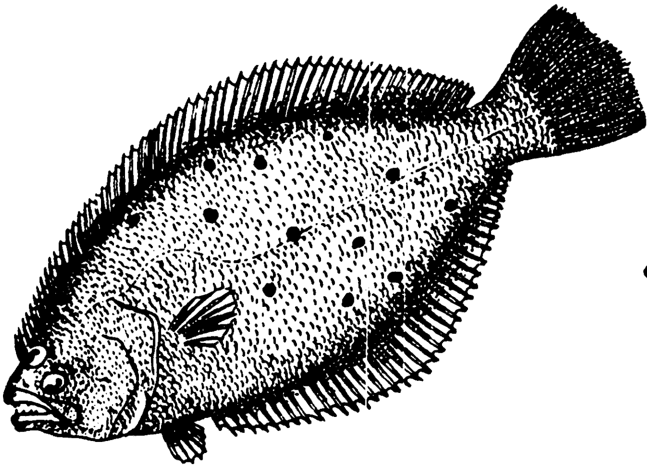
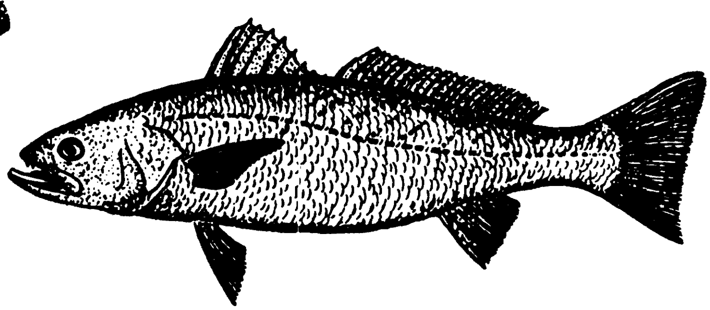
1986

Enhancing the value of commercial fish species through quality control procedures : an integrated approach for Mid-Atlantic fisheries.

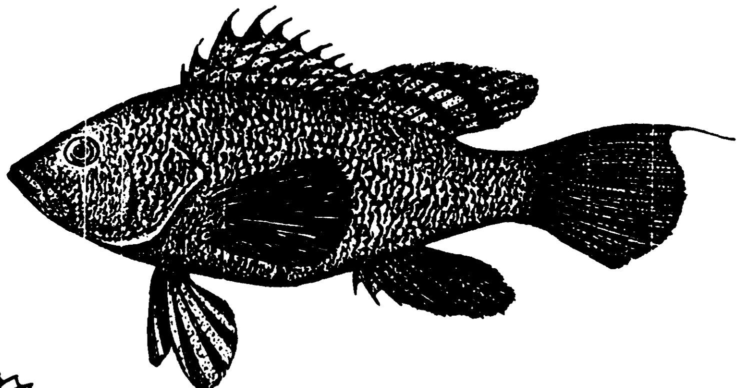
Virginia Sea Grant Marine Advisory Program

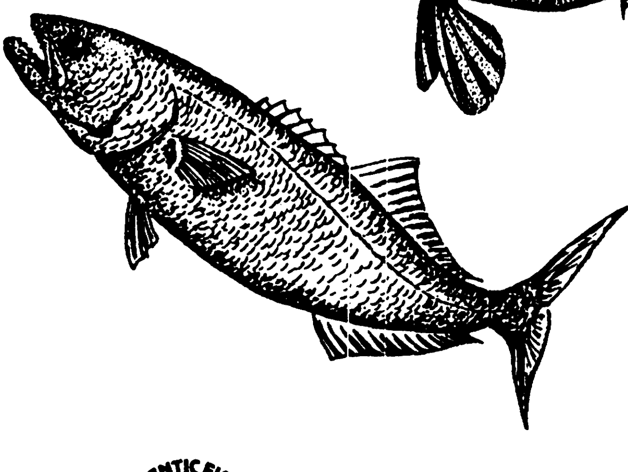
Virginia Institute of Marine Science

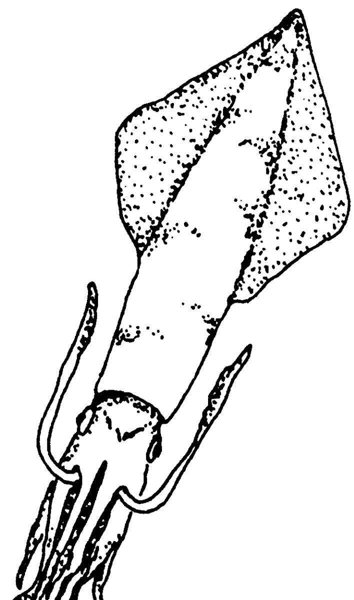




Enhancing the Value of Commercial Fish Species through Quality Control Procedures: An Integrated Approach for Mid-Atlantic Fisheries







Mid-Atlantic Fisheries
Development Foundation, Inc.

Virginia Sea Grant College Program

Virginia Institute of Marine Science

ENHANCING THE VALUE OF COMMERCIAL FISH SPECIES THROUGH QUALITY CONTROL PROCEDURES: AN INTEGRATED APPROACH FOR MID-ATLANTIC FISHERIES

A Technical Report Submitted in Partial Fulfillment

of Contract No. 86-23-17922V to the

Mid-Atlantic Fisheries Development Foundation, Inc.

Virginia Sea Grant College Program
Marine Advisory Services
Virginia Institute of Marine Science
School of Marine Science
College of William and Mary
Gloucester Point, Virginia 23062

Table of Contents

Page

Acknowledgments ii

List of Tables iii

List of Figures iv

I. Introduction 2

II. Defining Quality and Quality Control Procedures . 4

III. Factors Affecting Fish Quality 4
- A. General Factors 4
- B. Biological Factors 6

IV. Procedures for Quality Control 7
- A. On-Board Seafood Quality Experiment 7
- B. Procedures Examined 9
- C. Harvesting 9
- D. Problems and Recommendations 10
- E. Efficiency and Crew Size 11
- F. At Sea Processing and Storage 12
  - 1. On-Board Processing 14
  - 2. On-Board Stowage 17
- G. Processing and Distribution 23
  - 1. Dockside Handling 23
  - 2. Processing 24

V. The Economics of Quality Control Production 27
- A. Price Assessment 27
- B. Economic Feasibility 28
- C. The Open Access Profit Level 30

VI. Summary and Conclusions 31

VII. Literature Cited 34

VIII. Appendices 35
- A. Appendix I 36
- B. Appendix II 39
- C. Appendix III 41
- D. Appendix IV 45
- E. Appendix V 48

Acknowledgments

Funding for this study was provided by the Mid-Atlantic Fisheries Development Foundation, Inc., Annapolis, MD. Contract No. 86-23-17922V.

Figures 1-8 were in part taken from those in the New England Fisheries Development Foundation publication: "Fishing: Quality at Sea, A Manual for On-Board Quality Procedures." 2nd edition, by G. Connors and J. Ostergard, 1986. N.E.F.D.F., Inc. Boston, Massachusetts. 55 pp.

The line drawings of fish on the cover of this report were done by Dick Cook.

This report would not have been possible without the extensive help and cooperative efforts of fishermen in Virginia. We would like to thank all those captains who participated in this research project.

List of Tables

Page

Table 1. Suggested at sea handling methods for selected mid-Atlantic commercial species 13

Table 2. Gross nutritional composition of selected mid-Atlantic commercial species 29

List of Figures

		Page
Figure 1.	Two stage gutting station	15
Figure 2.	Manifold system using vessel's wash down pump as a source of processing water	16
Figure 3.	Deck layout of <u>F/V</u> <u>Darana R</u>	18
Figure 4.	Fish are delivered to slaughter house below deck through the dover funnel for boxing	19
Figure 5.	Proper short shelving techniques for finfish	20
Figure 6.	An example of a possible hold configuration providing options for traditional bulk storage, short shelving, and boxing	22
Figure 7.	Method for unloading single Pers box using grip claw	25
Figure 8.	Method for unloading pallet multi-boxes, using grip claws and knuckle boom	26

ENHANCING THE VALUE OF COMMERCIAL FISH SPECIES THROUGH QUALITY CONTROL PROCEDURES: AN INTEGRATED APPROACH FOR MID-ATLANTIC FISHERIES

Marine Advisory Services, Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, Virginia 23062.

Introduction

Poor quality has often been cited as a major obstacle to increased foreign and domestic sales of U.S. harvested fish. In a report on fisheries trade prepared for the 1984 New England Governors' Conference, the absence of quality standards, particularly for finfish, was cited as a major reason for diminished economic returns to fishermen (Background Paper on Fisheries Trade 1984). A subsequent study by the New England Fisheries Development Foundation (NEFDF) revealed a definite need for vessel operators and buyers to initiate quality control in order to effectively compete for world markets (Connors and Ostergard 1986). The need for procedural changes which will result in high quality products has been well documented; the next step is to define what is a "quality product." More importantly, the characteristics of finfish that exemplify "quality" to a buyer or consumer must be determined, and as well as the basis for that quality differentiation.

