



Economics of the Dungeness Crab Industry

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COVER: *A Dungeness crab fishing boat unloads a catch at an Oregon port.*

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Economics of the Dungeness Crab Industry

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SUMMARY

The Dungeness crab is handled by several market intermediaries in its movement from the ocean floor to the ultimate consumer. The marketing process is begun by fishermen who catch the crabs and sell them to processors or marketers of fresh crabs. The processed products are sold through brokers or directly to fish wholesalers or large retailers. Although about one fifth of Oregon's Dungeness crab products are sold directly by processors to chain stores, the most prevalent marketing method continues to be the broker-wholesalers channel.

Data for the study were gathered by a survey of Oregon's Dungeness crab fishermen and representatives of the commercial crab processing industry. Those fishermen who responded to the survey caught about two thirds of the state's total Dungeness crab production during the 1965-66 season. Most of these fishermen realized larger gross incomes and higher net profits from crab fishing during that season than they had during the previous year. In addition, 70% of the respondents indicated that they prefer good fishing and poor prices over poor fishing and good prices. Thus, it appears that larger supplies of Dungeness crab and relatively lower prices favorably affect fishermen's incomes.

When fishermen were asked to list the major problems facing the Dungeness crab industry, one third listed advertising and marketing problems, one fourth mentioned competition from king crab, and the rest listed problems with the legal season, fluctuations in

production, and miscellaneous other problems. Processors were asked the same question, and they felt that the following (in order of importance) were the major problems facing the industry: advertising and marketing, production fluctuations, competition from king crab products, and quality control in processing.

Almost 90% of the fishermen in the survey stated that the opening date of the Dungeness crab ocean season influenced the time that they started crab fishing. On the other hand, most respondents listed physical characteristics of the crab (molting) and the desire to begin fishing for salmon as the main reasons they cease crab fishing.

About 45% of the fishermen expressed a willingness to contribute one-half cent per pound to a Dungeness crab commission, while 26% were undecided. About 82% of the Oregon processors interviewed also expressed a willingness to contribute to such a commission.

Processors receive most of the Dungeness crab caught by fishermen. They are processed and sold as fresh shell crab, or as frozen, fresh frozen, or canned crab meat. Over three fourths of Oregon's annual Dungeness crab harvest is exported to surrounding states, with two thirds of total production sold in California markets. Virtually all Dungeness crab products are transported to market in refrigerated trucks.

There have been few significant technological innovations or investments in Dungeness crab processing

facilities during the last 20 years. In some cases, antiquated machinery and processing methods have adversely affected the quality of the final product. At present, research is being conducted in irradiation and pasteurization of Dungeness crab meat in an attempt to extend the storage life of this product.

Both individual firm capacity and market share vary among Oregon processors. During the 1965-66 marketing season, capacity ranged from 10,000 pounds to 50,000 pounds of green crab per day, while actual processing volume varied from 75,000 pounds to 2,000,000 pounds for the entire season. Oregon's largest firm processed about 20% of the state's production that year, but it handled less than 5% of estimated total United States production. While the eleven Oregon firms interviewed processed over 70% of the state's 1965-66 production, together they handled less than one sixth of total United States production.

The Oregon firms interviewed handled other fish products besides crab. All firms handled salmon, 70% processed bottom fish, 50% marketed shrimp, 40% canned tuna, and 10% sold clams. Little complementarity of equipment exists between Dungeness crab and the other species in the product mix. Thus, each firm must have special equipment, such as crab cookers and brine tanks, to process and market crab. Washington and California firms follow essentially the same processing and marketing procedures for Dungeness crab as do Oregon firms.

No apparent price premiums are received by any processor for his Dungeness crab products, although each firm sells crab meat under its own brand names. Very little advertising or product promotion is conducted by proc-

essors for their Dungeness crab products. The absolute marketing margins realized by processors tend to be fairly constant, however. Hence, significant fluctuations in wholesale and retail prices exert a proportional influence on prices received by fishermen for the green crab they supply to processors.

The Newport Dungeness Crab Association, a nonprofit corporation, was formed in January 1966 for the express purpose of advertising and promoting Dungeness crab products. Fishermen contributed one cent per pound of catch to finance the activities of this organization. Its advertising efforts apparently have beneficially influenced Dungeness crab prices, and the organization plans to expand its activities during future seasons.

Prices received by fishermen for Dungeness crab have generally been higher and have fluctuated more widely than king crab prices. Dungeness crab prices show a definite seasonal trend. Prices start out relatively low at the beginning of the legal season and rise throughout the season, reaching a peak in August. However, cyclical fluctuations in price have had a far greater impact upon fishermen's revenues than have seasonal fluctuations. Prices have varied inversely to the quasi-cyclical movement in total catch or supply of Dungeness crab during the last decade. Dungeness crab supply and average prices paid fishermen for Alaska king crab explained most of the statistical variations in Oregon Dungeness crab prices from 1956 through 1965.

Major differences exist between the processing and marketing of Dungeness crab and king crab. The king crab industry is comprised of a few large firms and several small firms, with the largest processing firm handling about one half of total king crab production.

King crab processing is more mechanized, and about three fourths of its products are shipped to market by rail. Whereas Dungeness crab is sold mainly on the west coast, king crab is sold throughout the United States and in Europe. A large amount of advertising is conducted by king crab processors and by the Alaska King Crab Marketing and Quality Control Board.

Alaska king crab production has risen dramatically during the last ten years. However, prices received by king crab fishermen have remained fairly constant during the same time period. A king crab fishermen's bargaining association and large industry advertising expenditures may be responsible for this situation.

INTRODUCTION

The Dungeness crab industry represents a small but significant portion of the economies of Oregon and other Pacific coast states. While the value of the Dungeness crab catch constitutes only about 10% of the total value of all fish caught by Oregon fishermen, it is an important part of the total income of many of the state's fishermen, processors, and fish wholesalers. The total Oregon catch during the 1965-66 ocean season was 6.24 million pounds, worth approximately \$1.13 million to fishermen. At average 1965 wholesale prices of \$1.20 per pound for crab meat and 35 cents per pound for shell crab, Oregon processors added \$680,000 to the value of the catch. Thus, the total wholesale value of the state's catch in 1965 was about \$1.81 million.¹

Oregon Dungeness crab is also important when viewed as an export commodity. During the 1965-66 season, for example, about two thirds of the state's total production was sold in California markets. Shipments of this product to

other states resulted in additions of over one million dollars to Oregon's economy in 1965.

