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INSHORE GROUND FISH PILOT PROJECT:
FREEZING FOR LATER PROCESSING

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**INSHORE GROUND FISH PILOT PROJECT:
FREEZING FOR LATER PROCESSING**

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Replacement

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INTRODUCTION

The changeover from primarily a saltfish industry to a fresh frozen industry by the Newfoundland fish processing sector has led to a number of problems. Where once fishing crews did most of their own processing ie. salt fish, they are now almost entirely dependent on fresh fish processing plants for their market. Usually this is not a problem, however, during peak periods of the inshore groundfish fishery catches often exceed processing capability. Commonly called "the glut" this occurrence, which usually takes place during May through July, burdens both fishermen and processor and impacts negatively on the industry in general.

Fishing crews are frequently required to operate on a reduced quota basis at a time when fish are plentiful. This means a significant loss of potential income which cannot be recouped later in the season. Processors are forced into rapid throughput in plant, processing much of their fish into block rather than prime packs which fetch a higher price on the marketplace. Many plant employees suffer as well working only 1 to 3 months when fish are available and being laid off when the peak fishery has passed.

In recent years, both "over-the-side sales" to foreign vessels and increased salt fish production has reduced the glut problem in some areas though it could be argued not to the full benefit of the Newfoundland fishing industry.

With increasing stocks and improved harvesting capability, it appears that problems of short-term oversupply will continue to plague the industry each summer. It is therefore imperative that practical and viable solutions be devised to afford industry the opportunity of obtaining the maximum benefit from all fish harvested by our fishermen.

In 1980 the Fisheries Development Branch of the Department of Fisheries and Oceans, in conjunction with industry, began investigating the glut problem and attempted to identify potential solutions to it. It was believed that if excess fish could be frozen during the glut and processed later when raw material was in short supply, then a number of benefits could be achieved. Fishermen would be able to sell all or most of their catch, processors could produce a higher ratio of prime pack versus block and increase their operating season and throughput, thereby increasing profit margins and employment. Employees would also benefit from a longer employment period.

This report describes two separate experiments conducted in 1982 and 1983. It outlines the procedures and controls used in selecting, preparing and processing groundfish and the conditions, schedules and results obtained from processing the frozen, stored material relative to quality, pack-out form and costs.

Each experiment has been isolated and dealt with on an individual basis. Experiment controls were purposely kept to a minimum so as not to incur additional costs. The reason for this was to determine what industry

could accomplish in terms of freezing and processing under normal operating conditions. To have imposed strict controls on the experiments would have meant that any results obtained would be reflective of controlled experiment efforts and not those that industry could achieve under commercial production procedures.

CHAPTER ONE

TRAPFISH EXPERIMENT

Overview

A major contributor to the glut problem in the Newfoundland fishery is the cod trap. The high volumes of fish harvested by this fishing method, primarily during June and July when other fisheries are also going full swing, places a high burden on the processing sector. To increase throughput and help cope with the situation, many plants direct all or most of their production into frozen block. If excess trap fish could be frozen and stored until needed, then processors would have the increased opportunity of producing much of their raw material into prime packs.

In 1982 Ocean Harvesters Limited of Harbour Grace supplied under a D.S.S. contract to the Department of Fisheries and Oceans, 194,200 lbs* of trap fish which was in turn prepared and placed in storage for 3 months.

Material Preparation

The bulk of the fish used in the experiment originated from cod traps at Grate's Cove, Red Head Cove, Bay de Verde and Old Perlican. Small

* Head On Gutted

quantities of handline and jigger fish were included when the trap fishery declined in these areas in order to provide a sufficient amount of raw material for processing. All fish was purchased head-on-gutted at dockside and trucked to the Ocean Harvesters plant at either Old Perlican or Harbour Grace. At dockside, all fish was iced into insulated fish containers or plastic tote boxes. Upon arrival at the plant, this fish was placed in a holding room prior to final selection and preparation.

Each lot of fish intended for freezing was inspected by Department of Fisheries and Oceans personnel. Based on the results of texture and intrinsic factor analysis, implemented on randomly selected samples, lots were either accepted for storage or rejected. Fish selected were not 100% Grade A but were of acceptable quality (Grade A, B) or good quality trap fish.

Following acceptance of individual lots, all selected fish were inspected for complete gut removal. Fish under 16" were rejected from the lots. The remaining fish were individually size separated into separate packs, ie. 16-20" in one pack, over 20" into another pack.

The fish were then packed into aluminum freezer trays, lined with polyethelene. These trays contained approximately 18 kg (40 lbs) and were marked to indicate the size range of fish inside. These blocks were then frozen in both Sharpes and Blast Freezers accordingly for periods ranging from 18-24 hours.

Upon removal from the freezer, each tray of fish with polyliner intact was placed in a polyethelene bag, mastered and strapped with appropriate identification showing species, form, size range, etc., and placed in cold storage. Cold storage temperatures were continuously monitored and indicated an average storage temperature of -20°C . Samples were taken from time to time to check for dehydration.

