

# CRAB BYPRODUCTS AND SCRAP 1980

A Proceedings



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## A Proceedings

Edited by Mary Beth Hatem

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## Foreword

Chesapeake Bay blue crab landings average 67.1 million pounds annually. Ten percent of that poundage represents profit; another ten percent is lost as water or liquid waste. The remaining eighty percent is an expensive headache for processors and a potential bottleneck for the industry.

On September 9, 1980, concerned crab processors, industry spokesmen, researchers, local government officials and representatives from various funding and regulatory agencies gathered at a conference presented jointly by Maryland and Virginia to discuss the crab scrap disposal problem. The purpose was twofold: to outline the dimensions of the problem and to examine technologies producing valuable byproducts.

For over 25 years, solid crab waste has been collected from picking houses, transported to commercial drying facilities and used to produce a dried meal product that is marketed to producers of livestock feeds, particularly chicken feed. But meal plants face an uncertain future. The combination of increased energy costs, more severe environmental regulations and fluctuating demand has forced some meal plant operators to close down or to curtail operations.

Because of the problems crab meal plants face, processors have increasingly relied on landfills for disposal of their crab scrap. Concerned about the risk of polluting groundwater, health officials question this alternative as a permanent solution. Additional problems result from the lack of suitable landfill sites, the special handling required and

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objections by landfill personnel to the odor of the waste and its delivery at day's end. Landfills presently discourage crab waste and many have indicated that they soon will refuse to handle it at all.

Crab processors desperately need a reliable, long-term solution to their crab scrap disposal problems. In addition to being uncertain, existing alternatives are expensive and offer no possibility of financial return. But according to many conference participants, crab scrap presents an opportunity for resource recovery and an end to the economic waste of disposal.

Conference participants outlined a wide range of technologies and applications. They analyzed the feasibility of chitin-chitosan extraction, protein recovery, silage, composting, mechanical separation and modern crab meal production with an eye towards marketing potential for use in wastewater treatment, fertilizers, pharmaceuticals, petfood, food dye, animal feed and minced crab products.

Much work remains to be done on these possibilities; the goal of this conference was to help focus these efforts. When industry, researchers, local government and funding agencies are able to get together, decisions on priorities can only improve and possibilities for cooperative ventures and effective combinations of solutions increase.

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## Welcoming Remarks

James Douglas, Jr.  
Chairman, Virginia Marine Resources Commission

I would like to officially welcome you to the Commonwealth of Virginia and specifically to Virginia Beach. It is a privilege for me as part of the Virginia government to have a group in Virginia discussing such an important problem as crab waste.

I want to also recognize at this time some folks who have been extremely important in putting together today's program—from Virginia, Virginia Polytechnic Institute and State University, particularly Donn Ward, who has worked on the program; from Maryland, Don Webster from the University of Maryland and Bill Sieling, who is with the Maryland Department of Natural Resources. Those three deserve the lion's share of the credit for getting this program together.

I thought it would be appropriate that I share with you today the findings of a study I was reading last night. The study is the Global Year 2000 Report to the President, entitled "Entering the 21st Century." In this report, the Council on Environmental Quality in the Department of State advises the President as to the state of things both in the United States and in the world in the year 2000. Some of the points made in the report will serve, I think, to bring today's conference into focus.

The Council predicts an increase of 50% in the world's population from 4.0 billion in 1975 to 6.4 billion in the year 2000 and a 90% increase in world food production over the thirty years from 1970 to the year 2000. That amounts to a

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per capita increase of 15%, but the report further indicates that the bulk of that increase will go to countries that are already consuming the great majority of the world's food.

Another point that would be of interest to this group in particular is that arable land will increase only 4% by the year 2000. If arable land is going to increase by only 4% in the next twenty years, yet the population is going to increase 50%; then even with some increase in production from land, the world is going to be relying much more heavily on the sea as a food source. This is what we have been hearing for years; now the data are providing substantiation. The Council also foresees more pollution problems. This makes sense. First of all, the population will increase and with people you get pollution. Second, the scientists will be more clearly defining pollution and scientists can come up with a lot more problems than those of us who are in government can ever solve. They stay well ahead of us in that regard.

I think you have two sides to the coin: a growing population demanding both more and more foodstuffs and an increasingly pollution-free society as well. You are in the business of producing protein, and yet you are also in the business of insuring that your production facilities do not pollute. I think this is one of the major quandaries that anybody in business today faces. In this program we can at least attack one small problem along that line of producing more food and yet producing it pollution-free.

There is one other point I want to make. I wasn't born a bureaucrat. Nobody stamped government employee on my forehead when I was born. I came out of private industry and took a job with the state of Virginia. It has been very rewarding in many respects, but I am convinced that government is not going to solve all of the problems. In fact, I am convinced that government isn't going to solve many. This meeting is not so government can solve your problem. This is government bringing you together with experts in the fields to discuss solutions in hopes that you, as industry, will be able to resolve your own problems. In the final analysis, this is what makes your industry strong. If this conference helps to that extent, then we are pleased to put it on.

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## Introduction: A Crab Scrap Crisis?

William Peter Jensen  
Maryland Department of Natural Resources

This conference today typifies to me the kinds of energies and the attention that I think we can bring to bear on problems that face all of us. I would immediately disabuse any idea that the sponsors bring any special expertise to this other than our good offices and the ability to get you all together to talk about the problem and share ideas. We are relative newcomers. Most of you in the audience know more about the problem and have been with it a much longer time than we have. A strong but unstructured connection exists between the harvesters and the processors and the businessmen and the consumers, and in this case, the governments. I am very pleased that we have local governments represented on the agenda today and participating in some of the panels.

When we became more familiar with this problem early this year, it became fairly clear to us that there were a lot of diverse efforts going on and we could see a clear danger that if someone didn't begin to focus those efforts, they were going to be easily fragmented. One of the problems we in government share with people in business is that resources are limited, yet we would like to be as productive as we can. We decided that we would try to help focus the attempts to find an efficient resolution of the crab scrap problem.

So far, the response has been very good and Jim appropriately thanked all of the people that have spent long, hard hours getting this conference together. The institutions are just as important, including the industry institutions--The

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Blue Crab Association and the Seafood Packers. They have contributed generously to try to make this conference a success. Donn Ward, Don Webster, Bill Sieling and Bill Outten are to be personally thanked for organizing this conference.

I want to reassure you that we really can recognize a crisis when we see one. It is not at all difficult. Eugene McCarthy and James Kilpatrick made this point as they detailed their knowledge of some of the strange creatures they had come across in the course of their careers. The authors considered galloping inflation, leaping quantum, pregnant pauses, dilatory motions and the like. Here is what they had to say about mounting crises:

It might be supposed considering the nature of the beast that crises are as rare as pileated woodpeckers. This was true in another era, but in our own century crises have returned from the brink of extinction and now "crises" abound. In 1978 alone, merely in the city of Washington, scores of "crises" were sighted and recorded. Taking some as typical, one recalls that the President was grappling with the coal crisis, the dollar crisis, the Mid-East crisis, the energy crisis, the crisis of confidence, all at the same time. He was also attempting to cope with the crisis on the farm, the crisis in the city, the crisis in relations with blacks, Congress, and Jewish voters of Florida and New York. A crisis was approaching, so it was said, in his own political fortunes. At some point in its lifespan every crisis mounts. Experts are divided on the question of what becomes of a mounting crisis. Some authorities believe that crises are resolved; some report that crises fade; from our own observations we have concluded that crises simply disappear. Sometimes they also reappear. One day they are all over page one. They dominate the evening news on TV. The next day one detects no mention of

them. Then after some lapse of time they return, still mounting. A sturdy crisis, fed a balanced diet of facts and rumors, can keep this up indefinitely. Consider the Mid-East crisis. It has been mounting for four millennia.

Now I hope we are not creating a crab scrap crisis. I really do, and I hope that this conference will keep crab scrap in perspective; that we will keep our sense of humor about whether we have a crisis or not. Some of you might care to consult this book; you will find some very apt descriptions as to what our conclusions might be—whether they be slim mandates or impressive mandates, or what they call a gathering momentum. In any case, I don't wish to insult our southern hosts but I think what we need to do is simply apply some Yankee ingenuity. So let's get with it.

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## A Historical Perspective

Clayton Brooks  
President, J. M. Clayton Company

The removal of crab meat by machinery started in earnest about twenty years ago. A Maryland group called "Sea Mech," a Mr. Lockerby from Texas, a Mr. Johnson from Baltimore, a Mr. Rosin of the Washington area, the National Marine Fisheries Service and another company headquartered near Beltsville were all unable to develop an effective operation. They were slinging, floating, flushing, vacuuming, shaking and heat-treating the crab to produce crab meat.

In 1971 Sea Saver was formed, consisting of the Sea Mech group and others from the Hampton, Virginia area. An engineer was hired full time and after several different concepts were tried, the rapid shake technique was adopted in 1978. Known as "quick pick," it was capable of extracting about 50,000 pounds of crab meat that year; in 1979, about 75,000 pounds were extracted. With mechanization and the possibility of increasing production, the crab meal producer began to wonder what other byproducts could be obtained from crab scrap.

A chemist interested in the byproducts of crab and shrimp scrap moved to Virginia. For two years, he explored economical methods of extracting chitin and concentrated protein products from crab scrap. Another year was spent working with Velsical Chemical Company, a nationally known subsidiary of Northwestern Industries, in the hope that this company would put the new method in production. The capital expenditure for the venture would require a large volume

## A HISTORICAL PERSPECTIVE

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of scrap—more than produced in Maryland, North Carolina or Virginia. Letters, telephone calls and visits to the producers in these three states resulted in about sixty percent of the crab producers agreeing to make their scrap available to this company. It was evident at the time that crab meal operations were producing decreased revenues due to high energy costs and competition from other feeding materials.

Terms of the proposed contract between Velsical and the processors could not be reached. The company wanted the scrap in quantities and conditions as they dictated. They would have left the processors with no place for their waste for weeks at a time. In addition, Velsical expected federal financial assistance that was not forthcoming. After Velsical, a Washington firm, Systems Consultants, proposed a prospectus with terms equally severe. Next came Thorocon Incorporated, a midwestern firm in the pet food business, but again negotiations went no further than the first conference.

In the meantime, the original crab meal plant in Dorchester County had closed after about 35 years in production. Scrap from Dorchester's 15 crab processing plants was then delivered to a poultry rendering plant near Cambridge. They used crab scrap to periodically clean their vessels of caked poultry offal. When the poultry plant asked \$40 per wet ton to receive the scrap, crab processors could not afford the additional production cost of 15 to 18¢ per pound produced of edible crab meat. After two and a half years' operation, the poultry plant discontinued receiving crab scrap and a nearby landfill became the new disposal site. In November 1979, the crab meal plant in Somerset County closed, leaving the Delmarva Peninsula without a crab meal operation and forcing them to rely on landfills. Since the first of the year, crab scrap has been received by farmers for fertilizer and hog feeding and by landfills, with landfills again receiving the majority of tonnage.

This past winter a contact was made with the Public Works Department in Cambridge, Maryland, to explore the feasibility of composting sewer sludge and crab scrap. Apparently an earlier experiment had been successful. A meeting of county and city officials, chemists, Extension agents,

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farmers, Health Department personnel, crab meat processors and haulers concluded that the market value of the compost would not justify the capital required for wood chips, acres of land, tons of dirt and expensive equipment.

Realizing the severe problem crab processors faced, the Chesapeake Bay Seafood Industries Association of Maryland requested a conference of crab processors, state and federal Extension agents, personnel from the Maryland Seafood Laboratory in Crisfield and representatives from Maryland's Department of Natural Resources. This conference produced no feasible solution to the crab scrap problem. In April of 1980, the Dorchester County Seafood Packers met with the Executive Director of the Chesapeake Bay Seafood Industries Association, officials from Maryland's Department of Natural Resources and a representative of the Eastern Shore Rendering Company, who contracted at that meeting with Marine Agri-products of Wheaton, Maryland to run feasibility studies of processing crab with enzymes.

A meeting was also held in Hampton, Virginia, with personnel from Zepata Haynie, a fish rendering firm, exploring the possibility of their rendering crab scrap from the western shore of Virginia at Reedville. At that time the crab meal plant in Hampton was very close to closing. It was thought that to further remove particles of meat from crab scrap with a Baader or squeezer would be a possible solution, but extensive maintenance caused by the abrasive properties of the backshell and claws prohibit this process. Bodies and legs can be economically processed, but the resulting scrap still needed to be disposed of. The \$30,000 capital investment required, more than many crab meal plants can afford, posed an additional problem.

Two other firms have contacted me. An Annapolis firm is exploring the idea of mixing crab scrap in a slurry for fertilizer. I hope to hear more from them. A chemical firm from California is claiming crab scrap can be mixed under pressure to produce chitin and high concentrated protein. Unfortunately, the firm was unable to send a representative here, but I do have a letter roughly outlining the process. It seems different from Marine Agri-Product's effort.

## A HISTORICAL PERSPECTIVE

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There are four situations that must be faced before a process utilizing crab scrap is accepted. First, odors must be reckoned with. Although odors and gases from a crab meal operation are harmless, the opinion of the public and government cannot be ignored. Second, crab scrap is very perishable. A shower of rain falling on an open container of crab scrap accelerates decomposition. Scrap can tolerate warm wather conditions for only five hours. Third, twenty years ago, poultry feed was managed by small producers who thought in terms of tens and hundreds of tons of feed. Now Perdue and Holly Farms require thousands of tons. They constantly test feed ingredients for protein content, which varies in crab meal according to the season. Dorchester County will provide about 800 tons of crab meal per year, Somerset about the same and Virginia maybe twice that much. Compared to soybean and fish meals, this is small tonnage to interest the feed industry. Fourth, any new product derived from crab scrap will need state and maybe federal verification before it can be marketed. This could take months or even years of testing as well as dollars. It is therefore obvious the process must provide marketable products that will eventually generate lasting income if we are to find investors willing to enter such a program of manufacture. An ideal solution would produce byproducts that would generate sales as opposed to overboard or landfill disposal.



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## Crab Scrap Disposal in Maryland

Russ Brinsfield  
Maryland Marine Advisory Service

Roughly 20,730,000 pounds of crab scrap are produced in Maryland. Processors here are currently using two methods to dispose of the scrap: landfill and direct farm application. Some combine the two: when the farmland isn't available, they go to landfill.

Processors in Maryland rely primarily on landfills as their method of crab scrap disposal. Three landfills, two in Dorchester County and one in Somerset County, receive about 90% of the waste. After the crabs have been picked in the plant, the scrap is shoveled out onto a conveyor belt and then hauled in a dump truck. Since the scrap is high in organic material, it decomposes quickly and it must be taken to the landfill on a daily basis. Otherwise we have a severe odor problem. Presently the scrap is taken to the landfill, dumped and, at the end of each day, covered with dirt. Even with the crab chum being covered with dirt, the volatile gases produced in the decomposition of the crab meat still cause some cracking of the soil resulting in some odor problems.

The second method of disposal currently used in Maryland is direct farm application, which works very nicely for a processor who owns his own land. He can take the scrap from the plant directly in a manure spreader and simply spread it on the land. This does cause some odor problems, although in a rural area the problems are not too great. To realize the maximum fertilizer value of the crab scrap and to minimize odor problems, the farmer should immediately incorporate

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the scrap into the soil. The main limitation in this method of disposal is that it is only a viable alternative in the spring before the farmer plants his crops or in the fall after the crops have been harvested. Unfortunately, production levels of crab scrap are the highest after the farmland has been planted (Table 1).

In examining county, regional or statewide utilization of crab waste byproducts, the distribution of that waste is crucial (Tables 2 and 3, Figure 1). Of the state's 44 processors, 29 are located in Somerset or Dorchester counties—accounting for 66% of the scrap produced in the state. Talbot county, with 4 plants, produces another 14% of the waste.

Dave Swartz and I have recently surveyed crab processors in Maryland to find out from each what method(s) of disposal he used and how much it was costing per ton to dispose of the waste (Table 4). Based on 32 respondents, the average volume of waste generated per day is approximately 2 tons disposed of at a cost of a little over \$26 per day. When asked to estimate their total costs for disposal, we assume the processors included the transportation cost and the cost for labor to run the trucks as well as capital cost for the truck.

The difference in cost between the various methods of disposal (Table 4) is interesting. An average of 1.64 tons of waste is going to the landfill per day at a cost to the processor of a little over \$27, or about \$16.80 per ton. For direct farm land application, the average number of tons per day is 2.65 tons with an average cost per day of \$14.00, an average cost per ton of \$5.28—significantly lower than for the landfill option. For those who are using a combination of the two, the cost per ton is between that for the landfill and that for direct farm application. For those processors without access to farmland, an alternative would be to try to rent some farmland or to work closely with a farmer to provide land for disposal when the crab waste is being generated. Direct farm application is the least expensive method of crab waste disposal currently being used in the state of Maryland.

One of the last questions we asked the processors was simply: "Do you think that the landfill option represents a permanent solution?" Three said yes. Twenty-nine said no.

## CRAB SCRAP DISPOSAL IN MARYLAND

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One was undecided. The processors realize they are faced with a dilemma if we don't find an alternative method of disposal. They realize that in the long run the landfill is not going to be an option. When asked what they thought the long term solution could be, eleven processors indicated overboard dumping; nine, a rendering plant; five, fertilizer and stabilizer; eight were undecided. The crux of this issue is, I think, that the processors have a pretty good handle on the situation and are interested in finding a solution. I have found them most cooperative in trying to work with us in finding that solution.