This report summarizes the results of a study on the feasibility of implementing quality control procedures for regionally underutilized mid-Atlantic species. Underutilized species were chosen for the study because the suggestion has been made that inferior quality has prevented an increase in their sales. The species selected were mackerel, scup, bluefish, croaker, and squid. Flounder and seatrout, though not underutilized, were designated candidates for similar studies in the future, because they are mid-Atlantic commercial species with the potential for yielding substantially higher economic benefits, if quality control procedures were to be adopted. (Existing consumer demand for these species could support a increase in price for higher quality products without much problem.)

However, before quality control can be initiated for these less popular species, preliminary groundwork must be completed. Consumers and retailers need to be educated about the nutritional benefits of these species, and the value of enhanced fish quality. A market for the products must be developed, one that recognizes differences in quality. In turn, price differentials will promote the production of higher quality seafood (Donohue 1986).

The effects of harvesting methods on seafood quality, sales, and marketing were evaluated for their applicability to underutilized mid-Atlantic species in this study. Recommendations are given for improving basic at sea handling of finfish products, and various on-board processing options presented for consideration. Economic factors associated with the implementation of quality control procedures are also discussed.

Defining Quality and Quality Control Procedures

There is no singular or simple definition of "quality" for fish products. Seafood dealers and consumers typically define quality in terms of the physical attributes of the products. Characteristics assessed include appearance, texture, odor, color, and taste. Product safety is another concern. A critical element in defining quality is consumer acceptance (D. J. Dalrymple 1961; D. G. Dalrymple 1968) and an expectation of the highest quality product available at a reasonable price.

The intrinsic quality of a product can only be maintained, not improved. In general, a quality control procedure may be defined as any method used during harvesting, processing, and distributing of fish products which maintains product attributes at defined levels. Since finfish species vary in normal shelf life expectations, a quality control program can be modified to sustain the quality of any fish product. The primary goal of quality control is to maximize the net monetary return from any fish product, by producing a product worthy of a higher price.

Factors Affecting the Quality of Fish

General Factors

Numerous physical, biological, environmental, technical, and economic factors affect the quality of fish. Method of harvesting, air and water temperatures, type of substrate (if any) to be fished, volume of product per tow, and on-board handling and storage all influence the condition of the landed fish. For example, the weight of a large trawl catch can compress and bruise the fish, causing immediate product devaluation. Thermally abused fish (i.e. left on deck too long) also undergo a reduction in quality, as bacterial spoilage is unchecked and shelf life shortened. The physical appearance may deteriorate also, through the loss of scales, etc. Bulk storage is perceived as a major factor negatively influencing dollars received for pounds of fish landed. It can be an inefficient and costly method of storage, in terms of both fish quality and time required for unloading.

The NEFDF report identified nine quality control points for species harvested in the New England region (Connors and Ostergard 1986). These same guidelines can be modified (if necessary) and applied to mid-Atlantic species. They are:

1. Fish damage
2. Temperature
3. Fishing practices
4. Length of trip
5. Efficiency of operation
6. Stowage methods and equipment
7. Proper tools and equipment
8. Sanitation
9. Unloading

Inadequate consideration of any of these control points can result in product deterioration during harvesting.

The quality of the final product is not determined solely by the handling practices of fishermen. A number of biological and environmental factors can initially influence the condition of the fish. These include individual health, sex, stage of lifecycle (pre-spawning, post-spawning, etc.), biochemical properties of the flesh, season of the year, and fullness of stomach at time of landing. Since the quality of the fish landed can only be sustained, the state of the fish upon landing pre-determines the highest level of quality possible.

Processors, shippers, and retailers also play an important role in determining the quality of the final product. The consequences of poor handling, inadequate icing, storage, or displaying of fish are inferior products in the eyes of the consumer. Prices and sales suffer.

One factor with important implications for the maintenance of quality is timeliness of processing. Handling techniques during processing affects product quality and therefore sales. Proper tools and equipment, sanitary conditions, and efficient off-loading procedures are necessary to sustain the quality of seafood products.

Biological Factors

Some product deterioration is caused by the biochemical composition of various species. Other factors that contribute to the degradation of fish products are habitat type and any associated microorganisms, feeding habits, and life history. These variables are important to fishermen in a number of ways. Different habitats afford distinct foraging opportunities, substrate types, and naturally occurring microorganisms, all of which can have an effect on fish condition. For example, benthic-feeding fish are more likely to be physically covered in sediments and their associated microorganisms than species that feed in open water.

In one study, feeding condition influenced the length of time it took bluefish to degenerate to an unacceptable level (VPI-SU 1986). Bluefish with full stomachs deteriorated at an accelerated rate when packed in the round. Based on the indications of this and other studies, it becomes apparent that the stomach content of the fish caught should influence the choice of handling and packing methods. The problem is determining the feeding state of the fish, since it can vary from individual to individual.

The life history of a species can be a useful tool also, by providing fishermen with pertinent information on particular life stages that may affect the quality of a fish. For example, fish tend to build up body reserves and weight prior to spawning, and may be more desirable (and therefore valuable) products. In the post-spawning period, energy reserves are depleted and the fish may be in a more weakened condition; this could influence both value and shelf life. Some of this life history information is listed by species in Appendices I, II, and III. Selected references on the biochemical compositions and life histories of these mid-Atlantic species can be found in Appendices IV and V, respectively.

Procedures for Quality Control

On-Board Seafood Quality Experiment

During 1986, a seafood quality improvement experiment was conducted jointly by the Marine Advisory Services Department at VIMS and the VPI seafood processing lab in Hampton (VPI-SU 1986). With industry assistance, the project tested different means for improving at sea handling practices in order to sustain higher quality products and achieve premium fish prices for the fishermen. Four to six handling techniques were used simultaneously on each trip so that comparisons could be immediately and accurately made.

The first step was to design an on-board handling system for gutting, bleeding, and washing fish prior to storage in the hold. An important consideration was to ensure that the system would occupy minimal space and be compatible with the size and layout of the majority of vessels comprising the mid-Atlantic fishery fleet. Designed by the commercial fishing gear specialist at VIMS, the system was composed of a two stage gutting and bleeding station and a circulating wash tank. A delivery chute moved fish from station to station without deck contact. After the product was gutted and washed, it was conveyed to the hold for hand-packing in plastic Pers boxes and subsequent storage.

The additional equipment was installed on board the F/V Darana R (James Rhule, captain) in one day without any major alterations to the layout of the deck. The vessel's wash down hose served as the source of processing water, thus saving time and reducing costs.

Minor modifications were made in the hold:

1. Metal brackets were installed in the fish pens for short shelving.
2. A wooden platform was placed in the fish pen to provide a level surface for storage.
3. Hold down brackets on the bulwarks and hatch coaming were added to secure the tanks in heavy weather.

The first trip, made in mid-January, produced 10,000 pounds of Loligo squid and a few hundred pounds of mixed finfish. The squid were handled in the following manner: (1) boxed and washed; (2) boxed; (3) short shelved; and (4) traditional bulk storage in the pens.

The boxed, and the boxed and washed squid were superior to both the short shelved and bulk products. The most obvious differences were that the boxed squid retained its freshly-caught red coloring and had substantially less slime on the outer membrane. Of particular interest to commercial fishermen was the significant reduction of weight loss and shrinkage over the traditionally handled products.

On the second trip in early February, the handling system was tested at maximum capacity. In two days of intensive trawling, the vessel stocked over 50,000 pounds of bluefish and 5,000 pounds of Loligo squid. The bluefish were handled by: (1) one stage (gutted), boxed and washed; (2) two stage (bled and gutted), boxed and washed; (3) washed and boxed in the round; (4) unwashed boxed in the round; (5) short shelved; and (6) traditional bulk penned. Again, the preliminary results indicated that the boxed, and the one and two stage handled fish were of superior market quality to both the short shelved and bulk penned fish.

It is important to note, however, that the short shelved fish were of better quality than the traditionally handled fish. Furthermore, the boxed and short shelved fish had less weight loss due to shrinkage than the bulk fish.

Procedures Examined

The control points identified in the NEFDF report were examined for pertinence and applicability to fishing and processing activities in the mid-Atlantic region. Harvest-related activities reviewed were: length of tows, number of days at sea per trip, volume of product per tow, temperature, and efficiency of operation. All of these factors could have some effect on the quality of the landed product. Components of processing examined were: sanitation, off-loading, tools and equipment, storage methods, and efficiency of operation.

Harvesting

The decision to implement changes in harvesting techniques hinges upon a number of factors. Two critical considerations in the decision-making process are: will the adoption of quality control procedures result in economic gain, and can the quality control procedures be integrated with the safe operation of the vessel?

This work and associated projects by Virginia Sea Grant personnel have identified several areas where quality control problems exist for mid-Atlantic fishing vessels, similar to those identified in the report by the NEFDF (VPI-SU 1984; 1986). Specifically, sanitation, minimization of physical damage to the fish, and regulation of "on deck" and stowage temperatures were found lacking or deficient. Mid-Atlantic fisheries also have problems associated with the size of the catch per tow and product load.