In recent years a combination of conditions has posed a serious threat to the stability and growth of the Pacific coast Dungeness crab industry. One disturbing factor has been the quasi-cyclical nature of domestic Dungeness crab production (Figure 1). Over the past decade, Oregon's production has varied from a high of 11.8 million pounds in 1957 to a low of 3.1 million pounds in 1964. Total production in three Pacific coast states (California, Oregon, and Washington) followed a similar pattern, varying from a low of 8.6 million pounds in 1964 to a high of 41.8 million pounds in 1957. Alaska's relatively young and undeveloped Dungeness crab fishery showed substantial production increases during the 1956-65 period.² That these marked fluctuations in total supply have had an important impact on Dungeness crab prices will become evident in subsequent discussion.

¹Data on Oregon catch and fishermen prices were obtained from C. Dale Snow, Director of Shellfish Investigations, Oregon Fish Commission, Newport, Oregon. Wholesale prices for 1965 were taken from interviews with processors.

²Oregon accounted for an average of 31% of the three contiguous states' production and 23% of total U. S. Dungeness crab production during the 1956-65 period.

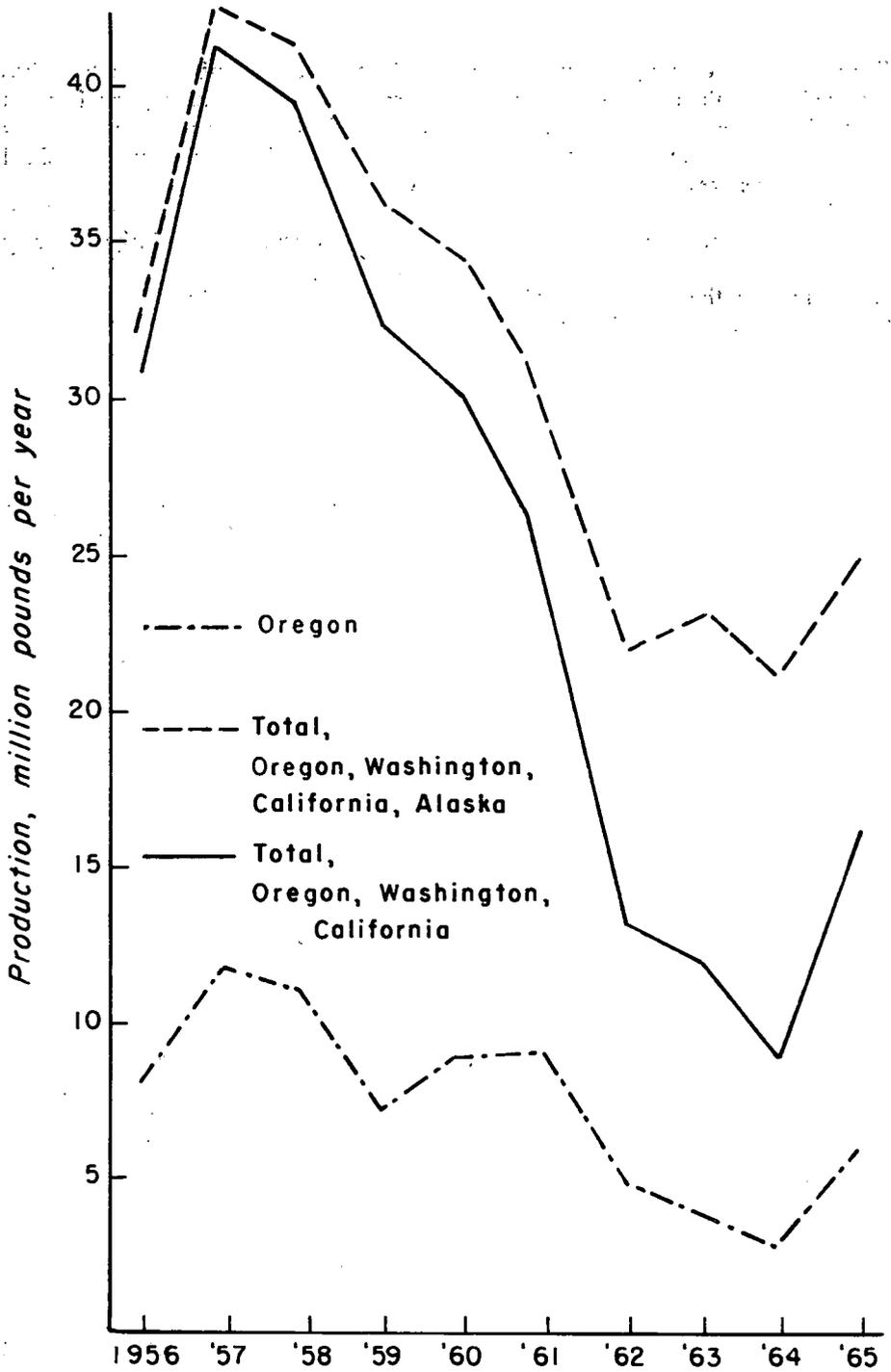


Figure 1. Production of Dungeness crab, 1956-1965.