**Question:** I've got a question from a farmer's perspective. Is there any cost associated with the farmer's direct land application or are there savings in fertilizer?

**Answer:** There is a fertilizer value associated with the raw crab waste. In some quick calculations that Dave (Swartz) and I have made, we figured the value of the raw material if it were worked into the ground immediately. Otherwise a lot of your nitrogen is going to be lost in the atmosphere. Worked in immediately, we figure the value of the fertilizer of the crab waste is probably equivalent to about \$15-\$20 per ton. It can displace that amount of fertilizer from a farmer's point of view. Now whether or not the crab processor can get that is another story.

**Question:** Do you know how much money the farmer is spending to actually disk the waste in?

**Answer:** No. I think it is not being worked in directly. It is simply being spread and allowed to dry on the surface. In the case of one processor, the farmer was taking the waste for nothing from the processor early this spring to incorporate up until planting time. After that, the processor had to go to the landfill alternative.

**Question:** How do the farmers feel about it?

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**Answer:** I think the farmers are in favor of it. They will take it when it is available to them. As a matter of fact, one farmer in Dorchester County has contemplated trying to find a way to take it all. If he could find a way to store it, he would like to store it during the off season. The farmers are very interested; they realize that it does have some nutrient value. The logistics of supply, demand and disposal by direct farmland application presents the problem. We need to find a way to stabilize the waste such that farm application at a later date would be a viable solution.

**Question:** Is the difference in cost between landfill and direct application primarily a transportation cost?

**Answer:** Yes, and also in some of the cases with the landfill, the processors were paying a disposal fee.

**Comment - Dave Swartz:** The larger the plant, the lower the cost.

**Question:** How much does it cost to have the landfill accept this material? Did you include the cost of this to the municipal government in the county?

**Answer:** This was direct cost to the processor. It did not include the cost for the government to maintain that landfill or for the operator of the equipment or whatnot. It only included the cost of the landfill operator required a payment from the processor. So this was direct cost to the processor out of the hip pocket.

**Question:** Was there any water pollution runoff from this crab scrap on land?

**Answer:** I would say if you would get a high intensity of rainfall directly after application, you might get some, but most of the places where they are applying the waste directly it has some grass on it. So the grass acts as a buffer, and it

## CRAB SCRAP DISPOSAL IN MARYLAND

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minimizes runoff. I would say it would be a very small amount. I would not consider that to be a problem.

Table 1

TOTAL ANNUAL BLUE CRAB LANDINGS IN LBS.  
FOR  
MARYLAND BY MONTH AND ESTIMATED SOLID WASTE  
GENERATED (1960-1978 AVERAGED)

<u>MONTH</u>	<u>LBS.</u>
September	4,215,256
October	3,047,887
November	896,099
December	99,133
January	1,133
February	793
March	1,384
April	377,972
May	1,159,042
June	3,028,147
July	5,082,731
August	5,124,676
TOTAL	23,034,253
*TOTAL SCRAP	20,730,828

Source: Commercial Fishing Newsletter Vol. 1 No. 1.

\*Based upon 10% yield of meat.

Table 2

AVERAGE DISTRIBUTION OF SOLID WASTE  
ON A  
DAILY BASE BY COUNTY

<u>COUNTY</u>	<u>% TOTAL</u>
Anne Arundel	5
Caroline	2
Dorchester	36
Queen Anne's	9
Somerset	30
St. Mary's	2
Talbot	14
Worcester	2
	100

Table 3

DISTRIBUTION OF CRAB PROCESSORS  
IN MARYLAND BY COUNTY

<u>COUNTY</u>	<u>NUMBER</u>
ANNE ARUNDEL	
Annapolis	$\frac{2}{2}$
CAROLINE	
Goldsboro	$\frac{1}{1}$
DORCHESTER	
Crapo	1
Cambridge	3
Wingate	2
Toddsville	3
Fishing Creek	4
Hoopersville	2
Crocheron	$\frac{1}{16}$
QUEEN ANNE'S	
Grasonville	$\frac{4}{4}$
SOMERSET	
Crisfield	$\frac{13}{13}$
ST. MARY'S	
Mechanicsville	$\frac{1}{1}$
TALBOT	
Sherwood	1
McDaniel	1
Wittman	1
St. Michaels	2
Bellevue	$\frac{1}{6}$
WORCESTER	
Stockton	$\frac{1}{44}$
STATE TOTAL	$\frac{1}{44}$

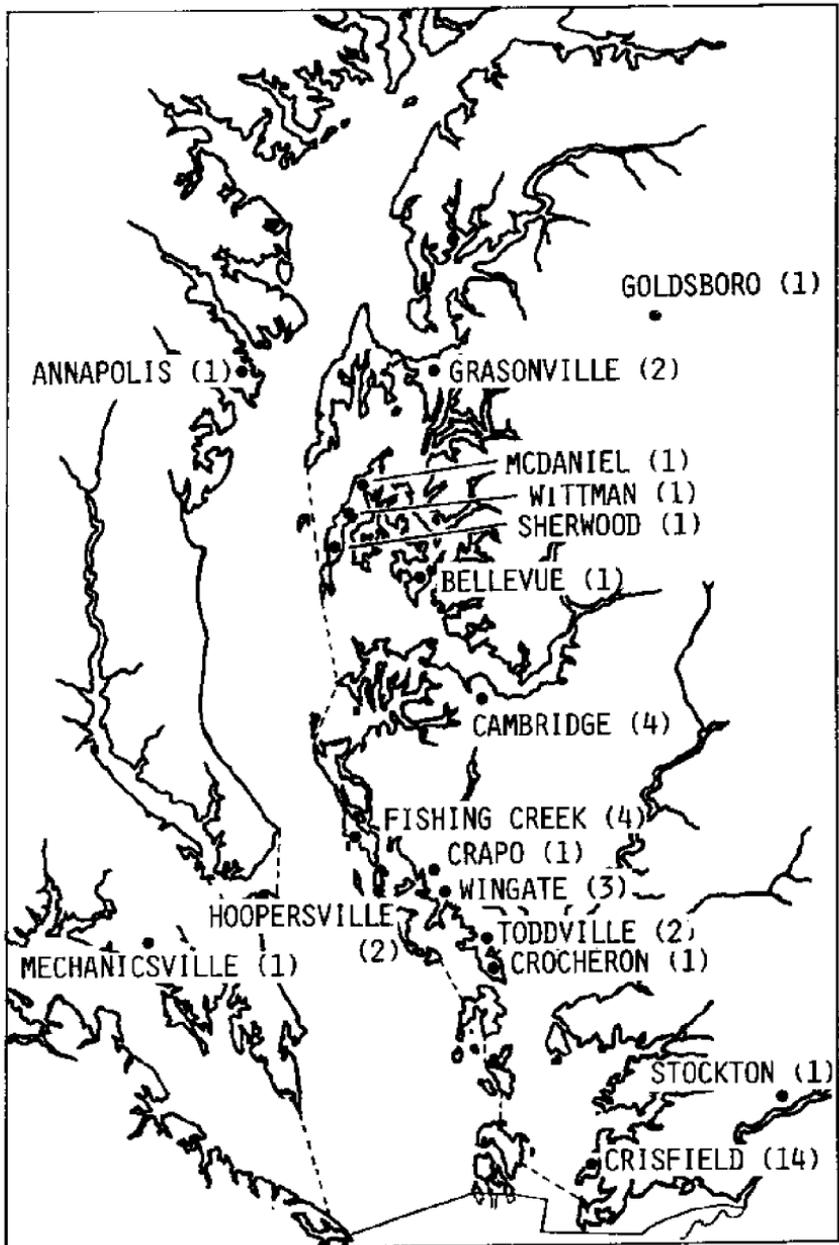


TABLE 4  
 Current Average Volume and Cost  
 For  
 Disposal of Crab Waste In Maryland

	Avg. Vol- ume Waste Per Day	Avg. Total Cost Per Day	Avg. Cost Per Ton
All	2.00 *(32)	\$26.44 (33)	\$13.25
Landfill	1.64 (25)	\$27.56 (26)	\$16.80
Farmland	2.65 (5)	\$14.00 (5)	\$ 5.28
Farmland & Landfill	4.35 (2)	\$38.00 (2)	\$ 8.74

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\*Number of Processors

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## Crab Scrap Disposal in Virginia

Dr. Charles W. Coale, Jr.

Virginia Polytechnic Institute and State University

Crab meat is commercially produced in 12 Tidewater counties and cities in Virginia. In 1979, Virginia crab processors produced 2,305 tons of crab meat and 21,309 tons of scrap that had to be disposed of at the plant site quickly to minimize odor and other environmental problems. The concentration of plants and the volume of waste differ in each region in Virginia (see Tables 1 and 2). For this analysis, Virginia is divided into three regions: Northern Neck and Middle Peninsula, Hampton Roads, and Eastern Shore.

The objectives of this paper are to illustrate the site location of commercial Virginia crab processing facilities and to describe the 1979 volume of crab scrap generated by the processing plants. The data on crab scrap was collected by personal interview of all 35 commercial (200 pounds or more of meat picked/day) plants in operation in 1979. The data format consists of number of plants by political subdivision, weight of live crab processed, weight of meat production, weight of crab scrap, method of disposal and range of disposal costs by ton.

### Northern Neck-Middle Peninsula

The raw crab input for the 18 processing plants in Region I is 10,774 tons per year. Assuming one pound of meat per 10 pounds of raw crab, this amounts to 1,074 tons of meat per year and 9,700 tons per year of scrap.

## **CRAB SCRAP**

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There are three disposal methods: meal plant pickup, public landfill and private landfill. Meal plant pickup is strictly small time. Not many people are interested in it because of the high cost for dehydrating the scrap and the trucking costs of picking it up. Another problem associated with the meal plant is the odor of the crab waste in transit. The Penfield, Pennsylvania plant that is the destination of much of the scrap will readily take the scrap provided they can get it.

County dumps are generally free but transportation must be provided to get the scrap to the county dump. Those processors with private dumps take the scrap to their own land and simply cover it up. Another viable alternative is the farmers. They take what scrap they can get and apply it on a field, as Russ said earlier, generally two times during a year--before planting and after harvest.

### **Hampton Roads**

Crab processors located in Hampton Roads picked about 1,164 tons of meat, which generated about 10,731 tons of crab scrap. Crab processors disposed of the crab scrap through a local crab meal plant. The scrap was picked up at the crab processing plant and delivered to a crab meal plant. The monthly fee for crab scrap disposal was fixed at the same level for each plant regardless of the volume of scrap produced. The average disposal cost per ton for crab waste in Hampton Roads was \$6.41 and a range from \$1.20-\$20.00 for 1979. The larger volume plants in Hampton Roads had a lower disposal cost per ton because of economies of size.

### **Eastern Shore**

Based on 1979 data obtained from the 4 crab processing plants on Virginia's Eastern Shore (Accomack County), 675 tons of crabs were picked. Using a conversion rate of 10% meat yield, there were 68 tons packed in 1979 and 607 tons of waste generated. This information takes into account that one processor operated less than half a year.

## CRAB SCRAP DISPOSAL IN VIRGINIA

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Currently crab processors in Accomack County have no waste disposal problem. Free pick-up services are provided daily by local hog producers who use crab scrap as a feed supplement. In-plant handling expense is the only cost associated with disposing of crab waste. This handling expense is labor cost required to move crab scrap out to the pick-up area. On a cost-per-ton basis, this handling expense ranged from \$5.44/ton to \$23.13/ton, with the average equalling \$10.30.

### Summary

Crab waste disposal presents a challenge to crab processors to find an effective means to deal with the problem. Considerable variation exists among the three Virginia regions in terms of: 1) the number and dispersed site location of crab processing facilities, 2) the tonnage of crab waste available for crab meal production, 3) alternative disposal methods and 4) the average cost per ton for crab waste disposal.

The current crab waste disposal alternatives represent a relatively small production cost when compared to the total cost of producing crab meat; however, there are potential risks that might increase the cost of crab scrap disposal significantly. Although the tonnage of crab waste appears large, the processing plants are dispersed throughout Tidewater Virginia causing higher assembly costs for utilization in meal plants as energy costs rise. In the Hampton Roads region, a meal plant is the one means of disposal, but meal plants are facing an uncertain future. Increasing energy costs, more severe environmental regulation and fluctuating demand for crab meal are making it difficult for management to continue operations. If the meal plant should close, the cost of disposal would increase. In any event, new waste disposal methods must be found to deal with the environmental problems faced by crab processors.

TABLE I

Site Location of Virginia Crab Producing Plants  
(200 or more lbs. per day) 1979

REGION	NUMBER OF PLANTS	
	Subtotal	Total
I. NORTHERN NECK-MIDDLE PENINSULA		18
Mathews County	2	
Gloucester County	3	
Middlesex County	1	
Lancaster County	3	
Westmoreland County	5	
Northumberland County	4	
II. HAMPTON ROADS		13
York County	2	
Hampton	5	
Newport News	4	
Poquoson	1	
Norfolk	1	
III. EASTERN SHORE (Accomack County)		4
TOTAL PLANTS		35

TABLE 2

Crab Waste Volume, Method of Disposal  
and Cost in 35 Virginia Crab Plants, 1979

REGION	RAW CRAB INPUT (TONS)	PRODUCTION (TONS)	SCRAP (TONS)	DISPOSAL METHOD	COST	AVERAGE COST/TON
I. NORTHERN NECK- MIDDLE PENINSULA	10,774	1,074	9,700	*Meal plant Pick up *Public Landfill *Private Landfill	Transportation	\$4.40 (Range \$1.00-8.00)
II. HAMPTON ROADS	11,924	1,164	10,732	*Meal Plant Pick Up	Fixed Monthly Fee	\$6.41 (Range \$1.20-20.00)
III. EASTERN SHORE	675	67	607	*Pick Up at Plant	Labor Expense In-plant	Zero Cost for Disposal
TOTAL	23,373	2,305	21,039			Range \$1.00-20.00

\*Estimates based on industry personal interviews.

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## Scrap Handling Practices Nationwide

David Dressel  
National Marine Fisheries Service

If I were a blue crab processor, I would want to know something about the practices of other seafood processors in the hope that they might shed some light on my own waste problems. I'd like to offer then a broad overview.

United States fisheries harvest roughly one hundred different stocks of fish. The Environmental Protection Agency (EPA) has taken these hundred species and broken them down into thirty-nine categories of seafood processors; categories are based on the species processed, the type of processing and the geographical location. There are eighteen species groups of finfish, and of the five shellfish groups it is important to remember that there are arthropods—crabs, shrimp and lobster—and mollusks—the oysters and clams. Of these, let's concentrate on the arthropods.

In looking at waste treatment disposal problems, there are going to be several universals. You are going to have liquid waste streams and, with the exception of remote processors in Alaska, solid waste streams. In some cases, you are going to also have sludge disposal, another form of solids which we won't go into today, except to say that they are residuals generated from dissolved air flotation and biological treatment systems.

Finfish scraps are commonly converted into meal with a high protein content and value, and many of them are associated with oil production. By comparison, crab and shrimp scraps are low in total protein content. There are an

incomplete array of amino acids; thus you have a low value for the meal. A look at the relative value for the various meals competing on the market shows fish meal in August 1980 at \$380 a ton and soybean meal at \$201-215, depending upon the amount of protein. Crab meal last year went for an average of \$121 a ton and shrimp \$71.

The difference in the values of the meal is just the beginning of the contrast between the successful fishmeal menhaden industry and the crab scrap problem. More importantly, in the case of crab (and shrimp) no oil is produced when you generate that meal. The menhaden industry is an ideal situation with three general products--meal, oil and solubles. Each product has a tremendously high volume with a uniform composition and quality. Moreover, the solubles are roughly fifty percent solids.

A closer look reveals that the Atlantic menhaden plants have about a 3 % yield. For an input of fifty tons of fish, one ton of meal is produced valued at \$380 a ton, 0.70 tons of solubles valued at \$77 a ton and roughly 0.20 tons of oil valued at \$360 a ton. So for fifty tons of fish, the total products are valued around \$514. The results of the same operation in the Gulf are rather striking. The figures work through the same except for the production of oil. Instead of roughly 0.20 tons of oil, in the Gulf 1.10 tons of oil are generated. Now the oil is worth more than the meal; the total value becomes \$853 for the fifty tons of fish processed--up from \$514 in the Atlantic area. Industry sources all agree: the sale of fish meal solubles covers the cost of production, but the sale of oil accounts for the profit.

The pet food industry comes to mind next when thinking about ways to utilize scrap. Some tuna plants do in fact have a pet food line, but their tremendous volume and steady production make tuna plants unique. Additionally, they use the same hygienic controls for making pet food that they do for human foods. For a small company pet food does not present much of an opportunity; a tight market, it requires a huge advertising budget.

There are other possibilities for shellfish wastes. In shrimp shells, for instance, the carotenoid pigments have

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## CRAB SCRAP

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been used in shrimp feeding rations and also extracted and used to supplement meals for trout and salmon feeding. The carotenoid pigments impart a red color to the flesh of the fish, increasing its market value. Except for the red crabs found on the Pacific Coast and also in the New England area, these pigments are not found to the same extent in crab shells.