Problems and Recommendations

Problem number 1:

High bacterial levels before and after cleaning indicate ineffectiveness of procedures currently used by mid-Atlantic fishing vessels (VPI-SU 1984).

Recommendation:

Use of non-porous materials for equipment and storage facilities (VPI-SU 1984; 1986). Wash down with detergents, clean water, and bristle brush. Follow with a sanitizing routine, using solutions containing either chlorine or iodine. A chlorine-containing solution can be made from household bleach (1/2 cup to one gallon water. Do not make up ahead of time because of chemical changes in chlorine solutions.) Scrub again with brush and rinse with clean fresh water (Kramer and Paust 1985; Perkins 1986). Do not use 'lysol' or pine cleaners; they contain phenols which will contaminate the catch, rendering it worthless (Kramer and Paust 1985).

Problem number 2:

Physical damage to fish by gaffs, shovels, and handling by crew.

Recommendation:

Common sense handling and sorting of fish. Avoid procedures which damage marketable portions of flesh.

Problem number 3:

Product deterioration due to inadequate temperature control.

Recommendation:

Quickly process product to minimize the time the fish are on deck and are therefore exposed to thermal abuse. Ice heavily. Install 'spot check' thermometers in storage areas and monitor frequently.

Problem number 4:

Excess product load may damage fish and prevent implementation of quality procedures.

Recommendation:

Shorten the duration of each tow and increase the number of tows made per day. If tow yields more than 3,000 pounds, it may not be feasible to implement any quality procedures other than quickly stowing the catch. As an alternative, consider the feasibility of increasing crew size, assigning additional crew to quality handling procedures.

Efficiency and Crew Size

The size of the catch per tow is a major restriction to the implementation of quality control procedures. The results of the recent experiments at sea indicate that the optimal catch for a crew of three individuals is between 1,500 and 3,000 pounds of fish per tow. Three crew members should be able to box, ice, and stow 3,000 pounds of 'in the round' product per hour. The arrangement can be modified for gutting and gilling. Two crew members can gut and gill while the third can box and stack. In this manner, three crew members can process 2,500 pounds of product per hour.

Recommendations for the basic handling of each species of fish are presented in Table 1. Implementation of these procedures assumes a normal crew size for a vessel in a particular fishery. Several conditions may warrant the addition of crew. First, if the fishery lands mixed species, it may be justifiable to increase crew size if the extra individuals are assigned to work only with certain species. Second, if the product volume is high but of low value, additional crew may be assigned the task of working with only a selected quantity of fish. Third, if the fishery has a substantial by-catch, extra crew may be recruited to process only the by-catch species. The decision to add crew members must be balanced with an expectation of increased revenues for the higher quality product that will sufficiently cover the rise in costs. (However, there may be some reluctance upon the part of the captain and crew to augment the crew size if there is not an increase in earnings for all crew members also.)

It is imperative that the captain evaluate any and all circumstances where quality control procedures could yield greater earnings. He should assess whether or not to implement quality control on a case-by-case basis.

At Sea Processing and Storage

Employment of an appropriate method for processing and stowing fish at sea should result in a high monetary return at the dock while not interfering with safety or efficiency of operations on the vessel. The

Table 1. Suggested at sea handling methods for selected mid-Atlantic commercial species.

Species	Handling Method
Atlantic croaker	Box whole
Black sea bass	Box whole
Bluefish	Gut and box in the round
Flounder	Box whole
Mackerel	Box whole
Scup	Box whole
Seatrout	Gut, box or short shelve in the round
Spot	Box whole
Squid	Box whole

processing method should be chosen in accordance with prevailing circumstances both on board the vessel and on the market. Other considerations in selecting handling methods are: the length of time at sea, the species of fish, the gear type, and the expected price or market value at the time of landing.

On-Board Processing

Methods for handling and stowing fish depend upon the species to be processed. At sea processing can be done in a number of ways:

1. Bleed, gut, gill, wash, and box (two stage process).
2. Gut, gill, wash, and box (one stage process).
3. Gut, wash, and box.
4. Box whole or in the round.
5. Short shelve in the round.
6. Traditional bulk storage.

All processed products should be heavily iced immediately. Moreover, it should be recognized that eviscerated products are considered higher quality than 'in the round' products. This is because the body cavities can be packed with ice to speed cooling and retard spoilage.

The design of an efficient and effective processing system depends upon the equipment and space available, and how they are utilized. The 'on deck' system used in this study was a two stage gutting station (Figure 1) with a circulating wash tank secured to the port side bulwarks parallel to the main hold, and a removable delivery chute attached between the two stations. A manifold system was incorporated with the vessel's wash down pump as a source of raw seawater for washing and eviscerating (Figure 2). (Note: all equipment pieces should be constructed of 409 stainless steel).

Figure 1. Two stage gutting station.

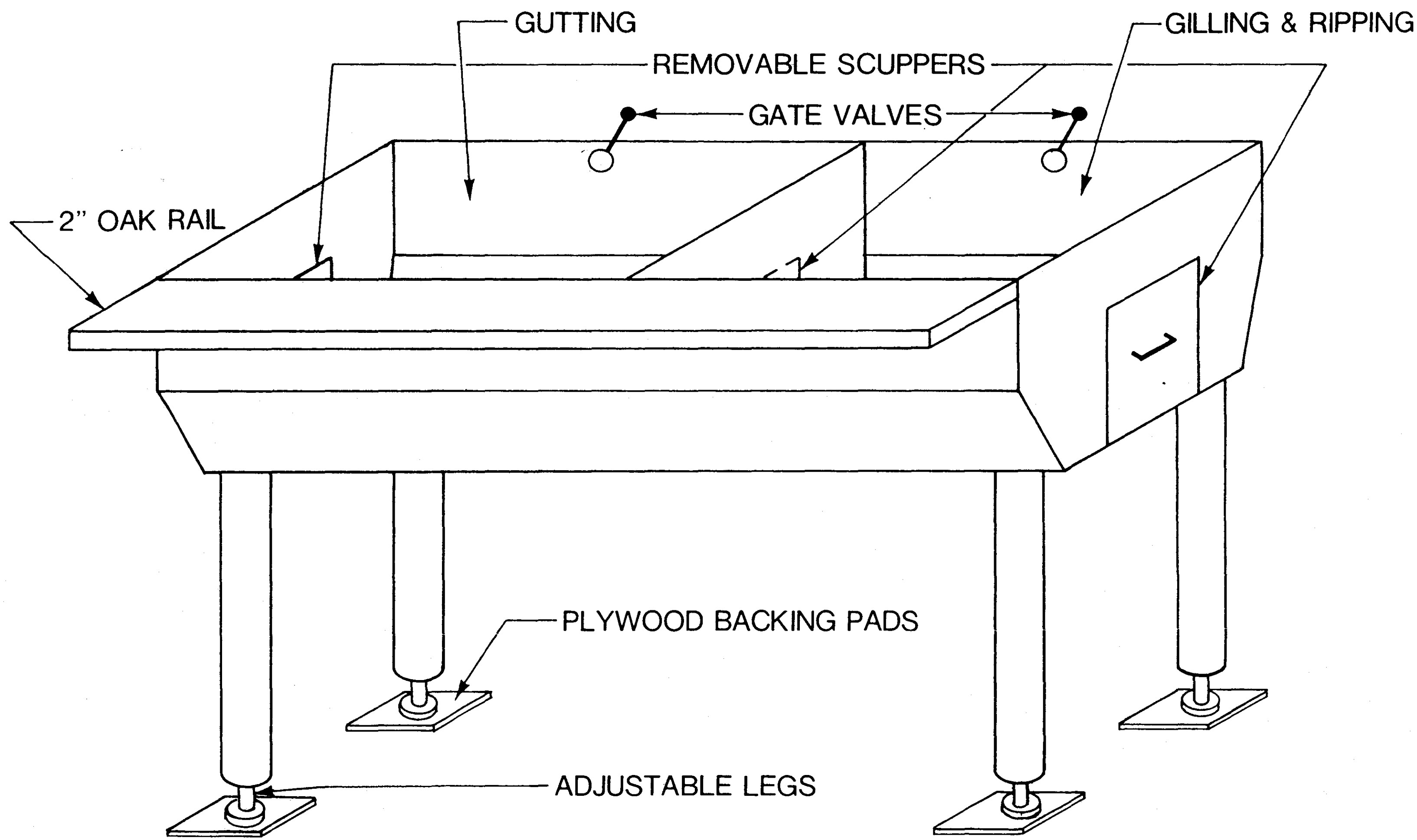
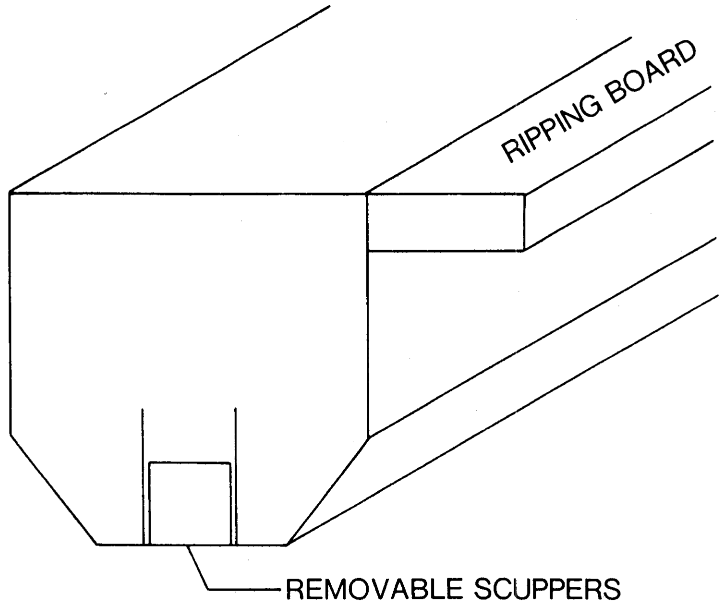
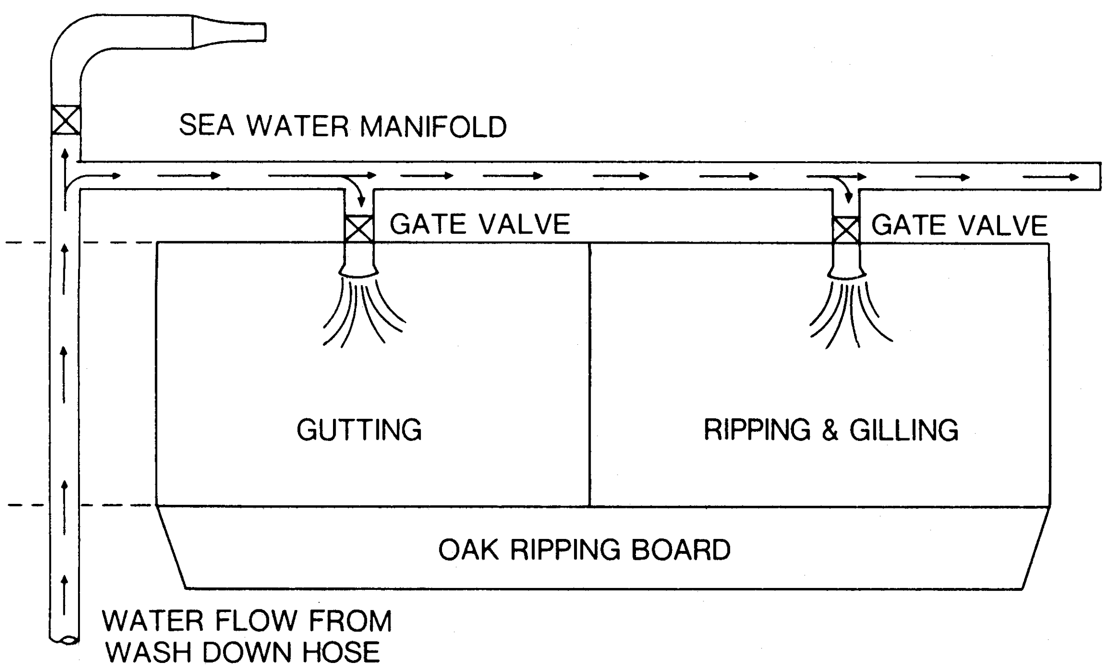