In all, a total of 88,600 lbs H.O.G. 16"-20" and 105,600 lbs H.O.G. 20" and over were prepared and placed in storage during July and August and held until December. Total costs for handling, packaging and freezing amounted to \$17,478, an average cost of 9 cents per lb.

PROCESSING

Preview

Before processing of the frozen fish was undertaken, a brief survey of defrosting methods used by Newfoundland plants was undertaken. This survey showed that none of the plants sampled were technically geared up for defrosting frozen fish. It did indicate that four methods of fish defrost were utilized to some degree by all plants sampled, namely

- (1) thawing in insulated containers using running fresh water;
- (2) thawing in insulated containers using running sea water;
- (3) air thawing by blast freezer reversal;
- (4) air thawing at room temperature.

As mentioned, there was no tried and proven method used to any extent by the sampled plants. Operators tend to make use of equipment on hand. It was therefore decided to allow the successful contractor to use those methods in his capacity and to impose few restrictions as possible in order to minimize work schedule disruption and unnecessary expense.

Prior to freezing, random packs were selected and sampled to identify the quality of fish being frozen. Samples from both size ranges, 16"-20" and 20" and over were taken. Fish quality grades were established using dockside grading criteria. Table 1 shows the distribution of grades by size category.

Seven companies were invited to submit proposals to Department of Supply and Services for the purchase, defrosting and processing of the stored fish. However, little interest was shown by these companies partly because many were not interested in purchasing frozen trap fish. Only two proposals were received. The final contract was awarded to Ocean Harvesters Limited of Harbour Grace who purchased the fish and agreed to follow as closely as possible, defrosting and processing procedures set down by the Development and Analysis Division of the Department of Fisheries and Oceans.

Defrosting Operations

Product defrosting began on December 10, 1982 at Ocean Harvesters using both running fresh and running sea water. These defrost methods were used because cold weather did not permit open air defrost. Blast freezer reversal was not undertaken as past experience by Ocean Harvesters indicated

Table 1. Fish Grades from Randomly Selected Blocks Prior to Freezing. Size Range 16"-20"

| <u>No. Fish Examined</u> | <u>Grades</u> | <u>No. Fish</u> | <u>%</u> | <u>Avg. Fish Length</u> | <u>Avg. Fish Weight</u> |
|--------------------------|---------------|-----------------|----------|-------------------------|-------------------------|
| 174 | A | 61 | 35.05 | 17.75" | 2.10 lbs |
| | B | 80 | 45.98 | | |
| | C | 32 | 18.40 | | |
| | R | 1 | 0.57 | | |

Size Range 20" and Over.

| | | | | | |
|----|---|----|-------|--------|----------|
| 98 | A | 30 | 30.61 | 23.75" | 4.82 lbs |
| | B | 45 | 45.92 | | |
| | C | 23 | 23.47 | | |
| | R | 0 | 0.00 | | |

this method to be a rather slow defrost method and fairly labor intensive.

The frozen product was placed in insulated containers with a constant flow of water entering each unit from the bottom. Conditions were continuously monitored to identify when each container of fish had reached the defrost level which allowed it to be processed. If defrosted fish were left in water, they were very susceptible to increased quality deterioration due to texture loss. Ideally, fish should be removed from the water immediately following complete defrost and put through the processing line. This is not always practical as individual fish defrost at various rates and fish in each block or container are not always exposed to the same defrost conditions.

Random samples of the thawed fish were taken and graded using dockside grading criteria prior to processing. As shown in Tables 2 and 3, none of the fish were Grade A with 32.65% and 3.57% being rejected for fish 16"-20" and greater than 20" respectively.

Table 2. Defrosted Fish Grades 16"-20".

| <u>No. Fish Examined</u> | <u>Grades</u> | <u>No. Fish</u> | <u>%</u> | <u>Comments</u> |
|--------------------------|---------------|-----------------|----------|---|
| 97 | A | 0 | 0.00 | All rejected fish was due to flabby texture. |
| | B | 10 | 10.21 | |
| | C | 56 | 57.15 | |
| | R | 32 | 32.65 | |

Table 3. Defrosted Fish Grades - Size 20" and Over.

| <u>No. Fish Examined</u> | <u>Grades</u> | <u>No. Fish</u> | <u>%</u> | <u>Comments</u> |
|--------------------------|---------------|-----------------|----------|---|
| 29 | A | 0 | 0.00 | All rejected fish was due to flabby texture. |
| | B | 7 | 25.00 | |
| | C | 20 | 71.43 | |
| | R | 1 | 3.57 | |

The quality differences between the 16"-20" fish and fish greater than 20" would indicate that the smaller trap fish suffered significant deterioration which may be a result of either the frozen storage or the defrosting or a combination of both.

Storage and defrosting impacted negatively on both lots of fish as shown in Table 4 and 5.

