Silver Hake—A Prospectus

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ABSTRACT—The silver hake (whiting) resource off the U.S. east coast is currently being underharvested. Limited markets for traditional product forms and lack of adequate processing technology to produce new product forms have curtailed full utilization of the resource. This paper describes recent trials using commercially available equipment and discusses the economic feasibility of processing small whiting into fish blocks.

Introduction

Silver hake, *Merluccius bilinearis*, is commonly referred to as "whiting" along the eastern seaboard of the United States. Geographically it ranges from North Carolina to Newfoundland. Whiting prefer somewhat warmer water than other gadoid species and can be found over a variety of bottom types, except rocky bottoms, from the tide line to 400 fathoms. Whiting seldom grow larger than 60 cm with an average length of approximately 35 cm (Bigelow and Schroeder, 1953).

Historically whiting have played an important role in the commercial fisheries of the Atlantic coast. Landings peaked during the late 1950's at about 60,000 t (Fig. 1) (Fritz, 1963). Since then, however, landings have declined steadily averaging approximately 19,500 t during the last 5-year period (1974-78). The New England catch represents over 70 percent of the total U.S. landings.

During the period 1962-76, the Atlantic whiting resource was harvested intensely by several foreign nations (Combs, 1977). In 1965, the U.S.S.R. harvested nearly 300,000 t from the Georges Bank area. From 1966 to 1976, foreign landings averaged approximately 100,000 t annually. After implementation of the Fishery Conservation and Management Act (FCMA) in 1977, foreign fleets were allocated quotas to harvest whiting on the basis that stocks were in reasonably good shape and U.S. capacity was less than estimated optimum yield. Foreign allocations for 1977, 1978, and 1979 were 73,720 t, 50,400 t, and 52,200 t, respectively.[1]

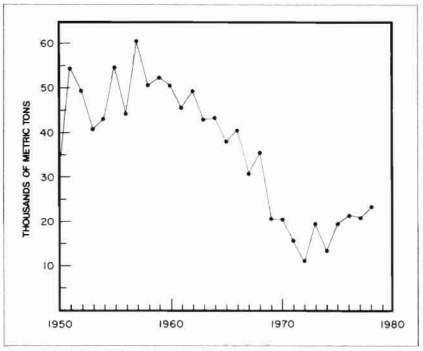

Figure 1.—Annual Atlantic coast silver hake landings, 1950-78.

Whiting has been an important food fish since the 1920's with principal markets in the Midwest and South (Fritz, 1962). It was processed into a variety of market forms, headed and gutted or dressed (H&G); "butterfly" fillets; and the larger fish ("king" whiting) sold in regular fillet form. Large quantities were also used for industrial products such as fish meal and other types of animal food (O'Brien, 1962).

Since the early 1960's, consumer demand has declined, particularly for butterfly fillets. The majority of the fish landed today are processed into H&G packs. Processors begin packing H&G whiting about May of each year and continue until October or November. Most of the production for a particular year is sold by the beginning of the Lenten Season the following year. Recently, however, the domestically produced product has been competing with lower priced imported packs and some local processors have experienced difficulty in reducing inventories.

Secondary processors (producers of fish sticks and portions) experienced a record-setting year in 1978 for portion production (U.S. Department of Commerce, 1979). Imports of frozen fish blocks also established a new record, with cod, pollock, and haddock being the principal species used for the production of sticks and portions. Worldwide shortages of these three species have caused processors to look for alternative species. Whiting imports seem to have increased rapidly from practically nothing in 1974 to almost 18,200 t in 1978 (Table 1). Whiting blocks appear to be established firmly in the U.S. market.

[1]Total Allowable Level of Foreign Fishing (TALFF), New England Regional Fishery Management Council.

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Considering the apparent strength of the whiting resource and the apparent acceptance of whiting in the marketplace, the New England Fisheries Development Program (NEFDP) set out to determine what impediments exist before total utilization of the resource could be realized by U.S. fishermen.

