PROCEEDINGS OF THE
SEAFOOD
SCIENCE
AND
TECHNOLOGY
WORKSHOP
A SELECTION OF
UNSOLVED PROBLEMS
May 24-26, 1982
Washington, D.C.
SEAFOOD SCIENCE AND TECHNOLOGY WORKSHOP

May 24-26, 1982, Washington, D.C.

SPONSORING ORGANIZATIONS

National Sea Grant College Program
National Marine Fisheries Service
National Fisheries Institute

STEERING COMMITTEE

David H. Attaway, National Sea Grant College Program
Thomas Billy, National Marine Fisheries Service
James Brooker, National Marine Fisheries Service
George Flick, Virginia Polytechnic Institute and State University
Lamartine F. Hood, Cornell University
George Knobil, National Marine Fisheries Service
Roy Martin, National Fisheries Institute, Inc.
Donald F. Squires, SUNY/Cornell Sea Grant College Program
Carolyn A. Thoroughgood, University of Delaware Sea Grant College Program
PROCEEDINGS OF THE

SEAFOOD SCIENCE AND TECHNOLOGY WORKSHOP

A SELECTION OF UNSOLVED PROBLEMS

May 24-25, 1982
Washington, D.C.

CAROLYN A. THOROUGHGOOD
Workshop Moderator
and
Proceedings Editor

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University of Delaware
Sea Grant College Program
Newark, Delaware 19711
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FOREWORD

The problems of the seafood industry are of prime concern to the Department of Commerce and the National Oceanic and Atmospheric Administration (NOAA) because of the annual $3 billion deficit in trade of seafood and because two of NOAA’s main components, the National Marine Fisheries Service and the National Sea Grant College Program are responsible for helping to solve these problems. Changing attitudes toward Federal governmental responsibility and declining Federal funds for research and service emphasize the importance of reexamining the problems on which to focus financial and intellectual resources.

The workshop will bring together seafood processors and retailers, institutional buyers of seafood, and governmental and academic personnel to specify the problems preventing greater use of domestic seafood here and abroad. Many of these problems should be amenable to solution through research. Their definition will serve as a basis for strengthening or redefining NOAA’s role in seafood science and technology and will lead to determination of appropriate governmentally sponsored research and service for Federal laboratories and for universities. I believe the process of the workshop will foster closer and more productive collaboration among industry, government, and universities in attempts to exploit underutilized species, to greatly enlarge the share of American seafood products in domestic and foreign markets, and to improve efficiency and technology of processing and handling fish.

–James W. Winchester
Associate Administrator
National Oceanic and
Atmospheric Administration

Excerpt from letter of invitation to workshop participants.
WORKSHOP OBJECTIVES, ORGANIZATION, AND FOLLOW-ON PLANS

The workshop was held on May 24-26, 1982, at the Holiday Inn, 2101 Wisconsin Avenue, Washington, D.C.

WORKSHOP OBJECTIVE

The workshop brought together seafood users and representatives from industry, government, and academic institutions to identify and rank in order of priority the most important problems in seafood science and technology that, if solved, could lead to better commercial use of fisheries resources.

WORKSHOP DESCRIPTION

The workshop was sponsored by the National Fisheries Institute, the National Marine Fisheries Service, and the National Sea Grant College Program. A steering committee representing each of these organizations prepared a list of invitees selected from the following categories: seafood consumers/users, seafood processors, researchers and/or marine advisors, and policy makers/regulators. The list of invitees and attendees, shown by category, is provided below. A full list of attendees and their affiliations is provided as Appendix I.

<table>
<thead>
<tr>
<th>Category</th>
<th>Invitees No.</th>
<th>Attendees No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seafood Consumer/Users</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Seafood Processors</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>Researchers and/or Marine Advisors</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Policy Makers/Regulators</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>54</strong></td>
<td><strong>41</strong></td>
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PREPARATIONS FOR THE WORKSHOP

Each participant was expected to prepare for the workshop by defining one or more seafood science and technology problems of commercial significance. Forms were provided for their use.

Two example problems were enclosed. One, "Disposal of Wastes From Processing of Shellfish," is exemplary of problems in the area of engineering and waste treatment. The second, "Improving Quality and Yield of Processed Seafood," is representative of a set of problems associated with processing, handling, and preservation. There were, of course, many other potential problem areas, such as product development, by-product recovery, organoleptic, microbiological, and nutritional quality, and marketing.

There was no limit to the number of problems each participant could bring to the workshop; each problem was to be defined as clearly and as interestingly as possible. Also, each participant was encouraged to contact colleagues or business associates to obtain problems to bring to the workshop. The only requirement was that each participant understand the problem in sufficient depth to discuss it and, if necessary, modify it at the workshop. Each participant represented an entire commercial community, regulatory agency, etc. This restriction was necessary to keep the working group to a manageable size.

It is also important to note that the workshop was not concerned primarily with equipment or instrument-development needs, although equipment will be needed to solve most problems. The goal of the workshop was to define those problems clearly and to rank them in order of importance.

Before preparing the problem statements, workshop participants were asked to read a supplemental background reading packet. Included in this packet were the following:
1. A General Description of the National Sea Grant College Program;

2. A Report on Seafood Science and Technology in the National Sea Grant College Program;

3. A General Description of the National Marine Fisheries Service (NMFS);

4. The Proceedings of a Symposium on Food Science and Technology. Articles in this section included

5. A Paper Titled "U. S. Seafood Industry's Big Opportunity--Quality Assurance;"

6. An NMFS Issue Paper on the Quality of U.S.-Produced Fish and Fishery Products;

7. An NMFS Issue Paper on Utilization Research;
8. A Letter to The Honorable Philip M. Klutznick, Former Secretary of Commerce, from Henry Eschwege, Director, Community and Economic Development Division, U.S. General Accounting Office. Subject: Need to Assess the Quality of U.S.-Produced Seafood for Domestic and Foreign Consumption;


The full texts of these references are found as Appendix 2.

HOW THE WORKSHOP WAS CONDUCTED

A modification of the Nominal Group Method was used. This approach is designed to insure full participation by each attendee. It was important for each participant to be there from beginning to end. A workshop agenda is included as Appendix 3.

The workshop consisted of five parts. The first was registration and a get-acquainted period on Monday evening; attendance was optional. The second part, problem identification and description, began Tuesday morning and continued until all of the problems were presented by participants. This was done by asking each participant, in turn, to present his or her highest-priority problem. Only one problem was presented by each participant at each turn. Each problem title was printed for posting on the wall of the meeting room and was assigned a number. This activity continued until each participant had exhausted
all of his or her problems. Thus, participants who came with only one problem spoke once and passed thereafter. Problem descriptions were kept brief, and questions from other participants were held to points of information and clarification.

The third part of the workshop was problem consolidation and clarification. This step was necessary because several individuals proposed similar problems. When this happened, one of the proposers was asked to chair a task group to draft a consolidated problem description which may have one or more parts. The other members of the task group (the individuals who suggested similar problems) were expected to review, modify, and agree to the consolidated problem description. When this was done, the consolidated problem description replaced the several similar problems proposed originally. At the conclusion of the third part of the workshop, Wednesday morning, each task group chairman summarized the consolidated problem for all of the participants.

The fourth part of the workshop was devoted to the preliminary ranking of the problems in order of importance. This was done by each participant selecting and ranking his or her top 15 problems.

A typist was available throughout the working meeting so that new problem descriptions were completed and distributed before the participants departed.

The fifth and final part of the workshop was devoted to a discussion of the mechanisms required to insure maximum use of the workshop output.

As a follow-on to the actual workshop, problem descriptions were refined and distributed to all workshop attendees for final ranking. The participants again were asked to rank their top 15 problem statements.
This exercise provided a consensus and guide to the participants' views on the most important problems.

OUTPUT OF THE WORKSHOP

The tangible output of the workshop is this report, which includes all the problem descriptions presented. These are listed in the order established by the participants. Each participant will receive a copy of the report, and sponsoring organizations will have multiple copies for distribution. The intangible output will be a better appreciation by each participant of the interrelationships of scientific and technological problems confronting seafood users and their regulators, particularly as they promote the development of this industry to its fullest potential.

WHAT ACTION WILL OCCUR AS A RESULT OF THE WORKSHOP?

The definition of these important problems will be factored into planning future research and public educational activities of university-based Sea Grant programs and of the National Marine Fisheries Service. The Office of Sea Grant and NMFS will encourage organized and collaborative efforts within and between their organizations and with industry for resolving the most important problems for which their personnel are suited. It is also hoped acquaintances made or renewed at the workshop and the report of the workshop will naturally foster closer and new collaborative activities between academe, government, and industry in trying to solve the problems.

A number of the problems identified refer to the need for application and communication of technological solutions already available. This
emphasizes the opportunities for marine advisory service in the National
Sea Grant College Program. Because budgetary restrictions will prevent
hiring additional advisory agents soon, collaboration among industry,
NMFS, and Sea Grant will be especially important for the success of
educational programs in meeting this need.

The Steering Committee will remain together as a working group and
will annually account for the progress made toward the solutions of the
problems identified as critical to the commercial viability of the
seafood industry. An annual reconvening of all the workshop participants
is also being considered. It could be scheduled at the time of one of
the national professional meetings usually attended by many of the
participants.

ACKNOWLEDGMENT

Both the participants and staff worked hard to make this workshop
productive. The following individuals deserve a great deal of credit
for their part in making the workshop operate smoothly: Dr. Dietrich
Knorr, workshop secretary; Ms. Doris Hicks, technical editor, Ms. Ellen
Stroud, graphic artist; Ms. Dot Black, typist, and Ms. Sue Thompson,
logistical assistant and typist.

C. A. Thoroughgood,
Workshop Chair, on behalf
of the Steering Committee

September 1982
Participants identified 96 problems, which were then consolidated into the 57 that are presented in order of priority in this section. Participants established priorities by completing score sheets, listing their top 15 problems in descending order (see Analysis of Results, p. 67). When the score sheets were tallied, the problem with the lowest score represented (according to consensus of the group) the highest priority.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Maintaining Quality of Fresh Fisheries Products in Distribution Channels

Proposed by: J. Sackton

PROBLEM DESCRIPTION:

Much attention has been focused on new technologies to extend the shelf life of fresh fish. Before these technologies can reach their potential, some of the basic problems with the present seafood distribution system have to be overcome.

Two of these problems are lack of knowledge and control at the retail level in handling fresh fish and difficult and often inadequate shipping arrangements due to shippers reluctance to handle fresh fish, and the small volumes of fish shipped compared to other commodities.

One approach to this problem is to attempt to make packages and procedures "idiot proof" so that fish will arrive in good condition, no matter what. The other approach is to use training and work with shipping companies, retailers, and processors to upgrade the knowledge about handling and shipping seafood throughout the industry. Such training, based upon appropriate research and handling methods, has benefited the presentation of other food commodities.

POTENTIALLY RESPONSIVE RESEARCH:

Investigate how standard procedures in use in the poultry, vegetable, and meat industries for shipping and handling could be applied to shipping fresh fish.

Evaluate new technologies such as modified atmospheres, blanching, additives to ice, etc., to determine their sensitivity to abuse in actual usage.

COMMERCIAL SIGNIFICANCE:

Our Foundation sees a strong demand for both training programs of this type and shipping studies and alternative arrangements. Once the basic work of setting up these types of programs has been done, industry will pay the cost of continuing them. The result will be to improve fish quality at the consumer level and to increase consumption of fresh fish.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Methods for Shipboard Handling, Pretreatment, and Storage of Fish that are Essential to the Subsequent Quality of all Fisheries Products

Proposed by: W. S. Otwell, L. Regier, and J. Sackett

PROBLEM DESCRIPTION:

Traditional and emerging fisheries need to implement improved on-board handling and processing technologies that are designed to better preserve the initial quality of the products. Loss of quality is associated with current on-board handling methods resulting in bruising, pitchforking, and crushing. There are also problems resulting from improper cooling methods.

Fish-handling systems have to be integrated between vessels and plants and fit the marketing practices of the region. As a result, fish-handling systems often represent the lowest common denominator of the available technology. Because many processors and fishing vessels are not vertically integrated, they have no common incentive to introduce improved offloading and material handling. Neither party alone wants to assume the cost of the engineering and design work.

POTENTIALLY RESPONSIVE RESEARCH:

Research devoted to upgrading the quality of fisheries products through improved unloading and material-handling systems. Studies of a systems approach to seafood handling within particular ports. Integration of seafood-handling systems with processing and marketing needs. Documentation of damage and losses that occur to seafood from conventional handling practices. Consumer and market research to quantify the effect of negative experiences. Extensive literature search (including Baltic countries) on work done on design and operation of fish pumps.

COMMERCIAL SIGNIFICANCE:

Better-quality fishery products mean higher yields for processors and increased sales at the retail market.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Management of Fisheries Wastes: Improved Technology; Recovery of High-Value Products; Recovery of Low-Value, High-Volume Components for Food and Feed. Study of Functionalities and Properties of Fisheries By-products and Isolates from Wastes


PROBLEM DESCRIPTION:

To manage wastes generated in fish/shellfish processing, cost effectiveness will be dependent upon conversion of waste to marketable products.

1a. High-value products such as enzymes, therapeutic proteins, hormones, and other bioactive compounds.

1b. Low-value, high-volume components for food and feed, such as fertilizer or dietary extenders.

Studies must be carried out to determine the functionalities and properties of these products.

POTENTIALLY RESPONSIVE RESEARCH:

Research will focus on methods and mechanisms for isolation, characterization, and preparation of these products in a highly cost-effective way. Application of novel separation procedures employing monoclonal antibodies and other techniques to isolate and purify marine bioproducts will yield significant return in the form of new, commercially-important products.

COMMERCIAL SIGNIFICANCE:

The fishing industry of the U.S. discards anywhere from 60 to 80 percent of the fish that are caught or, at best, turns them into animal feed or fertilizer. The recovery of products such as those stated above from fish waste would allow the upgrading of the waste material and would help pay for the cost of waste disposal.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

[Please limit description to space provided.]

Title: Determination of Maximum Shelf-life for Fresh Fish and Effect of Handling and Unit Processing Operations on Ultimate Quality

Proposed by: G. J. Flick

PROBLEM DESCRIPTION:
Retail food firms do not know how long a specific fish will maintain quality in the marketing system even though some of the processing conditions may be defined. A systematic study is needed that will define optimum shelf-life of various fish species and how handling procedures affect final product quality.

POTENTIALLY RESPONSIVE RESEARCH:
Expanded sale of fresh seafood in noncoastal areas.

COMMERCIAL SIGNIFICANCE:
Retail food stores will purchase fresh fish if there is some information as to how long the product will be maintained in high quality.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Characterization and Utilization of Nontraditional Species


PROBLEM DESCRIPTION:

Many types of underutilized species are available. Many species not often fished by U.S. fishermen include large numbers of small fish because existing technology for handling and processing is designed to deal with relatively large fish.

An impediment to the utilization of many species is that little is known about their chemical and biochemical characteristics. These include the makeup of the constituents of the fish and the enzymatic systems present that cause their conversion and breakdown. Without this information, it is not known for what types of products they would be best suited, what their storage characteristics might be, and the best type of processing procedures for them to undergo. This information will be necessary for the development of these species as edible food sources. Another major consideration in the use of underutilized species is their current nonacceptability on the U.S. food market.

Production of minced fish is a way to use the above products. However, comminuted fish has not received wide application, due to textural limitation and, therefore, needs further study.

POTENTIALLY RESPONSIVE RESEARCH:

Species that have indications of reasonable sustainable annual yield should be examined for their chemical composition and their decomposition characteristics under various conditions of processing and storage, i.e., refrigeration, freezing, canning, dehydration, salting, smoking, etc. Acceptability to consumers by sensory testing should also be carried out. Determination of the spoilage characteristics of various species will allow proper handling and storage procedures to be developed.

COMMERCIAL SIGNIFICANCE:

Efficient utilization of non- and underutilized fish species as raw material for the manufacture of foods.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Maintaining quality of Frozen Fisheries Products through the Transportation and Distribution Chain

Proposed by: R. J. Learson

PROBLEM DESCRIPTION:

Much of the seafood is now landed and processed in good condition. Time-temperature abuse during the transportation and distribution of seafood products is one of the major contributors to poor quality.

POTENTIALLY RESPONSIVE RESEARCH:


COMMERCIAL SIGNIFICANCE:

More market demand for higher-quality products.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Inadequate Technology for Extending Shelf-life of Processed Fisheries Products: Need for Flexible Packaging, Controlled-Environment Storage, Dehydration, Thermal Processing, etc.

Proposed by: W. L. Baran, K. O. Hultin, A. G. Rand and J. Salmon

PROBLEM DESCRIPTION:

The preservation of fish and shellfish requires adjuncts in addition to ice or refrigeration to maintain quality and expand the affective market. Ideally this treatment should be applied to whole fish immediately post harvest and carried through the processing and distribution phases. At present, the consumption of fisheries products is lower than their potential because of their relatively short shelf-life.

POTENTIALLY RESPONSIVE RESEARCH:

Investigate methods for shelf-life extension, including controlled-atmospheric storage, pasteurization by ionizing radiation, cryovacing, chemical treatments, blanching, etc. Optimal conditions should be developed for all these to maintain high quality for as long as possible. Food safety and toxicological problems attendant on the processes should be examined, and where possible, resolved.

COMMERCIAL SIGNIFICANCE:

Consistent, high-quality fisheries products developed for distribution across the country would mean higher consumer demand.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Failure to Apply State-of-the-Art Technology to Produce Fisheries Products of High Quality

Proposed by: D. J. Toloday

PROBLEM DESCRIPTION:

There is technology available at this time for the handling and processing of all finfish and shellfish in order to deliver them to the consumer with excellent quality and wholesomeness. These technological processes and practices are not and have not been communicated to the finfish and shellfish harvester and transporter in ways that they understand and to which they respond.

Because of this, the consumer has a significant lack of confidence in the quality and wholesomeness of finfish and shellfish.

POTENTIALLY RESPONSIVE RESEARCH:

Development of easier-to-understand technological procedures for harvesting, chilling, and transporting products should be developed and administered through existing government agencies that can assure not only the communication but also the monitoring and continued education programs that are needed to alleviate the problem.

COMMERCIAL SIGNIFICANCE:

Increased confidence on the part of the consumer will raise the per capita consumption and tend to stabilize and lower prices while expanding markets.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

Title: Lack of Rapid Methods to Judge Fish Quality

Proposed by: R. R. Zall

PROBLEM DESCRIPTION:

We know that consumers are hard-pressed to assess the fine differences in fish quality (fresh and frozen). Research personnel are also troubled by the lack of reliable methods to judge fish quality. What is needed are new methods for grading fish quality on piers, in stores, and in the home.

POTENTIALLY RESPONSIVE RESEARCH:

Technology will be used to process fish, i.e. "blanching," before refrigerating and storage.

COMMERCIAL SIGNIFICANCE:

In many cases, better-quality fish might be offered for sale, which would probably increase the per capita consumption of fish in the USA.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Nutritional Information for Seafoods as Marketed and Consumed

Proposed by: B. M. Barton

PROBLEM DESCRIPTION:

How much cooked, edible meat will a pound of raw, whole squid yield? How many milligrams of sodium in three ounces of cooked whiting from a one-pound package of frozen fillets? How many two-ounce servings of cooked shrimp from a pound of frozen, raw, peeled, deveined shrimp and how many calories per serving? Unfortunately, much of the seafood nutritional information currently available for use is conflicting, misleading, and unresponsive to the needs of both the professional and technical community as well as the average consumer.

POTENTIALLY RESPONSIVE RESEARCH:

Development of nutritional composition and yields of seafoods as currently marketed and consumed in households and institutions.

COMMERCIAL SIGNIFICANCE:

The nutritional value of seafoods is a popular and legitimate marketing tool being employed to increase seafood consumption by health-conscious Americans. The availability of reliable and meaningful information about seafood nutrition will benefit all nutrition-education efforts aimed at achieving this goal.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

This: Technological Problems and Other Impediments to the Production and Utilization of Minced Fish for Food Use.

Proposed by: A. P. Bimbo, L. Regier, J. Spinelli
(Replaces 6, 6A, and 26)

PROBLEM DESCRIPTION:

There is interest in the fish meal industry to upgrade the various species of pelagic fish to food use. A major problem with small pelagic fish is that large volumes are landed in short periods of time, and these large volumes of fish must be processed quickly. One stumbling block is degutting of these fish: conventional degutting machines do not appear to be suitable.

Having surmounted this and other technological problems, a probable market "food" form for "industrial fish" is minced fish. Consumer-acceptable products to use large volumes of minced fish have not yet been defined.

POTENTIALLY RESPONSIVE RESEARCH:

Development of a method to degut small pelagic fish quickly so that spoilage and rancidity can be avoided. Product development and market research must be carried out to exploit large volumes of edible fish.

COMMERCIAL SIGNIFICANCE:

Increase in the economic value of traditionally restricted use to "industrial fish."
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Low Value of Nontraditional Species: Need for Conversion into Product Forms Suitable for Food Use.

 vấn đề: Low Value of Nontraditional Species: Need for Conversion into Product Forms Suitable for Food Use.

Proposed by: A. P. Bimbo

PROBLEM DESCRIPTION:

There is a world-wide movement in the fish meal industry to upgrade the various species of pelagic fish to food use. This concept has been endorsed by FAO.

Should all the pelagic fish currently being utilized for fish meal be converted to edible use, where will the products be sold? Is there a market for raw, frozen mince? What are the products that can utilize this type of mince and can it be sold at a profit?

POTENTIALLY RESPONSIVE RESEARCH:

A study of the potential markets, domestic and export, for raw, frozen mince from pelagic species.

COMMERCIAL SIGNIFICANCE:

If the markets can be demonstrated then the incentive to produce products from the underutilized species will be greatly increased.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Common Names that Discourage Purchases; For Example, Ratfish

Proposed by: R. Martin

PROBLEM DESCRIPTION:

Seafood with strange names.

POTENTIALLY RESPONSIVE RESEARCH:

Continue support for expanded physical, chemical and sensory evaluations that could provide reliable information to the consumer on what unfamiliar fish taste like in the form of an edibility profile.

COMMERCIAL SIGNIFICANCE:

Open new marketing options.
SEAFood SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Determination and Control of Sodium in Fisheries Products

Proposed by: J. Spinelli

PROBLEM DESCRIPTION:

Because of poor processing and lack of knowledge (salt penetration), the salt content of several commercially important fish and shellfish is too high and extremely variable. These practices contribute to a wide range of organoleptic variability and to a higher-than-necessary sodium contribution in the U.S. diet.

POTENTIALLY RESPONSIVE RESEARCH:

Improve procedures for brine freezing and refrigerated seawater (RSW) systems. Investigate the use of additives to retard salt penetration in brine and RSW systems.

COMMERCIAL SIGNIFICANCE:

The maintenance of low and consistent sodium contents in seafoods will enhance their nutritional image and improve sales.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

Title: Limited Variety of Products from Traditional Fish and Seafood Species for the Retail and Related Food Services Industry

Proposed by: W. L. Baran and G. J. Flick
(Combines 36 and 36A)

PROBLEM DESCRIPTION:

There is a need to develop new products from traditional fish and shellfish species. For example, the only fish product used by the fast food industry is a breaded, deep-fat-fried cod product. Many grades or products of an acceptable fish and shellfish species can be produced in a quantity that greatly exceeds demand. Some of these products are standard-size oysters, machine-picked crab meat, and chowder clams.

POTENTIALLY RESPONSIVE RESEARCH:

Development of new fisheries products, particularly using raw materials available in excess quantities. Use of restructured-product technology for fish products may be useful.

COMMERCIAL SIGNIFICANCE:

The potential of greater revenues due to increased variety in product lines.
SEAFood Science AND Technology PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Chemical Contamination of Fisheries Products

Proposed by: G. M. Meaburn

PROBLEM DESCRIPTION:

There is a continuing influx of chemical contaminants into the marine environment. Chief among the organic contaminants are petroleum hydrocarbons and a wide array of synthetic chemicals, such as PCBs and chlorinated pesticides that have been or continue to be heavily used in industry or agriculture. Little is yet known about the potential hazards arising from the consumption of seafoods contaminated by these materials or their metabolites. Heavy metals such as mercury, cadmium, and lead may be found in certain species at disturbingly high levels. Again, however, safety problems due to these contaminants remain implied rather than confirmed. Public confidence in the safety and wholesomeness of seafoods is further diminished with each reported pollution incident, regardless of the true public health significance of these contaminants, with a consequent impact on the fisheries industry.

POTENTIALLY RESPONSIVE RESEARCH:

Evaluation of the toxicity of organic contaminants in fishery products, including studies of the uptake, transformation, and interactions of specific compounds in several model systems, using fish and mammalian tissues.

COMMERCIAL SIGNIFICANCE:

Improved capability to provide a rational assessment of possible dangers to public health from consuming contaminated fishery products will lessen impact on the fisheries industry.
SEAFood SCiENCE AND TEChNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Suitable Standards for Fisheries Products Suitable for Human Consumption

Proposed by: J. R. Brooker

PROBLEM DESCRIPTION:

There is no baseline quality level for seafoods produced and marketed in the U.S. that establishes it as being suitable for human food use. The legal operating procedure is to subjectively evaluate how spoiled the product has become; at a point it becomes actionable by regulatory authorities. Currently, fresh and frozen seafoods can contain as much as 20 percent by weight decomposed product before it is actionable as being an adulterated.

POTENTiALLY RESPONSiVE RESEARCH:

Many traditional and underutilized species need to be analyzed using a standard methodology in relation to an established set of criteria (model) to establish a baseline level of quality for seafoods suitable for human consumption.

COMMERCIAL SIGNIFICANCE:

SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Control of Microbial Flora of Raw Fisheries Products through Better Handling Techniques and Use of Processing Aids

Proposed by: W. Biegoslawski and R. R. Pedraja
(Combines 7 and 7A)

PROBLEM DESCRIPTION:

Oftentimes, excessive numbers of microorganisms are found in raw fishery products, including the presence of pathogens at significant levels. Also, bacteria can be introduced through the use of commercially produced "infected" ice.

POTENTIALLY RESPONSIVE RESEARCH:

Improved handling and processing techniques as well as research on the use of processing aids that will inhibit or control bacterial growth during processing without affecting eating qualities, wholesomeness, and safety of the products.

COMMERCIAL SIGNIFICANCE:

Minimize potential public health hazards and increase public confidence in the safety of fishery products. Improve economy of the industry by reducing product rejection.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Absence of information on and procedures for implementing optimum time-temperature regimes for quality maintenance of frozen food

Proposed by: H. O. Hultin, H. W. Symons, R. R. Zall
(Replaces 14A, 14D, 14G)

PROBLEM DESCRIPTION:

The U.S. frozen food industry laid down the principles of frozen food storage before the high Q10 values found in most seafood materials were discovered. The generally accepted storage temperature of 0°F (-18°C) is widely considered to be inadequate for any but transient handling (e.g., during distribution) of frozen seafood; -22°F (-30°C) is the widely accepted temperature necessary for long-term bulk storage of most seafood. The temperature chosen for storage will determine the shelf-life of the product. Usually the judgment is made based on the shelf-life necessary to maintain a product at a given quality. The poor acceptance of many frozen seafood products by the American consumer, as well as the low quality of the products sent to foreign markets, shows that the problem should be examined within the context of the species and products manufactured in the U.S.

POTENTIALLY RESPONSIVE RESEARCH:

Relative shelf-life should be determined for various types of fish products as a function of storage temperature and time. Major types of quality deterioration, such as lipid oxidation and/or protein denaturation, should be followed objectively as well as by sensory evaluation. In addition to technical research, a study of consumer attitudes should be undertaken as well to promote consumer acceptance.

COMMERCIAL SIGNIFICANCE:

Better-quality frozen seafood products would be available in the domestic and foreign marketplaces.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Place limit description to space provided.)

Title: Inadequate Measures for Water and Energy Conservation During Seafood Processing

Proposed by: G. J. Flick and W. S. Otwell
(Combines 40 and 40A)

PROBLEM DESCRIPTION:

Seafood plants must reduce their resource use, particularly water and energy resources. Population pressure and limited financial support for wastewater treatment will continue to accelerate the user costs for water and wastewater treatment. In certain areas of the country, water availability is limited regardless of cost. The consequence for seafood processors is increasing product costs, limited water use, and pressure to implement more regulatory restrictions. Thus, the economic security of the fishing industry is threatened and expansion is restricted.

POTENTIALLY RESPONSIVE RESEARCH:

Develop alternative unit-processing operations that require less water and energy inputs. All work should be closely coordinated with the pertinent regulatory agencies to allow cooperative education and assure product quality and safety will not be compromised.

COMMERCIAL SIGNIFICANCE:

Processing operations will become less expensive and disposal problems will be reduced.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Control of Lipid Oxidation in Seafood

Proposed by: H. O. Hultin

Problem Description:

A major cause of quality loss in both fresh and processed seafoods is lipid oxidation. Lipid oxidation is especially serious in fish because of the high concentrations of highly unsaturated fatty acids in the tissue. Lipid oxidation reduces shelf-life, particularly in fatty-type fish and minced-fish products. Thus, this represents a major obstacle to the development of our underutilized fish resources and recovery of material currently discarded.

Potentially Responsive Research:

An understanding of the mechanism of lipid oxidation in fish tissue should lead to better methodology for slowing down the deterioration of fish due to these reactions. Pro-oxidants and anti-oxidants should be identified as should their change with time during storage and processing. The nature of the lipid oxidation compounds and their interactions with other components of the fish muscle tissue should be determined, particularly as they affect quality of the product.

Commercial Significance:

Increased shelf-life of fishery products would be attained. It will be especially important in developing consumer products for fatty-type fish and for deboned fish of underutilized species or waste material.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Reliable Tests for Fish Quality and Methods of Projection of Shelf Life of Fresh Fish

Proposed by: J. Liston

PROBLEM DESCRIPTION:

There is no satisfactory, single test or combination of tests that can measure quality over a wide range of fresh seafood products. Even in cases where traditional chemical, physical, and/or microbiological tests provide some measure, it is not possible to project future shelf life in many cases. This creates difficulties for processors, retailers, and regulating agencies.

POTENTIALLY RESPONSIVE RESEARCH:

There is need for more fundamental research on the mechanisms of change in fish held unfrozen, post mortem. These should be examined in terms of biochemistry, structural change, and associated microbiological change for a representative selection of a wide range of species to find a common pattern of consumer reactions that can be used as "universal indicators." This will need coordinated research in a number of areas of the U.S.A.

COMMERCIAL SIGNIFICANCE:

The value of a reliable set of quality tests that could be related to tables of expected shelf life and tabulated for different temperatures and conditions to all branches of the fish industry and related government agencies would be inestimable. This would provide a rational basis for dealing with the quality problem, which still plagues large sectors of the U.S. industry.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

Title: Development of Cost-Effective Waste Treatment Methods

Proposed by: G. Peterson

PROBLEM DESCRIPTION:

Treatment of wastes from seafood plants is not a simple matter. Wastes from frozen processed seafood plants present different challenges from waste generated by a shellfish cannery, for example.

POTENTIALLY RESPONSIVE RESEARCH:

Research and development of model treatment systems in the following processing categories: fresh packers, frozen processed seafood plants, seafood canneries.

COMMERCIAL SIGNIFICANCE:

Waste treatment is expensive. Development of effective treatment systems is often by trial and error. Research could point the way toward more cost-effective treatment plants.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Market-Research Information that will Guide Development of New Products

Proposed by: J. Salmon and J. Slavin
(Combines 45A and 45B)

PROBLEM DESCRIPTION:

In developing new products for export and domestic market, it is important to know what the economic preferences are and the types of products that may be in high consumer demand. Factors of concern include availability, species, preparation, nutritional aspects, etc. Such knowledge of consumer preferences will guide product development and promotion of fisheries products.

POTENTIALLY RESPONSIVE RESEARCH:

Market research in foreign countries with potentially high fish consumption. Investigation into both government funds and industry support to develop a national marketing concern, specifically through the Saltonsett-Kennedy Act.

COMMERCIAL SIGNIFICANCE:

Develop the general public's knowledge of the U.S. fisheries to increase consumption and promote high-quality products.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

Title: Lack of Mariculture/Aquaculture Systems

Proposed by: H. O. Hultin

PROBLEM DESCRIPTION:

The great majority of fish caught and consumed in the U.S. today are wild animals. Since it is basically a hunting operation, production of fish as food can be said to be approximately where the land animal industry was some 10,000 years ago. The ability to raise known species of fish and shellfish under controlled conditions should allow for better control of quality and level out the ups and downs of supply. This should tend to stabilize prices and cause an increased demand for consumers who would be assured of a constant supply.

POTENTIALLY RESPONSIVE RESEARCH:

Much research has to be done on all aspects of mariculture and aquaculture. Nutritional requirements, disease resistance, genetic development, optimization of growth per unit of feed, containment, and prevention of loss of feed are all areas of importance.

COMMERCIAL SIGNIFICANCE:

Sustained and guaranteed yields of high quality edible products of finfish and shellfish will be available tending to lower prices and increase demand.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Analytical Tests for Seafood Freshness, Safety, and Identity

Proposed by: H. O. Hultin

PROBLEM DESCRIPTION:

Much fish arrives at the processor with an unknown history. A simple, inexpensive, and convenient means for determining the state of freshness of these fish would be most useful in establishing prices to be paid for the fish and its expected shelf-life. Many of the tests and procedures developed to date are cumbersome and require expensive equipment or significant technical sophistication. Likewise, the ability to determine the safety of seafood products could be improved. Detection of natural breakdown products such as the di- and polyamines, bacterial contamination, or intentional or unintentional additives are some examples of substances for which improved detection would be useful.

POTENTIALLY RESPONSIVE RESEARCH:

Development of better and simpler analytical tests for the quality and safety of fish would allow better control of the raw material and give increased confidence to the consumer, thus helping to increase the demand for seafood products. Recent developments in biotechnology such as immobilized enzyme electrodes, affinity chromatographic techniques, and monoclonal antibodies should be examined for their applicability to solving these problems.

COMMERCIAL SIGNIFICANCE:

The ability to put on the market products of better quality and greater safety should increase the consumption of fish by the U.S. consumer.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

Title: Absence of Procedures for Packaging Fisheries Products in Retortable Pouches

Proposed by: J. Emerson

PROBLEM DESCRIPTION:

Development of the retortable pouch in the US began in early 1950s. Much of the work was done by the US Army Natick Devel Center because the military was, still is, interested in its use for combat rations. The meals-ready-to-eat (MRE) program is now underway. There are a number of food entrees currently being packed in retort pouches under this program, e.g., chicken, beef stew, ham slices. To date, no seafood entrees have been developed for the program.

A major advantage to packaging foods in retort pouches is reduced severity of the thermal process required. Retort pouches combine the shelf-stability advantages of metal and glass containers with the high quality inherent in frozen boil-in-bag products. Thus, seafoods packed in this manner should be superior in flavor, texture, color, and nutrient retention.

The total energy requirements of retort pouch/tray technology are significantly less than that required for frozen product. Whereas the energy requirement for frozen product continues through storage, transportation, distribution, that required for retorting stops at the processing point. Further, use of retort pouch configurations reduces energy requirements, as compared to conventional retort can methods. The use of HTST systems increases efficiency and energy savings even more.

Unlike freezing, which permits quality loss through undesirable chemical, textural, and flavor changes, retorted product remains highly consistent in quality.

Application of retort pouch technology to seafoods remains undone. There is a need to develop seafood-product formulations suitable to the process and determine effects on palatability, nutritionally significant chemical changes, alterations in appearance-taste-odor, and product safety.

COMMERCIAL SIGNIFICANCE:

Direct benefits could include increased market potential, improved product quality, elimination of deterioration of product quality after processing, less costly transport and storage, and increased profitability.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

( Please limit description to space provided.)

Title: Lack of "Microwavable" Fisheries Products

Proposed by: Discussion among participants

PROBLEM DESCRIPTION:

Consumer and industry use of microwave cooking has accelerated rapidly in the past five years. In fact microwave ovens can be found in one out of every four households. What is lacking is the availability of microwave-compatible fishery products.

POTENTIALLY RESPONSIVE RESEARCH:

Investigation of species (traditional and non-traditional) best suited for microwave processing. Development of product forms and their packaging requirements that are acceptable to the consumer and industry, especially the fast food and institutional food service systems. Investigation of the nutrient losses and benefits of microwaving fish.

COMMERCIAL SIGNIFICANCE:

Benefits would include an increased market potential, improved product quality and acceptance, and greater profits to the seafood industry.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

Title: Detection of Pathogenic Viruses in Molluscs

Proposed by: G. M. Neaburn

PROBLEM DESCRIPTION:

The sanitary quality of oysters, from a regulatory standpoint, is based on the concentration of fecal coliform bacteria found in the animals or their growing waters. The efficacy of using coliform levels as indicators of viral contamination, however, is open to question. In spite of regulatory action to prevent harvesting, processing, and distribution of contaminated oysters and other molluscs, there continue to be sporadic outbreaks of gastrointestinal illness attributed to the consumption of shellfish, including hepatitis A and other disorders presumed to be of viral etiology. The economic loss to the industry resulting from closure of productive harvest areas is thus compounded by public apprehension about the safety of oysters and other shellfish.