It is important to see what happens to crab scrap in other locations, particularly where the volume is significant. In Alaska, the rendering of crab waste is handled by the BioDry Company in Kodiak. In order to make their operation viable, they depend upon the processing of salmon and fish scrap which have high oil content. In Kodiak, there are seventeen processors operating year round. A \$21 a ton surcharge is assessed to the processors to even handle the wastes, even though they have tremendous volume and a yearly production. Other facilities in Ketchikan, Cordova and Petersburg are operating at a loss right now. This is strictly a waste disposal technique, not a money maker. The cost data are detailed in the Federal Register of August 7, 1980. If you look closely at the returns, you will see oil production featured. This is how the cost of rendering is offset. In Alaska, landfill is actually prohibited in some areas because it attracts bears. In other areas, there is not enough soil to have a landfill so that is ruled out. Ocean barging is practiced but the expense and the weather cause problems. Again, this data was detailed in the August 7th Federal Register showing the industry's cost projections for barging and putting in docking facilities and holding facilities to contain these wastes before they are put on the barges to be disposed of.

Elsewhere around the country, other options are being investigated. Composting has been tried experimentally in the Gulf area and also in California. Don Foxx from that state will be talking later about composting crab wastes and other fish wastes along with sawdust. Chitin and chitosan production is also being looked at. A chief component of all the arthropod shells, even insect wings, it could hold a potential for developing cost effective solid waste utilization systems.

The first international conference on chitin and chitosan was held in Boston in 1977. It has been three years since then, yet Japan remains the only producer of chitin and chitosan. There are no established markets in the United States. Why? Is it a lack of sufficient products for testing or is the quality of the products poor? Are there substitute products in existence? Are there any uses for chitin and chitosan for human or animal foods that the Food and Drug Administration would consider acceptable? The menhaden oil sold to Europe for use in margarine would not be allowed in American margarine.

Overall, this meeting offers many potentials but no easy answers. It will be up to the processor to sift through the alternatives in terms of his own operation. To sit by idly and think the problem will solve itself ignores economic realities. The smart businessman helps shape his future.



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## Report from the Landfill

George Miles  
Somerset County Government

I am superintendent of landfill of Somerset County. Contrary to the happiness that is in Dorchester County, the people, the pickers and the contractors in our county are not very satisfied with the use of the landfill for disposing of crab waste. In September 1979, our only rendering plant announced that it would close at the end of the season. Several factors forced the decision. The volume of the crab scrap had decreased over the years because the more select blue crabs were being shipped to northern markets for steaming rather than being picked at the houses. Local residents were complaining about the odor from the plant. Over \$100,000 was required to bring the plant up to air quality standards.

Faced with this situation, county authorities and pickers decided to haul crab scrap to the one county landfill. Transportation costs are considerable for the pickers; some haul as far as 30 miles. The amount of crab scrap that we received at the end of the 1979 season was minimal, but we were not looking forward to 1980. This year to date, we have received roughly 15 tons, or 5500 cubic yards of crab waste. By the end of the season, the total should exceed 7000 cubic yards--quite an amount to be buried in a landfill of no use to anyone.

The decision has not made anybody at the landfill happy, either. I have to sympathize with the personnel there. I am in and out, but the contractor and his men are there 10 hours at a time and they really suffer. I don't think any of you would want to spend 10 hours a day, 6 days a week at our

## CRAB SCRAP

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landfill with this crab waste coming in on a daily basis. We have this summer fielded our first odor complaint in 4 years from nearby neighbors. In addition to our daily cover of 6 inches, we now must cover at interim times during the day when there is a rush of crab scrap coming in. It is delivered fresh but if the slightest amount is left uncovered for any amount of time at all, with the typical hot weather, the odor is terrible. It seems likely that we will have to haul in additional cover, which at our location is going to be very costly. Given our present tax base and the population in our county, this represents a severe hardship for our citizens.

In Somerset County, we would appreciate any alternative to disposal in our landfills.

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## Overboard Discharge

Hillmer J. Olsen  
York Crab and Oyster Company, Inc.  
Seaford, Virginia

The only advantage of dumping overboard is that it helps avoid filling up our landfills. Possibly it also causes a short-term increase in the biological activity in the water.

The disadvantages are many. First would be the difficulty of determining a place of embarkation for your product. You would have to find a docking facility and I know in my Hampton, Newport News area, the facilities are few. Equipment would also be a problem. For an overboard discharge operation, you would have to have two towboats and a minimum of two barges. With fuel costs having doubled in the past year and expected to climb further, this is an expensive fleet to operate. In addition, you would need certified captains, crews and permits for dumping and your equipment would have to be Coast Guard certified to operate. You might also have to grind the scrap because by law you can't have any floating particles. So that is another cost, both in terms of capital investment and energy.

Another consideration, which none of us has any control over, is the weather. Imagine the consequences if you have your barge tied up somewhere and are filling it up with scrap when a northeaster sets in and the barge can't leave the dock for a day or two. We ordinarily have a problem with odor, but to have anything like that happen would be a disaster. Some type of deodorizing and cleaning operation to eliminate the odor is going to be needed merely to have the empty barge sitting at your dock for the weekend. Some type of facility

## CRAB SCRAP

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for loading and unloading when you get out to your dumping ground is also going to be necessary. It could be some type of conveyor arrangement or even a front end loader.

I just don't see how it will be feasible to eliminate the crab scrap problem by dumping overboard. All in all, I just can't conceive of anyone even considering dumping overboard.

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## Running a Crab Meal Plant

Weston Conley  
RCV Seafood Corporation

My crab meal operation on the Northern Neck of Virginia draws from three of the five major crab processors in the immediate area.

Overall, we are very satisfied with our operation. Normally, we crank the plant up once a day. The other crab plants bring their scrap in by 3 o'clock. We supply dump trucks at the various sites along with maintenance and gasoline, but, in most cases, the plants supply the drivers. Other than feed, ours is a completely automated system. As most of you crab meal processors know, the way crab meal bridges, to get the material to an auger is difficult. It's not easy to have a system to feed under a constant situation; therefore, we have a large screw conveyor and we use a bobcat so very little work is done by hand. Normal processing time is about 6 1/2 hours. Currently, we are running the plant at 65% capacity and fuel consumption is around 22 gallons an hour. We feel we have a very efficient operation. The cost factor has been much better than the figures I originally plugged in.

Anyone considering opening a crab meal dehydration plant is going to have to consider much more than just the commodities market. The capital outlay involved and the choice of equipment are major concerns. When I first went into this business eleven years ago, I started out with a storage area and storage crew, a bobcat and half a building. Decisions about equipment are never easy to make. At one

## CRAB SCRAP

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point I was ready to spend \$40,000 for a piece of equipment I found out was virtually obsolete. When I finally did buy, the company went on strike for nine months. During that one season I was out of business, I spent \$13,000 for dump truck axles alone.

Air pollution is another potential problem. With our old operation we ended up in court when the lady next door objected to the smell. We now have an air recirculation device that cost \$10,000. The result is that there is very little odor when the scrap is processed properly. Three neighbors live within 500 feet of the plant and there have been no complaints. As an employer of 125 people pumping from \$30,000 to \$50,000 into the local economy, we don't get a lot of flak from the community.

Volume and merchandising also pose problems. The production volume in the state of Virginia is quite small compared to the volume produced by one large firm; at Anheiser Busch, for instance four or five trailers haul mash continually. At the other end of the scale, crab meal producers have had to group together to guarantee one or two of the larger users as much as 100 tons of meal a week. The total production of our plant this year will be 800 to 850 tons.

I would highly recommend to anyone who is interested in going this route to come look at what we have. If you are seriously interested, I will certainly be glad to let you look at some of the figures we have.

**Question:** Would you be willing to put a crab dehydration plant around here?

**Answer:** Let me answer your question indirectly. Knowing what I know about my operation, I would say no operation is any better than the manager. You need somebody who is on top of things all the time. I know of a plant that cost \$135,000 that is just sitting out in the middle of a field, brand new. Well, the downtime is just so ridiculous that I know the plant can't make any money. You need a good operator, but it is one of the most undesirable jobs that I can think of--135 degree heat and odor just for starters. Consequently, if

## RUNNING A CRAB MEAL PLANT

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someone is not riding herd on what is going on, operation and maintenance costs could be excessive.

**Question:** What do you think the impact of new technology will be on the price of the crab meal?

**Answer:** Well, I'm in a situation right now. I can get \$45,000 for this piece of equipment today as it sits; if chitin or chitosan or whatever comes along, I think I would be willing to invest another \$40 or \$50,000--if I thought I was going to utilize this product without a high energy cost. I am glad to see someone is actively pursuing other areas because I think someday maybe we will be at a point where, if the soybean price comes down, we've got a problem. If you go to a machine operation, say an extractor such as a Baader machine, you are going to cut your protein down. Our plant is so efficient that my competitors are probably coming out with 15 or 16% more moisture. They are being cut on that tonnage price and when the guy goes to dump the trailer, the meal won't even slide out of the trailer. We tried for two reasons to maintain and guarantee a 10% moisture factor: one is to have another product and the other is the storability of the product in a pile. We don't have to turn the meal. You know when a lot of these guys put the meal in a pile, when they go to get it, it is a big cake. That is because of their equipment. They have no automatic controls. The minute it gets too hot, they turn it down.

In terms of protein, we are guaranteeing 31%. It had never been less than 33%; now it is up to 46%. So you know what is happening to the crab. More of it is going into the scrap pile. They are not picking them. They are cutting the tops off the crab. They throw those in and if somebody is not standing right by those people 24 hours a day, you know you are not going to stop that and I say right now our protein is running (we can guarantee you) 35% at no problem and more like 38%. I think this is fairly well true with all of the small operators that are processing hand picked crabs at this point.

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## Crab Meal Production: Costs and Returns

Thomas Murray  
Virginia Institute of Marine Science

Underlying the crab waste disposal problem has been the widespread assumption that the cost of operating a crab meal production unit and the limited market disqualify crab meal production as a viable waste treatment option. In light of this assumption, I would like to consider the costs and returns of a model crab meal production enterprise.

The budget developed here depicts the fixed costs of required drying equipment, buildings, etc.; the projected annual costs of operation of three different production levels; and a summary of the costs, returns and earnings for such an enterprise over one year.

The Heil SD 75-22 dryer was selected for this analysis for the following reasons:

1. A facility using this same model is in operation in Virginia and therefore management information (not a part of the manufacturer's specifications) would improve budget estimations.
2. This particular drying system is capable of rendering the large quantities of scrap generated at industry centers such as Crisfield and Cambridge, MD and Hampton, VA.

As indicated in Table 1, estimates were made of total fixed costs of operation for the complete dryer system, manufacturer's installation and a tractor to facilitate scrap handling at the plant site. The building and grounds expenses were estimated by contractors in the Tidewater Virginia area.

## COSTS AND RETURNS

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Taxes and insurance annual carrying costs, figured at fourteen mills and \$10/\$1,000 respectively, are believed reasonable. Tax rates will vary by location and insurance rates will change with a number of factors such as building materials used, number of personnel and location and age of physical plant.

The \$17,000 under fixed labor costs represents a reasonable salary for a plant manager who will be the primary operator of the drying enterprise. Manufacturer's specifications and processor information indicate that this particular unit is highly automated and may be operated by a single individual. Annual variable labor costs, however, do include an additional worker to supplement the plant operation (Table 2).

Average costs for repair and maintenance quoted by the manufacturer were not utilized but rather more pessimistic estimates for repair rates were used. Discussions with existing plant operators indicate the graduated rates are reasonable. The simple assumption is that wear and tear on the unit will increase proportionally with use. Repair costs of such a unit depend upon a number of conditions such as quality of operating personnel and equipment maintenance records. Rates used are proportionate to hours of dryer activity.

In annualizing the fixed costs of operation, depreciation was figured using the IRS replacement schedule (20 years for building, 15 years for equipment), using straight line depreciation and assuming a zero salvage value.

The annual principle and interest expenses were figured by assuming all capital required is borrowed at 12% for seven years. The amortization payment of \$35,849.00 was figured based upon the capital recovery formula:

$$A = P \frac{i(1+i)^n}{(1+i)^n - 1}$$

Where: P = Loan or Debt.  
i = Annual Compound Interest Rate.  
n = Number of years.  
A = Annual payment required to repay debt with interest "i" in "n" years.

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## CRAB SCRAP

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Interest is charged for all capital needed irrespective of whether it is borrowed or not. Therefore on any equity, the 12% interest represents an "opportunity cost" or foregone return on the capital in some other use.

Projected fuel consumption includes a reported 5-10% reduction in fuel use by installation of the budgeted vapor recycling duct, which also significantly reduces particulate emissions from the facility.

The Heil SD 75-22 Dryer can be adapted for natural gas. According to officials at Virginia Electric and Power Company (VEPCO), use of natural gas would cut the fuel costs by an estimated 35%. However, natural gas is not available at all locations and energy experts expect substantial increases in the cost of natural gas as federal controls are removed; theoretically, this will ultimately equalize relative energy input costs.

Because fuel costs have been widely identified as a source of investment risk in a commercial drying operation, further analysis of fuel cost variability and financial impact are considered later in this report. Electrical costs were also figured on an hourly basis as per manufacturer's horsepower specifications. The cost of electricity to run the various motors used by the drying system (totaling 60 h.p.) were figured at .75 K.W.H./H.P.H. and \$ .08/K.H.W. (VEPCO).

One element that has been omitted from plant costs is land. Land costs have been ignored for two reasons:

- 1 The great variability in land values surrounding the Chesapeake Bay. For example, acreages available in Tidewater Virginia, although two miles apart, are being offered at \$25,000/acre (waterfront) and \$3200/acre (inland).
- 2 In terms of total fixed costs, this value will probably be relatively minor and can be an appreciable asset.

The total fixed costs are translated into annualized values along with the strictly operational (variable) costs of production. The fixed and variable costs represent the yearly expenses of producing different volumes of meal.

Enterprise cost data were estimated on the basis of hour-

ly costs of operation by combining the manufacturer's specifications with actual plant data. Production figures derived from actual plant data are projected for operating the plant at 65% of plant capacity. At this level, 1.5 tons of meal would be produced per hour from approximately 3.5 tons of scrap. A processor-derived estimate of a 43% yield of meal from wet scrap was used to specify plant output at the 65% capacity level.<sup>1</sup>

The costs for fuel, electricity and maintenance were also figured on an hourly basis. Fuel consumption was budgeted at 65% of the unit's maximum fuel consumption, which is rated

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<sup>1</sup> Exact yields of meal from wet crab scrap vary considerably depending upon a number of factors such as the physical state of the animal, method of picking and efficiency of the dryer. More complete drying of scrap material reduces the moisture content of the meal product; thus the yield (conversion factor) would decrease. However, because crab meal is valued for its protein content, a more thoroughly dried meal having a higher protein content would receive a higher price.

For example, processor information indicates that at a 30-35% conversion rate the meal protein content would be over 40% and thus the meal would command a higher price.

Generally the conversion factor and protein content will vary inversely. The assumption herein is that percentage changes in meal conversion rates are offset by opposite changes in the total revenue generated from the higher value product.

Thus for the sake of revenue projections herein, 43% conversion to 31% protein meal is considered reasonable.

## CRAB SCRAP

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at 60 g.p.h. At 65% capacity processor information indicates a burn rate of about 30 gallons per hour.

Fifty-three percent of the annual fixed costs are comprised of payments to principal and interest (Table 2). The size of actual cash capital expenses will vary greatly depending upon a number of factors such as actual loan sources and terms as well as the amount of equity capital available (for example, 75% financing at the terms budgeted reduces the average fixed costs expenditure per ton for the smallest scale operation by \$30.00 to \$82.00).

The model crab meal production facility is characterized by substantial economies of scale with decreasing average total costs per ton throughout the relevant range of production levels (Table 2). Firms locating in areas without the availability of substantial quantities of crab scrap could consider handling other scrap products locally available to more fully utilize the production capacity of this particular plant. Most modern dryers are adaptable for all grains, agricultural products, meat and seafood products. A smaller scale operation and the availability of used drying equipment would significantly reduce the capital investment. The processing system budgeted in this report was chosen because of its capability to render the great quantities of crab scrap generated at processing centers such as Crisfield, Maryland and Hampton, Virginia.

I will be glad to discuss any questions you might have with some of these assumptions or the analysis we have done.

TABLE I  
Fixed Costs for Crab Meal Plant  
Prices for August, 1980

<u>Equipment</u>		
Heil SD 75-22 Dryer Complete	\$	42,114
Feeder and Infeed Conveyor		19,188
Jacobsen Hammer Mill		4,128
Rotary Air Lock		4,025
Output and Loading Screw Conveyors		9,600
Vapor Recycling Duct		5,000
Refractory Material		2,300
<u>Installation</u>	\$	<u>35,040</u>
<u>Total Drying Unit</u>	\$	<u>121,395</u>
<u>Front End Loader (Ford "Bobcat")</u>	\$	<u>9,500</u>
<u>Total Equipment</u>	\$	<u>130,895</u>
<u>Building and Grounds<sup>1</sup></u>		
60' x 80' x 20' (Mitchell)		
Metal Bldg.	\$	24,000
4800 sq. ft. Concrete Slab		4,800
Taxes and Insurance		<u>4,000</u>
<u>Total Building and Grounds</u>	\$	<u>32,800</u>
<b>TOTAL FIXED COSTS</b>	\$	<u><b>163,695</b></u>
<u>Labor</u>		
Salary and Fringe Benefits	\$	<u>17,000</u>

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<sup>1</sup> Industry sources indicate a possible need for additional covered meal storage capacity at larger production levels.