Table 4. Quality comparisons for Fresh Fish Versus Defrosted Fish 16"-20".

| <u>Quality In</u> | | <u>Quality Out</u> | |
|-------------------|----------|--------------------|----------|
| <u>Grade</u> | <u>%</u> | <u>Grade</u> | <u>%</u> |
| A | 35.05 | A | 0.00 |
| B | 45.98 | B | 10.21 |
| C | 18.40 | C | 57.15 |
| R | 0.57 | R | 32.65 |

Table 5. Quality comparisons for Fresh Fish Versus Defrosted Fish 20" and Over.

| <u>Grade</u> | <u>Quality In</u> | <u>%</u> | <u>Grade</u> | <u>Quality Out</u> | <u>%</u> |
|--------------|-------------------|----------|--------------|--------------------|----------|
| A | | 30.61 | A | | 0.00 |
| B | | 45.92 | B | | 25.00 |
| C | | 23.47 | C | | 71.43 |
| R | | 0.00 | R | | 3.57 |

A total of 59,622 lbs and 60,144 lbs were defrosted by fresh and sea water respectively with each defrost method being used on two separate lots of fish.

Table 6 gives a breakdown of final pack outs, production yields and labor costs for each defrost method. Both fish size groups were processed simultaneously to provide sufficient material for plant workers. Therefore no separate analysis on either production or pack out is available for the two size classes. From Table 6 it can be seen that the frozen fish defrosted in sea water produced the higher yield at lower cost with an average yield of 31.16% at an average cost of 37.17 cents per lb. This cost reflects labor costs only and does not include the preparation, freezing and storage of the fish. The significantly higher processing cost of 50.23 cents/lb on Lot #1 (fresh water defrost) is not reflective of what actual costs should be as indicated by the costs for the remaining lots. Weighted average cost for the

Table 6. Production Yields, Costs and Pack Outs for Frozen Trap Cod.

| <u>Lot. No.</u> | <u>Defrost Method</u> | <u>Weight to Filleting (lbs)</u> | <u>Final Production Weight (lbs)</u> | <u>Type Packs</u> | <u>Final Yield (%)</u> | <u>Overall Labor Cost per lb.</u> |
|-----------------|-----------------------|----------------------------------|--------------------------------------|-------------------|------------------------|-----------------------------------|
| 1 | Fresh Water | 29,754 | 7,821 | 100% Block | 25.14 | 50.23 cents |
| 2 | Fresh Water | 28,868 | 10,098 | 100% Block | 33.80 | 30.87 cents |
| Comb. 1 & 2 | | 59,622 | 17,919 | 100% Block | 30.05 | 39.23 cents |
| * 3 | Sea Water | 36,540 | 11,401½ | 100% Block | 31.20 | 39.79 cents |
| 4 | Sea Water | 23,604 | 7,342½ | 100% Block | 31.10 | 33.09 cents |
| Comb. 3 & 4 | | 60,144 | 18,744 | 100% Block | 31.16 | 37.17 cents |

* Includes 6,468 lbs from Sea Water Defrost Lot No.

Overall Product, Yield and Cost Combining the Four Lots.

| <u>Weight to Fil- leting (lbs)</u> | <u>Final Production Weight (lbs)</u> | <u>Type Pack</u> | <u>Final Yield (%)</u> | <u>Overall Labor Cost per lb.</u> |
|--|--|------------------|----------------------------|---------------------------------------|
| 119,766 | 36,663 | 100% Block | 30.61 | 38.49 cents |

for the other three lots was 34.96 cents/lb. Lot #1 was the first run attempt and resulted in significantly higher costs because this fish took longer than anticipated to defrost. Subsequently, work crews had finished their shift by the time the fish was ready for processing. The delay in processing further reduced the quality of the product. This in turn resulted in increased trimming costs and lower yields.

Table 7 provides a breakdown of final pack outs, yields and costs for all the fish processed by Ocean Harvesters.

SUMMARY

A total of 194,200 lbs H.O.G. trap fish were frozen in 40 lb blocks with a polyethelene wrap placed in polyethelene bags and put in cold storage for approximately 4 months. The quality of fish randomly determined prior to freezing was 33.45% Grade A, 45.96% Grade B, 20.22% Grade C, 0.37% reject. Total cost for preparing handling, wrapping, freezing and cold storage amounted to \$17,478 or 9.0 cents per lb.

Lots of the frozen fish were defrosted in circulating fresh and circulating sea water prior to processing. Randomly selected samples of the defrosted product using dockside grading standards showed 0.0% Grade A, 13.49% Grade B, 60.32% Grade C and 26.19% R, indicating a significant decrease in fish quality. This decrease is partly attributable to quality deterioration during storage and partly due to defrosting. Many in the processing sector are of the opinion that the high moisture content of trap fish causes a texture breakdown under freezing conditions. This texture deterioration is compounded during defrosting when the flesh of the fish absorbs more water.

Average yields amounted to 30.61% which included both cod and minced block at 31,498 and 5,164 lbs respectively. Total costs which include preparation, freezing, wrapping and cod storage of the raw material and total processing costs excluding fish purchase and transportation amounted to 46.72 cents.

