reworked.

c) As well, the reasons for deviations must be found, documented, and corrected.

d) The fifth column under "Actions on Deviations" in each table of Part II lists appropriate actions to take when CCP criteria are not met.

6. Establish Record Keeping Systems to Document HACCP Plan

a) A single individual should be made responsible for ensuring all data is collected and recorded. This individual must have authority to ensure:

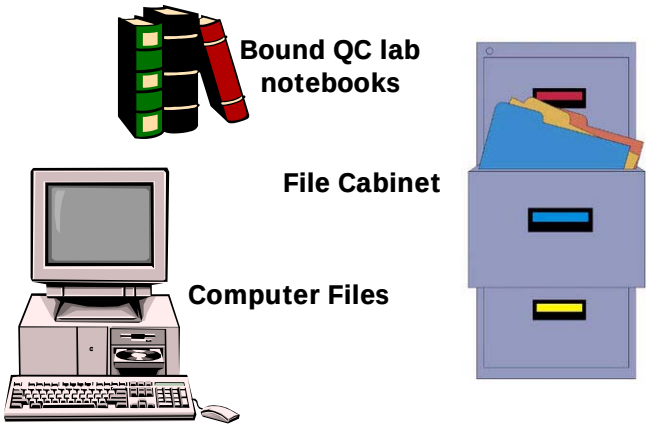
   i) all data is collected (i.e. testing and monitoring data, in-house verification reports, equipment maintenance and calibration);
   ii) all data is centrally located and thus easy to retrieve;
   iii) a record of all CCP deviations is kept, and most importantly;
   iv) documentation of the appropriate action taken when results deviate beyond the critical limits.

b) The record-keeping system must be as simple as possible. A single binder for smaller operations or a single filing cabinet for larger operations should be more than adequate.

c) Records are kept for a minimum of 2 years.

Establish a Recordkeeping Procedure

- Assign responsibility for filling out and signing records.
- Determine how you want to store records:



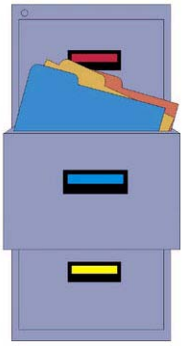
7. Verify that the HACCP Program is Working

a) Some processing plants are already performing regular quality control testing of their finished products. Results from quality control tests can often indicate that a HACCP program is not performing as required. In such cases, the program must be reviewed to ensure:

   i) the present HACCP program is being followed

   ii) all hazards were identified in the initial HACCP program.

- **Verification of the HACCP Program**



- **In-house verification is on a regular schedule**
- **Regulatory verification is done less frequently**

b) Other methods to verify the HACCP program is working include:

   i) close monitoring of consumer complaints.

   ii) in-house and regulatory verification inspections to confirm that CCPs are under control.

   iii) review of the current HACCP program to determine if processes, procedures, or formulations have changed since the initial HACCP program was implemented.

   iv) random sample collection and testing.

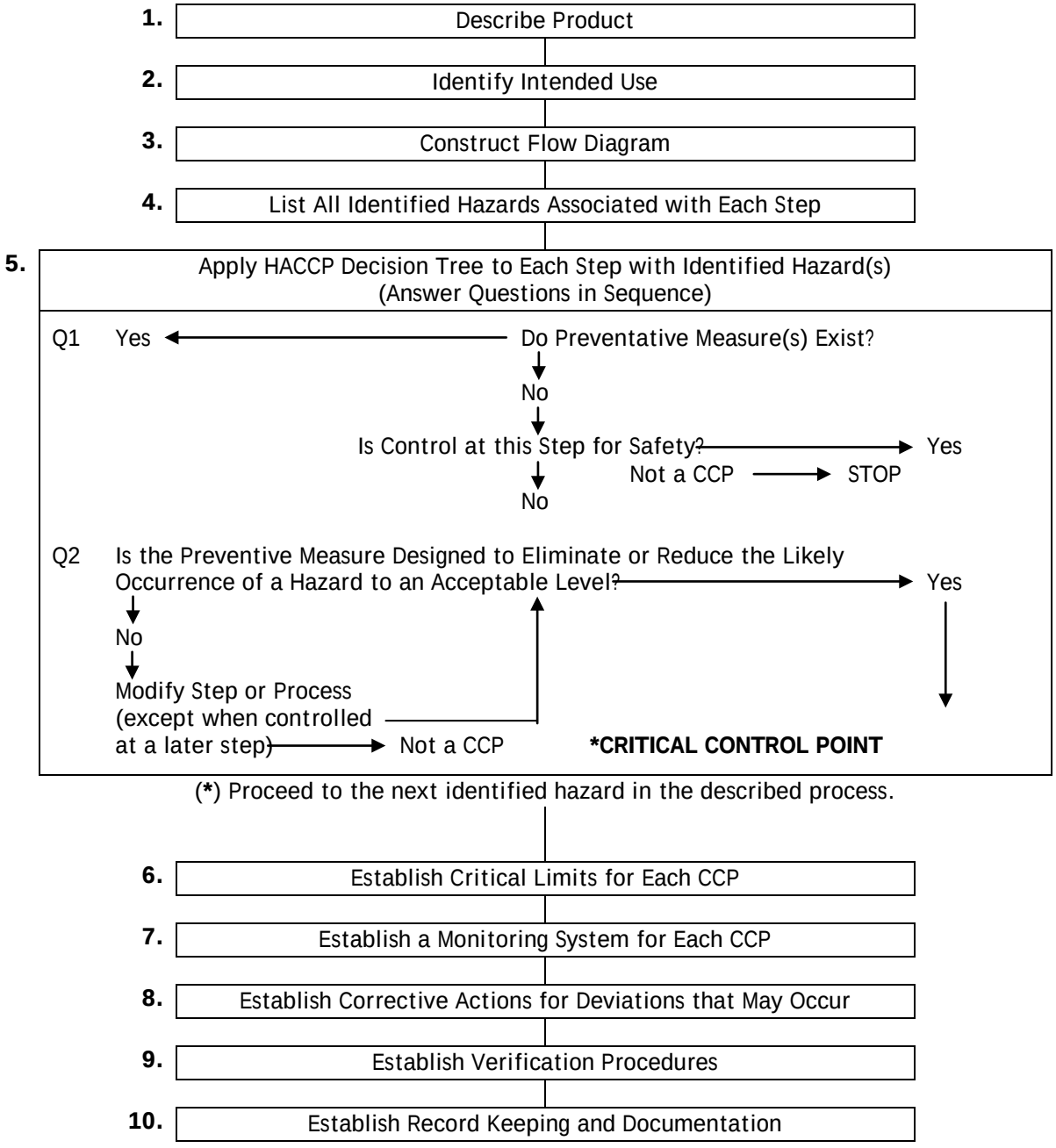
Summary

Plants that have a good existing Quality Assurance Program should not face much of an effort or manpower increase when adopting a HACCP program. Rather, it should be more of a shift in emphasis and direction. Emphasize specifications for incoming ingredients. Consider supplier qualifications in addition to just price. Do the environmental sampling. Analyze the hazards. Identify the critical control points. Monitor them. Keep careful track of material usage and production codes. Systemize it all to keep it manageable, and then write down the results and maintain them in an orderly manner. By doing this, the HACCP approach is pro-active rather than re-active. Its implementation may not always be easy but neither are the potential lawsuits, prosecutions, and recalls that a company can be exposing itself to if HACCP is not part of its thinking.

Fish Processing Plants (HACCP)

DIAGRAM 1

Logic Sequence for Application of HACCP



PART II THE HACCP PROGRAM CRITICAL CONTROL POINTS IN A FISH PLANT

Introduction

The primary intent of Part II is to select the typical critical control points (CCPs) for three selected processes commonly found in fish plants. Identified CCPs are then expanded to describe:

1. Monitoring Steps,
2. Monitoring Frequency,
3. Critical Limits, and
4. The action required when deviations from critical limits occur.

There are, however, hazards that are common to all plants, but are difficult to assign to a particular critical control point. They are referred to as **Universal Control Points**. Monitoring and/or prevention of these hazards require the use of good manufacturing practices throughout the total process.

One example of a Universal Control Point is pest control. Pests represent a hazard because they can act as a source of contamination, but they cannot be effectively controlled by assignment of a specific critical control point. Rather, the implementation of a pest control program (a good manufacturing practice) will be more effective by preventing the entry of pests into the fish plant. A *List of Universal Control Points* is presented first, since their control is critical for safe processing within all plants.

The following charts and accompanying information have been provided to act as a model or building block for a HACCP program. Because procedures, equipment, and plant designs vary greatly between processing plants, the information provided in Part II will not necessarily include all hazards found in your facility. In order to implement an effective HACCP program, the plant manager must follow the steps outlined in the next section while using the information provided in the Appendix as a guide for a HACCP program.