In 1977, the NEFDP Task Force contracted with Earl R. Combs, Inc.[2] (ERC, Inc) Economic Consultants, to analyze the whiting fishery and recommend a course of action that could lead toward complete utilization of the resource by U.S. industry. In their analysis, ERC, Inc., suggested that the fresh whiting market was limited and the markets for H&G product were close to being saturated at the current production levels. The only real prospect for a significant expansion of the fishery was in the area of fillet block production. However, mechanized processing facilities capable of processing large quantities of small fish would be essential.[3]

ERC, Inc., arranged to process a small quantity (90 kg) of whiting using commercially available machines which were on display at Fish Expo in Seattle, Wash., in October 1977. These machines, manufactured by the ARENCO Corporation, Gotenburg, Sweden, were designed to process small cod, haddock, pollock, and European whiting 25-40 cm in length. The results indicated that mechanical processing was technically possible but more extensive commercial-scale trials would be needed to demonstrate the practical application and economic feasibility of such a venture.

Scope of the Project

The ARENCO Corporation offered to make available on loan to the NEFDP one SFA-4 filleting skinning machine (Fig. 2) and one CIV heading machine (Fig. 3) for use by the NEFDP for a period of time necessary to evaluate the effectiveness of these machines for processing whiting.

It was agreed that a demonstration would be more meaningful if the machinery was located in a processing plant and operated by plant personnel. Arrangements were made with a Gloucester processor to install the machinery and provide labor to process an amount of round whiting necessary to produce 2,275 kg of fillet blocks.

The machines were tested for performance on firm as well as soft fleshed fish to determine differences in yield. It was also necessary to determine the capability of the SFA-4 to deep skin or defat whiting fillets (Fig. 4) to see what effect this has on shelf life of the finished blocks in frozen storage. Studies were also initiated to test the effectiveness of different packaging techniques and chemical additives on shelf life. Samples were examined at each stage of processing for bacterial buildup. Complete records for each day's run were kept for an economic evaluation. The overall quality of the blocks was determined by standard lot inspection procedures in accordance with U.S. Department of Commerce (USDC) standards throughout the production period. Finished blocks were to be distributed to major secondary processors for evaluation.

Results

Approximately 14,000 kg of round whiting were processed during an 11-day period. The inplant activities were supervised by a consultant experienced in block making and production

Table 1.—Imports of fish blocks of selected species.

Year	Imports (1,000 t) Cod	Pollock	Haddock	Whiting
1975	73.0	34	16.6	3.9
1976	81.9	43.2	12.9	9.4
1977	93.1	37.7	14.0	10.2
1978	93.0	36.9	12.3	18.2

Source: NMFS statistics.

Table 2.—Cost estimates for producing whiting fillet blocks.

Item	Cost est.
Machine cost	
One processing line including:	Total cost (C.I.F. processing plant
(1) ARENCO elevator and washer de-icer to feed CIV header	$ 7,224
(1) ARENCO CIV header (125 fish/min)	18,984
(2) ARENCO SFA-4 filleting and skinning (@ $38,640 ea.)	77,280
(1) ARENCO Flexodul conveyor system	14,400
Standard "rubber-band" conveyor	1,500
Candling tables and conveyors	3,000
Subtotal	$122,388
Amortization @ 10 years	12,239/year
Maintenance @ 20% of machine capital costs per year	24,477
Total yearly cost of one line	$ 36,716
Production cost	
Assuming 1,000 hours/year operation, machine costs = $36.75/hr	
Assuming an actual processing rate of 100 fish/minute, a 50-minute working hour, and 2 fish per pound, then 2,500 lb of round fish per hour will be processed. At an average yield of 27 percent, 675 lb per hour of fillets will be produced	
Total machine cost per pound of fillets	$0.054
Labor cost	
CIV	2 operators
SFA-4	2 operators
Fillet inspection	2 operators
Trimming	2 operators
Block packing	2 operators
Floor labor	1 operator
Total	11 operators
Average rate including benefits is $6.50/hour/person times 11 people equals $71.50/hour	
Labor cost per pound of fillets	$0.106
Raw material cost	
At 27 percent yield, 3.7 pounds of round fish will be required to produce one pound of fillets. At an ex-vessel price of $0.10 the raw material cost is $0.37/lb	
However, for each pound of fillets produced, 73 percent or 2.71 lb is waste. Assuming $.015/lb waste value then $0.04/lb can be deducted from the raw material cost for each pound of fillets produced	
Adjusted raw material cost	$0.33/lb
Total: machine, labor, and raw material cost	$0.490/lb
Total: transportation, packaging, and freezing cost	$0.080/lb
Total cost to produce blocks	$0.570/lb

Source: ERC, Inc.