TABLE 2

## Annual Costs for Three Levels of Crab Meal Production

<u>Fixed Costs</u>				
Depreciation <sup>1</sup>		\$	8,726.00	
Salary Mgr.			17,000.00	
Principal and Interest <sup>2</sup>			35,849.00	
Insurance and Taxes			4,000.00	
Miscellaneous			1,500.00	
<b>TOTAL FIXED COSTS</b>		\$	<b>67,075.00</b>	

	<u>Tons of Production</u>		
	<u>600</u>	<u>1200</u>	<u>1800</u>
<u>Variable Costs</u>			
Fuel <sup>3</sup>	\$ 13,800	\$ 27,600	\$ 41,400
Repair and Maintenance <sup>4</sup>	654	1,309	1,963
Electricity <sup>5</sup>	1,424	2,848	4,272
Selling Expense	1,800	3,600	5,400
Office Supplies	500	500	500
Telephone	500	500	500
Labor	7,280	7,280	7,280
FICA (.0613)	446	446	446
Unemployment and Workmen's Comp. (.013)			
<b>TOTAL VARIABLE COSTS</b>	<b>26,499</b>	<b>44,178</b>	<b>61,836</b>
<b>TOTAL COSTS</b>	<b>\$ 93,574</b>	<b>\$ 111,233</b>	<b>\$ 128,931</b>

- 1 Depreciation = 20 year for Building,  
15 year for Equipment - IRS Replacement Schedule.
- 2 Assume 100% Borrowed Capital at 12% for 7 years.  $163,695 \times (.219) =$  uniform annual payment based upon the capital recovery formula

$$A = P \frac{i(1+i)^n}{(1+i)^n - 1}$$

where: P - Loan or Debt.  
i = Annual Compound Interest Rate  
n = Number of Years.

A = Annual payment required to repay debt with i in n years.

- 3 Maximum fuel consumption (as per mfg. specifications) = 60 G.P.H. Assume at 65% of capacity consumption = 30 G.P.H. of #2 fuel oil at \$1.15/ga. as per processor information. Approximately \$34.50/hour of dryer operation.
- 4 Repair and Maintenance = 0.5% of total equipment cost at 600 tons total equipment cost at 1800 tons output, 1.0% of total equipment cost at 1200 tons output; 1.5% of total equipment cost at 1800 tons output.
- 5 Electricity at .746 K.W.H./H.P. for 60 H.P. = 44.76 K.W.H./Hr. operation \$3.56/Hr. of dryer operation.
- 6 Selling expense of 3% considered standard for commodities broker.

TABLE 3

## Summary of Costs, Returns and Earnings

<u>Tons of Meal Produced</u>	<u>600</u>	<u>1200</u>	<u>1800</u>
Total Assets	1 63, 695	1 63, 695	1 63, 695
Gross Receipts* (\$100/Ton)	60,000	120,000	180,000
Total Variable Costs	26,499	44,178	61,856
Total Fixed Costs	67,075	67,075	67,075
Total Costs	93,574	111,253	128,931
Net Receipts	-33,574	8,747	51,069
% Return on Assets	-----	5%	31%
% Return on Sales	-----	7%	28%

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\* Based upon revenues of \$100.00 per ton for crab meal.

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## The Use of Fish Solubles and Crab Wastes on Agricultural Crops

Dr. Louis H. Aung  
Virginia Polytechnic and State University

Dr. George J. Flick, Jr.  
Virginia Polytechnic and State University

Interest in the use of fish solubles for growing crops started at Virginia Tech four years ago. The results obtained have been encouraging, and may have some implications for the use of crab waste as well.

Fish solubles have been used to grow some popular house plants such as peperomias, philodendrons, umbrella (*Schefflera*) plants, and vegetable crops of tomato, lettuce, peas and radishes. More recently, fish solubles were tested on corn and soybeans. The decorative house plants fertilized with fish solubles grew well and had a dark coloration and a glossy sheen on the foliage. They aged more slowly than plants fertilized with inorganic nutrients. The growth of vegetable crops was also promoted. Corn responded to fish solubles with vigorous vegetative growth, while soybeans grown under both greenhouse and field conditions gave significantly greater seed yield. The nature of the soybean cultivars also had an influence on final seed yield.

The anti-aging factor(s), which causes plants to age more slowly, has been tentatively identified as a cytokinin in the fish solubles. Further study is required to definitively confirm the preliminary result.

Crab wastes added at 10-40 g per 3.5 kg of sand medium did not appreciably inhibit corn growth compared to corn fertilized with fish solubles. These same rates of crab wastes inhibited tomato growth. The inhibitory property of crab

## CRAB SCRAP

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waste may be useful to control excessive vegetative growth of crop plants.



Figure 1. Growth of umbrella (Schefflera) plant fertilized with fish solubles and inorganic fertilizer (25-10-10).



Figure 2. Growth of radish fertilized with inorganic nutrient solution and fish solubles. *Left to right:* Water, inorganic nutrient solution, 30 ml fish solubles per 3.8 liter of water weekly and 30 ml fish solubles per 3.8 liter of water bi-weekly.



Figure 3. Growth of tomato fertilized with fish solubles, inorganic nutrient solution and different rates of crab wastes. Left to right: 15 ml fish solubles per 3.8 liter of water weekly, inorganic nutrient solution weekly, 10 g crab waste per pot (3.5 kg sand), 20 g crab waste per pot, 30 g crab waste per pot and 40 g crab waste per pot.



Figure 4. Growth of corn fertilized with fish solubles and different rates of crab wastes. *Left to right*: 15 ml fish solubles per 3.8 liter water weekly, 10 g crab waste per pot, 20 g crab waste per pot, 30 g crab waste per pot and 40 g crab waste per pot.

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## Ensiling Crab Waste

Dr. Joe Fontenot  
Virginia Polytechnic and State University

There are two reasons to process crab waste or any other waste. The first is to make it handleable and storable. The second and more important is to get rid of potential pathogens. With animal waste, ensiling seems to work; given the right ensiling practices, I think the same can be said about crab waste.

Dr. Aung talked earlier about plant nutrition. The problem for livestock and humans is similar. The digestive tract is blind. It is looking for its nutrients and it usually doesn't matter where the nutrients come from: they could come from corn, from soybean meal, from hay, corn silage or from animal wastes silage or from crab solids.

People always ask if using ensiled waste as feed has negative effects on the quality and taste of the meat. As far as the taste of the product, we have never detected any difference at all. Our testing has indicated no problems with the taste of the meat resulting from broiler litter as cattle feed. Studies with other wastes have produced the same results. Caged layer waste, for instance, had no negative effect on the taste of milk.

How do we propose to go about ensiling crab waste? We have proposed to the Sea Grant Program to mix crab wastes with a crop residue such as corn stalks, straw or peanut hulls. We may have to add some soluble carbohydrates in the form of molasses or whey or such. We would ensile for a minimum of 30 days and then the silage could be fed to cattle.

## CRAB SCRAP

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There is definitely potential for utilization of crab waste as a solid to feed to livestock, especially cattle. A handful of tons per week could be handled by a fairly small or moderate-size cattle producer. He could do the ensiling and then take the feed to the cattle.

We do need to sample the wastes. By looking at the composition in terms of soluble carbohydrate, moisture level and the like we are able to tell how well it will ferment. Then we would take some small amounts of the waste and ensile them in gallon containers with crop residues and add different amounts of soluble carbohydrates. We would probably look at different moisture levels in the range of 30-50% moisture.

The next step is to remove the silage and measure the pathogens in the silage, the pH, the lactic acid, determine how well it has fermented and make some general observations. At this point we would move to a larger structure, probably scale up to a barrel; then feed the silage to animals and look at the palatability and digestability of the more promising mixtures. We wouldn't ensile all the mixtures, only the more promising ones. Next, we would ensile large amounts and run a feeding test with, say, finishing cattle, for example, in which we would have the silage supplying at least a protein supplement and maybe also some wintering cattle or growing cattle. In addition to looking at palatability, we would measure the rate of grain and feed efficiency. After that, what we propose to do is to encourage the use of the ensiled waste by setting up some demonstrations. In this, we would work with local beef producers who are in close proximity to crab processing plants.

From work that we have done on ensiling other types of waste materials—principally animal wastes and crop residues—I think we can do some mixing and make use of crab waste. Someone was mentioning a while ago the possibility of using some broiler house litter. I don't think it will work for composting because both the waste and the litter are too high in nitrogen, but in terms of ensiling, that potential is there. If the material happens to be too dry when you mix it with crop residues, you can take caged layer waste or wet cattle waste and mix with it; or if it is too wet, you can take some

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## ENSILING CRAB WASTE

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broiler litter and put it in. My impression is that in the areas where you have both crab processing wastes and a fair amount of poultry industry, there is a possibility of blending these. Initially we will be looking at the crop residues and the crab wastes.

I am sorry that I don't have some hard information to present to you on the ensiling of crab waste, but to my knowledge it just wasn't there.

**Question:** What condition would you anticipate that crab waste would have to be in to ensile? Could it be fresh or would you have to dry it?

**Answer:** It would be fresh; the fresher, the better. This will present a problem because you can't ensile every day. On the other hand, hopefully, there may be a way to keep it for a few days until you can accumulate enough to ensile. There is another possibility in addition to ensiling that I should mention, and this is one of the things that we would like to look at also. There are some chemical treatments that will get rid of most of the odor and get rid of the organisms. In other words, the material could be mixed in with other feeds and fed fresh. A small amount of formaldehyde mixed in will do a pretty good job. I really think that crab waste has the potential to be used as animal feed.

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## Composting Blue Crab Waste: The Engineering

Russ Brinsfield  
Maryland Marine Advisory Service

Composting blue crab waste converts the waste product to a stable, usable product with economic value, especially for fertilizer for farm use. Though the composting process is reasonably well understood, little data exists on efforts to compost blue crab waste. Dr. Fred Wheaton, Dave Swartz and I have submitted a proposal to the University of Maryland Sea Grant Program to research this application. I will present the engineering aspects of the proposal, and Dave (Swartz) will follow with a look at the economics.

Composting is a biological process carried out in either anaerobic or aerobic condition. The anaerobic condition simply means that we let nature take its own course, allowing bacteria to decompose the material at their own rate. Aerobic composting occurs when air is supplied to the compost to try to enhance the rate of decomposition of the material with an end product that is stable, humus-like and, hopefully, of some economic value.

There are several reasons for choosing an aerobic over an anaerobic process for composting. Supplying air to the compost material enhances decomposition and reduces the unpleasant odors associated with an anaerobic process. Moreover, if optimized, the aerobic process requires less land. In addition, the higher temperature in the aerobic compost pile results in less weed seed, fly ova and pathogenic organisms.

The overall composting scheme is shown in Figure 1. The inputs on the far left are the crab wastes and either wood

chips or possibly sawdust. One of the major concerns with aerobic composting is to achieve an even air distribution throughout the composted pile to get equal decomposition of the material independent of its position in the pile. Another consideration is that we have sufficient proteinaceous matter in the raw material to cause the composting process to take place. One method to enhance the rate of decomposition would be possibly to grind the material into finer particles. By doing that, you increase the total surface area of the material and accelerate its rate of decomposition. On the other hand, because of the energy cost for the grinding, we don't want to reduce the particle size substantially. Finding the optimum size of particle for the composting process will be one of the important variables in this project.

After grinding, you mix the waste and bulking agent at about two parts sawdust to one part crab waste, aerate and then dry. If wood chips are used, the compost is screened and recycled to minimize cost. The screened compost is cured and made ready for a market.

The basic engineering objectives of this project proposal are to determine the effect of various process variables on composting rate and end-product stability. We want to determine the interrelationships between such variables as air flow rate, size of the compost pile, the mixture of wood chip to waste in the input, particle size, etc. and determine how these relationships affect the rate of composting and end-product stability.

What we propose to do for the first year is to construct a lab model composting unit to determine the interrelationships between the composting variables. The variables that we plan to control and/or measure over the compost cycle are temperature, moisture content, pH, air flow rate, pressure drop, porosity and particle size. Tests will be constructed to optimize the interrelationship among these variables. Once we get into the project, other variables could be studied as well.

A scheme of what we see as the compost process is shown in Figure 2. A layer of the composted material is spread over the material to be composted; air is pulled through it, and

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## CRAB SCRAP

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finally, the air is filtered to reduce odor prior to exhausting the air to the atmosphere.

The nutrient value of a ton of raw crab waste is well documented. Crab waste is high in nitrogen, phosphate and potash, indicating that it does have some value as a commercial fertilizer (Table 1). The nutrient value of the composted material, however, is unknown. We will need to determine the nitrogen, phosphate, potash and calcium content of the composted material to establish its value as a commercial fertilizer for direct agricultural application.

FLOW CHART SHOWING BASIC COMPOSTING ACTIVITIES

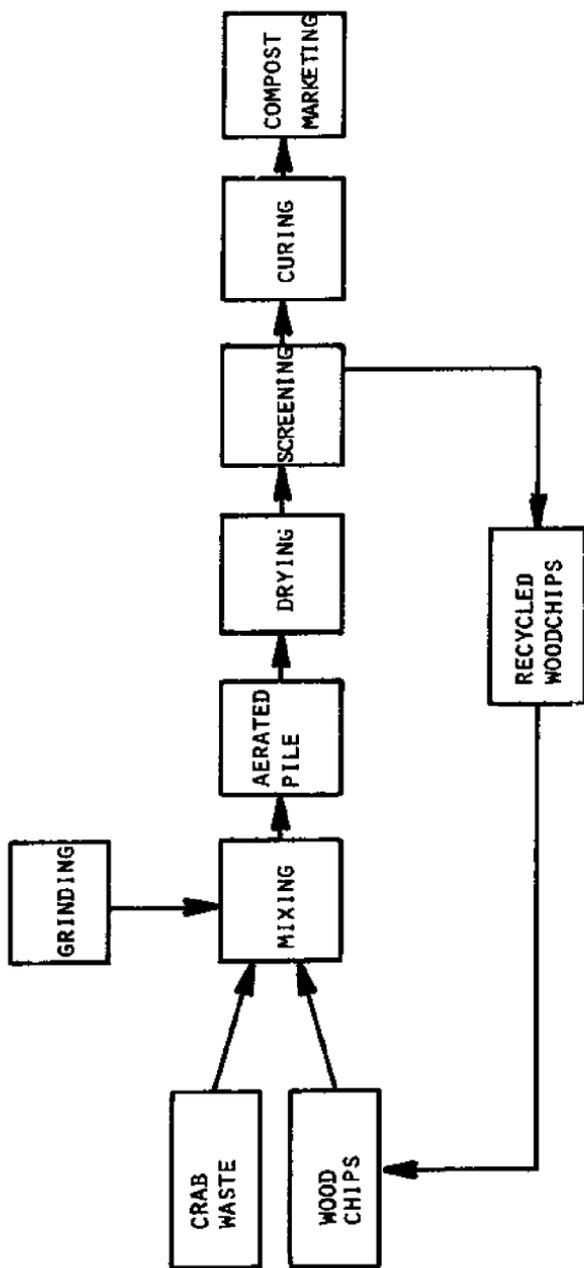


Figure 1.

## COMPOSTING WITH FORCED AIR

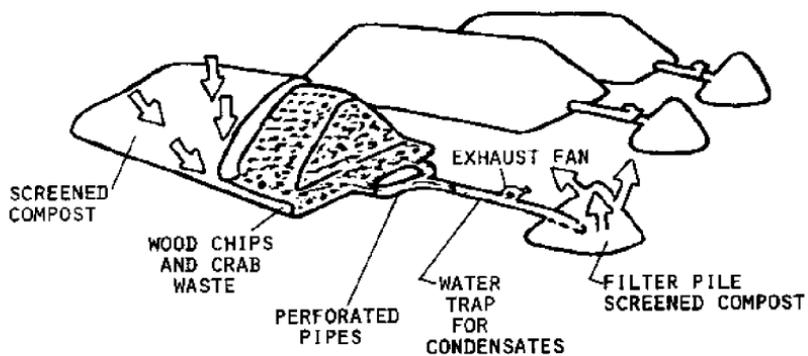


Figure 2.

TABLE I  
Nutrient Value Of One Ton Of  
Fresh Crab Waste (Jordon Co., 1979)

<u>Compound</u>	<u>LB/Ton of Crab Waste</u>
Nitrogen	32.0
Phosphate ( $P_2O_5$ )	24.0
Potash ( $K_2O$ )	5.9
Sulfur	3.7
Lime	300.0
Magnesium	6.6
Boron	0.03
Water	1280.0

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## Composting Blue Crab Waste: The Economics

David G. Swartz  
Maryland Marine Advisory Service

I would like to spend a few minutes discussing the research we intend to do and then share with you some of the economic research that has been done on composting.