POTENTIALLY RESPONSIVE RESEARCH:

Development of specific and sensitive methods of enumerating enteric viruses from implicated shellfish and growing waters. Evaluation of the effectiveness of coliform levels as indicators of viral contamination.

COMMERCIAL SIGNIFICANCE:

Improved confidence in regulatory action, when required, to prevent contaminated oysters entering the market, leading to lessened public fears over shellfish safety. Better definition of viral contamination and corresponding coliform standards will also favor increased utilization of the oyster resource.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Detection of Ciguatoxin in Fisheries Products

Proposed by: G. M. Meaburn

PROBLEM DESCRIPTION:

Ciguatera is a serious illness that develops when fish containing ciguatoxin are ingested by man. The heat-stable toxin is produced by natural processes and transmitted to a variety of important reef-associated species (e.g., snapper and grouper) found in tropical and subtropical waters. Ciguatera thus impacts on the safety of seafoods, raising issues of costly legal liability in cases of ciguatera poisoning. Its presence in the Caribbean and the South Pacific Islands is seriously impeding development of commercial reef fisheries in those areas.

POTENTIALLY RESPONSIVE RESEARCH:

Development of a specific, sensitive test for detecting ciguatoxin in fish flesh. Evaluation of processes in the marine food web leading to ciguateric condition in reef fish.

COMMERCIAL SIGNIFICANCE:

The ability to distinguish ciguatoxic fish and remove them from commerce should greatly enhance the development of commercial reef fisheries while significantly reducing the incidence of ciguatera poisoning among consumers.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

Title: Wasted Fish Protein

Proposed by: R. J. Learson

PROBLEM DESCRIPTION:

The majority of the fish protein harvested is wasted. Discards at sea and processing waste probably represent better than a 50 percent loss of the edible marine protein now harvested.

POTENTIALLY RESPONSIVE RESEARCH:

New product development especially from underutilized species and processing waste.

COMMERCIAL SIGNIFICANCE:

Optimum economic use of marine protein.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

Title: Lack of Procedures for Safely Storing Fisheries Products in Controlled or Modified Atmospheres

Proposed by: R. Martin and J. Emerson
(Combines 35 and 35A)

PROBLEM DESCRIPTION:

Fish is one of the most perishable of foods. In unfrozen seafood, bacterial activity is primarily responsible for product spoilage. Refrigeration has for many years been successfully used to retard spoilage of fresh fish. As a supplement to refrigeration, variations in the gaseous composition of storage conditions have been proposed or used as methods of extending the fresh storage life of fishery products.

While oxygen depletion is effective in retarding the growth of the typical spoilage bacteria, there is a possibility, if the product is temperature abused, that it may become toxic through the growth of pathogenic organisms before spoilage is apparent.

POTENTIALLY RESPONSIVE RESEARCH:

Study of spoilage and pathogenic microorganisms in fishery products stored in controlled or modified atmospheres. Candidate organisms include Salmonella, Vibrio, Clostridium, Yersinia, and Campylobacter.

COMMERCIAL SIGNIFICANCE:

Building consumer confidence in vac-packed and tray-overwrapped seafood.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Information on Merits of Dating Fresh and Frozen Fisheries Products

Proposed by: G. M. Knobl

PROBLEM DESCRIPTION:

Consumers are "turned off" when they buy low- or poor-quality fresh or frozen seafood. While many factors are involved in providing high-quality seafoods, certainly storage time is of major importance. Consumers, except in a few instances, have no way of knowing how long a seafood product has been held in storage; hence, how long it will remain of high quality. Dating is becoming more and more prevalent for meat and poultry. Would dating help in selling seafoods? I suggest that research be conducted on the advisability of dating fresh and frozen seafoods.

POTENTIALLY RESPONSIVE RESEARCH:

A study should be conducted using dated and undated products in a retail outlet to determine if consumers prefer one over the other.

COMMERCIAL SIGNIFICANCE:

Could result in a higher demand for seafoods.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Inadequate Technology in Firms of Small and Medium Size for Marketing Fabricated Fisheries Products

Proposed by: J. Sackton

PROBLEM DESCRIPTION:
New technologies in producing fabricated seafood products from minced fish, or a surimi-type base, may well be the "fish stick revolution" of the 1980s. The potential of making substitute scallops, crab legs, lobster chunks, and shrimp is very great. Without quick action, this market will quickly be dominated by the Japanese. Our own producers of scallops and lobsters, for example, will not know what hit them.

With proper assistance, U.S. seafood processors of small to medium size could become integrated into the fabricated seafoods market. The result would be that the industry could gain advantages from potential changes that otherwise would prove another disastrous setback for particular sectors of the seafood industry.

No cooperative industry/government/academic research will replace the new-product capacity of the largest food processors. However, such research may well determine whether the smaller, second-tier processor, who makes up the bulk of the industry, has a chance to participate with domestic fishermen as primary suppliers of raw material.

POTENTIALLY RESPONSIVE RESEARCH:
Categorization of U.S. species in terms of their suitability for use in surimi-type material.

Economic studies of regional species abundance and processing capacity to determine regions where a fabricated-products industry might be successful.

Handling and process studies to determine the cheapest acceptable way to supply fish for this use.

COMMERCIAL SIGNIFICANCE:
A strong commitment from the government/industry/academic seafood research and development community could provide the impetus needed for U.S. producers to gain a share of this market. Otherwise, like production of frozen blocks, the entire market is likely to be dominated by foreign producers.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(please limit description to space provided.)

Title: Extending the Frozen Shelf-Life of Processed, Prepared Fisheries Products

Proposed by: R. R. Pedraja

PROBLEM DESCRIPTION:

Frozen shelf-life of processed prepared fishery products throughout the commercial cycle is rather limited. Oftentimes dehydration, oxidation, and discoloration occur bringing about undesirable textural and eating qualities.

POTENTIALLY RESPONSIVE RESEARCH:

Refinement of handling practices as the various stages of the distribution cycle, improved refrigeration methods, development of processing aids and techniques that will retard undesirable changes even when products may be subject to deviations in ideal handling practices.

COMMERCIAL SIGNIFICANCE:

Reduction of spoilage and waste, and wider consumer acceptance of frozen fishery products.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Grades and Quality Standards for Fisheries Products

Proposed by: A. C. Rand, Jr.

PROBLEM DESCRIPTION:

While significant advances have been made in efforts to guarantee the consumer a high-quality commodity, a "credibility gap" still remains, which is a vital problem for the seafood industry. There is a need to gain consumer confidence in the quality of fish and to improve the image both for domestic sales and export. Introduction of a standardized grading system would be an important factor in increasing the purchase of U.S.-caught fish in domestic and foreign markets. However, the grading systems proposed have only been based on sensory criteria.

POTENTIALLY RESPONSIVE RESEARCH:

Determine the potential to integrate existing, nonevasive, objective, quality tests with sensory criteria to form a standard system of grading.

COMMERCIAL SIGNIFICANCE:

Development of a satisfactory evaluation process and a list of grade standards that reflect fish quality will improve consumer acceptance. Grade standards will also encourage development of price differentials and provide incentive for improvements in raw-product quality.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

Title: Limited Use of Current Technologies in Certain Areas of the Seafood Industry

Proposed by: J. Salmon

PROBLEM DESCRIPTION:

Harvesting and storing seafood products on board vessels can be improved using available or new technology. Antiquated techniques currently being used can be inefficient, decrease yields, and, therefore, can be more expensive.

a) Oyster dredging
b) General processing/filleting, herring gutting, etc.
c) Packaging
d) Unloading of shrimp via pneumatic equipment
e) Shrimp - vessel design, fuel consumption and rig design

POTENTIALLY RESPONSIVE RESEARCH:

Research funding opportunities for industry to upgrade and improve upon current practices of production through increased emphasis by Sea Grant Programs on direct application of technologies.

COMMERCIAL SIGNIFICANCE:

Incentives that are provided would help increase operating efficiencies and improve overall production of seafood products.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Detection of Paralytic Shellfish Poisoning and Detoxification of Edible Molluscs

Proposed by: J. Liston

PROBLEM DESCRIPTION:

Large quantities of commercially valuable molluscs (clams and mussels) in Alaska, Washington State, and elsewhere are unavailable for harvest because of persistent toxicity due to toxins from Gonyaulax species ingested by the animals. Recent work has greatly clarified the chemistry of the toxins involved. However, at present, no reliable, rapid method of analysis is available for all toxins. Moreover, no satisfactory method for detoxification of the molluscs, other than depuration, is known.

POTENTIALLY RESPONSIVE RESEARCH:

Studies of analytical methods using HPLC are yielding promising results which indicate that rapid and definitive analysis may be possible. Work on toxin conversions in the molluscs may provide a basis for interfering with toxin retention in the animals.

COMMERCIAL SIGNIFICANCE:

A rapid toxin assay will enable growers and regulatory agencies to monitor shellfish beds more effectively, perhaps facilitating shorter closures. The commercial significance of a detoxification procedure is obvious.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

Title: Lack of Technology for Using/Fisheries Products as Meat Extenders

Proposed by: J. L. Secrist
(Replaces 288 and 46)

PROBLEM DESCRIPTION:

To increase fisheries use through the development of an innocuous-flavored material from fisheries products to serve as a functional extender of red meats such as ground, flaked and formed, chunked and formed, etc.

POTENTIALLY RESPONSIVE RESEARCH:

Freeze dry (conventional or microwave method) minced fish to produce extenders for inclusion in fabricated red meat.

COMMERCIAL SIGNIFICANCE:

Provides avenue for complete use of fisheries products, improving industrial profit margin, lowering costs of red meat, and extending the world's protein base.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Information on Food Application, Functionality, Availability, Toxicology, and Nutritional Quality of Chitin, Chitosan, and Related Products

Proposed by: D. H. Attawy and D. Knorr
(Replaces 32, 32A, 32B, and 54)

PROBLEM DESCRIPTION:

One of the major problems in processing commercially important crustaceans is disposal of waste, which in large part is chitin. A useful industrial polymer, chitosan, can be made from chitin. One of the major potential uses for chitosan is in coagulation of organic matter in effluents from food processing plants, but for chitosan to be economically applied for this purpose, the resulting precipitate must be usable in animal feed. Inclusion of chitosan in animal feeds requires FDA approval, which must be based on conclusive feeding trials.

The unique binding properties of chitin and chitosan offer potential applications. Examples of investigations on such binding properties include protein binding, water and fat binding, dye binding, and pesticide uptake by chitin or chitosan. Also, increasing attention is being given to application of naturally occurring polymers that can be used as food additives or carriers of food additives but will not be absorbed by the human organism.

POTENTIALLY RESPONSIVE RESEARCH:

Conduct of feeding trials and associated chemical and biological analyses.

Investigation of feasibility of chitin as a good polymer and as a general-purpose binding agent.

COMMERCIAL SIGNIFICANCE:

Companies producing chitin/chitosan could become economically viable and waste disposal problems in shrimp and crab processing plants would be alleviated.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Technology for Use of Surimi as a Resource in Simulated Shellfish Products

Proposed by: J. L. Secrist

PROBLEM DESCRIPTION:

To make use of the unexploited, underutilized finfish species that inhabit the oceans and seas of the world by a process of mincing, concentrating the salt-soluble proteins into a highly functional shellfish-like product. The simulated products utilize the finfish in a way that will create a demand for underutilized fishing stocks that are almost entirely utilized by foreign countries, due to lack of domestic markets.

POTENTIALLY RESPONSIVE RESEARCH:

Development of uses for underutilized finfish species and their upgrading to shellfish status.

COMMERCIAL SIGNIFICANCE:

Provides avenues for the utilization of low-market-potential finfish, which will upgrade them to a status of shellfish marketability. It will expand existing markets, improve industrial profit margin, and lower costs to consumers.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Effect of Microbial-Secreted Enzymes on Storage Quality of Frozen Fish Fillets

Proposed by: D. Farkas

PROBLEM DESCRIPTION:

Major quality losses during frozen storage of fish fillets and fish minces have been identified. This lowers the food acceptance of the products and reduces their shelf life. Additional work is needed on the interaction between microbial enzymes and frozen fish quality.

POTENTIALLY RESPONSIVE RESEARCH:

A better understanding of the effects of microbial enzymes on the quality deterioration of frozen fish fillets should lead to better processing and packaging methods for maximizing quality retention. The effects of sample source and sample quality before freezing as well as of packaging material and atmosphere on frozen fish quality should be studied.

COMMERCIAL SIGNIFICANCE:

Benefits would include increased consumer acceptance and greater market potential of frozen fish and development of new storage and packaging processes for fish fillets.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Size-Selective Harvesting Gear

Proposed by: R. J. Learson

PROBLEM DESCRIPTION:

Nonselectivity of harvesting gear generates waste. Small fish and undesirable species represent a large portion of discards at sea. The development of fishing gear that is relatively species or size selective will reduce by-catch, increase vessel efficiency, and protect the fish stocks.

POTENTIALLY RESPONSIVE RESEARCH:

Develop trawls, traps, etc., for specific fisheries to reduce discards.

COMMERCIAL SIGNIFICANCE:
SEAFood Science and technology Problem Statement

(please limit description to space provided.)

Title: Species Identification Data Bank Through Isoelectric Focusing

Proposed by: NMFS

Problem Description:

The substitution of lesser-value or lower-quality fish for those costly items in high demand is becoming more common. Because of the extremely low priority placed on economic violations of the Federal Food, Drug, and Cosmetic Act by the Food and Drug Administration, little effort has been made toward curbing the practice through the judicial system.

The identification of species of fishes is performed by NMFS, using the isoelectric focusing method. The positive identification of a species requires that the results of the method performed on a suspect sample be compared to the results of an authenticated control sample run simultaneously with the suspect sample. Not infrequently, it is difficult or impossible to obtain an authenticated control sample.

The establishment and maintenance of a bank or depository of authenticated samples of the major fishes sold commercially in national and international trade would solve the principal problem of NMFS in species identification.

Potentially Responsive Research:

Commercial Significance:

The ready availability of authenticated samples of the major commercial species of fish would enable NMFS and the Food and Drug Administration to protect the financial interests of the legitimate members of the seafood industry.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Identification and Removal of Naturally Occurring Parasites in Fisheries Products

Proposed by: W. L. Baran and T. Billy
(Combines 49 and 49A)

PROBLEM DESCRIPTION:

Cases of parasitic infections in fishery products have been identified. Consumers have discovered "worms" in fish products served by fast food chains. Another example was the recent halting of distribution of calico scallops as a result of parasitic infection.

POTENTIALLY RESPONSIVE RESEARCH:

Studies to determine the extent of the problem and the frequency of the occurrence need to be conducted.

Methods of parasite removal need to be developed.

COMMERCIAL SIGNIFICANCE:

Would provide guidelines for establishing harvest protocol and would help improve consumer acceptance of fishery products.
SEA FOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Textural Changes in Fish Caused by Protein Denaturation

Proposed by: H. O. Hultin

PROBLEM DESCRIPTION:

The contractile proteins of fish muscle are very sensitive to a variety of conditions that lead to their denaturation. This denaturation affects the texture, and in some cases, the appearance of the fish tissue. These changes are undesirable and reduce the acceptability of the products. Protein denaturation may be due to salt effects during frozen storage or it may be due to compounds such as formaldehyde, a product of the breakdown of trimethylamine oxide.

POTENTIALLY RESPONSIVE RESEARCH:

Understanding of the processes involved in the protein changes in stored fish, especially frozen fish, would allow intelligent approaches to be made to minimize such changes and prolong the shelf-life of the fish product. In many cases, textural changes that occur in protein denaturation are the limiting factor in the shelf-life of the product.

COMMERCIAL SIGNIFICANCE:

Shelf-life of products will be significantly increased if this quality change can be slowed down or eliminated. It should also allow the use of other fish species for commercial development, since the sensitivity of these species to storage has limited their usefulness in the past.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

Title: Bone in Minced Fish

Proposed by: H. S. Rodriguez

PROBLEM DESCRIPTION:

The products made with minced fish have low acceptability in schools because of the bone level.

POTENTIALLY RESPONSIVE RESEARCH:

Do product development and improve mechanical deboning methods.

COMMERCIAL SIGNIFICANCE:

If minced fish products were more acceptable, then schools would likely increase their frequency of use.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Uneconomical Methods for Chemical and Microbiological Depuration of Molluscan Shellfish

Proposed by: W. Blogoslovak and C. W. Wiley
(Replaces 21A, 56, and 56A)

PROBLEM DESCRIPTION:

A significant portion of clams, oysters, and mussels lay in sewage-contaminated growing areas where animals are prohibited for food use. These animals also are often subjected to contamination from hazardous metals and chemicals, due to juxtaposition to industrialized area. The present method of removing or depurating contamination from shellfish involves harvesting from the polluted area and relaying to an approved growing area for a specified time under controlled temperature and salinity conditions. In the case of heavy metal contamination, it is not known how long it is required to purge such metals as cadmium, arsenic, chromium, lead, mercury, and others.

Many shellfish are lost or damaged in various harvesting and relaying cycles; industrially contaminated shellfish cannot be used in the relaying process because of the public health consequences of this uncertainty.

Research should be carried out to determine the proper type of decontamination procedure, thereby enhancing the marketable quantity of molluscan shellfish.

POTENTIALLY RESPONSIVE RESEARCH:

Evaluation of recent advances in decontamination methodology in other countries, including use of disinfectants, such as ultraviolet light, chlorine, or ozone gas.

Determination of adequacy of decontamination procedure involving use of cages or racks.

Development of estimates of time intervals required under various salinity and temperature regimes to purge molluscan shellfish of hazardous metals after relaying from polluted to approved growing areas.

Development of state/federal recommendations on the use of decontamination technology.

COMMERCIAL SIGNIFICANCE:

Opening of millions of closed acres of shellfish grounds to commercial shellfishermen and processors.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Absence of Fully Developed Technology for Using Heat Treatment in Preserving Quality of Fish Fillets

Proposed by: D. Farkas

PROBLEM DESCRIPTION:

Fresh-caught fish are highly perishable through microbial activity, from enzymes in the fish flesh, and from exoenzymes secreted from microbes.

Heat treatment immediately following filleting could prevent quality loss through enzymatic and microbial activity. Heat treatment can, however, change the structure of the flesh.

A detailed study of heat transfer is needed to be able to optimize the beneficial effects of heat treatment while minimizing undesirable effects. Work would be carried out with the constraints of on-vessel-processing technology.

POTENTIALLY RESPONSIVE RESEARCH:

Recent work at Cornell has shown the benefits of pasteurization before freezing.

COMMERCIAL SIGNIFICANCE:

An enzyme-stabilized, frozen product may have better storage qualities than untreated fish.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Information on Unique Nutritional Components of Fisheries Species

Proposed by: D. Farkas

PROBLEM DESCRIPTION:

The variety of species of fish used for food far exceeds all other sources of animal protein. The protein efficiency, lipids, and availability of minerals such as zinc or iron and vitamins such as B_12 or A may make fish-specific species highly desirable for specific segments of the population.

POTENTIALLY RESPONSIVE RESEARCH:

Look at amino acid composition, PLR value digestibility, availability of nutrients species by species.

COMMERCIAL SIGNIFICANCE:

Nutrient value is critical.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Title: Relationship Between the Physiological Condition of Live, Marine Animals and Quality of the Resulting Product

Proposed by: C. W. Wiley

PROBLEM DESCRIPTION:

If the quality of live fishery products could be enhanced through better storage and protection techniques from the time of harvesting until delivery to the processors, would the ultimate quality of the processed meat and shelf life be improved?

POTENTIALLY RESPONSIVE RESEARCH:

Research is needed to determine if improved handling and storage of uncooked fishery products, especially in warm weather, would improve the quality and keeping qualities of the meat after cooking and processing.

COMMERCIAL SIGNIFICANCE:

Improve consumer acceptability of the product and reduce recalls due to inferior or unacceptable quality.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Small Pelagic Resource Definition for Commercial Exploitation

Proposed by: L. Regier

PROBLEM DESCRIPTION:

A number of small pelagic species such as squid, round herring, thread herring, scaled and Spanish sardines, and round scad have been identified as potential resources with MSY above 50,000 tons.

Data on where and when to find them as well as sizes and age structure are too limited to support development of fisheries.

Methods for collecting these data by fisheries-independent surveys are very expensive.

POTENTIALLY RESPONSIVE RESEARCH:

Development of fishery-independent survey systems that are less costly, cheaper platforms.

Sonar-system evaluations.

Satellite-imaging-system evaluation.

COMMERCIAL SIGNIFICANCE:

Decisions for developing new fisheries need assurance of available resource.

Management-plan development relates to the ultimate best use of the resource, and reliable data are also crucial for plan development.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Low Fish-to-Fat-Batter Ratio in Battered and Breaded Fisheries Products

Proposed by: H. S. Rodriguez

PROBLEM DESCRIPTION:

The portion size of fish products required to meet the meal-pattern requirement in the National School Lunch Program is too large. The large size is caused by the low yield value for fish and by the large amount of breading that is used on products. This large portion size contributes to high cost, and high plate waste.

POTENTIALLY RESPONSIVE RESEARCH:

Develop new yield data information. Develop new products.

COMMERCIAL SIGNIFICANCE:

If the portion size and the cost were reduced, then the purchasing of fish by the National School Lunch Program would increase.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(please limit description to space provided.)

Title: Production of Low-Fat, Prefried Battered and/or Breaded Products

Proposed by: R. R. Pedraja

Problem Description:

Excessive grease in prefried battered and/or breaded products has been a deterrent to wider consumer acceptance of this category of products.

Potentially Responsive Research:

Development of processing methods and improved functional character of coatings to substantially reduce the oil absorbed during prefrying. The reduction should be in the magnitude of 50 to 70 percent of the oil, based on the finished product weight.

Commercial Significance:

Wider consumer acceptance and fewer calories per serving.
SEAFood SCiENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Migration of Moisture from the Fishery Product Component into the Breading or Batter of Coated Fishery Products

Proposed by: T. Billy

PROBLEM DESCRIPTION:

The amount (percentage) of the fishery-product component in relation to the amount of the coating in a frozen, breaded, or battered fishery product (e.g., frozen, raw, breaded shrimp) determines whether the product is properly labeled in accordance with the Federal Food, Drug, and Cosmetic Act, and, if graded, whether the product meets the requirements of the U.S. grade standards.

It is well known that variations in the amount of the fishery product component (i.e., fish flesh or shrimp material) occur, when measured during production and when measured at different time periods following freezing. Studies have demonstrated that a migration of moisture from the fishery-product component into coating does occur. Some industry members maintain that the fishery component remains unchanged, except that some of its moisture with nutrients has migrated into the coating. Yet, measurements by purchasers and regulatory agencies maintain that a shortage of the fishery component exists.

POTENTIALLY RESPONSIVE RESEARCH:

There is a need to establish how much moisture migration occurs in these products under current, good manufacturing, freezing, handling, storage, and shipping conditions, so that a standard allowance for it can be established and used to determine product conformance on a national basis.

COMMERCIAL SIGNIFICANCE:

The major benefit to the industry, the consumer, and regulatory agencies would be the availability of a scientifically-sound data base for use in determining product compliance with product specifications, regulatory requirements, or voluntary grade standards.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Determination In-Shell of Net Weight of Crab Products and Other Block Frozen Fisheries Products

Proposed by: J. Emerson
(Combines 47 and 47A)

PROBLEM DESCRIPTION:

A major part of the commercial harvest of crabs, e.g., king crab, snow crab, etc., is sold frozen in the shell. There is no official method for determining the net weight of these products. The major purchasers of these products are institutions and restaurants who have no means of determining the net weight of products received and, therefore, of determining the most economical source of similar-quality products.

In the trading of block frozen fishery products, industry is interested largely in knowing the net weight of the product. For some products, e.g., frozen crabmeat blocks and frozen peeled shrimp blocks, AOAC procedures are available for determining the drained weight. Yet, none are available for determining the net weight.

The development of a procedure or method for determining the net weight of these products, which could be adopted by the AOAC, would find greater acceptance and use by industry than the methods now available.

POTENTIALLY RESPONSIVE RESEARCH:

COMMERCIAL SIGNIFICANCE:

The development and availability of a method for determining net weight in-shell of crab products and other block frozen fishery products would provide the seafood industry with the means to promote fair trade through honest weight for these products.
SEAFOOD SCIENCE AND TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Optimum Procedures for Preserving Fresh Fisheries Products Through Irradiation, and Finding a Suitable Name for Labeling the Process

Proposed by: R. R. Pedraja

PROBLEM DESCRIPTION:

Fresh fishery products have a very limited shelf-life under refrigeration. Extending the shelf-life will have a significant economic impact on the industry as well as a beneficial effect on consumer acceptance. Finding a name for the process that will meet with consumer approval. The names "radiation" or "irradiation" are perceived negatively by the public.

POTENTIALLY RESPONSIVE RESEARCH:

Continue research on optimum radiation treatment to preserve freshness and textural qualities of raw fishery products.

COMMERCIAL SIGNIFICANCE:

Reduce waste, minimize spoilage, and increase safety of products.
ANALYSIS OF RESULTS

The participants identified 96 problems, which were consolidated into the 57 problems presented in order of priority in the previous section of this report.

It was the intent not to lose detail or specifics from the original statements when consolidating several problems. However, to insure that the maximum amount of information brought to the workshop is included in this report, the original problems are included as Appendix 4.

To establish priorities, participants completed individual score sheets and listed the top 15 problems in descending order. The criteria agreed to was that participants would select those problems of greatest importance to their organizations or to the professional areas in which they were most active.

Scoring was done by assigning the priority number to each problem: the problem among the 57 finalists that received the lowest score was the highest priority in the opinion of all participants, considered as a group. For example, a first priority note on an individual's sheet would cause a score of one to be entered for that problem. A score of 12 would cause a score of 12 to be entered for another problem. For all problems beyond the 15 ranked by the individual, a score of 16 was assigned. The results of the ranking are included as Appendix 5. Only three problems were not ranked at least once in the top 15 problems.

The participants agreed that it would be valuable to readers of this report to tally priorities grouped by affiliation. Therefore, priority rankings were established for three groups: those affiliated with industry, government, and universities.
## INDUSTRY

**Number of Voting Participants = 7**

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<th>Priority Problem #</th>
<th>Total Points For Problems Ranked 1-15</th>
<th>Total Points For Problems Top 15 (N)</th>
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*Problems numbered "A, B, C" indicate tie vote.
INDUSTRY

(continued)

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*Problems numbered "A, B, C" indicate tie vote.
GOVERNMENT

Number of Voting Participants = 13

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Total Points
For Problems
Ranked 1-15
Total Points
Problems in
Top 15 (N)
Total Points
For Unranked
Problems
(N x 16)
Total Points
(Col. 2 + 4)
Ranking*

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3  45   6  112  157 10
4  18   6  112  130  3
5  60   7   96  156  9
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8  35   7   96  131  4B
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*Problems numbered "A, B, C" indicate tie vote.
GOVERNMENT

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*Problems numbered "A, B, C" indicate tie vote.
## UNIVERSITIES

Number of Voting Participants = 14

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*Problems numbered "A, B, C" indicate tie vote.
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Number of Voting Participants = 14

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*Problems numbered "A, B, C" etc. indicate tie votes.
The problems identified by the participants can be grouped into larger classes of research. For example, the top 15 priority problems may be organized as follows:

A. Quality Assurance Research
   This category includes problems 1, 2, 4, 6, 7, 8, and 9.

B. Developmental Research (New Products and New Technologies)
   This category includes priority problems 5, 11, 12, and 15.

C. Processing Research
   This category includes priority problems 3 and 14.

D. Marketing Research
   This category includes priority problems 10 and 13.

Having established the priority problem rankings by affiliation and then grouping these problems by research categories, the following data were generated:

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Although the ordering of the top 15 problems changed among the participants from industry, government, and universities, in general, the three groups ranked the same problems among the 15 most important
problems. Some exceptions, evident from the above table, were the
problems related to product safety research, identified as more
important to government and industry, (in the overall ranking, a
problem devoted to product safety ranked 16) and the greater emphasis
by government participants on quality assurance research.

This workshop has produced a consensus among the participants as
to the most important problems facing the seafood industry. The real
challenge lies with forming a functioning partnership to solve these
problems in a timely manner.
APPENDICES

Appendix 1: Participants
Appendix 2: Background Reading
Appendix 3: Schedule of Workshop Activities
Appendix 4: Original Texts of Problem Statements
Appendix 5: Raw Scores of Ranked Problems
Appendix 1: Participants

Dr. David H. Attaway, Associate Program Director, National Sea Grant Program, NOAA, 6010 Executive Boulevard, Rockville, MD 20852.

Dr. Robert C. Baker, Department of Poultry Science, Rice Hall, Cornell University, Ithaca, NY 14850.

Dr. W. L. Baran, Director of Quality Assurance/Research & Development, MRO - Marriott Corporation, 215 West Church Road, King of Prussia, PA 19406.

Dr. Stanley M. Barnett, Department of Food Science & Technology, Nutrition & Dietetics, University of Rhode Island, Kingston, RI 02881-0801.


Mr. Thomas Billy, National Marine Fisheries Service, 3300 Whitehaven Street, NW, Washington, D.C. 20235.

Mr. Anthony Binbo, Zapata Haynie Corporation, P.O. Box 175, Reedville, VA 22539.

Dr. Walter Blogoslawski, Milford Laboratory, National Marine Fisheries Service/NOAA, Milford, CT 06460.

Mr. James Brooker, National Marine Fisheries Service, 3300 Whitehaven Street, NW, Washington, D.C. 20235.


Dr. Daniel F. Farkas, Chairperson, Food Science and Human Nutrition, University of Delaware, Newark, DE 19711.

Dr. George Flick, Food Science and Technology, V.P.I. and State University, Blacksburg, VA 24061.

Dr. Spencer Garrett, Chief, National Seafood Quality and Inspection Laboratory, National Marine Fisheries Service/NOAA, P.O. Drawer 1207, Pascagoula, MS 39567.

Mr. Douglas Gordon, National Food Processors Assoc., 1133 20th Street, NW, Washington, D.C. 20036.

Dr. Lamartine F. Hood, Department of Food Science, 108 Stocking Hall, Cornell University, Ithaca, NY 14853.
Dr. Herbert O. Hultin, Hodgkins Cove, University of Massachusetts, Marine Station, Box 128, Lanesville Station, Gloucester, MA 01903.


Mr. George Knobl, National Marine Fisheries Service, 3300 Whitehaven Street, NW, Washington, D. C. 20235.

Dr. Dietrich Knorr, Food Science and Human Nutrition, University of Delaware, Newark, DE 19711.

Mr. Robert Learson, Acting Director, Gloucester Laboratory, National Marine Fisheries Service/NOAA, Emerson Avenue, Gloucester, MA 01930.

Dr. John Liston, College of Fisheries, University of Washington, Seattle, WA 98195.

Mr. Roy Martin, National Fisheries Institute, Inc., 1101 Connecticut Avenue, NW, Washington, D. C. 02236.

Dr. Malcolm Meaburn, Charleston Laboratory, National Marine Fisheries Service/NOAA, P. O. Box 12607, Charleston, SC 29412.

Dr. Steve Orwell, Seafood Technologist, University of Florida, Building 803, Gainesville, FL 32611.

Mr. E. Ray Pariser, Sea Grant Program, Massachusetts Institute of Technology, Room E 38-66, 77 Massachusetts Avenue, Cambridge, MA 02139.

Dr. Rafael R. Pedraja, Vice President, Research, Development & Quality Assurance, Booth Fisheries Corporation, 2 N. Riverside Plaza, Chicago, IL 60606.

Ms. Glynn Peterson, The Corton Group, 327 Main Street, Gloucester, MA 01930.

Dr. G. Arthur Rand, Jr., Chairman, Food Science, Technology & Nutrition, 17 Woodward Hall, University of Rhode Island, Kingston, RI 02881.

Mr. Lloyd Regier, Charleston Laboratory, National Marine Fisheries Service/NOAA, P. O. Box 12607, Charleston, SC 29412.


Mr. John Sackton, Program Director, New England Fisheries Development Foundation, Inc., Suite 2716, 100 Summer Street, Boston, MA 02110.

Mr. James E. Salmon, Manager of Procurement, Red Lobster Inns of America, P. O. Box 13330, 6770 Lake Ellenor Drive, Orlando, FL 32859.
Mr. John L. Secrist, U. S. Army Natick Research and Development Laboratory, WTA, Natick, MA 01760.

Dr. Tony Sinskey, Professor of Applied Microbiology, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139.

Mr. Joseph Slavin, Seafood Industries Authority, 8203 Excaliber Avenue, Annadale, VA 22003.

Dr. John Spinelli, Director, Utilization Research Division, National Marine Fisheries Service/NOAA, 7600 Sand Point Way, N.E., Seattle, WA 98115.

Mr. Larry Steed, Delta Catfish Processors, Inc., P. O. Box 850, Indianola Industrial Park, Indianola, MS 38751.

Mr. Hugh W. Symons, American Frozen Food Institute, 1700 Old Meadow Road, Suite 100, McLean, VA 22102.

Dr. Carolyn A. Thoroughgood, Executive Director, Delaware Sea Grant College Program, University of Delaware, College of Marine Studies, Newark, DE 19711.

Mr. Don Toloday, Executive Vice President of Production, Quality Assurance, and Engineering, Singleton Packing Corporation, P. O. Box 2819, Tampa, FL 33601.

Dr. Robert R. Zall, Professor of Food Science, Institute of Food Science, New York State College of Agriculture and Life Sciences, Cornell University, Stocking Hall, Ithaca, NY 14853.
Appendix 2: Background Reading Material

BACKGROUND ON SEA GRANT FOR
PARTICIPANTS IN THE
WORKSHOP ON SEAFOOD SCIENCE AND TECHNOLOGY
(May 18-19, 1982)

The National Sea Grant College Program was created in 1966 by an act of the U.S. Congress. Each of the 27 major state or regional programs, which make up the national programs, have three major components, education, advisory service and research and all are oriented toward development and wise use of marine resources. Although the programs place heavy emphasis on fisheries and the fishing and fish-processing industries, the legislative mandate does not limit activities to this area but directs attention to the full spectrum of marine industries and marine resources.

The major purpose of the workshop is to aid in defining what areas of research should be pursued in seafood science and technology during the 1980's. It is hoped that the workshop will lead to a definition of the appropriate role of academic research as distinguished from those of governmental and industrial laboratories. The workshop is also intended to foster direct collaboration among governmental, academic, and industrial researchers. Most academic research in seafood technology is funded through Sea Grant programs and almost all the research projects are generated in response to locally or regionally identified problems and opportunities. The Office of Sea Grant in Washington plays a passive role in determining what specific research projects will be proposed. It also takes a passive role
in determining the degree of emphasis research is given in the state and regional programs. Research emphasis is determined through advice from local advisory panels made up of academic, industrial, and governmental representatives. The Office of Sea Grant takes a strong role in evaluating proposals in terms of scientific quality, rationale (relationship to a significant problem or opportunity), and degree of relationship to a user of the results of the research. In general terms, the Office of Sea Grant gives guidance on what it perceives as important and on what it perceives as inappropriate topics. The attached report, which gives the status of Sea Grant research in this field in fiscal year 1981, provides examples of this guidance on page 7. The report also discusses some of the recent academic accomplishments in this field, describes the research generally, and lists in the appendix all research projects in progress in fiscal year 1981. The research can be placed in the following four categories:

1. Engineering and Waste Treatment;
2. Product Development and By-Product Recovery;
3. Microbiological and Nutritional Quality; and
4. Handling and Processing.

The National Sea Grant College Program has not undertaken, at least not to a significant degree, certain kinds of activities which are routinely handled by the laboratories of the National Marine Fisheries Service. Among these are the following:
1. Development of standards for seafood products;
2. Development of specifications for seafood products;
3. Analysis of seafood for chemical contaminants; and

Since most of the 27 state or regional Sea Grant Programs have at least a part-time advisory specialist in seafood processing (there are 26 nationally -- time spent is equivalent to 16 full-time positions), much of the academic research program is aligned closely to practical problems of the fishing and fish-processing industries, particularly those of smaller processors. Less emphasis is put on long-term, fundamental research issues. This, however, may be the very place where the innovative academic atmosphere could be used more fully.
SEAFOOD SCIENCE AND TECHNOLOGY

in the

NATIONAL SEA GRANT COLLEGE PROGRAM

October 30, 1981

David H. Attaway
Office of Sea Grant
6010 Executive Boulevard
Rockville, Maryland 20852
(301) 443-8920
Success of U. S. fishery products in domestic and international markets depends to a large degree on quality of the products, their attractiveness and suitability in a wide variety of markets, and the efficiency of their production. These are among the major issues in seafood science and technology in the National Sea Grant College Program.