[2]Reference to trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

[3]Earl, P.M. 1978. Preliminary results of testing commercially available equipment for processing small whiting (*Merluccius bilinearis*). Unpubl. manuscr., 6 p. Fisheries Development Services Branch, National Marine Fisheries Service, NOAA, P.O. Box 1109, Gloucester, MA 01930.

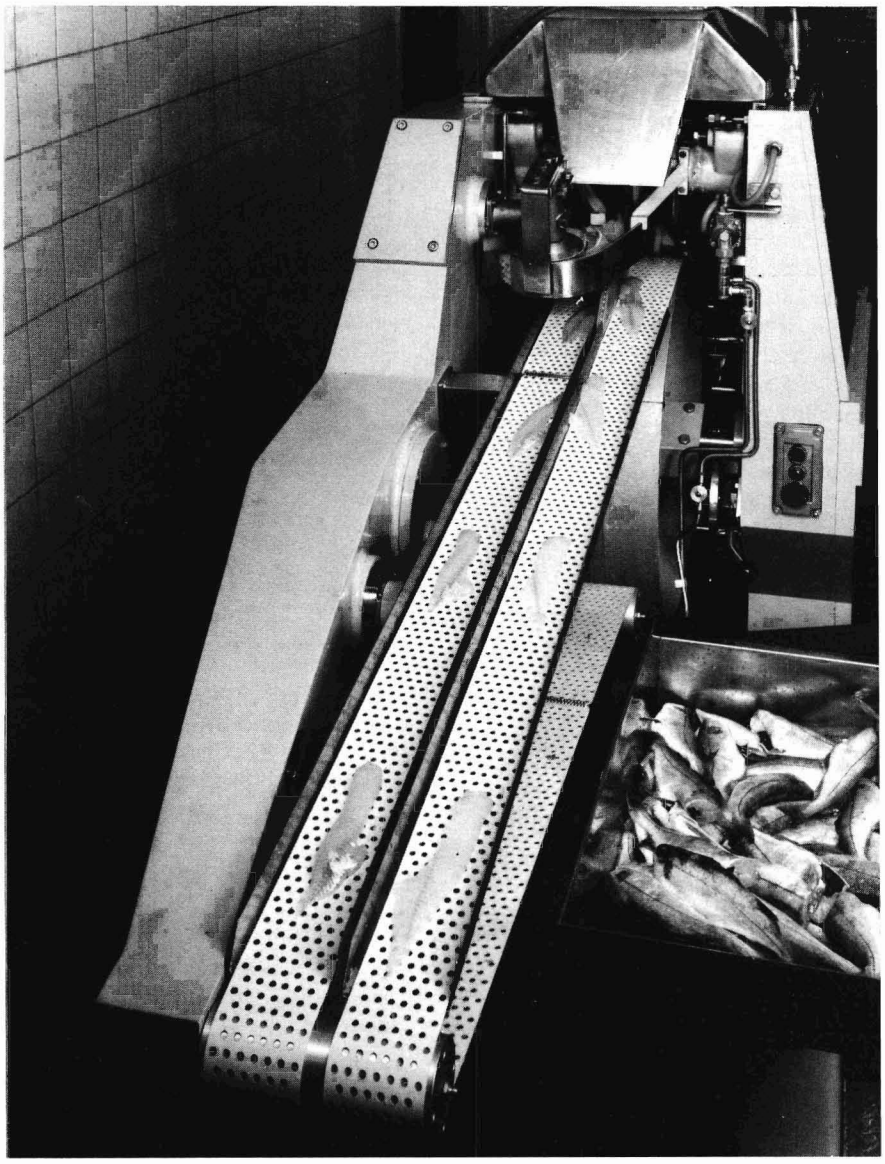
techniques. The labor force varied from four to eight people depending on the quantity of fish available for each day's production. One to two workers were required to sort and weigh fish and supply the CIV heading machine. One person operated the CIV machine and one person fed the SFA-4 filleting and skinning machine. Two to three people were required for inspection and trimming fillets and one person for block making.