By producing a stable product that can be stored, converting crab waste into compost solves the immediate problems of odor and possible health hazards. Such a product would also find ready markets in agriculture. Land or farm application of crab waste, as Russ noted earlier, results in a lower per unit cost of disposal than landfill.

Our first economic objective is to determine the optimal size and location of a composting facility. The engineering data that Russ feeds me and data regarding transportation costs will be the major considerations. Basically, the trade-offs are between centralization of a composting facility and the transportation costs of getting the scrap to the facility.

A further economic objective is twofold: to determine the market values and markets in which the composted product can move. If there is a market and if the composted product proves to be a substitute for some other product, it will be very easy to determine the market value; but in the event that it is not, we will have to do some sort of economic analysis to determine its value. Should we not find a market, the economic analysis will focus on the least cost method of disposal of the compost. Different ways to utilize the composted product are shown in the flow chart (see Figure 1).

Some might be revenue-producing; others not. We will be examining the various possibilities.

The published research on the economics of composting has dealt with composting sewage sludge. The available information indicates that in the past it has not been a profitable operation.

The value of bagged sewage sludge compost has been estimated to range between \$62 and \$69 per dry ton (in 1979 dollars). On a bulk basis, actual sales suggest a value of between \$16 and \$30 per dry ton. The actual price of a composted crab product will differ somewhat. The level of nitrogen, phosphorous, potash and organic material would likely be different from composted sewage sludge. Other factors may also change the willingness of consumers to pay for the product. Composted sewage sludge, for instance, has aesthetic problems associated with using it for food production.

The actual costs involved in a composting facility for sewage sludge in Camden, N.J. are shown in Table 1. The operation, is very labor intensive. Two or three shifts of employees at this public facility work around the clock to operate the plant. For an operation to be profitable, it would need to be privately run by someone who is willing to work long hours. The labor represents 25% of the total cost and 43% of the operating cost.

Another large percentage of the cost is the bulking agent at 21% of total cost. An inexpensive bulking agent such as sawdust would reduce costs considerably. With this in mind, we will be attempting to design a process that will minimize the use of the expensive bulking agent. In the Camden operation, costs are not being covered. Although the total cost per ton is \$89, the maximum they could expect to receive for a bagged compost product is approximately \$70.

The relative costs of different disposal processes are outlined in Figure 2. These options tend to overlap somewhat, but a look at the expected values of each does tell us that overboard barging tends to be the cheapest followed by landfill and then composting. Because the composting process results in a byproduct however, revenue may be generated that could offset the greater cost. Note also that values are cited

## CRAB SCRAP

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in 1976 dollars so they have been adjusted somewhat down from the estimate noted a moment ago.

Although composting may not appear to be the most cost effective method, the constraints of a moratorium on ocean dumping or a closure of landfills to crab waste force us to examine other alternatives. Given the different cost sensitive parameters, a design may be found that can reduce our cost significantly, to a point where composting might actually be a profitable operation.

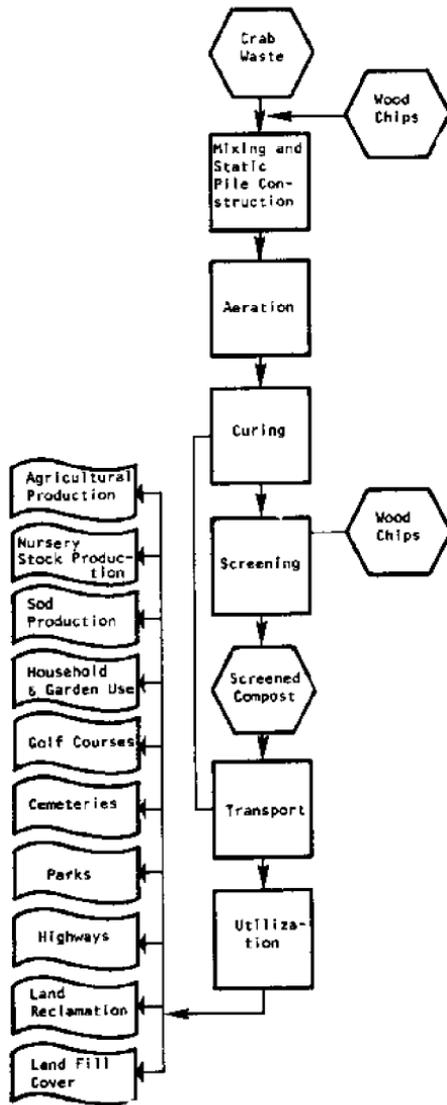


Figure 1. Flow chart of composting activities and product uses.

TABLE 1  
Composting Cost Per Dry Ton  
Camden County Municipal Utility Authority, 1978

<u>Variable Costs</u>	<u>\$/Dry Ton</u>	<u>Percent</u>
1. Labor	22.41	25
2. Bulking Agent	19.27	21
3. Repair	4.34	5
4. Fuel, Oil & Electric	4.49	5
5. Piping	<u>1.46</u>	<u>2</u>
Subtotal	51.97	58
 <u>Fixed Costs</u>		
1. Site Development	13.77	15
2. Equipment	12.18	14
3. Administration	5.92	7
4. Building & Land	2.71	3
5. Engineering	1.76	2
6. Monitoring	<u>.68</u>	<u>1</u>
Subtotal	37.02	42
	88.99	100

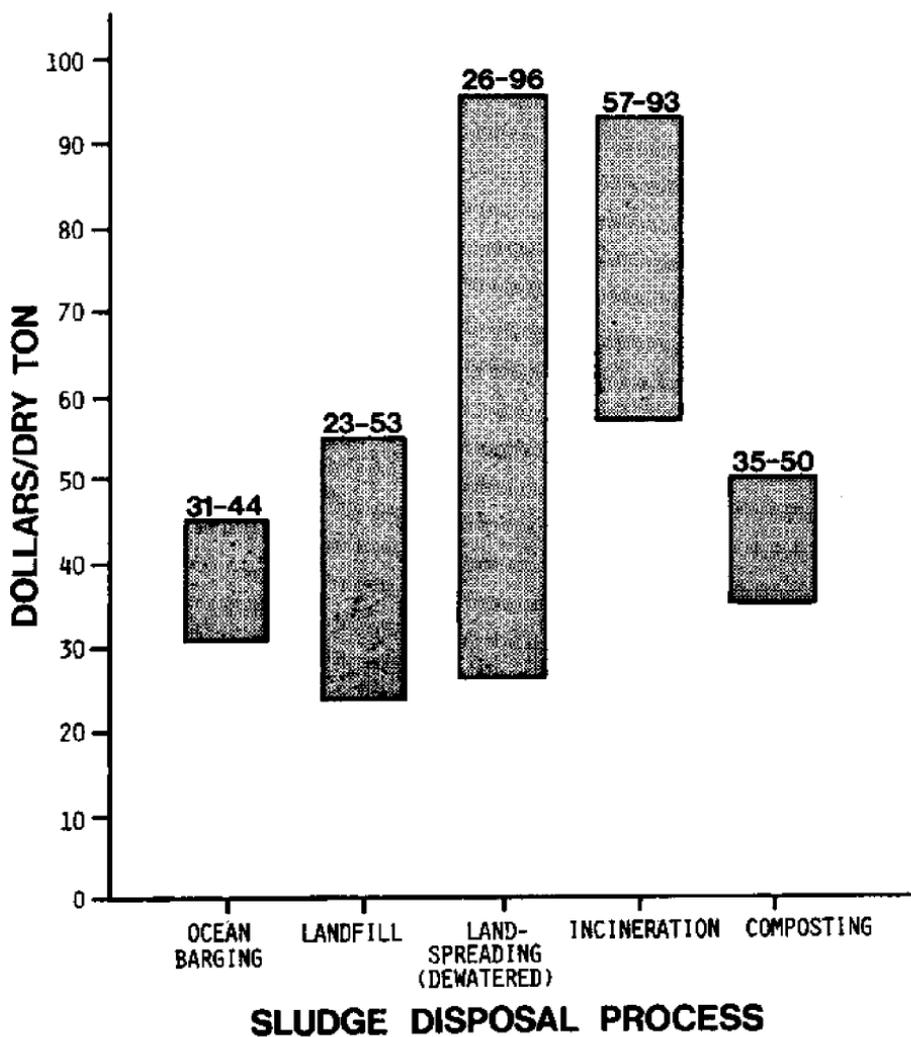


Figure 2. Comparative costs for various sludge processors (1976 dollars).

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## Protein Extraction

Lee Fryer  
Marine Agri-Products

First, who we are and what we do. Think of me and my technical work group as emerging from the fertilizer industry rather than from the food industry and having been brought into the protein field because we have been converting fish wastes and other wastes into high quality fertilizers. In the last five years we have provided the technology for the production of about 70,000 gallons of high quality liquid fish fertilizer and we have marketed it. Our first plant, established in 1951 in Bellingham, Washington, converted salmon wastes into high quality liquid fish fertilizer concentrate. To extract the protein from the waste, we use a modified form of the alkaline hydrolysis process that Syd Cantor mentioned.

I want to orient us just a little bit more. As far as we can see, and I hope this doesn't sound arrogant, every single bit of protein that's available in all kinds of fishery waste, including shellfish waste, is going to be extracted and used, and all of the other values such as chitin are also going to be extracted and used. The energy crisis and the food crisis compel us to go that direction. There is an absolute crushing shortage impending now of protein with respect to feeding the world population. How do our efforts fit in? The protein that we extract from fishery waste can be used for either fertilizer or animal feed and we are involved with both.

In this country, it currently takes 500 billion cubic feet of natural gas per year to produce our fertilizer nitrogen. Only

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## PROTEIN EXTRACTION

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7 years ago, that gas cost 15¢ a thousand cubic feet. The cost now is \$2.50 a thousand. The increase in the cost of petrochemicals, and this is a point Syd Cantor made as well, is going to compel us to extract these values out of shellfish waste. There are two requirements for this operation. One is that the protein and other values in fish wastes have to be upgraded in the processing procedure. With all due respect to the excellent people working on this, if you cannot substantially upgrade the value and produce these more sophisticated products that you can afford to ship and move into various markets, you are out of the business from a long standpoint.

The second requirement is that we have to recover all of the values that are in the waste. If a specific waste, whether finfish or shellfish, can contribute feed protein, fertilizer protein, food protein in liquid and dry form, and also chitin/chitosan, we are going to go after all of those values, and in the recovery process we are going to upgrade the values so that the end product can be sold into the higher value markets. Rising costs for transport, handling and energy demand the utilization of processes that upgrade the value of the end products.

Since 1950, we have been in the field of formulating or manufacturing every conceivable kind of fertilizer. Marine Agri-Products, Inc. is now specializing in the extraction of protein and other values from fishery wastes and other wastes. Presently we are providing under contract the technology for the Coos Bay Fish Waste Recovery Plant that is now under construction and will go into operation in about 60 days. It will be processing about 6,000 tons per year of finfish waste and about 5,000 tons per year of shellfish waste at Coos Bay, Oregon. We are providing the enzyme hydrolysis technology for recovering the protein with the use of minimal heat (120° - 140° F) and also the chitin technology.

Our involvement in the Chesapeake Bay situation began in March when the State of Maryland and the Dorchester County Seafood Association decided to go along with us on the very modest process of submitting some typical samples of crab wastes and poultry feathers to the enzyme extraction process. We took three samples of typical crab waste select-

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## CRAB SCRAP

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ed by Clayton Brooks and his group. From these samples, we extracted the protein and also the chitin.

Our findings, and most everyone concerned seems to agree, indicate that it is possible to recover between 5 and 6% by weight of chitin from typical Chesapeake shellfish waste. That means being able to extract at least 100 pounds of chitin from a ton of waste. This is a conservative estimate; potentially more could be extracted. The amount of protein that can be extracted from a ton of raw waste, we found to be between 7 to 10%, or 140 to 200 pounds. One serious problem we ran into was that the protein is very live; it decomposes very rapidly. All of the samples of shellfish waste delivered to our laboratory plant in New Jersey had so much decomposition of the protein that extraction by the enzyme process yielded a lower grade of protein than we would need to command the necessary price in the feed markets. There has to be a stabilization process at the meat picking site if the protein extracted from the crab waste is to command the high price, for example, that you can get from fin-fish waste.

As fertilizer people, we have concluded tentatively that the protein extracted from shellfish waste should move into the liquid fertilizer concentrate market rather than moving into either the dry fertilizer or the feed protein market. The lowest price at which that liquid fish fertilizer concentrate was marketed was \$4 a gallon. Now that is rather high in relation to fish soluble sold by Zepata Haynie or any fish soluble company. We believe that the protein in Chesapeake crab waste can be extracted using a very efficient process and sold as a liquid fish fertilizer concentrate for at least \$2 a gallon. I want to comment upon this.

Over half of all fertilizers used in California are in liquid form. Although soil fertilizers will always be used to some extent, the elite liquid fertilizer market should be the target for fertilizers produced using protein from crab scrap. When you spray crops with any liquid fertilizer, you will need a buffering in that formulation and also an ingredient which keeps the liquid fertilizer from shocking and burning the crop. Liquid fish fertilizer is the ideal material for this. I predict

## PROTEIN EXTRACTION

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that in California alone there is going to be a virtually unlimited market for the fertilizer you can make out of protein from your crab waste. Because nutrients sprayed on the foliage are 500% more effective than nutrients applied to the soil, fertilizer companies are increasingly engaged in the manufacture and sale of full-year fertilizers to be sprayed on the foliage.

A typical ton of Chesapeake crab waste and would yield a minimum of 50 gallons of liquid fish fertilizer sold at \$2 a gallon for \$100 total. At least a hundred pounds of chitin having a value of \$1.50 a pound for \$150 total could also be produced. We believe that the round working figure for your industry is that you can recover approximately \$250 at the wholesale level of values out of your shellfish wastes. Again, I think most of you would agree that this is a conservative estimate.

In the Chesapeake area with a gross value of \$250 a ton projected for shellfish waste and approximately, 20,000 tons per year to process, you have the basis for a \$10 million industry. I don't agree with anyone that believes that you are going to have to wait until some major company comes in and does the job for you. You may as well face the fact that you are going to have to create your own company. You are going to have to find some energetic, capable young people to set up in business to recover these wastes. They are going to enter a new but vital U.S. industry: the successful recovery of resources in masses of waste.

Instead of having so many more conventional feasibility studies, we recommend you synthesize and analyze the information available now, and we urge that the state and federal agencies have enough confidence in you and in everyone concerned so that they proceed with the financing of the next pilot state in this operation. It is going to cost for the pilot stage, something on the order of \$150,000-250,000. We think this kind of financing should be provided for the seafood industry of this region so you can get on with the solution of your problem.

Sydney Cantor, I believe, presented a solid case for the marketability of chitin/chitosan. Step by step, after

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## CRAB SCRAP

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abandoning the defeatist view that no market exists, we must begin creating these markets by offering into the trade initially modest quantities of the product and beginning to adapt the industry to serve the needs of the customer.

You have two ways to go with your protein. You can go into the feed markets and you can go into the fertilizer markets. At Coos Bay, Oregon we are now making a fish protein concentrate that has about 82% protein; it has all of the amino acids in it and it will be selling for \$750 a ton when ordinary fish meal sells for around \$400. In other words, there is a beautiful premium market out there, but we think that you have to stabilize your raw protein or you can't reach that feed market.

**Question:** Could this kind of operation be set up by an independent, non-funded, private business, or are the production costs of developing the raw product into a marketable product so extreme that it isn't realistic given the volume?

**Answer:** The capital cost required is a very important component in your end cost. Installation of the Coos Bay plant using the enzyme process has cost about \$300,000. This is a more elaborate plant using the enzyme process. Let me mention this to you. When you use the enzyme process you do what is called hydrolizing the protein which means that you break it down into its separate amino acid components. When this is done without the use of excessive heat or chemicals, it results in a feed product that has superior feeding, feed efficiency and capacity. If you put in an alkaline hydrolysis process which produces a fertilizer end product, as far as I am concerned, it depreciates the feed value. If you use the alkaline hydrolysis process you will have a very low cost for your plant installation. We have provided technology for three plants in the last five years and none of those plants cost as much as \$50,000. In other words you can take the protein out of your crab waste with a plant costing not over \$40,000 bucks. It is a very profitable enterprise. If we can teach you how to recover your chitin/chitosan, together with the alkaline hydrolysis process of recovering the protein, I think you

are in business. Your total plant cost then should not exceed more than a quarter of a million dollars.

**Question:** What about the operating costs?

**Answer:** The operating costs are very basically low. You are talking here about a two-man operation. Incidentally, we ran the feather sample. The feather sample had 91% protein in it, dry basis. If the crab industry can find a functional basis for either buying or receiving feather and blood waste combined with your shellfish waste you can have a year-round operation and substantially decrease your costs. But you are talking basically about a production operation that requires not more than two workers. In other words, we are in a capital intensive and low-labor requirement enterprise.

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## Chitin-Chitosan Production

Dr. Sydney Cantor  
Kypro Corporation

Is waste a material which we will be satisfied merely to get rid of, or can it be a raw material for treatment and utilization? I do believe that as concern about waste and pollution increases, the latter view gains support. Recovery of valuable byproducts can be the basis for new industry. We are moving, as I see it, towards a holistic view of raw materials. In the case of crab, for instance, this means the integration of waste treatment into the crab utilization process.