A large proportion of fishery resources within 200 miles of U. S. coasts are harvested by foreigners because the domestic industry is largely incapable of producing acceptable products at competitive prices for foreign markets. At the same time more than 60 percent of the seafood consumed domestically is imported even though the United States' fishery resources are among the richest. These imports account for 10 percent of the national trade deficit or more than $2.5 billion annually. The opportunities to expand and enhance the United States' seafood industry are enormous; their realization depends to a large degree on advancements in seafood technology.

Exploitation of these opportunities must be pursued in part by resolving problems in handling, processing, and preservation of seafood so that consistently high organoleptic and microbiological quality is achieved and so that new markets can be entered or developed. These opportunities include improving efficiency of processing and developing concepts for new products from waste materials, underutilized species and species not traditionally harvested by U. S. fishermen. The problems include those associated with handling wastes and effluents under increasingly stringent regulatory standards, and those associated with assuring high quality and safety of seafood at the table.

Research, education, and advisory service in seafood science make up an important component of the National Sea Grant College Program because most processing companies are relatively small (45 percent less than $200,000 volume annually; 74 percent less than $1 million) and without research components and because many of the problems and opportunities of the industry are of interest to academic scientists and amenable to their research methods. Too, some problems in producing high quality products relate to treatment of fish aboard ship and during delivery to processors; thus, there is no private entity responsible for the full range of research problems that bear on quality of seafood.

Before the establishment of the National Sea Grant College Program little emphasis had been put on seafood technology in academic circles. Although a few institutions such as Oregon State University and the University of Washington had included research and education in this field among its activities for a number of years, most universities, even those with strong departments of food science had turned little attention to fisheries.
They were concerned primarily with traditional agricultural products. Now, however, in most of the Sea Grant Colleges and some other academic institutions the opportunity to aid an important industry through research and education has been recognized and useful results are coming forth from a variety of projects.

These projects can be thought of as falling in four categories shown in the table below which also shows the number of projects in the categories and the funding for each in fiscal years 1979 and 1981.

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The table indicates a significant increase in funding for research in categories III and IV since 1979; however, the apparent increase in category III results from including research in environmental microbiology of human pathogens that was not included in the FY 1979 accounting. There has been an increase in research on handling and processing of seafood since 1979, but the overall program in seafood science and technology has grown only by approximately three projects and $170,000 since 1979. The level of effort in engineering and waste treatment remains quite low even though problems and issues surrounding regulation of effluents from processing are still of importance and there are needs to improve efficiency of processing through engineering.

The attached appendix lists the projects in each of the four categories above with its level of funding in fiscal year 1981, the principal investigator for each and the Sea Grant program with which he or she is affiliated.
Engineering and Waste Treatment

Although several species of squid are important food in a number of foreign countries, squid represents a vastly underutilized resource and much of this resource lies along the coasts of the U. S. One of the problems inhibiting development of this resource has been the high cost of cleaning squid by hand, a laborious and unpleasant task. Agricultural and food engineers at the University of California set about to solve this problem three years ago and recently they unveiled a machine that automatically aligns and decapitates squid, then skins, and eviscerates them. It also removes the pen, an internal piece of cartilage. This process is completed in seconds. The pilot-scale machine has the potential for scaling up to industrial size and may be a key to development of resources whose world-wide annual sustainable yield has been estimated as high as 100 million tons.

Engineers at MIT engaged in related work have designed, constructed and developed an advanced prototype machine for processing the spiny dogfish, a type of shark and another underutilized species. The machine, which was constructed primarily of aluminum, stainless steel and plastic to permit easy maintenance and cleanliness, follows the same steps used in manual processing of dogfish. Independent components are used to remove the tail, dorsal fins, belly-flap and back skin. These components are actuated pneumatically. Where cutting was required, rotary blades driven by air motors were used. The machine is controlled by a solid-state, programmable device and can process one fish in 12 seconds. It is believed this time can be reduced considerably by use of more powerful motors.

Both these engineering projects have been accompanied, or preceded by other projects which have developed a number of new products from squid and dogfish, and others which have defined the life histories of individual species, their geographical range, and their potential for commercial harvest, so the research is relevant to real opportunities.

Engineers at the University of Alaska are developing solid-liquid separation and water-conservation systems for use in seafood processing for three important reasons -- local shortages of water in Alaska and other states, the potential for recovery of food-grade by-products, and more stringent regulatory requirements to reduce wastes from processing plants. They designed and successfully tested in the laboratory a hydrocyclone that removed many particles smaller than 100 μ (smaller than particles removed by screens commonly recommended for seafood processors). Subsequent pilot-scale testing in a processing plant also indicated the potential economic advantage for using cyclones. The research is being expanded to include use of coagulants with the centrifugal system to improve its efficiency.

One of the more innovative approaches to dealing with wastes from processing of fish was the basis for research started at the University of Washington almost ten years ago. Researchers there believed it would be possible through the use of enzymes and other chemicals to break down completely wastes from processing fish and convert them into useable materials. A process based on this "total utilization concept" and the corresponding research at the University of Washington was developed by an Alaskan
corporation. The first commercial application of this technology to finfish and shellfish waste began in the fall of 1980 in Coos Bay, Oregon; the end products include fish oil, bone meal, purified protein, and deproteinated chitin.

Enzymatic technology for processing shellfish wastes is limited currently to that used for finfish wastes and the subsequent recovery of high quality protein as in the Coos Bay operation. Investigators at the University of Alaska believe it can be extrapolated to include conversion of chitin, the material making up the shells of crabs and shrimps, to chitosan, a polymer with many useful properties. They initiated a project to explore this possibility because they believe such a system using microbially produced enzymes can provide the breakthrough needed to turn shellfish reduction and chitosan production from a marginally viable enterprise into a soundly profitable one.

Product Development and By-Product Recovery

Increasing the consumption of underutilized species is being approached at the University of Georgia (UGA) through development of products that are already used in traditional markets in other countries. For example, in Nigeria the consumption of seafood is high (10.5 kg/capita annually) and 45 percent is imported. One of the major imports is "stockfish," a dried hard product used in stews and made conventionally from cod, haddock, or hake. Developing an acceptable stockfish from domestic fishes here will require basic understanding of dehydration in order to select an efficient drying system, determination of optimal drying conditions, and production in pilot-scale quantities for test marketing. These are the objectives of the work in progress at UGA. The investigators have shown previously that Yu-sone, a minced product used in enormous quantities in the far east can be produced in commercially competitive quality from stingray, mako shark and mullet.

Researchers at Cornell University also have focused considerable attention on development of new products from underutilized species and from edible protein and flavorings normally discarded in processing. This successful work has culminated in increased processing efficiency, fewer waste-disposal problems, and successful test marketing of several new products including canned minced mullet (an alternative to tuna fish in sandwiches and salads), canned pollock, and other products from minced fish. Success has depended in part on expertise developed over many years at Cornell through research on new products from poultry.

Untreated chitin from processing of shellfish has attached to it about 50 percent by weight protein and for this reason it has potential as a feed supplement for domestic animals. Consequently, the nutritional and safety aspects of chitin as a feed supplement have been explored with encouraging results. For example, Sea Grant research at the University of Alaska over the past two years has shown that king crab, tanner crab and shrimp meals can be used effectively in diets for growing swine and that it also may be a viable source of energy for ruminants when a period of dietary adaptation precedes prolonged feeding of the material. This work was motivated by the high quantities of wastes generated in Alaska from processing of king crabs and the tightening regulations on disposal of wastes. It is particularly appropriate in Alaska because of the State's recent emphasis on expanding
animal husbandry in a climate which is not favorable for production of plants traditionally used to supply protein for livestock.

Researchers at the Virginia Polytechnic Institute and State University (VPISU) are also attempting to develop agricultural applications for wastes resulting from processing of seafood. In Virginia disposal of waste from menhaden, blue crabs, flounder and pogies is a serious problem that threatens portions of the processing industry with closure. Research directed at solving this problem has shown already in the laboratory and greenhouse that soluble materials from processing of menhaden is nutritious to a wide range of agricultural crops. An extension of this promising work, which is partially funded by industry, will be made to field studies in Arkansas, Virginia and West Virginia.

The researchers at VPISU are also approaching the problem of waste disposal from another direction -- ensilage. They believe that they can determine optimum combinations of seafood wastes and other underutilized substances that will produce nutritious and palatable silages for ruminants. They believe this process will be more economical than production of dried meals.

Researchers at North Carolina State University have developed a shrimp-shaped product composed of 55% minced fish and 45% shrimp which is better in tests by taste panels than existing commercial products composed entirely of shrimp. Success in developing new products of this type is based on basic information previously developed and research still underway on the relationship between biochemical and physical properties of minced fish and the textural properties of finished products. This work is part of a larger effort to develop new products for domestic and foreign markets from mechanically deboned fish. Other work there is focused on methods of producing surimi from domestic fishes. Surimi, or minced fish, is the starting material for fish cake, kamaboko, a staple food item in Japan and other oriental countries.

Microbiological and Nutritional Quality

Microbiological research is a major focus of the program in seafood science because it bears on human health and the perishability of seafood products. For example, shellfishing grounds are opened and closed on the basis of concentrations of coliform bacteria, but exactly how or if this measure of quality relates to the number of all human pathogens in shellfish has not been established. In some cases the differences and relationships between virulent and avirulent strains of bacteria and their natural occurrence in coastal wastes are unknown. Also, there is a need to improve some of the methods used in enumerating microorganisms in seafood and the marine environment so that decisions in management of resources can be made efficiently and with greater certainty.

As part of their work on some of these issues investigators at North Carolina State University (NCSU) have developed a new method for enumeration of coliform bacteria. It is direct, more nearly accurate, less variable and less time consuming than the procedures now recommended for analyzing seafood and other marine samples. It is expected to improve the quality of information used in opening and closing shellfish areas.
In South Carolina researchers have initiated research directed at enhancing the effectiveness of depuration, a natural process used to take clams and oysters from microbiologically polluted waters safe for human consumption. Depuration is natural elimination of foreign materials from mollusks as they pump clean water through their bodies. The shellfish are simply held in clean water after harvesting, but this is an expensive operation that becomes more nearly economical the quicker it can be accomplished. Because copper is known to be toxic to certain bacteria and some viruses, the researchers believe it can be used to enhance the speed and thoroughness of depuration. They will test their hypothesis in carefully controlled laboratory and field experiments using various forms of organically complexed copper.

As the result of eleven unusual and alarming cases of cholera contracted by eating improperly cooked and stored crabs on the Gulf Coast in 1973, a cooperative project among Sea Grant programs in four states (Florida, Louisiana, Maryland and Oregon) was initiated to examine the status of the causative organism, Vibrio cholerae, and three other pathogenic species of this genus in marine environments and their relationships with fishery species. The study which is coordinated by the University of Maryland, is still underway, but it is showing that some strains of the genus Vibrio are natural inhabitants of estuarine habitats, that their presence does not correlate with the presence of bacteria common to sewage, that no part of the seafood industry was responsible for the outbreak of cholera in Louisiana and that proper handling of crustacean shellfish can render them safe.

Only certain types of the V. cholerae are considered capable of causing severe disease or epidemics so it was necessary to be able to identify these types. Because no reliable method was available for isolating specifically these types (O1 serovars) from water or other specimens, microbiologists at Louisiana State University made the first significant contribution of developing one. Their innovative method uses polystyrene beads coated with antibodies against the O1 serovars to separate the organisms from aqueous media which are passed through a column of the beads. The virulent strains are held by the antibodies to the beads which are then transferred to a solid culture medium that enhances growth of the isolates. It is likely that the procedure will prove useful for the isolation of specific strains of other pathogenic microorganisms and that the principal of the method can be applied clinically to isolation of specific organisms from pathological specimens.

Studies underway at the University of West Florida on the effects of storage and handling on concentrations of human pathogens in shellfish have defined the bacterial composition of clams and oysters, shown that the microbial quality of oysters is more sensitive to storage conditions than clams and determined the effects of storage time and temperature on quality.

**Handling and Processing**

At Oregon State University, food scientists developed new procedures for handling Pacific shrimp during the period before they are peeled and processed. The procedures, involving use of preprocessing solutions and temperature control, are relatively simple to apply and increase the yield of processed shrimp by about 25 percent. They have already been applied in several plants in Oregon. If all the processors just in Oregon adopt the procedures a yearly savings of over $10 million of currently wasted shrimp will result.
Research at Cornell University have applied a common process to one of the big problems of the seafood industry—the short shelf life of fresh fish. They noted that no matter how well fish were iced, they maintained a "good" rating for no longer than ten days and an "excellent" rating for six days. But if the fish are blanched for two seconds in water at 90°F before icing, the excellent condition can be prolonged to 9 1/2 days and the good rating can be maintained for 11 1/2 days. The blanching destroys bacteria and bacterial enzymes on fish, but the heat does not penetrate the skin and does not affect the physical appearance of the fish. The researchers suggest that it may be possible to economically apply this procedure aboard ship by using the stack exhaust to heat the water.

Studies at the University of California have shown that packaging fish in gaseous mixtures of carbon dioxide and air inhibits the growth of major aerobic spoilage bacteria in minced fish and that this kind of treatment is effective in maintaining the quality of fresh Pacific red snapper. Studies to determine the exact proportions of gases necessary for safe preservation for better preserving other fishes are continuing there.

Opportunities, Responsibilities and Needs

Of high priority for Sea Grant are research projects that address the problems preventing delivery of fresh, frozen and preserved domestic seafood of high microbiological and organoleptic quality to consumers in the U.S. and in foreign countries. The research may encompass development of concepts for new products that could create new domestic markets; allow U.S. fishery resources, including underutilized species, to be used in traditional foreign markets; and enhance productivity by providing uses for food- or feed-grade materials currently wasted in processing. Other work relevant to these problems may include efforts to improve practice in handling, processing, transporting, and storing fish and fishery products so that safe food of consistent high quality can be expected from the industry. A fundamental understanding of seafood quality in terms of flavor, texture, biochemistry and microbiology is needed. Of equal importance is research directed toward development of generic techniques for improving efficiency in processing which can and should include engineering approaches.

Of fundamental importance in assuring high quality fish in the market place is proper handling of fish at sea—both during the process of harvesting when fish can be bruised and during transportation to processing plants when maintenance of low temperatures in storage holds is essential. The later point is not simply a matter of having sufficient capacity for refrigeration; other factors come into play such as the basic texture of the flesh of various species and levels of alimentary bacteria and digestive enzymes and how their growth or reactions affect quality. Some species should be at least partially processed aboard ship and this is a difficult matter for which there are few good methods and machines applicable to the small fishing vessels characteristic of the American fleet. Even after fish reach a harbor great care should be used in unloading and holding prior to processing and in this regard there are needs for better methods and equipment.
Even after processing, high quality fish can become second rate or inedible because of improper handling as it moves through the distribution channels. The procedures proven reliable for red meat and poultry are not directly applicable to fish, so there are needs for pinpointing problems in distributing seafood and developing reliable methods and standards for handling it properly.

Another of the major issues confronting seafood processors is increasingly stringent regulation of quality of effluents. Consequently, research directed at alleviating this growing problem is important. A wide range of approaches are appropriate from, for example, development of methods for decreasing volumes of effluents to development of useful products from waste materials and development of new, inexpensive biological or physical methods for making effluents conform to regulatory standards.

Of special concern to both fishermen and processors are problems associated with polluted shellfishing beds. More than 60 percent of their total area along the coasts of the United States is closed to fishing for clams, oysters, and scallops because of concern about contamination with paralytic shellfish poison or pollution with bacteria and viruses pathogenic to humans. In Puerto Rico and Hawaii there are problems with ciguatoxic finfish. The basis on which decisions on opening and closing fishing beds are made is not precise especially in regard to viruses and pathogenic bacteria of the genus Cholera. There are no good methods for predicting the occurrence of ciguatoxic fish. Better and faster laboratory methods are needed to aid in making these decisions. In addition, there are other serious issues concerning microbiological depuration and chemical pollution, so there are many complex research opportunities appropriate for academe that will aid in fuller and safer use of fisheries and potential fisheries.

Sea Grant research in seafood science has included studies in microconstituents of seafood and on its nutritional quality. Work of this type is still appropriate if it is justified on the basis of its relevance to well defined problems of health or safety. In some quarters, there has been concern about bioavailability of chemicals especially inorganic constituents. Studies which will develop reliable information on bioavailability in many cases require the use of human subjects and/or careful controls. Experiments of this type are expensive and if undertaken through Sea Grant, should be on the basis of highly significant and well defined problems or opportunities in development of resources. Of low priority is work directed toward cataloging concentrations of chemical constituents of seafood without justification on the basis of specific problems or opportunities.
## SEAFOOD SCIENCE AND TECHNOLOGY

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<tr>
<td>University of California, Davis</td>
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<tr>
<td>Concentration of human pathogens by commercially important shellfish: I.</td>
<td>$ 49,700</td>
<td>$ 21,900</td>
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<tr>
<td>As affected by Environmental factors</td>
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<td>Blake, Norman J. (35)</td>
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<tr>
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<tr>
<td>Concentration of human pathogens by commercially important shellfish: II.</td>
<td>$ 28,000</td>
<td>$ 13,500</td>
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<td>As affected by storage and handling</td>
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<td>Hood, Mary A. (35)</td>
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<td>University of West Florida</td>
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<tr>
<td>Serological determinants of vibrio cholerae from seafood and waters of Louisiana</td>
<td>$ 23,104</td>
<td>$ 26,136</td>
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<td>Siebeling, R. J. and A. D. Larson (8)</td>
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<td>Louisiana State University</td>
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<td>Improvement of seafood quality through investigations of potential pathogens</td>
<td>$ 16,265</td>
<td>$ 10,251</td>
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<td>Hackney, Cameron (35)</td>
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<td>Louisiana State University</td>
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<td>Distribution of vibrios and related species, pathogenic and non-pathogenic,</td>
<td>$ 60,600</td>
<td>$ 9,219</td>
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<tr>
<td>in shellfish</td>
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<td>Colwell, Rita R. (40)</td>
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<td>University of Maryland, College Park</td>
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<tr>
<td>Enteroviruses in prohibited oysters and marine sediments</td>
<td>$ 18,633</td>
<td>$ 9,597</td>
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<td>Ellender, R. (45)</td>
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<td>University of Southern Mississippi</td>
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<td>Luminous bacteria as indicators of shellfish contamination by pathogenic vibrios</td>
<td>$ 22,944</td>
<td>$ 16,810</td>
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<td>Greenberg, F. P. (35)</td>
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<td>Cornell University</td>
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<tr>
<td>Nutrients, nutritional value, and quality of fish and seafood</td>
<td>$ 25,250</td>
<td>$ 22,767</td>
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<td>Kinsella, J. P. (35)</td>
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<td>Coliform analysis of Great South Bay</td>
<td>$18,134</td>
<td>$12,588</td>
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<td>Weyl, R. K. (45)</td>
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<td>State University of New York, Stony Brook</td>
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<td>Enteric virus and bacteria contamination of shellfish and their habitat</td>
<td>$25,496</td>
<td>$33,043</td>
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<td>Sobsey, M. D. (45)</td>
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<td>University of North Carolina, Chapel Hill</td>
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<td>Microbiological impacts of seafood process modification</td>
<td>$42,100</td>
<td>$49,800</td>
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<td>Lee, J. S. (35)</td>
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<td>Oregon State University</td>
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<td>Nutritional evaluation of stored, processed, and cooked fish</td>
<td>$18,991</td>
<td>$12,640</td>
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<td>Percival, Susan S. (35)</td>
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<td>Assessment and control of viral pollution of marine resources</td>
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<td>$20,678</td>
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<td>Melnick, Joseph L. and Charles P. Gerba (45)</td>
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<td>Baylor College of Medicine</td>
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<td>Content of mineral elements and bioavailability of calcium, iron, and zinc from seafood</td>
<td>$10,000</td>
<td>$13,600</td>
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<td>Ritchey, S. J. (35)</td>
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<td>Virginia Polytechnic Institute &amp; State University</td>
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<td>Effect of fish quality, reprocessing, and storage conditions on mutagen occurrence in canned fish</td>
<td>$21,700</td>
<td>$15,300</td>
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<tr>
<td>Twaika, Wayne T. (35)</td>
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<td></td>
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<tr>
<td>University of Washington, Seattle</td>
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<tr>
<td>Subtotal</td>
<td>$427,635</td>
<td>$292,865</td>
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D. Handling and Processing

| Seafood science and technology: modified atmosphere storage | $15,543 | $23,791 |
| Brown, W. D. (35) | | |
| University of California, Davis | | |
| Control of clostridium botulinum outgrowth and toxin production in smoked fish | $6,400 | $6,900 |
| Telfedo, Romeo (35) | | |
| University of Georgia, Athens | | |

96
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<td>Low temperature storage of freshwater prawn</td>
<td>$ 9,140</td>
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<tr>
<td>Macrobrachium Rosenbergii</td>
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<td>Nip, Wat Kit (35)</td>
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<tr>
<td>University of Hawaii</td>
<td></td>
<td></td>
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<tr>
<td>Biochemical, microbiological, and ultra-structural changes in shrimp freezing</td>
<td>$ 26,044</td>
<td>$ 5,662</td>
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<tr>
<td>Meyers, Samuel P. (35)</td>
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<tr>
<td>Louisiana State University</td>
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<tr>
<td>The shelf-life extension of underutilized fish</td>
<td>$ 14,754</td>
<td>$ 21,899</td>
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<tr>
<td>Regenstein, J. M. (35)</td>
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<td>Cornell University</td>
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<tr>
<td>Assurance of quality in prepackaged fresh fishery products</td>
<td>$ 25,906</td>
<td>$ 15,589</td>
</tr>
<tr>
<td>Lanter, Tyre C. (35)</td>
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<tr>
<td>North Carolina State University, Raleigh</td>
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<td>Seafood process and product improvement</td>
<td>$ 68,000</td>
<td>$ 56,700</td>
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<td>Crawford, D. L. (35)</td>
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<tr>
<td>Oregon State University</td>
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<td>Seafood preservation and handling</td>
<td>$ 17,200</td>
<td>$ 27,000</td>
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<td>Kolbe, F. R. (35)</td>
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<tr>
<td>Oregon State University</td>
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<td>Alternative for expansion of seafood processing plant capacity</td>
<td>$ 37,076</td>
<td>$ 32,122</td>
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<td>Barnett, S. and A. G. Rand, Jr. (35)</td>
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<td>University of Rhode Island</td>
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<td>Seafood technology</td>
<td>$ 72,000</td>
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<td>Finne, Gunnar and Carl Vanderzant (35)</td>
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<td>Texas A &amp; M University, College Station</td>
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<td>Appropriate technology for seafood processing and handling</td>
<td>$ 19,000</td>
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<td>Tanchoco, Jose M. A. (35)</td>
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<td>Virginia Polytechnic Institute &amp; State University</td>
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<td>A study of spoilage rates of Pacific Northwest fish species</td>
<td>$ 15,900</td>
<td>$ 8,300</td>
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<td>Liston, J. (35)</td>
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<td>University of Washington, Seattle</td>
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<td>Safety of modified atmosphere packaging of refrigerated fresh fish</td>
<td>$25,655</td>
<td>$5,964</td>
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<td>Robert Lindsay (35)</td>
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<td>University of Wisconsin</td>
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<td>Extending the storage life of Whitefish through lipid oxidation studies</td>
<td>$17,944</td>
<td>$6,319</td>
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<td><strong>Subtotal</strong></td>
<td>$370,562</td>
<td>$272,833</td>
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<td><strong>Grand Total</strong></td>
<td>$1,299,655</td>
<td>$869,145</td>
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The mission of the National Marine Fisheries Service (NMFS) is:

"A continued optimum utilization of living marine resources for the benefit of the Nation."

This mission is derived from the more than 100 Federal laws administered by the Service which relate to living marine, anadromous, and commercial fresh water fisheries resources and their habitats. Significant among these laws are the American Fisheries Promotion Act of 1980, the Magnuson Fishery Conservation and Management Act of 1976 (MFCMA), the Fish and Wildlife Act of 1956, the Marine Mammal Protection Act of 1972 (MMPA), the Endangered Species Act of 1973 (ESA), the Fish and Wildlife Coordination Act, the Saltonstall-Kennedy (S-K) Act, and Titles V and XI of the Merchant Marine Act of 1936 (financial assistance programs).

The Service has evolved from a long line of agencies that have been merged with or split from, other agencies having responsibilities for natural resources. Except for laws implementing international conventions, the predecessor agencies of the Service lacked any significant management authority over living marine resources. Following the establishment of the National Oceanic and Atmospheric Administration (NOAA) in 1970, a series of new and complex statutes and legislative amendments greatly increased the authorities and responsibilities of the Services.

The growing concerns over the continued decline of fishery resources off the coasts of the United States as well as the opportunities for U.S. fisheries development resulted in passage of the MFCMA, the most significant piece of
fishery legislation in our nation's history. By extending U.S. management
authority over fishery resources seaward to 200 nautical miles of the coastline,
and beyond for anadromous and Continental Shelf species, the Service assumed
responsibility for an area covering 2 million square miles and an estimated
20 percent of the world's traditionally harvested fishery resources (i.e.,
the U.S. Fishery Conservation Zone (FCZ)). The MFCMA directed that immediate
action be taken to conserve and manage these fishery resources, and established
eight Regional Fishery Management Councils to prepare, monitor, and revise
management plans governing their harvest.

Passage of the MFCMA resulted in vastly increased opportunities for the
domestic fishing industry. As a result, the Administration announced a fisheries
development policy in 1979 consistent with the purposes of the MFCMA, to
facilitate the development of U.S. fisheries through a cooperative federal
Government and fishing industry program to utilize fishery resources in the
FCZ not traditionally harvested by American Fishermen. Elements of the program
included: (a) Increasing research to provide information to consumers and
industry on the safety, quality, and nutritional value of seafoods; (b) Adapting
existing technology and disseminating technological information to allow the
industry to modernize and improve its facilities, equipment, and practices;
(c) Providing foreign market access through Government negotiations, better
information on market conditions and trade opportunities, to increase foreign
markets and help reduce our massive trade deficit; (d) Facilitating industry
access to private venture capital for vessels, processing plants, and support
facilities; and (e) Reviewing Government regulations applicable to the industry
to ensure fair and equitable treatment and an adequate basis for all regulatory
actions.
The status of this policy in the new Administration is uncertain. However a subsidiary policy linking fish allocations among foreign nations to fishery product trade concessions, known as "fish and chips," is being actively pursued. In allocating surplus fish to foreign nations, NMFS seeks to further the broad objectives of the MFCMA, including the development of the U.S. fishing industry.

Industry response to the opportunities created by the MFCMA, particularly in fisheries not traditionally fished, was considered too slow by the Congress. Also, since passage of the MFCMA, the economy has been characterized by relatively high inflation and high interest rates which have created investment and marketing problems for the industry. Escalating fuel costs, consumer resistance to higher prices, and duty free imports have combined to put several fisheries in a cost/price squeeze. As a result, Congress passed the American Fisheries Promotion Act (AFPA) in 1980 to aid the industry in removing technical impediments to growth, to open export markets, to closely monitor and reduce foreign fishing in the FCZ, and to provide expanded financial assistance.

In tandem with its fishery management and development activities, NMFS is an active participant in program directed toward the protection of the coastal and marine habitat which support fishery resources. As a result of commercial development, hydroelectric power projects along the coastline, and offshore energy development, major losses of estuarine habitat and coastal wetlands have occurred. These areas are vital to the health and growth of
living marine resources as spawning, nursery, and forage grounds. Contributing to a continuing loss or degradation of vital living marine resources habitat are construction and maintenance of navigation channels; dredge and fill activities; draining, ditching, and impoundment of wetlands; offshore drilling, mining, and lumbering; and ocean dumping and waste disposal. These losses continued to accelerate in the 1970s as development efforts in the coastal zone and offshore intensified. As a result, the number of requests to NMFS for environmental analyses and recommendations greatly increased. The NMFS has an obligation to prevent or mitigate the loss of these habitats.

In summary, the legislative mandates and executive policies of the 1970s have required NMFS to reexamine its role in relationship to other Federal agencies, the States, foreign nations, and affected domestic constituencies including industry and universities. It is clear there are many challenges ahead. Existing personnel and fiscal constraints will necessitate a hard look at the ability of NMFS to tackle these challenges.
INNOVATION IN FOOD SCIENCE RESEARCH

A symposium presented in cooperation with the Grocery Manufacturers of America, Inc., at the 41st Annual Meeting of the Institute of Food Technologists, Atlanta, Ga., June 7-10, 1981. Co-Chairmen of the symposium were R. Froely of Gerber Products Co. and A.G. Elbert of the Wm. Underwood Co.

89 Needs and Capabilities in Food Research in Academia—Report of the IFT Committee on Research Needs
   William W. Marion, Iowa State University

92 The Future of Food Science Research in Academia
   B.S. Schweigert, University of California-Davis

94 Industry-Government Cooperation in Setting Food Research Priorities
   Howard E. Bauman, The Pillsbury Co.

96 U.S. Food and Agricultural Research—Problems and Opportunities
   Michael J. Phillips, Office of Technology Assessment

101 National and Multinational Opportunities for the Encouragement of Innovation
   Monte C. Throahl, Monsanto Co.

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NEEDS AND CAPABILITIES IN FOOD RESEARCH
IN ACADEMIA—REPORT OF THE IFT COMMITTEE
ON RESEARCH NEEDS

WILLIAM W. MARION

1. The Research Needed. To support an expanding food industry, there should be a cooperative venture among food manufacturers, the federal government, universities, and private laboratories. This process involves frequent assessment of research needs and the accomplishments of scientists in each of the above groups. Challenges in food research are similar in nature to those facing other segments of society. The real dollar support for research has lagged behind that needed to answer the most critical questions. In addition, too little attention has been given to defining and implementing research goals, and to coordinating food-related research.

In 1978, the President of the Institute of Food Technologists, Dr. B.S. Schweigert, established an Ad Hoc Committee on Research Needs, consisting of six persons representing industry, government, and academia: W.W. Marion (chairman) of Iowa State University; C.F. Niven Jr., formerly of Del Monte Corp., now retired; D.F. Parkas, previously with Agricultural Research, U.S. Department of Agriculture and now with the University of Delaware; M. Karel of Massachusetts Institute of Technology; J.E. KinSELLA of Cornell University; and J.R. Kirk of the University of Florida. Now a permanent commodity of IFT, the group assists the Institute to focus on the issue of research in much the same way as the Institute traditionally has focused on education and communication.

TEN CRITICAL AREAS IDENTIFIED

The committee's first task was to review many of the existing sets of priorities developed by governmental, industrial/commodity, and university groups. Many of these priority statements emphasize the anticipated shortage of scientists as well as the research needs of the area in question.

After reviewing reports prepared by the General Accounting Office, the National Science Foundation, the Office of Management and Budget, the Office of Technology Assessment, the Office of Science and Technology Policy, the U.S. Department of Agriculture, and several industry groups concerning research needs in food and agriculture, the committee developed the following list of critical needs in food research:

1. Food Safety. To continue to ensure reasonable safety of food (with regard to intentional and unintentional additives, contaminants, microorganisms, microbial toxins, and processing- and cooking-induced hazards), food scientists and others must give increased attention to the identification, quantification, and evaluation of hazards associated with food products and processing systems. This growing base of scientific information is of value not only to food manufacturers but also to consumers who demand assurance of food safety and who often are suspicious that the industry is not fulfilling its complete role in this regard. Continued research is needed on analytical techniques, synthesis, metabolism, and effective methods of estimating risks related to processes and to individual food products.

2. Energy Use and Conservation. The high degree of dependence of the food industry upon petroleum and natural gas as an energy source is cause for much concern. The sophistication and extent of processing has increased the demand for energy to the extent that, as a minimum, one-third of the energy needs of the entire food chain is accounted for by processing alone. New processing techniques and more efficient food preservation, storage, and distribution methods are needed. Considerable public money is needed to effect major gains in processing efficiency.

3. Maintaining and Enhancing the Nutritional Quality of Food. Nutrition and dietary intake are related to diseases, including dental caries, diabetes, cardiovascular and cerebrovascular diseases, gastric diseases, and cancer. Malnutrition and marginal nutrition have also been related to decreased learning capacity and work performance. These conditions and others account for increased health and education costs. Research should be encouraged which will lead to the maintenance and enhancement of the nutritional quality of foods. This research should be directed toward the identification of nutrient deficits and processing losses, and the development of technology to minimize processing losses and permit desirable fortification. The results of such research will ensure the nutrient quality of the food supply and, hence, the health and well-being of the population.

4. Food Losses. A program of research should be initiated to identify, control, and reduce the major losses in food materials which occur in the food pipeline between harvest and consumption. The General Accounting Office report, "Food Waste: An Opportunity to Improve Resource Use" (September 1977), states that 20% of all food produced for human consumption is lost annually in the United States, representing a multi-billion dollar loss. Research is needed to develop economical approaches to reducing food losses in all parts of the delivery system, including the home. Such savings could result in food being made available to a greater number of people and/or a significant reduction in the use of energy and other resources.

5. Physical, Chemical, and Functional Properties of Foods. Food manufacturers do not have the resources or inclination to explore the fundamental properties of foods. There is a clear and continuing need for new data on animal, fruit, microbial, and vegetable sources of food. New cultivars or phenotypic changes resulting in compositional or functional differences need careful documentation. Such changes influence the characteristics and perhaps even the nutritional properties of the final product. Public research groups are appropriate bodies for accumulating data of this type.

6. Innovation and Technological Developments. A comparison of the food supply in the U.S. today with that of an earlier date, e.g., 1900, clearly shows that great technological changes have occurred. The changes themselves are the result of many factors, such as urbanization, population growth, improved and enlarged food production, general scientific and technological advances, food preservation and processing methods, packaging development, increased nutrition knowledge, food safety and sanitation improve-
great potential for meeting present and future needs. The U.S. science base being other countries in this important and potentially efficient technology which complements

10. Biomass Conversion to Energy. Because significant expertise in microbiology, practical fermentation technology, and properties of natural products exists in the food science field, the support of research for conversion of agricultural biomass to high-energy compounds (methane, alcohol) should be increased in established institutions. Developments in this area should enhance the utilization of agricultural products and enhance production of energy.

CAPABILITIES OF FOOD SCIENCE DEPARTMENTS

The committee next directed its attention to the development and use of a questionnaire to assess the nation's capabilities in food research. Thus far, the survey has dealt only with food science departments in universities. The following tables provide a profile of 37 departments responding to the survey.

- Personnel. The respondents were asked how many and what types of Ph.D. research scientists were in their department. As shown in Table 1, the average number of Ph.D. research scientists per department is just in excess of 1.6, ranging from 3 to 15. As for types of scientists, fewer institutions reported a sensory scientist position compared with food scientist positions. In several of the categories, less than one research scientist or engineer was designated per department. And although the survey did not assess the situation further, the research commitment of such a scientist is spread across many departments.

- Research Space. Respondents were asked how much laboratory and pilot plant space was available in their department. The respondents were allowed to use their own definitions of "laboratory" and "pilot plant." The results, shown in Table 2, indicated that for 34 institutions responding, research space amounted to an average of 1,056 m² and pilot plant operations amounted to half that much. No further definition of space, facilities, and equipment was sought. Only a relatively few instances were moderately large facilities reported.

- General Research Thrust. The general direction or thrust of food science research was ascertained by asking respondents to classify their department's efforts. As shown in Table 3, the split between fundamental and applied research.

Table 1—NO. AND TYPES OF Ph.D. RESEARCH SCIENTISTS

<table>
<thead>
<tr>
<th>Type of scientist</th>
<th>No. of departments responding</th>
<th>No. of Ph.D.s</th>
<th>Mean</th>
<th>Range</th>
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<tr>
<td>Food scientists</td>
<td>34</td>
<td>5.0</td>
<td>1-20</td>
<td></td>
</tr>
<tr>
<td>Biochemists</td>
<td>21</td>
<td>2.7</td>
<td>1-12</td>
<td></td>
</tr>
<tr>
<td>Chemists</td>
<td>15</td>
<td>2.0</td>
<td>0.8</td>
<td>6.8</td>
</tr>
<tr>
<td>Food engineers</td>
<td>21</td>
<td>1.8</td>
<td>0.2</td>
<td>5.5</td>
</tr>
<tr>
<td>Microbiologists</td>
<td>21</td>
<td>1.8</td>
<td>0.5</td>
<td>4.2</td>
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<tr>
<td>Nutriologists</td>
<td>21</td>
<td>3.5</td>
<td>0.5</td>
<td>8</td>
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<tr>
<td>Sensory scientists</td>
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<td>0.8</td>
<td>0.15</td>
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<tr>
<td>Administrators</td>
<td>22</td>
<td>1.0</td>
<td>0.25</td>
<td>2</td>
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<tr>
<td>Total</td>
<td>35</td>
<td>13.4</td>
<td>3-45</td>
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</table>

Table 2—RESEARCH SPACE AVAILABLE

<table>
<thead>
<tr>
<th>Type of facility</th>
<th>No. of departments responding</th>
<th>Amount of space (m²)</th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory</td>
<td>34</td>
<td>4,595</td>
<td>60-5,500</td>
<td></td>
</tr>
<tr>
<td>Pilot plant</td>
<td>35</td>
<td>758</td>
<td>40-5,000</td>
<td></td>
</tr>
</tbody>
</table>

Table 3—GENERAL RESEARCH THRUST

<table>
<thead>
<tr>
<th>Type of research</th>
<th>No. of departments responding</th>
<th>% of departments conducting that type of research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamental</td>
<td>36</td>
<td>37%</td>
</tr>
<tr>
<td>Applied</td>
<td>37</td>
<td>40%</td>
</tr>
<tr>
<td>Development</td>
<td>30</td>
<td>16%</td>
</tr>
</tbody>
</table>

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*The lower the score for a given area, the better.
research effort was about even at 37.40\% of the effort. However, 15 departments reported effort in developmental research, interpreted to mean the development of a system, an apparatus, a machine, or possibly a program. The original data point out that few departments commit half or more of their effort to fundamental research.