Fish for each day's production came from the following sources: 1) Penned fish[4] bulk held in chilled seawater (CSW) before processing, 2) boxed fish from day boats, and 3) penned fish iced onboard, then boxed.

Most of the fish used during the trials were boxed fish less than 1 day old, landed in the afternoon and held, refrigerated, overnight, and processed the next day. For comparison purposes, day boat fish held in CSW after landing and 3-day penned fish were also processed.

[4]Penned fish refers to iced fish stored in pens in the hold of fishing vessels.

Figure 2.—The ARENCO SFA-4 filleting and skinning machine for processing small groundfish species. The machine employs an electronic computer to adjust the cuts for different fish sizes.



The fish were received in the processing area and the internal flesh temperature taken. The fish were then sorted by size and those under 25 cm and over 40 cm were rejected. Fish 25-40 cm long were weighed prior to feeding to the heading machine. Weight of heads was recorded and headed fish were conveyed to the SFA-4 for filleting and skinning. Napes were also weighed.

The CIV heading unit worked flawlessly on fish of the proper size. Problems were encountered, however, when fish larger than 45 cm or fish improperly oriented were run through the machine.

Some experience was necessary for feeding fish to the SFA-4. If fish were fed too rapidly or oriented improperly, jamming of the machine resulted. Soft fish also caused the machine to jam. Generally, if the fish were firm and the size differential between successive fish not too great, the machine performed well and down time was minimal. The amount of hand trimming necessary to remove bones or pieces of skin was also dependent on the condition of the fish. Softer fish required more hand trimming than firmer fish.

To demonstrate the importance of fish condition on yield, boxed fish were taken directly from the vessel and transferred to a CSW container at the plant. They were held in CSW overnight and processed the next day. The percentage yield of these fish was among the highest for any day's production. Heavily iced fish also produced high yields. It was evident throughout the trials that as the internal temperature of the fish increased, the yield decreased.

The skinning adjustment was very reliable and deep skinned fillets could be produced consistently without frequent readjustment. The average yield for deep skinned fillets throughout the production period was approximately 21 percent. Heads were 28 percent; napes 20 percent; skin, bones, and viscera (including roe and milt) 31 percent

of the round weight. Blocks were packed using 18 pounds 14 ounces of fillets in each carton.[5]

All lots of fish inspected by USDC inspectors were of Grade A or high Grade B quality. Flavor and odor were Grade A throughout. All significant defects in the blocks could be attributed to handling problems caused by insufficient floor space and makeshift arrangements. They were not related to inadequacies of the machinery. Most grading defects stemmed from improper fill or underweights. Point deductions for extraneous material such as fins, scales, etc., would have been reduced had the line been set up properly.

Although there are no established bacterial standards for total plate count and fecal coliforms of frozen fish blocks, the blocks produced were within limits currently acceptable by the "trade." There was no bacterial buildup on the fillets or blocks throughout the day's production. Fecal coliforms and *Escherichia coli* were absent.

Of the questionnaires distributed to secondary processors by the NMFS Marketing Staff, 78 percent were returned and most were quite positive. All but one firm indicated that the overall quality was excellent and they would purchase domestically produced whiting blocks if they became available. The most common criticism concerned the small size of the fillets.