Since 1962, I have been associated with people who have been studying crab waste as well as shellfish and other fish waste. Their work was initiated by an overwhelming shellfish waste problem in Kodiak, Alaska. During the early consumer enthusiasm for king crab, processors there were dumping 75 to 80% of the live weight of the catch into Kodiak Bay. The waste went out with the tide but unfortunately it also came back—to a point where for some time Kodiak, Alaska was for all practical purposes shut down. Waste was suddenly a crucial element of the effort to get as much king crab into the U.S. market as possible. Since then, based on careful marketing, crab meal has become an important product. One aspect of this marketing has been the incorporation of fish scrap into the crab meal to raise the value so that the total protein is sufficient for animal feed. Note the change in perspective: the Alaska King crab business becomes the animal feed business as well. This new thinking clears the way for

## CHITIN-CHITOSAN PRODUCTION

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the necessary evil of meal drying to become instead a profitable business.

With the advent of a more enlightened point of view about waste, some of the technology of thirty years ago is being reintroduced. In the past it was overshadowed by the problem of getting the main product to market. In this era of pollution, however, the thinking is changing; the economies are changing. There is a new urgency based on the real threat of entire industries shutting down.

For the past couple years I have also been involved with the treatment of soluble waste from agricultural raw material processes. This waste is water which is slightly polluted—ranging from 1,000 to 8,000 parts per million of soluble COD. A few years ago treating it was an active nuisance. Some companies regarded dumping it into the river and paying a fine as the cheapest way of handling it. The need for improved municipal services because of increasing population and industrial activity led to the recognition by municipalities that increased fees could help pay for their necessary investment. This increase in cost to send materials to municipal systems has led industries to study waste systems of their own. One approach has been to look at the problem from the standpoint of recycling much-needed water. This is a sound approach. For the last three or four years, water has been at the top of the list of national problems. It isn't that we don't have enough water; rather, we don't have enough good water in the right places, a problem that is increasingly serious.

Soluble waste in some industries then is becoming an asset rather than a liability because it can contribute to the reduction of energy costs. There are well controlled anaerobic methods, for example, for generating methane gas from soluble waste. Although the capital investment may be significant, so is the value of the gas that is generated.

It seems to me that this is the view which must be taken with respect to crab waste; to transform a problem into an opportunity. I happen to think on the basis of the work that has been done by the Kypro Company that crab waste (and shellfish waste generally) presents an opportunity for an industry. However, it is going to require recognition by the

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## CRAB SCRAP

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community and the industry that it is in the best interest of both to work together. This conference marks a very promising step in that direction and I congratulate the people who have put this program together.

The Kypro Company, which was organized in 1972, produces chitin and chitosan in the United States—not as much however as the Japanese industry produces. Our site is Seattle and the raw material is dungeness crab waste when we can get it and shrimp waste when we can get it. The production capacity is reasonably good for the state of the art at the present time. Kypro has probably sampled more chitin and chitosan than even the Japanese and has also sold substantial quantities —on the order of 2 to 3 tons a month. The ratio of the dry waste needed to produce a pound of chitin and from that a pound of chitosan is about 5 or 6 to 1.

In looking at utilization of materials from crab waste it is easy to talk about technology, but is difficult to talk about profitable marketing. There are three products we can talk about from crab waste: chitosan, chitin and protein. Each has its own uses and its own markets(s).

Chitosan has been in the chemical literature for years. A derivative of cellulose, it is best described as a gum. Chitosan is the skeletal material of many shellfish and of a great many other products as well (mushrooms, for example). Of all the applications examined at Kypro, the best and most likely market for chitosan is primary wastewater treatment. The U. S. Army Engineers have been examining ways to flocculate spoil or settle clay from dam building wastewater and then from the spoil to recover water of sufficient quality to be put back onto the surface. Chitosan compares favorably to the synthetic flocculants, most of which are acrylates and acrylamides. Unlike the synthetic flocculants, it is non-toxic and biodegradable and it is seven times more effective. On a cost effectiveness basis, if you sell the petro-chemical base material for \$1.50 to \$2.00 a pound, a price increasing rapidly, you should be able to get \$10 to \$14 a pound for chitosan. The market is such that in the primary treatment of wastewater for the removal of insoluble floc between 4 and 5 parts per million of this material will be used.

## CHITIN-CHITOSAN PRODUCTION

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To be useful, chitosan must be put into solution. A 1% solution is the best feed material for use as a flocculant. Thus, marketing chitosan involves setting up dissolving stations so that it can be sold as a ready to use product. By doing so, you add considerably to the value of the product. For chitosan to be seen as cost effective and competitive, this step is a must.

The next problem is to collect the waste at one place where it can be handled economically to produce a product that will sell for anywhere from \$3 to \$12 per pound. On the basis of our experience with Kypro, a plant not much larger than this hall could process about 5 million pounds a year. To the chemical industry, 5 million pounds is a small plant, too small to provoke interest. I could give you a long list of chemical companies that we have tried to interest in chitosan. Still, plant size is relative. Although it may be a relatively small plant to someone in the gum business, in the water treatment business a plant producing 5 million pounds of chitosan would be considered large.

The tremendous volume of crab waste produced makes the Chesapeake Bay area one of the best places in the world for a chitosan plant. You need to either find the right company or set one up yourselves. The Japanese, who use chitosan exclusively as the flocculant for the treatment of their polluted inter-island waters, have long been willing to finance a plant in this area. Unfortunately, they want all of the chitosan produced—a prospect which disqualifies its use in American wastewater treatment.

Chitin has its own markets. Essentially insoluble, it is simply the cleaned up waste from which protein and minerals have been removed, leaving chitin, which is also the raw material for chitosan. Chitin is also proving to be a valuable raw material in its own right for the production of the monomer, glucosamine. Produced in the United States by only one company today, crystalline glucosamine sells for between \$10 and \$15 a pound. It functions as a potentiator for certain antibiotics and is used in relatively small quantities for compounding antibiotics.

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## CRAB SCRAP

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There also exists a market for protein of almost any kind. It is a world market and one of its components is in this country, which consumes more protein than any other country in the world. U.S. protein markets are both food and feed. A great deal of attention has been paid to the production of protein isolates from a number of sources—oilseeds, fish, various scraps. A fish protein concentrate from scrap fish has been developed on the West coast at Corvallis, Oregon under a Sea Grant Project. This product has now been sold, at least in small volumes, to the Mexican government for use in fortification of tortilla flour.

The other side of the protein market is the crab protein isolate, which happens to be a very good protein nutritionally. There was a suggestion that it might not be very good, but it is excellent. In the process of isolating the protein, methionine, one of the essential amino acids is partially destroyed. Fortunately, methionine is one of the cheaper amino acids to produce synthetically so it can be restored at relatively little cost. Most tuna processors also produce special cat foods from the scrap. In a market much larger than that for baby food, cat food producers are always seeking protein.

Fractionating crab scrap may also provide other business opportunities. On the West coast, work is being done on recovering red dye from the red crab. With the advent of pen raising salmon, feed pigments are needed that make the flesh look appropriately pink and that are acceptable to food and drug officials. The pigment commands about \$40 a pound so although the market is small, it is high value. A number of such markets can make for a very interesting and substantial business.

In this activity of fractionating crab scrap and providing the basis for a business, I have described four potential markets: the pharmaceutical industry, the wastewater treatment industry (and wastewater treatment is only one use for chitosan), the cat food market and the food dye market. I would reemphasize that in concentrating on waste and technology, let's not forget what we are in business for: not simply to get rid of waste but rather to isolate products and understand their uses. That is my message.

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## CHITIN-CHITOSAN PRODUCTION

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Finally in closing I would like to spend a few minutes on production. Figures 1 and 2 outline what Kypro has done. As noted, Kypro has been operating a small plant since 1972 producing some of the fractions that I have talked about. Shown here is essentially the first step in the process—protein extraction. It looks complicated but it really isn't. What we do is wash the waste with dilute caustic soda which comes back from the end of the entire process; then we precipitate the protein out of the extract. We get about a 90% yield of the protein. The basis is total waste, butchering waste and picking scrap—all of which have a fairly high protein concentration. Now with the mechanical picking, the effect of the reduced protein is very significant and one needs to think of lesser byproduct value. This reduces the value of, let's say, the primary product which is chitosan; I'll come back to that in a moment.

The second step takes the deproteinized or washed waste and demineralizes it by treatment with acid and then dries it. At this point chitin can be recovered. Then the demineralized material (chitin) is converted by a new process which we have developed—removal of an acetyl group to chitin.

Table 1 gives a breakdown of crab meal. As a valuable raw material. On a dry basis, a hundred pounds of crab waste gives us about 21 pounds of chitin and 20 pounds of protein. To produce one million pounds of chitosan 1.25 million pounds of chitin are required. Five million pounds dry basis of crab scrap and 15 million pounds wet basis of the crab scrap are needed to produce the same end products. This relationship is very significant in designing and running a plant.

We have looked at a number of factors which I can only tell you are collection costs and all the factors involved in collection. If you think of a hundred pounds of dry scrap being equivalent to 21 pounds of chitin, then on the wet basis when you buy the raw material, if its cost is 2¢ per pound, it is already 10¢ a pound when delivered to the plant. Obviously, if it is 10¢ delivered to the plant, it is 50¢ in terms of chitin that you want. Again the business structure is critical and waste disposal does not provide the basis for a profitable venture. On the other hand, the recognition that a coopera-

## CRAB SCRAP

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tive venture which disposes of a waste problem and translates the fractions into valuable industrial materials starts out by disposing of an expensive community problem. The raw material cost can take a social credit which can help to get the enterprise started. It can also help to carry on a valuable food crop and maximize its contemporary value.

I PROTEIN EXTRACTION PROCESS

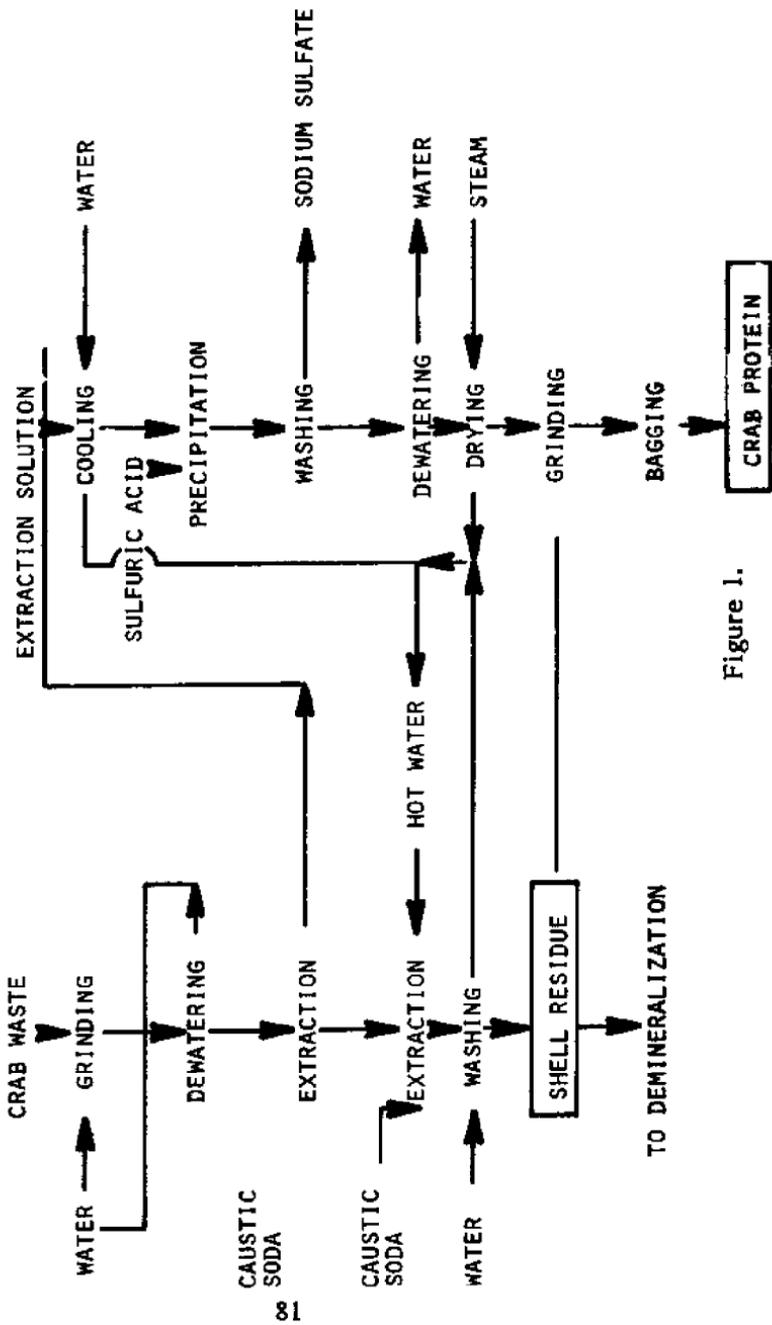


Figure 1.

II CHITIN AND CHITOSAN  
DEMINERALIZATION AND DEACETYLATION

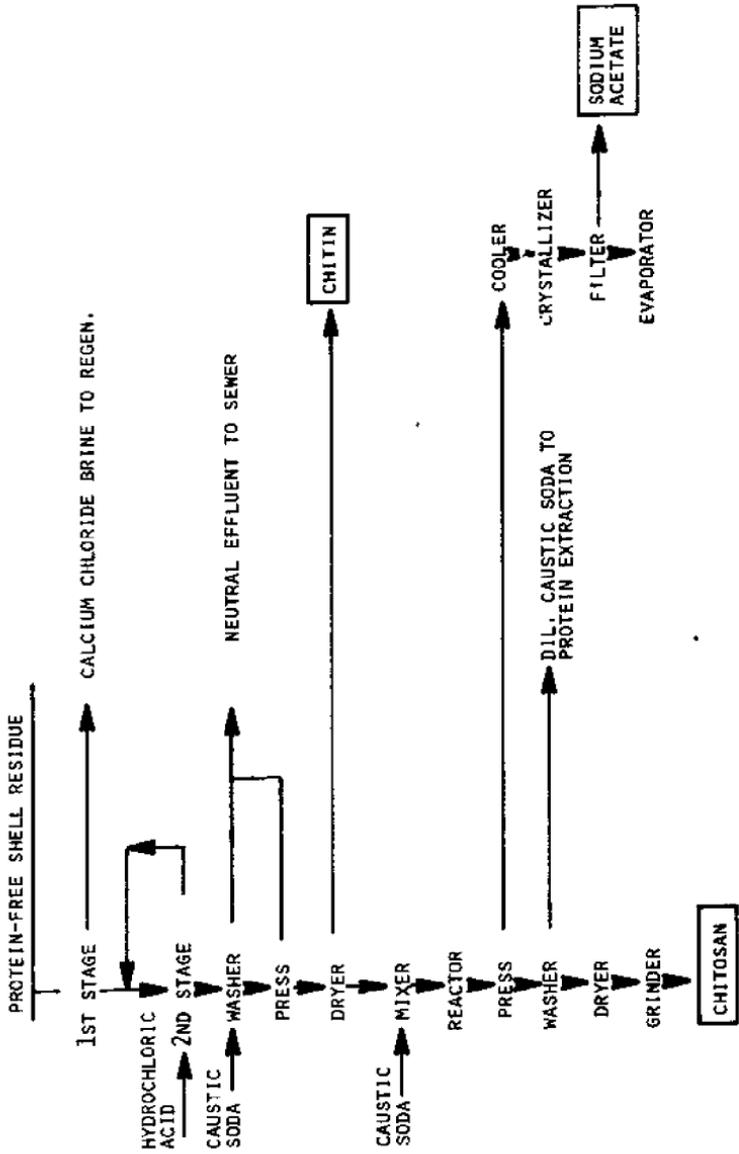


Table I  
ANALYSIS OF BLUE CRAB MEAL

	<u>Percent</u>	<u>Dry Basis %</u>
Water	9.3	—
Calcium Carbonate	42.7	47.0
Protein	23.3	25.7
Chitin	20.2	22.3
Fat, etc.	4.5	5.0

100 Lbs. Crab Waste (Dry Basis)  
= 21 Lbs. Chitin + 20 Lbs. Protein

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## Mechanical Separation

Burton L. Tinker  
National Marine Fisheries Service  
Northeast Fisheries Center

These gentlemen have been talking about wastes and how to utilize the waste products, but I would like to talk about getting more of edible protein from the product before you consider it as waste. Waste utilization is probably one of the greatest challenges that is facing the U. S. processing industry today. We know that the edible meats available in crab and other crustacea range from 12 to 20 percent. This represents a tremendous waste of good proteins. With the rising cost of materials and processing, utilization of these waste products is becoming increasingly important.

Meat/bone separation technology represents a breakthrough for the fishing industry with applications for both finfish and shellfish. The mechanical basis for this effective separation is rather simple. Although the various machine designs differ, the separation procedures are similar. Meat/bone separation removes flesh from the material by a squeezing and/or tearing action, after which the flesh is pressed through perforated stainless steel drums. In some machines the wide flexible belt that moves against the outside perforation moves at a speed different from that of the drum. With shellfish, the shearing action that results tends to imbed shell particles into the meat—hardly an ideal situation. In the type of machine that is presently being used in the industry, however, the belt and the drum move at the same speed, causing less damage to the final product.