- **Major Research Categories.** Respondents were asked to provide information on the major categories of research underway in their department/unit and to rank their research in terms of the ten critical areas identified by the committee, plus a few other areas. The results are given in Table 4. The small number of institutions reporting in certain categories is indicative of few commitments to those areas. Overall, the category of physical, chemical, and functional properties of food received the highest ranking. There were individual efforts—e.g., in cancer research, for example—not reported in summary form in Table 4.

- **Research Efforts by Commodity.** Respondents were asked to report the commodities of major research interest. The results are shown in Table 5. Note the relatively high frequencies associated with cereals, fruits and vegetables, and formulated foods. Research on legumes was reported in only three instances.

- **Research Funding.** Respondents were asked to report the amount and source of their funding for research and salaries. The data are shown in Table 6. The average state-appropriated financial support amounted to $490,000 for 31 institutions reporting. Given the average of 13.4 Ph.D. scientists per department (from Table 1), state-appropriated money amounts to an average of approximately $35,800 per scientist (although $56,000 is generally considered modest support for one scientist).

The range and magnitude of financial support from all sources provide an interesting and challenging picture. Non-state support is important in all instances, and in the case of private universities such support determines whether a food science research program, or any other program, will exist.

It is an obvious fact that universities and scientists vary greatly in their ability to obtain grants and contracts. The data in Table 6 corroborate the importance of these funds to food science research.

- **Agricultural Income vs Research Funding.** The data in Table 7, compiled by the committee, are presented as an addendum to the survey results. They relate the cash farm receipts in selected states to the funds appropriated for research on food and agricultural issues. The data point out at least a couple of interesting facts: Both income and appropriations vary considerably among the states, and there is no direct relationship between cash farm receipts and money appropriated for research. For example, the legislatures of Iowa and Illinois make relatively small commitments to research funding compared with the legislative bodies in Florida and North Carolina. The data in Table 7 should be of value to legislators who must in the appropriation process weigh the needs and values of one funded area against those of another.

**SERIOUS LIMITATIONS EXIST**

In general, the results of this survey indicate that some serious limitations exist in the resources available for food science research and for training of future research scientists needed by industry, government, and academic institutions.

The IFT Committee on Research Needs intends to extend the survey to industrial and governmental research laboratories because a reasonably accurate assessment of the capability of all groups in food science research and in training programs is critical.

Based on a paper presented during the symposium, "Innovation in Food Science Research," presented in cooperation with the Grocery Manufacturers of America Inc. at the 1st Annual Meeting of the Institute of Food Technologists, Atlanta, Ga., June 2-6, 1981.
IT IS MOST APPROPRIATE to focus our attention on the scope and trends in food science research as we begin the 1980s. To gain some insight as to the future trends, it is useful to review recent experience to establish a data base and to perceive whether any significant trends may be emerging. As background, I will discuss research support of faculty programs in the Department of Food Science and Technology at the University of California—Davis.

FUNDING AT UC—DAVIS

Table 1 provides a summary of the funds available to the university from extramural research support (federal, state, and private) during an 8-year period (1973-80). Note that these are unofficial figures based on data available in the department; also that any unused extramural funds can be carried over to the next fiscal year, and would be thus available for research support in future years.

Modest increases in teaching and research funds available from the university through appropriations were made throughout the 8-year period. Although the specific funds for research are not separated out from teaching funds, both increased at approximately the same rate.

Extramural research support is needed for significant augmentation of university research programs. In our department, extramural support has approximated a million dollars per year, with approximately half of it coming from federal grant and contract sources (National Institutes of Health, National Science Foundation, U. S. Department of Commerce, U. S. Department of Agriculture, etc.), 10-15% from state funds (California Dairy Council of California, Commodity Advisory Boards, including peach, pear, almond, apricot, rice, tomato, etc.), and 35-40% from food and allied industry grants.

While some variation occurred in funding from year to year—depending on the timing for initiation and completion of individual grant programs—all three sources of extramural grant support have generally been maintained or increased slightly. We have had a number of new grants from private sources during the past year, and it will be of interest to see if this effort for increased support can be maintained. (I would like to point out here the special value of unrestricted gifts from private sources for support of research. The leverage to commit in advance, to encourage initiating new areas of research for new or senior faculty, is very important. Increased support in this area would be of major importance.)

The purchasing power of these extramural funds has been decreasing with inflation; this is no doubt a common occurrence in many groups. It is important to point out, however, that no major decrease has been noted in any of the three sources of extramural support in our department. Consequently, we have no evidence from this limited set of data to suggest a major trend—in either direction—in research support from these funding sources.

TYPES OF SUPPORT

The nature of research support available will vary somewhat from university to university, in particular, funds that
are available through special commodity groups in the state, for example, may vary widely. Some generalizations can be made with respect to the attraction of financial support for specific areas of research in food science. It has been our experience that federal agencies are most likely to support food research that has nutritional and/or toxicological significance, and that it is difficult to attract support for research relating to the physical and chemical properties of food constituents, for example, unless such properties have a nutritional or toxicological relationship. In recent years, projects related to energy (such as evaluating energy needs in various food processing unit operations) have attracted support. An update on federally supported nutrition research has recently been published by the Joint Subcommittee on Human Nutrition Research (1981).

An area of major importance is support through food and allied industry groups, including foundations. We have been fortunate to attract a number of grants, with relatively few restrictions, to pursue research in such areas as thermal processing, microbial genetics, food enzymes, nutritional studies, marine food products, ultratization, sensory science, etc. These projects are particularly valuable in extending research support in the area of a faculty member’s major research interest, and, of course, are particularly adaptable to graduate thesis research problems. We give high priority to encouraging and developing this type of continuing research support. The importance of this aspect of research support was discussed by Niven (1981).

Our department is not involved in any major international programs with large multifaculty participation. As a consequence, no international projects of this type are included in the above list. Our faculty members do, however, participate on an individual basis in international programs. We are currently in the exploratory stage of developing a somewhat larger role in food science collaborative research and training programs through the University of California–Egypt Project.

The Future

It is important for food science research to provide the link between plant and animal science research and human nutrition and food distribution research in the future. Some modest progress in increasing the awareness of this role has been made with food and allied industry leaders and with leaders in agricultural research in our universities and in the federal government.

With respect to the financial outlook for the future, I perceive a steady basis for support, with some promise for modest expansion. The current climate in the federal government may be somewhat more encouraging for research support in food science, in view of the importance of this research to expanding the industrial base. It will be our challenge to clarify the importance of food science research to the economic well-being of the country and to the maintenance and improvement of human health through the continuing provision of a wholesome and nutritious food supply at modest cost. In this respect, the Institute of Food Technologists through its Committee on Research Needs (Martin, 1982) will play a valuable role in bringing the importance of research priorities to the attention of all of us, and, in providing a perspective for the contributions that have been made and will be made by food scientists through research in the public and private sector in the future.

REFERENCES


Based on a paper presented during the symposium: "Innovation in Food Science Research," presented in cooperation with the Grocery Manufacturers of America, Inc. at the 51st Annual Meeting of the Institute of Food Technologists, Atlanta, Ga., June 7-10, 1981.

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JANUARY 1982 — FOOD TECHNOLOGY
INDUSTRY-GOVERNMENT COOPERATION IN SETTING FOOD RESEARCH PRIORITIES

HOWARD E. BAUMAN

During 1980, Dr. Dennis Prager, the Associate Director of the Office of Science and Technology Policy (OSTP), met informally with representatives of several industry associations on the issue of food processing research. Through these meetings and by use of an informal polling system covering a cross-section of academic and industrial scientists involved in food processing research, OSTP developed a preliminary list of research needs generic to the food processing industry. This list is shown in Table I.

Although developing the list of research needs was one of its principal tasks, OSTP also felt that it was necessary to pursue potential government/industry cooperation in initiating and conducting research programs to meet those needs. Therefore, in October 1980, OSTP convened a meeting with a small group of food industry corporate executives, industry association representatives, and government officials to discuss the following:

1. The general areas of food processing research needs that had been identified to date.
2. The ability of the food processing industry to carry out the research identified.
3. The most desirable role for the federal government in the conduct and support of the research identified.
4. The feasibility and desirability of government/industry cooperation in food processing research.
5. Alternative approaches that might be used to establish a joint government/industry research program.
6. Possible next steps that might occur after this particular meeting.

This article will briefly report on some of the subjects discussed during the meeting.

ATTITUDES AND COOPERATION DISCUSSED

Basic issues that were troubling some of the industry representatives were discussed at the meeting. A number of industry representatives asked about the attitude or policy of the federal government toward the food processing industry. There appeared to be a strong perception within the management levels of at least part of the food industry that the government has taken an adversary role toward the U.S. food industry. Many firms felt that there was a lack of understanding of the food industry's problems and that until now, there had been no desire to develop a cooperative working relationship with the business sector. A specific that was advanced relating to the effects of the federal government on research was a statement that approximately 23% of current research goes to support regulatory compliance. This precipitated a discussion regarding regulations and particularly overregulation. The main theme of the meeting, however, was: "How can industry continue to commit large percentages of resources to needs such as environmental protection regulatory requirements and other regulations, and at the same time take on new research initiatives to maintain and strengthen productivity?" To do this would require substantial additional resources. There was no question that some regulation is necessary, but overkill must be avoided.

A number of suggestions were made as to how industry might be helped by government. One was that the capital-gains tax structure should be revised to encourage long-range investments in research. Another participant reported that the Industrial Research Institute had expressed a need for more emphasis on research to solve short-range needs. Some of the participants felt that current industrial challenges are so critical that some immediate solutions are needed, and this would require stronger support for research which promises quick, short-range benefits.

In a discussion relating to research support for large vs. small companies, there was a general consensus that a major share of the good ideas, perhaps up to 56% in some areas, evolve from small enterprises. There are spinoffs from these contributions to large companies and industry in general. If there was any consensus regarding incentives and/or public funds, it was that they should be targeted to specific areas of research and especially to small firms.

A common thread of the discussion was a lack of understanding between the private sector and the federal government, and, most particularly, questions about the degree of understanding of high-level administrators concerning the role of research in the public and private sectors, this probably applies to both government and industry administrators.

Concern was also expressed about the need to improve interdepartmental cooperation within the government, specifically between the U.S. Department of Energy and the U.S. Department of Agriculture regarding energy research. The lack of communication between the private sector and the government appeared to be one of the primary stumbling blocks. To lay the groundwork for improved government/industry cooperation, a meeting between high-level government officials and the chief executive officers from food processing companies was suggested. This would strengthen and build government/industry trust, which most people present felt had declined dramatically in recent years. A great deal of background work would probably be needed before such a meeting could be scheduled, to make sure that there would be a genuine interest between both parties to develop a cooperative relationship.
I. Food Preservation
A. Improved methods of food preservation: increased productivity, efficiency; maintenance of sensory quality (flavor, aroma, appearance); improved mechanisms of heat and mass transfer.
B. Improved packaging: increased effectiveness, decreased quantity of packaging materials.
C. Quality identification and measurement: basic analytical methods and rapid on-line procedures.
D. Transportation: sanitation and preservation.
E. Special problems of fresh fruits and vegetables: preservation during transportation/distribution; extension of shelf life; biochemistry of ripening and senescence; nutrient content.
F. Special problems of fisheries: improved techniques for harvesting, handling, freezing, and processing; control of anti-flavor development.
G. Postharvest/slaughtering physiology and bioregulation of foods.
H. Improved nutrient retention: kinetics of nutrient losses; enzyme reaction dynamics.
I. Microbial germination, outgrowth, toxin production, and mechanism of surface adherence in food spoilage.
J. Identification of sources and modes of microbial contamination.
K. Measurement and control of food spoilage organisms (biological, chemical, and physical methods or combinations of methods); chemical kinetics of spoilage reactions.

II. Food Waste Reduction and Utilization
A. Identification and quantification of food losses from harvest to consumption.
B. Reduction of food waste at all steps from harvest through storage, transportation, and processing, to marketing and consumption.
C. Ecology and physiology of pests of stored food commodities.
D. Utilization of crop and food wastes and by-products from harvest to consumption; special waste utilization problem of fisheries.

III. Energy
A. Improvement of energy efficiency of current processes and equipment.
B. Energy recovery, utilization, and recycling at all energy-intensive steps.
C. Development of alternative energy sources for food processing.
D. Development of new processing, preservation, and packaging technologies with greatly reduced energy requirements.
E. Conversion of nonfood plant parts and by-products to energy: fermentation, combustion, research on the basic conversion processes.
F. Conversion of animal wastes, especially animal fats, to useful hydrocarbon sources.
G. Development of new food distribution systems to reduce fuel requirements for transportation.

IV. Environmental Protection
A. Water conservation: reduced use; recycling.
B. Water effluent control: reduction, sterilization, and purification.
C. Air effluent control.
D. Workplace environmental control: food-chain contaminants.

V. New Food Systems
A. New ingredients, food analogs, and novel, nonconventional sources.
B. Methods for precooked, fabricated food.
C. Abiotic food production: synthesis from chemicals.
D. Biological synthesis of foods (new production systems): cloning, tissue culture.
E. Use of microorganisms to preserve foods.

and to work toward building a higher level of trust than currently exists.
Specific research areas needing attention were also discussed. Many of the research needs listed in Table 1 are rather sketchy. It would be necessary to become more precise not only in designating the specific research areas needing attention but also in defining specific research projects. For example, what should the priority areas be for energy research in food processing? How much do we know about where energy is used in food processing? And what do we know about the amount of energy used in specific areas of the food processing system? Only through this type of information could the best opportunities to improve energy efficiency over the short run and long term be determined. Similar questions can be asked with regard to research on food losses, e.g., identification of where the losses occur, and what might be done to alleviate them. It was recognized that some work has been done on energy research opportunities in certain areas of food processing by the Department of Energy and Purdue University, however, this work covered only certain areas of food processing. Additional studies would be needed on red meat, poultry, frozen vegetables, etc. It might be necessary for OSTP to sponsor a conference to aid in defining research areas and priorities of importance with the food industry.

POSSIBLE CHANGES IN GOVERNMENT PARTICIPATION
In recent discussions, Dr. Prager pointed out that although the list of research priorities, with some potential changes or sharpening of definitions, is still relevant, the approach of the current administration is toward less active government participation, leaving the primary thrust to the private sector. This leaves OSTP in somewhat of a quandary as to whether it will continue to pursue government/industry cooperation in this area. However, he did agree that it is important to do so since it not only affects the delineation of some of the major research priorities in the food industry, but also could focus attention on many of the regulatory areas that are a hindrance to full utilization of research in the food area. There is also a place for government involvement as a basis for assisting industry groups to get together to work out common problems without violating the antitrust laws and to develop a more refined list of research projects. If this government involvement occurs, I have no doubt that the private sector would pick up the effort and carry the ball by itself.

Based on a paper presented during the symposium, "Innovation in Food Science Research," presented in cooperation with the Grocery Manufacturers of America, Inc., at the Annual Meeting of the Institute of Food Technologists, Atlanta, Ga., June 7-10, 1981.
U.S. FOOD AND AGRICULTURAL RESEARCH—PROBLEMS AND OPPORTUNITIES

MICHAEL J. PHILLIPS

HOW ARE food and agricultural research priorities to be established? How is the research agenda to be funded? Who will coordinate this undertaking? What will the respective roles of the research participants be? These and other equally troublesome questions prompted Congress in 1980 to request that the Office of Technology Assessment (OTA) conduct an assessment of United States food and agricultural research. The specific committees requesting the study were: the Senate Committee on Appropriations; the Senate Committee on Agriculture, Nutrition, and Forestry; and the House Agriculture Committee. The following objectives for the assessment were established:

- Evaluate the funding, benefits, and burdens of food and agricultural research.
- Determine the basis, scientific or otherwise, for the classification of research from a management perspective.
- Identify the roles of federal, state, and private institutions in developing technologies for solutions to international, national, regional, and state or local problems.
- Examine the management, structure, and policies of the U.S. Department of Agriculture in the conduct of food and agricultural research.
- Evaluate methods by which the expertise and interests of federal, state, and private research organizations can be brought to bear cooperatively in identifying priority research areas.
- Provide public policy options for Congress that will maximize our research potential.

Because the OTA assessment is not yet complete, I will not discuss the findings of the assessment nor the policy options that deal with the issues. I will, however, discuss some of the concerns and questions that provided the basis for the assessment request.

GOALS AND PRIORITIES NEEDED

The changing food and agricultural setting calls for changing emphasis in research. Some priorities must be given more attention than others. Requests for across-the-board funding increases for each scientific discipline will not be convincing to the appropriations committees but will appear as more of a defense of the research bureaucracy than an earnest effort to solve food and agricultural problems. How then, are priorities to be determined? What should the process be, particularly at the federal level? Who will set research goals, the Congress or the cabinet? The credibility of the research effort can be established only if leadership will assume these difficult tasks.

Society has a role in this priority determination process—mainly, establishing goals for food and agriculture. It is ironic that the U.S. has never had a well-articulated set of food and agricultural goals. Without such goals, the process of research priority determination is difficult.

A goal is defined as the end toward which effort is directed. The end must be definable and achievable, at least in theory. Some people assume that the goal of U.S. agriculture is to provide an ample supply of nutritious food for the consumer at reasonable cost with a fair return to farmers within an agricultural system that is sustainable in perpetuity. However, this “goal” is open-ended and therefore not achievable. For example, what is meant by an “ample supply”? Does it mean just to produce to meet U.S. demands or produce to meet world market? Or to produce to meet “plus concessional food to poorer countries”? How would we know when an “ample supply” is achieved? What is “nutritious food”? How is it defined? Is it “reasonable cost” to consumers 15, 20, or 30% of disposable income, or someone else’s figure? Is it “a fair return to the farmer” 10, 15, or 20% on investment? And when should we expect to achieve this “fair return”—in 1995, 2000, 2500? Is it a “sustainable” system one that adheres to 5, 10, or 15 tons of erosion per acre annually?

These and other questions must be answered for a goal to have meaning and to be useful for the research community in planning a research agenda. With such questions answered, setting research priorities is a fertile task.

Society, through its elected officials, has in the past set well-defined, achievable goals. It set a goal of putting a man on the moon by a certain date, and met the goal. It has set goals for the level of gasoline consumption for different sizes of cars, etc., by certain dates. It should be possible for society to set well-defined, achievable goals for U.S. food and agriculture as well.

EXPENDITURES FOR RESEARCH

Food and agricultural research in the U.S. is conducted chiefly by USDA: the-state agricultural experiment stations (SAES), including the 1890 Schools and Tuskegee Institute; and private industry. Both USDA and SAES research constitute public research, regardless of the source of supporting funds. USDA agricultural research is funded from federal sources. SAES research is supported by federal funds, state appropriations and sales, and grants from private sources. In addition, certain non-land-grant universities—including those both publicly and privately financed—also have food and agricultural research programs supported by public funds.

The scope and magnitude of food and agricultural research performed by private industry cannot be accurately reported because of the lack of reliable data. Private firms engaged in agricultural research are not required to identify themselves, nor are they required to publicly disclose their investments in agricultural research. Thus, any analysis of agricultural research by private industry has to be based on incomplete data. Some figures are available, however, and these will be discussed below.

- USDA and SAES Funding. Accurate figures are available for total expenditures out food and agricultural research by both USDA and SAES. Among the major federal agencies conducting research, USDA ranks the lowest in dollar expenditures, in terms of constant dollars, for research. In 1978, total federal expenditures for research and development were $282.2 billion. USDA expenditures were $281.7 million, or about 1.3% of the total. This compared to 45% for the Department of Defense, 16% for the Department of Energy, and 12% for the Department of Health, Education, and Welfare. USDA's states among federal agencies represents a continuing decline in the

The author is Project Director, Food and Renewable Resources Program, Office of Technology Assessment, U.S. Congress, BCC Pennsylvania Ave., S.E., Washington, D.C. 20510

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federal R&D budget—from a high of 39% in 1940 to 1.5% in 1978.

Expenditures on total agricultural research for the USDA, SAES, and USDA and SAES combined for 1968-77 are presented in constant dollars in Figure 1. The increase in the purchasing power of the total SAES and USDA agricultural research expenditures increased by 23% during this period. The pattern, however, differed sharply by each—agricultural research expenditures of USDA increased by only 1%, while those of SAES increased by 40%. Clearly, during this 14-year period and particularly during the latter part of the period, inflation severely eroded the purchasing power of agricultural research funds. Moreover, the constant-dollar expenditures of USDA remained at about the same level, so that the modest increase that occurred is attributable to SAES expenditures. Thus, during this period, SAES expenditures accounted for an increasingly greater share of public agricultural research funds.

During the same period, USDA scientist-years devoted to agricultural research decreased slightly in 1967-68, then remained nearly constant (Fig. 2). There was a very gradual upward trend in the SAES scientist-years devoted to agricultural research, and the total SAES increase from 1966 to 1979 was approximately 40% scientist-years. Increases in expenditures in agricultural research by USDA and SAES have basically been used to cover the salaries and supporting research equipment and supplies for a nearly constant scientist manpower force. Yet during this 14-year period, the demands on agricultural research have been greater than ever.

While the number of USDA agricultural research scientists has remained relatively constant, the average age has been increasing. Between 1969 and 1976, the number of those scientists 50 years of age and older increased from 28% to 35% of the work force; and the number of scientists 30 years of age and under decreased from 9% to only 2%. By way of comparison, at the National Institutes of Health, 15% of the scientists were 50 years of age and over in 1976, and 25% were 30 years of age and under. The average age of the USDA scientists in 1975 was 47, compared to 35 for the NIH scientists (UAO, 1977).

Most research institutions desire a continuous influx of young scientists. Both personnel ceiling and shortage of funds are valid reasons often given for this trend. Since both (especially personnel ceilings) will probably remain as constraints in varying degrees in the near future, some management practices need to be established to assure the attraction and hiring of capable young scientists by USDA.

- Experiment-Station Funding: Levels of federal expenditures on SAES agricultural research for 1968-77 are shown in terms of constant dollars in Figure 3. The largest source was the formula funds, including Hatch and other appropriations. In current dollars, these expenditures steadily increased from 1966 to 1979. The 1979 level was nearly 200% greater than the 1966 level. However, in constant dollars, this translates to a 20% increase, or an average increase of about 1.5% per year.

Cooperative grants and cooperative agreements (CGCA) were the smallest component of federal funding in both current and constant dollars. These funds declined from 1968 to 1971 but since then have been increasing. Over the entire 14-year period, the current-dollar expenditures increased by 17%, while the constant-dollar expenditures increased by only 20%.

Other federal funds for SAES agricultural research are one-half to one-third the size of formula funds, but 2-3 times the size of CGCA expenditures. These other federal funds have been an important source. With some variation, the current-dollar expenditures increased by 129% from 1966 to 1979, but the constant-dollar expenditures decreased by 7%.

The major source of SAES agricultural research funding is state appropriations and sales. Expenditures from these sources, along with expenditures from private sources and formula funds from federal sources, are presented in constant dollars in Figure 4. State appropriations and sales increased nearly fourfold, from 1966 to 1979, resulting in a constant-dollar increase slightly under 57%.

Private research funds for SAES agricultural research are small relative to the state appropriations and sales and the federal formula funds. Nonetheless, they have steadily increased since 1966 and are becoming an important source.
of agricultural research funds. During 1966-79, private research funds have also increased fourfold in current dollars and by 67% in constant dollars.

- **Industrial Research Funding:** Data on expenditures for agricultural research by private industry are considerably more limited than data on the expenditures by SARES and USDA. Some data concerning with applied research and development for agriculture-related products during 1966-75 have been obtained from National Science Foundation surveys (NSF, 1977) and are shown in Figure 5.

In current dollars, the total expenditure by private industry for agricultural research increased from about $220 million in 1966 to about $761 million in 1975—about a 170% increase. In constant 1987 dollars, this is a 39% overall increase or a 35% average annual increase.

Less comprehensive data on private agricultural research were obtained from a survey of agricultural firms conducted by the American Research Institute in 1975 (Windle and Williamson, 1977). The estimated research expenditures by agricultural firms in 1975 were $57.3 million, which is slightly less than the $69 million estimated from the NSF survey for 1975. The categories in the ARI survey are not strictly compatible with those in the NSF survey, so direct comparison of categories and scientist years for the two surveys is not possible. However, the similarity of the estimated overall level of private research from these two sources help substantiate the NSF figures as reasonable estimates of the level of agricultural research being conducted. By private firms.

In 1975 the total expenditure by private industry on applied research and development for agriculture-related products was about 72% of the total public expenditure (SARES and USDA combined) on agricultural research. This total expenditure by private industry in 1975 was approximately 23% greater than the SARES expenditure on agricultural research and about 57% greater than the USDA expenditure on agricultural research.

**Implications of Low-Level Funding**

In discussing the implications of these data, it is well to keep in mind that not only is the food and agriculture industry the largest of all U.S. industries but also that the application of science to agriculture has played a major role in making the U.S. a giant of industrial enterprise.

One of the major ways in which agriculture has contributed to this status is the phenomenal increase in agricultural expenditure on research. Expenditures rose from $2.9 billion in 1950 to $3.2 billion in 1970, then increased sharply to $21.9 billion in 1975 and $41.2 billion in 1980. This growth had the effect of increasing the agricultural balance of trade from a deficit of $1.1 billion in 1950 to a surplus balance of $23.8 billion in 1980. In contrast, the U.S. had a negative trade balance of $42.6 billion for all other commodities in 1980.

The fact that the production of some commodities seems to be leveling off—together with the fact that the level of federal funds for research has been declining—raises concerns as to whether the high levels of agricultural exports can be maintained. Concern is also being expressed as to whether this disparity might also lead to markedly higher food prices at home.

In addition to the low level of funding, the cost of conducting research has increased substantially. Research today requires more sophisticated and costly equipment and support staff than were required 10 years ago. For example, new research horizons such as genetic engineering and systems approaches to agriculture are much more costly than traditional research.

Researchers are having difficulty in replacing worn-out or obsolete equipment and acquiring newly developed equipment. Total capital expenditures per scientist doubled from 1965 to 1979 (Berloitz et al., 1981). A recent study of five important agricultural subdisciplines showed that the cost of scientific instruments rose at an average rate of 20% from 1970 to 1978, far exceeding the average inflation rate (Berger and Cooper, 1979).

At many institutions, operation and maintenance costs for scientific equipment could be supported by other budgets in the past, but now the costs exceed the capacity of institutional funds to meet them (Berloitz et al., 1981). When institutions cannot meet operation and maintenance costs, scientific equipment is improperly maintained, shortening its useful life; support personnel are decreased, and support activities are adversely affected, and faculty and graduate students function as technicians, with a consequent loss of time for research and training. These consequences greatly hinder a research program.

In addition to the traditional research areas such as production efficiency, resource conservation, and food processing and marketing, there are many new areas of concern that require research such as environmental concerns, community services, community living standards, and human nutrition, to name a few. Thus, many traditional research areas actually are receiving less funding today because the total research funds are being spread among a wider range of research areas, some of which require considerable support.

Although federal funding of agricultural research in the U.S. has remained nearly static since 1965, many other countries have had major increases in expenditures for agricultural research. Even as late as 1989, U.S. public expenditures for agricultural research were significantly greater than those in such areas as the USSR, Western Europe, Japan, and Asia. This is not true today.

It appears that the primary responsibility for this decline and low level of federal research funding for agriculture is a lack of interest in and appreciation of the research potential and a generally low level of research priority within USDA. To be sure, the Office of Management and Budget puts limits and pressure on all departments to stay within monetary budget levels, but department heads do have discretion within these limits to make priority adjustments within their departments. Up to 1980, the executive budgets did not show the needed increases in agricultural research, nor did they show strong USDA support for research. As a general rule, Congress has appropriated the full requested budget level for agricultural research and in some cases
increased the level of spending.

Since the productivity of agriculture and most industries relies heavily on research and new technologies, it appears evident that if the U.S. is to maintain the strength and responsiveness necessary to meeting the growing U.S. and worldwide needs for food and other agricultural products, a major change will be needed in the trend of public expenditures in U.S. agricultural research.

Questions that need to be addressed are: What should be the extent of public investment in U.S. food and agricultural research? From what sources should the funding of publicly supported research come? How should food and agricultural research dollars funded by the federal government be distributed? In other words, how should the federal government divide funds among the participants—USDA, SAES, and non-land-grant universities—as well as give incentives to the private sector?

ROLES OF THE RESEARCH PARTICIPANTS

Most agricultural administrators—whether SAES, USDA, or other—recognize that there is no unanimity as to how best to manage and carry out U.S. food and agricultural research and what the appropriate roles of the various actors for an effective and efficient research system should be.

Federal formula funds allocated to the states are to be used primarily to supplement state programs designed to solve problems related to state and local needs. Directors of SAES are accountable for these funds. Most of these programs contribute to the solution of problems of regional and national importance, but they do not necessarily have regional or national problem solutions as their primary objectives. On that point there are disagreements at the research administrative level.

Federal funds are allocated to USDA primarily for problems of regional or national importance, where the nature and magnitude of the problem is such that (a) a single state cannot provide the resources for its solutions; (b) there is some regional or national concern for the problems, or (c) the risk is too high from an industrial standpoint, or too demanding for any one industrial component. USDA also has responsibility for servicing the research needs of its action agencies. USDA is accountable to both the executive and legislative branches of government for the administration and national coordination of such programs.

In an effort to strengthen the role of USDA and more effectively coordinate its activities, the 95th Congress, in enacting the Food and Agriculture Act of 1977, designated USDA as the principal agency of the federal government for agricultural research. The Act also directed the Secretary of Agriculture to coordinate all agricultural research, extension, and teaching activities conducted or financed by federal funds.

Although the state agricultural experiment stations were originally established as distinct and separate institutions to serve farmers and the agricultural sector of their states, their role has been modified by a number of factors and actions in the past twenty years.

The Research and Marketing Act of 1946 increased federal funds to the states on a formula basis and made provision for regional research by SAES with federal grants. In 1965, the Special Research Grants Act authorized grants to the state experiment stations and to individuals to perform research on problems of concern to USDA.

Over the years, as the purchasing power of both Hatch and state funds declined, scientists and administrators sought new funding sources. To a certain degree, the Congress furthered this trend by appropriating funds for special grants and competitive grants. These grants were justified on the basis that certain high priority areas of food and agricultural research were not receiving the research excellence they deserved.

Proponents of formula funding saw the introduction of competitive grants, which were open to all universities and research institutions, as a force eroding the clout of land-grant universities and their agricultural experiment stations. Others reasoned that excellence in food and agricultural research might very well exist in institutions other than those in the land-grant system. As indicated, in the early years, the state agricultural experiment stations were concerned almost totally with state and local research problems. However, as they grew and additional acts were
U.S. Food and Agricultural Research . . .

passed by Congress providing wider use of funds, their research has broadened to include regional, national, and international activities.

Meanwhile, USDA has developed a wide range of research laboratories, stations, and activities that include not only national, regional, and international activities but also an increasing involvement in strictly local problems.

This broad base of agricultural and natural resource problems has led some, including Congress, to question the degree of planning and coordination of research that exists, especially at the top levels of administration.

Many comment that the problem is a result of the continuing tight budget and that all problems would be solved if only there were enough money. While the problem is undoubtedly exacerbated by a continuing tight budget, this is only superficial answer. The facts are that at the administrative level there is, in a general sense, no agreement on the roles of SARES and USDA, and until there is some understanding and agreement of the roles of these two primary public actors in U.S. food and agricultural research, there can be no effective agreement on overall cooperation in the very important aspects of U.S. agricultural research.

To an outsider of the system, it does not appear that this should be a difficult task if the actors can realistically evaluate their roles, strengths, and responsibilities in an atmosphere free of bureaucratic consideration.

At least ten federal agencies other than USDA—such as NIH, the Tennessee Valley Authority, the Environmental Protection Agency, the Department of Defense, etc.—conduct or fund some kinds of food and agricultural research. To better coordinate the research activity of USDA and these other federal agencies, Congress recently created the Committee on Food and Renewable Resources. This committee, chaired by USDA, is a potentially useful forum for information exchange, but it has yet to satisfactorily fulfill its role. In fact, it has yet to determine the type of research and the amount of funds spent by each of these agencies on food and agricultural research.

Among the non-land-grant universities, about three dozen private universities such as Harvard and Stanford account for 60% of total federal research expenditures in universities. The chief barrier to performing more agricultural research in these universities is that status and reward within science disciplines put strong pressure on the performance of basic research rather than applied or mission-oriented research.

Generally, there has been little coordination among the land-grant universities, USDA, and the non-land-grant state universities. The primary deterrent to cooperation has been lack of a format for exchanging information. This situation did improve somewhat with the passage of the Food and Agriculture Act of 1977. But most of the non-land-grant universities have no federal or state charter for research, thus making financing difficult except through the competitive grant system.

Private industry contributes to the productivity and efficiency of American agriculture in a number of ways: (a) investment, improvement, and manufacturing of farm machines; (b) selection of crop plants and animals; (c) development and production of a wide range of agricultural chemicals such as insecticides, fungicides, and fertilizers; (d) processing, preservation, and production of both animal feed and human food; and (e) development and improvement of a wide variety of farm structures.

Although different segments of the food and agricultural industries perceive their roles differently, most of them are generally motivated by economic reasons. If management can foresee a profit from their research efforts, funds are set aside for the research program. In many cases, industry research results in payoffs not only for industry but also for both the food and agricultural sector and consumers.

In recent years, the Office of Management and Budget (OMB) has adopted a policy of determining which research areas should be performed primarily by industry. OMB has done this with the occurrence of USDA and with little or no discussion with industry itself. However, OMB judgments have little effect on the types of research industry undertakes. One result of this situation is that there are certain areas of research in which both agriculture and consumers are not being served as they should. The postharvest technology area is one example.

LEADERSHIP AND COOPERATION NEEDED

The need for some degree of relatedness in the various agricultural research undertakings is clear. The agricultural experiment station is perhaps unique among the tax-supported research institutions. They were established nearly 100 years ago when the prevailing mood was more individualistic than it has recently become. The states were more important then. Volunteerism and cooperation were in vogue—central direction and coordination were anathema. Experiment stations reflected their times.

The recent surge of tax-supported research in fields other than agriculture and in agencies other than experiment stations has led to problems: more central direction, more team activity, more concern about externalities, less emphasis on the criteria long used by the land-grant colleges—efficiency.

There is now an effort on the part of those who provide federal funds to bring the experiment stations and food and agricultural research generally into the modern setting, with more central direction, to have it conform to the current mood. Experiment stations, with their proud history, understand the need for this.

Some form of leadership is essential. Strong central direction and coercion are repugnant for a number of good reasons. A loose voluntary cooperative type of guidance is desirable. The accepted, though much scorned, word for this is coordination, and it must be exercised if the research community is to appear to the appropriations committees as something other than a group of bureaucratic self-seekers. USDA is central, it is directly involved in the acquisition and distribution of federal funds, and it comes closer to perceiving the broad public interest than does any other segment of the research system (Paarlberg, 1980). However, neither USDA nor any other federal agency should undertake to coordinate or supervise research done by the experiment station with state and privately supplied funds, which are about four times as great as the federal input.

There may have been a time when quarrels among the various sectors of agriculture could be indulged. This is not so at present, nor prospectively. This is not a time for division—but for cooperation. And it needs to be cooperation and coordination suited to the needs of today and tomorrow, not of yesterday. This is a time when the food and agricultural problems need to be identified, the research to attack those problems determined, the role of each research participant identified, and the organization of each participant provided to determine if it can effectively carry out its role. Only when will we be able to merit and obtain the resources to do the research that is needed.

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Based on a paper presented during the symposium, "Innovation in Food Science Research," presented in cooperation with the Grocery Manufacturers of America, Inc. at the 21st Annual Meeting of the Institute of Food Technologists, Atlanta, Ga., June 7-9, 1981.

The views expressed are those of the author and not necessarily those of the Office of Technology Assessment.
NATIONAL AND MULTINATIONAL OPPORTUNITIES FOR THE ENCOURAGEMENT OF INNOVATION

MONTE C. THRODAHL

INNOVATION does not need encouragement, it needs responsiveness—responsiveness from government and from management. National opportunities for innovation can be divided about equally between government and private sector management. The lack of responsiveness in both have a great deal to do with the United States’ innovation dilemma.