Fish Processing Plants (HACCP)

1. FISH PROCESSING PLANTS - UNIVERSAL CONTROL POINTS

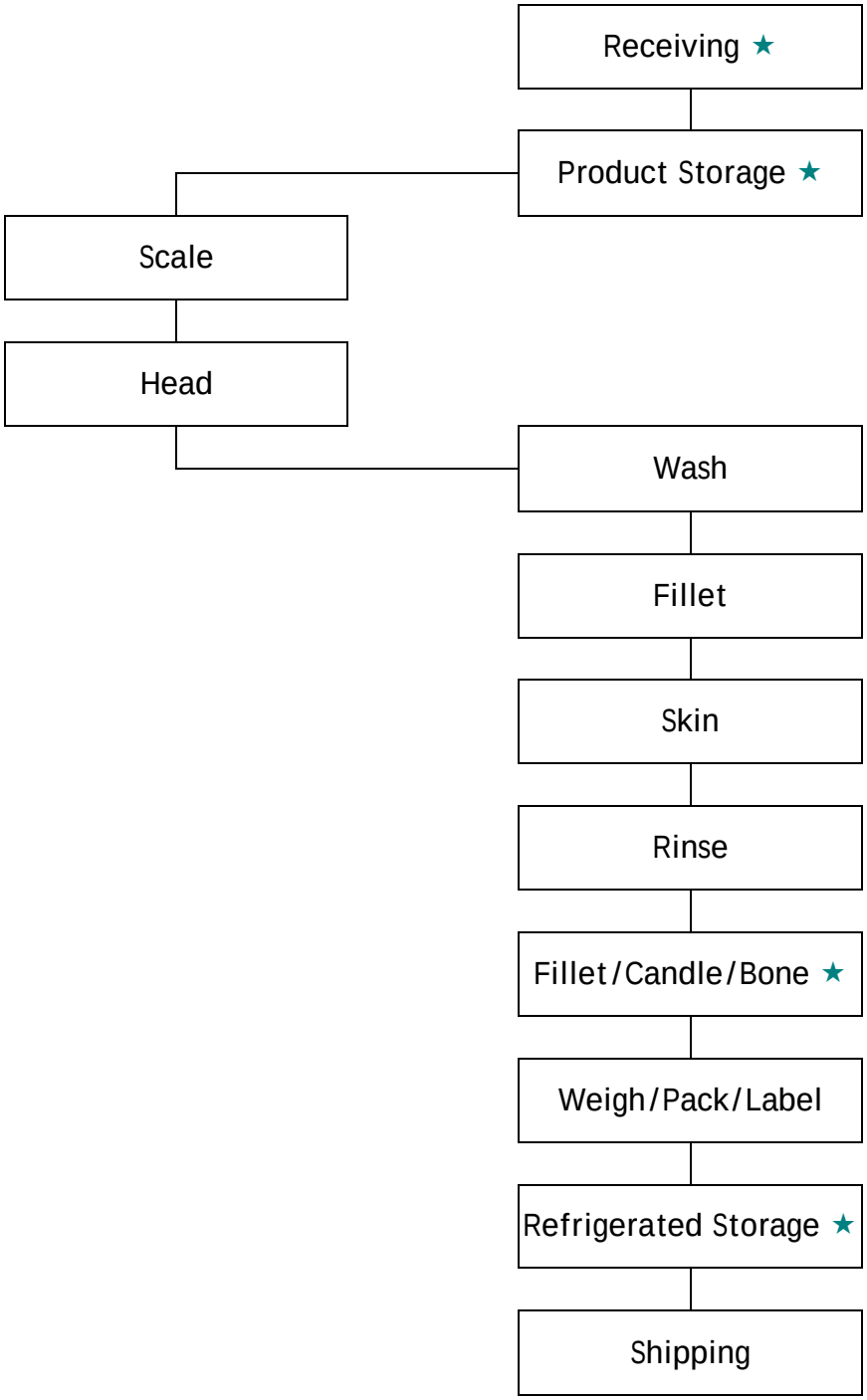
Universal Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
General Environment: **Equipment Design and Maintenance** **Sanitary Conditions**	Inspect general environment (walls, ceilings, floors, etc.) and equipment to ensure finished product cannot be compromised. Confirm written cleaning/disinfection procedures are followed.	Ongoing. Monthly evaluations. Ongoing. Daily evaluations.	General environment and equipment must be designed for the intended use and in good repair. General environment and equipment must be regularly cleaned and sanitized.	Review maintenance procedures. Adjust as necessary. Discard or process contaminated ready-to-eat products. Review cleaning/disinfecting procedures. Adjust as necessary and monitor effectiveness after changes.
Personnel Practices and Hygiene	Ensure that staff are fully trained in HACCP concepts and food safety. Employee to report to supervisor when ill or suffers from infected cut, boil, etc. Clarify duties and responsibilities through cleaning schedules and written job descriptions. Confirm washing facilities and dips readily available.	Ongoing. Verify that all personnel practices (handling of ingredients, finished product, product contact surfaces, use of equipment, etc.) cannot compromise finished product safety.	All personnel must follow good manufacturing practices.	Modify practices as necessary. Detain product. Product action to be determined by a supervisor. Restrict carrier from work.
Cross Connection Control	Examination of equipment to verify that no potential cross connections exist. Confirm a sanitary zone for finished product is maintained.	Ongoing. After new installations or changes are made.	Absence of potential cross connections.	Immediate removal of potential cross connections. Discard or reprocess contaminated finished products.
Pest Control	Verify that all pest control procedures for excluding and eliminating pests are adequate.	Ongoing. Monthly.	Absence of pest activity.	Review pest control procedures. Adjust as necessary and monitor effectiveness after changes.

Fish Processing Plants (HACCP)

Universal Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Ingredients Listing: **Allergen Control**	Ensure ingredients are clearly and accurately labelled. Ensure all ingredients meet required specifications.	Ongoing. After any changes to formulation are made.	All storage containers are to be clearly labelled. All ingredients actually used must be noted on the package label.	Determination of potential allergic reaction to unlisted ingredients. Distribution withdrawal and/or public recall may be necessary.
Control of Chemicals, Cleaners, Lubricants	Confirm chemicals, cleaners, and lubricants are properly labelled and stored in secure areas separate from ingredients, etc.	Ongoing.	All containers are to be sound, clearly labelled, and stored in designated areas.	Determine potential for contamination - recall may be necessary. Review plan to prevent re-occurrences.

2. FRESH FISH PROCESSING

Fresh Fish Flow Diagram



NOTE: *★ denotes that one or more CCPs have been identified.*

Fish Processing Plants (HACCP)

Step: Receiving

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Acceptance of Raw Product	Check product temperature. Confirm fish are in acceptable condition (not contaminated with excess bacteriological loads, chemicals or foreign material). Inspect interior of delivery vehicle and containers. Confirm all other purchasing specifications are met.	When product is received (sample 4 fish per tote or minimum of 2 fish for smaller lots).	All fish to be belly iced and layered in ice. Fish temperature not to exceed 4°C. Fish received only from reputable suppliers. Vehicle interior and containers do not pose a risk of contamination. Product to meet all purchasing specifications.	Re-ice fish. Supervisor to be notified to determine product action. Histamine-producing fish will not be accepted if 4°C is exceeded. Contaminated fish are segregated and culled. Refuse shipment.
Lot Identity	Confirm that tag or fish slip containing required information identifies each lot.	Each receipt of product.	Source identity of each lot for recall purposes. Receiving date placed on each tag.	Assign a lot identity and receiving date if none.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

NOTE: *Decomposition is not included since it is generally considered a quality Issue.*

Fish Processing Plants (HACCP)

Step: Product and Refrigerated Storage FRESH FISH

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Storage Temperature	Verify required storage temperature is met.	Prior to production start and in afternoon.	Maintain product between 0°C and 3°C.	When internal temperature exceeds 3°C, product is culled by a supervisor for decomposition.
Multiple Use of Storage Area	Confirm processed and raw fish are separated by a divider. Confirm that no chemicals or cleaners are in storage unit.	Daily.	No mixing of processed and raw fish products. No chemicals or cleaners in storage unit.	Confirm if stored product is contaminated and cull as required. Remove chemical/cleaners. Check product for contamination.
Product Inspection	Inspect each lot for decomposition and required identification. Confirm proper icing of unprocessed fish.	Each Monday and Thursday.	Each lot to be adequately identified (receipt date or production date and source). All unprocessed fish to be layered and covered with ice.	Assign lot identity. Re-ice products when required.
Rotation of Stock	All product is checked to determine length of storage. Confirm stock (raw and finished) is rotated on a first-in first-out basis.	Weekly.	Use dressed fish for production within 5 days. Ship finished product within 3 days. Rotation system is adhered to.	Ensure passed product is immediately processed or shipped. Modify rotation system.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

Fish Processing Plants (HACCP)