GUTTING
GILLING & RIPPING
REMOVABLE SCUPPERS
GATE VALVES
2" OAK RAIL
PLYWOOD BACKING PADS
ADJUSTABLE LEGS

Figure 2. Manifold system using the vessel's wash down pump as a source of processing water.



END VIEW



TOP VIEW

A layout of the deck is given (Figure 3). Using this figure as a guideline, appropriate deck layouts can be improvised for individual vessels. The layout of the deck should not interfere with the landing of fish, and should be readily accessible to wash water. It should complement the fish packing and icing work in the hold.

On-Board Stowage

Methods for below-deck fish storage (Figures 4 and 5), were derived from the NEFDF study. The fish are delivered through the dover funnel to the slaughter house for boxing (Figure 4). Full boxes are stored forward of the delivery pen. Fish to be short shelved are processed in the delivery pen area and packed head to tail in a proper mix of ice to fish (Figure 5). The shelves should be eighteen inches apart. The recommended ice to fish ratio is 100 pounds of fish to 300 pounds of ice in the summer, and 100 pounds of fish to 100 pounds of ice in the winter (Connors and Ostergard 1986). The ice should surround each fish, but should not be packed so fully that the ice touches the bottom of the shelf above. The temperatures of the fish should be 32-34^{o}F at the end of the trip.

Although a variety of hold configurations are possible (Figure 6), all designs should consider the timing of the at sea catch processing with respect to the start and completion of the trip. The configuration presented represents one possible method for equipment storage and subsequent catch stowage during fishing. Options are provided for traditional bulk storage, short shelving, and boxing - depending on the circumstances of a particular fishing trip.

Several components of the mid-Atlantic fishery are strong possibilities for the initiation of quality control measures. In particular, large volume mixed species fisheries, highly valued fisheries, and fisheries with

Figure 3. Layout of deck of <u>F/V Darana R</u>.

F/V DARANA R.
DECK LAYOUT

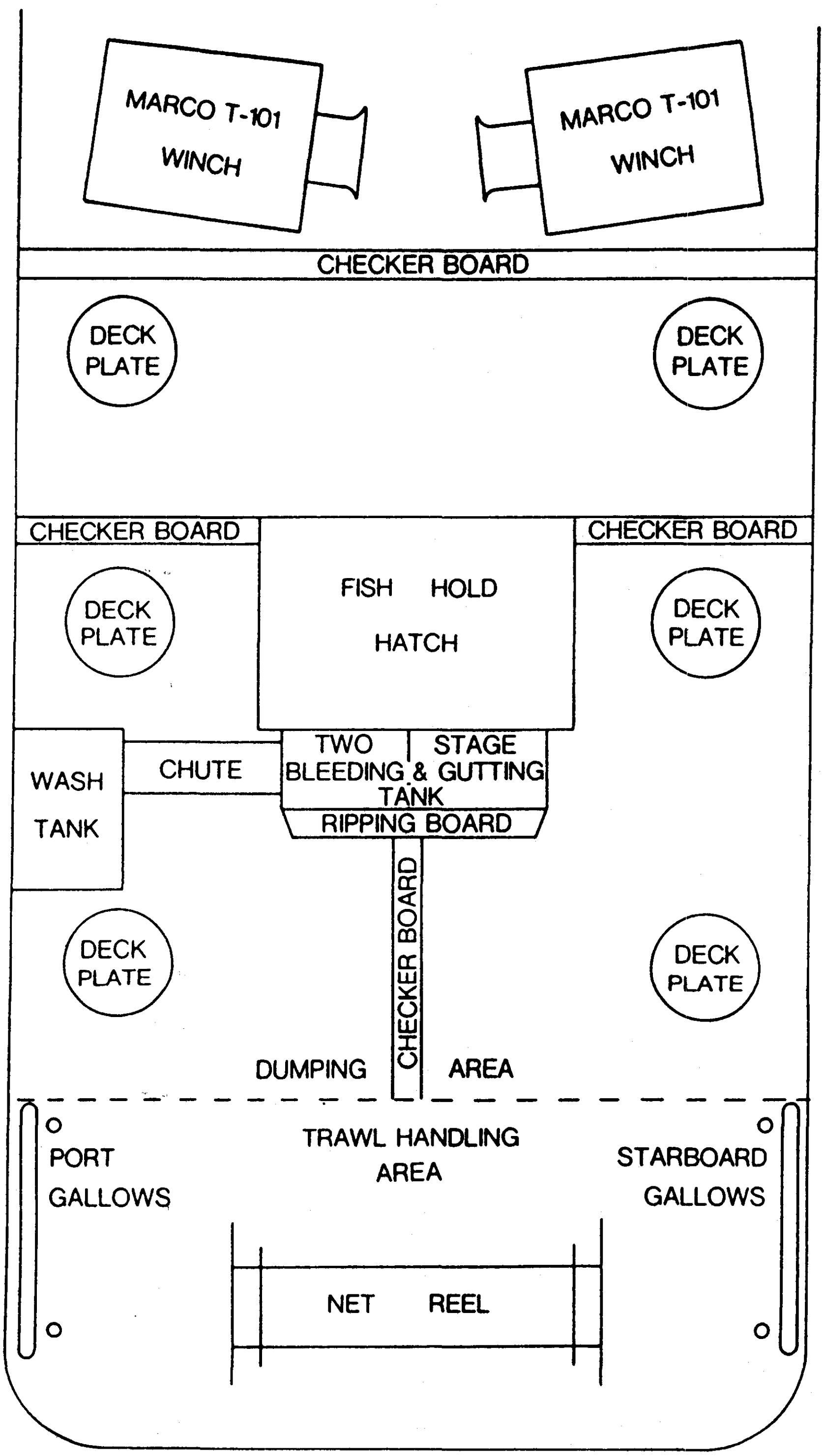


Figure 4. Fish are delivered to slaughterhouse below deck through dover funnel for boxing.