Final product pack out went to 100% block as the final product grading indicated no amounts of fish of suitable quality for prime packs.

CHAPTER TWO

FRESH FROZEN FISH TO SALT FISH PRODUCTION

Another phase of this project involved the defrosting and processing of the stored trap fish into light, salted, and dried cod. H.B. Dawe Ltd. of Cupids, Newfoundland purchased 49,405 lbs of the frozen H.O.G. trap cod for experimental pickling and drying.

The frozen blocks of H.O.G. fish were placed on adjustable freezer racks. The racks were then submerged in large tanks filled with sea water. The temperature of the water varied between 27° and 29°F during defrost. The tanks were filled from the bottom which gave a constant recirculating movement all through the defrosting process. The defrosting time was logged at 70 to 120 hours. The reason for such lengthy defrost times is attributed to the low temperature of the sea water used for defrosting. Nine blocks of fish were placed into a vat of circulating water and the defrosting time was reduced to 30 hours. The time difference was a result of fish being broken apart after it was partly defrosted.

Following the defrosting cycle, the fish were taken and the heads removed with a knife. It was then split and washed in two different waters. Due to the softness of the fish, the splitting machine did a very poor job on some of it. The split fish was light salted (9 lbs of salt to 100 lbs fish). After 1 to 2 days, it was discovered that the formation of pickle was too slow and the cold temperatures seemed to be the deterrent. A solution was then made with a 20% brine content and approximately 2 gallons was added to each tote box of fish. The normal time for curing is 5 days but due to low temperatures in the building, it took double this time for sufficient curing. When the fish was removed from the pickle, it had a moisture content of 70% and it was then put through the following stages:

- Stage 1: It was spread on trays and placed in dryer until the moisture content fell to 50%.
- Stage 2: Taken out of dryer, removed from trays and placed in a pile face up for a period of 3-5 days.
- Stage 3: Spread back on trays again and loaded back into dryer for 24 hours during which time the moisture content fell to 45%.
- Stage 4: Taken out of dryer and piled face up with weight being applied to top of pile. It was kept like this for 7 to 10 days.
- Stage 5: Respread back on trays again and loaded back into dryer until the moisture content was 38-40%.

Stage 6: Taken out of dryer and piled with weight being applied to the top for a period of 1 to 2 weeks.

Stage 7: Fish was then taken and culled for various grades and packaged for the marketplace.

Table 8 provides a breakdown of quality grades for the light, salted, dried product.

Normal yields obtained from fresh fish when it is light salted is approximately 39.8%. During this experiment we achieved a yield of 36.69%.

The shelf life of this product appears equal to that of fish cured in the usual way. A box was opened 10 months after it was packed and following an examination, it was found to be in perfect condition.

Table 8. Light Salted Dried Fish Production - H.B. Dawe Limited.

| | |
|-----------------------|------------|
| H & G cod received | 49,405 lbs |
| Packed off production | 17,631 lbs |

Yield - 36.69%

* Grades and Respective Amounts

| | | | |
|------------|-----------|---|--------|
| Choice | 750 lbs | = | 4.25% |
| Amarbon | 8,791 lbs | = | 49.85% |
| Amaruno | 6,015 lbs | = | 34.11% |
| West India | 1,995 lbs | = | 11.31% |
| Tom Cods | 20 lbs | = | .11% |
| Bonacara | 66 lbs | = | .37% |

* Grade Classification Light Salted Dried Cod.

| | |
|------------|---|
| CHOICE | - Top quality, thick, smooth and well split fish, free from blood, defects and stains. |
| AMARBON | - Fish slightly lower in quality, some minor imperfections resulting from curing. |
| AMARUNO | - Third quality fish, downgraded because of imperfect splitting showing mild sunburn or skin heating. |
| WEST INDIA | - Poorly split fish, fish that were of soft texture prior to splitting. |
| BONACARA | - Good quality salt fish, however, too much salt used for a light salted product. |
| TOM CODS | - Good quality fish less than 12" when dried. |

CHAPTER THREE

GROUNDFISH EXPERIMENT

Overview

In the summer of 1982, Beothic Fisheries Limited at Valleyfield, Newfoundland experienced oversupply problems. These resulted from a successful groundfish fishery, primarily from gillnets and cod traps. The company anticipated a similar situation during the summer of 1983 and requested assistance from the Development and Analysis Division to determine whether or not it was practical to overcome the glut problem by freezing surplus fish and holding it for processing later in the year when raw material was in short supply.

Since this company was prepared to cold store groundfish and trap cod, Development staff felt that this opportunity would afford a comparison of the two types (trap vs. gillnet) of fish in terms of defrosting and processing under commercial conditions. Originally, the company intended to store quantities of flounder and turbot as well. However, industry conditions prevented this. The Development and Analysis Division also purchased from the Fogo Island Co-op 40,000 lbs of Grade A (dockside graded fish) to be used as a control in determining the impacts of frozen storage and processing, relative to initial product quality. Again, no restrictions were placed on the company (Beothic Fisheries Ltd.) that would cause any undue expense or change in their normal operations.