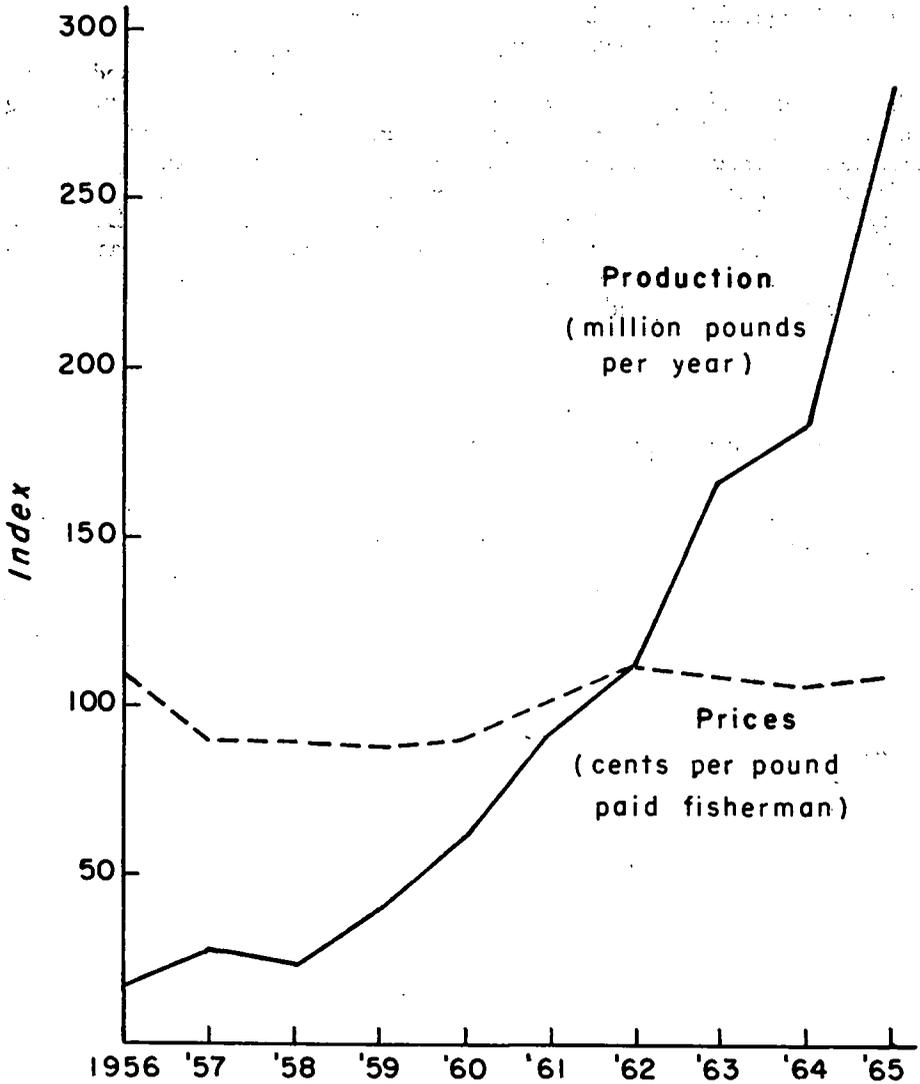


Figure 2. Index of fluctuations in Alaska king crab production and prices, 1956-1965. (Ten-year average equals 100.)

The introduction of large quantities of Alaska king crab into traditional Dungeness crab markets is another factor that has threatened the growth and stability of the Dungeness crab industry. The production of king crab has climbed steadily from 8.8 million

pounds in 1956 to over 131 million pounds in 1965, a period when Dungeness crab production was experiencing marked fluctuations. And yet king crab prices have remained relatively constant in the face of this rapidly expanding supply. Figure 2 shows the

relative changes in king crab production and prices from 1956 through 1965.

These and other factors have resulted in depressed prices to Dungeness crab fishermen and processors for their products in recent years. This study was made to identify the salient features of the Dungeness crab industry and to analyze some economic factors in the marketing and pricing of

Dungeness crab. It describes the marketing of Dungeness crab, from ocean floor to ultimate consumer, and recommends changes to improve marketing efficiency. In addition, economic relations among prices and production levels in the Oregon Dungeness crab industry, the Pacific coast Dungeness crab industry, and the Alaska king crab industry are determined.

OREGON'S DUNGENESS CRAB INDUSTRY

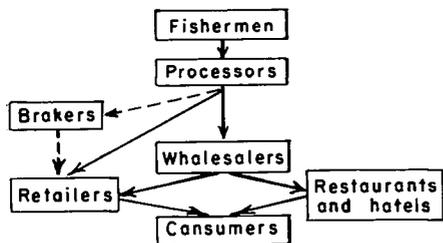
The typical marketing channels for Dungeness crab products (fresh whole crab and fresh or frozen crab meat) are illustrated in Figure 3. Fishermen initiate the marketing process by catching the crabs in their pots on the ocean floor and delivering them to processors or fresh marketers. From the processor, the crab is sold either directly or through brokers to fish wholesalers or to large fish retailing firms. About 20% of the crab is sold directly by processors to chain-store retailers. However, the most prevalent method of marketing Dungeness crab is through

brokers to fish wholesalers; the latter handle almost 80% of all Dungeness crab produced in Oregon. A significant portion of total Dungeness crab volume goes from wholesalers to restaurants and better hotels.

Dungeness crab fishermen

More than 65% of the Oregon fishermen contacted returned usable questionnaires. These fishermen caught 66.9% of the total Dungeness crab harvested in Oregon during the 1965-66 fishing season.³ During that season, they used an average of 217 crab pots to catch an average of 92,434 pounds of crab. During the 1964-65 season, the comparable averages were 210 crab pots and 80,769 pounds caught.

Perusal of Table 1 reveals that more fishermen were in the lowest "pounds caught" category during the 1964-65 season than in the 1965-66 season.



— Physical movement of crab and economic transactions
 - - - Economic transactions only

Figure 3. Marketing channels for Dungeness crab.

³This percentage was computed by comparing this group's total catch with the total Oregon Dungeness crab catch during the 1965-66 season. The 1965-66 figures were supplied by C. Dale Snow, Head of Shellfish Investigations, Oregon Fish Commission, Newport, Oregon.

Table 1. Amount of Dungeness crab caught by Oregon fishermen, 1964-65 and 1965-66

Pounds caught	1964-65 Season				1965-66 Season			
	Fishermen		Total catch		Fishermen		Total catch	
	<i>No.</i>	%	<i>Lbs.</i>	% of total	<i>No.</i>	%	<i>Lbs.</i>	% of total
0- 49,999	26	40.0	650,000	12.4	21	29.2	525,000	7.5
50,000- 99,999	21	32.3	1,575,000	30.0	27	37.5	2,025,000	28.9
100,000-149,999	11	16.9	1,375,000	26.2	11	15.3	1,375,000	19.6
150,000-199,999	4	6.2	700,000	13.3	6	8.3	1,050,000	14.9
200,000-299,999	2	3.1	500,000	9.5	4	5.5	1,000,000	14.2
300,000-399,999	0	0	0	0	3	4.2	1,050,000	14.9
400,000-499,999	1	1.5	450,000	8.6	0	0	0	0
TOTAL	65 ¹	100.0	5,250,000	100.0	72 ¹	100.0	7,025,000	100.0

¹ Total numbers of fishermen are not equal because some of the survey respondents did not fish for Dungeness crab during one season or the other.

Three out of the top four catch categories had more fishermen in the 1965-66 season than in the previous season. In the 1965-66 season two thirds of the fishermen each caught less than 100,000 pounds, but their combined catches accounted for only 36.4% of all respondents' catches. During the same season, the 18.4% in the three largest categories accounted for 44% of this group's total catch.

The sale of Dungeness crab accounted for an average of 60% of the respondents' total fishing revenue. The sale of salmon accounted for an average of 29% of their gross fishing income. The remaining 11% was derived from the sale of tuna, bottom fish, shrimp, and other kinds of fish. Only 10% of the Dungeness crab fishermen

fished exclusively for crab, with the rest fishing for one to three other species in addition to crab.

Catch size and fishing profitability

An important issue to consider is the relation between the size of the Dungeness crab catch and the gross and net incomes realized by fishermen. Apparently, the larger Dungeness crab catch during the 1965-66 fishing season, as compared with the previous season, had a favorable impact upon the profitability of crab fishing. Table 2 shows that over 53% of the fishermen reported higher gross incomes and larger net profits from crab fishing in 1966 than in 1965, while only 31% had lower gross incomes and net profits in 1966 than in 1965.



During the 1965-66 fishing season, the average Oregon fisherman caught more than 92,000 pounds of Dungeness crab. Most Oregon fishermen realized higher gross incomes and net profits in seasons when Dungeness crab supplies were relatively high.