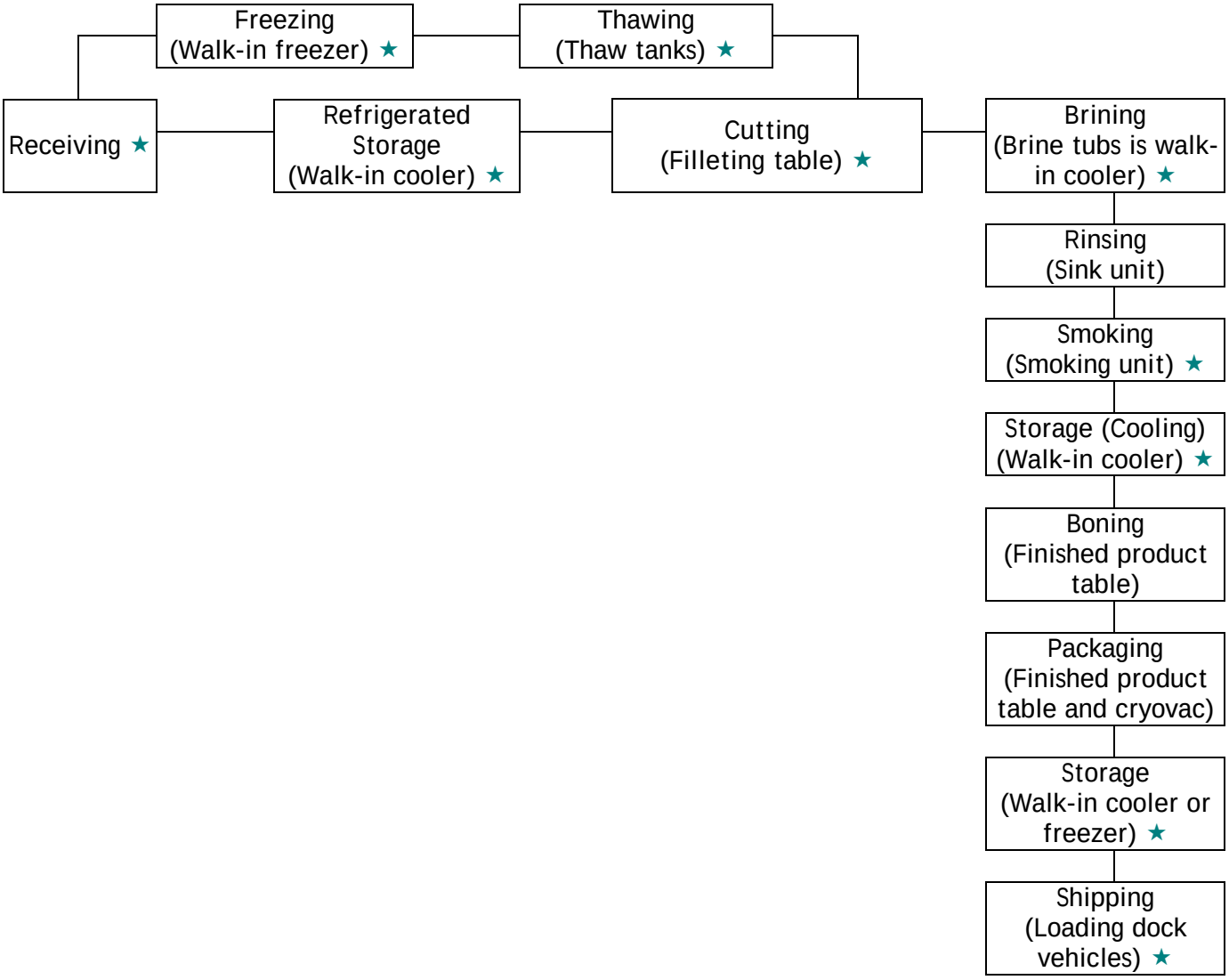
Step: Fillet/Candle/Bone FRESH FISH

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Inspection of Processed Product*	Sample each production line for bones and nematodes.	Every ½ hour.	No bones to exceed 5 mm in length and 2 mm in diameter in one 5 pound package and/or no more than 5 parasites per 15 pounds of fillets.	All production since last check to be set aside and reworked for bones and recandled for nematodes.
Production Flow	Supervisor to monitor production flow.	Ongoing supervisory duties.	Time taken to process fish not to flow.	Production adjusted to ensure an even and timely production flow. Supervisor to be notified to determine product action.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

***NOTE:** *This step is considered a CCP particularly when fillets are sold boneless and/or seafood is consumed raw or lightly cooked.*

3. SMOKED FISH PROCESSING

Smoked Fish - Flow Diagram



★ One or more CCPs identified

Step: Receiving SMOKED FISH

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Acceptance of Raw Product	Check product temperature. Confirm fish are in acceptable condition (not contaminated with excess bacteriological loads, chemicals or foreign material). Inspect interior of delivery vehicle and containers. Confirm all other purchasing specifications are met.	When product is received (sample 4 fish per tote or minimum of 2 fish for smaller lots).	All fish to be belly iced and layered in ice. Fish temperature not to exceed 4°C. Fish received only from reputable suppliers. No contaminated fish accepted. Vehicle interior and containers do not pose a risk of contamination. Product to meet all purchasing specifications	Re-ice fish. If specification is not met, the supervisor will be notified to determine product action. Histamine-producing fish will not be accepted if 4°C is exceeded. Contaminated fish are segregated and culled. Refuse shipment.
Lot Identity	Confirm that tag with required information identifies each lot.	Each receipt of product - receiving date placed on each tag.	Source identity of each lot for recall purposes.	Assign a lot identity and receiving date if none.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

Step: Storage (Freezer & Cooler) SMOKED FISH

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Storage Temperature	Verify required storage temperatures are met.	Prior to production start and in afternoon.	Maintain fresh product between 0°C and 3°C and frozen product at-20°C or less.	Product is culled when internal temperature exceeds 3°C. Remove partially thawed product for processing. Adjust freezer temperature.
Multiple Use of Storage Area	Confirm processed and raw fish are stored in separate cooling units. Confirm dressed fish and partially processed fish are separated by a divider. Confirm that no chemicals or cleaners are in storage unit.	Daily.	No mixing of processed and raw fish products in same cooling unit. No mixing of dressed and partially processed fish (divider OK). No chemicals or cleaners in storage unit.	Reprocess finished product or discard. Reject product for processing or shipment if contaminated. Remove chemicals/cleaners. Check product for contamination.
Product Inspection	Inspect each lot for decomposition and required tagging information. Confirm proper icing of unprocessed fish.	Daily.	No processing of decomposed fish. Each lot to be adequately identified (Source and Receipt Date or Production Date). All dressed fish to be layered and topped with ice.	Discard decomposed fish. Identify lot. Re-ice product when required.

Step: Storage (Freezer & Cooler) SMOKED FISH

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Rotation of Stock	All product is checked to determine length of storage. Confirm stock (raw and finished) is rotated on a first in/first out basis (FIFO). Confirm all product that will be cold smoked is kept in freezer for minimum of 7 days.	Weekly.	Use dressed fish for production within 5 days. Ship finished product within 3 days. Rotation system is adhered to. 7 day frozen storage required for cold smoked products.	Review FIFO program and modify. Redirect product for hot smoking.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

Step: Thawing SMOKED FISH

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Introduction of Frozen Product into Thaw Tank	Confirm that 3 tank system is used(i.e. small, medium or large). Check incoming water temperature. Confirm removal of packaging materials. Confirm constant overflow.	Each loading.	Uniform sized fish thawed for each batch. Incoming water to range between 3°C - 6°C. No packaging materials. Minimum overflow of 1L/15 seconds.	Review thawing procedures and adjust. Remove packaging materials. Increase overflow.
Product Temperature	Check internal temperature.	Every 4 hours (Check internal temperature of 3 fish per tank).	Temperatures of 2 of the 3 fish checked do not exceed 4°C.	Review thawing procedures and adjust. Cull batch and notify supervisor if >4°C.