Material Preparation

The raw material (cod) used in this project was harvested mainly by gillnets in the area around Greenspond, Lumsden, Musgrave Harbour, during the period July 5-25. Upon arrival at the Valleyfield plant, fish were de-iced, washed and graded according to company standards prior to packaging. The average grade (company standards) of the 162,386 lbs of H.O.G. material prepared was 75-80% A. This grade is based primarily on visual inspection of whole fish with texture and physical defects being the main determinants of fish quality.

The fish were not packaged according to any size range or weight. However, packaging crews estimated that most of the product was greater than 20". The H.O.G. cod were placed in open cardboard cartons lined with polyethelene, weighed, marked and blast frozen for periods ranging from 12.5-15.5 hours. Costs incurred in preparing, freezing and packaging amounted to 7 cents/lb. Truckage amounted to 1.4 cents/lb while stretch wrapping and cold storage costs were 3.7 cents/lb for the 3.5 month period.

The packaged product was trucked to B & L Cold Storage at Boyd's Cove, where it was stretch-wrapped on pallets and stored at temperatures ranging from -10°C to -20°C for a 2-month period.

The 40,000 lbs of H.O.G. Grade A cod prepared by the Fogo Island Co-Op was composed of 20,200 hook and line fish and 19,800 lbs gillnet fish. Prior to freezing, the fish were size-sorted into 18-24", 25-34" and 35"+ lots.

The product was individually wrapped, placed in cardboard cartons (50 lb/cartons) and blast frozen. Upon removal from the freezer, covers were placed in each box which were in turn strapped and shipped to B & L Cold Storage.

This fish was purchased by the Development and Analysis Division and later sold to Beothic Fisheries to be used as a control group in the defrosting and processing experiment.

PROCESSING - DEFROSTING OPERATIONS

Product defrosting commenced on November 1, 1983 when 41,320 lbs of the gillnet fish prepared by Beothic Fisheries were defrosted using blast freezer reversal. This defrost method proved unacceptable due to a number of factors.

- (1) The outer surface of the fish is dried out by the warm circulating air.
- (2) The alignment of the racks of fish in the freezers promotes deflection of the warm air away from the product, consequently only those fish in the direct path of the flowing air were defrosted.
- (3) The constant and necessary rearranging of the racks within the freezer is labor intensive and therefore a costly operation.

In addition to defrosting by this method, Beothic Fisheries personnel conducted a trial defrost using circulating sea water to determine the better

procedure. Table 9 shows defrosted product grades using the two defrost methods.

Table 9. Defrosted Fish Grades.

| <u>Grades</u> | <u>Blast Freezer Defrost %</u> | <u>Sea Water Defrost</u> |
|---------------|--------------------------------|--------------------------|
| A | 0.00 | 0.00 |
| B | 4.79 | 18.98 |
| C | 54.49 | 45.98 |
| R | 40.72 | 35.04 |

These results indicate that defrosting by circulating sea water to be the better of the two procedures with the significant improvement in fish quality favouring sea water defrost.

These results led to the decision to defrost the remaining fish in sea water and to try one lot of Grade A fish defrosting by open air. Due to cold outdoor temperatures however, the open air defrost method proved impractical and air-defrosted fish had to be placed in water to speed up defrosting. To have done otherwise would have resulted in a close down of plant operations for lack of material.

The Grade A fish packed by the Fogo Island Co-Op was defrosted by circulating sea water and open air defrost. Grading of randomly selected samples for both sea water and open air showed that once again sea water defrost produced better quality as indicated in Table 10.

Table 10. Quality Comparisons for Open Air and Seawater Defrost.

| <u>Grades</u> | <u>Open Air and Seawater Defrost %</u> | <u>Sea Water Defrosted %</u> |
|---------------|--|------------------------------|
| A | 4.76 | 14.06 |
| B | 28.57 | 32.81 |
| C | 61.91 | 42.19 |
| R | 4.76 | 10.94 |

Throughout the course of the experiment, all fish rejected during quality analysis resulted from poor texture in sampled fish.

Processing

This phase of the project involved the filleting, trimming, deboning, grading, packaging and freezing of the product. Processed fish from each defrost method were isolated to identify yields, pack outs and costs for the respective procedures.

Table 11 provides a breakdown for fish defrosted by blast freezer reversal. It shows an average yield of 33.68% including minced block. This fish was processed simultaneously with a batch of fish defrosted by sea water as indicated in Table 11. Therefore production costs presented are those realized for the two groups of fish. It shows that yields obtained from blast freezer reversal were 2.26% higher than those obtained from sea water defrost.

The remaining product (105,253 lbs) was all defrosted by sea water. Table 12 gives a production and cost breakdown.