On the basis of these two seasons, it appears that fishermen's gross incomes and profits from Dungeness crab fishing may be highest during seasons of large supplies of crab and relatively low prices.⁴ In fact, 70% of the fishermen surveyed stated that they prefer a situation where fishing is excellent but prices poor, to a situation where fishing is poor but prices are excellent. The other 30% prefer the latter over the former.

⁴ Higher gross incomes in the face of increased supply suggest that Dungeness crab products are a luxury food.

Problems facing crab fishermen

The fishermen were asked to list the major problems facing the Dungeness crab industry. Their answers are summarized in Table 3. The category titled marketing and advertising, which accounts for 33% of the answers, includes reliance upon too limited a marketing area, an excessive marketing margin between consumer prices and prices received by fishermen, and insufficient industry advertising of Dungeness crab products.

Competition from king crab products in traditional Dungeness crab

Table 2. Comparison of gross incomes and net profits, Oregon fishermen, 1965, and 1966

	<i>No.</i>	<i>%</i>
Both gross income and net profit higher in 1966 than in 1965	34	53.1
Both gross income and net profit lower in 1966 than in 1965	20	31.3
Gross income higher but net profit lower in 1965 than in 1966	6	9.4
Gross income lower but net profit higher in 1966 than in 1965	4	6.2
TOTAL	64 ¹	100.0

¹ Twelve fishermen did not answer this question. In most cases they did not fish for crab during one of the two seasons.

Table 3. Major problems facing the Dungeness crab industry as listed by fishermen

	Fishermen indicating this category	
	<i>No.</i>	<i>%</i>
Marketing and advertising problems	36	33.0
Competition from king crab	27	24.8
Miscellaneous problems ¹	26	23.9
Legal season problems	13	11.9
Production fluctuations	7	6.4
	109	100.0

¹ These problems include a need for pot limits and designated fishing areas, competition from Russian fishermen, offshore mining, and so forth.

markets comprised about one fourth of the problems listed. Miscellaneous problems—including a need for pot limits and designated fishing areas, competition from Russian fishermen, and offshore mining—also represented nearly one fourth of the answers. Seven fishermen listed fluctuations in Dungeness crab production as a major industry problem.

Some fishermen felt that there were problems with the legal fishing season for Dungeness crab. The length of the ocean season, the starting date, and the very existence of a legal season were mentioned as problem areas. In an effort to determine the effect of the legal season on actual fishing behavior, the fishermen were asked what determined the date at which they actually started and ceased crab fishing. Almost 90% indicated that the opening date of the legal ocean season influenced the date at which they actually started crab fishing (Table 4). None of the other reasons listed in Table 4 for starting to fish for crab was given by more than ten of the fishermen.

On the other hand, only 13% of the fishermen stated that the close of the ocean season on August 15 was an important factor in their decision

to quit fishing for crab. Most respondents listed the physical characteristics of the crab and the desire to begin fishing for another species (usually salmon) as their principal reasons for the cessation of crab fishing.

According to Snow,⁵ during July and August Dungeness crabs enter the molt stage, at which time they shed their old shells and begin growing new ones. During this period, the meat is not of the highest quality, and the yield of meat from green crab is quite low. The season is closed on August 15 to allow the crabs to grow inside their shells, thereby increasing the yield and the quality of these shellfish. By December the crabs have almost filled their shells and have regained their quality; thus, the season is again opened on that date.

The fishermen were also asked if they would be willing to contribute one-half cent per pound of crab caught, if the processors would do likewise, to a Dungeness crab commission for the purpose of advertising and quality control. Of the 76 respondents, 45% indicated a willingness to contribute, 29%

⁵ C. Dale Snow, Director of Shellfish Investigations, Oregon Fish Commission, Newport, Oregon.

Table 4. Reasons for starting and ceasing crab fishing, Oregon Dungeness crab fishermen

Reason	Start fishing		Cease fishing	
	No.	%	No.	%
Opening or closing of the ocean season....	68	89.5	10	13.2
End or start fishing for another species....	4	5.3	23	30.3
Some physical characteristics of the crab itself	6	7.9	27	35.5
Crabs becoming abundant or scarce enough to make fishing profitable or unprofitable	10	13.2	16	21.1
TOTAL	88	115.9¹	76	100.1¹

¹ Fishermen were allowed more than one choice.

were not willing to contribute, and 26% were undecided. Although the fishermen were not made aware of this fact, Public Law 88-309 makes federal funds available on a matching funds basis to the states for research and advertising of fish and fish products. It may be that, had the fishermen been aware of this possibility, more unde-

ecided respondents would have expressed a willingness to contribute to such a commission. Oregon processors were asked the same question; of the 11 firms queried, 9 expressed a willingness to contribute, while 2 processors were against the formation of or contribution to a Dungeness crab commission.

Processing Dungeness Crab

Most fishermen sell their Dungeness crab catches to processors. The eleven Oregon firms in the study received their crab from 93 Oregon fishermen and 3 Washington fishermen. The number of Dungeness crab fishing boats selling to one processor ranged from 3 to 20, and averaged 8.7 boats per firm.

At the processing plant, the crabs are sorted according to size and quality. If a crab is of a certain size and has all ten legs, he may be processed and sold as shell crab (many of the Dungeness crabs delivered to the processing plant are missing one or more legs). The other crabs are picked and the meat is sold as a different product.

Shell crabs (i.e., whole cooked crabs) are cooked, cooled, and packed in ice. All shell crab is sold fresh; none is frozen. Approximately 31% of the crab processed by the eleven firms interviewed was sold as shell crab in 1965, with the remainder being merchandised as crab meat.

Processing of crab meat consists of backing and butchering, cooking, cooling, picking, brining, washing, packing, and canning. Backing and butchering involves hand removal of the backs and viscera. This process kills the crab, whereas in shell crab processing the crabs are killed during the cooking process.

Two types of machines are used in cooking Dungeness crab. One machine is a metal vat containing boiling water or live steam. The crabs are placed in wire baskets and dipped into the vats. The other type of machine consists of a continuous chain conveyor running through either boiling water or a live steam bath. The speed of the conveyor is regulated according to the temperature of the water or steam and the desired cooking time.

After cooking, the crab is cooled in cold water. Cooling allows the workers to handle the crab, and it enables the meat to be more easily separated from the shell. Once they are cooled, the crabs are moved to the picking tables where most of the shell is removed by hand from the meat. The meat is placed in a salt brine solution where the meat floats and the small pieces of shell sink to the bottom. After being rinsed in fresh water to remove the salt, the meat goes to packing tables to be placed in metal cans, weighed, and vacuum sealed. The cans of crab meat will be frozen and sold as fresh frozen crab meat, iced to be sold as fresh meat, or canned. The average yield of meat from the whole crab is approximately 22%. Thus, a 2.5-pound live crab will yield an average of 0.55 pounds of meat, with the yield from this size ranging from 0.45 to 0.63 pounds.