## MECHANICAL SEPARATION

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The Japanese developed meat/bone separation for fish many years ago for use in making their traditional fish sausage, surimi and kamaboko. Recognizing the great possibilities of meat/bone separation, the fishing industry in the West began to develop minced products more to the European and American taste.

The first minced fish products were fish blocks for the breaded fish sticks and portion trade. Although the production of these products initially showed promise, it was soon found that mechanically deboned fish flesh presented serious quality problems during long-term frozen storage--the product becoming tough and rancid.

Since then, the development of this technology has continued on many fronts throughout the world. High quality minced fish blocks are currently being produced using fillet trimmings or scraps. Recently, some European producers are making combination fillet/minced fish blocks where 15-20 percent minced is coated onto the fillets prior to packing. Sensory and chemical tests on the quality of these products carried out at our laboratory have shown that there was no significant difference in overall quality between whole fillet blocks and combination fillet/minced blocks over nine months of frozen storage (0° F).

The shellfish industry today is actively engaged in mechanically deboning, primarily crustacea. Research has shown that overall meat yields can be doubled using meat/bone separation techniques. Minced products are currently being produced from lobster, several crab species and shrimp. From work we did earlier, we know that there is at least 30-35 percent of edible protein in blue crab and now we are able to extract at least 24% of edible protein with this process.

The future for mechanically deboned fish flesh lies in the area of new product development. Research is currently being carried out in several areas using either waste materials or underutilized fish species for processed products such as soups, stews, casserole items and specialty products. Researchers have shown good results with meat and fish combinations. High quality minced fish flesh is bland tasting and represents an excellent low fat, high protein material.

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## CRAB SCRAP

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Ground beef can be extended with minced fish flesh up to a 20% level, and current research has shown that 15-20 percent fish flesh can be added to sausage products. One of the most interesting areas of new product development using deboned fish and shellfish is in "reforming" or "restructuring." One process presently being used in the industry is an extrusion system using a calcium alginate binder. This process involves mixing a minced seafood product such as clam meats or shrimp with sodium alginate. A shaped product such as a strip or ring is then formed by means of an extruder. After forming, the product is immersed in a calcium ion solution--usually calcium chloride. The calcium ions replace the sodium ions of the alginate producing a gel skin, which solidifies the shape of the product for battering and breading by conventional machines. Since these alginate gels are stable during freezing and thawing and also heat processing, many other applications are possible. At our laboratory in Gloucester, we have produced several crabmeat products using alginates to form a uniformly texturized crabmeat resembling the typical flaky texture of the natural product.

The development of underutilized species and new products and processing technology can only result in more efficient use of the raw materials available. Increased production of fishery products results in a corresponding rise in marketing potential. New products can be marketed with a vigorous effort; we must go beyond our conventional methods of marketing crab meat and other seafood products.

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## From the Mayor of Crisfield

The Honorable Charles McClenahan  
Mayor of Crisfield

In Crisfield and in Somerset County as a whole, seafood stands unrivalled as the number one industry with crab processing the major portion. Until last year, our crab disposal was handled through a dehydrating plant and George Miles touched on this yesterday. But unfortunately, due to some regulations that were passed, the condition of the plant, and the age of the operator, Mr. Ted Ranke was forced to close the plant. Declining production and the increased cost of operations also figured in the decision. Mr. Ranke gave us fair notice and told us he would do anything he could possibly do to help us find a way to reopen the plant. I can personally say Mr. Ranke has been very cooperative.

Notice of the November 1979 closing created a great deal of problems for our local government. The immediate impact was five people out of work and a loss of an annual 900 ton production of crab meat. We lost an industry that was vital to Somerset county in that it jeopardized our crab meat processing industry. What if we did not have a way to dispose of crab waste? The impact would be immense. In Somerset county we have over 600 licensed watermen and 14 packers, 12 right in Crisfield. There are over 700 pickers in the county, so we are talking about 1300 jobs in jeopardy. Not to mention the 23,000 crab pots that are put into the water around Somerset county and Crisfield or the 207 registered vessels and the 508 boats under 5 net tons. And then there are 3 crab pot manufacturers and support services such as

## CRAB SCRAP

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fuel, boat repairs, paint, supplies, and bait with over 700 licensed eel potters in the county. These figures are from 1976—the latest I have. That year over 6 million pounds of crabs were landed in Somerset county, As you can well imagine, we were very concerned. Somerset county has not been a very productive county in the past and we could not afford to lose our major industry.

We immediately started having meetings with county government officials and local processors to come up with an alternative solution to crab scrap disposal. Our first alternative was to reopen the old plant, to find somebody or some system to put a product back into productivity. A long range plan we have been talking about for Somerset county is a chitin or chitisan plant. But again that is still a good way off. We even looked at the possibility of dumping scrap overboard and we asked our state Department of Natural Resources to explore that alternative.

The final and the least attractive option was to place waste in the landfill. Yesterday it was suggested that this should be a backup system and this is my feeling as well. I don't think we can afford to take a product that was making money and just throw it away. It is a poor solution and I am not in favor of it. But that was our only alternative; we had to keep the industry going. It has also created some problems with the landfill as George Miles noted yesterday. There were times that our haulers couldn't get to the landfill because they were closing at 5:00 pm and this meant that if the packers wanted to pick a little bit longer, some crab waste had to be left over and then there was an odor. On more than one weekend this summer, local residents phoned to point this out to me and ask what I was doing about crab waste.

What we would like to see in Somerset county is a new system. It was reported yesterday that the RCV plant is working well and making a profit. I think a plant like that in Somerset county could immediately handle 900 tons of crab waste. I just found out yesterday that one thing our plant had done in the past years as a convenience to the industry, was to stay open in the winter months when the crab waste was not that high in production and the plant lost money during

## FROM THE MAYOR OF CRISFIELD

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this period. This does not seem feasible; at such times the landfill could be the backup system until we can come up with a better system. We need to establish a plant in Somerset county and then organize a research organization to explore the future technology, maybe a chitin or compost plant or whatever. I don't think we can continue to place scrap in the landfill. It is creating problems, and again we are throwing a viable product away and I don't agree with that.

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## A City Manager's View

O. Wendell White  
Hampton City Hall  
Hampton, Virginia

I came over really to learn rather than to present any new ideas to this group, but I do know a lot about garbage. We go to some 40,000 homes twice a week and pick it up and dispose of it. When the crab scrap problem develops from time to time in our city, we come to the aid of the industry as best we can. We schedule the landfill to accommodate the industry, but we don't consider it a good solution. We need to be able to work together more effectively. Please don't look to your city or any other government to solve your problem. In this era that would be a mistake. I am constantly being asked to cut back, so I have to take a very hard look at every request for expanded services. You need to know that when you come to your locality for help.

On the other hand, today's economy is very complex and we are interdependent on each other. Your local government is therefore taking an increasingly active role in helping industry. Take advantage of this by letting officials know the impact your industry has on the local economy. In my own particular community, the shipyard and its activities in Newport News, the governmental involvement of NASA at Langley Air Force Base and Fort Monroe, the Veterans Administration, the colleges and the tourist industry have all spoken up. They seem to have overshadowed what has been the area's oldest and most successful industry—the seafood industry. You simply must do a better job of selling local community leaders on what you are doing. Let us know in no un-

## A CITY MANAGER'S VIEW

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certain terms the problems that you cannot solve for yourself so that we can become acquainted with them and help.



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## Current NMFS Projects

John T. Everett  
National Marine Fisheries Service

The National Marine Fisheries Service (NMFS) has three technology laboratories around the country, including the Gloucester Lab represented here today. Our laboratories have done some work on waste disposal in the past although we are not doing a whole lot of it at the moment. Presently, we do have some work in progress on silages and on the use of fish waste as food in aquaculture. Most of our work, however, has gone into increasing the yield of the fish that is processed. Where we can mostly help with the crab scrap problem is through the Saltonstall-Kennedy Act program which provides about 10 million dollars each year for projects that are designed to develop or strengthen the fishing industry.

In the case of crab waste, a suitable proposal might be to determine methods of handling the waste and then to demonstrate both the technical and the economic feasibility of different methods--whether silage or composting or whatever. Through workshops or publications, we can then get the information out to the industry.

Currently we have four proposals underway that deal with waste problems. In the first, funded at \$40,000 at Washington State University, fish waste and wheat straw will be ensiled in small batches and treated with a variety of ingredients. Desirable silage will be fed to lambs and cattle in order to establish methods and levels of supplementation needed to utilize the straw/fish waste silage animal feeds. Data derived

## CRAB SCRAP

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will be used to make an economic comparison between silage and traditional feeds.

The second project is an economic study of the utilization of fisheries waste from the states of Alaska, Oregon and Washington as fish silage. Funded at \$75,000, it will take place at the Oceanic Institute of Belview, Washington. The sponsor will identify possible markets for fish silage produced in the three states and determine the competitive factors necessary to market it. Possible use patterns in markets for fish silage dried into a variety of products and included in animal feeds will also be determined.

The next two proposals are from this area. The Mid-Atlantic Fisheries Development Foundation, in a project funded at \$32,000, is looking at conversion of seafood waste into marketable byproducts. The project will identify waste materials and commercial handling in processing facilities that have potential for conversion to valuable byproducts. Methods for recovering and stabilizing these materials will be evaluated. People here might talk to Kerry Muse about this project.

The next and final project went to the Department of Natural Resources in Annapolis. "Processing of Solid Crab Waste" is the title and \$70,000 is the funding. The project sponsor will manage several subcontracts to identify economically advantageous methods to dispose of crab waste that will meet existing environmental standards. The economic feasibility of existing alternatives and potential technologies will be investigated with special emphasis on those that can be utilized to produce marketable byproducts. Potential areas of investigation include feasibility studies for an enzyme process to recover crab waste. A microbiological fermentation process for amino acids from crab waste for uses as food supplements will also be studied, as will a process for composting crab waste and overboard disposal. This was somewhat of a last minute proposal that Pete Jensen got in, but because the problem is recognized as important nationwide, the proposal got high priority ranking.

There were some other waste management proposals that did not get funded. In these cases, it was either because of

## CURRENT NMFS PROJECTS

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something not really right in the proposal or because the proposal of the competitors was somewhat better. In our SK project review process, we have a regional review and once the projects make it through the regional review, they are reviewed at headquarters by industry people and our fisheries development chiefs from each region.

NMFS can also help in making sure that the Environmental Protection Administration and other regulators affecting the seafood industry are aware of the impact that proposed regulations will have on the industry. In the case of existing regulation that we find to be unnecessarily restrictive or in some way damaging to the industry, we work to get things turned around.

The other part of NOAA that deals with the seafood industry is the Office of Sea Grant. Sea Grant can help fund research through the university systems to develop and demonstrate better ways to process waste. They can help where we can't: in getting the information out to the users. The regional Sea Grant people, as well as some of my staff, are also familiar with the way cooperatives work and can help if a group of processors wants to get together to set up a joint drying or mulching operation.

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## Possible EDA Assistance

Walter Archibald  
Economic Development Association

At the Economic Development Administration (EDA) our interest is in any part of the economy with problems. In Virginia and Maryland, most areas that have a seafood industry have been specifically designated for assistance.

That aid might take several forms. Some EDA programs are directed toward business; others toward the community as a whole. We have a business loan and loan guarantee program that can help processors to expand their operations, to modernize or to take care of their crab scrap problems. In the area of technical assistance, we would work in conjunction with NMFS and follow their lead in supporting viable fisheries related projects. We also have a public works program that could be used for such things as a seafood industrial park of some sort.

There are certain areas that we have no interest in. We see no benefit of dumping, either into a landfill or into the ocean. These solutions are strictly temporary and likely to cause greater environmental problems down the road. Moreover, there is no reason not to use a valuable product to produce a useable commodity. The name of the game in government today is resource recovery. Crab meal, fertilizer, food for livestock—all of these are good uses for crab scrap. EDA programs might be able to help finance these ideas. Contact either Bob Roberts in Annapolis or Dave Wenzlaff in Richmond for specific projects ideas.

## POSSIBLE EDA ASSISTANCE

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Wherever there is the danger of losing jobs and the potential to create new jobs, EDA is interested. Presently, we are assisting the Gulf and South Atlantic Fisheries Development Foundation, which has been affected by foreign competition in shrimp. We are also working with the Maine and Alaska fisheries to try out some new ideas in methods of harvesting and processing a variety of sea foods. In Gloucester, Massachusetts, we have studied and helped build a new fishing pier. With the crab waste problem, we could help in a variety of ways. If it is clear that a study is needed, we can do the study. If it is a case of local communities and county governments having to make an investment, we can assist in that investment. We may deal with solving some pollution problems; we may help in establishing the seafood park idea, to concentrate the seafood processors or to finance the actual businesses.

Clearly your area is faced with major problems beyond your control whose solutions you probably cannot finance by yourselves. We are treating the whole world like everybody has to take two showers a day and make sure they use the right deodorant. In effect, we extend this thinking to industry by saying each plant must be absolutely clean and not have any smell so we can't possibly have any complaints from the neighbors. We can't have any waste floating in the air. Making these changes out of current income may be impossible for the businessman or local government, thus the federal programs might be of assistance. Certainly in this case EDA can help.

As far as our business loan program goes, those things that are covered normally by the Small Business Administration (SBA), we probably would not touch, mainly because we have a tendency to give a larger loan. If SBA can provide the assistance, then EDA wouldn't as a general rule. When you start talking about plants to process the waste, however, you are well within the realm of EDA. It may be that the processors and the crabbers themselves may have to form some sort of co-op. There are many possibilities for joint ventures.

Certain problems you are going to have to live with. Transportation, for instance, has been cited as a major

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## CRAB SCRAP

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problem. Unless you are going to consolidate all of your processing plants, you aren't going to get around it. Somebody is going to have to pay the price to move the waste from the processor to a rendering plant or to a farm for fertilizer or feed or what have you. That cost is going to be part of the cost of the product.

Still, EDA can help with some of the things you are faced with. As I said before, we have offices in both states and our people are very interested in the fishing industry. We think you have problems and we think we have the programs to help. Now it's up to you to give us an idea of what you want to do.

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## The Impact of Environmental Regulations

John Riley  
Environmental Protection Agency

EPA regulations, both current and upcoming, are bound to influence business decisions with regard to the crab scrap recovery process. I would like to outline the regulations governing the processing of wastewater from crab processing operations and also touch on the solid waste regulations that might have some bearing on the industry.

In 1972, Congress enacted technology-based legislation for the control of wastewater pollutants from industrial discharges. Prior to 1972, regulations were based on water quality standards; for various reasons--political, technical, and legal--these were unfair or impractical to implement. According to the 1972 legislation then, EPA was to identify the levels of technology that would be suitable to control the wastewater pollutants being discharged without regard to the impact on water quality. By 1977, industry was to be using BPT, or Best Practical Technology Currently Available. A more stringent level of technology was ordered to be met in 1983. This technology, called BAT, Best Available Technology Economically Achievable, would go beyond BPT to control the pollution and produce a better effluent quality.

In 1977, water pollution regulations underwent some extensive fine tuning with the Clean Water Act Amendments that established an intermediate level of technology between BPT and BAT, called BCT--or Best Conventional Pollutant Control Technology. BCT came about because individual dischargers felt they were doing a good job of cleaning up the

## CRAB SCRAP

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environment with BPT in place. Probably less stringent than what was originally envisioned for the industry to put in by 1983, BCT technology is more stringent than the level of technology to have been in place for 1977.

The E. C. Jordan Company has done a study for EPA on some candidate technologies that could be used by your industry at the BCT level. That report has been sent out for comment to the industry, the trade associations and other members of the seafood industry; David Dressel, alone, sent me 108 pages of comments. As we digest these comments, we want to do some other things, too; the E. C. Jordan Company has identified four levels within the vast range of conventional technologies. We have some economists who are helping us to determine the financial viability of the industry and give us feedback as to whether the implementation of the highest level of technology would have an adverse effect on the industry. We are committed to selecting a technology that is economically achievable by the industry; we don't want to attain pollution control for control's sake. At EPA we are very dependent on good feedback from the industry and the public. It is essential that you participate and let us know what's going on; that goes not just for industry people, but for those responsible for implementing the laws in the states. If something doesn't make sense or is unreasonable or not stringent enough, we need to hear from you.

Table 1 shows some in-plant modifications and effluent treatment costs for the conventional blue crab subcategory. In-plant controls are such things as dry cleanup; that is cleanups using less water, not using full running hoses or using nozzles on the hoses which control water flow. For the 2 ton/day plant, we have for screening alone a \$46,000 capital investment.

Table 2 shows the mechanized blue crab category. Here we are talking about wastewater flows that are much greater than in conventional blue crab. The hydraulic loading alone causes increases in certain costs, particularly in the operating of maintenance cost. Remember for the hand-picked crab, there are three levels of technology: screening, screening with grease traps and in-plant control. For the mechanized

## ENVIRONMENTAL REGULATIONS

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crab operation, there is a fourth level of technology to the wastewater treatment processes. It is dissolved air flotation (DAF) and it adds a very significant capital cost as well as operating cost to the wastewater treatment. The capital investment is \$250,000 for the 2 ton a day plant, or \$290,000 for a 10 ton a day plant. For the bottom line then (everything else is pretty much the same, except the flow rates on the upper part of the chart), we are looking at flows for 2 ton a day plants of 15,000 gallons per day; for a 5 ton day plant, 37,000 gallons per day and for a 10 ton a day plant, 75,000 gallons per day. The large capital cost is the addition of a DAF unit to the wastewater treatment at 250,000 dollars for a 2 ton a day plant; 262,000 dollars for a 5 ton a day plant; and 290,000 dollars for a 10 ton a day plant. Yesterday I saw people wincing at the mention of \$50,000 capital investment cost, so you may have to give us another opportunity to review these costs.