Table 11. Fish Defrosted by Blast Freezer Reversal and Sea Water.

| | <u>Blast Freezer Reversal (lbs)</u> | <u>Sea Water (lbs)</u> |
|---|---|----------------------------|
| Cod to Filleting Line | 41,320 | 15,636 |
| Cod Rejected | 5,967 | 2,258 |
| Cod to Production | 35,353 | 13,378 |
| Pack Out: | | |
| 5's | 895 | 300 |
| 10's | 190 | 60 |
| Block | 7,969 | 2,805 |
| Mince | 2,854 | 1,039 |
| Yield based on fish actually processed excluding Mince. | 25.61% | 23.65% |
| Yield based on fish actually processed including Mince. | 33.68% | 31.42% |
| Yield based on fish to fil- leting line excluding Mince. | 21.91% | 20.24% |
| Yield based on fish to fil- leting line including Mince. | 28.82% | 26.89% |
| Production Costs: (For both lots of fish) | | |
| Holding Room | \$ 456.95 | |
| Filleting & Skinning | 1,483.34 | |
| Trimming | 972.00 | |
| Weighing & Packaging | 972.00 | |
| Others | 350.42 | |
| Freezing | 278.55 | |
| Clean-up | 236.80 | |
| TOTAL | <u>\$4,750.06</u> | |

Average Direct Processing Cost/lb = \$4750.06 16,112 lbs = 29.48 cents

Table 12. Defrosted in Sea Water, Processed Nov. 3,4 and 9.

| | <u>(lbs)</u> |
|---|-------------------|
| Cod to Filleting Line | 105,253 |
| Cod Rejected | 29,825 |
| Cod to Production | 75,428 |
| Pack Out: | |
| 5's | 565 |
| 10's | 140 |
| Block | 18,648.5 |
| Mince | 5,923.5 |
| Yield based on fish actually processed excluding Mince. | 25.66% |
| Yield based on fish actually processed including Mince. | 33.51% |
| Yield based on fish to filleting line excluding Mince. | 18.39% |
| Yield based on fish to filleting line including Mince. | 24.02% |
| Production Costs: | |
| Holding Room | \$1,500.35 |
| Filleting & Skinning | 1,843.00 |
| Trimming | 1,159.10 |
| Weighing & Packaging | 1,186.46 |
| Others | 496.22 |
| Freezing | 371.40 |
| Clean-up | 236.80 |
| TOTAL | <u>\$6,793.33</u> |

Average Direct Processing Cost/lb = \$6793.33 ÷ 25,277 lbs = 26.88 cents/lb.

The final phase of the experiment involved the 40,000 lbs of Grade A fish frozen by the Fogo Island Co-Op. An attempt was made to open air defrost some of the fish. However, cold outdoor temperatures increased defrosting time to such a degree that this lot of fish had to be placed in sea water.

Tables 13 and 14 show production and costs for fish defrosted by open air and sea water, and fish defrosted by sea water only. While all fish defrosted by the former method was packed as block, approximately 15% of the fish defrosted by sea water went into 5's and 10's. Production costs were higher than the average for air and water defrosting, due to the extra handling and time required to initiate the two defrost methods. Fish prepared for open air defrosting had to be taken and placed into a circulating seawater bath to obtain complete product defrosting. This extra handling, system preparation and additional time resulted in higher cost.

If one compares fish quality after defrosting, final pack outs and yields for all lots of fish, one will see the Grade A fish (Fogo) defrosted in sea water produced higher quality and yield at lower processing costs. In addition, using this defrost method resulted in less dumping of fish by plant workers.

A summary of quality analysis, production cost and yields for all lots of fish are shown in Table 15.

Table 13. Fogo (Grade A) Fish Defrosted by Air & Sea Water.

| | <u>(lbs)</u> |
|---|--------------|
| Cod to Filleting Line | 10,500 |
| Cod Rejected | 620 |
| Cod to Production | 9,880 |
| Pack Out: | |
| 5's | 0 |
| 10's | 0 |
| Block | 2,937 |
| Mince | 791.5 |
| Yield based on fish actually processed excluding Mince. | 29.72% |
| Yield based on fish actually processed including Mince. | 37.73% |
| Yield based on fish to filleting line excluding Mince. | 27.97% |
| Yield based on fish to filleting line including Mince. | 35.51% |

Production Costs:

| | |
|----------------------|-------------------|
| Holding Room | 310.80 |
| Filleting & Skinning | 285.28 |
| Trimming | 172.80 |
| Weighing & Packaging | 182.14 |
| Others | 136.72 |
| Freezing | 92.85 |
| Clean-up | 59.20 |
| TOTAL | <u>\$1,239.79</u> |

Average Direct Processing Cost/lb = $\$1,239.79 \div 3,728.5 = 33.25$ cents

Table 14. Fogo (Grade A) Fish Defrosted by Sea Water.