Capacity, production, and market share

The size of Oregon Dungeness crab-processing firms, whether measured by processing capacity or by actual production, varies widely. The combined maximum processing capacity of the nine firms supplying data was 175,000 pounds of green crab per day. The plants ranged in size from 10,000 to 50,000 pounds per day maximum capacity.

However, most firms indicated that picking labor, not plant capacity, was the limiting factor in their operation. All Oregon processing firms are located in small coastal communities where a limited supply of seasonal labor is available for crab picking.

Not only do Oregon firms vary widely in terms of maximum capacity, but they also exhibited a wide range in total Dungeness crab production for the 1965-66 fishing season. It can be seen from Table 5 that their annual volumes ranged from under 75,000 pounds to over 2,000,000 pounds of green crab.⁶

The largest Oregon firm processed approximately 40% of the state's 1965-66 Dungeness crab production (Table 5). Oregon has processed a ten-year

average of 23% of the total United States Dungeness crab production. Using this figure and Oregon's 1965-66 production of 10.0 million⁷ pounds, total Dungeness crab production was estimated at 43.5 million pounds. As shown in Table 5, Oregon's largest firm processed less than 5% of estimated total United States production, and Oregon's three largest firms processed less than 10% of total production. The eleven firms interviewed processed over 70% of Oregon's production, but they handled less than 17% of the 1965-66 season's total United States production.

Product mix

Ten Oregon firms provided information on other fish products that they process and sell in addition to Dungeness crab. One firm handles clams, 4 handle tuna, 5 sell shrimp, 7 process bottom fish, and all 10 handle salmon.

With the exception of continuous chain cookers, all Dungeness crab processing equipment can also be used for processing shrimp. However, there exists almost no common use of equipment, with the exception of the refrigeration unit, between crab and any

⁶ At that, 2,000,000 pounds of green crab is a relatively small absolute amount compared to the largest king crab processor's annual volume of over 40,000,000 pounds.

⁷ This figure obtained by personal communications with C. Dale Snow, Director of Shellfish Investigations, Oregon Fish Commission, Newport, Oregon.

Table 5. Market share of Oregon Dungeness crab processing firms 1965-66

	Total pounds	Percent of Oregon production	Percent of total U. S. production
	lbs.	%	%
Three largest firms	4,000,000	40.0	9.2
Five largest firms	5,500,000	55.0	12.6
Seven largest firms	6,350,000	63.5	14.6
Nine largest firms	6,845,000	68.5	15.7
Eleven firms interviewed	7,095,000	71.0	16.3

of the other products listed above. Thus, only a small amount of equipment complementarity exists between Dungeness crab and the rest of the product mix. The absence of new investment in Dungeness crab-processing equipment during the last fifteen years may be partially explained by the lack of complementarity in the product mix, small absolute volumes of Dungeness crab, and a small market share accounted for by any one firm.

Markets for Dungeness crab

The eleven participating firms use refrigerated trucks to transport 78% of all the Dungeness crab they process to buyers. Most of the Dungeness crab produced in southern Oregon is trucked to markets in California. A smaller but significant proportion of northern Oregon's Dungeness crab production is also sold in California. A minor portion of Oregon's production is sold in Washington and in the Rocky Mountain states. Over 76% of the 1965-66 season's total catch was exported from Oregon, with 67% of total production moving into the California markets.

Approximately 80% of the total Dungeness crab produced by the eleven participating firms was sold to wholesale fish buyers, with the remaining 20% being sold directly to chain-store buyers. Selling directly to chain-store buyers is relatively new in the fresh-fish industry. In the Dungeness crab industry, direct selling has reached significant proportions only during the 1964-65 and 1965-66 seasons.

No apparent price premiums are received for any particular brand of Dungeness crab meat. All eleven participating firms sell crab meat under their own brand names, and only two of the firms pack crab meat under buyers' labels. The amount of crab

meat sold in this fashion by these two firms is a very small proportion of their total sales volumes. No brand identification is used in selling shell crab.

Only two of the Dungeness crab processors in the survey indicated that they have engaged in or contributed to advertising or promotion of Dungeness crab. In both cases the expenditures for these activities have been very small.

Wholesale prices

During the 1965-66 season, the average price received by Oregon processors for Dungeness crab meat was \$1.01 per pound. The average price for shell crab was 26 cents per pound. During the 1964-65 season the average wholesale price was \$1.05 per pound for crab meat and 29 cents per pound for shell crab. Thus, average wholesale prices dropped 4 cents per pound for crab meat and 3 cents per pound for shell crab from one season to the next. During this same period, the average price received by fishermen dropped about 4 cents per pound, from 18 cents to 14 cents per pound.

This evidence suggests that the absolute marketing margin (i.e., the difference between wholesale prices received by processors and prices paid to fishermen) is fairly constant. At least this margin appears to be rigid relative to downward wholesale price movements. Under these conditions, it is not surprising that prices paid fishermen fluctuate dramatically in response to production variations and other factors. Fishermen's prices will be examined more closely in a subsequent section.

Washington and California processors

The firms interviewed in Washington and California are relatively larger, in terms of total Dungeness crab proc-

essed, than Oregon processing firms.⁸ The out-of-state firms processed an average of 1.9 million pounds of green Dungeness crab during the 1965-66 season. This average output is over 300% larger than the average production of the eleven Oregon firms included in the survey. The largest firm processed 7.2% of estimated total Dungeness crab production in the four states, while the largest Oregon firm processed only 4.6% of this same total. Including Oregon firms, the four largest firms handled 23.3% of total Dungeness crab production, and the eight largest firms processed 36.0% of total production. The seventeen firms in the survey handled 43.3% of total Dungeness crab produced in the United States during the 1965-66 season.

Oregon processors sold approximately 31% of their green Dungeness crab as shell crab during the 1965-66 season. The participating firms in Washington and California sold about 39% of their green crab as shell crab the same year. California firms sold almost 100% of their Dungeness crab products in California. Oregon firms

⁸ Part of the reason for this difference is that absolute size was one of the principal criteria used in selecting the out-of-state sample.

sold about 67% of their Dungeness crab in California, while Washington firms sold only about 27% of their production in California. Average Dungeness crab processing capacity of Washington and California firms was about 43,000 pounds per day, as compared to about 21,000 pounds per day for Oregon firms in the survey.

Processing and marketing procedures followed by Dungeness crab processing firms in all three states are very similar.

Problems facing crab processors

All processing firms interviewed were asked what they saw as major problems facing the Dungeness crab industry. Their replies are grouped into four categories in Table 6.

Marketing and advertising problems were mentioned most frequently. Replies in this category included reliance upon limited marketing areas, such as the San Francisco Bay area and the Los Angeles metropolitan area, and lack of advertising of Dungeness crab products.