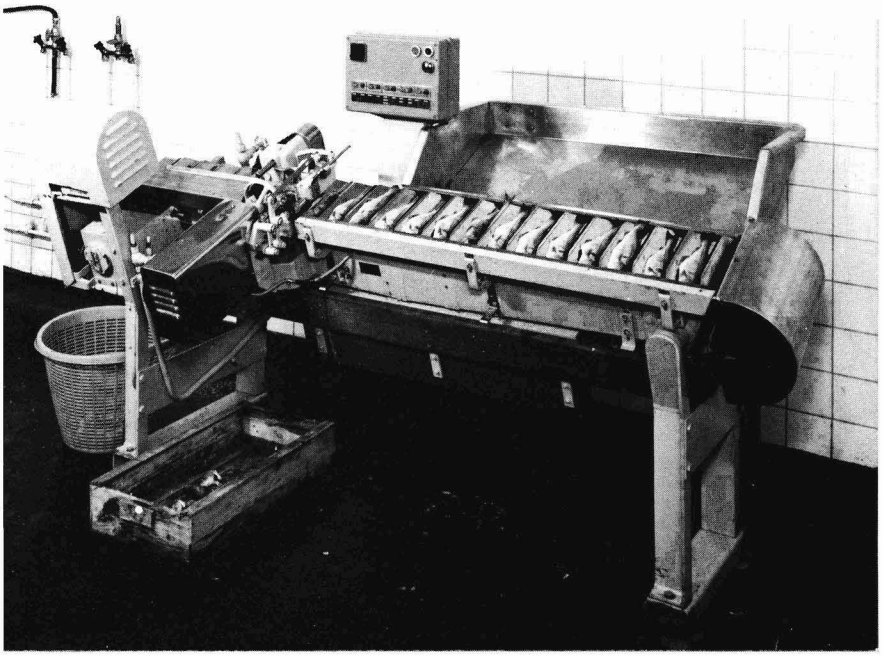


Figure 3.—The ARENCO CIV heading machine. The suit automatically adjusts for different sizes of fish for maximum yield.

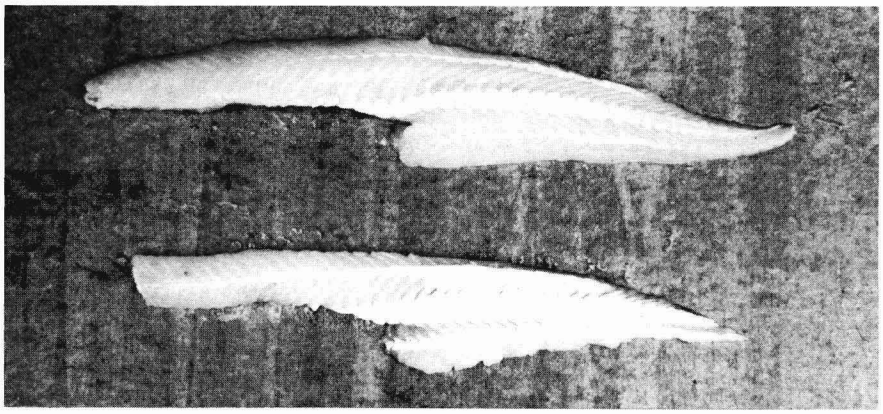


Figure 4.—Deep skinned ("defatted") fillets (above) or "regular" fillets (below) could be produced with a simple adjustment on the SFA-4 filleting and skinning machine.

Discussion

Quality of the raw material (whole fish) was the most important in the overall results during the trial of the ARENCO CIV and SFA-4 machinery. Good quality fish resulted in less jamming of the machinery, and provided the highest yield.

The machinery performed well throughout the production run and maintenance was minimal. Frequent adjustments were not necessary when size limits for the fish were adhered to. The SFA-4 produced smooth fillets without ragged edges or tearing. Cleaning of the machinery was easily accomplished. The only shortcoming of the equipment was the yield of the end product.

Close examination of the skeletal structure revealed that whiting has fewer pinbones than a cod or haddock. Consequently, more of the nape was being removed than was necessary.

[5]This amount may have been somewhat generous, depending on the time the fillets were allowed to drain before packing. Although more trials would be necessary, it appears that 18 pounds 12 ounces of fillets could still yield a consistent net weight of 18.5 pounds after freezing, if the blocks were made immediately after inspection and trimming.