| | <u>(lbs)</u> |
|---|-------------------|
| Cod to Filleting Line | 29,500 |
| Cod Rejected | 1,203 |
| Cod to Production | 28,297 |
| Pack Out: | |
| 5's | 510 |
| 10's | 810 |
| Block | 7,590 |
| Mince | 2,178 |
| Yield based on fish actually processed excluding Mince. | 31.48% |
| Yield based on fish actually processed including Mince. | 39.18% |
| Yield based on fish to filleting line excluding Mince. | 30.20% |
| Yield based on fish to filleting line including Mince. | 37.59% |
| Production Costs: | |
| Holding Room | 381.10 |
| Filleting & Skinning | 686.34 |
| Trimming | 401.76 |
| Weighing & Packaging | 446.40 |
| Others | 204.60 |
| Freezing | 92.85 |
| Clean-up | 59.20 |
| TOTAL | <u>\$2,272.25</u> |

Average Direct Processing Cost/lb = $\$2,272.25 \div 110.88 = 20.49$ cents

Table 15. A Comparison of Quality, Pack Outs, Yields and Costs for (4) Four Procedures.

| | Average Grade In % A + B | Average Grade Out % A + B | Rej. on Cutting Line % Dumped | Pack Outs % 5 + 10 | % Block | **Yields % | Costs (cents) |
|---|-----------------------------------|------------------------------------|--|-----------------------|---------|---------------|------------------|
| Beothic Fisheries Blast Freezer Reversal | 75-80 | 4.79 | 14.44 | 11.98 | 88.02 | 33.66 | *** |
| Beothic Fisheries Open Air + Sea Water | 75-80 | * | 39.88 | 10.1 | 89.89 | 35.24 | 25.88 |
| Beothic Fisheries Sea Water | 75-80 | 18.98 | 22.77 | 4.81 | 94.22 | 33.34 | 26.21 |
| Fogo Open Air + Sea Water | 100 | 33.33 | 5.90 | 0 | 100 | 37.73 | 33.25 |
| Fogo Sea Water | 100 | 46.87 | 4.08 | 14.8 | 85.2 | 39.18 | 20.49 |

* This lot of fish was not sampled after defrosting.

** Includes Minced Block and reflects yields from fish that was actually processed.

*** This lot of fish was processed simultaneously with fish defrosted by sea water.

When viewing processing costs, the reader should bear in mind that the costs presented in the text are representative only of those incurred by the two processing companies involved in the procedures described. Other fish plant operators may or may not be able to realize similar costs. When evaluating the viability of similar undertakings, each reader should apply the costs that they feel would be appropriate in their own particular operation.

Attempts to identify normal production costs, ie. costs incurred during average day-to-day production from several inshore plants indicated that there is no set cost that can be applied to either block or prime pack production. Day-to-day costs vary and are influenced by numerous factors including the average size and quality of raw material, availability of fish and product mix.

OBSERVATIONS

Several observations were made by project staff throughout these projects and if used by the processing sector should help make freezing, defrosting and processing operations less costly.

1. A commitment to freeze raw material should be followed by a subsequent commitment to freeze only top quality fish.
2. Fish should be separated according to size with equal size groups or ranges being packaged separately. Fish of varying sizes, frozen together and then defrosted, pose a number of problems in the defrost. Smaller fish defrost faster than large fish and are therefore susceptible to increased deterioration if left in water while awaiting for the full batch of fish to defrost. In addition, with large and small fish together defrosting and processing schedules are difficult to determine.
3. Circulating sea water should be applied to fish filled containers from the bottom to permit complete circulation around the fish.
4. Blocks of frozen fish immersed in circulating sea water should be arranged in such a manner as to provide maximum exposure of the block surface to the water.
5. When blocks become partially thawed or to a point where individual of groups of fish can be separated from the block, these separations should be undertaken.

6. Ideally fish should be cut immediately after defrosting is completed, holding fish on ice or in holding rooms compounds texture breakdown.
7. That freezer guard be used to prevent drip loss and packed weight losses from defrosted fish products.

CONCLUSIONS

Trap Cod

The trap caught cod fish were very susceptible to quality deterioration when frozen, held in cold storage and then defrosted. This deterioration was more pronounced in smaller sized fish. In this experiment, trap cod were separated into two size categories, 16-20" and 20" and over, blast frozen and cold stored for a 4 month period. Quality comparisons using dockside grading criteria showed that both sized lots were significantly downgraded following defrosting. Fish 16-20" went from 35.05 to 0.00% A, 45.98 to 10.21% B, 18.40 to 57.15% C and 0.57 reject to 32.65% reject. Fish in the 20" and over size range went from 30.61 to 0.00% A, 45.92 to 25.00% B, 23.47 to 71.43% C and 0.00 to 3.57% reject, which shows less deterioration in the larger size fish.

Final pack outs produced no prime packs as processed fish for both size groups were not up to prime pack standards. The main reason for this was poor texture in fish fillets. Yields obtained from frozen and defrosted trap cod amounted to 30.61% which included minced block production. Minced

block amounted to 14.09% of the total product produced.

Production costs which include defrosting, processing, packaging & freezing amounted to 38.22 cents/lb including minced product or 44.99 cents/lb excluding mince. Total cost of preparing, freezing, storing, processing, packing and freezing amounted to 47.22 cents/lb. Again this cost includes mined block.