The second major problem voiced by processors was the fluctuations in production of Dungeness crab. Within the last decade, Oregon production has varied from a high of 11.9 million

Table 6. Major problems facing the Dungeness crab industry, all Dungeness crab processing firms interviewed, 1966

	Number of replies	Percent of total replies
	<i>No.</i>	<i>%</i>
Competition from king crab	6	27.3
Fluctuations in production	7	31.8
Marketing and advertising	8	36.4
Quality control	1	4.5
TOTAL	22	100.0

pounds of green crab to a low of 3.2 million pounds (see Figure 1). Associated with these production variations have been fluctuations in prices paid fishermen for green crab of from 8.2 cents per pound to 24.9 cents per pound.

The problem mentioned as third in importance by processors was competition from Alaska king crab products. King crab production has risen steadily from an annual production of 11.2 million pounds in 1958 to 131.8 million pounds in 1965 (see Figure 2). During this same period, wholesale prices of king crab have remained quite stable

and relatively low, compared to fluctuating Dungeness crab prices. Although the king crab meat has a different texture, color, and flavor than Dungeness crab meat, the two products are similar enough for restaurants and consumers to substitute king crab for Dungeness crab, and vice versa.

An interesting observation is the marked similarity between the industry problems mentioned by processors and those listed by fishermen. Evidently many of the industry's problems have been easily identifiable; it is workable solutions that have been difficult to achieve.

The Newport Dungeness Crab Association

In January 1966, the Newport Dungeness Crab Association was formed as a nonprofit corporation for the express purpose of advertising Dungeness crab. A summary of the activities of this association, based on interviews with the president and treasurer of the association, follows.

During the early part of the 1965-66 fishing season, Oregon fishermen were faced with catch limits imposed by processors and with a relatively low price of 12 cents per pound for green Dungeness crab at Newport, Oregon. The fishermen attributed these conditions to an unusually large Dungeness crab production and to competition from king crab for the consumer's food dollar. They felt that a promotional campaign was necessary to help alleviate these problems.

Since the processors were unwilling to conduct a promotional campaign for Dungeness crab, the Port of Newport Dungeness crab fishermen formed a nonprofit corporation. This organiza-

tion was supported by voluntary contributions of one cent per pound of the fishermen's Dungeness crab catch. The association engaged a Portland advertising agency, Showalter-Lynch, to advise them and to conduct their advertising activities. The advertising agency also spent considerable time and effort in an attempt to arouse interest and contributions among fishermen, processors, chain stores, and state governmental agencies.

Approximately \$16,000 was contributed by fishermen during the 1965-66 crab fishing season. All but \$2,500 was spent during that season, with the remainder carried over to start advertising for the 1966-67 crab marketing season. A breakdown of the association's expenditures is given in Table 7. Over one half of the association's funds were spent for radio and television commercials, with another 35% going for other advertising and administrative expenditures.

Table 7. Distribution of expenditures, Newport Dungeness Crab Association, 1965-66 Dungeness crab marketing season

Type of expenditure	Amount spent	Percent of total income ¹
	<i>Dol.</i>	<i>%</i>
Radio time	\$ 6,700	41.6
Television time	1,500	9.5
Layout	2,900	17.9
Carry-over of 1966-67 season	2,500	15.5
Miscellaneous ²	2,500	15.5
TOTAL	\$16,100	100.0

¹ Percentages shown here have been calculated from original data and rounded in presentation.

² Includes cost of incorporation, advertising agency fees, and accounting fees.

The Newport Dungeness Crab Association plans to continue to operate during future seasons on revenues contributed on a voluntary basis by Oregon crab fishermen. Both the president and treasurer of the association believe that the advertising activities have been beneficial to fishermen and processors

by making it possible to sell larger quantities of Dungeness crab at higher prices than would otherwise prevail. They feel that marginal returns to fishermen have been greater than the cost of their contributions, and that advertising will continue to be a profitable venture for Newport fishermen.

Dungeness Crab Price Analysis

An important variable in evaluating the performance of the Dungeness crab industry is the prices paid by processors to fishermen for green crab. At least two aspects of these prices—their absolute levels and their stability over time—would appear important in making such an evaluation. Thus, we now consider some aspects of the prices paid to fishermen by processors. Seasonal and cyclical fluctuations in Dungeness crab prices will be considered. Relationships between quantities and prices of Dungeness crab and king crab will also be examined.

In this section, “price” is defined as the amount, in cents per pound of live crab, paid to fishermen by processors.

The major share of all Dungeness crab production consists of ocean crab, as distinguished from bay crab. Since the latter constitutes a very small proportion of total production, only ocean crab price data will be used to examine seasonal trends.⁹

Seasonal price fluctuations

Price variations that occur on a systematic basis over a less-than-one-year time period are usually called seasonal fluctuations. The price of Dungeness

⁹ As noted earlier, the ocean crab season opens on December 1 and closes on August 15 each year. The bay crab season is open all year.

crab is generally low during the early part of most Oregon ocean seasons and then rises, reaching its peak in July and August. A simple-average method of calculating seasonal variation¹⁰ was used to compute the line shown in Figure 4. The simple-average price for Dungeness crab rises from 13.97 cents per pound in December, the start of the season, to 20.30 cents per pound in August, the close of the season.

Thus, it can be seen that a definite seasonal movement does exist in Dungeness crab prices. During the early part of the season, crabs are quite abundant and easily caught. During the

latter part of the season, the catch of crab decreases considerably as they become more scarce. Peak demand for Dungeness crab is in the summer months. Since prices are determined by supply and demand, this situation results in higher prices during the latter part of the season.

Cyclical price fluctuations

Price variations that occur on a systematic basis over some time period longer than one production or marketing season are generally termed cyclical fluctuations. Considerable evidence exists to suggest that Dungeness crab production and prices have behaved in a quasi-cyclical manner during the past decade.

The quasi-cyclical movement in Dungeness crab catch or supply from 1956 through 1965 is shown in Figure 1. Perusal of Figure 5 reveals an inverse relationship between total catch of Dungeness crab in all four Pacific coast states and the prices paid to Oregon fishermen. The line in Figure 5

¹⁰ Monthly prices were obtained from the Bureau of Commercial Fisheries for the ten-year period 1956 through 1965. Using Thompson and Foote's method (F. L. Thompson and R. J. Foote, *Agricultural Prices*, 2d ed. New York: McGraw-Hill, 1952, pp. 324-327), the December prices were added and the sum divided by the number of years. A figure for each of the other eight months was similarly computed. These figures were then plotted in Figure 2, and a line connecting them was drawn.