Responsiveness from government can take the form of removing unrealistic obstacles to allow the market system to work more freely. There is no shortage of ideas that begin the flow of innovation, but without substantial relief from a number of unrealistic obstacles, U.S. innovation will be at a serious disadvantage in the world scene.

There are equally important obstacles which private sector management must remove. These may be even more critical when the worldwide food processing industry is considered.

SOME GOVERNMENT APPROACHES

The U.S. Department of Commerce’s 1978 Domestic Policy Review Study of U.S. Innovation was an excellent concept—imaginatively handled by seven knowledgeable groups from the private sector who produced some excellent recommendations, but quietly buried by the last Administration. Many of these recommendations were proposed to the new Administration for reconsideration, and examination of some of them will help get a perspective on the removal of obstacles to innovation.

The recommendations, in order of priority, were as follows:

1. Reduce Adverse Impact of Regulation on Innovation without Sacrifice of Social Objectives:
   • Limit regulations to standards of performance. Do not dictate the processes used by industry to achieve standards.
   • Issue a long-range statement of regulatory intent from each regulatory agency. This could serve as a guideline for both agency and regulated.
   • Establish a federal government-wide regulatory budget, subject to review by the Executive Branch and by Congress. The budget would set overall limits to the economic impact resulting from government regulation.
   • Separate the functions and powers in the regulatory system: Separate standard-setting from enforcement; provide appeal mechanisms outside the agency; and set up special courts with the expertise to understand the issues.
   • Provide a Specialized Appellate Court for patent cases. Develop an effective computer-based search and retrieval system for the Patent Office’s own use and to provide improved search service to users.
   • Develop appropriate classification and indexing schemes. These would provide an umbrella under which to integrate the systems for the various technologies.

2. Provide Greater Direct Economic Incentive for Innovation:
   • Allow immediate write-off of all research and development expenditures, properly defined, including those for facilities and equipment.
   • Permit R&D expenditures incurred in the U.S. to be allocated solely to the U.S. income of the taxpayer.

3. Reduce the Worldwide Competitive Handicap of U.S. Firms:
   • Weigh the generally pro-competitive short-range domestic effects of now permitting large foreign firms with minor U.S. market share to acquire U.S. firms against long-range competitiveness of the surviving U.S. firms in both U.S. and international markets.
   • Increase the foreign market position of the foreign acquiror.

SOME PRIVATE SECTOR APPROACHES

The point was made earlier that ideas that begin the innovation process abound. But innovation is not for everyone—it is fragile, and the mortality of innovative projects is great. Frankly, most managers are impatient with many innovation features and with innovators themselves. Let’s see why.

There are four rules in innovative efforts that are useful to understand and that we interpret properly. We have learned that when we forget or ignore these rules, we are...
usually disappointed. They are as follows:

1. There is a threshold level of technical effort necessary to remain consistently competitive in a market. A different, higher level is required to capture and hold market leadership.

2. Time and timing require rare management judgment. Time is usually longer than expected, and timing is right over a very small period.

3. Predictability is complex in the area of technology and is a factor from which management cannot escape.

4. Uncertainty accompanies innovation by definition. It is an element of the process with which management must learn to cope.

The following are some approaches for improving the corporate climate for innovation:

- Rethink the Corporate Future. For managers who are convinced that their corporation's future is stable and secure, it seems a luxury to spend resources for institutionalizing growth and change. But for managers who do not see their corporation's future as a simple extension of the past, it seems appropriate to reexamine what already exists in explicit form and commit themselves to rethinking the alternatives of the corporation they could become.

- Bring Innovation into the Fold. From among alternatives, find an approach to technical innovation which is right. Whatever the new form of organization so shaped, it might have these attributes: It places senior management in direct communication on direction and appraisal; it is large enough to have a critical mass of effort and talent; and its structure can vary with business objectives, either division or corporate.

- Assign New Relationships Among Organizations Devoted to Change. Rethink organization relationships among line executives and the units called upon to provide alternatives (with strategy) for senior management choices. Some of these actions could be: to provide at the corporate level a means to accomplish coordination, direction, and evaluation across the corporation; establish for Commercial Development a conscience role; and reestablish a new internal rapprochement among R&D, Marketing, Finance, and Commercial Development.

- Go Beyond Tradition. With senior management participating, the strategy process (at least on an intermittent basis) must show imagination, particularly in the refurbishing of old industries and old ways of serving markets. Some of these actions could be: handling the "future" with the aid of more sophisticated forecasting tools; dealing with or bridging gaps heretofore thought to be alien—e.g., universities, the Soviets, governments.

**SOME MULTINATIONAL CORPORATION APPROACHES**

Philosophically, management of a multinational corporation believes that the multinational corporation is capable of being an agent of change in both industrial and developing countries, even in the face of forces immiscible to the corporation.

During the next decade and so, conflict of interest among multinational corporations and the numerous national interests will continue and will probably become worse. Key factors in this conflict are: (a) mobility of raw materials and products across borders; and (b) mobility of capital and technology transfer, especially where there is a large disparity of technology and capital from the national unit to another. Obviously, both of these factors can lead to national government concerns about valuable natural resources, jobs, and job dislocation. And in this sense, the multinational corporation becomes involved as an instrument of the political economy.

It seems realistic to believe that those who make policy—in both the hundred or so national states of the world and the several hundred multinational corporations—can think of the world simply as a marketplace for those who sell and those who buy. Students of this concept refer to the world as a power situation. They consider the multinationals as immense devices for overcoming hurdles of this system of national states.

It is fairly easy to consider how business organizations can operate without conflict totally within boundaries of a national state. But it is difficult to envision how national economies—even the most effective and richest—could carry out world production and distribution via some sort of state-owned economic organization.

There is no historical precedent to guide such a thought. In fact, the contrary view was expressed in the early experience of trading companies. Certainly, the largest collectivist enterprise, the USSR, cannot provide for its own needs from entirely national resources, let alone supply others outside its national boundaries.

The following are some examples of issues that require rethinking by the multinational management:

- The reductionist economics and politics of the old mercantilism are not valid, but something more than simple market growth is also required.

- The concept of choice in the markets of the world has been established; but we are limited by our inability to find the signs of directions of the future. The uncertainties, the long lead times for patient commitment to business development, and the capital exposure require that somehow we learn how to read the signs.

- We are less sanguine than in earlier times about what attracts and motivates people. Perinatal practices of early and some present multinational won't make effective continuation of these organizations.

- Governmental relationships, laden with unpleasant past experiences, are fraught with suspicion and hostility to a point where comparison with non-U.S. government cooperative attitudes contrasts sharply with the U.S. government's adversary role.

- Attitudes toward "foreign" trade are changing too slowly in the U.S. For example, non-U.S. "home" markets are small compared to the rest of the world; therefore, "foreign" is natural. Also, U.S. "home" markets have generally exceeded those of the rest of the world combined. Therefore, "foreign" takes second class in terms of treating customers.

**MULTINATIONALS PLAY IMPORTANT ROLE**

Multinationals perform a unique role in our society. They are into being via the genius of self-interest serving needs by bringing together resources in a unique way that no other societal organization has achieved. Just as the multinational was one of the prime movers in the economic recovery of Europe and the unity of the European Economic Community, so I think it will be the unifier for easing the tensions of the East-West situation. Multinationals in search of developing new business with the USSR and China will have more to do with continuing political deserts than any other single force.

Technical innovation will help the continuing growth of U.S. multinationals abroad, but the predominantly one-way street will be reversed. It is already happening.

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U.S. SEAFOOD INDUSTRY’S
BIG OPPORTUNITY —
QUALITY ASSURANCE

Louis J. Ronsivalle is laboratory director for National
Marine Fisheries Service, Northeast Fisheries Center,
Gloucester Laboratory, Emerson Avenue, Gloucester,
Massachusetts.

INTRODUCTION

I have been told by a clever and successful professor that:

*It is good to be blessed with opportunities that
lead to success, but it is better to create oppor-
tunities and be prepared to take full advantage
of them when they materialize.*

Fish fillets, like meats and poultry, are perishable
commodities that lose their eating quality relatively
quickly. The rate at which fish fillets spoil depends
on the temperature of the environment to which they are
exposed. Fresh-caught fish that are iced immediately
and held in ice thereafter will remain of high quality
(U.S. Grade A) for 8 to 9 days and of edible quality for
about two weeks. Held at room temperature on a hot
day, the freshest fish will become inedible within
the span of one day. At the other extreme, if fish are
properly packaged and brought to a temperature of
-20°F and held at that temperature or below, they will remain
their high quality for more than one year and will remain
inedible for much longer. Thus, 100 percent of the eating
quality of fish will be used up in two weeks, only one
day, or more than one year, depending on the product
temperature.

Currently, in the U.S., fish are not held at a constant
temperature throughout their distribution. Instead, they
may be held at one temperature on the vessel, at another
temperature in the processing plant, and yet at another
temperature in the retail outlet. So, as fish proceed
through the distribution chain, they are constantly losing
quality, quickly or slowly, depending on their temperature;
and once the good quality is completely lost, the fish will soon become objectionable and, for all
practical purposes, inedible.

The quality of fish is officially defined by the grade
standards that are promulgated by the U.S. Department
of Commerce Inspection Service. The official standards
for grades of quality of fish fillets are divided into three
categories: U.S. Grades “A,” “B,” and “C,” and there
is a “Substandard Grade” that may be wholesome and
of acceptable quality but does not meet physical specif-
ications (e.g., presence of bones, workmanship, etc.).
Details regarding grading criteria are found in the Offi-
cial Grade Standard paragraph 203.104 (U.S. Depart-
ment of Commerce, 1979). While we know that the
quality of fish passes through grades A, B, C and event-
ually to spoilage within 2 weeks at 32°F and that fish
fillets remain at U.S. Grade A level for 8-9 days, we do
not know when fish go from Grade B to Grade C or
when they go from Grade C to below that quality level.
However, the known facts suggest that these unknown
times would be relatively short. For this reason and as
an added insurance to assure quality at point of con-
sumption, we are recommending that the intent is to
have seafoods reach consumers while they still have a
reserve of U.S. Grade A quality.

It is the purpose of this paper to outline the handling
procedures that will deliver to the consumer U.S. Grade
A fish fillets and will generate a general attitude that
recognizes the value of U.S. Grade “A” quality, the
dietary and economic values of seafoods, and the
economic value of eliminating spoilage and waste. This
should lead to an improved image for the U.S. seafood
industry, and an increased demand for U.S. produced
seafoods.

RATIONALE FOR THE RECOMMENDED
PROCEDURE

Figure 1 shows the sequence and the basic elements of
the distribution chain that take fish from the sea to the
point of their consumption as food. The product to be
told as fresh should be held at 32°F or less (but not so
cold as to freeze it). The only element where the temper-
ature can be allowed to rise and then only up to 40°F is
at the processing plant where lower temperatures would
be intolerable to employees. The figure shows that the
fresh product does not go to a warehouse. This is
because the total shelf life of fresh fish fillets is so short
that there is no time for warehouse storage. Table 1 pro-
vides insight to the limits of shelf life, and Tables 2 and
3 summarize the maximum temperatures at which either
fresh or frozen products can be held at each of the elements of distribution.

Table 1 shows the potential economic penalty for being lax about temperature control. From Table 1, we can see that the time during which fish fillets at 32°F remain at U.S. Grade A (eight-nine days) is 60 percent of the total shelf life. This means that limits have to be placed on the times that the fish can be held at each of the distribution elements.

Table 2 shows the recommended maximum times that fish or fish fillets can be held at each distribution element when the temperature of the product is controlled to hold at 32°F. These data lead us to conclude that fish which are more than seven days out of water have no place at all in a guaranteed Grade A quality program and that only the catch from boats which fish for up to two days and the top of the catch from boats that fish for longer periods should be considered for the fresh market. The times in Table 2 may, to some, appear impractical or unacceptable; and in some situations, this may well be the case for one or more of the elements. However, because of the time limitation which is unacceptable, for every time increase allowed in any distribution element, there must be an equal time decrease in the rest of the system. The only element in Table 2 from which time can be subtracted is the retail outlet, but this is the only one of all the elements which cannot fix the time that it requires to carry out its responsibility — to sell the product, and it is the element that will suffer the economic loss if it cannot sell the product.

Table 3 shows the maximum times that fish or fish fillets can be held at each distribution element when the temperature of the product is controlled to hold at 0°F. There should be no problem with the holding times shown in the table. By lowering the product temperature, the times can be extended. The only element that may be controversial is the vessel. Despite the opinions of some who contend that fish can be held for ten days or more in ice before putting it into the distribution chain, it is just not so. Fish older than seven days in ice will probably not be at U.S. Grade "A" at point of consumption, except under unusual circumstances. This does not mean that vessels should not make trips that are longer than seven days or that fish older than seven days are of no value. It only means that fish older than seven days in ice should not be scheduled for a distribution system which is expected to deliver to the consumer either fresh or frozen fish fillets of U.S. Grade "A" quality. In the following section that describes the vessel's role in more detail, recommendations are made for fish that are eight days or older.

Vessel

Theoretically, the optimum method of handling fish is to freeze them immediately after catching. By freezing at sea and holding at sufficiently cold temperatures (no
higher than 0°F), the fish will remain at high quality for months. Freezing to and holding at even lower temperatures (e.g., -20°F), the product quality will remain high for more than 1 year.

Since most of the vessels that are engaged in harvesting groundfish off the U.S. coasts do not freeze the catch, this section will deal only with handling at 32°F.

Regardless of the method of catching, the important thing is that the fish be brought to the temperature of melting ice as soon after death as possible. Thus, it can be seen that fish trapped in a gill net that is left in the water for a long period may undergo considerable quality degradation before they are brought on board the vessel, whereas fish that are trapped or hooked may be alive and of prime quality when hauled on board. Fish caught by long-line or traps have better keeping quality than fish caught by trawling. In the latter process, the fish are dragged along the ocean bottom and, in addition, they are subjected to considerable pressure when the net is hauled out of the water. This not only damages the texture but also may force some of the intestinal contents out of the fish, thus contaminating the surfaces of surrounding fish. As soon as possible after catching, the temperature of the fish is usually lowered by icing the fish in the hold. However, if this is improperly done, for example, not enough ice, or if the fish are allowed to be pressed against the pen boards without an intervening layer of ice, the quality of the fish may deteriorate and the fish may even develop a bilgy flavor and odor. Also, if the fish are piled too high, excessive pressure on the bottom fish damages them. This can be prevented by stowing the fish iced in boxes or in refrigerated seawater. The latter offers the additional advantages of rapid heat removal and lowering of the temperature of the fish very close to its freezing temperature, resulting in an increase in storage life. The use of boxes and proper icing is highly recommended. Also, the boxes should carry the date when they are filled.

The fish should be eviscerated since the stomach contents may contain feed with high proteolytic activity which can rapidly digest the belly area.

<table>
<thead>
<tr>
<th>TEMPERATURE (°F)</th>
<th>SHELF LIFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>1 day</td>
</tr>
<tr>
<td>60</td>
<td>2.5 days</td>
</tr>
<tr>
<td>42</td>
<td>6 days</td>
</tr>
<tr>
<td>32</td>
<td>2 weeks</td>
</tr>
<tr>
<td>29</td>
<td>3.4 weeks</td>
</tr>
<tr>
<td>10</td>
<td>~2 months</td>
</tr>
<tr>
<td>0</td>
<td>~1 year</td>
</tr>
<tr>
<td>-10</td>
<td>~2 years</td>
</tr>
<tr>
<td>-20</td>
<td>&gt;2 years</td>
</tr>
<tr>
<td>-40</td>
<td>indefinitely</td>
</tr>
</tbody>
</table>

It should be noted that the periods during which the fresh products remain at the U.S. Grade A level are shorter by about 40 percent than the shelf life times shown.

Fig. 1
The Sequence of the Basic Elements of Distribution That Take Fish from the Sea to the Table.
For short term storage, the use of refrigerated seawater (RSW) and chilled seawater (CSW) systems are among the best that can be used because of the rapidity with which they can cool fish and the thorough temperature control that is possible. Because of the buoyancy effect of such systems, fish are not pressure damaged and they are easier to unload, especially by a pump.

Until recent years, the pitchfork was extensively used for transferring fish from the pen to unloading systems and sometimes within the processing plant to unload fish from boxes. This was a poor practice which bruised and contaminated the muscle. Where it is still used, evidence is seen in the blood spots and discolorations of the muscle.

Vessels which have no facilities to maintain the temperature of the catch at less than 32 °F should not stay out for longer than seven days at sea unless there is a specific plan to handle that catch portion that will be more than seven days old when landed in some other way.

There may be a specific buyer who has the facilities to handle the fish quickly, e.g., a shoreside restaurant that has a high demand and quick turnover for seafood entrées and that employs personnel who are expert in seafood quality and are reliable enough to pull out inferior quality products.

Another alternative for vessels that plan to fish for more than seven days is to handle the first part of the catch so as to preserve its quality. One possibility is to freeze the first part of the catch. This can be accomplished by installing a small freezer on board the vessel. The second possibility is to salt the first part of the catch at sea. Either of these alternatives is more economical and more practical to do than to put the first part of the catch into the normal fillet distribution chain as is done now. Another alternative is to consider a technique that has been proposed in the past for the U.S. fleet and is already practiced by the Japanese and possibly others — the use of fast transport vessels that take fish from fishing vessels before the fish become too "old" to safely put into the distribution system.

Fishermen must constantly remember that it is not enough to bring in fish that is of high quality when landed, because that is not where the quality judgment is made by the consumer. Landed fish must have a reserve of high quality to last to the point of consumption.

Processor

The processor should not maintain the processing room temperature higher than 40 °F. The product should be handled quickly, and there should be no delays whatever in the plant. The plant should be operated under good manufacturing practices. The refrigerated holding room should be at 29 °F but not higher than 32 °F, and the freezer holding room should be at as low a temperature as is possible but not higher than 0 °F.

The product should be prepackaged at the processing plant. This would insure that the product could not, subsequently, be exposed to pathogenic microorganisms (as can readily occur when handled under uncontrolled conditions). At the processor level, U.S. Grade "A" fresh fillets could be transferred to the freezer just before their quality fell to below U.S. Grade "A." In this way, none of the fillets would be lost to spoilage.

Relevant to the merchandising of U.S. Grade "A" fillets is the current concept that fresh ones are of high quality and command a better price than frozen ones. Because of this concept, anyone who processes or otherwise handles fillets anywhere in the distribution is compelled, for economic reasons, to sell his inventory as fresh if he can. Also, because of this, fillets produced in the U.S. are only handled as frozen when their quality is such that they could not be sold in the fresh market. Thus, the concept that fresh is better than frozen is propagated. There is a need to demonstrate the higher value of frozen fillets over fresh fillets; because, ultimately, the best quality fillets and the best overall economic benefits will come from freezing the highest quality fish and fish fillets.

Processors must constantly remember that it is not enough to produce seafood products that are of high quality, because that is not where the quality judgment is made by the consumer. Products must have a reserve of high quality to last to the point of consumption.

Warehouse

There is little likelihood that any product quality will be lost at the freezer warehouse as long as temperature control and product rotation are maintained and there are no delays in loading and unloading at the warehouse dock. The product temperature should never exceed 0 °F, but it should be obvious that lower temperatures provide a better protection of product quality. Temperature fluctuation should be minimized.

There is no provision for storing fresh fillets in warehouses, because of the limited time that they have as U.S. Grade "A" product.

Retail Outlet

Fillets received at the retailer's unloading platform
should be transferred immediately to the holding rooms. This step should not wait because of a lunch break, coffee break, or any other reason for not moving the product.

The temperatures of the holding rooms should be strictly controlled. The freezer room should maintain as cold a temperature as possible but, under no circumstances, should it be higher than 0°F. The refrigerator room should maintain a temperature of about 29°F but, under no circumstances, should it be higher than 32°F.

Since fresh fillets have only a limited time that they can be held at the retail outlet (under favorable circumstances, about five days), it can be seen that for every day that they spend in the holding room, it will be one day less that they can be displayed, and those that are not displayed cannot be sold. Seafoods generally provide a retailer with a relatively high return. Therefore, the retailer should devote the time that is required to see that the display cases are held at the proper temperature; the display cases are not overloaded (so that the product temperature can be maintained); that the fillets are rotated; and, especially, that fillets which are at lower than U.S. Grade “A” quality be removed and disregarded — discarded, not frozen for subsequent display in a freezer case or sold at a lower price. Either of these latter practices simply propagates the relatively low image of seafood quality and provides no economic advantage for the long term. The only real alternatives are either to discard products of mediocre quality or to freeze or sell products at a discount price but only while they are still at U.S. Grade “A” quality. In this way, none of the product will be allowed to spoil, and customers will be unable to purchase seafoods of poor quality.

The transfer of fresh seafoods to a freezer or to the freezer display case should be done no later than one day before the end of the Grade “A” quality. Assuming that the packaging material is suitable, only the pull date and any reference to fresh need be changed. Even if the freezing process is slow, by starting it one day early, spoilage reactions will be slowed and finally come to a virtual halt soon enough so that the product will retain its U.S. Grade “A” quality.

In addition to the responsibilities described above, retailers can impart information to the consumer regarding methods of preparation, dietary facts, facts on preservation of quality, etc.

Retailers must remember that when they receive seafood products of high quality, that of itself does not insure that the product will be of high quality when the consumer eventually eats it — and that is where and when the quality of the product is eventually judged.

While the consumer has a role in assuring high quality (e.g., proper care of the product in the home and proper preparation procedures), this part of the handling is beyond the scope of this paper.

NECESSITY FOR MONITORING

Of all the fresh and frozen flesh foods available to the U.S. consumer, only seafoods are not produced under mandatory inspection; and of all fresh and frozen flesh foods available to the U.S. consumer, only fish have a high degree of unreliable and inconsistent quality. It is the human tendency to wander from committed and/or expected performance unless there is some sort of mechanism to monitor performance. The handling procedure recommended in this paper has considerable potential, but it is unlikely that the full potential will be realized or that whatever level of success is reached can be sustained unless a provision for monitoring the procedure is included. Nothing is more disappointing to all concerned than a commitment which is not met consistently. The image of the U.S. Department of Commerce Inspection Service, the image of the company that produces U.S. Grade “A” fillets, and the image of the logo which identifies the U.S. Grade “A” product will all suffer unless consumers find the products to be consistently of U.S. Grade “A” quality. Thus, the seafood industry must find a way to monitor the seafood handling chain, even if it requires the establishment of a private organization that can offer monitoring services for a fee on a voluntary basis.

NOTE: This procedure is not to be construed as official National Marine Fisheries Service policy.

INDUSTRY INNIATIONS AND NEWS

Continued from page 15

ACQUIRED ASSETS

Clear Springs Trout Company, Buhl, Idaho, recently acquired the assets of Thousand Springs Trout Farms Inc., a wholly owned subsidiary of Inmont Corporation, of Clifton, New Jersey.

Larry W. Cope, executive vice president of Clear Springs, said, “The acquisition is an indication of our continued commitment to the further development of the trout industry. We intend to maintain continuity of service to Thousand Springs customers in all parts of the United States and abroad. Products will continue to be marketed under the Thousand Springs name.

Founded in 1966, Clear Springs is an Idaho investor-owned corporation which produces, packs and markets frozen and fresh Idaho Rainbow trout products in the Clear Springs brand. In addition, the company also operates a fish food manufacturing plant and markets trout feeds throughout the western and midwestern United States.
ISSUE PAPER ON THE QUALITY OF U.S. PRODUCED
FISH AND FISHERY PRODUCTS

The Need for a National Seafood Quality Improvement Program

BACKGROUND

The National Marine Fisheries Service (NMFS) received a strong mandate under the MFCMA and the AFPA to promote the development of U.S. Fisheries and assist in displacing foreign fishing effort in the FCZ with domestic effort. Approximately 20 percent of the world supply of marine resources available for harvesting for food use is within the FCZ. The successful (a) displacement of foreign fishery effort with domestic effort and (b) converting the available marine resources into products suitable and acceptable to consumers in the international and domestic markets depends heavily upon the efficient and consistent production and marketing of high-quality seafoods.

The U.S. industry has not paid adequate attention to the quality of U.S. produced seafoods during the past 15 years for a variety of reasons, including the following.

- Imports comprise 60 - 70 percent of U.S. seafood consumption.
- Responsibilities for quality control of products were assigned to the major producing countries exporting fishery products to the United States through purchase instruments and contracts.
- There are few economic incentives to adopt new technologies, handling practices, and quality control of fish in the harvesting, transportation, storage, and processing sectors.

- Few efforts have been made to adopt and install adequate refrigeration equipment and address fresh and frozen seafood product abuse during distribution and at food outlets.

Similarly, the quality of U.S. produced seafoods has received minimal attention by the Federal Government during the past fifteen years, as evidenced by the following:

- Congress has considered but not passed adequate legislation for controlling the quality of seafoods.

- No objective studies have been conducted to determine the level of quality of U.S. produced seafoods, or consumer interest in the quality level of available seafoods.

- No minimum standards of quality for seafoods have been developed and established by the Federal and/or State Governments.

- Few regulatory or advisory codes for transport and marketing of fresh and frozen seafoods have been established and implemented.
A model frozen food ordinance has been adopted by a few states but not by the Federal Government.

The NMFS has taken some steps toward quality improvement by expanding the inspection program, participating in the development of international standards, revamping domestic quality standards and conducting a guaranteed quality program for fresh fish. However, NMFS has not assumed a leadership and coordination role, and in conjunction with industry sought voluntary solutions to the existing problems of seafood quality.

NEED TO IMPROVE QUALITY--DOCUMENTATION OF QUALITY PROBLEMS

As interest in expanding U.S. production of seafoods was renewed as a result of enactment of the MFCCMA, questions about the acceptability and suitability of U.S. produced seafoods on the world market began to arise. Very limited studies have been conducted to assess and document the relative acceptability of U.S. produced seafoods with other major competing seafood producing countries. However, one study was conducted on The Market in Western Europe for Dogfish, Squid, Skate, Monkfish, and Whiting.

The results of the study, funded by NMFS and published in January 1975, contained some extremely detailed conclusions about the reputation for poor quality of these U.S. produced products in Western Europe. Another conclusion revealed the marked preference for frozen-at-sea products in Western Europe and particularly Italy, where this practice (freezing-at-sea) is equated to good quality and the quality of the fish is discounted when it is not frozen at sea.
The report contained several recommendations which referred to methods for assessing and establishing quality requirements using as a reference, competitive products on the market. It also recommended that exporters familiarize themselves with the quality of competitive products. Appendix I provides the conclusions and recommendations of the study. Although this study was limited to select species and markets, the recommendations appear to be suitable, with modifications, to be used as guidelines for addressing broader questions of quality improvement.

In October 1980, the General Accounting Office (GAO) completed a study and provided the Secretary of Commerce with a letter report on the Need to Assess the Quality of U.S. Produced Seafood for Domestic and Foreign Consumption. (Appendix II) That report concluded that there is a need for a comprehensive, objective assessment of the quality of seafood produced by U.S. processors for domestic and foreign consumption, and recommended that NOAA be directed to initiate such a study. The NMFS agreed with the conclusions of the letter report that such a study is needed in order to establish a reliable information base relative to the nature and extent of the quality problems and to indicate what may be the priorities for future corrective action.

More recently, in June 1981, the GAO provided the Secretary of Commerce with a second letter report, the subject of which was Follow-up On The National Marine Fisheries Service's Efforts to Assess the Quality of Produced Seafood.

The follow-up letter report reiterated the recommendation in the October 1980 letter report for a comprehensive survey to assess
seafood quality, and contained two additional conclusions and recommendations as follows:

- (a) NMFS inspectors should be trained in the technical and quality requirements of seafoods established by importing countries.

- (b) A feasibility study should be conducted to investigate dockside grading of landed fish.

Copies of the June 22, 1981, GAO Letter Report and the NMFS response agreeing with the GAO conclusions and recommendations are provided (Appendix III).

In the spring of 1981, the food Marketing Institute (FMI) conducted a qualitative consumer research study to provide insight into consumer attitudes on the selection, preparation and handling of seafood and seafood products. The report entitled Consumer Attitudes Toward Seafood published in September 1981, contains a wide variety of consumer views on the poor quality image of seafoods in the domestic market place, and particularly the perception of a lack of quality in frozen fish products. The image of seafood overall and recommendations contained in the FMI Report are provided in Appendix IV.

In addition to the aforementioned studies, the poor and variable quality of seafoods and impact on trade and consumption of specific seafoods has been the topic of numerous articles, correspondence, complaints, and speeches. Starting about 1975,
an increasing body of information and data have been collected which clearly documents the existence of serious quality problems associated with U.S. production and marketing of seafoods. The body of information:

- applies to a wide variety of traditional and underutilized species.
- applies to fresh, frozen, and canned products.
- applies to products marketed domestically and internationally.

Appendix V provides some examples of the types and kinds of products and/or situations in which quality has been identified as an impediment to the sale.

In conclusion, the aforementioned studies and other documents demonstrate that there are a number of very real and entrenched quality problems with U.S. produced seafoods. Consequently, the "image" of U.S. produced seafoods continues to worsen. Unless this situation is reversed in a timely manner by major improvements, the U.S. seafood industry could find its products non-competitive in the domestic and international markets.

ADVOCATES FOR IMPROVING THE QUALITY OF SEAFOODS

Since enactment of the MFCMA in 1976, two studies were conducted to assess the need for a stronger fishing industry and to set goals and recommendations for the future. These two studies (a) A Marine Fisheries Program for the Nation, published in July 1976, and
(b) *Eastland Fisheries Survey*, published in May 1977, both drew attention to the need for improving the quality of U.S. produced seafood.

The *Marine Fisheries Program for the Nation* recommended, among other things, the development of "simple, practical, and enforceable quality standards for fishery products at the vessel, processing, and retail levels." *(Appendix VI)*.

The *Eastland Fisheries Survey* recommended the establishment of (a) standards both for domestic and imported fish products, and (b) good codes of practice, specified quality control, and mandatory inspection. *(Appendix VII)*.

**ECONOMIC BENEFITS OF HIGH QUALITY**

During 1974 - 1976, on the basis of some evidence and many implications that the quality of fresh seafoods available to U.S. consumers is generally poor, a NMFS/industry study was undertaken to determine the economic feasibility of assuring the quality of the product at the point of sale. The technology for achieving this goal was largely known but the economic feasibility was not. It was obvious that unless the economic feasibility could be shown, implementation of effective quality control programs by industry likely would not occur.

When the study was completed, it was demonstrated that it is economically feasible to assure the quality of fresh fillets to be U.S. Grade A at the point of sale, and that both industry and consumers are ready to accept quality control measures necessary to achieve this goal. Hard evidence of this demonstration is the
existence of an enterprise which has been established during the course of this study and continues to operate. By the early part of 1980, the enterprise had grown to an annual volume of about 11,000,000 pounds worth nearly $30,000,000 per year. The details of this study and related information are provided in Appendix VIII.

While similar studies have not been conducted on preserved products, particularly frozen seafoods, the fresh fish study strongly suggests that there is an opportunity to make an economic impact "orders of magnitude" greater than that which was achieved in the fresh fish trade. The reasons are simple. The proportion of frozen seafood in commerce is much greater than that of fresh fish. Here again, the technology for assuring the quality of frozen fish at point-of-sale is largely known. What is needed is a demonstration of the feasibility of assuring consistently high quality products and the economic benefits to scale.

GOVERNMENT INVOLVEMENT IN COMPETITIVE COUNTRIES

A review of the success of major fish producing countries in capturing and maintaining world markets for seafoods reveal several similarities in the manner in which the quality of seafoods is addressed. Some of the main characteristics that are evident follow:

1. Commitment to assured quality is a matter of Government policy and a leadership role is evident.

2. Quality control begins at the point-of-harvest and extends to point-of-sale.
3. Formal Government programs exist to assist industry through research and technical assistance to develop and implement effective and efficient quality control programs.

4. Governments with industry cooperation, have established technical product quality standards and grading systems that are used to achieve industry wide uniformity.

5. Governments have enacted legislation that eliminates certain types of quality problems by imposing certain mandatory inspection requirements on the domestic industry and products.

6. Established mandatory standards are applied to imports to assure that domestic markets are not inundated with poor-quality (cheap) products that compete with domestic production.

The principal countries that employ some or all of these activities include Norway, Iceland, Spain, Denmark, Japan, New Zealand, Australia, South Africa, and Canada. Several countries in South America, Uruguay, Argentina, Chile and Peru are in the process of upgrading their fish inspection and quality-control system in order to secure a larger portion of the world markets for seafoods.

Canada in particular has launched a major seafood quality improvement program entitled Quality Excellence for the 80's. Under this program and in cooperation with industry they are:
- Adopting and distributing international Codex codes of handling practices for handling, transport and preservation of catches.

- Introducing quality control programs for the fishing industry.

- Establishing quality grade standards for major commodities such as salmon, groundfish, crab meat, and yellow pike fillets.

- Establishing vessel certification requirements and requirements for the offloading, handling, and transportation of fresh fish for processing.

- Requiring inspection and certification of all exports.

RECOMMENDATIONS

1. Make assured quality of seafoods a matter of U.S. Government (DOC) policy and assume a leadership role in seafood quality improvement.

2. Develop a comprehensive U.S. cooperative quality improvement program in collaboration with industry associations and foundations and through them -
   (a) cooperate with industry to develop and implement quality control guidelines and codes of practice by major fisheries, for handling, storage and processing--vessel to package.
(b) investigate the feasibility and interest in vessel inspection and dockside grading of fish for quality, to provide economic incentives and to increase the dollar return to fisherman for higher quality landed fish.

3. Advocate, expand and otherwise advance the use of inspection and quality grading service for seafood exports, and educate U.S. inspectors about domestic and foreign country requirements for quality.

4. Conduct a comprehensive survey of the quality of selected U.S. produced seafoods as recommended by GAO.

5. Accelerate the development of new and updated quality standards to include new species and product forms.

6. Conduct quality research studies to assess the economic feasibility of supplying consistently high quality seafoods to domestic and foreign markets.

7. Initiate steps to help prevent the importation of substandard quality products.

8. Educate consumers about the improvement in the quality of U.S. produced seafoods.
APPROACH

A suggested approach for moving ahead with a national seafood quality improvement initiative is as follows:

1. Establish a working group to develop an overall plan for a quality improvement program which could be done in about three months.

2. Hold a workshop or other suitable forum to adopt an implementation plan consisting of:
   - Regional roles.
   - Center roles.
   - Other industry, foundation, trade association roles.

3. Develop a schedule of events and a list of specific tasks to be achieved with milestones.
15 SEP 1981

ISSUE PAPER
ON
UTILIZATION RESEARCH

Issue:

What is the role of NOAA/NMFS utilization research in addressing the technological needs of industry in the 1980's?

Background:

On a number of occasions, members of industry have expressed their concerns about the direction and type of technological research within the National Marine Fisheries Service (NMFS). They indicated an awareness of the need to conduct technology research related to seafood quality and safety, energy conservation, harvesting and processing efficiency, and other problems which could affect the competitive edge of U.S. seafood products. They stressed the important role which the NMFS Utilization Laboratories can and should play in this effort and expressed some concern as to whether or not there was adequate focus within NMFS to assure that the right amount and type of technologically-oriented R&D was being carried out at these institutions.

In view of the above concerns of industry, the present reductions in the S-K grant program and the continuing, tightening manpower situation, the need to reassess research priorities at our utilization laboratories is now more critical than ever. Our technological research must be directly targeted towards increasing efficiency and productivity in the harvesting and processing sectors, the quality and safety of seafood products, as well as towards other problems which affect the competitiveness of U.S. seafoods in domestic and foreign markets.

In his January 29th message, Secretary Baldrige stated his four priority

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objectives and the need to manage our resources and programs aggressively to meet them. Briefly, his four priorities are: (1) to promote the international competitiveness of American industry; (2) to foster greater productivity and innovation by American enterprise; (3) to increase the Department's ability to influence the Federal Government's economic policy making process and decisions in order to fulfill our responsibilities to American business; and (4) to reduce the burden of unnecessary or ineffective regulations on American industry. In his message, he further stated that "although these will be our top priorities, I do not intend to ignore the Department's many basic ongoing programs which support American business and industry. Our applied science and engineering programs, our oceanic and atmospheric services, and similar efforts will be supported to the extent that they contribute to our fundamental priorities." (emphasis added). The Secretary's statements are particularly appropriate with respect to our future utilization research needs.

The U.S. General Accounting Office (GAO), in its June 22, 1981, report to Secretary Baldrige, also provided useful guidance. They stated that they had "found that quality consideration, along with price, marketing techniques, and other factors, have limited U.S. exports; however, there is a lack of conclusive evidence to demonstrate the extent or degree that poor quality is impeding U.S. exports. A comprehensive evaluation...is needed to determine the extent of the quality problem and to ascertain how it is impeding the demand for seafood products." In response to the GAO recommendation that the Secretary of Commerce direct the Administrator of NOAA to initiate a comprehensive study to assess the quality of U.S. seafood produced for domestic and foreign consumption, funds were allocated to design and test a protocol for a comprehensive seafood quality assessment study, to be followed by directed technological assistance to eliminate the causes. NOAA/NMFS is prepared to allot the necessary S-K funds, if available, to carry out the full effort in
cooperation with industry.