Fish Processing Plants (HACCP)

Step: Fillet/Candle/Bone SMOKED FISH

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Production Flow	Confirm production time.	Ongoing.	Maximum 2 hours from start to finish. Finished product to be brined within ½ hour.	Adjust production line and/or place backed-up product in cooler.
Product Sampling	Sample at end of each line for bones and nematodes (sample is 15 pounds of fillets).	Every ½ hour.	Maximum of 2 bones that exceeds 5 mm in length and/or 2 mm in diameter. Maximum 5 parasites.	Rework all production since last sampling.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

Fish Processing Plants (HACCP)

Step: Fillet/Candle/Bone SMOKED FISH

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Brining Tubs	Confirm required brine strength is achieved. Confirm brines are pre-chilled prior to use. Confirm a fresh brine is used for each batch. Ensure brining time occurs in cooler. Confirm fish are separated by size. Verify brining times for specified size and species.	Each batch.	All brines to exceed 15% salt. Temperature of brines not to exceed 4°C. New brine required for each batch. Brining to occur in cooler. Each batch to contain uniform sized fish. Brining time to meet or exceed "brining chart".	Review brining procedures and adjust. Notify supervisor to determine required action.
Ingredients	Confirm ingredients are labelled and properly stored. Confirm ingredients are approved.	Monthly.	Minimal potential of contamination of ingredients. Proper labelling of ingredients. Ingredients included in the Canadian Food Inspection Agency's List.	Discard ingredients exposed to contamination. Label for clear identity. Discard ingredients not approved by the Canadian Food Inspection Agency.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

Fish Processing Plants (HACCP)

Step: Hot Smoking SMOKED FISH

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Cooking Time / Temperature	Record internal temperature. Use time/temperature thermometer.	Ongoing.	Minimum 70°C for 2 minutes (internal temperature of thickest fish) or equivalent to give 6D process for *L. monocytogenes* (Ref)*.	Reprocess batch.
Cooling Time	Confirm batch is rapidly cooled after process is complete.	Weekly.	Cool processed fish to 2°C - 3°C within 2 hours.	Review process and adjust. Notify supervisor to determine action.
Batch Identity	Confirm that identity of each batch is maintained.	Daily.	Each batch is identified by date processed and batch number.	Correct deficiency.
Product Testing	Collect 2 sides of finished product for lab analysis (aerobic plate count, water phase salt level).	Monthly.	Maximum APC of 10,000/g; Minimum WPS of 3.5%.	Supervisor to review results and determine appropriate action.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

*Reference: Fish and Fisheries Products Hazards and Control Guidance, 3rd edition, Food and Drug Administration

Fish Processing Plants (HACCP)

Step: Cold Smoking SMOKED FISH

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Product Freezing	Confirm product is previously frozen to ensure nematode destruction.	Ongoing.	Minimum 15 hours freezing at -35°C or 7 days freezing at -20°C or frozen to -35°C until solid and stored at -20°C (*Ref)	Detain batch and freeze after smoking or hot smoke batch.
Cooling Time	Confirm batch is rapidly cooled after process is complete.	Weekly.	Cool processed fish to 2°C - 3°C within 2 hours.	Supervisor to review procedures and adjust.
Batch Identify	Confirm that identity of each batch is maintained.	Ongoing.	Each batch is identified by date processed and batch number.	Assign lot identity.
Product Testing	Collect 2 sides of finished product for lab analysis (Aerobic Plate Count (APC), *Staphylococcus aureus*, Water Phase Salt).	Monthly.	Maximum APC of 100,000/g. Maximum *Staphylococcus aureus* of 1,000/g. Minimum 3.5% WPS.	Supervisor notified to determine required action. Hot smoke product. Review sanitation program. Recall product shipped out and destroy product.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

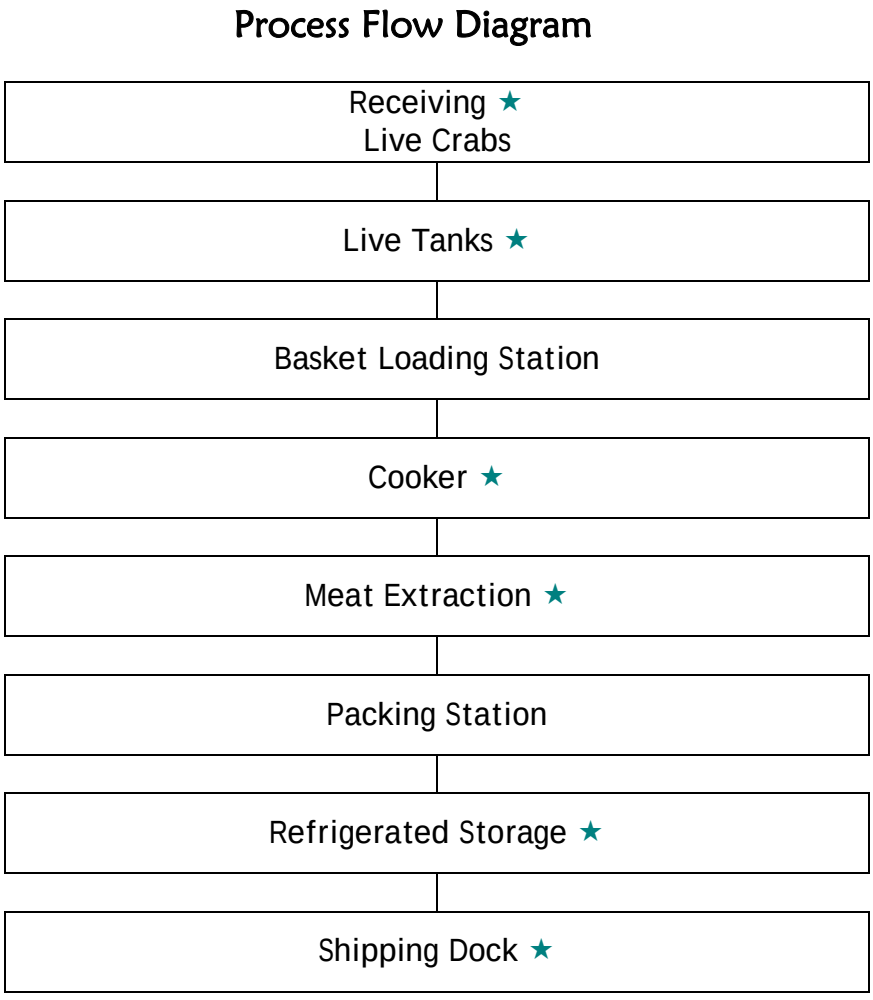
- Per US FDA code 3-402.11

Step: Cold Smoking SMOKED FISH

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Product Temperature	Confirm delivery vehicles have functional refrigeration. Confirm minimum product time at shipping station. Confirm all vacuum packaged fish is frozen.	Ongoing.	Vehicle capable of maintaining product at 4°C or at -18°C if frozen (Mailing packages are insulated and packed with sufficient ice packs). Vehicle pre-cooled to required temperature. Exposure to outside temperature not to exceed 1 hour. All vacuum packaged fish must be frozen prior to shipping.	Refuse carrier for shipment. Review shipping procedures and adjust. Refuse product for shipment.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

4. COOKED DUNGENESS CRAB PROCESSING

Cooked Dungeness Crab - Flow Diagram



★ Identifies a Critical Control Point

Step: Receiving COOKED DUNGENESS CRAB

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Acceptance of Raw Product	Confirm crabs are in acceptable condition. Confirm crabs are harvested in an open area. Confirm all other purchasing specifications are met.	Each shipment.	All crabs must be alive and non- defective (i.e. cracked shells, weak crabs). Harvest area must be open area. Purchasing specifications complied with.	Cull out defective/dead crabs. Refuse shipment if harvest area cannot be determined. Notify supervisor of discrepancy.
Lot Identity	Confirm each lot has the required information.	Each shipment.	Identify each lot as to date received and supplier.	Attach required information.

Step: Live Tanks COOKED DUNGENESS CRAB

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Tank Operation	Confirm lots are maintained separately. Confirm daily culling of dead/defective crabs. Confirm water quality and temperature requirements are met.	Ongoing.	Each lot kept separate. No dead or defective (i.e. cracked shells, weak crabs). Turbidity not to exceed 20 NTU and water temperature ≤10°C.	Review tank procedures and adjust. Examine lot and discard defective product. Check equipment and adjust.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

Step: Cooker COOKED DUNGENESS CRAB

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Product Temperature	Check internal temperature of largest crabs.	For each cook, check internal temperature of 2 crabs.	Minimum 82°C internal temperature required.	Extend cooking time to ensure temperature requirements.
Product Identification	Confirm lot identification accompanies each lot.	Ongoing.	Source and date received information required.	Review procedures and adjust.
Cooling Water	Confirm water temperature prior to cooling cooked product. Confirm water is changed regularly.	Ongoing.	Rinse in water at 10°C or less, then chill to 4°C for cooling water. Replace water after every third use.	Add potable ice to lower water temperature. Review procedures and adjust.
Product Temperature	Confirm product is placed in walk- in cooler immediately after cooling tank.	Ongoing.	Internal temperature to be reduced to 4°C within 1 hour (after cooking).	Inspect product for decomposition and reject if found. Review procedures and adjust.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

Step: Meat Extraction COOKED DUNGENESS CRAB

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Product Temperature	Confirm meat temperature. Confirm processing time.	Twice daily.	Meat temperature not to exceed 4°C. Time to extract meat and return to cooler not to exceed 1 hour.	Notify supervisor for required product action.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