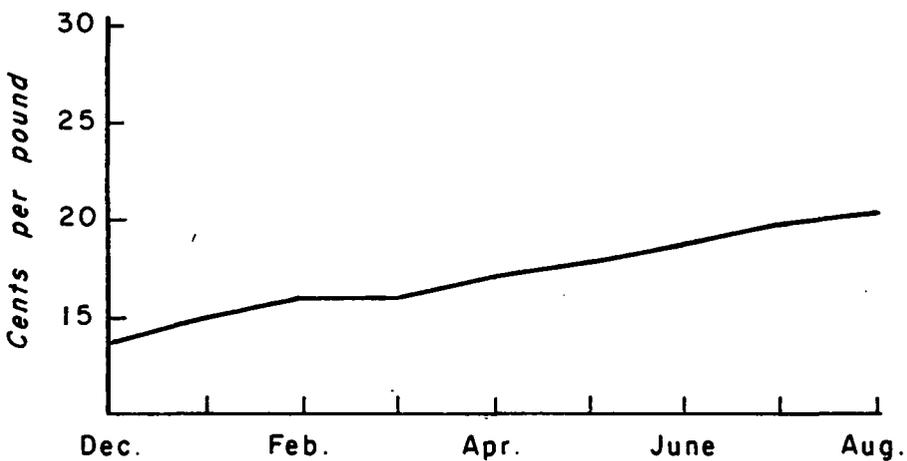


Figure 4. Average Oregon Dungeness crab prices by months, 1956-1965.

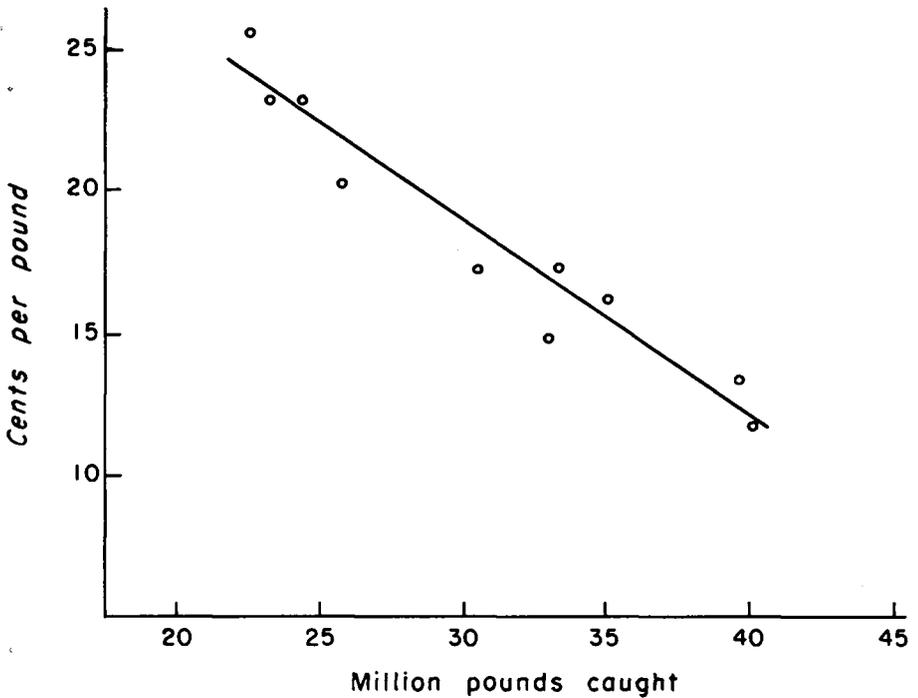


Figure 5. Oregon Dungeness crab prices and total quantities of Dungeness crab caught in Oregon, Washington, California, and Alaska.

was fitted to the data using the least-squares linear regression technique.¹¹

Factors influencing crab prices

What factors can be expected to explain variations in Oregon Dungeness crab prices over time? Oregon is hardly an isolated production or market area for Dungeness crab (it was noted above that over two thirds of Oregon's production is sold in California markets). Thus, total Dungeness crab production, as well as Oregon production, might be expected to influence Oregon prices. In addition, the quantities and

prices of Alaska king crab could be related to fishermen's prices for Dungeness crab.

In an effort to test these hypotheses, least-squares multiple regression was used to determine relations between Oregon Dungeness crab prices over the past decade and with the following variables: (1) quantity of Dungeness crab caught by year in Oregon; (2) total quantity of Dungeness crab caught by year in Oregon, Washington, California, and Alaska; (3) average prices paid fishermen for Alaska king crab; and (4) quantity of Alaska king crab caught by year.

The statistical analysis revealed that the second and third variables were significant in explaining variations in Oregon Dungeness crab prices during

¹¹ For the derived regression equations, see John R. Wix, *Some Economic Considerations in Dungeness Crab Marketing*, OSU, M. S. thesis, 1967, pp. 50-59.

the 1956-65 period. Total quantity of Dungeness crab caught explained nearly 93% of the variation in prices, while king crab prices explained almost 5% of the price variation. Although no

direct cause-and-effect relationship can be inferred from the analysis, it is evident that the above-mentioned variables are statistically related to Oregon Dungeness crab prices.

THE ALASKA KING CRAB INDUSTRY

The king crab processing industry is composed of five or six large firms and a number of small firms. All five Washington firms interviewed had king crab processing plants in Alaska. Four of these firms also had Dungeness crab processing plants in Washington. These four firms handled about seven times as much king crab as they did Dungeness crab. The largest king crab processing firm handled about 50% of total king crab production in 1965-66, as compared to the largest Dungeness crab processor handling only 7.2 percent of total Dungeness crab production.

Several important differences exist between the processing and marketing of king crab and Dungeness crab. All king crab meat is sold in a fresh frozen form. Dungeness crab meat is sold both fresh and fresh frozen. Dungeness crabs are also sold whole as shell crab. King crabs are not sold whole, but parts of the legs are sold in the shell as king crab sections. King crab processing plants rely more upon machinery and less on hand labor than do Dungeness crab processing plants. For example, a rubber wringer machine is used to separate king crab leg meat from the shell. Hand labor is used to pick Dungeness crab meat from the shell.

Handling large quantities of king crab permits certain economies of scale in processing and transportation. For

example, sufficiently large quantities of king crab are shipped to specific market destinations to allow whole carload shipments. Approximately 75% of the king crab sold by the five participating firms in 1965 was shipped from Seattle by rail; the other 25% was shipped by truck. Almost all Dungeness crab is transported by truck.

Whereas Dungeness crab is sold mainly on the west coast, king crab is sold throughout the United States. Some king crab is also exported to certain European countries. Approximately 60% of the king crab processed by the five participating firms was sold on the east coast in 1965. A possible reason for the large king crab marketing area, as compared to limited Dungeness crab marketing areas, is the large amount of advertising and product promotion done by king crab processors and the Alaska King Crab Marketing and Quality Control Board.