We are presently being faced with a number of specific challenges in the seafood utilization area. These include, in addition to the above: (1) implementation of the American Fisheries Promotion Act; (2) the effect of current domestic and foreign regulations regarding the harvesting, processing and sale of fish as food; (3) quality barriers to the acceptance of U.S. exports; and (4) the problems of seafood labeling. We need to continue to address the recognized seafood safety problems which represent an impediment to full development and utilization. We should continue to address technological impediments to the development of key fisheries and their effects on general productivity. We need to identify better the types of technical assistance required by industry and the best means to provide it.

A number of actions have been taken to date to address the above concerns and needs. For example, with regard to the safety of U.S. seafoods, NMFS and the Food and Drug Administration (FDA) recently effected a Memorandum of Understanding (MOU) which recognizes the desirability and need for coordination of research on seafood problems of concern to both agencies. Through this MOU, an interagency scientific committee will be established to meet periodically to review ongoing research, identify newly recognized issues, and recommend coordinated/cooperative approaches, as appropriate, to their resolution. It is expected that the initial meeting of this committee will take place during October or November of this year.

In addition to the above, program reviews of utilization research have been conducted during this year at the the Northwest and Alaska Fisheries Center (Seattle), the Southeast Fisheries Center (Charleston), and the Northeast Fisheries Center (Gloucester). These reviews were very productive from a regional and individual laboratory standpoint and the comments and recommendations of the
review members (NMFS and industry) are being collated and summarized to provide the basis for setting priorities, identifying reprogramming opportunities, etc.

Need:

The issue of "what is the role of NOAA/NMFS utilization research in addressing the technological needs of industry in the 1980's?" needs to be considered from a national standpoint and in terms of three information-generation resources, i.e., (1) the NMFS base utilization program, (2) the Saltonstall-Kennedy (S-K) grant program for fisheries development, and (3) the NOAA Sea Grant Program.

Options:

The issue can be addressed through a number of mechanisms, including:

(1) the determination of the NOAA/NMFS role through in-house discussions only;
(2) its incorporation into the Management By Objectives (MBO) exercise on "Industry Assistance," and
(3) through a national workshop with industry and government participation.

The above options are not mutually exclusive; that is, it would be appropriate and possibly best to exercise each of these options. In any case, to best address the issue, industry must be directly involved. Our judgement is that the limited, regional industry involvement, although helpful in the short-term, does not suffice to address the issue from a long-term, national perspective. The longer term industry needs through the 1980's must be addressed, and this has not yet be done.

Given the current retrenchment needs, it would be timely, appropriate and consistent with the Secretary's policy to consult industry and others to provide
a basis for the new Assistant Administrator to redefine our utilization policy and role.

The MBO exercise, in itself, is not specific enough to address this issue since it covers a much broader spectrum of issues, and none to the depth and time frame required here.

Finally, of the three options identified above, only the national workshop approach provides the mechanism for all concerned parties (e.g., NCES Center, Regional, and Office Directors, as well as other interested Federal agencies and wide industry representatives) to convene together to address this issue.

Recommendation:

The issue is best addressed through a national workshop dedicated specifically to this subject. The workshop should be conducted during either October or November so that its outputs can be useful and timely to the MBO Task Force on Industry Assistance, to the Research Council during its meeting scheduled for January, and as a basis for the recommendation of a utilization research policy for concurrence by the new Assistant Administrator.
The Honorable Philip M. Klutznick  
The Secretary of Commerce  

Dear Mr. Secretary:

Subject: Need to Assess the Quality of U.S.-Produced Seafood for Domestic and Foreign Consumption  
(CED-81-20)

The General Accounting Office is studying the adequacy of current Federal efforts to improve the quality and safety of seafoods processed in the United States for domestic and foreign consumption. As part of that study, we are assessing the National Marine Fisheries Service (NMFS) program and efforts to improve the quality and safety of seafood harvested and processed in the United States.

During our study, we have become aware of the controversy that exists over whether the quality of U.S.-produced seafoods is or is not competitive for foreign trade or adequate for domestic consumption. While some seafood industry officials contend that U.S. seafood processors produce a high-quality product, NMFS officials believe that the variable quality of U.S. seafoods is contributing to the low volume of U.S. seafood exported and the low volume of seafood sales in the United States.

The statistics show that the U.S. trade deficit for all seafood products is approximately $2.8 billion. Also, the United States is importing 60 percent of the edible seafood consumed domestically even though an estimated 20 percent of the world's seafood is found within the 200 mile U.S. fishery conservation zone.

THE EXPORT MARKET

Problems of seafood quality are particularly apparent in exported U.S.-produced seafood. As early as 1975, NMFS sponsored a research report for the New England Fisheries Development Program. The report indicated that east coast
groundfish products have a reputation for poor quality in Western Europe. More recently, foreign buyers at a seafood exposition in Newport, Rhode Island, reported that the poor quality of U.S. products was a major obstacle to increasing U.S. exports.

As you are aware, several countries have complained about the quality of U.S. seafood products. Some of the more significant complaints include the following:

-- Japanese fishing interests reported that only 25 percent of U.S.-produced butterfish imported in 1978 could be marketed for human consumption.

-- Japanese buyers took a harder line in 1979 and rejected nearly 4 million pounds of frozen salmon because of poor quality.

-- A Canadian international trading company has complained to NMFS that it has incurred considerable losses while trying to market U.S.-produced skate, dogfish, squid, and herring in Europe and Japan because of the products' poor quality. This firm has recommended that its U.S. suppliers cease production of these products until the causes for the seafood's poor quality have been identified and corrected.

-- The European market for U.S.-produced eels has been threatened by a shipment to Denmark of eels infested with worms and marked by skin ulcerations believed to be caused by bacterial contamination.

THE DOMESTIC MARKET

The problems with our exports raise questions about the quality and safety of seafood Americans consume. Senate hearings on the Fishery Products Protection Act held in July 1967 disclosed that surveys by the Bureau of Commercial Fisheries, NMFS' predecessor, found the quality levels of seafoods in the domestic market to be very low, with large quantities receiving substandard grades. The Consumers Union, publisher of Consumer Reports, tested fishery products purchased at the retail level between 1961 and 1965 and found that 30 to 46 percent of the sampled products were substandard. The results of these tests indicated that the reasons these products were substandard included (1) the use of old or spoiled raw material, (2) poor processing techniques, (3) improper handling during transportation and storage, (4) excessive storage time, and (5) poor packaging.
During the past decade, consumer and certain industry publications have been critical of the quality of U.S. seafood products. Consumer Reports gave low quality ratings to many brands and varieties of U.S.-produced seafood, including frozen fish sticks (1970), frozen breaded shrimp (1972), frozen fish fillets (1973), frozen unbreaded shrimp (1974), and canned tuna (1974 and 1979). An article in the National Fishermen (1977) reported that those in the fishing industry and Government believe that much of the fish sold in chain stores is not edible. The article states that the poor quality is not because of the initial processor but because of retail handling of the product.

NMFS' Role

One of NMFS' goals is to ensure that the seafood offered the consumer is wholesome and meets consistent high standards of quality. Another NMFS goal is to enhance the development of the U.S. seafood industry and encourage expanded usage of that industry's products. The Administrator of the National Oceanic and Atmospheric Administration (NOAA) recently stated that the agency is making a big push to export more U.S. seafood. Recent trade missions to Europe and Asia by NMFS personnel appear to have relaxed some of the trade barriers imposed by Japan on U.S. seafood exports. However, these efforts will likely go unrewarded if the U.S. seafood processor is unable to deliver a quality product to the foreign buyer.

NMFS conducts an inspection program for seafood processors who want their products to carry a Federal inspection or grade label and for export certification. This program, however, is voluntary and is not used, at this time, by many in the seafood industry because they believe it provides few benefits and is too costly. In 1977, NMFS' Gloucester and National Seafood Quality and Inspection Laboratories jointly proposed to test and evaluate for quality a sampling of seafood produced by U.S. processors. We were informed by the Chief, Seafood Quality and Inspection Division, that the project would have cost $300,000 but was not approved for budgetary reasons. However, NMFS quality and safety personnel still believe the survey's purpose is good and that the survey is needed to document the extent that quality defects exist in U.S.-produced seafood products.

Congressional Interest

The question of seafood quality has been and continues to be an issue of congressional interest and concern. For
example, the House Merchant Marine and Fisheries Committee'sJune 26, 1980, report (Rept. 96-1138 Part 1) on H.R. 7039—
"American Fisheries Promotion Act"—states that one of the
three national priority projects to be carried out using
Saltonstall-Kennedy Act funds is a project to "establish
and operate a voluntary system to grade the quality of fish
landed at a United States port." The purpose of the
**project is to encourage the industry to
develop a program whereby the quality of fish
landed at the dock is graded, thus enabling
fishermen bringing in the higher quality fish
to command a higher price."

Also, staff of the Subcommittee on Fisheries, Wildlife
Conservation, and the Environment, House Committee on Merchant
Marine and Fisheries, recently told us that they received com-
plaints from foreign buyers about the quality of U.S.-produced
seafood and from fishermen in Alaska stating that U.S. pro-
cessors are responsible for the quality problems associated
with the large salmon catches in that region.

CONCLUSIONS AND RECOMMENDATIONS

Based on the information presented in this letter, we
believe that there is a need for a comprehensive, objective
assessment of the quality of seafood produced by U.S. pro-
cessors for domestic and foreign consumption. NMFS has the
personnel qualified to conduct such an assessment, and its
quality and safety personnel have previously stated their
interest in doing so. The rationale by NMFS officials that
such an assessment is budgetarily infeasible is more than
offset by the positive benefits which might accrue to re-
duce our Nation's seafood trade deficit.

Therefore, we recommend that you direct the Administra-
tor of NOAA to initiate a study to assess the quality of
U.S. seafood produced for domestic and foreign consumption.
Depending on the results of this assessment, NMFS can take
appropriate steps or actions to help ensure the continuous
supply of suitable high-quality seafood products. The
results of this effort would benefit the seafood industry,
NMFS in its efforts to manage Federal seafood programs, and
the Congress in its role as legislator and overseer of
Federal programs.
As you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the Senate Committee on Governmental Affairs and the House Committee on Government Operations not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We are sending copies of this report to your Assistant Secretary for Administration and your Inspector General; the Administrator, NOAA; the above House and Senate committees; and the House Committee on Merchant Marine and Fisheries.

Sincerely yours,

Henry Eschwege
Director
The Honorable Malcolm Baldrige
The Secretary of Commerce

Dear Mr. Secretary:

Subject: Followup on the National Marine Fisheries Service's Efforts to Assess the Quality of U.S.-Produced Seafood (CED-81-125)

On October 15, 1980, we reported to Secretary Philip M. Klutznick that a comprehensive assessment is needed of the quality of seafood produced by U.S. processors for domestic and foreign consumption. We pointed out several examples of foreign complaints about U.S. exports and noted that consumer and industry publications have been critical of the quality of U.S. seafood products. We recommended that the Administrator of the National Oceanic and Atmospheric Administration (NOAA) initiate a study to assess the quality of U.S. seafood produced for domestic and foreign consumption.

On March 16, 1981, the Acting Inspector General, in responding to our report, stated that the Administrator of NOAA would request proposals for the study to be conducted with fiscal year 1981 Saltonstall-Kennedy funds. 1/ Although the National Marine Fisheries Service (NMFS) received a proposal from its laboratory in Gloucester, Massachusetts, for an evaluation of seafood quality, we understand that the project will not be funded because of budget reductions and because higher priority projects will be funded instead.

Since our earlier report was issued, we have collected additional information on the quality of U.S. seafood products that further demonstrates the importance of our recommended study. For example, we found that quality considerations, along with

1/The Saltonstall-Kennedy Act (15 U.S.C. 713 c - 2 - 713c 3) makes 30 percent of the gross receipts collected under custom laws from duties on fishery products available to the Secretary of Commerce. These funds may be used to promote the free flow in commerce of, and to develop and increase markets for, domestically produced seafood products. Each year NMFS makes a portion of these funds available for solicited fishery development and utilization projects.
price, marketing techniques, and other factors, have limited U.S. exports; however, there is a lack of conclusive evidence to demonstrate the extent or degree that poor quality is impeding U.S. exports. A comprehensive evaluation such as we recommended is needed to determine the extent of the quality problem and to ascertain how it is impeding the demand for seafood products.

We also have determined that improvements are needed in the NMFS voluntary seafood inspection program. Specifically, we found that seafood products certified by NMFS inspectors are sometimes unacceptable to foreign importers. NMFS needs to improve its management of this program by training inspectors and informing them of foreign quality requirements.

Additionally, opportunities to improve fish handling techniques onboard fishing vessels could significantly improve overall seafood quality. NMFS needs to work with industry to establish the feasibility of dockside quality grading of fish and a system of price differentials to increase the amount paid to fishermen for high quality fish.

The objectives of our work were to assess the overall quality of fish and the foreign attitude toward the quality of U.S. seafood exports, to evaluate the effect of quality on the foreign demand for U.S.-produced seafood, and to identify needed improvements in NMFS' quality program. During our work we visited Japan, Germany, Spain, France, and England and discussed with business, government, and trade association representatives their experiences with U.S. exports. We selected these countries because they are either large importers of U.S. seafood products or represent significant opportunities for increased sales.

In these countries we discussed standards and methods used to assure seafood quality, the quantity of seafood imported by species and product from major producing countries, seafood product rejections, and the experiences of government and industry with U.S. seafood products. While information was not available for us to independently verify foreign claims of shipments of unacceptable quality, we did obtain and use the documentation that was readily available that described the condition of the shipments. We also discussed with NMFS, State, and U.S. industry officials their efforts to improve seafood quality and safety. Specifically, we obtained information on NMFS' administration of its voluntary inspection program and the U.S. seafood industry's attitude toward the program. We discussed with NMFS officials responsible for promoting U.S. fisheries in foreign countries their views and position on U.S. seafood quality and its effect on exports. We also contracted with Dr. Ranzell Nickelson, a seafood technology specialist, to conduct a literature search on seafood quality and safety and to determine areas for improving the overall quality of U.S. seafood products. Dr. Nickelson is the author of numerous publications on the quality of seafood, is an associate professor at Texas A & M University, serves as an associate member on seafood
technical committees, and is a project group supervisor for marine resources in a project supported by Sea Grant.

The following information discusses examples of the foreign reaction to U.S. seafood products, improvements that are needed in NMFS' seafood quality program, additional details on the factors that influence the export market potential of U.S.-produced fish products, and opportunities to improve seafood quality.

QUALITY OF U.S. SEAFOOD EXPORTS

Officials from various segments of the U.S. seafood industry, including processors and retailers, have different opinions on the quality of U.S. seafood products. Some processors contend that the United States produces a high quality product while others believe that major improvements are needed. NMFS officials stated that the "variable quality" of U.S. seafood is contributing to the low volume of domestic as well as foreign sales.

Our work in five foreign countries showed that foreign importers of U.S. seafood products have experienced serious problems with U.S. exports. Foreign importers attribute problems to U.S. industry practices that fail to recognize foreign seafood quality requirements. For example:

--Spanish industry officials said the U.S. seafood industry is unfamiliar with procedures to produce commercial quality squid and added that poor quality results from inadequate handling at sea and poor processing procedures. The failure to quick freeze the product and poor grading were noted as major problems.

--German industry officials said herring imports from the United States were of poor quality because procedures were not established to keep the fish fresh while onboard the fishing vessels and the herring were badly handled during processing. They said when German importers cooperated with U.S. processors to improve the quality, they were satisfied with the end product.

--In France we were told by one importer that he stopped importing salmon from the United States because, among other reasons, the salmon were damaged by fishermen using nets or hooks rather than the preferred method of trolling. The salmon also weighed less on the average than salmon from other countries. The importer added that inconsistent deliveries and excess ice, which reduced the net usable weight of the salmon, also were factors that led to his decision to stop importing U.S. fish products.

--Several English importers complained that products were not fresh because of inadequate U.S. processing procedures
and facilities. An importer said the salmon marketed in 1979 was of poor quality because the fish were bruised and damaged by poor shipboard handling and were frozen in cold storage boxes rather than being hung frozen.

We also interviewed a number of Japanese importers and the examples of problems they experienced. For example, two companies said in 1979 they had problems with their imports of Alaskan Tanner crabs. One company said the crabs had undesirable meat coloring, broken legs, product dehydration, and poor size assortment. The most frequent problem cited by the Japanese importers was excess ice, which reduced the net usable weight of the seafood products.

In discussing the quality of seafood exports, several U.S. processors stated that quality is not a problem in U.S. production. For example, one processing company official said some foreign complaints about U.S. quality are influenced by whether foreign importers have purchased more fish than they can market. This processor also said he received a complaint that a shipment of squid to Italy had not been properly graded. NMFS had inspected the product before shipment. Samples of the shipment were sent back to the United States and were reinspected by NMFS. The reinspection showed that the squid had been properly graded during the first inspection. Another processing company official said quality is not a significant problem and that the industry is becoming more familiar with foreign quality requirements.

A U.S. processor who exports seafood to Italy and France said he has not had quality problems. He did state, however, a shipment of dogfish he sent to France did not satisfy the French Government requirements for ammonia content. He added that neither he nor the NMFS inspectors were aware of the French requirements.

We also discussed U.S. seafood quality with officials for trading companies that buy seafood products from U.S. processors and sell to foreign importers. One trading company official said quality is not a big problem and that his company has not received any complaints on NMFS-inspected exports (other than for specifications such as the size of a particular cut of fish during the past several years. Another trading company official, however, stated that quality is a serious problem in exports and that many foreign complaints on quality are valid. A number of other processors supported the position that major improvements are needed in the quality of U.S. seafood exports.

**IMPROVEMENTS NEEDED IN NMFS' INSPECTION PROGRAM**

As previously discussed, importers of U.S. seafood products attribute quality problems to industry practices that result,
large degree, from the U.S. industry's unfamiliarity with foreign quality requirements. NMFS inspectors also are not familiar with the foreign quality requirements.

We found cases in which seafood products inspected and certified by NMFS as meeting prescribed quality standards were unacceptable to the importing country. For example, a German importer said that his company cannot fully rely on NMFS' certification. He told us that his company registered a complaint with the Department of Commerce involving a shipment of silver eels. The company official said the quality and sizes of the eels did not comply with the terms of the sales agreement or the quality standards described in the Commerce export certificate. An inspection of the shipment by a municipal veterinarian showed that the eels were frozen dead rather than alive and were spoiled. The shipment was of "considerable inferior quality" and was prohibited by German law for sale for human consumption.

The company sent a letter to NMFS regarding the poor condition of the eels. NMFS responded:

"The inspector was asked to examine the product for quality, condition, and wholesomeness. These factors were found to be acceptable at the time of the inspection, as he has certified. Further, although the inspector did not see the product before it was frozen, he noted that the eels were interwined (sic) together after freezing, the best evidence that they were frozen live. Dead eels would have remained single and unentangled when frozen."

NMFS in addressing other questions on the quality of the eels raised by the municipal veterinarian stated:

"Our inspector was not asked to examine the product for net weight, average weight of individual fish, or uniformity of size. "Wholesome and Edible" on our certificate does not refer to the contents of the digestive organs of the eel, but only to that part of the eel regarded as human food, primarily the muscle flesh of the eel."

* * * * *

"We cannot judge the results of your inspection as to the condition of the product now, and cannot conclude from his results that no deterioration occurred in transit or storage."

* * * * *

"In the future, we suggest that the USDC Inspector be furnished a copy of the letter of credit pertaining
to the part of the sales agreement which describes product requirements to our inspector before inspection and certification of the product."

Another German importer registered a trade complaint with the American consulate because he received a consignment of poor quality dogfish from a U.S. exporter who refused to negotiate a settlement. The consignment had an NMFS export certificate that stated the product was examined for quality and condition, possessed good flavor and odor, was practically free from defects, was fit for human consumption, and was free of abnormal ammonia and/or other odor. However, the German importer found that over 50 percent of the shipment was too small in size and gray in color and much of the product had the skin intact, which did not satisfy the importer's quality requirements.

According to the German importer, the American exporter visited Germany to inspect the shipment and verify the claim. Upon returning to the United States, the exporter advised the importer that the product had been inspected by NMFS, which certified the quality of the product. The exporter said the shipment must have been damaged in transit. The shipping company, however, said that there was no breakdown of refrigeration during transit. The importer also pointed out that the condition of the dogfish—bad cuts, skin on, broken, undersized, and discolored—clearly indicated that the product had not been processed or packaged very carefully.

In another case, a French importer said a dogfish shipment that NMFS certified as a product of good character, flavor, and odor and free from defects was found to have excessive levels of ammonia and was unfit for human consumption.

French Ministry of Agriculture officials told us that France requires an NMFS certificate on U.S. exports. These officials said U.S. inspectors certify that the fish are caught, processed, and prepared in accordance with French regulations when, in fact, many inspectors are not even familiar with French regulations and requirements.

We discussed these examples with the Chief, Standards, Specifications, and Labeling Branch, NMFS. He stated that NMFS inspectors are not familiar with foreign quality requirements. He pointed out also that NMFS started work in September 1980 on a project to collect and publish pertinent information on foreign seafood quality requirements that will be useful to exporters and inspectors in determining what constitutes acceptable quality in foreign countries. He stated that NMFS had planned to complete this work for five countries each year but, because of limited manpower resources, summaries have been drafted for only two countries—Nigeria and Italy—and neither have been published. He was unable to give us any information on when these summaries will be published or others completed.
Another factor that contributed to NMFS' certifications of unacceptable products is the fact that NMFS does not have any type of training program for its inspectors to familiarize them with foreign country requirements. NMFS officials agreed that the lack of training contributed to the inadequate NMFS certifications and stated that they are currently surveying their inspectors' qualifications and experience to obtain information on their education, work experience, previous training, and need for additional training.

OTHER FACTORS AFFECTING EXPORTS

The above examples show that U.S. seafood exports do not always satisfy foreign quality standards. Variable quality as well as prices, marketing techniques, and other factors affect U.S. exports of seafood products. There is no conclusive evidence, however, to demonstrate the specific extent or degree that variable quality impedes exports.

In some cases, quality is the determining factor in decisions to import U.S. seafood products. For example, a French importer of canned U.S. seafood told us that, although it is very expensive because of such things as duties and tariffs, he nevertheless imported quality crabmeat from Alaska. This importer said he discontinued purchases of U.S. canned shrimp, which was also expensive but was only of "a fair quality."

Japanese importers said that U.S. quality is improving, but remains a factor inhibiting expansion of imports from the United States. Some importers told us that, while quality inhibits U.S. exports, price is also a factor. These importers told us, however, that they do not keep records of rejected U.S. fish products or products sold at reduced prices because of poor quality.

Foreign country officials also criticized U.S. marketing techniques as a primary factor inhibiting imports even of good quality products. For example, an official of the largest firm that smokes salmon in the United Kingdom told us that U.S. salmon is of a good quality. The company, however, does not purchase much U.S. salmon because of problems it encountered in identifying suitable U.S. suppliers and trying to obtain U.S. Government cooperation in establishing business relationships with appropriate U.S. companies. The company imports Pacific salmon from Canadian brokers because of their interest and the Canadian Government's support in developing a European export market.

The United Kingdom official stated that in 1979 his firm contacted the American Embassy in London and requested information about salmon fisheries off the coast of Seattle, Washington, and Alaska in anticipation of expanding its business. The company was told to contact the Department of Commerce; however, it did
not receive a response from Commerce and became dissatisfied with U.S. Government assistance. Only after several additional contacts through the U.S. Embassy did the company receive the information it requested. The United Kingdom official said most of the company's Pacific salmon imports now come from Canada because "The Canadian Government realized our potential and furnished ** end of help."

United Kingdom officials told us that U.S. exporters must be able to provide a continuous supply of quality products and develop professional business relationships with foreign importers. They pointed out that countries such as Canada have emphasized these factors and have maintained "their share" of the competitive market. The officials said also that Canadian exporters have trade specialists in the United Kingdom overseeing their product to develop and protect good business relationships.

**THE OPPORTUNITY TO IMPROVE THE QUALITY OF LANDED FISH**

Onboard handling techniques and the time between catch and delivery often contribute to poor quality seafood products. Foreign importers criticized the handling of fish onboard U.S. fishing vessels as well as U.S. processing techniques, with particular reference to the lack of adequate, prompt refrigeration of the products. The opportunity to improve seafood quality through improved handling techniques was also noted by our seafood technology consultant. The consultant concluded that the greatest gains in quality can be made by improving handling techniques aboard vessels. He concluded also that price differentials paid to fishermen for quality products is a viable alternative to achieving better onboard handling techniques.

Fishermen are not usually paid a differential price based on the quality of their products. NMFS officials, including the Chief of Fisheries Development, said improved handling by fishermen is an important factor in developing underutilized fisheries and in assuring quality in established fisheries. These officials stated that price differentials for quality combined with a dockside grading program would provide the incentive for fishermen to improve their onboard fish products handling techniques. They said, however, that seafood product wholesalers prefer the current pricing system and would resist any changes that would establish different price levels based on the quality/condition of the product.

**CONCLUSIONS**

Variable quality, as well as prices, marketing techniques, and other factors, inhibit the demand for U.S. seafood products in foreign markets. However, evidence is not readily available to demonstrate conclusively the specific extent and degree that
variable quality impedes U.S. exports. Additionally, NMFS' voluntary inspection and certification program does not assure importers that U.S. products will meet or satisfy their quality requirements primarily because inspectors are not familiar with or trained in foreign quality standards.

The quality of U.S. exports, as well as domestic products, can be improved by better onboard seafood handling techniques. Incentives, such as price differentials, to fishermen for higher quality products could help in achieving needed improvements.

We believe a thorough evaluation of U.S. seafood quality, such as we previously recommended, is needed to

---establish the extent and degree that quality is, or is not, a problem impeding demand for U.S. products in both domestic and foreign markets;

---identify any specific problem areas;

---determine specifically which industry practices result in unacceptable quality; and

---provide a basis for industry and government programs to work together more closely to achieve the common goal of improved quality.

This effort would also be valuable in enhancing the reliability of NMFS inspections. The information could be used in developing inspector training programs in both foreign quality requirements and industry practices that affect the quality of the products and that often result in unacceptable products being sent to importers.

RECOMMENDATIONS

Therefore, we restate our earlier recommendation that you direct the Administrator of NOAA to initiate a comprehensive study to assess the quality of U.S. seafood produced for domestic and foreign consumption. We also recommend that, because budget reductions and higher priority projects for Saltonstall-Kennedy funds have prevented the needed evaluation, you review other options to support the evaluation. One option would include a cooperative effort utilizing NMFS and industry resources.

We also recommend that you direct the Administrator of NOAA to establish a program to train inspectors with particular emphasis on informing them of foreign seafood quality regulations and requirements.

Improvements are possible in onboard vessel handling of fish, and we recommend that you work cooperatively with the fishing industry, including fishermen, wholesalers, processors, and
retailers, to establish the feasibility of a dockside grading program together with a system of price differentials for high quality products.

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As you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the Senate Committee on Governmental Affairs and the House Committee on Government Operations not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We are sending copies of this report to your Assistant Secretary for Administration and your Inspector General; the Administrator, NOAA; the above House and Senate committees; and the House Committee on Merchant Marine and Fisheries and its Subcommittee on Fisheries, Wildlife Conservation and the Environment.

Sincerely yours,

Henry Eschwege
Director
Appendix 3: Schedule of Workshop Activities

SEAFOOD WORKSHOP
To Identify Seafood Science and Technology Problems

May 24, 25, & 26, 1982
Holiday Inn
2101 Wisconsin Avenue
Washington, D.C.

Monday, May 24, 1982

1800  Registration and social hour
1900  Dinner on own

Tuesday, May 25, 1982

0830   Welcome and Workshop Orientation
0845   Working Session I
       Problem Identification—Nominal Group Method
1200   Lunch
1300   Working Session II
       Continue Problem Identification and begin
       Problem Consolidation
1530   Break
1600   Continue Working Session II
1800   Dinner on own
2030   Task Group Work as required

Wednesday, May 26, 1982

0830   Working Session III
       Complete Task Group work and describe consolidated
       problems to participants
1200   Lunch
1300   Participants establish priorities for problems
1430   Break
1500   Discussion of Use of Workshop Output
1600   Adjourn
Appendix 4: Original Texts of Problem Statements

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: What is the supply situation of underutilized species of fish and other seafood for product development?

Proposed by: Robert C. Baker, Cornell University

PROBLEM DESCRIPTION:

We all hear of an overabundance of many species of underutilized fish and other seafood. There is a severe problem, however, in obtaining these underutilized species for product development. The question is - Is there an overabundance, and if so, why is it so difficult to obtain the product both for research and for industry people interested in product development.

POTENTIALLY RESPONSIVE RESEARCH:

Development of products from underutilized species of fish and other seafood.

COMMERCIAL SIGNIFICANCE:

Many commercial companies would develop products from underutilized species of fish and other seafood if they could obtain product.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Identify Species Characteristics for Product Development Use

Proposed by: Dr. William L. Baran, Ph.D., Director - Quality Assurance and Research and Development, Marriott Corp., Washington, DC

PROBLEM DESCRIPTION:

Many types of underutilized species are available but what typical characteristics do they possess? Many industrial food scientists may be looking for such information to develop new products.

POTENTIALLY RESPONSIVE RESEARCH:

Test underutilized species for various product characteristics, for example: oiliness, texture, or product integrity.

COMMERCIAL SIGNIFICANCE:

Provide guidance to other food areas as to species usage, future supplies, and product usage.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Characterization of non-traditional Species

Proposed by: Herbert O. Hultin, University of Massachusetts Marine Station,
Gloucester, MA 01930

PROBLEM DESCRIPTION:

An impediment to the utilization of many species of fish is the fact that little is known concerning their chemical and biochemical characteristics. These include the make-up of the constituents of the fish and the enzymic systems present which cause their conversion and breakdown. Without this information it is not known for what types of products they would be best suited, what their storage characteristics might be, and the best type of processing procedures for them to undergo. This information will be necessary for the development of these species as edible food sources.

POTENTIALLY RESPONSIVE RESEARCH: Species which have indications of reasonable sustainable annual yield should be examined for their chemical composition and their decomposition characteristics under various conditions of processing and storage, i.e., refrigeration, freezing, canning, dehydration, salting, smoking, etc. Acceptability to consumers by sensory testing should also be carried out. Determination of the spoilage characteristics of various species will allow proper handling and storage procedures to be developed.

COMMERCIAL SIGNIFICANCE: The number and type of fish will be increased for the commercial marketplace.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Seafood Waste Utilization


PROBLEM DESCRIPTION:

Treatment and discharge of wastewater from seafood processing is a problem for the industry, as well as health and regulatory agencies. The key to a solution is recognizing the fact that potentially valuable products, particularly proteins, are either dumped or wasted by traditional methods.

POTENTIALLY RESPONSIVE RESEARCH:

The development of simple and inexpensive technology is needed to treat the wastewater while permitting the recovery of marketable by-products.

COMMERCIAL SIGNIFICANCE:

Identify processes suitable for existing industries to meet federal and state regulations. Obtain a better understanding of waste by-products and the potential to utilize this material in new applications.
Chapter Title:
Recovery of Proteolytic Enzymes From Shellfish Viscera. A By-
Product Recovery From Clam Wastes

Proposed by: R. R. Zall, Cornell University

PROBLEM DESCRIPTION:
Clam wastes are troublesome to the shellfish processing industry. Such material is unutilized or underutilized and causes a waste disposal problem to seafood processors and handlers.

POTENTIALLY RESPONSIVE RESEARCH:
Uses for clam wastes (exclusive shells) could be a good source of food grade enzymes and spin-off products might be useful in other seafood products.

COMMERCIAL SIGNIFICANCE:
Return additional revenue and profits to the seafood industry.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Useful By-Products from Fish Waste

Proposed by: Herbert O. Hultin, University of Massachusetts Marine Station, Gloucester, MA 01930

PROBLEM DESCRIPTION:

It has been said that the hog processing industry saves everything but the squeal. In contrast, the fishing industry of the U.S. discards anywhere from 60 to 80% of the fish that are caught, or at best, turns them into animal feed or fertilizer.

POTENTIALLY RESPONSIVE RESEARCH:

It is likely that there are a large number of useful biochemical products which can be recovered from fish waste. These may be enzymes, drugs, hormones, or edible products. The rapid development of biotechnology and the use of biologicals in a variety of ways would indicate that the time is right for examination of fish waste for useful commercial significance: product recovery.

The recovery of products such as those stated above from fish waste would allow the up-grading of the waste material and would help pay for the cost of getting rid of the waste. In addition, valuable enzymes or pharmaceutical products might be made available to the U.S. market.
Original Problem Statement

**SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT**

(If necessary, limit description to space provided.)

**Title:** Establish Protein Isolation Procedures for Marine Products

**Proposed by:** Tony Sinskey, M. I. T.

**PROBLEM DESCRIPTION:**

Currently, many available metabolites and related products found in the marine environment or produced by marine organisms, including those in seafood products and wastes, are not utilized. Enzymes, therapeutic proteins, fish hormones and biomaterials, such as heparin, histamine, and polysaccharides are not being utilized at all because of inaccessibility of raw materials or tedious extraction procedures.

**POTENTIALLY RESPONSIVE RESEARCH:**

Research will focus on methods and mechanisms for isolation and characterization of these products in a highly cost-effective way. Application of novel separation procedures employing monoclonal antibodies and other techniques to isolate and purify marine bioproducts will yield significant return in the form of new commercially important products.

**COMMERCIAL SIGNIFICANCE:**
SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Development of Yields and Nutritional Information for Seafoods as Marketed and Consumed

Proposed by: Beverly M. Barton, Fisheries Development Division, NMFS/NOAA/
Washington, DC

PROBLEM DESCRIPTION:

How much cooked edible meat will a pound of raw whole squid yield? How many milligrams of sodium in 3 ounces of cooked whiting from a one pound package of frozen fillets? How many 2 ounce servings of cooked shrimp from a pound of frozen raw peeled, deveined shrimp and how many calories per serving? Unfortunately, much of the seafood nutritional information currently available for use is conflicting, misleading, and unresponsive to the needs of the professional and technical community, as well as the average consumer.

POTENTIALLY RESPONSIVE RESEARCH:

Development of nutritional composition and yields of seafoods as currently marketed and consumed in households and institutions.

COMMERCIAL SIGNIFICANCE:

The nutritional value of seafoods is a popular and legitimate marketing tool being employed to increase seafood consumption by health conscious Americans. The availability of reliable and meaningful seafood nutritional information will benefit all nutrition education efforts aimed at achieving this goal.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Nutrition Data Bank for Processed Seafood Items

Proposed by: Ken Iwamoto, The Corton Group, Gloucester, MA

PROBLEM DESCRIPTION:

Nutrition is becoming an issue of the 80's. Information on processed seafood items is dated or non-existent.

POTENTIALLY RESPONSIVE RESEARCH:

Development of a nutrition data bank covering species, area of harvest, processing methods, etc.

COMMERCIAL SIGNIFICANCE:

A data bank of nutrition information meeting FDA protocols would serve the needs of the industry on a cost effectiveness basis.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: The Measurement of the Migration of Moisture from the Fishery Product Component into the Breading or Batter of Coated Fishery Products

Proposed by: NMFS; Seafood Research, Inspection, and Consumer Services Division Washington, DC

PROBLEM DESCRIPTION:
The amount (percentage) of the fishery product component in relation to the amount of the coating in a frozen breaded or battered fishery product (e.g., frozen raw breaded shrimp) determines whether the product is properly labeled in accordance with the Federal Food, Drug, and Cosmetic Act, and, if graded, whether the product meets the requirements of the U.S. Grade standards.

It is well known that variations occur in the amount of the fishery product component, i.e., fish flesh or shrimp material, when measured during production and when measured at different time periods following freezing. Studies have demonstrated that a migration of moisture from the fishery product component into coating does occur. Some industry members maintain that the fishery component remains unchanged, except that some of its moisture with nutrients has migrated into the coating. Yet, measurements by purchasers and regulatory agencies maintain that a shortage of the fishery component exists.

There is a need to establish how much moisture migration occurs in these products under current good manufacturing, freezing, handling, storage, and shipping conditions, so that a standard allowance for it can be established and used to determine product conformance on a national basis.

POTENTIALLY RESPONSIVE RESEARCH:

COMMERCIAL SIGNIFICANCE:
The major benefit to the industry, the consumer, and regulatory agencies would be the availability of a scientifically sound data base for use in—determining product compliance with product specifications, regulatory requirements, or voluntary grade standards.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Conversion of Nontraditional Species of Fish to Food Uses

1. Processing

Proposed by: Anthony P. Bimbo, Zapata Haynie Corporation, Reedville, VA

PROBLEM DESCRIPTION:

There is a current would wide movement in the Fish Meal industry to upgrade the various species of pelagic fish to good use. This concept has been endorsed by FAO.