Step: Storage (Freezer & Cooler) COOKED DUNGENESS CRAB

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Storage Temperature	Verify required storage temperatures are met.	Prior to production start and in afternoon.	Maintain refrigeration unit between 0°C and 3°C and freezer unit at -20°C or less.	When cooler exceeds 3°C, product to be culled. Adjust freezer temperature. Notify supervisor for required product action.
Multiple Use of Storage Area	Confirm processed and raw products are stored in separate cooling units. Confirm that no chemicals or cleaners are in storage unit.	Daily.	No mixing of processed and raw products in same cooling unit. No chemicals or cleaners in storage unit.	Reprocess finished product or discard. Notify supervisor for required product action. Confirm if exposed product is contaminated and cull as determined by supervisor.
Product Inspection	Inspect each lot for evidence of contamination and required tagging information.	Daily.	Reject contaminated product. Each lot to be adequately identified (Source and Receipt Date or Production Date).	Discard contaminated products. Identify lot.
Rotation of Stock	All product is checked to determine length of storage. Confirm stock (raw and finished) is rotated on a first in/first out basis.	Weekly.	Ship finished product within 3 days and process fresh (raw) product within 5 days. Rotation system is adhered to.	Review procedures and adjust.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

Step: Storage (Freezer & Cooler) COOKED DUNGENESS CRAB

Critical Control Point	Monitoring Step	Monitoring Frequency	Critical Limits	Action on Deviations
Product Temperature	Confirm delivery vehicles have functional refrigeration. Confirm minimum product time at shipping station. Confirm product temperature.	Ongoing.	Vehicle capable of maintaining product at 4°C or 0°C (mailing packages are insulated and packed with sufficient ice packs). Vehicle pre-cooled to required temperature. Exposure to outside not to exceed 1 hour. Maximum product temperature to be 4°C.	Refuse carrier for shipment. Review shipping procedures and adjust. Detain product and contact supervisor to determine action.
Product Testing	Collect two samples (200 g each) of finished product for lab analysis.	Monthly .	Maximum APC of 10,000/g.	Supervisor to review results and determine appropriate action.
				Notify supplier for all noted deviations. All corrective actions to be recorded and signed by supervisor.

APPENDIX A DEFINITIONS

CCP Decision Tree: A sequence of questions to determine whether a control point is a CCP.

Continuous Monitoring: Uninterrupted collection and recording of data such as temperature on a strip chart.

Control: (a) To manage the conditions of an operation to maintain compliance with established criteria.
(b) The state wherein correct procedures are being followed and criteria are being met.

Control Point: Any point, step, or procedure at which biological, physical, or chemical factors can be controlled.

Corrective Action: Procedures to be followed when a deviation occurs.

Criterion: A requirement on which a judgement or decision can be based.

Critical Control Point (CCP): A point, step, or procedure at which control can be applied and a food safety hazard can be prevented, eliminated, or reduced to acceptable levels.

Critical Defect: A deviation at a CCP that may result in a hazard.

Critical Limit: A criterion that must be met for each preventive measure associated with a critical control point.

Deviation: Failure to meet a critical limit.

HACCP Plan: The written document that is based upon the principles of HACCP and which delineates the procedures to be followed to assure the control of a specific process or procedure.

HACCP System: The result of the implementation of the HACCP plan.

HACCP Team: The group of people who are responsible for developing a HACCP plan.

HACCP Plan Re-evaluation: One aspect of verification in which a documented periodic review of the HACCP plan is done by the HACCP team with the purpose of modifying the HACCP plan as necessary.

HACCP Plan Validation: The initial review by the HACCP team to ensure that all elements of the HACCP plan are accurate.

Hazard: A biological, chemical, or physical property that may cause a food to be unsafe for consumption.

Monitor: To conduct a planned sequence of observations or measurements to assess whether a CCP is under control and to produce an accurate record for future use in verification.

Pathogen: Any "disease-causing agent, usually micro-organisms or their toxins.

Preventive Measure: Physical, chemical, or other factors that can be used to control an identified health hazard.

Random Checks: Observations or measurements, which are performed to supplement the scheduled evaluations, required by the HACCP plan.

Risk: An estimate of the likely occurrence of a hazard.

Sensitive Ingredient: An ingredient known to have been associated with a hazard and for which there is reason for concern.

Severity: The seriousness of a hazard.

Target Levels: Criteria that are more stringent than critical limits and which are used by an operator to reduce the risk of a deviation.

Verification: The use of methods, procedures, or tests in addition to those used in monitoring to determine if the HACCP system is in compliance with the HACCP plan and/or whether the HACCP plan needs modification and revalidation.

APPENDIX B EXAMPLES OF QUESTIONS TO BE CONSIDERED IN A HAZARD ANALYSIS

The hazard analysis consists of asking a series of questions that are appropriate to each step in a HACCP plan. It is not possible in these recommendations to provide a list of all the questions that may be pertinent to a specific food or process. The hazard analysis should question the effect of a variety of factors upon the safety of the food.

A. Ingredients

1. Does the food contain any sensitive ingredients that may present microbiological hazards (e.g. Salmonella, Staphylococcus aureus); chemical hazards (e.g. aflatoxin, antibiotic or pesticide residues); or physical hazards (stones, glass, metal)?
2. Is potable water used in formulating or in handling the food?

B. Intrinsic Factors

Physical characteristics and composition (e.g. pH, type of acidulants, fermentable carbohydrate, water activity, preservatives) of the food during and after processing.

1. Which intrinsic factors of the food must be controlled in order to assure food safety?
2. Does the food permit survival or multiplication of pathogens and/or toxin formation in the food during processing?
3. Will the food permit survival or multiplication of pathogens and/or toxin formation during subsequent steps in the food chain?
4. Are there other similar products in the market place? What has been the safety record for these products?

C. Procedures Used for Processing

1. Does the process include a controllable processing step that destroys pathogens? Consider both vegetative cells and spores.
2. Is the product subject to recontamination between processing (e.g. cooking, pasteurizing) and packaging?

D. Microbial Content of the Food

1. Is the food commercially sterile (e.g. low acid canned food)?
2. Is it likely that the food will contain viable spore-forming or non spore-forming pathogens?
3. What is the normal microbial content of the food?
4. Does the microbial population change during the normal time the food is stored prior to consumption?
5. Does the subsequent change in microbial population alter the safety of the food, pro or con?

E. Facility Design

1. Does the layout of the facility provide an adequate separation of raw materials from ready-to-eat foods if this is important to food safety?
2. Is positive air pressure maintained in product packaging areas? Is this essential for product safety?
3. Is the traffic pattern for people and moving equipment a significant source of contamination?

F. Equipment Design

1. Will the equipment provide the time-temperature control that is necessary for safe food?
2. Is the equipment properly sized for the volume of food that will be processed?
3. Can the equipment be sufficiently controlled so that the variation in performance will be within the tolerances required to produce a safe food?
4. Is the equipment reliable or is it prone to frequent breakdowns?
5. Is the equipment designed so that it can be cleaned and sanitized?
6. Is there a chance for product contamination with hazardous substances; e.g. glass?
7. What product safety devices are used to enhance consumer safety?
   - metal detectors
   - magnets
   - sifters
   - filters
   - screens
   - thermometers
   - deboners
   - dud detectors

G. Packaging

1. Does the method of packaging affect the multiplication of microbial pathogens and/or the formation of toxins?
2. Is the package clearly labelled "Keep Refrigerated" if this is required for safety?
3. Does the package include instructions for the safe handling and preparation of the food by the end user?
4. Is the packaging material resistant to damage thereby preventing the entrance of microbial contamination?
5. Are tamper-evident packaging features used?
6. Is each package and case legibly and accurately coded?
7. Does each package contain the proper label?

H. Sanitation

1. Can sanitation impact upon the safety of the food that is being processed?
2. Can the facility and equipment be cleaned and sanitized to permit the safe handling of food?

3. Is it possible to provide sanitary conditions consistently and adequately to assure safe foods?

I. Employee Health, Hygiene and Education

1. Can employee health or personal hygiene practices impact upon the safety of the food being processed?
2. Do the employees understand the process and the factors they must control to assure the preparation of safe foods?
3. Will the employees inform management of a problem that could impact upon safety of the food?

J. Conditions of Storage between Packaging and the End User

1. What is the likelihood that the food will be improperly stored at the wrong temperature?
2. Would an error in improper storage lead to a microbiologically unsafe food?

K. Intended Use

1. Will the food be heated by the consumer?
2. Will there likely be leftovers?

L. Intended Consumer

1. Is the food intended for the general public?
2. Is the food intended for consumption by a population with increased susceptibility to illness (e.g. infants, the aged, the infirm, immunocompromised individuals)?

APPENDIX C DESCRIPTION OF DISEASE CAUSING ORGANISMS ASSOCIATED WITH FISH

The microbial flora of seafood directly reflects the environment from which the fish or shellfish is extracted. The gill, intestine, and slime of the fish contain specific micro-organisms. Mud attached to bottom fish, crab, and shrimp is another source of micro-organisms. The following pathogenic micro-organisms are characteristically associated with seafood. Their control and/or elimination should be considered critical and this can only be done by understanding the growth requirements and the means of inactivation of each organism.