The annual king crab harvest has risen dramatically from 1956 to 1965 (see Figure 2). This phenomenal increase can be attributed to fishermen harvesting virgin stocks of king crab that have never been fished before. At present there is a great deal of uncertainty as to what the sustained yield of the king crab fishery will be.

During this rise in total production of king crab, annual average prices paid fishermen have remained quite

stable (Figure 2). Apparently this tremendous increase in total catch has had little or no effect on king crab prices. Several factors might explain these findings. For example, there exists some evidence to indicate that the price of king crab is dependent upon the relative bargaining strength of processors and the king crab fishermen's bargaining association. Each year, before the opening of the season, the king crab fishermen's association bargains with the various processors to arrive at a price for the coming season. Although data were not available to test this hypothesis, this barter price seems to have a strong impact upon

prices paid king crab fishermen throughout the remainder of the season.

Apparently there has also been a significant increase in demand for king crab. King crab processors and the Alaska King Crab Marketing and Quality Control Board have done considerable advertising and product promotion throughout the United States. King crab processors and brokers have also entered the California crab market, offering former Dungeness crab buyers stable prices and a constant supply throughout the year. Many California institutions¹² have switched from Dungeness crab to king crab for use in crab salads and crab cocktails.

RECOMMENDATIONS

On the basis of this study's findings, the following recommendations are made as possible solutions to some of the Dungeness crab industry's problems:

1. Fishermen, processors, and other industry groups should explore the possibility of establishing an industry-wide Dungeness crab commission. The primary purpose of such a commission would be to advertise and promote Dungeness crab products, thereby increasing the demand for these products and allowing them to compete more effectively with Alaska king crab. Since the Dungeness crab industry is, in fact, composed of processors and fishermen in all four Pacific coast states, a four-state commission would be preferable to an Oregon commission. However, an Oregon commission

would be a good place to start, and it would be preferable to no commission at all. The Oregon Dungeness crab industry might also assess the feasibility of joining forces with the presently existing Oregon Otter Trawl Commission, to form a state commission of all commercial fish industries.

The majority of Oregon fishermen and processors have indicated a willingness to contribute one-half cent per pound each to a commission. Oregon's 1965-66 seasonal harvest was over 10 million pounds of crab. An assessment of one cent per pound (one-half cent per pound from both fishermen and processors) would have resulted in collections of more than \$100,000 during the 1965-66 season. If all four states had participated in such a commission last season, estimated collections would have totaled about \$438,000. Public Law 88-309 funds can be used on a matching basis for market development

¹² Restaurants, night clubs, and others who use large amounts of crab.

and promotion projects. The availability of these funds for use in promoting Dungeness crab should be determined.

King crab processors have advertised very successfully for a number of years. The Alaska King Crab Marketing and Quality Control Board was formed by the state of Alaska for advertising king crab and for the establishment of grades and standards of quality. The advertising programs conducted by this board through its private advertising agency apparently have been very successful. It appears that the Dungeness crab advertising program initiated last year by the Newport Dungeness Crab Association has also been a worthwhile venture. However, it is questionable whether a program financed by voluntary contributions from a small number of fishermen will have as great an impact on demand over time as an industry-wide effort supported by both fishermen and processors.

In light of this evidence, it is recommended that a Dungeness crab commission, or a commercial fish commission that includes the Dungeness crab industry, be established.

2. The feasibility of opening the ocean season for Dungeness crab on January 1 instead of December 1 should be explored.

Dungeness crab processors are faced with peak production of crab during the early winter months of each season, peak demand for crab during the summer months, and a limited storage life for frozen crab meat. By delaying the opening of the season one month, the required storage time would be reduced substantially. Since quality declines as storage time increases, the general quality of Dungeness crab meat should also be improved.

The present capacity of nine processing firms apparently is large enough to handle the maximum annual Dungeness crab production in approximately two months. Their capacity, plus the capacity of other Oregon firms, is large enough that processing capacity does not present a deterrent to opening the ocean season on January 1. The extra month of closed season would also allow the crabs to fill out their shells more fully, thus increasing the yield of meat from green crab.

Since a scarcity of crab influenced the decision of when to cease crab fishing for over 60% of the survey, the extra month of closed season probably would not significantly change the total annual volume of Dungeness crab caught.¹³ On the other hand, the elimination of one month of fishing would be expected to reduce fishermen's costs of harvesting Dungeness crab.

3. The possibility of expanding into new market areas should be examined. King crab has been sold throughout the United States. Presently Dungeness crab is consumed almost exclusively on the west coast.

Alternative methods of transportation should also be investigated. For example, it may be feasible to sell Dungeness crab meat in certain mid-west markets. If the meat were shipped by air freight, it could be in retail markets within 24 hours of being killed. It may also be possible for two or more processors to ship frozen Dungeness crab meat in one shipment, obtaining the rail rate savings associated with whole carload shipments.

It seems reasonable to assume that an expansion of marketing areas would increase total demand for Dungeness

¹³ The impact of such a change on the salmon industry also needs to be considered.

crab. This expansion in demand could result in greater returns to both fishermen and processors. Processors and officials of the industry should investigate the feasibility of market expansion.

4. Additional technological research should be conducted in Dungeness crab processing. Dungeness crab meat is now picked from the shell entirely by hand. Research needs to be conducted to develop mechanical means of picking the crab meat from the shell to eliminate part of the present labor requirement.

The possibility of utilizing crab processing wastes (i.e., backs, shells, and viscera) should be explored. A fish meal plant located in the middle of the Oregon coast might utilize the wastes from Dungeness crab and other fish products from the state's entire fish industry. The potential volume for this type of plant is quite large. For example, during the 1965-66 crab fishing season, about 5.3 million pounds of crab wastes alone were produced in Oregon.

5. The feasibility of establishing grades and quality standards for Dungeness crab products should be explored. At the present time the crab the consumer buys in one time period may not have the same color, texture, odor, or flavor as the crab purchased during a different time period. As a result of this situation, many con-

sumers are reluctant to buy Dungeness crab. A provision for inspection and grading by the USDI, similar to the red meat inspection conducted by the USDA, needs to be established to grade crab products, encourage quality control, and protect customers. Processor participation in an inspection program would probably need to be on a voluntary basis, at least at the outset.

The establishment of grades and quality standards is another useful function that an industry commission might perform. The inspection program could complement the advertising and promotional activities of such an organization. Dungeness crab products that have met certain minimum standards could carry a label to this effect. It might even be feasible to "brand" shell crabs as a means of distinguishing them from uninspected products.

6. It is recommended that further economic studies be made to determine costs of harvesting, processing, and marketing Dungeness crab. A descriptive analysis of the other marketing channels, including wholesale fish buyers, fish brokers, chain-store buyers, and restaurants, should be included. Determination of consumer demand in present and potential market areas is another subject worthy of research. Data of these types are needed to make policy decisions and to help Dungeness crab industry personnel find solutions to their problems.