A major problem with small pelagic fish is that large volumes are landed in short periods of time, and these large volumes of fish must be processed quickly. One stumbling block is degutting of these fish. Conventional degutting machines do not appear to be suitable.

POTENTIALLY RESPONSIVE RESEARCH:

Development of a method to degut small pelagic fish quickly so that spoilage and rancidity can be avoided.

COMMERCIAL SIGNIFICANCE:

If a method can be found, a major source of edible fish protein would be commercially available.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Preparation of Stabilized Fish Protein Intermediates

Proposed by: John Spinelli, NWFSC, NMFS, NOAA, Seattle, Washington

PROBLEM DESCRIPTION:

The value of several species of fish could be increased if processing techniques were expanded to allow for manufacture of several end products, i.e., Alaska pollock and menhaden into stabilized protein intermediates than simply fillets, meal, and oil.

POTENTIALLY RESPONSIVE RESEARCH:

The development of stabilized protein intermediates from either fresh or cooked fish muscle. Conceptual research for end uses for the protein intermediates.

COMMERCIAL SIGNIFICANCE:

It is doubtful that our pollock resource can be utilized unless more than one product is made from the resource. It is also doubtful whether fish meal can remain a viable economic enterprise unless the value of the protein is increased.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Better Utilization of Small Fish and By-Catch (incidental catch)

Proposed by: John Liston, Professor, University of Washington

PROBLEM DESCRIPTION:

Many species currently little fished by U. S. fishermen include large number of small fish. Current technology of handling and processing is designed to deal with relatively large fish which are more resistant to spoilage, easier to fillet and steak, and yield a better proportion of edible product to waste than small sized fish. In the by-catch there is customarily a mixture of fish, many of small size.

POTENTIALLY RESPONSIVE RESEARCH:

New or improved methods for handling and preserving such fish on board ship—particularly smaller vessels—is needed. Automatic sorters, simple heading and gutting or filleting machines should be developed. Innovative techniques for separating flesh from skin and bones should be sought, which will provide for efficient separation also of pigmented and white meat. New processing procedures are needed.

COMMERCIAL SIGNIFICANCE:

This would provide for a greatly increased domestic and export supply of fish that would have to be associated with a good marketing program for success.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

**Title:** Utilization of Underutilized Fish Species for the Manufacture of Food Ingredients

**Proposed by:** E. Ray Pariser – MIT Sea Grant College Program

**PROBLEM DESCRIPTION:**

Many species of edible fish currently available from U.S. fishing grounds remain unutilized as human food because of the species' non-acceptability on the U.S. food market.

**POTENTIALLY RESPONSIVE RESEARCH:**

Development of food products that have lost their raw material identity and that can be used as high-grade food ingredients.

**COMMERCIAL SIGNIFICANCE:**

Efficient utilization of un- and under-utilized fish species as raw material for the manufacture of foods.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: The Use of Comminuted Fish as an Ingredient in Processed Prepared Foods such as Snacks to Expand Fish Utilization

Proposed by: Dr. Rafael R. Pedraja, Vice President Research, Development & Quality Assurance, Booth Fisheries Corporation

PROBLEM DESCRIPTION:

Comminuted fish made from edible parts of the fish that have lower value than the fillets or made from the whole carcass of the fish has not found a wide application because of textural limitations. More extensive usage of this material could expand the utilization and increase the yields of edible portions of fish. It could also promote the use of lower cost fish species and be of economic value to the industry as well as offering definite benefits to the consumer.

POTENTIALLY RESPONSIVE RESEARCH:

Diversify the usage of comminuted fish flesh as an ingredient in a wide variety of processed prepared foods including but not limited to snacks, sausages, pastes and other blended food products.

COMMERCIAL SIGNIFICANCE:

Expand the commercialization of fish and open the door for the utilization of certain lesser known lower cost fish species while enhancing the nutritional value of resulting processed prepared foods.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Development of Quality Products from Fish Minces

Proposed by: Herbert O. Hultin, University of Massachusetts Marine Station, Gloucester, MA 01930.

PROBLEM DESCRIPTION:

The yield of fish flesh of the U.S. fishery could be approximately doubled by the recovery of flesh from racks and by the use of species which, due to their size and/or shape, are currently discarded. Production of minced fish is a way to utilize the above products. The importance of high quality protein in the diet of people is sufficient to merit the development of these types of products.

POTENTIALLY RESPONSIVE RESEARCH:

For the development of the U.S. market, much work has to be done. First, there is the necessity to develop improved methods or production of fish muscle minces. It is then necessary to develop the stability of these fish minces. Those made from fatty-type fish will need the lipids stabilized. Those from non-fatty-type fish may be possibly stabilized by the production of surimi-type products. Consideration should also be given to stabilizing fish mince by procedures other than washing so that the 25 to 30% of soluble protein does not have to be discarded. In addition, product development work to make suitable products from minced fish which will be attractive and accepted by the American consumer are needed.

COMMERCIAL SIGNIFICANCE:

Approximately 50% of the fish consumed in Japan is in a minced form. In the U.S. the percentage is very low. Development of desirable minced fish products will greatly enhance the supply of high quality protein available to the American public or for export.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Conversion of Nontraditional Species of Fish to Food Uses

2. Storage, Shelf Life and Preservation

Proposed by: Anthony P. Bimbo, Zapata Haynie Corporation, Reedville, VA

PROBLEM DESCRIPTION:

There is a current world wide movement in the Fish Meal industry to upgrade the various species of pelagic fish to food use. This concept has been endorsed by FAO.

A major intermediate product which appears to be feasible is a mince.

Since most pelagic species are oily, shelf life and storage of the raw mince may be a serious problem.

POTENTIALLY RESPONSIVE RESEARCH:

Studies on the shelf life and measurement of the flavor stability of these raw minces will be of high priority.

COMMERCIAL SIGNIFICANCE:

Shelf life and flavor stability will be of utmost importance in determining the marketability of these minces.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Control of Microbial Flora of Raw Fishery Products Through Better Handling Techniques and Use of Processing Aids

Proposed by: Dr. Rafael R. Pedraja, Vice President Research, Development & Quality Assurance, Booth Fisheries Corporation

PROBLEM DESCRIPTION:

Often times excessive microorganisms are found in raw fishery products including the presence of pathogens at significant levels.

POTENTIALLY RESPONSIVE RESEARCH:

Improved handling and processing techniques as well as research on the use of processing aids that will inhibit or control bacterial growth during processing without affecting eating qualities, wholesomeness and safety of the products.

COMMERCIAL SIGNIFICANCE:

Minimize potential public health hazards and increase public confidence in the safety of fishery products. Improve economy of the industry by reducing product rejection.
Original Problem Statement

SEAFood SCiENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Improving Quality of Fresh and Processed Seafood

Proposed by: Donald J. Toloday, Executive Vice President Singleton Packing Corp., P.O. Box 2819, Tampa, FL 33601

PROBLEM DESCRIPTION:

There is technology available at this time for the handling and processing of all finfish and shellfish in order to deliver them to the consumer with excellent quality and wholesomeness. These technological processes and practices are not and have not been communicated to the finfish and shellfish harvester and transporter in terminology and significance to which they understand and respond.

Because of this, the consumer has a significant lack of confidence in the quality and wholesomeness in the finfish and shellfish.

POTENTIALLY RESPONSIVE RESEARCH:

Development of easier to understand technological procedures for harvesting, chilling, and transporting of the products should be developed and administered through existing Government agencies that can assure not only the communication, but the monitoring and continued education program which is necessary to alleviate the problem.

COMMERCIAL SIGNIFICANCE:

Increased confidence on the part of the consumer will raise the per capita consumption and tend to stabilize and lower prices while expanding markets.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Rapid Methods to Judge Fish Quality

Proposed by: R. R. Zall, Cornell University

PROBLEM DESCRIPTION:

We know that consumers are hard-pressed to assess the fine differences in fish quality (fresh and frozen). Research personnel are also troubled with reliable methods to judge fish quality. What is needed are new methods for grading fish quality on piers, in stores, and in the home.

POTENTIALLY RESPONSIVE RESEARCH:

Technology will be used to process fish, i.e. "blanching", before refrigerating and storage.

COMMERCIAL SIGNIFICANCE:

In many cases, better quality fish might be offered for sale which would probably increase the per capita consumption of fish in the USA.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Baseline Quality Levels for Seafoods

Proposed by: J. R. Brooker, NMFS

PROBLEM DESCRIPTION:

There is no baseline quality level for seafoods produced and marketed in the U.S. that establishes it as being suitable for human food use. The legal operating procedure is to subjectively evaluate how spoiled the product has become, at a point it becomes actionable by regulatory authorities. Currently fresh and frozen seafoods can contain as much as 20% by weight decomposed product before it is actionable as being an adulterated.

POTENTIALLY RESPONSIVE RESEARCH:

Many traditional and underutilized species need to be analyzed using a standard methodology in relation to an established set of criteria (model) to establish a baseline level of quality for seafoods suitable for human consumption.

COMMERCIAL SIGNIFICANCE:

Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Determination of Fish Quality and Projection of Shelf Life in the Fresh Condition

Proposed by: John Liston, Professor, University of Washington

PROBLEM DESCRIPTION:

There is no satisfactory single test or combination of tests which can measure quality over a wide range of fresh seafood products. Even in cases where traditional chemical, physical and/or microbiological tests provide some measure it is not possible to project future shelf life in many cases. This creates difficulties for processors, retailers and regulating agencies.

POTENTIALLY RESPONSIVE RESEARCH:

There is need for more fundamental research on the mechanisms of change in fish held unfrozen post mortem. These should be examined in terms of biochemistry, structural change and associated microbiological change for a representative selection of a wide range of species seeking a common pattern of consumer reactions which can be used as "universal indicators." This will need coordinated research in a number of areas of the U.S.A.

COMMERCIAL SIGNIFICANCE: The value of a reliable set of quality tests which could be related to tables of expected shelf life, tabulated for different temperatures and conditions, to all branches of the fish industry and related government agencies would be inestimable. This would provide a rational basis for dealing with the quality problem which still plagues large sectors of the U.S. industry.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Application of Retortable Pouch Technology to Fishery Products

Proposed by: NMFS; Seafood Research, Inspection, and Consumer Services Division, Washington, DC (E.E.L., Inc.; NFPA; Colo. State U.)

PROBLEM DESCRIPTION:

Development of the retortable pouch in the US began in early 1950's. Much of the work done by the US Army Natick Devel Center because military was, still is, interested in its use for combat rations. The meals-ready-to-eat (MRE) program now underway. There are a number of food entrees currently being packed in retort pouches under this program, e.g., chicken, beef stew, ham slices. To date, no seafood entrees have been developed for the program.

A major advantage to packaging foods in retort pouches is reduced severity of the thermal process required. Retort pouches combine the shelf-stability advantages of metal and glass containers with the high quality inherent in frozen boil-in-bag products. Thus, seafoods packed in this manner should be superior in flavor, texture, color and nutrient retention.

The total energy requirements of retort pouch/tray technology are significantly less than that required for frozen product. Whereas energy requirement for frozen product continues through storage, transportation, distribution...that required for retorting stops at processing point. Further, use of retort pouch configurations reduces energy requirements as compared to conventional retort can methods. The use of HTST systems increases efficiency and energy savings even more.

POTENTIALLY RESPONSIVE RESEARCH: Unlike freezing, which permits quality loss through undesirable chemical, textural, and flavor changes, retorted product remains highly consistent in quality.

Application of retort pouch technology to seafoods remain undone. There is a need to to develop seafood product formulations suitable to the process and determine effects on palatability, nutritionally significant chemical changes, alterations in appearance-taste-odor, and product safety.

COMMERCIAL SIGNIFICANCE: Direct benefits could include increased market potential, improved product quality, elimination of deterioration of product quality after processing, less costly transport and storage, increased profitability.

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Original Problem Statement

SEAOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Mechanism of Heat Transfer to Fish Fillers During Heat Treatment Prior to Freezing

Proposed by: D. Farkas, University of Delaware

PROBLEM DESCRIPTION:

Fresh caught fish are highly perishable through microbial activity, from enzymes in the fish flesh and from exoenzymes secreted from microbed.

Heat treatment immediately following filleting could insure prevention of enzymatic and microbial quality loss. Heat treatment can, however, change the structure of the flesh.

A detailed study of heat transfer is needed to be able to optimize the beneficial effects of heat treatment while minimizing undesirable effects. Work would be carried out with the constraints of on vessel processing technology.

POTENTIALLY RESPONSIVE RESEARCH:

Recent work at Cornell has shown the benefits of pasteurization prior to freezing.

COMMERCIAL SIGNIFICANCE:

An enzyme stabilized frozen product may have better storage qualities than untreated fish.
Original Problem Statement

**SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT**

(Please limit description to space provided.)

**Title:** Optimum Shelf Life of Fresh Fish

**Proposed by:** George J. Flick, Virginia Tech.

**PROBLEM DESCRIPTION:**

Retail food firms do not know how long a specific fish will last* in the marketing system even though some of the processing conditions may be defined. A systematic study is needed that will define optimum shelf life of various fish species and how handling procedures affect final product quality.

* Maintain quality

**POTENTIALLY RESPONSIVE RESEARCH:**

Expanded sale of fresh seafood (fish) in non-coastal areas.

**COMMERCIAL SIGNIFICANCE:**

Retail food stores will purchase fresh fish if there is some information as to how long the product will be maintained in high quality.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(please limit description to space provided.)

Title: Frozen Fish Temperature Guard

Proposed by: R. R. Zall, Cornell University

PROBLEM DESCRIPTION:

The consumer may not know whether or not packaged frozen fish has thawed post-packaging and in storage prior to sale.

POTENTIALLY RESPONSIVE RESEARCH:

Frozen fish quality will not be improved if storage temperature is allowed to fluctuate. Each package as sold could contain some inexpensive monitoring device that changes color or shape, etc., if surface thawing occurred. This tell-tale device would motivate better vending and storage practices.

COMMERCIAL SIGNIFICANCE:

Better quality frozen seafood products would be sold in the marketplace.
SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Quality Improvement Through the Transportation and Distribution Chain.

Proposed by: R. J. Learson, NMFS, Gloucester, MA

PROBLEM DESCRIPTION:

Much of the seafood is presently landed and processed in good quality condition. Time-temperature abuse during the transportation and distribution of seafood products is one of the major contributors to poor quality.

POTENTIALLY RESPONSIVE RESEARCH:

Time temperature tolerance studies. New handling and storage practices. Education of personnel in retail stores.

COMMERCIAL SIGNIFICANCE:

More market demand for higher quality products.
Original Problem Statement

SEAFood SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Maintaining Seafood Quality in Distribution Channels

Proposed by: John Sackton, Program Director-New England Fisheries Development Foundation, Boston, MA

PROBLEM DESCRIPTION:
Much attention has been focused on new technologies to extend the shelf life of fresh fish. Before these technologies can reach their potential, some of the basic problems with the present seafood distribution system have to be overcome.

Two of these problems are: lack of knowledge and control at the retail level in handling fresh fish, and difficult and often inadequate shipping arrangements due to shippers reluctance to handle fresh fish, and the small volumes of fish shipped compared to other commodities.

One approach to this problem is to attempt to make packages and procedures "idiot proof" so that fish will arrive in good condition, no matter what. The other approach is to use training, work with shipping companies and retailers, and processors to upgrade the knowledge about handling and shipping seafood throughout the industry. Such training, based upon appropriate research and handling methods, has benefited the presentation of other food commodities.

POTENTIALLY RESPONSIVE RESEARCH:
--Investigate how standard procedures in use in the poultry, vegetable, and meat industries for shipping and handling could be applied to shipping fresh fish.
--Evaluate new technologies such as modified atmospheres, blanching, additives to ice, etc., to determine their sensitivity to abuse in actual usage.

COMMERCIAL SIGNIFICANCE:
Our Foundation sees a strong demand for both training programs of this type and shipping studies and alternative arrangements. Once the basic work of setting up these types of programs has been done, industry will pay the cost of continuing them. The result will be to improve fish quality at the consumer level, and to increase consumption of fresh fish.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Optimum Long Term Storage Temperatures for Frozen Seafood

Proposed by: Hugh W. Symons, American Frozen Food Institute

PROBLEM DESCRIPTION:

The U.S. frozen food industry laid down the principles of frozen food storage before the high Q10's found in most seafood materials were discovered. The generally accepted storage temperature of 0°F (-18°C) is widely considered to be inadequate for any but transient handling (e.g. during distribution) of frozen seafood; -22°F (-30°C) is the widely accepted temperature necessary for long term bulk storage of most seafood.

POTENTIALLY RESPONSIVE RESEARCH:

Cold store stability studies of selected species important on the U.S.A. market.

COMMERCIAL SIGNIFICANCE:

Difficult to quantify. Probably true to say that the lack of adequately cold storage temperatures will pose insuperable barrier to more widespread consumer acceptance of frozen seafood.
SEAFood SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

Title: Extending the Frozen Shelf Life of Processed Prepared Fishery Products

Prepared by: Dr. Rafael R. Pedraja, Vice President Research, Development & Quality Assurance, Booth Fisheries Corporation.

PROBLEM DESCRIPTION:

Frozen shelf life of processed prepared fishery products throughout the commercial cycle is rather limited. Often times dehydration, oxidation and discoloration occur bringing about undesirable textural and eating qualities.

POTENTIALLY RESPONSIVE RESEARCH:

Refinement of handling practices at the various stages of the distribution cycle, improved refrigeration methods, development of processing aids and techniques that will retard undesirable changes even when products may be subject to deviations in ideal handling practices.

COMMERCIAL SIGNIFICANCE:

Reduction of spoilage and waste, and wider consumer acceptance of frozen fishery products.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Effect of Microbial Secreted Enzymes on Storage Quality of Frozen Fish Fillets

Proposed by: D. Farkas, University of Delaware

PROBLEM DESCRIPTION:

POTENTIALLY RESPONSIVE RESEARCH:

COMMERCIAL SIGNIFICANCE:
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Adequate Time-temperature Regimes for Quality Maintenance of Frozen Fish

Proposed by: Herbert O. Hultin, University of Massachusetts Marine Station, Gloucester, MA 01930.

PROBLEM DESCRIPTION:

Suggestions have been made that the proper temperature for frozen storage of fish is $-30^\circ C$ and not $-20^\circ C$ which is current commercial practice in the United States. The temperature chosen for storage will determine the shelf life of the product. Usually, the judgement is made based on the necessary shelf life of a product to maintain a given quality. The poor acceptance of many frozen seafood products by the American consumer, as well as the low quality of products sent to foreign markets is indicative that the problem should be examined within the context of the species and products manufactured in the U.S.

Relative shelf life should be determined for various types of fish products as a function of storage temperature. Products should be chosen representative for fatty- and non-fatty-type fish as well as different types of products, for example, e.g., breaded, precooked, fillets, etc. Major types of quality deterioration such as lipid oxidation and/or protein denaturation should be followed objectively as well as by sensory evaluation so that proper handling and storage procedures can be recommended for a large variety of products. In addition to the technical research, a study of consumer attitudes should be undertaken as well as a major effort as consumer education to accept frozen products.

POTENTIALLY RESPONSIVE RESEARCH:

COMMERCIAL SIGNIFICANCE:

Determination of the proper storage conditions for fishery products should allow for adequate shelf life, while at the same time, maintaining quality which will boost American sales and improve the acceptance of U.S. products in the foreign market. In many cases where it is not feasible to send fresh fish into a given market, it may be possible to use the frozen product. Also, in cases where a constant supply of a given species is not possible because of the seasonal nature of the catch, it would be possible to extend the season over which the product was available by freezing the product during the peak season.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Consistent Quality in the U.S. Seafood Market

Proposed by: Red Lobster - Jim Salmon

PROBLEM DESCRIPTION:

Seafood quality must be monitored and controlled throughout the chain of events from catch to consumer. Fishing vessels catch, can range from good, marginal, to unacceptable. These landings will be processed by the same vessel, and have varying degrees of quality, due to handling, storage, catch date and final processing date.

Other areas of quality concerns may include high microbiological counts, and organoleptic characteristics.

POTENTIALLY RESPONSIVE RESEARCH:

Investigation into fish quality grading program, which could be funded through the Saltonstall-Kennedy Act. Continued emphasis by the Sea Grant Program in handling, processing, distribution, and inventory of seafood so that safe food of consistent high quality can be provided.

COMMERCIAL SIGNIFICANCE:

Increased consumption of seafood and shellfish, due to high quality products available to the consumers.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Low Quality of Fishing Products

Proposed by: Joe Slavin, Fishing Consultant

PROBLEM DESCRIPTION:

There is a mistrust in buying fishery products and they do not enjoy the same confidence as do dairy or poultry products.

POTENTIALLY RESPONSIVE RESEARCH:

Develop an integrate program involving: (1) Objective tests, (2) Grading criteria, (3) Educational material, (4) Regulating guidance, (5) systemati way of monitoring performance for improving quality from catching through distribution and retail sale.

COMMERCIAL SIGNIFICANCE:
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Control of Lipid Oxidation in Seafood

Proposed by: Herbert O. Hultin, University of Massachusetts Marine Station Gloucester, MA 01930

PROBLEM DESCRIPTION:

A major cause of quality loss in both fresh and processed seafoods is lipid oxidation. Lipid oxidation is especially serious in fish because of the high concentrations of highly unsaturated fatty acids in the tissue. Lipid oxidation reduces shelf life, particularly in fatty-type fish and minced fish products. Thus, this represents a major obstacle to the development of our underutilized fish resources and recovery of material currently discarded.

An understanding of the mechanism of lipid oxidation in fish tissue should lead to better methodology for slowing down the deterioration of fish due to these reactions. Pro-oxidants and anti-oxidants should be identified as should their change with time during storage and processing. The nature of the lipid oxidation compounds and their interactions with other components of the fish muscle tissue should be determined, particularly as they affect quality of the product.

COMMERCIAL SIGNIFICANCE:

Increased shelf life of fishery products would be attained. It will be especially important in developing consumer products for fatty-type fish and for deboned fish of underutilized species or waste material.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Development of Waste Treatment Methods for Cost-Effectiveness

Proposed by: Ken Iwamoto, The Corton Group, Gloucester, MA

PROBLEM DESCRIPTION:

Treatment of wastes from seafood plants is not a simple matter. Wastes from frozen processed seafood plants present different challenges from waste generated by a shellfish cannery, for example.

POTENTIALLY RESPONSIVE RESEARCH:

Research and development of model treatment systems in the following processing categories; fresh packers, frozen processed seafood plants, seafood canneries.

COMMERCIAL SIGNIFICANCE:

Waste treatment is expensive. Development of effective treatment systems is often by trial and error. Research could point the way toward more cost-effective treatment plants.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Dating of Fresh and Frozen Fish and Seafoods

Proposed by: George M. Knobl Jr., NMFS/NOAA

PROBLEM DESCRIPTION:

Consumers are "turned off" when they buy low or poor quality fresh or frozen seafood. While many factors are involved in providing high quality seafoods, certainly storage time is of major importance. Consumers, except in a few instances, have no way of knowing how long a seafood product has been held in storage; hence, how long it will remain of high quality. Dating is becoming more and more prevalent for meat and poultry. Would dating help in selling seafoods? I suggest that research be conducted on the advisability of dating fresh and frozen seafoods.

POTENTIALLY RESPONSIVE RESEARCH:

A study should be conducted using dated and undated products in a retail outlet to determine if consumers prefer one over the other.

COMMERCIAL SIGNIFICANCE:

Could result in a higher demand for seafoods.
SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

Title: Reduction of Wasted Fish Protein

Proposed by: R. J. Learson, NMFS, Gloucester

PROBLEM DESCRIPTION:

The majority of the fish protein harvested is wasted. Discards at sea and processing waste probably represent better than a 50% loss of the edible marine protein presently harvested.

POTENTIALLY RESPONSIVE RESEARCH:

New product development especially from underutilized species and processing waste.

COMMERCIAL SIGNIFICANCE:

Optimum economic use of marine protein.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Nomenclature

Proposed by: Roy Martin, Natural Fisheries Institute

PROBLEM DESCRIPTION:

Seafood with strange names

POTENTIALLY RESPONSIVE RESEARCH:

Continue support for expanded physical, chemical and sensory evaluations.

COMMERCIAL SIGNIFICANCE:

Open new marketing options.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Enteric Virus Contamination of Oysters

Proposed by: G. Malcolm Meaburn, SEFC Charleston Laboratory
National Marine Fisheries Service, Charleston, S.C.

PROBLEM DESCRIPTION:

The sanitary quality of oysters from a regulatory standpoint is based on the concentration of coliform bacteria found in the animals or their growing waters. The efficacy of using coliform levels as indicators of viral contamination, however, is open to question. In spite of regulatory action to prevent harvesting, processing and distribution of contaminated oysters and other molluscs, there continue to be sporadic outbreaks of gastrointestinal illness attributed to the consumption of shellfish, including hepatitis A and other disorders presumed to be of viral etiology. The economic loss to the industry resulting from closure of productive harvest areas is thus compounded by public apprehension about the safety of oysters and other shellfish.

POTENTIALLY RESPONSIVE RESEARCH:

Develop specific and sensitive methods of enumerating enteric viruses from implicated shellfish and growing waters. Evaluate effectiveness of coliform levels as indicators of viral contamination.

COMMERCIAL SIGNIFICANCE:

Improved confidence in regulatory action, when required, to prevent contaminated oysters entering the market, leading to lessened public fears over shellfish safety. Better definition of viral contamination and corresponding coliform standards will also favor increased utilization of the oyster resource.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Shellfish Depuration by Seawater Disinfection

Proposed by: Walter Blogoslawski, NOAA, NMFS, Milford Laboratory, Connecticut

PROBLEM DESCRIPTION:

A significant portion of clams, mussels, and oysters lay in sewage-contaminated growing areas prohibited for food use. Recent foreign advances in forced depuration using seawater disinfectants such as ultraviolet light, chlorine, or ozone gas makes recovery and use of this valuable resource (shellfish) a reality. Research should be completed to determine the proper type of depuration for each coastal region to achieve economic cleansing of bacterially contaminated shellfish. Proof to the U.S.F.O.A. that these treatments are successful are important targets in this research.

POTENTIALLY RESPONSIVE RESEARCH:

Development of state/U.S. recommendations on the use of depuration technology.

COMMERCIAL SIGNIFICANCE:

Opening of millions of closed acres of shellfish grounds to commercial shellfishermen and processors. The establishment of stations to treat this new resource will provide income for the processors. Close federal/state supervision is required to see that all contaminated shellfish are treated prior to sale.
Original Problem Statement

SEAFood ScIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Investigate and Implement Improved On-board Handling and Processing Techniques

Proposed by: W. Steven Otwell, Seafood Specialist, Florida Sea Grant Program, University of Florida

PROBLEM DESCRIPTION:

Traditional and emerging fisheries need to implement improved on-board handling and processing technology designed to better preserve the initial quality of the products. Traditional fisheries in the southeast (shrimp, snapper-groupers, stone crabs, oysters, etc...) must combat the detrimental influences of warmer temperatures and increasing fishing time. Emerging fisheries (sardines, sharks, squid, deep sea crabs, etc.) combat similar and additional concerns unique to the individual species.

POTENTIALLY RESPONSIVE RESEARCH:

Investigate existing and new technology which can be scaled and modified to suit the current mode and scale of fishing common to the Gulf and South Atlantic regions. Methods for further investigation include refrigerated seawater systems, better control for brine and dip tanks, cooking and frozen storage, temporary and final packaging, etc.

COMMERCIAL SIGNIFICANCE:

Better methods for preserving seafoods immediately after harvest will enhance quality of the final products. Regardless of the dockside methods for handling and preservation, and the subsequent attempts for quality control during distribution, the quality of the seafoods can never be better than at the moment of harvest.
Original Problem Statement

SEAFood SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: How to Make Quality Pay

Proposed by: John Sackton, Program Director, New England Fisheries Development Foundation, Boston, Mass.

PROBLEM DESCRIPTION:

Upgrading the quality of seafood has been repeatedly identified by government, industry, and academic groups as a major concern. However, translating this concern into a series of economically feasible steps the industry can take has proven extremely difficult. Three aspects of this problem are:

A. Upgrading handling and storage of seafood aboard vessels.

   Improved methods require investment, more work, or changes in traditional procedures. Only an economic incentive, or strict federal regulation can bring about major changes. Obviously, the economic incentive is preferred.

B. Better quality means higher yields for processors.

   The economic value represented by these higher yields is an important source for the price premium that must be paid to vessels to assure better quality fish and shellfish.

C. At retail, better quality will lead to increased sales, and fewer bad experiences with seafood. When quantified, this is another potential source for a price premium to the vessel.

POTENTIALLy RESPONSIVE RESEARCH:

A. Documentation of damage and losses that occur to seafood from conventional handling practices.

B. Detailed descriptions of yield gains possible in different species under controlled conditions of handling and processing.

C. Consumer and market research to quantify the effect of negative experiences with seafood on per capita consumption.

COMMERCIAL SIGNIFICANCE:

Attacking this problem will allow the industry to capture the economic benefits of improved quality, leading to changes in handling and processing methods, investment, and market expansion so as to receive greater value from our existing seafood resources.
Original Problem Statement

SEAFood SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Limited Use of Current Technologies in Certain Areas of the Seafood Industry

Proposed by: Red Lobster - Jim Salmon

Problem Description:

Harvesting and storage on board each vessel of seafood products can be improved, utilizing available or new technology. Antiquated techniques currently being utilized can be inefficient, decrease yields, and subsequently be more expensive.

i.e.  

a) Oyster dredging
b) General Processing/Filleting, Herring Gutting, etc.
c) Packaging
d) Unloading of shrimp via pneumatic equipment
e) Shrimp - vessel design, fuel consumption and rig design

Potentially Responsive Research:

Research funding opportunities for industry to upgrade and improve upon current practices of production, through increased emphasis of Sea Grant Programs involving direct application of technologies.

Commercial Significance:

Incentives which are provided would help increase operating efficiencies, improve overall production of seafood products.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

**Title:** Production of Low Fat Pre-Fried Battered and/or Breaded Products

**Proposed by:** Dr. Rafael R. Pedraja, Vice President, Research, Development & Quality Assurance, Booth Fisheries Corporation

**PROBLEM DESCRIPTION:**

Excessive grease in pre-fried battered and/or breaded products has been a deterrent for wider consumer acceptance of this category of products.

**POTENTIALLY RESPONSIVE RESEARCH:**

Development of processing methods and improved functional character of coatings to substantially reduce the oil absorbed during pre-frying. The reduction should be in the magnitude of 50 to 70% of the oil based on the finished product weight.

**COMMERCIAL SIGNIFICANCE:**

Wider consumer acceptance and fewer calories per serving.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Development of Microwavable Products

Proposed by:

PROBLEM DESCRIPTION:

POTENTIALLY RESPONSIVE RESEARCH:

COMMERCIAL SIGNIFICANCE:
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Fresh Fish Preservation

Proposed by: Arthur G. Rand, Jr., Food Science & Nutrition Department, University of Rhode Island, Kingston, RI

PROBLEM DESCRIPTION:

The preservation of fish as a fresh product requires adjuncts, in addition to ice or refrigeration to maintain quality and expand the effective market. Ideally, this treatment should be applied to whole fish immediately post-harvest, and carried through the processing and distribution phases.

POTENTIALLY RESPONSIVE RESEARCH:

Development of safe and effective fish preservatives which will inhibit spoilage in whole fish as well as processed products. Scale-up studies to establish the effectiveness on a commercial scale, as well as the economic impact.

COMMERCIAL SIGNIFICANCE:

Improvement in the storage of fresh fish, extension of shipping distances, and an increase in the quality of fish products.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Extension of Shelf Life of Fresh Fish

Proposed by: Herbert O. Hultin, University of Massachusetts Marine Station, Gloucester, MA 01930

PROBLEM DESCRIPTION:

The consumption of fresh fish is lower than its potential, particularly in inland markets because of the relatively short shelf life of fresh fish. Ability to increase this shelf life will allow the development of additional markets and increase the consumption of fish in the U.S.

POTENTIALLY RESPONSIVE RESEARCH: Methods of extending shelf life of fresh fish should be investigated. Modified or controlled atmospheric storage, pasteurization by ionizing radiation, chemical treatments and blanching are some of the approaches which may be applied. Optimal conditions should be developed for all of these to maintain high quality for as long as possible. Food safety and toxicological problems attendant on the processes should also be examined, and where possible, resolved. Procedures for optimal handling techniques should be recommended.

COMMERCIAL SIGNIFICANCE: Markets for fresh fish would be significantly developed tending to lower prices and expand markets.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Develop Packaging Alternatives for Fish in the Fresh State

Proposed by: Dr. William L. Baran, Ph.D., Director - Quality Assurance and Research and Development, Marriott Corp., Washington, DC

PROBLEM DESCRIPTION:

Consumers are expressing concern for fried foods and desire fresh fish products. The food service industry needs fresh fish that will retain its quality under normal refrigerator conditions throughout the distribution chain.

POTENTIALLY RESPONSIVE RESEARCH:

Investigate various gas atmospheres, packaging materials, and microbial inhibitors, both chemical and processed (blanching, etc.) that will reduce fish decomposition in a refrigerator state.

COMMERCIAL SIGNIFICANCE:

If a consistent, high quality fish product could be developed for distribution across the country, higher consumer demand for fish products could be developed.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Consumer Products from Minced Fish

Proposed by: Lloyd Regier, NMFS, Charleston, SC

PROBLEM DESCRIPTION:

Many species of fish are not readily marketable in traditional forms.

Major available underutilized resources include these species. "Industrial Fish" such as menhaden are major examples.

Major impediment to consumption of fish is the presence of bones.

Meat bone separators are available and much information available on the technology of minced fish.

Consumer acceptable products to use large volumes of minced fish have not yet been defined.

POTENTIALLY RESPONSIVE RESEARCH:

Product development - non competitive with current
Market research - needs, desires of consumers
Economic analysis - put all in and output into economic terms.

COMMERCIAL SIGNIFICANCE:

Conversion of 3% of menhaden landings to a food product with value of 20¢/lb rather than current estimated 6.6¢/lb (2 billion lbs x 3% = 60 million lbs.) would yield $6.7 million in increased value. Multiplied effects would be added to this to give approximately $40 XX of value to industry.
Original Problem Statement

**SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT**

(Please limit description to space provided.)

Title: Conversion of Nontraditional Species of Fish to Food Uses.  
3. Marketing

Proposed by: Anthony P. Binbo, Zapata Haynie Corporation, Reedville, VA

**PROBLEM DESCRIPTION:**

There is a current world wide movement in the Fish Meal industry to upgrade the various species of pelagic fish to food use. This concept has been endorsed by FAO.

Should all the pelagic fish currently being utilized for fish meal be converted to edible use, where will the products be sold? Is there a market for raw frozen mince? What are the products that can utilize this type of mince and can it be sold at a profit?

**POTENTIALLY RESPONSIVE RESEARCH:**

A study of the potential markets, domestic and export for raw frozen mince from pelagic type species.

**COMMERCIAL SIGNIFICANCE:**

If the markets can be demonstrated then the incentive to produce products from the underutilized species will be greatly increased.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Portion Size

Proposed by: Mr. Henry S. Rodriguez, Director, Nutrition and Technical Services Division, Alexandria, VA

PROBLEM DESCRIPTION:

The portion size of fish products required to meet the meal pattern requirement in the National School Lunch Program is too large. The large size is caused by the low yield value for fish and by the large amount of breading that is used on products. This large portion size contributes to high cost, and high plate waste.

POTENTIALLY RESPONSIVE RESEARCH:

Develop new yield data information. Develop new products.

COMMERCIAL SIGNIFICANCE:

If the portion size and the cost were reduced then the purchasing of fish by the National School Lunch Program will increase.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Capturing the Market for Fabricated Seafood Products for U.S. Producers

Proposed by: John Sackton, Program Director, New England Fisheries Development Foundation, 100 Summer St., Boston, MA 02110

PROBLEM DESCRIPTION:

New technologies in producing fabricated seafood products from minced fish, or a surimi type base, may well be the "fish stick revolution" of the 1980's. The potential of making substitute scallops, crab legs, lobster chunks, and shrimp is very great. Without quick action, this market will quickly be dominated by the Japanese. Our own producers of scallops, and lobsters, for example, will not know what hit them.

With proper assistance, U.S. seafood processors of small to medium size could become integrated into the fabricated seafoods market. The result would be that the industry could gain advantages from potential changes that otherwise would prove another disastrous setback for particular sectors of the seafood industry.

No cooperative industry/government/academic research will replace the new product capacity of the largest food processors. However, such research may well determine whether the smaller, second tier processor, who makes up the bulk of the industry, has a chance to participate with domestic fishermen as primary suppliers of raw material.

POTENTIALLY RESPONSIVE RESEARCH:

--Categorization of U.S. species in terms of their suitability for use in surimi type material.