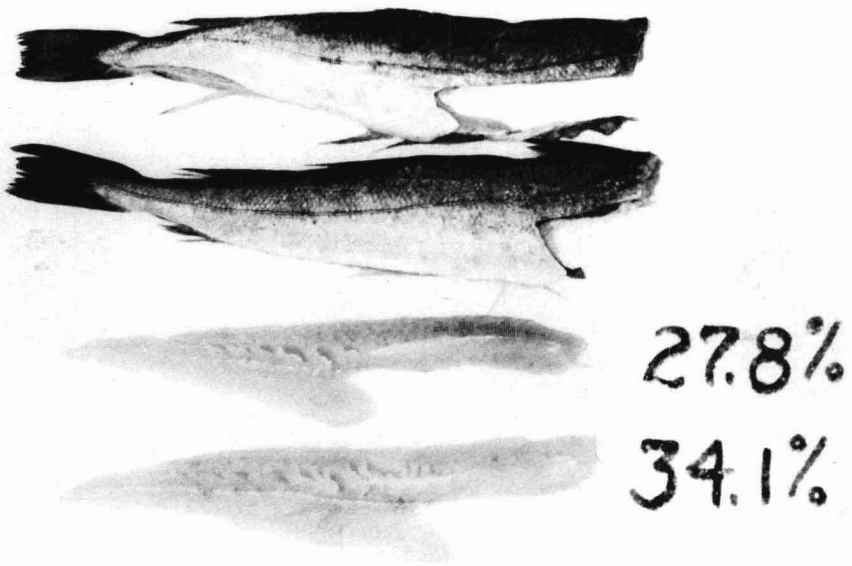


Figure 5.—Before the SFA-4 filleting and skinning machine was modified, more of the nape was being taken away than was necessary to remove the pinbones (upper fish frame and resulting fillet, 27.8 percent yield). After modification the yield was improved, in this instance, to 34.1 percent.

Table 3.—Cost estimates for producing H&G whiting.

Item	Cost est.
Machine cost	
(1) two sided heading unit	$20,000
(1) rotary washer-scaler	10,000
(1) packing-inspection table	8,000
Misc. conveyors, flumes, etc.	6,000
Subtotal	$44,000
Amortization @ 10 years	4,400/year
Maintenance @ 20% machine capital costs per year	8,800/year
Total yearly cost of one line	$13,200/year
Production cost	
Assuming 1,000 hours/year operation, machine costs = $13.20/hour	
Assuming a processing rate of 12,000 lb per hour, a 50 minute working hour and a yield of 50 percent, then 5,000 lb per hour of H&G whiting will be produced.	
Total machine cost per pound	$0.003
Labor cost	
Heading unit	12 operators
Packing table	12 operators
Weighing	2 operators
Floor labor	6 operators
Total	32 operators
Average rate including benefits is $6.50/hour/person times 32 people equals $208.00/hour	
Labor cost per pound of H&G	$0.042
Raw material cost	
At 50 percent yield, 2.0 pounds of round fish is required to produce 1 pound of finished product. At an ex-vessel price of $0.10/pound the raw material price is $0.20/lb	
For each pound of H&G produced, 50 percent or 1.0 pound is waste. Assuming $0.015 waste value then $0.15/lb can be deducted from the raw material cost for each pound of H&G produced	
Adjusted raw material cost	$0.185/lb
Total: machine, labor, and raw material cost	0.227/lb
Total: transportation, packaging, and freezing cost	0.080/lb
Total cost to produce H&G	$0.307/lb

[1]Based on personal communication with processors.

After the production trials the machinery was moved to the NMFS Gloucester Technology Laboratory where ARENCO engineers redesigned the nape cutting arrangement. These redesigned parts were fabricated in Sweden, returned to Gloucester, and installed. A few hundred pounds of fish were processed and the results suggest that the yield was increased significantly. Before modification, a yield of 27-28 percent was achieved during a short run. This yield figure dropped to 20-21 percent during the production trials. After modification, the yield increased to 33-34 percent during a short run (Fig. 5). Although the SFA-4 was not tested in a production situation after modification, it is assumed that an increase of 6-7 percent could be achieved if another production trial was made.