Screening technology is in place in blue crab, the grease trap is in process in blue crab and sardines, and air flotation is being used in the tuna industry. What we would be doing is transferring the technology from the tuna industry to the crab industry. It is obvious what the other technology options are going to do: air flotation, further BOD reductions of 40-65%, suspended solids reductions of 60-75% and still further reductions of 70-90%.

For a 2 ton a day plant we have estimated about 10,000 dollars investment, and a daily cost of about \$5.00 a day. For a 7 ton per day plant, we estimate the same capital investment. For the mechanized blue crab we would believe that in-plant control consist of procedures to optimize water use during picking and product wash, eliminate the fumes, isolate the cook water and modify the wash down. For a 2 ton a day plant we are talking about a \$20,000 investment and a \$10.00 per day O&M cost. A 10 ton per day plant would require about a \$25,000 investment.

Over in the office of solid waste, they haven't been idle. They have a new regulation recently published called "Criteria for the Classification of Solid Waste Disposal Facilities and Practices." Since I am going to make you take all this

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## CRAB SCRAP

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stuff out of the water, you are going to have to have a place to put it. This in turn requires each state to have an approved solid waste disposal plan.

To my knowledge, none of the states have their plans approved; this probably won't happen until the first of the year. The state plans will be looked at in terms of eight criteria that came out in 1979. The criteria would have to address such issues as whether the landfill facility is going to interfere with the flood plain or whether it is going to cause a blockage or a diversion of water in the flood plain. It will also have to be determined that the proposed disposal facility does not deprive an endangered species of their habitat or natural food. You would have to determine that the runoff from the landfill would not contaminate the surface water or the wetland. Ground water, frequently a drinking water source, would also have to be examined. Obviously in any food waste landfill you are also concerned about nitrates, which you don't want in the ground water.

Application to food crops and disease factors must be studied also as should air pollution and general safety factors including gases, fires, bird hazards, and access to the facility. A May 1980 report done for the Office of Solid Waste by the Energy Resources Company in Massachusetts list those states with applicable regulations governing each area. For flood plains, 92% of the states already have applicable regulations; for endangered species only 2%; for surface water, 94%; only 44% for wetlands; for ground water, 74% of the states already have applicable regulations. For disease, most all of the states have applicable regulations; fires, 84%; bird hazards only 10%; access, 84%. Some of the conclusions resulting from the study are:

- (1) The majority of the food processing waste disposal sites which included seafood are not currently responsible for known environmental problems.
- (2) The most common environmental problems are odor and disease factors.

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- (3) The disposal practices causing pollution of surface waters are rare.
- (4) There is no information currently available on the extent of ground water pollution caused by food processing waste disposal.
- (5) For the most part, the landfill criteria will not significantly impact current food waste disposal practices.
- (6) The acceptable disposal practices for each food processing waste have been adequately demonstrated; in other words, people know how to operate landfills to minimize these problems of odor and ground and surface water contaminations from food processing wastes.

As I said before, we at EPA are very dependent on good feedback. If you have any questions, please feel free to visit my office, write, or give me a call.

**TABLE 1**  
**In-Plant Modifications and Effluent Treatment Costs**  
**For**  
**Conventional Blue Crab Plants**

		Processing Day: Season: Process Flow Rates:		8 hours 120 days 1,100 l/kg (264 gal/ton)	
Production Rate	(kkg/hour) (tons/day)	0.2 2	0.8 7	0.2 2	0.8 7
Hydraulic Loading	(m <sup>3</sup> /day) (gal/day)	2.1 528	7.2 1,850	2.1 528	7.2 1,850
<b>TREATMENT ALTERNATIVES</b>		<b>Capital Cost</b> (Thousands of Dollars)		<b>Daily O&amp;M Cost</b> (Dollars)	
S*		46	46	7	7
S,GT*		47	47	9	10
S,GT,IP*		57	57	14	15

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\*S - Screening  
 GT - Grease trap  
 IP - In-plant control

**TABLE 2**  
**In-Plant Modifications and Effluent Treatment Costs**  
**For**

**Mechanized Blue Crab Plants**

Processing Day: 8 hours  
120 days  
Season: 31,400 1/krig  
Process Flow Rates: (7,530 gal/ton)

Production Rate	(krig/hour) (tons/day)	0.2	0.6	1.1	0.2	0.6	1.1
Hydraulic Loading	(m <sup>3</sup> /day) (gal/day)	2	5	10	2	5	10
		58	150	300	58	150	300
		15,100	37,700	75,300	15,100	37,700	75,300

**TREATMENT ALTERNATIVES**

Capital Cost (Thousands of Dollars)      Daily O&M Cost (Dollars)

S*	49	50	52	12	23	35
S <sub>1</sub> GT	51	52	55	17	31	48
S <sub>2</sub> GT,IP	71	72	80	27	41	63
S <sub>3</sub> GT,IP,DAF	250	262	290	263	280	385

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\*S - Screening  
GT - Grease trap  
IP - In-plant control  
DAF - Dissolved air flotation



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## A Word to Businessmen and Regulators

Roy Martin  
National Fisheries Institute

Consider what we have discussed at this meeting and you will realize something the National Fisheries Institute (NFI) has long contended: regulatory agencies must evaluate impact problems on a case by case basis; there is no one easy answer. In addition--if, and it is a very big if--the state and federal regulators are really serious about saving seafood interests for the national good, then they too must become more actively involved in helping find answers to some of the complex problems discussed at this meeting. We have a seafood heritage that is beginning to slip away. If we are not careful planners, we will have been a part of this particular accident. Regulations must be re-evaluated and re-addressed to save the seafood heritage for the communities we live in and for those who are dependent on the industry. We can't afford regulation for regulation's sake. It makes little difference if you are a regulator or part of the industry, the same concern still exists--food and jobs.

Industry does have options to explore, none of which are easy, but a beginning must be made. What are these options? This conference has suggested eleven: landfills (public or private), composting, protein recovery, chitin or chitosan production, meal conversion, overboard discharge, farm land surface application, silage or enzyme crab concentrates, mechanical recovery techniques, direct feeding to livestock and food raw material recovery. Each has a cost associated

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with it as an initiation fee. It is no longer going to be acceptable to do things the old way. A new club must be joined. The options are there and continued research may make others available as well.

Combinations of these options might also prove feasible, varying perhaps with the seasons. In the shrimp industry, for example, the boats don't fish one variety of shrimp; they move through three seasons. Perhaps you will have to do the same, using multiple options. As processors, another operating option you should explore is the establishment of regional co-ops, with you as an active partner using professional management to investigate one or more of these alternatives. A great deal could be accomplished by ten cooperating companies that are convinced the problem is real. The next job is to go back home and do some convincing. You have heard some possible solutions; now you must get together as businessmen and solve the problems. Go to Weston Conley, take a look at his operation; he will be happy to help you. Use him as a consultant, if you will, and get your operation into gear.

Now a word to our regulator friends. For the period ahead, I urge patience. Until these options have been exercised, more rules and regulations will not solve anything. Economics alone are driving the industry to seek solutions. Livelihoods are at stake here. Can you really suggest protection for homeowners from garbage dumps? If an individual wants to live by one, that is his free choice. Why not go to your legislative bodies and suggest setting up zones of non-complaint around particular dump areas that will be stipulated by state law into home sales contracts? Is it right to buy a house near an airport and then turn around and complain about the noise? Most of the landfill sites have been there a lot longer than new housing developments. You have a whole nation, a whole county, a whole city of taxpayers to represent, not just a few complainants. It is difficult to strike a balance but regulators sometimes need a little bit more courage than they have shown lately. In addition to courage, cooperation is called for; we need each other's help. If cooperation fails, so shall a large historical part of this great country of ours.

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## A Look at the Options

Robert J. Learson  
National Blue Crab Industry Association

The primary role of industry is to do what it must do to survive: produce a good quality product and make a dollar profit. The blue crab industry has done that very well for about two hundred years, but lately it is becoming increasingly difficult to do business. First came welfare, social security and the minimum wage laws; later came FDA and the state and local public health agencies, and more recently OSHA, EPA and others. I am simplifying, of course, but I hope to suggest that although the crab industry generates the scrap, government regulations help to generate the problems.

For a day or so we have listened to discussions of various technologies for eliminating the crab waste problem. I would like to add some comments of my own. I would prefer not to talk about the methods of overboard dumping or landfill because I don't consider them actual technologies.

Those of us who have been involved in crab processing technology have been hearing about chitin-chitosan production for years. Unfortunately, it does not seem to be any closer than it did seven or eight years ago. The technological feasibility is proven, but the economic feasibility looks rather dim; only when the economics are there will something happen. The biggest problem right now appears to be finding a marketplace for the chitin product. In the meantime, someone ought to investigate how the individual processor is going to keep the crab waste in a food-grade quality or in an inter-

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mediate state until it can be converted eventually to chitin-chitosan.

The technology is also in place for producing liquid fertilizer from crab waste. A fairly simple technology involving protein hydrolysis, it has been a subject of investigation all over the world. In the long run, liquid fertilizer could become very important because manufactured fertilizer, which requires petroleum products, is getting too expensive. However, it seems unlikely that crab waste solubles will penetrate the fertilizer market in the near future. Manufactured fertilizers are still available and fish solubles which could be competitive are in plentiful supply.

Silage operations where crab waste are ensiled with hay or grain for animal feed represent an excellent potential solution for a processor who happens to be located near farming areas. Done cooperatively with local farmers, silage could represent an immediate solution to the waste problem for some processors. I feel that the industry would give full support to research studies in this area.

Composting is another possibility, but there is some disagreement over whether or not blue crab waste would compost as easily as the dungeness crab waste or fish waste as reported. Another consideration is the availability of the necessary bulking agents. Sawdust, for instance, is in demand for chicken farming and also for the manufacture of particle board. Other cellulosic materials could be used but the availability and composting ability of these should be investigated. Nonetheless, for some processors that composting could represent an immediate solution.

Meat/bone separation, a technology studied at Gloucester Laboratory and now being instituted by the industry, merits continued attention. As many as ten machines are currently producing edible meat from blue crab waste using this technology. The potential for blue crab producers is tremendous. Fifteen to twenty percent of crab waste can be converted to edible minced crabmeat. Similar products are now being sold for about \$1 to \$1.25 per pound. A marketing problem still remains however. The minced crabmeat produced is being used primarily for reprocessors for stuffed flounder, soups

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and other prepared products. In this limited market, the competition is great from Canadian and Japanese minced crab meat.

The number one short term solution seems to be crab meal production. The technology is available, and the problems for the most part can be associated with older, inefficient plants that now require substantial upgrading for more efficient operation and odor control. The economic viability of a modern crab meal plant needs to be investigated. Two traditional problem areas, odors and transportation, are stubborn but not insoluble. Methods of stabilization to prevent odors during storage are now available.

Given the setup of the crab processing industry, it is likely that no one technology represents the solution to the crab waste disposal problem. The geographical location and available facilities are different for each crab processor, and in some cases one type of crab waste disposal method will work better than others. For some processors, a combination of technologies might be the best solution. Meat/bone separation, for instance, could be used to recover the edible protein followed by a drying procedure to reduce the moisture content. This would produce a reasonably dry calcium material that could be stabilized for eventual shipment to a chitin-chitosan processing plant or simply hauled to a farmer to spread on his fields.

To recap, I think that the methods of composting and silage should definitely be investigated. The work on meat-bone separation should be continued with emphasis placed on new product development and identifying the markets for the product. Crab meal production should also be investigated from the point of view of modern facilities and new technologies.

Those interested in doing research on the crab waste problem should use the National Blue Crab Industry Association (NBCIA) as much as possible as a forum to talk about these technologies and to collect feedback from the industry in terms of finding the best technology for a particular operation. Formed to become a clearinghouse for technical information for the blue crab industry, the NBCIA has membership from Delaware to Texas, and the annual meetings are

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held in different geographical locations specifically to maintain contact with local processors. The NBCIA works to keep its membership up-to-date in terms of recent technology, new government regulations and anything else that can affect the blue crab industry.

I think the industry would also support me if I stated that if anyone doing research on crab waste needs several tons of crab chum, I could guarantee that the price, if any, would be minimal provided you supply the transportation.

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## On Behalf of Industry

W. Robert Prier

Chesapeake Bay Seafood Industries Association

Realizing that Maryland's crab industry depends on the picking operation for at least half of their market and that these same processors have been dangerously dependent on crab meal plants to dispose of their daily waste, the Chesapeake Bay Seafood Industries Association has for years made finding alternative uses for crab waste a high priority. We probably did not realize the seriousness of the problem, nor the time frame in which we had to work. If we had, I am not sure how we could have acted differently. In 1978, we encouraged the Office of Economic and Community Development to contact a Chicago-based chemical company that had expressed an interest in locating chitin-chitosan plant using crab waste in the Maryland-Virginia area. After two years of negotiation, the company, at least temporarily, dropped all plans to build an operation in this area.

At the same time that these negotiations were going on, we were meeting with the crab industry to explore other means of waste disposal. By this time, because of some closings of crab meal operations, disposal had become the problem the industry had feared it would be. We arranged for several meetings to discuss this problem with suggested uses ranging from overboard discharge, composting, chemical fertilizer, improved crab meal, crab silage, methane gas production, chitin-chitosan to landfills. A small project sponsored by the Tidewater Administration of the Department of Natural Resources with the Dorchester County Seafood Packer As-

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sociation and Marine Agri-Products resulted in testing enzyme technology for reduction and processing of shellfish waste. The results of this test only pointed out the need for more studies and definitive results.

While all these meetings and tests and studies were underway, another ominous cloud formed on the horizon. The Environmental Protection Agency (EPA) was preparing to update their effluent guidelines and felt the blue crab industry should be compelled to treat their effluent in a way which would be much more costly than before. The study done for EPA by E. C. Jordan Company suggests that solid crab waste could be used for commercial products such as fish silage, chitin peptone, enzymatic digestion products and other applications. Seafood processing facilities, according to the report, are also capable of generating secondary products for human consumption. Several other ways crab waste could be turned into a profitable byproduct are listed, and the entire text is designed to prove that the blue crab industry would not have any difficulty in meeting the additional financial burdens caused by more sophisticated effluent treatment. Our response was not so optimistic. We answered the report by detailing inaccuracies and fallacies in the Jordan report and by aiding the National Marine Fisheries Service in drafting an in-depth response along the same lines.

On another front, we have also been working with Mr. Robert Gracer, Regional Manager of the Council of Revitalization of Employment and Industry at the Trade Adjustment Assistance Center, to determine if financial help could be obtained from that source because of damage done the industry by imported crab product. This has proved difficult to document. We are still active in all these projects and will continue to work for the crab industry to solve yet another in what seems to be an unending series of problems. We only wish we could have more of a success story to tell you.

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## Potentials and Problems

Dr. George J. Flick  
Virginia Polytechnic and State University

Do we have a crab scrap crisis? We certainly do--although maybe not everywhere. Do we have answers? It all depends. The resources of the crab industry are spread all over the coast--from Texas to Virginia to Maryland--and conditions vary from one location to the next. If you live in a rural area with a good supply of crabs all year round, you probably can have a successfully operated dehydration plant. In a large city, complaints and zoning difficulties might contribute to your having a dehydration plant that does not work as well. In areas where you have a limited supply of crabs, the economics might make crab scrap an impossible problem.

The various uses of crab waste do impact on each other; nor can they be considered apart from crab processing technology. On the one hand, we have the potential to produce and market chitin or protein concentrates. On the other hand, in a year or two we could introduce a new technology into the crab processing industry that will lower the quality of the scrap. What effect would that have on the production and marketability of these byproducts?

By going to extruder products and producing protein for people, we can get greater utility and a higher price because we are operating on several levels: nitrogen, protein, calories and satisfaction are all involved. As we produce edible portions, however, we make our waste less valuable to the dehydration plant. The best management plan for crab waste is

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probably combinations of our options, each adapted to geographic location and to changing conditions.

In the final analysis, it is going to be up to industry to decide what they want to do. We have the basis for a lot of imagination and a great deal of technology. Federal agencies that have the money and are willing to look at cooperatives are going to have to help. The greatest problem is that we are working with undercapitalized industries that lack technical staff. With crab plants, one person often is the manager, buyer, salesman, and troubleshooter and in charge of long range planning, of research and development and everything else. Certainly quite a task. Look at the example of the large food companies. Two weeks ago Swift announced that they are getting out of the food industry. They found playtex and stereos and everything else much more profitable than food. And certainly they had a bigger research budget than the whole seafood industry combined. So we really are asking quite a bit of the crab industry. I don't think many processors are staying home today because they are making a big profit.

The industry is going to have to get together as a group and let us know how we can best serve them. This conference has only been a beginning, one channel for communication between industry, research and government. The challenge is to go the next road: to make decisions and to implement them.