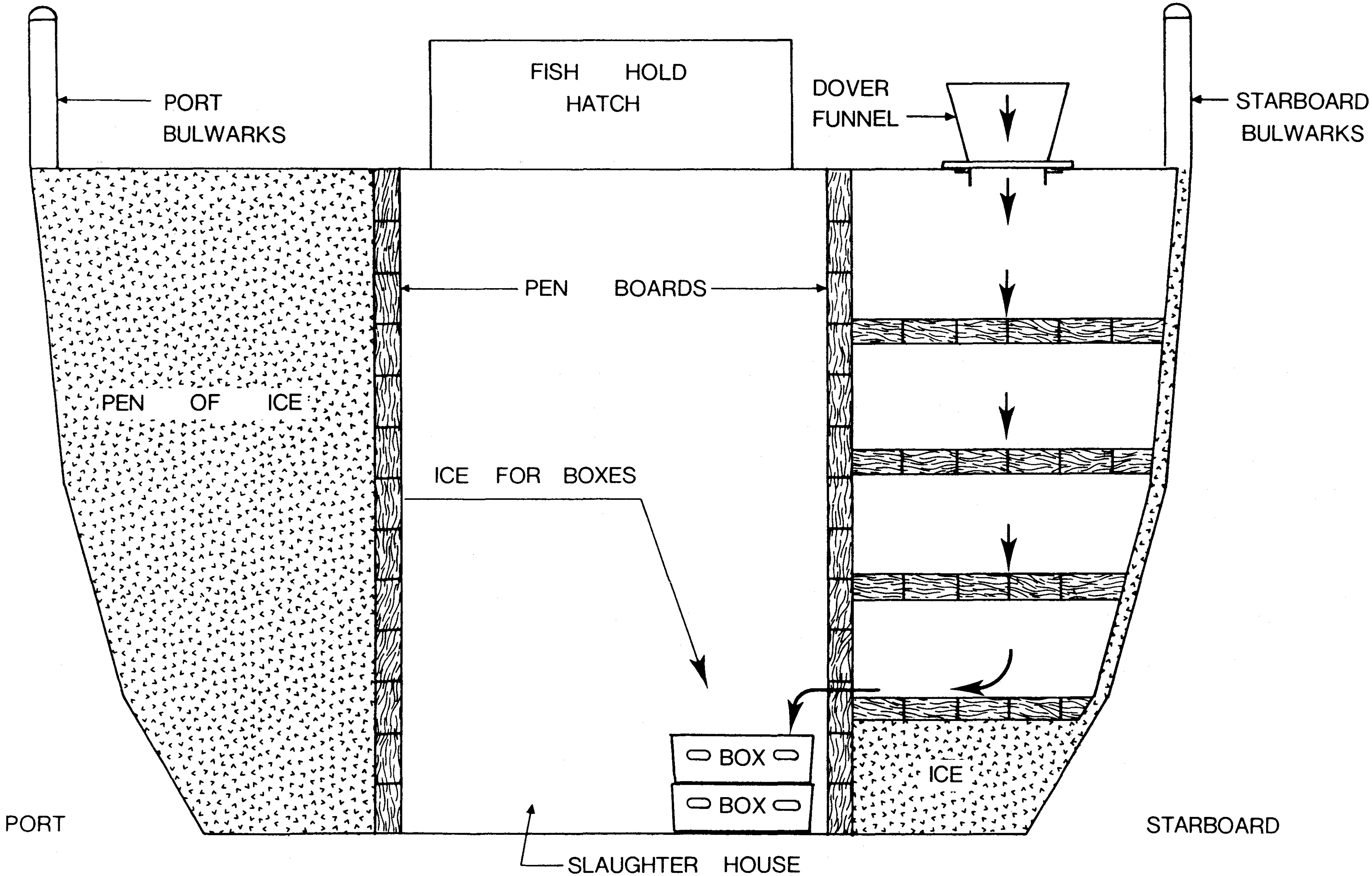
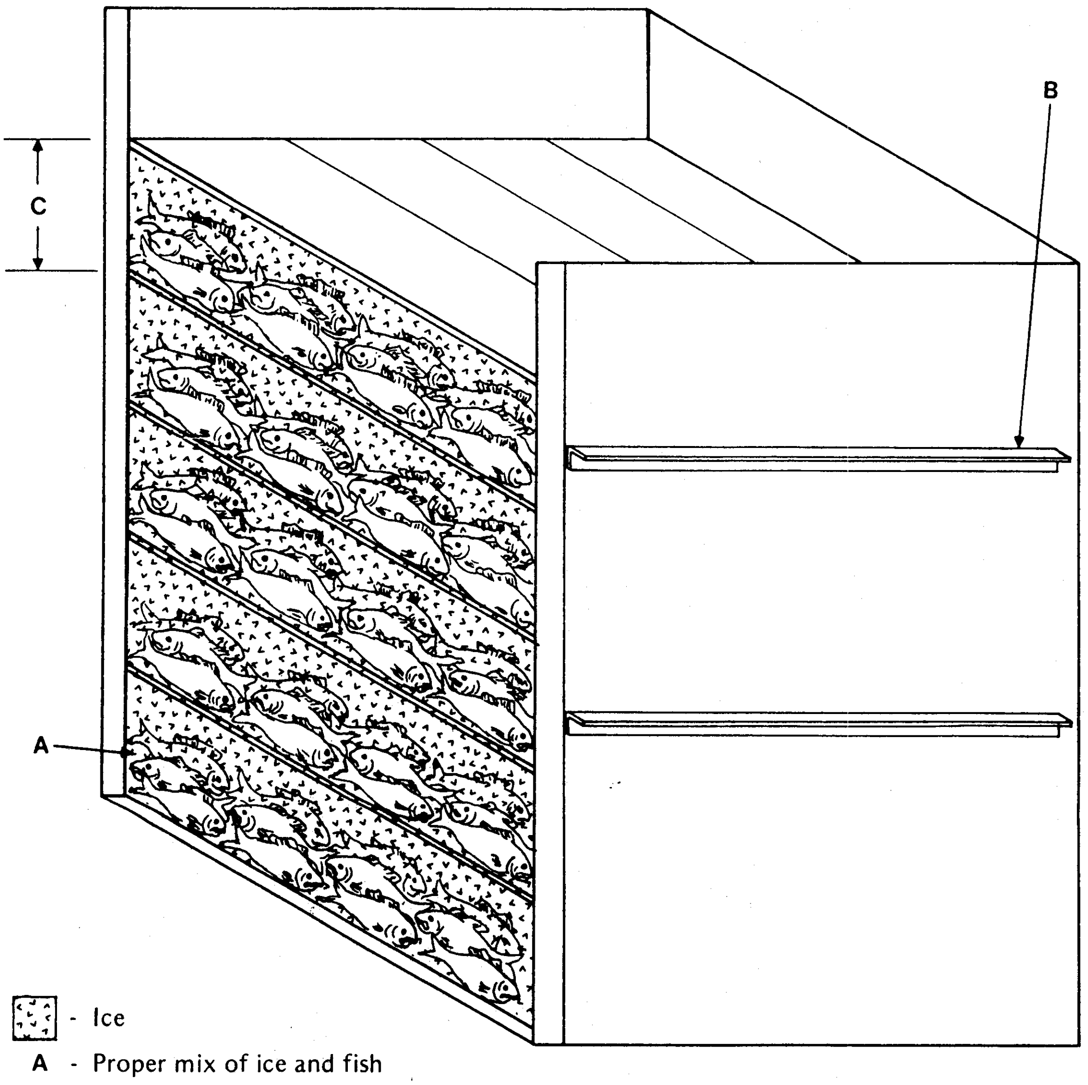

PORT BULWARKS
FISH HOLD HATCH
DOVER FUNNEL
STARBOARD BULWARKS
PEN BOARDS
PEN OF ICE
ICE FOR BOXES
BOX
BOX
ICE
PORT
STARBOARD
SLAUGHTER HOUSE

Figure 5. Proper short shelving technique for finfish.

Proper Short Shelving Techniques



- Ice

A - Proper mix of ice and fish

B - Shelf brackets - Stainless Angle Iron

C - 18″ - 24″ Proper spacing

marketable by-catches are excellent candidates.