In recent years, micro-organisms have been recognized that are not pathogenic to "normal" healthy individuals but are extremely virulent to certain susceptible individuals. Because of the severity of the symptoms they cause, these micro-organisms are included among the pathogens described below.

I. FOOD INTOXICATION *(Illness due to ingestion of toxins produced by micro-organisms)*

1. *Clostridium botulinum*

An anaerobic spore-forming bacterium, *Clostridium botulinum* is found in soil, sediment, fish intestines, and water and produces a deadly toxin in the absence of air. Seven different types of *C. botulinum*, designated from A to G, are currently recognized.

Types A, B, and E are most commonly implicated in human botulism. The spores of types A and B are heat resistant and thus require heating at or above 120°C for over 15 minutes to be destroyed. Salt (NaCl) in excess of 10%, acidity below a pH of 4.6, or a temperature below 10°C will prevent the growth of types A and B. Although less common, types A and B have been associated with fish products.

Type E (*C. botulinum*) is closely associated with fish and is found abundantly off the northern Pacific Coast in soils, sediments, and the intestines and gills of fish and shellfish. It is less resistant to heat than are types A and B and can be destroyed by heating at or above 82°C for over 30 minutes. Type E cannot grow in seafood that contain salt (NaCl) in excess of 5% or acidity below pH 5.0, but it can grow and produce toxin at temperatures as low as 3°C.

Botulism poses a threat for two reasons. First, it produces one of the most potent poisons known to humans. It doesn't take much for this micro-organism to become lethal, and a drop of pure toxin can wipe out half a million people. Second, an outbreak of botulism food poisoning creates a media sensation, and the resulting negative publicity drastically affects the food industry. For example, in 1982 when two men in Belgium died from eating Alaskan canned salmon, the incident directly cost the industry $148 million from lost sales.

Common Causes:

a) Insufficient processing of home-canned or commercially canned low acid foods (most vegetables, meat, poultry, and fish products).
b) Failure to maintain high salt levels or frozen storage conditions for vacuum packed, smoked fish (see *Food & Drug Regulations B 21.025*)

2. *Staphylococcus aureus*

Staphylococcus aureus resides on human skin and in mucous membranes. Human handlers contaminate seafood with this organism through nose and throat discharges and infected skin lesions. The organism is extremely salt tolerant and can withstand 17% NaCl. Because of its salt tolerance it can grow in the brine and contaminate any other seafood dipped in that brine. The toxin produced by this organism is heat stable and cannot be destroyed even by boiling for an hour.

Because *S. aureus* is suspected to be of human origin, its presence in food is considered evidence that the food has had excessive human handling.

Common Causes:

a) Lack of personal hygiene and good hand-washing practices (food handlers are often infected without experiencing symptoms).

b) Foodservices personnel who work in food facilities with unprotected infected cuts and abrasions, boils, and pimples. S. aureus is spread into the food where it will multiply and produce toxin if kept at temperatures between 7° and 48°C.

II FOOD INFECTION *(Illness due to ingestion of micro-organisms)*

1. *The Vibrios*

The *vibrios* are marine bacteria that occur naturally in the environment. Different species may cause gastro-enteritis, wound infections, and septicaemia. The *vibrios* are more frequently found in warmer waters, increasing in number in summer months.

Foods commonly involved with *vibrios* are contaminated cooked crabs, raw and partially cooked oysters and clams, and raw seafood.

1a. *Vibrio parahaemolyticus*

V. parahaemolyticus is heat sensitive and can be destroyed by heating at or above 60°C for 5-6 minutes. It does not grow at temperatures below 4°C or at a pH below 5.0, but it can tolerate salt (NaCl) in excess of 10%. Furthermore, it can grow very rapidly, therefore storage of bivalve molluscs and cross-contamination of cooked products followed by favourable incubation temperature must be avoided at all costs.

1b. *Vibrio vulnificus*

V. vulnificus can cause serious wound infections and fatal septicemia (blood poisoning).

Infection may result from eating raw or undercooked molluscan shellfish. Susceptible individuals usually have underlying chronic liver or blood-related disorders that tend to elevate the level of serum iron. The fatality rate is 67%.

V. vulnificus is present in the coastal waters of the Atlantic, the Pacific, and the Gulf. It has been isolated from oysters harvested from both approved and unapproved waters. Cooking will destroy this pathogen.

Concern about this micro-organism has prompted the State of California to require restaurants to use a warning label for all Gulf oysters served raw:

> WARNING: EATING RAW OYSTERS MAY CAUSE SEVERE ILLNESS AND EVEN DEATH IN PERSONS WHO HAVE LIVER DISEASE (FOR EXAMPLE, ALCOHOLIC CIRRHOSIS), CANCER OR OTHER CHRONIC ILLNESSES THAT WEAKEN THE IMMUNE SYSTEM. IF YOU EAT RAW OYSTERS AND BECOME ILL, YOU SHOULD SEEK IMMEDIATE MEDICAL ATTENTION. ***IF YOU ARE UNSURE IF YOU ARE AT RISK, YOU SHOULD CONSULT YOUR PHYSICIAN.***

1c. *Vibrio cholerae*

V. cholerae is a bacterium commonly found in warm marine environments. It may also be present in or on some fishery products. *Vibrio* enter the gastrointestinal tract of oysters and clams and can survive for over one month when shellfish are stored at 0° - 4°C. *V. cholerae* incidences in seafood have been on the rise since its epidemic spread from South America.

Common Vibrio Causes:

a) Improper handling (cross-contamination) and temperature control of seafood especially bivalve molluscs.
b) Processors and food service operators lack accurate temperature measuring devices to record when seafood products are cooked.
c) Government shellfish control programs do not include tests for *Vibrio*.

2. *Listeria monocytogenes*

Next to *C. botulinum*, the micro-organism that concerns the seafood industry most is *L. monocytogenes*. *L. monocytogenes* is a common inhabitant of the intestinal tract of seagulls and animals. It is a hardy micro-organism. Like *C. botulinum*, it can be found in soil and in fish-processing plants, and is found in biofilms in plants. It can also grow at refrigeration temperature, like *C. botulinum*, and it can survive in saturated brine, like *S. aureus*. *L. monocytogenes* is extremely virulent to immunocompromised individuals, including pregnant women and unborn infants. The fatality rate for susceptible individuals is as high as 30%.

In 2009 a survey was conducted in dairy, fish and meat facilities in BC that produce RTE foods. The survey was conducted to estimate the prevalence of generic *Listeria* and *Listeria monocytogenes* in the foods and production environments of BC food processing facilities. Overall, generic *Listeria* species were found in 9% and *Listeria monocytogenes* was found in 5% of ready-to-eat foods. When considering results by type of facility, ***Listeria monocytogenes* was only found in ready-to-eat foods collected from fish processors** . The types of foods contaminated included cold-smoked salmon and hot-smoked salmon products such as salmon leather and jerky.

In a systematic survey of crab and shrimp processing plants in Oregon, the Oregon Department of Agriculture found *L. monocytogenes* wherever dirt and debris had accumulated--on the floor near the drain, on walls with peeling paint, and on the tops of processing tables. *L. monocytogenes* was also found in saturated brine and in sea gull droppings. Cooked crab meat and shrimp were contaminated with *L. monocytogenes* by contact with the dirty table top, by steam condensate dripping from the ceiling, and by aerosol generated by the high-pressure hose spray that kicked up the dirt on the floor. When a stringent cleaning and sanitizing regime was enforced, the *L. monocytogenes* problem disappeared. Thus, proper application of detergents and sanitizers at regular and frequent intervals, according to the manufacturer's directions, seems to eliminate the *L. monocytogenes* problem.

L. monocytogenes grows at refrigeration temperatures and high salinity. It is a serious problem in foods that will be eaten without further cooking prior to consumption. These foods include cooked crab, cooked shrimp, and smoked fish.

Common Causes:

a) Unsanitary plant conditions and poor food handling practices leading to cross-contamination of finished products.
b) Improper storage temperatures (*L. monocytogenes* is capable of growing at -0.4°C).

3. *Salmonella*

Salmonella organisms originate in diseased humans or other warm-blooded animals. They can be carried in apparently healthy individuals for varying lengths of time after recovery from the disease. Seafood can be contaminated directly or through polluted water.

These heat-sensitive organisms are destroyed by temperatures at or above 74°C. They will not grow at temperatures below 5.2°C but will persist in either frozen or refrigerated seafood almost indefinitely. Since a small number of these organisms could initiate the disease, the processor must employ a stringent control measure.

Salmonella causes gastrointestinal disease resulting from the ingestion of the *Salmonella* organism. Of greatest risk are the aged, the ill, and the very young. In this group of individuals, the infection may become generalized and lead to death. The number of cases reported annually in the United States ranges from 20,000 to 40,000, and mortality is about 250 people annually. However, expert's estimate that 99% of the cases associated with this organism go unreported.