Economics

The trials described in this paper do not represent an accurate portrayal of an ideal processing operation. Lack of floor space, unfamiliarity with the equipment, and an inexperienced labor force contributed to inefficiences that were not overcome in the short period of time the equipment was available.

To demonstrate the importance of experienced labor, it was noted that direct labor costs were reduced 65 percent in a period of 7 working days. Much insight was also gained as to how a fillet block line should function to assure maximum efficiency for fish block production.

The cost analyses in Tables 2 and 3 are representative, in part, of a hypothetical processing situation for producing fillet blocks and H&G whiting. An accurate comparison would be difficult to make because of variations in plant design and equipment used. Most H&G equipment is "custom" built and tailored to an individual facility.

Plant operating costs such as indirect labor, maintenance and depreciation, taxes, etc., are not included and assumed to be the same whether blocks, H&G, or both are being produced. No adjustment has been made for variation in raw material cost. These so called "shrinkage" factors are somewhat artificial and often reflect inadequacies in processing capacity and/or excessive inventory buildup and are not always indicative of the condition of the catch. Furthermore, it is anticipated that a steady demand for fillet blocks will have a stabilizing effect on ex-vessel

Table 4.—Wholesale price comparisons (cents per pound) of imported and domestic whiting products—1978-1979.[1]

Date	Blocks		Five pound H&G	
	Regular	Defatted	Domestic	Imported
1978				
Jan.	60	78-82	—	—
Feb.	60	78-82	—	—
Mar	57-60	80	—	—
Apr.	57-60	80	—	—
May	58-60	80-81	45	47-49
June	60	81	45	47-49
July	60	80-81	48-50	48-49
Aug.	60	8-81	43	—
Sept.	60	80	42-43	—
Oct.	60-62	80	—	—
Nov.	60-62	80	—	—
Dec.	60-62	80	—	39-45
1979				
Jan.	59-62	80	—	41
Feb.	62	80-81	41-43	43
Mar	64-65	82	40	30-35
Apr.	65	82-85	40-43	20-25

[1]Hall, R. L. 1979. Current whiting situation. Unpubl. rep., 3 p. Market News Branch, National Marine Fisheries Service, NOAA, Gloucester, Mass.

price, and presumably markets for raw material could be available throughout the entire year.

Table 4 suggests that during May-July 1978 demand for H&G drove the price to the $0.45-0.50 level. As landings and production increased the price turned downward and continued to slide as markets became saturated and lower priced imports came onto the market. Production ended about November. It is likely that market conditions and not availability of the resource limited production.

The 1978 H&G pack was almost 10,000,000 pounds valued at $4,400,000.[6] This amounts to an average wholesale price of $0.44 per pound or a gross profit margin of approximately $0.133 per pound.

As mentioned earlier, the market for fillet blocks appears strong with prices moving steadily upward (Table 4). The latest quoted "wholesale" price for defatted blocks was $0.85/pound. Taking an average price of $0.81/pound, a processor would gross a $0.24 per pound profit.

Although a higher initial investment would be required to set up a fillet block operation, gross profit appears higher and returns on investment would be forthcoming over 10-12 months production, not 5-7 months as is the case for H&G.

Conclusion

Considering a resource that can be harvested more intensively, a fishing fleet that is rapidly being modernized with the capability to harvest this resource, a growing demand for high quality fish blocks, and now what appears to be adequate technology to process this resource, the silver hake fishery could expand to its full potential. Still untried and untested, however, are the economics surrounding a sustained fillet block operation.

Through the NEFDP, funds have been committed to support additional studies to determine the viability of a domestic silver hake fillet block operation. Commercial production will take place over the period of 1 year and a minimum of 45,000 kg of blocks will be produced. These blocks will be sold to secondary processors for conversion into sticks and portions. Records will be kept to determine if these domestically produced blocks can compete economically with imports.

[6]Preliminary data, NMFS Statistics Branch.

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