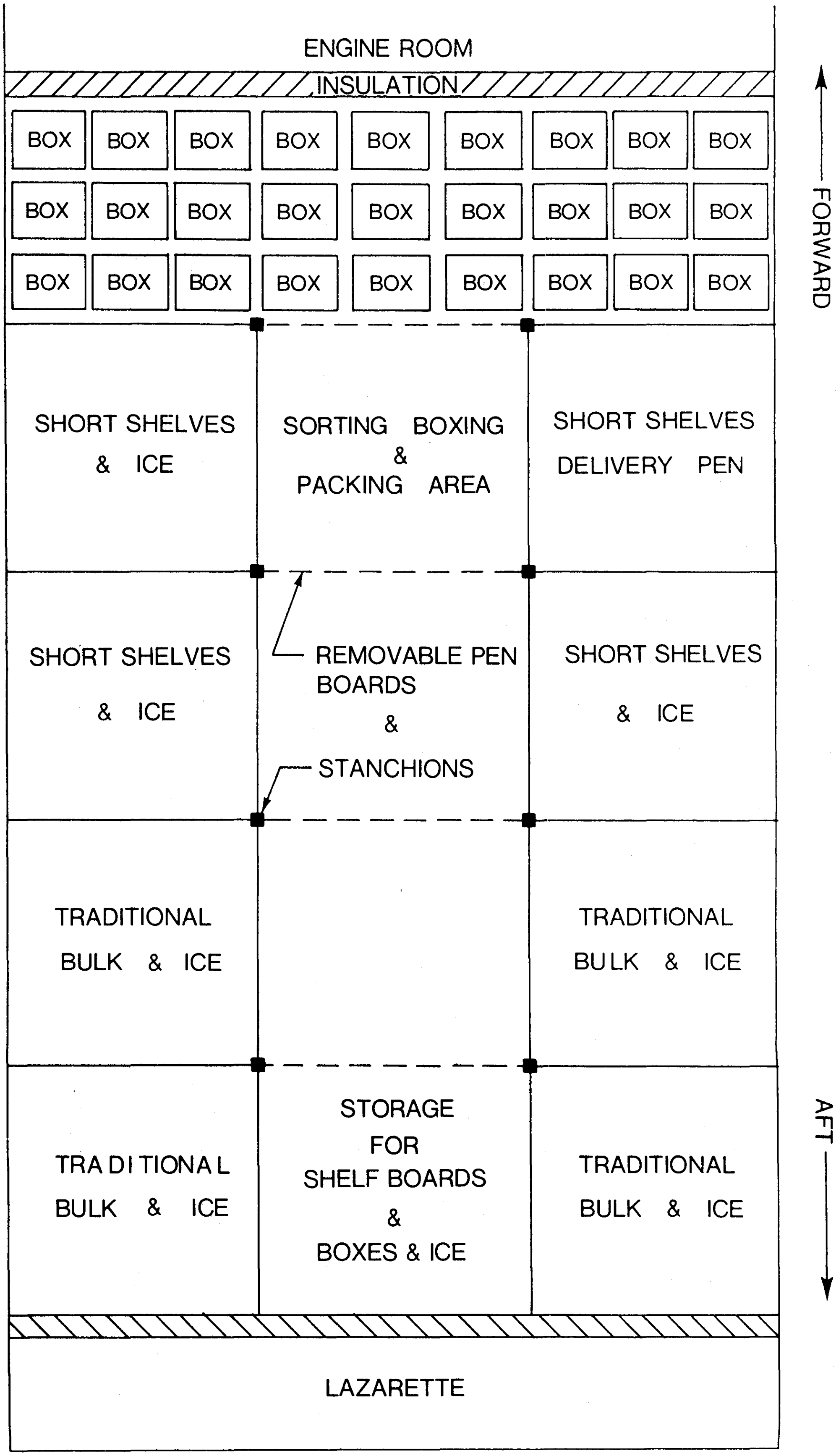
Large volume, mixed species fisheries are viable candidates provided that the species under consideration for the quality control procedures are not harvested in large quantities. These fisheries also create opportunities for additional crew members. The extra crew may be assigned to specialized culling and processing activities. The bulk of the catch may still be handled in the traditional manner while selected species receive more specialized care in handling.

Highly valued species are also excellent candidates for quality control measures. The reason is the demand for highly valued species appears to be more stable or consistent, and less sensitive to price fluctuations. In contrast, the demand for lower valued species is less stable and more sensitive to price change; a small increase in price may result in a large reduction in demand. For example, the popularity of bluefish appears to be quite price sensitive, whereas the demand for sea scallops is less sensitive. The higher valued fisheries appear to be prime choices for initiating boxing-at-sea practices.

By-catch species of directed fisheries are also believed to be potentially successful choices for implementation of quality control procedures. Quantities are typically small, therefore the crew can devote more time to the on-board processing, better handling, and stowage of by-catches. By-catches of directed fisheries in the mid-Atlantic typically include flounder, sea bass, and monkfish. Increasing the shelf life and meat quality of these popular species could be economically worthwhile.

Flounder and monkfish are frequent incidental harvests of the directed sea scallop fishery in particular (DuPaul unpubl. data). If boxing techniques were applied to these two species, their shelf life could be

Figure 6. An example of a possible hold configuration providing options for traditional bulk storage, short shelving, and boxing.



OPTIMAL FISHING LAYOUT

extended during the typical 12-15 day fishing trips. This should increase their dollar value dockside, compensating for the extra work during the trip.

Processing and Distributing

Dockside Handling

Improper handling of a seafood product dockside coupled with poor preparation for its distribution can drastically diminish quality. Cooperation and proper planning are the keys to maintaining the quality of a product from landing to consumption, and all aspects of the seafood industry must be involved. Efforts to maintain product quality on a fishing vessel can be negated by careless handling dockside, during processing or distribution. At the dock, fish must be handled quickly, kept at low temperatures, and loaded or unloaded with care, to minimize damage to the flesh.

Preservation of quality during off-loading is best accomplished using Pers boxes, and can be done at a rate of up to 150 boxes per hour (Connors and Ostergard 1986). The boxes can be winched out separately using a grip claw to hold the boxes securely (Figure 7) or together using a knuckle boom (Figure 8). The fish are culled prior to packing in the boxes, thereby minimizing handling dockside. Since the boxed fish are also chilled, the possibility of product warming is diminished. Fish that were short shelved can be rolled into the lumpers for unloading, eliminating the use of pitch forks and preventing excessive bruising of the fish.

Transferal of products for distribution must also be accomplished in a timely manner while preserving the quality of the catch. This requires educating all employees involved in the distribution process about the perishable nature of fish and other seafood, and about the pivotal role handlers play in maintaining quality (Donohue 1986).

Processors and retailers need to be aware of the precautions that should be taken to prevent degradation of quality in a finfish product. The low at sea storage temperatures must be maintained; products should not be allowed to sit unrefrigerated, at room temperature. The product must also be handled carefully to prevent bruising or damage to the flesh.

Processing

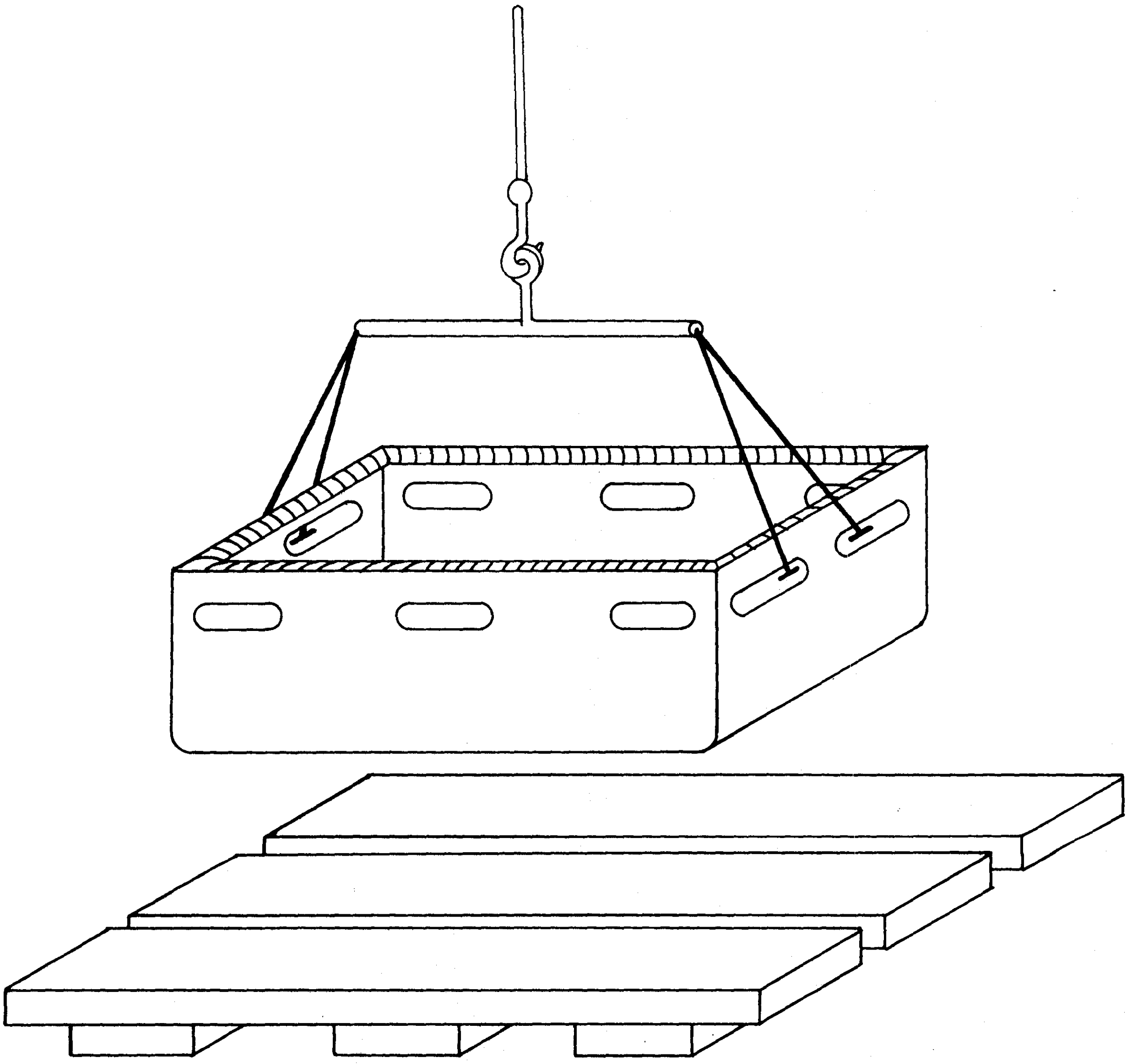
Processors and retailers need to consider both the processing subsequent to landing, and the associated shelf life after processing. Handling of the product by the processor is a critical stage for the preservation of quality. Currently, there are no mandatory handling procedures or guidelines from either the National Marine Fisheries Service (NMFS) or the Department of Agriculture (Haas et al. 1986; VPI-SU 1984; 1986). Processing plants are not subject to federal requirements for packaging and distributing (VPI-SU 1984; Haas et al. 1986).