Common Causes:

a) During transportation and distribution, temperatures are often above 4°C, allowing *Salmonella* to multiply.
b) Fish products may not be heated sufficiently to destroy *Salmonella*.
c) Post-cooking contamination.
d) People who are ill or carriers of *Salmonella* continue to work in food operations.

4. *Shigella*

Shigella species can cause a rather severe form of foodborne illness. Unlike many other disease-causing organisms, only low numbers of this bacterium are required to cause an illness. The normal habitat for *Shigella* organisms is the intestinal tract of humans and other primates (they are seldom found in other animals). Their source is people recovering from the disease.

Between 1972 and 1978, *Shigella* caused 6.5% of the known cases of foodborne illness in the US. The principal foods involved in these outbreaks were salads and seafood that became contaminated during handling by infected workers.

Shigella is readily killed by most heat treatments used in the processing and preparation of foods and does not survive well at a pH below 4.9. Under ideal circumstances, however, *Shigella* can survive for extended periods in food-for example, up to 50 days in clams and shrimp.

Prevention and control require either that infected persons not be permitted to handle foods or that they practice good personal hygiene. However, routine testing of food workers is not practical or necessary. Education of food handlers, with emphasis on good personal hygiene, is the best preventive measure.

Common Causes:

a) Sewage pollution resulting in contamination of water supplies.
b) Food handlers who are ill or are carriers of *Shigella* and who contaminate food after using the toilet.

5. *Viral Hepatitis*

Viral hepatitis associated with seafood is usually caused by ingestion of raw or undercooked shellfish harvested from polluted water. The hepatitis virus originates in diseased humans and not in domestic or wild animals. Although the virus is unnatural to the marine environment, it could survive in sediment for years. One recent

study has suggested that upwards to 25% of *Hepatitis A* cases may be due to consumption of contaminated shellfish. Besides shellfish, contaminated water used for seafood processing can spread this virus.

6. *Others*

According to the Center for Disease Control, the most common seafood-borne illness reported in the US is *ciguatera*, or "reef fish poisoning," resulting from the ingestion of certain tropical fish that have accumulated toxic plankton. Toxic fish cannot be differentiated from normal ones, but fishermen usually avoid certain reefs and larger fish that tend to accumulate more toxins.

The next most common seafood-borne illness in the US is *scombroid* fish poisoning, caused by microbial conversion of histidine to histamine in scombroid fish species. Histamine (scombroid toxicity) causes typical allergy-like symptoms and produces skin rashes. Scombroid toxicity results from ingesting fish that have been improperly handled or stored. The production of histamine can be fairly rapid (3- 4 hours) under optimal temperature conditions which is 20 - 30°C. Cooking, freezing, and smoking are ineffective in removing the toxin from fish flesh.

Fish parasites, such as nematodes (i.e. *anisakid*) and worms (i.e. *Diphyllobothrium* tapeworm), can also be a health concern to humans if ingested in their live state. Finding a parasite in fish is, however, considered a natural occurrence and not a form of contamination. Besides the physical removal of parasites at the processing level, the most effective methods to ensure that any remaining parasites are killed is to adequately freeze or cook the fish.

Paralytic Shellfish Poisoning is widespread throughout the world. This is sometimes but not always caused by "*red tides*" which are blooms of marine organisms known as dinoflagellates. These organisms produce a potent neurotoxin that can cause severe and sometimes fatal human poisonings following the ingestion of bivalve molluscs, which will retain the toxin as they filter feed. Another toxin, domoic acid is also a concern.

Table 1 Growth and Heat Inactivation Characteristics of Food Poisoning Bacteria Important in Seafood Processing

Bacteria	Growth Temperature (°C)			Lowest Ph for Growth (a)	Maximum NaCl (%) Tolerated
	Minimum (a)	Optimum (a)	Maximum (a)		
1. *C. botulinum*					
types A & B	10°	35°	50°	4.7	10.0
type E	3°	15°	30°	4.7	6.0
2. *Vibrio* spp.	5°	37°	43°	4.8	9-10
3. *Salmonella*	5°	37°	46°	3.8	8.0
4. *Shigella*	6°	-	47°	4.9	-
5. *S. aureus*	7°	37°	48°	4.0	17.0
6. *C. perfringens*	4°	45°	50°	5.0	5.0
7. *Listeria monocytogenes*	-0.4°	45°	50°	5.5	30.0

Ref: ICMSF (1996) Micro-organisms in Food 5: Characteristics of Microbial Pathogens, Roberts, T.A., Baird-Parker, A.C. and Tompkin, R.B. (eds) Blackie Academic & Professional London [ISBN 0412 47350X]

APPENDIX D RECORDKEEPING

Recordkeeping is an essential part of the HACCP system. The following pages contain (1) a description of key areas where records are often required, and (2) a sampling of forms that may be used to record the monitoring results and corrective actions (when necessary) for each CCP. These records are reviewed regularly to indicate to management and government inspectors that you maintained control by properly evaluating, handling, and processing your fish products and ingredients.

EXAMPLES OF HACCP RECORDS

A. Ingredients

1. Supplier certification documenting compliance with processor's specifications.
2. Processor audit records verifying supplier compliance.
3. Storage temperature record for temperature sensitive ingredients.
4. Storage time records of limited shelf life ingredients.
5. Shipping and receiving temperature records.

B. Records Relating to Product Safety

1. Sufficient data and records to establish the efficacy of barriers in maintaining product safety.
2. Sufficient data and records establishing the safe shelf life of the product, if age of product can affect safety.
3. Documentation of the adequacy of the processing procedures from a knowledgeable process authority.

C. Processing

1. Records from all monitored CCPs.
2. Records verifying the continued adequacy of the process.

D. Packaging

1. Records indicating compliance with specifications of packaging materials.
2. Records indicating compliance with sealing specifications.

E. Storage and Distribution

1. Temperature records.
2. Records showing no product shipped after shelf life date on temperature sensitive products.

F. Deviation and Corrective Action Records

G. Validation records and modification to the HACCP plan indicating approved revisions and changes in ingredients, formulations, processing, packaging, and distribution control, as needed.

H. Employee training records.

Ingredients and Supplies Log and Inspection Report Sheet

Ingredients and Supplies Log and Inspection Report										
Date Ordered	Ingredients / Supplies Qty, Pricing	Manufacturer	Product No.	Supplier	Date Arrived	Lot#	Code#	Expiry Date	Acceptable Condition	Initial

Fish Processing Plants (HACCP)

Freezer Log Sheet

Business Name: _____

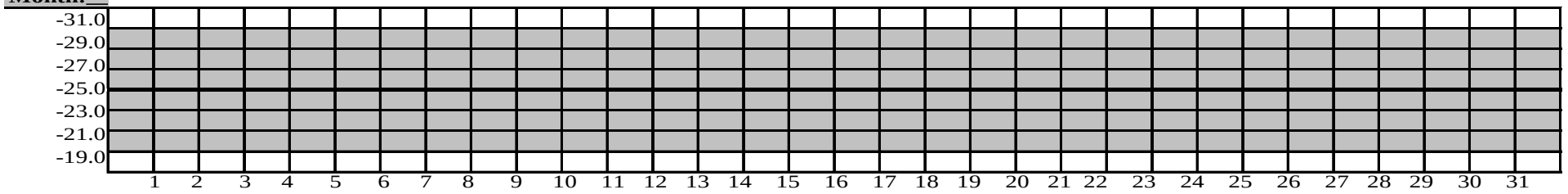
Year _____

FREEZER QUALITY CONTROL RECORD
Freezer Name: _____
Model #: _____
Serial #: _____
Acceptable Temp. Variation : -25.0°C ±5.0°C

DAILY OR EACH USE: Record temperature, note time if needed
MONTHLY: Check thermister reading, clean outside doors
SEMIANNUALLY OR AS REQUIRED 1. Defrost & clean inner doors
2. Check door gasket
3. Vacuum or dust condenser coil

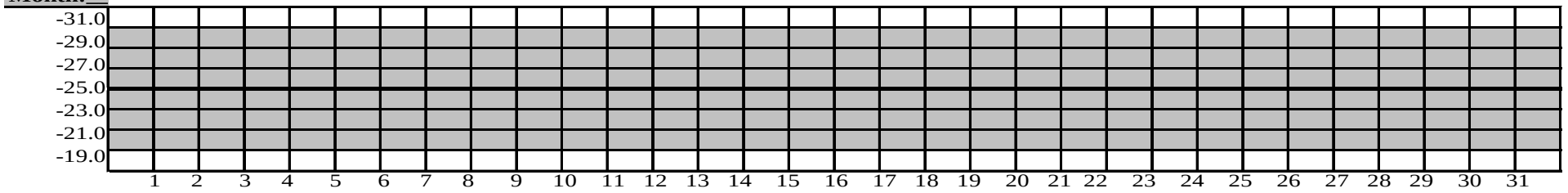
NOTE: RECORD TEMPERATURE AS REQUIRED. CHECK IF ALL PARAMETERS OK. DATE & INITIAL ACTIVITY PERFORMED. PROMPTLY REPORT PROBLEMS OR UNACCEPTABLE VARIATIONS TO THE SUPERVISOR(S)