--Economic studies of regional species abundance and processing capacity to determine regions where a fabricated products industry might be successful

--Handling and process studies to determine the cheapest acceptable way to supply fish for this use.

COMMERCIAL SIGNIFICANCE:

A strong commitment from the government/industry/academic seafood research and development community could provide the impetus needed for U.S. producers to gain a share of this market. Otherwise, like production of frozen blocks, the entire market is likely to be dominated by foreign producers.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Surimi as a Resource for Simulated Shellfish Products

Proposed by: John L. Secrist, U.S. Army Natick Research and Development Laboratories, Natick, MA 01760

PROBLEM DESCRIPTION:

To make use of the unexploited, underutilized fin fish species which inhabit the oceans and seas of the world by a process of mincing, concentrating the salt soluble proteins into a highly functional shellfish like product. The simulated products utilize the fin fish in a manner which will create a demand for underutilized fishing stocks which are almost entirely utilized by foreign countries due to lack of domestic markets.

POSSIBLY RESPONSIVE RESEARCH:

Development of uses for underutilized fin fish species and their upgrading to shellfish status.

COMMERCIAL SIGNIFICANCE:

Provides avenues for the utilization of low market potential fin fish which will upgrade them to a status of shellfish marketability. It will expand existing markets, improve industrial profit margin and lower costs to consumers.
Original Problem Statement

**SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT**

*(Please limit description to space provided.)*

**Title:** Squid as a Red Meat Extender

**Proposed by:** J. L. Secrist, U. S. Army Natick Research and Development Laboratories, Natick, MA 01760

**PROBLEM DESCRIPTION:**

To utilize the 350 species of squid that inhabit the oceans and seas of the world by a process of mincing, flaking, etc., and adding same to restructured meats. The object of this proposal is to extend red meat products such as ground, flaked and formed, chunked and formed, etc., with an innocuous flavored material such as squid which would act as a desirable extender without addition of distinctive flavors. It will upgrade the squid and lower costs of red meats.

**POTENTIALLY RESPONSIVE RESEARCH:**

Development of uses for squid as for example as extenders for fabricated red meats.

**COMMERCIAL SIGNIFICANCE:**

Provides avenues for the utilization of squid which will be reflective in expanding existing markets, improve industrial profit margin, lower costs of red meats and extending the world's protein base.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

[Please limit description to space provided.]

Title: Shelf Life Test of Finfish (specifically North Pacific) with Emphasis Various Packing Techniques

Proposed by: Red Lobster - Jim Salmon

PROBLEM DESCRIPTION:

Presently, many species of high oil content fish such as the Salmon, has a tendency to become spoiled under freezing in a short period of time (6 months) unless special care is taken with the product. Currently, cryovacing has been used to ensure prolonged periods of storage (up to a year) with very little degradation to the product.

POTENTIALLY RESPONSIVE RESEARCH:

Investigate the use of cryovac for shelf life tests and also its potential as an inhibitor or medium for bacteria growth.

COMMERCIAL SIGNIFICANCE:

Increased shelf life for finfish and quality assurance.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Information Data Base that Industry and Government can use for Fisheries Development

Proposed by: Joe Slavin

PROBLEM DESCRIPTION:

POTENTIALLY RESPONSIVE RESEARCH:

COMMERCIAL SIGNIFICANCE:
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Minimization of Salt in Seafood Products

Proposed by: John Spinelli, NWAFSC, NMFS, NOAA
Seattle, Washington

PROBLEM DESCRIPTION:

Because of poor processing and lack of knowledge (salt penetration), the salt content of several commercially important fish and shellfish is too high and extremely variable. These practices contribute to a wide range of organoleptic variability and to a higher than necessary sodium contribution in the U.S. diet.

POTENTIALLY RESPONSIVE RESEARCH:

Improve procedures for brine freezing and refrigerated seawater (RSW) systems. Investigate the use of additives to retard salt penetration in brine and RSW systems.

COMMERCIAL SIGNIFICANCE:

The maintenance of low and consistent sodium contents in seafoods will enhance their nutritional image and improve sales.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Binding Properties of Chitin and Chitosan

Proposed by: Dietrich Knorr, Department of Food Science & Human Nutrition,
             University of Delaware, Newark, DE 19711

PROBLEM DESCRIPTION:

The unique binding properties of chitin and chitosan offer numerous potential applications of chitin and chitosan. Examples of investigations on such binding properties include protein binding, water and fat binding, dye binding and pesticide uptake by chitin or chitosan as well as the immobilization of enzymes on chitin.

POTENTIALLY RESPONSIVE RESEARCH:

Initiate a systematic research program on the binding properties of chitin and chitosan and on the potential further improvement of these binding properties.

COMMERCIAL SIGNIFICANCE:

If a better understanding of binding mechanism of chitin and chitosan is achieved, increased utilization (e.g. in foods and pharmaceutical products) could result.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Food Application of Chitin

Proposed by: Dietrich Knorr, Department of Food Science & Human Nutrition, University of Delaware, Newark, DE 19711

PROBLEM DESCRIPTION:

In the food science area increasing attention is given to application of (naturally occurring) polymers which can be used as food additives or carriers for food additives but will not be absorbed by human organism.

POTENTIALLY RESPONSIVE RESEARCH:

Investigate the feasibility of chitin as food polymer.

COMMERCIAL SIGNIFICANCE:

Food application of chitin (e.g. as bulking agent, carrier and extender for food additives, humectant and flavoring agent) could increase the market and the value of chitin.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Nutritional Quality and Availability of By-Products from Food Processing Wastes Recovered with Chitosan

Proposed by: Dietrich Knorr, Department of Food Science & Human Nutrition,
University of Delaware, Newark, DE 19711

PROBLEM DESCRIPTION:

Chitosan has been shown to be an effective agent for the recovery of nutrients from food processing wastes. However, limited information is available on the nutritional quality and availability of these nutrients.

POTENTIALLY RESPONSIVE RESEARCH:

Conducting animal feeding studies with by-products recovered from wastes of various food processing operations. Investigate nutritional value and nutritional availability (digestibility) of such by-products recovered with chitosan.

COMMERCIAL SIGNIFICANCE:

Increased demand for the reduction of food processing wastes is expected. The use of chitosan to reduce the pollution effects of food processing waste and to convert waste products into animal feed could significantly increase the demand for chitosan and reduce the chitin disposal problem.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: What Should be the Role of a University in the Development of New Seafood Products for Industry?

Proposed by: Robert C. Baker, Cornell University

PROBLEM DESCRIPTION:

The question is often asked - should researchers in the various Universities get involved in the development of fish and other seafood products? Many feel that this research should only be done by industry.

POTENTIALLY RESPONSIVE RESEARCH:

More product development work using seafood could possibly be done by University researchers if they felt it should be done at the University level.

COMMERCIAL SIGNIFICANCE:

The industry needs further processing research.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Species Identification - Isoelectric Focusing

Proposed by: NMFS; Seafood Research, Inspection, and Consumer Services Division, Washington, D.C.

PROBLEM DESCRIPTION:

The substitution of lesser value/quality fish for those costly items in high demand is becoming more common. Because of the extremely low priority placed on economic violations of the Federal Food, Drug, and Cosmetic Act by the Food and Drug Administration, little effort has been made toward curbing the practice through the judicial system.

The identification of species of fishes is performed by NMFS using the isoelectric focusing method. The identification of a species positively requires that the results of the method performed on a suspect sample be compared to the results of an authenticated control sample run simultaneously with the suspect sample. Not infrequently, it is difficult or impossible to obtain an authenticated control sample.

The establishment and maintenance of a bank or depository of authenticated samples of the major fishes sold commercially in national and international trade would solve the principal problem of NMFS in species identification.

POTENTIALLY RESPONSIVE RESEARCH:

COMMERCIAL SIGNIFICANCE:

The ready availability of authenticated samples of the major commercial species of fish would enable NMFS and the Food and Drug Administration to protect the financial interests of the legitimate members of the seafood industry.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Safety of Fishery Products Stored in Controlled or Modified Atmospheres

Proposed by: NMFS; Seafood Research, Inspection, and Consumer Services
Division, Washington, D.C. (Arizona St. U.; U of Wash.) (Mr. Emer)

PROBLEM DESCRIPTION:

Fish is one of the most perishable of foods. In unfrozen seafood, bacterial activity is primarily responsible for product spoilage. Refrigeration has for many years been successfully used to retard spoilage of fresh fish. As a supplement to refrigeration, variations in the gaseous composition of storage conditions have been proposed or used as methods of extending the fresh storage life of fishery products.

While oxygen depletion is effective in retarding the growth of the typical spoilage bacteria, there is a possibility if the product is temperature abused, it may become toxic through the growth of pathogenic organisms before spoilage is apparent.

The field of modified and controlled atmosphere storage of muscle foods was recently reviewed by Finne (1982). In this review, little mention was made of the safety of storage in CO2. The major reference to date on safety is a report by Silliker and Wolfe (1980), which deals with fresh meats. Only limited studies have been conducted on pathogens in controlled atmosphere-stored seafoods. A recent Sea Grant proposal from the University of California—Davis addresses growth of Salmonella and Vibrio parahaemolyticus. The major food poisoning organism which has been studied is C. botulinum, but most of this work remains unpublished (Eklund, 1982). The literature on the growth of gram negative food poisoning organisms (Vibrio parahaemolyticus, V. cholera, Yersinia enterocolitica, Campylobacter fetus) on marine products packaged in modified atmospheres is scant.

POTENTIALLY RESPONSIVE RESEARCH:

COMMERCIAL SIGNIFICANCE:
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Controlled and Modified Atmosphere Packaging - Parameters of Safety

Proposed by: Roy Martin - National Fisheries Institute

PROBLEM DESCRIPTION:

By modification of package atmosphere, we modify microbiological flora - is this a positive or negative? At what point do we go beyond safe handling and storage?

POTENTIALLY RESPONSIVE RESEARCH:

Determine safe processing procedures and at what point does microbiological abuse take place?

COMMERCIAL SIGNIFICANCE:

Putting consumer confidence in vac-packed and tray overwrapped seafood.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Development of New Food Products from Traditional Fish and Seafood Species

Proposed by: George J. Flick, Virginia Tech., Blacksburg, VA

PROBLEM DESCRIPTION:

There is a need to develop new products from traditional fish and shellfish species. Many grades or products of an acceptable fish and shellfish species can be produced in a quantity that greatly exceeds demand. Some of these products are standard size oysters, machine picked crab meat and chowder clams.

POTENTIALLY RESPONSIVE RESEARCH:

Develop a market from products that are in excess of current market supply.

COMMERCIAL SIGNIFICANCE:

Greater revenues will accrue to the seafood industry from the ability to utilize their catch.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Development of New Fish Products for the Fast Food Industry

Proposed by: Dr. William L. Baran, Ph.D., Director - Quality Assurance and Research and Development, Marriott Corp., Washington, D.C.

PROBLEM DESCRIPTION:

The only fish product utilized by the fast food industry is a breaded deep fat fried cod product. The project would identify new species with sufficient availability for a continuous supply of a new unique seafood product.

POTENTIALLY RESPONSIVE RESEARCH:

Development of a fish product utilizing an academic, food processing and fast food industry resources. Use of restructured product technology for fish products may be useful.

COMMERCIAL SIGNIFICANCE:

Use various species of fish to produce one consistent product which could be utilized by the fast food industry.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Textural Changes in Fish Caused by Protein Denaturation

Proposed by: Herbert O. Hultin, University of Massachusetts Marine Station, Gloucester, MA 01930

PROBLEM DESCRIPTION:

The contractile proteins of fish muscle are very sensitive to a variety of conditions which lead to their denaturation. This denaturation affects the texture, and in some cases, the appearance of the fish tissue. These changes are undesirable and reduce the acceptability of the products. Protein denaturation may be due to salt effects during frozen storage or it may be due to compounds like formaldehyde, a product of the breakdown of trimethylamine oxide.

POTENTIALLY RESPONSIVE RESEARCH:

Understanding of the processes involved in the protein changes in stored fish, especially frozen fish, would allow intelligent approaches to be made to minimize such changes and prolong the shelf-life of the fish product. In many cases, textural changes which occur in protein denaturation are the limiting factor in the shelf-life of the product.

COMMERCIAL SIGNIFICANCE:

Shelf-life of products will be significantly increased if this quality change can be slowed down or eliminated. It should also allow the use of other fish species for commercial development since the sensitivity of these species to storage has limited their usefulness in the past.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Development of Species and Size Selective Harvesting Gear

Proposed by: R. J. Learson, NMFS, Gloucester

PROBLEM DESCRIPTION:

Non-selectivity of harvesting gear generates waste. Small fish and undesirable species represent a large portion of discards at sea. The development of fishing gear which is relatively species or size selective will reduce by-catch, increase vessel efficiency and protect the fish stocks.

POTENTIALLY RESPONSIVE RESEARCH:

Develop trawls, traps, etc., for specific fisheries to reduce discards.

COMMERCIAL SIGNIFICANCE:
Original Problem Statement

SEAFood SCience or TECHNOLOGY PROBLEM STATEMENT

(please limit description to space provided.)

Title: Detection of Paralytic Shellfish Poisoning and Detoxification of Edible Molluscs

Proposed by: John Liston, Professor
University of Washington

Problem Description:

Large quantities of commercially valuable molluscs (clams and mussels) in Alaska, Washington State and elsewhere are unavailable for harvest because of persistent toxicity due to toxins from Cymopolax species ingested by the animals. Recent work has greatly clarified the chemistry of the toxins involved. However, at present no reliable rapid method of analysis is available for all toxins. Moreover, no satisfactory method for detoxification of the molluscs other than depuration is known.

Potentially Responsive Research:

Studies of analytical methods using HPLC are yielding promising results which indicate that rapid and definitive analysis may be possible. Work on toxin conversions in the molluscs may provide a basis for interfering with toxin retention in the animals.

Commercial Significance:

A rapid toxin assay will enable growers and regulatory agencies to monitor shellfish beds more effectively, perhaps facilitating shorter closures. The commercial significance of a detoxification procedure is obvious.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Analytical Tests for Seafood Freshness and Safety

Proposed by: Herbert O. Rutilin, University of Massachusetts Marine Station, Gloucester, MA 01930

PROBLEM DESCRIPTION:

Much fish arrives at the processor with an unknown history. A simple, inexpensive, and convenient means for determining the state of freshness of these fish would be most useful in establishing prices to be paid for the fish and its expected shelf-life. Many of the tests and procedures developed to date are cumbersome and require expensive equipment or significant technical sophistication. Likewise, the ability to determine the safety of seafood products could be improved. Detection of natural breakdown products such as the di- and polyamines, bacterial contamination, or intentional or unintentional additives, are some examples of substances for which improved detection would be useful.

POTENTIALLY RESPONSIVE RESEARCH:

Development of better and simpler analytical tests for the quality and safety of fish would allow better control of the raw material and give increased confidence to the consumer, thus helping to increase the demand for seafood products. Recent developments in biotechnology such as immobilized enzyme electrodes, affinity chromatographic techniques and monoclonal antibodies should be examined for their applicability to solving these problems.

COMMERCIAL SIGNIFICANCE:

The ability to put on the market products of better quality and greater safety should allow increase in consumption of fish by the U.S. consumer.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Ciguatera Contamination of Seafoods

Proposed by: G. Malcolm Meaburn, SEFC Charleston Laboratory
National Marine Fisheries Service, Charleston, SC

PROBLEM DESCRIPTION:

Ciguatera is a serious illness that develops when fish containing ciguatoxin are ingested by man. The heat-stable toxin is produced by natural processes and transmitted to a variety of important reef-associated species (e.g., snapper, grouper) found in tropical and subtropical waters. Ciguatera thus impacts on the safety of seafoods, raising issues of legal liability in cases of ciguatera poisoning. Its presence in the Caribbean and the South Pacific Islands is seriously impeding development of commercial reef fisheries in those areas.

POTENTIALLY RESPONSIVE RESEARCH:

Development of a specific, sensitive test for detecting ciguatoxin in fish flesh. Evaluation of processes in the marine food web leading to ciguateric condition in reef fish.

COMMERCIAL SIGNIFICANCE:

The ability to distinguish ciguatoxic fish and remove them from commerce should greatly enhance the development of commercial reef fisheries while significantly reducing the incidence of ciguatera poisoning among consumers.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Investigate and Implement Improved Water Conservation Measures During Seafood Processing

Proposed by: W. Steven Otwell, Seafood Specialist, Florida Sea Grant Program, University of Florida

PROBLEM DESCRIPTION:

Increasing populations and limited financial support for wastewater treatment will continue to accelerate the user costs for water and wastewater treatment. In certain areas water availability is limited regardless of cost. This problem is most acute along coastal regions of the southeast. The consequence for seafood processors is increasing product costs, limited water use, and pressure to implement more regulatory restrictions. Thus, the economic security of existing fisheries is threatened and developing fisheries are restricted.

POTENTIALLY RESPONSIVE RESEARCH:

Investigate basic methods for in-plant water conservation and reuse of water during processing. All work should be closely coordinated with the pertinent regulatory agencies to allow cooperative education and assure product quality and safety will not be compromised.

COMMERCIAL SIGNIFICANCE:

Successful implementation should decrease the burden of increasing production costs and allow processors faced with water restrictions to continue operations. Likewise, the burden of wastewater treatment would decrease.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Resource Conservation in Food Processing

Proposed by: George J. Flick, Virginia Tech.

PROBLEM DESCRIPTION:

Seafood plants must reduce their resource utilization. Of primary concern is energy and water resources which are in either limited supply or expensive. Additionally, the disposal of resources can present an economic or technological problem.

POTENTIALLY RESPONSIVE RESEARCH:

Develop alternative unit processing operations that require less water and energy inputs.

COMMERCIAL SIGNIFICANCE:

Processing operations will become less expensive and disposal problems will be reduced.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Utilization of Fisheries Processing By-Products for the Manufacture of Bio-Medicinal Products

Proposed by: E. Ray Pariser, MIT Sea Grant

PROBLEM DESCRIPTION:

Millions of pounds of fisheries processing by-products are discarded annually, resulting not only in serious water pollution problems, but also in considerable financial loss, since many of the by-products contain valuable chemical components.

POTENTIALLY RESPONSIVE RESEARCH:

Identification, isolation and preparation of bio-medicinals.

COMMERCIAL SIGNIFICANCE:

Commercial utilization of valuable bio-medicinals, known to be present in fisheries by-products would increase the profitability of the fish processing industry.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Development of Grades and Standards for Fish

Proposed by: Arthur C. Rand, Jr., Food Science & Nutrition Department,
University of Rhode Island, Kingston, RI 02881

PROBLEM DESCRIPTION:

While significant advances have been made in efforts to guarantee the consumer a high-quality commodity, a "credibility gap" still remains which is a vital problem for the seafood industry. There is a need to gain consumer confidence in the quality of fish sold and to improve the image both for domestic sales and export. Introduction of a standardized grading system would be an important factor to increase the purchase of US-caught fish in domestic and foreign markets. However, the grading systems proposed have only been based on sensory criteria.

POTENTIALLY RESPONSIVE RESEARCH:

Determine the potential to integrate existing, non-evasive objective quality tests with sensory criteria to form a standard system of grading.

COMMERCIAL SIGNIFICANCE:

Development of a satisfactory evaluation process and a list of grade standards which reflect fish quality will improve consumer acceptance. Grade standards will also encourage development of price differentials and provide incentive for improvements in raw product quality.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Mechanization of Fish Handling/Holding Systems

Proposed by: Lloyd Regier, NMFS, Charleston, SC

PROBLEM DESCRIPTION:

Relatively low valued species caught at high rates need to be handled with minimum cost and maximum quality retention. Rapid heat transfer in liquids such as chilled or refrigerated seawater can give good quality but pumping transfer can cause significant bruising damage.

Extensive work has been done on the design and operation of fish pumps to minimize damage in the Baltic countries and especially in the USSR. This information is not readily available to the U.S. industry in a form that it can be used.

POTENTIALLY RESPONSIVE RESEARCH:

Extensive literature research and translation of USSR and others research results.

Trials of systems gleaned from this literature under realistic U.S. fisheries situations.

COMMERCIAL SIGNIFICANCE:

Potential decrease in handling costs and redesign of vessel and dock-side fish holding systems.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Improving Unloading and Material Handling Systems for Fresh Fish

Proposed by: John Sackton, Program Director, New England Fisheries Development Foundation, 100 Summer St., Boston, Mass.

PROBLEM DESCRIPTION:
Major damage to fresh fish comes from bruising, pitchforking and crushing associated with current on-board handling methods. Some of the impediments to improving this situation are:

1. Fish handling systems have to be integrated between vessels and plants, and fit the marketing practices of the region. As a result, fish handling systems often represent the lowest common denominator of the available technology.

2. Because many processors and fishing vessels are not vertically integrated, they have no common incentive to introduce improved offloading and material handling. The problem is that because the benefits will accrue to both parties, neither party alone wants to assume the cost of the engineering and design work necessary.

It is worth noting that our major seafood competitors, such as Iceland, Norway, and Canada, have been able to make improvements in material handling primarily in cases where their seafood production is vertically integrated, or the government steps in to assist independent parties.

POTENTIALLY RESPONSIVE RESEARCH:

a. Engineering support for improved unloading and material handling systems that will identify the cost-savings to be achieved by each party (vessel, plant).

b. Studies of a systems approach to seafood handling within particular ports.

c. Integration of seafood handling systems with processing & marketing needs.

COMMERCIAL SIGNIFICANCE:
The practice of storing fish in pens, and unloading them in baskets, is a major cause of poor quality. In order for new investment in material handling systems to be made as part of a quality improvement program, the benefits in terms of productivity and quality have to be introduced to processors and fishermen. Also many institutional impediments and marketing problems exist. These must be attacked on a research level before they can be attached on a commercial level.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Minced Fish

Proposed by: Mr. Henry S. Rodriguez, Director, Nutrition and Technical Services Division, Alexandria, Virginia

PROBLEM DESCRIPTION:

The products made with minced fish have low acceptability in the schools because of the bone level.

POTENTIALLY RESPONSIVE RESEARCH:

Do product development and improve the mechanically deboning methods.

COMMERCIAL SIGNIFICANCE:

If minced fish products were more acceptable, then the schools would likely increase their frequency of use.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Lack of Market Research Information which will Guide Development of New Products

Proposed by: Joe Slavin

PROBLEM DESCRIPTION:

In developing new products for export and domestic market, it is important to know what economic preferences are and the types of products which may be in high consumer demand. This will guide product development.

POTENTIALLY RESPONSIVE RESEARCH:

Market research in foreign countries of potentially high fish consumption.

COMMERCIAL SIGNIFICANCE:

Domestic market research on demographic patterns in seafood consumption. Improve use of our resources.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: National Marketing Concern for Seafood Products within the U.S. 
where Funding would be Allocated to Promote Seafood Products to the 
Consumer

Proposed by: Red Lobster - Jim Salmon

PROBLEM DESCRIPTION:

Limited National and Regional promotion of U.S. seafood products directly to the consumer. This includes areas such as: availability, species, preparation, nutritional aspects, and value. Overall seafood awareness by the public needs to be promoted.

POTENTIALLY RESPONSIVE RESEARCH:

Investigation into both government funds and industry support to develop a national marketing concern, specifically through the Saltonstall-Kennedy Act.

COMMERCIAL SIGNIFICANCE:

Develop the general public's knowledge of the U.S. Fisheries, to increase consumption, and promote high quality products.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Commercial Feasibility of Combining Freeze Dehydrated Fish and Red Meats

Proposed by: J. L. Secrist, U. S. Army Natick Research and Development Laboratories, Natick, MA 01760

PROBLEM DESCRIPTION:

To increase fisheries development and utilization by the process of freeze drying minced fish flesh derived from mechanically deboned fish frames and adding same to ground beef as an extender. The minced fish flesh will be made shelf stable by a conventional freeze drying method and by a novel microwave freeze drying method. The object of this proposal is to upgrade minced fish to the point where it will be a functional extender to meat products. This will bring a high monetary yield to the by-product of the filleting operating which presently yields very little.

POTENTIALLY RESPONSIVE RESEARCH:

Development of uses for reclaimed fish frames of commercial species and flesh from underutilized fin fish species.

COMMERCIAL SIGNIFICANCE:

Provides avenues for complete utilization of fin fish which will be reflective in expanding existing markets, improve industrial profit margin, lower costs of red meats and extending the world's protein base.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Net Weight Determination of Block Frozen Fishery Products

Proposed by: NMFS: Seafood Research, Inspection, and Consumer Services Division, Washington, D.C.

PROBLEM DESCRIPTION:

In the trading of block frozen fishery products, industry is interested largely in knowing the net weight of the product. For some products, e.g., frozen crabmeat blocks and frozen peeled shrimp blocks, AOAC procedures are available for determining the drained weight. Yet, none are available for determining the net weight.

The development of a procedure or method for determining the net weight of these products, which could be adopted by the AOAC, would find greater acceptance and use by industry than the methods now available.

POTENTIALLY RESPONSIVE RESEARCH:

COMMERCIAL SIGNIFICANCE:

The development and availability of a method for determining the net weight of block frozen products would provide the seafood industry with the means to promote fair trade through honest weight for these products.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Net Weight Determination of Frozen, In-Shell, Crab Products

Proposed by: NMFS, Seafood Research, Inspection, and Consumer Services Division, Washington, D.C.

PROBLEM DESCRIPTION:

A major part of the commercial harvest of crabs, e.g., king crab, snow crab, etc., is sold frozen in the shell. There is no official method for determining the net weight of these products. The major purchasers of these products are institutions and restaurants who have no means of determining the net weight of products received and, therefore, of determining the most economical source of similar quality products.

A method for determining the net weight of these products is needed.

POTENTIALLY RESPONSIVE RESEARCH:

COMMERCIAL SIGNIFICANCE:

The development and adoption by the AOAC of an official method for determining the net weight of frozen in-the-shell crab products would enable the major purchasers of these items to be assured that honest weight is being delivered and paid for.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Further Research on Irradiation of Fresh Fishery Products and Finding a Suitable Name for Labeling the Process

Proposed by: Dr. Rafael R. Pedraja, Vice President Research, Development and Quality Assurance

PROBLEM DESCRIPTION:

Fresh fishery products have a very limited shelf-life under refrigeration. Extending the shelf-life will have a significant economic impact on the industry as well as a beneficial effect on consumer acceptance. Finding a name for the process that will meet with consumer approval. The names "radiation" or "irradiation" are perceived negatively by the public.

POTENTIALLY RESPONSIVE RESEARCH:

Continue research on optimum radiation treatment to preserve freshness and textural qualities of raw fishery products.

COMMERCIAL SIGNIFICANCE:

Reduce waste, minimize spoilage and increase safety of products.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Naturally Occurring Parasite Population in Scallops

Proposed by: NMFS; Seafood Research, Inspection and Consumer Services Division, Washington, D.C.

PROBLEM DESCRIPTION:

The calico scallop industry in the Eastern U.S. was hard hit recently when the distribution of scallops was halted because of a seemingly excessive number of parasites. This caused a severe economic hardship on the scallop industry and deprived consumers of a highly desirable seafood.

A study of the problem is needed to determine the extent of the problem, the frequency of occurrence, and the normal parasite load in scallops, particularly calico scallops. This may enable State and Federal regulatory agencies to establish realistic guidelines for use in controlling the distribution of the product.

POTENTIALLY RESPONSIVE RESEARCH:

COMMERCIAL SIGNIFICANCE:

A study of this nature should benefit the Eastern U.S. scallop industry by assisting it in establishing harvesting protocols, and by enabling it to control harvesting when excessive numbers of parasites are first observed.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Removal or Prevention of Larva Nematode Infections

Proposed by: Dr. William L. Baran, Ph.D., Director - Quality Assurance and Research and Development, Marriott Corp., Washington, D.C.

PROBLEM DESCRIPTION:
Many consumers during the summer months discover "worms" in fish products served by the fast food industry. Although not a potential health problem it is an esthetic problem and leads to legal lawsuits.

POTENTIALLY RESPONSIVE RESEARCH:
Develop methods to prevent or remove "codworm" (poroecaecum) from cod products.

COMMERCIAL SIGNIFICANCE:
This would prevent expensive lawsuits to the food service industry and improve consumer acceptance of fish products.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Survey of Fisheries Species for Unique Nutritional Components

Proposed by: D. Parkas, University of Delaware

PROBLEM DESCRIPTION:

The variety of species of fish used for food far exceeds all other sources of animal protein. The protein efficiency, lipids, availability of minerals such as zinc or iron and vitamins such as B₁₂ or A may make fish specific species highly desirable for specific segments of the population.

POTENTIALLY RESPONSIVE RESEARCH:

Look at amino acid composition, PER value digestibility, availability of nutrients species by species.

COMMERCIAL SIGNIFICANCE:

Nutrient value is critical.
Title: Organic Contaminants in Seafoods

Proposed by: G. Malcolm Meaburn, SEFC Charleston Laboratory
National Marine Fisheries Service, Charleston, SC

PROBLEM DESCRIPTION:

There is a continuing influx of organic chemical pollutants into the marine environment. Chief among these are petroleum hydrocarbons and a wide array of synthetic chemicals, such as PCB's and chlorinated pesticides that have been or continue to be heavily used in industry or agriculture. Little is yet known about the potential hazards arising from the consumption of seafoods contaminated by these materials or their metabolites. Public confidence in the safety and wholesomeness of seafoods is diminished with each reported pollution incident, regardless of the true public health significance of these contaminants, with a consequent impact on the fisheries industry.

POTENTIALLY RESPONSIVE RESEARCH:

Evaluation of the toxicity of organic contaminants in seafoods, including studies of the uptake, transformation and interactions of specific compounds in several model systems, using fish and mammalian tissues.

COMMERCIAL SIGNIFICANCE:

Improved capability to provide a rational assessment of possible dangers to public health from consuming contaminated seafood will lessen impact on the fisheries industry.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Small Pelagic Resource Definition

Proposed by: Lloyd Regier, NMFS, Charleston, SC

PROBLEM DESCRIPTION:

A number of small pelagic species such as: Squid, round herring, thread herring, scaled and Spanish sardines and round scad have been identified as potential resources with MSY above 50,000 tons.

Date on where and when to find them as well as sizes and age structure are too limited to support development of fisheries.

Methods for collecting these data by fisheries independent surveys are very expensive.

POTENTIALLY RESPONSIVE RESEARCH:

Development of fishery independent survey systems which are less costly, cheaper platforms.

Sonar system evaluations.

Satellite imaging system evaluation.

COMMERCIAL SIGNIFICANCE:

Decisions for developing new fisheries need assurance of available resource.

Management plan development relates to the ultimate best use of the resource and reliable data is also crucial for plan development.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Development of Mariculture/Aquaculture Systems

Proposed by: Herbert O. Hultin, University of Massachusetts Marine Station, Gloucester, MA 01930

PROBLEM DESCRIPTION:

The great majority of fish caught and consumed in the U.S. today are wild animals. Since it is basically a hunting operation, production of fish as food can be said to be approximately where the land animal industry was some 10,000 years ago. The ability to raise known species of fish and shellfish under controlled conditions should allow for better control of quality and level out the ups and downs of supply. This should tend to stabilize prices and cause an increased demand for consumers who would be assumed of a constant supply.

POTENTIALLY RESPONSIVE RESEARCH:

Much research has to be done on all aspects of mariculture and aquaculture. Nutritional requirements, disease resistance, genetic development, optimization of growth per unit of feed, containment, and prevention of loss of feed are all areas of importance.

COMMERCIAL SIGNIFICANCE:

Sustained and guaranteed yields of high quality edible products of fin fish and shellfish will be available tending to lower prices and increase demand.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Toxicological Studies of Food Processing Wastes Coagulated with Chitosan

Proposed by: D. H. Attaway

PROBLEM DESCRIPTION:

One of the major problems in processing of commercially important crustaceans is disposal of waste, which in large part is chitin. A useful industrial polymer, chitosan, can be made from chitin. One of the major potential uses for chitosan is in coagulation of organic matter in effluents from food processing plants, but for chitosan to be economically applied for this purpose, the resulting precipitate must be usable in animal feed. Inclusion of chitosan in animal feeds requires FDA approval which must be based on conclusive feeding trials.

POTENTIALLY RESPONSIVE RESEARCH:

Because treating food wastes with chitosan cannot be patented, no single commercial firm can justify the expense of expensive feeding trials and associated chemical and biological analyses. Therefore, a project funded by government and industry should be undertaken to provide the data required by FDA.

COMMERCIAL SIGNIFICANCE:

Companies making chitosan could become economically viable and waste disposal problems in shrimp and crab processing plants would be alleviated.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Does the Condition of Live Blue Crabs Affect the Quality of the Processed Meat

Proposed by: Clowde W. Wiley, Virginia State Health Department, Richmond, VA

PROBLEM DESCRIPTION:

If the quality of live blue crabs could be enhanced through better storage and protection techniques from the time of harvesting until delivery to the processors, would the ultimate quality of the processed meat and shelf life be improved?

POTENTIALLY RESPONSIVE RESEARCH:

Research is needed to determine if improved handling and storage of uncooked blue crabs, especially in warm weather, would improve the quality and keeping qualities of the meat after cooking and processing.

COMMERCIAL SIGNIFICANCE:

Improve consumer acceptability of the product and reduce recalls due to inferior or unacceptable quality.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Determination of Heavy Metals Depuration Rate in Oysters and Clams

Proposed by: Cloyde W. Wiley, Virginia State Health Department, Richmond, VA

PROBLEM DESCRIPTION:

There are significant quantities of oysters and clams in growing areas subjected to heavy industrialization and contamination from hazardous metals and chemicals. Research has shown that shellfish relayed from contaminated growing areas to approved growing areas will purge themselves of bacterial contaminants in a reasonably short time under proper temperature and salinity conditions. However, it is not known how long is required under similar conditions to purge heavy metals such as cadmium, arsenic, chromium, lead, mercury, etc. Consequently, such shellfish cannot be utilized in the relaying process because of the public health consequence of this uncertainty.

POTENTIALLY RESPONSIVE RESEARCH:

Development of estimates of time intervals required under various salinity and temperature regimes to purge oysters and clams of hazardous metals after relaying from polluted to approved growing areas.

COMMERCIAL SIGNIFICANCE:

A valuable resource could be converted to market channels as a safe food source if it were known with a fair degree of certainty how long it takes oysters and clams to rid themselves of heavy metals under controlled salinity and temperature variations. This resource is currently unusable because of the lack of adequate research data.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: The Purging of Contaminants from Tray Held Oysters and Clams

Proposed by: Cloyde W. Wiley, Virginia State Health Department, Richmond, VA

PROBLEM DESCRIPTION:

The present method of removing or depurating contamination from shellfish involves harvesting from the polluted area and relaying loose on the bottom of an approved growing area for a specified time under controlled temperature and salinity conditions. Many of the shellfish are lost or damaged in the various harvesting and relaying cycles, which often makes the effort unprofitably and, consequently, a valuable resource goes unused.

POTENTIALLY RESPONSIVE RESEARCH:

Research is needed to determine if polluted shellfish can be adequately purged of contaminants in a cage or rack so they would not have to be re-harvested from the bottom a second time, which results in loss, breakage, or mortalities and is somewhat cost prohibitive.

COMMERCIAL SIGNIFICANCE:

Polluted shellfish could be placed in tamper proof racks or cages upon harvesting, placed in trucks for transporting, relayed to approved areas for cleansing, and removed for sale after completion of the cleansing process with reduced loss, mortality and expense. Consequently, price and quality should be improved. However, it would have to be determined if shellfish would adequately pump while in a confined position.
Original Problem Statement

SEAFOOD SCIENCE OR TECHNOLOGY PROBLEM STATEMENT

(Please limit description to space provided.)

Title: Degradation of Water Quality and Aquatic Environments in Coastal Estuaries of the U.S.

Proposed by: Red Lobster - Jim Salmon

PROBLEM DESCRIPTION:

Coastal zone development by the residential and industrial segments, has reduced areas in which most marine animals begin development. An example would be that more than 60% of the total areas along the coast of the U.S., are closed to fishing of clams, oysters, and scallops because of concerns about contamination paralytic shellfish poison or pollution with bacteria and viruses, pathogenic to humans. Many other examples would include, chemical waste, heavy metals, oil spills, waste treatment plants and increased recreational use of our waters.

POTENTIALLY RESPONSIVE RESEARCH:

Studies should be placed under review for current and potential rezoning of coastal areas, relative to species development and health. Review of Estuary Protection Act, and its success.

COMMERCIAL SIGNIFICANCE:

Increase total availability of harvested seafood products.
Appendix 5: Raw Scores of Ranked Problems

Number of Voting Participants = 36

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<th>Working Number of Problem*</th>
<th>Total Points For Problems Ranked 1-15 (N)</th>
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*Indicates order of presentation at workshop

**Problems numbered "A, B, C" etc. indicate tie votes
Appendix 5: Raw Scores of Ranked Problems

(continued)

Number of Voting Participants = 14

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*Indicates order of presentation at workshop.

**Problems numbered "A, B, C" etc. indicate tie votes.