It is important to maintain the quality of seafood products by using sanitary handling practices throughout processing and distribution. This requires utilization of non-porous materials during processing, and the use of cleaning agents for sanitizing and wash down (VPI-SU 1984; 1986; Haas et al. 1986; Donohue 1986). Coupled with strict efforts to maintain acceptable temperatures and process the products in a timely manner, these practices can check microbial activity, the prime agent of quality degradation.

The Economics of Quality Control Production

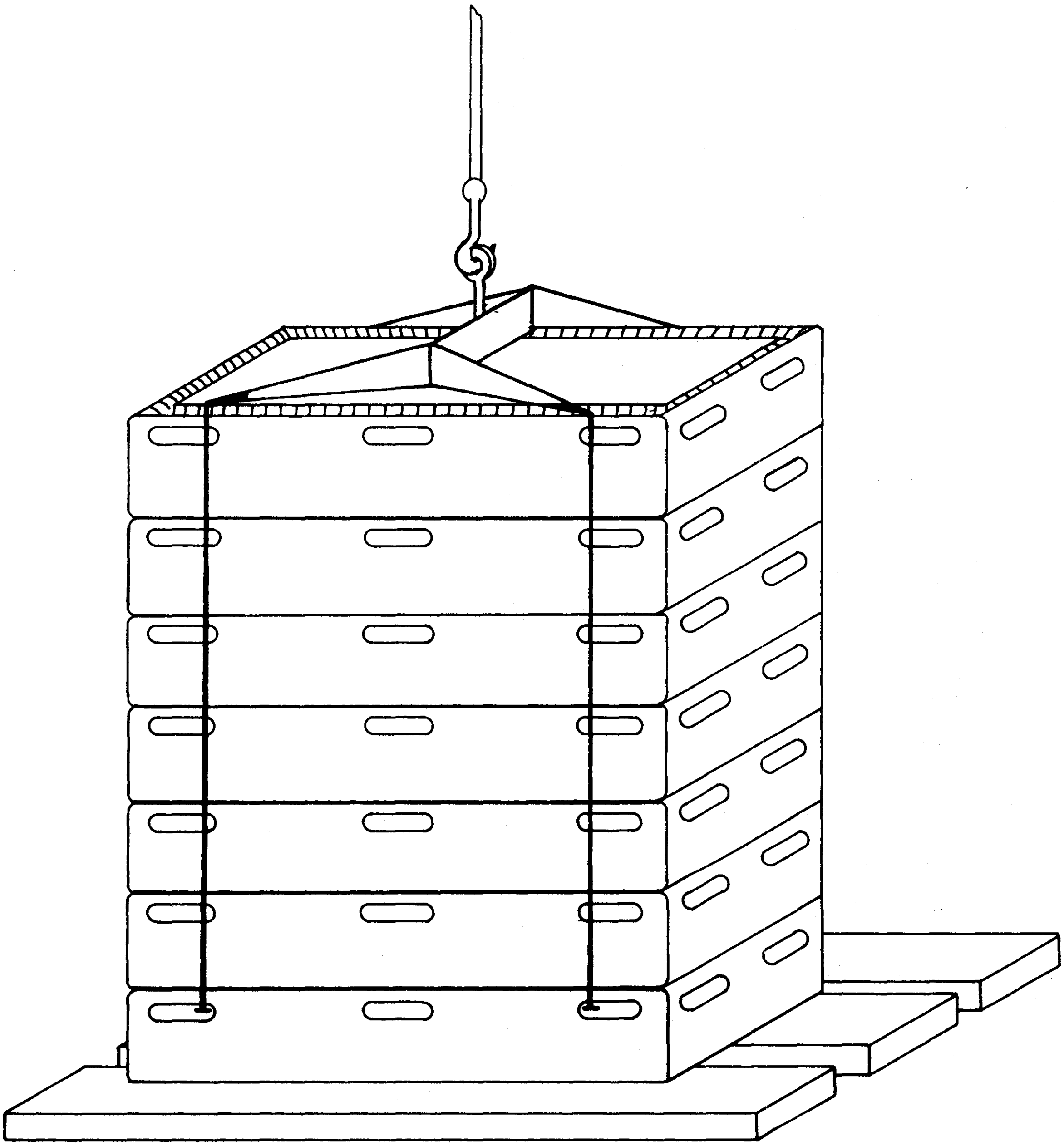
The goal of the initiation of quality control measures is maximization

Figure 7. Method for unloading single Pers box using grip claw.



One Or Two Box Grip

Figure 8. Method for unloading pallet multi-boxes using grip claws and knuckle boom.



Grip Claws For Pallet Multi-Boxes

of profits. In other words, to produce a quality product, so the net profit is greater than that obtained from a product of lower quality. Adoption of quality control procedures requires an evaluation of price, market conditions, and production costs.

A 'common sense' assessment of economic conditions should suffice in determining the feasibility of implementing quality control procedures on a vessel. Simply, is the expected net profit for a better quality product greater than that for a product perceived to be of lower quality? There are a few economic factors to be considered when making this assessment or judgement.

Price Assessment

Many factors affect the demand, and therefore the price of fish. The market price is primarily a function of product supply. It must be determined if price level is the only valid variable to consider in a decision to initiate quality control procedures in any particular situation.

For example, receipts from a high priced, low demand product may not be as great as those for a lower priced, high demand product. The decision to produce a quality product must, in part, be based upon total expected sales. That is, both the quantity demanded and the corresponding price must be considered.

It is also important, when considering whether or not to implement quality control procedures, to consider the price, supply, and demand for all related products. The demand for fish or other protein sources such as beef are interrelated. If the price of one protein source decreases, there is often a subsequent decrease in demand for other protein sources. For example, an increase in fresh cod fillets from Canada at a reduced price could lessen the demand for similar domestic products. Similarly, the demand for fish products could decline if beef prices fell.

Nutritional information increases consumer awareness of the health value of the fish, and the desirability of the product. It is important to make this information available to consumers, to encourage their choice of fish as a protein source. The findings on the health value of Omega-3 fatty acids and their high level in fish are certain to increase consumer awareness of the healthy advantage to fish consumption. In turn, increased awareness of these nutritional benefits should substantially affect the market for fish, increasing consumer desirability, and therefore product prices. The gross nutritional composition of some mid-Atlantic species are listed in Table 2.

The diverse factors that influence price suggest the possible necessity for contractual production at all levels of sales, in order to develop quality differentiated prices. A specific price and quantity combination may need to be established. As a result, fishermen, processors, wholesalers, and retailers would be subject to less uncertainty about expenditures and receipts. Unfortunately, this situation also leaves retailers bearing the burden of risk; they cannot be assured that consumers will purchase a specific quantity of fish at the higher price.

Economic Feasibility

A second, but equally important consideration is the cost of adopting quality control procedures. It should be apparent that if the initiation of these procedures results in related costs greater than the increase in revenue, quality control procedures are not economically feasible. Thus, firms contemplating the adoption of quality procedures must be fully

Table 2. Gross nutritional composition of selected mid-Atlantic commercial species. (Source unknown).