Though the quality of defrosted fish was much lower than that of the initial material and final pack outs did not produce any prime, higher priced packs, it can be argued that during the "glut" much trap cod is put into block even when it is processed without freezing. The increased costs for freezing, storing, defrosting and reduced yields may be offset by the increased employment and extended operating season generated by this type of operation.

Project efforts to identify the practicability of producing light salted, dried cod from frozen trap cod were more successful. The quality of fish produced 4.25%, 49.85%, 34.11% Choice, Amaron and Amaron respectively with lesser amounts going to West India, Tom Cods and Bonacara. This indicated that good quality light salted dried fish can be produced from frozen stored trap cod. Though production yields amounted to 35.69% or 4.11% less than average normal yields realized by the company, final product quality was, in the opinion of the company, quite acceptable.

Two of the most important factors affecting the quality of processed fish following defrosting was the initial quality of the raw material and the method of defrosting used. Defrosting procedures evaluated over the course

of these experiments indicated that defrosting fish in circulating sea water to be the better method of defrosting given the equipment available and environmental conditions existing during project operations.

Groundfish

Comparisons made based on initial quality of raw material showed that 100% Grade A fish (dockside graded) produced significantly better grades than fish of lesser grade (75-80% Grade A using company grading standards) after defrosting. Approximately 14.06% Grade A was realized from the 100% A graded fish while no Grade A was realized from the fish graded as 75-80% A by company standards. Significant difference in both Grades B, C and R also favoured the better quality dockside graded material as borne out in Tables 9 and 10 of the text.

Fish defrosted by blast freezer reversal (warm air) were of significantly lower quality when compared to fish defrosted in sea water. Though freezing and defrosting fish results in a general deterioration of the material, quality analysis comparisons made between lots of fish of the same origin showed that fish defrosted in circulating sea water to be of better quality when compared to blast freezer reversal defrost. A comparison of the two methods revealed that 18.98% vs. 4.79% Grade B and 45.98% vs. 54.79% Grade C in favour of seawater defrost. In addition 35.04% vs. 40.72% of all fish was reject grade, again favouring seawater defrost.

Production costs and yields also favor the preparation of high quality raw material for freezing and later processing. The Grade A fish (dockside graded) produced an average yield of 39.18% (including mince) at less cost than did material of lesser quality. In addition a higher percentage of this good quality fish went into prime packs. Similar results were recorded when defrost procedures other than seawater defrost were used.

One important piece of information that must be included in this evaluation, which is indicated in Table 15, is the amount of fish rejected on the cutting lines. Of the 162,386 lbs of groundfish (cod) frozen by Beothic Fisheries Ltd., approximately 38,050 lbs or 23% was unfit for processing. Of the 40,000 of Grade A material prepared, 1,823 lbs or 5% was rejected in plant. These losses when reflected back increase overall costs and reduce yield dramatically. However, these losses may be reduced if processing operations were specifically geared to preparing, freezing and defrosting operations.

Much of the work during these projects was undertaken on a trial and error basis. When mistakes were made, limited amounts of raw material did not permit trials and testing of more correct procedures. Delays in defrosting or incorrect projections of defrosting times often resulted in higher costs as plant workers were often kept on shift for short periods waiting for fish. Due to the commercial nature of the projects, fairly large amounts of fish were subject to the various defrost methods.

When the methods, blast freezer reversal for example, proved impractical much time and cost were needed to get the project back on track.

In the final analysis, quantities of good quality fish were processed with reasonable yields and at reasonable costs. This indicates that it is both practical and technically feasible to freeze fish during the summer glut and process it in the offseason.

As stated in Page 34, there are certain controls that should be followed when defrosting frozen fish. These may not be totally possible under commercial conditions. However, as fish plant operators gain experience in defrosting, more predictable flow rates, improved quality, higher yields and lowered production costs should be achieved.

RECOMMENDATIONS

1. That fish other than trap cod be frozen and stored for later processing. The small size and nature of trap fish makes it less suited to frozen storage because of quality deterioration in defrosted fish.
2. That fish should be prepared in head-off form to allow more efficient use of freezer space and reduce associated costs.
3. That processors contemplating similar freezing and defrost operations conduct small-scale experiments to determine the limits of their freezing and defrost capability and be better able to identify defrost schedules and costs.

4. That this type of production be undertaken with scaled down processing operations to allow greater flexibility in, and control over operations in general.
5. That an indepth investigation be undertaken to locate or develop more effective and efficient fish defrosting techniques.
6. That a monitoring program to evaluate defrosting techniques and associated production results obtained by Newfoundland inshore fishing plants operating under the Resource Short Plant Program be undertaken. Plants under the program have been receiving frozen groundfish from offshore trawlers for processing. Defrosting and processing procedures used by participating plants could possibly identify improved procedures and methods for handling, defrosting and processing frozen fish.
7. That further effort be undertaken to determine the feasibility of freezing groundfish species such as turbot and flounder during the summer fishery for later processing.