Month:__



Initial

Month:__



Initial

ACTIVITY	DATE PERFORMED	INITIAL	COMMENTS
Check thermister reading			
Clean outside doors			
Clean inside doors			
Check door gasket			
Vacuum or dust condenser coil			
Other			

DATE	PROBLEM / UNACCEPTABLE VARIATION	REPORTED BY	CORRECTIVE ACTION TAKEN	SUP. INITIAL

REVIEWED BY _____ **DATE :** _____

Refrigerator Log Sheet

Business Name: _____

Year _____

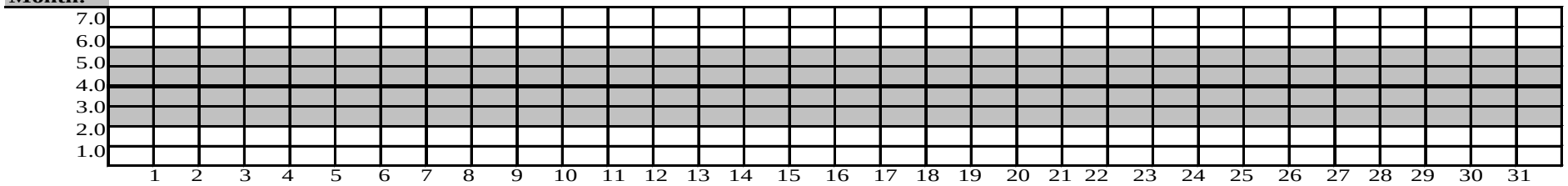
REFRIGERATOR QUALITY CONTROL RECORD

Refrigerator Name: _____
Model #: _____
Serial# _____
Acceptable Temp. Variation : $4.0^{o} \pm 2.0^{o}C$

DAILY OR EACH USE: Record temperature, AM & PM
MONTHLY: 1. Clean outside
2. Check thermister reading
SEMIANNUALLY OR AS REQUIRED 1. Clean, inside & out
2. Check door gasket
3. Vacuum or dust condenser coil

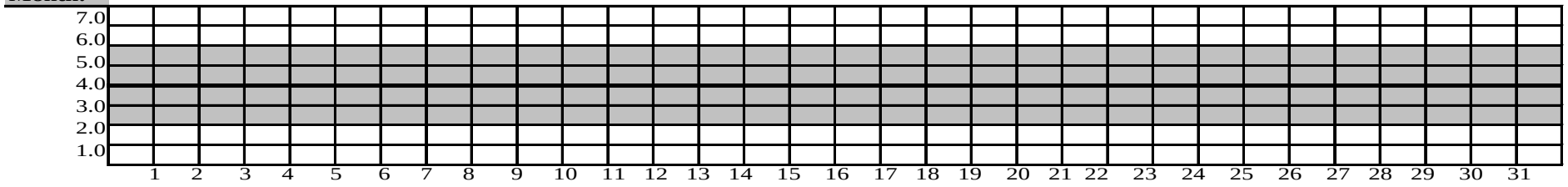
NOTE: RECORD TEMPERATURE AS REQUIRED. CHECK IF ALL PARAMETERS OK. DATE & INITIAL ACTIVITY PERFORMED. PROMPTLY REPORT PROBLEMS OR UNACCEPTABLE VARIATIONS TO THE SUPERVISOR(S)

Month:



Initial

Month:



Initial

ACTIVITY	DATE PERFORMED	INITIAL	COMMENTS
Clean outside			
Check thermister reading			
Clean inside			
Check door gasket			
Vacuum or dust condenser coil			
Other			

DATE	PROBLEM / UNACCEPTABLE VARIATION	REPORTED BY	CORRECTIVE ACTION TAKEN	SUP. INITIAL

REVIEWED BY _____ **DATE :** _____

Process Record for Smoked Products

Process Time / Temperature Record for Cooked / Smoked Products								
Date	Product	Code # / Lot#	Amount	Smoking Temperature	Smoking Time	Cooking Temperature	Cooking Time	Cooling Time to 4°C (39.2°F)

Freezing Record for Parasite Control

Freezing Record for Parasite Control										
To control for parasites fish must be frozen for either (a) -35°C (-31°F) for 15 hours or -20°C (0°F) for 7 days										
				Was fish previously frozen?	If yes, indicate		If no, record in-house freezing			
Date	Fish Description (e.g., sockeye)	Received From	Lot #	Yes/No	Time	Temp	Temp	Date	Time In	Time Out

Shellfish Receiving Record

Date Received	Product Temperature	Accept? [reject if temp>10°C]	Supplier	Product Description [list each oyster or shellfish description]	Tag present?	Batch Size	Lot Number

HOUSEKEEPING REPORT

PLANT NAME: _____ DATE: _____

AREAS	DESCRIPTION	DATE	INSPECTOR
FISH HOLDING AND CONVEYING			
a) adequate holding (time/temperature)			
b) fish washed before processing			
FOOD CONTACT SURFACES & ICE			
a) surfaces adequately cleaned and rinsed			
b) product contact surfaces sanitized			
c) surfaces properly maintained			
NON-FOOD CONTACT SURFACES-WET			
a) scheduled cleaning and rinsing adequate			
b) scheduled sanitizing adequate			
NON-FOOD CONTACT SURFACES-DRY			
a) adequately cleaned weekly			
RAINGEAR/EMPLOYEE APPAREL/GLOVES			
a) cleaned, maintained, properly stored			
SANITIZER			
a) sufficient strength, checked, used			
b) adequate contact time			
INSECT, RODENT, ANIMAL, BIRD CONTROL			
a) effective measures to exclude pests from facilities			
b) no evidence of pests			
c) traps maintained and approved			
REFRIGERATION & FREEZING FACILITIES			
a) equipment adequately cleaned & maintained			
b) equipment with working thermometers, proper temperatures			
STORAGE OF INGREDIENTS & PACKAGING			
a) sufficient, dry acceptable spaces provided			
b) separated from chemicals cleaning compounds etc.			
EMPLOYEE PRACTICES			
a) clean clothes jewellery removed hair restrained			
b) no tobacco, gum, food & drink in process area			
c) personnel with infections restricted			
TOILET FACILITIES			
a) adequate facilities clean stocked with supplies			
b) separated from processing areas			

TABLE 1 Study Results Showing Major Factors of Outbreaks Associated with Foods from Food Processing Plants

Inadequate heat processing	26.7%
Contaminated raw ingredients	18.7%
Improper cooling	14.7%
Improper fermentation	10.7%
Improper cleaning	10.7%
Colonized person handling implicated food	10.7%

TABLE 2 Bacteria Pathogens and the Most Sensitive Seafood

PATHOGEN	SENSITIVE SEAFOOD
Clostridium botulinum	a. Smoked fish, including kippered and cold smoked, eaten uncooked
	b. Fermented salmon roe
Vibrio parahaemolyticus	a. Raw oysters
	b. Cooked and picked crabmeat
	c. Frozen cooked shrimp, prawns, and lobster tail
	d. Fish eaten raw
	e. Frozen raw shrimp, prawns, and lobster tail
	f. Frozen raw breaded shrimp and prawns
Vibrio vulnificus	a. Raw oysters
Salmonella	a. Freshwater fish from warm waters
	b. Contaminated shellfish
Viral infections: norovirus, hepatitis	a. Raw or undercooked shellfish from contaminated waters
Staphylococcus aureus	a. Smoked fish eaten uncooked
	b. Frozen cooked shrimp, prawns, and lobster tails
Listeria monocytogenes	a. Cooked crab and shrimp eaten without further cooking
	b. Cold smoked fish eaten without further cooking

TABLE 3 Examples of Practices That Increase Potential Food Safety Hazards

Cross-Contamination
Storing raw foods with ready-to-eat foods
Practicing poor employee sanitation
Failing to clean equipment properly
Failing to protect food adequately from contamination
Improperly storing refuse in food-preparation areas
Use of utensils or equipment used earlier in process without proper cleaning and sanitation
Employee aprons who handle raw product
Improper Hot or Cold Storage
Storing foods at improper temperatures
Using coolers and display units without thermometers
Using poor cooling practices; overloading refrigeration units
Using hot display cases without thermometers
Storing food in improperly labelled containers
Neglect for storage temperature requirements
Other Hazards
Using improper or inadequate cleaning and sanitation practices
Using poor food preparation and handling practices
Keeping inadequate documentation and records
Storing chemicals and personal items improperly