Values for 100 grams (3.5 oz) raw edible portion	Fat (Total Lipid) gm	Moisture gm	Protein gm	Ash, Total gm	Nitrogen, Total gm	Sodium mg	Potassium mg	Cholesterol mg	Saturated Fatty Acids gm	Monounsaturated Fatty Acids gm	Poly-unsaturated Fatty Acids gm
Black Sea Bass	2.011 (.800-3.000)	78.264 (77.300-79.500)	18.433 (18.000-18.900)	1.092 (.900-1.200)	2.949 (2.880-3.024)	68.000	256.000	Not available (NA)	NA	NA	NA
Croaker	3.167 (1.210-5.830)	78.029 (75.220-80.260)	17.783 (17.375-19.518)	1.114 (.710-1.690)	2.845 (2.780-3.123)	87.400	234.000	61.000	1.226	1.293	.523
Spot	3.100	77.500	17.900	1.100	2.864	NA	NA	NA	NA	NA	NA
Scup	2.730 (1.210-4.060)	75.368 (73.600-77.000)	18.876 (18.400-19.100)	1.210 (1.100-1.300)	3.020 (2.944-3.056)	63.000	287.000	NA	NA	NA	NA
Silver Hake	2.603 (.970-3.800)	79.662 (78.700-82.400)	16.994 (15.200-17.800)	1.194 (1.010-1.260)	2.719 (2.432-2.848)	91.970 (65.000-105.000)	299.963 (257.000-347.000)	NA	.606	.767	1.029
Gray Trout	4.200	78.200	15.700	1.267 (1.070-1.300)	2.512	59.000	317.000	NA	NA	NA	NA
Atlantic Mackerel	13.891 (1.800-29.320)	63.552 (53.300-74.400)	18.599 (17.000-22.937)	1.347 (1.000-1.640)	2.976 (2.720-3.670)	89.953 (76.000-114.086)	314.119 (224.000-426.190)	80.000	3.532	5.912	3.641
Bluefish	6.490 (2.050-10.920)	71.560 (69.060-74.060)	20.520 (19.690-21.350)	0.960 (0.900-1.020)	NA	88.000 (86.600-89.300)	417.000 (409.000-426.000)	58.640 (44.090-73.200)	NA	NA	NA

cognizant of all technical requirements, additional production needs, and changes in costs.

One consideration which is typically overlooked is that it may become necessary to adopt quality control procedures in order to remain competitive in both the world and domestic markets. Fishermen may eventually have to produce higher quality products with little or no change in profits, just to contend with other suppliers.

The Open Access Profit Level

A final but seldom considered aspect of quality control implementation is the potential economic result of a successful quality control program in an open access, common property fishery. If quality control procedures are successful in enhancing steady profits, new entries into the fisheries can be anticipated. The ultimate consequence of these entries could be the eventual decline in profits; economic theory suggests these profits will drop to zero over time (Anderson 1977).

An associated problem of a successful quality control program, particularly with underutilized species, is that the supply of the underutilized species is quickly reduced and the price increases (Pratt 1987). This restricts the availability of the product to buyers, who in turn, respond by purchasing foreign supplies or other species.

Summary and Conclusions

This work demonstrated the possibility of implementing quality control procedures - suggested for New England fisheries by the New England Fisheries Development Foundation - in the mid-Atlantic fisheries. These measures can be adapted as primary treatments when the catch per tow is less than 3,000 pounds, or as secondary partial treatments when the catch is greater than 3,000 pounds. If adapted as a secondary treatment, the addition of an extra crew member to process some percentage of the catch using these procedures will produce a greater yield for high value species without interfering with normal operating procedures.

Several of the methods tested yielded good results. One such practice was the quick reduction in catch temperature using heavy icing, and maintaining the low temperatures by constantly adding more clean ice. Boxing of fish, but not necessarily gutting or gilling, was also effective. Eviscerating fish is beneficial in some situations, such as when the fish have recently fed. In addition, sanitizing surfaces with cleaning agents to facilitate the removal of microorganisms will help to improve quality. Sealing surfaces in the fish hold will help prevent microbial attachment and subsequent catch contamination. These measures should aid in maintaining a low level of microbial growth during fishing trips.

At this time, it appears that the implementation of these procedures in mid-Atlantic fisheries is prohibitive, due to the lack of economic incentive for the harvester. In New England, price differentials exist for quality fish. This is not yet true in the mid-Atlantic. In addition, there are other obstacles which exist throughout the fishing industry inhibiting the development of a system which allows for premium products. Particularly important is the lack of quality standards within the fishing industry and the absence of federal regulations. These are severe obstacles to the development of quality markets for underutilized species. According to a Canadian source, the first most important barrier to seafood sales is consumer fear of preparation, and the second variable quality (McMahon 1984). Therefore, it is likely that consumer education in seafood preparation and quality expectation will increase fish sales and initiate the price differential necessary to permit harvesters to utilize quality control methods. The profits derived from quality control procedures must be distributed back to the fishermen, otherwise there are no economic incentives to implement these procedures.

Currently, the U.S. fishing industry is in danger of being outcompeted by countries more committed to the production of quality fish. In order to reverse this situation, a concerted effort must be made by all components of the U.S. fishing industry to increase domestic as well as foreign demand for U.S. produced quality fish. This could be done by experimentally promoting "test" species with known marketing characteristics. It would involve marketing these species to the consumer in a form that is known and accepted at an appropriate time of year, in a location along the coast where the consumer is already well-acquainted with quality seafood.

An attempt to market new species in a market starved for fish would complicate the situation and defeat the purpose, because consumers are not familiar enough with product variances to differentiate quality and be willing to pay a premium price. Any plan to develop a valid premium for quality seafood should be handled on a contractual basis so that all the guidelines and restrictions are defined prior to its inception. This may help prevent logistical problems from interfering with the development of a viable and productive market.

Literature Cited

Anderson, L. 1977. The Economics of Fisheries Management. Johns Hopkins Univ. Press, Baltimore. 214 pp.

Background Paper on Fisheries Trade. 1984. A report prepared for the New England Governors Conference, Inc., First Annual Bilateral Symposium of New England-Eastern Canadian Affairs. 24-25 May. Providence, RI.

Connors, G. and J. Ostergard. 1986. Fishing: Quality at Sea, A Manual for On-Board Quality Procedures. 2nd edition. New England Fisheries Development Foundation, Inc., Boston, Massachusetts. 55 pp.

Dalrymple, D. G. 1968. On the economics of produce grading. Am J. Ag. Econ. 50: 157-159.

Dalrymple, D. J. 1961. A study of consumer preference for applesauce using the two-visit interview technique. J. Farm Econ. 43: 690-697.

Donohue, J. 1986. Fish Handling at Sea: "First Step Toward Quality." Sitka Sound Seafood Inc. Sitka, Alaska. 2nd edition. April. 33 pp.

Haas, E., D. Heiman, and M. Jones. 1986. American Fish Scandal: Health Risks Unchecked. A Report by Public Voice for Food and Health Policy. November. 44 pp.

Kramer, D. E. and B. C. Paust. 1985. Care of Halibut Aboard the Fishing Vessel. Univ. of Alaska Sea Grant College Program, Marine Advisory Bulletin No. 18. May. 30 pp.

McMahon, F. 1984. Atlantic fishery needs new products, markets. The Chronicle-Herald. Halifax, Nova Scotia. 27 March. p. 9.

Perkins, B. E. 1986. Shrimp Boat Sanitation and Quality Control. Circular CRD-36, MASGP-86-014. Alabama Sea Grant Marine Advisory Service, Alabama Cooperative Extension Service.

Pratt, S. 1987. Trendy fish are being promoted out of the market. Daily Press. 4 October.

Tomek, W., G. Kenneth, and L. Robinson. 1972. Agricultural Product Prices. Cornell Univ. Press. Ithaca, NY. 376 pp.

VPI-SU. 1986. A Seafood Quality Program for the Mid-Atlantic Region. Part II. A report submitted to the Mid-Atlantic Fisheries Development Foundation, Inc., by Sea Grant at Virginia Institute of Marine Science and Sea Grant at Virginia Polytechnic Institute and State University. Annapolis, MD. 97 pp.

VPI-SU. 1984. Demonstration of a Quality Maintenance Program for Fresh Fish Products. Part I. A report submitted to the Mid-Atlantic Fisheries Development Foundation, Inc., by Kroger Technical Center and Sea Grant at Virginia Technical Institute and State University. Annapolis, MD. 252 pp.

Appendices

Appendix I. Fishery location and seasonal distribution information for selected mid-Atlantic commercial species.

Species	Fishery Locations/Seasons
Grey Seatrout (*Cynoscion regalis*)	1. Based on 1975 to 1979 average data, the New England, Middle Atlantic, Chesapeake, and South Atlantic areas account for approximately 2, 31, 21, and 46% of the total catch, respectively (Wilk 1981). 2. Caught inshore along Atlantic coast, especially within bays and sounds during warmer months and offshore in South Atlantic region during winter (Mercer 1983). 3. Centers of abundance are NC, Chesapeake Bay, Delaware Bay, NJ coastal waters, and Great South Bay and Peconk Bay of eastern Long Island (Mercer 1983). 4. Distribution of landings has shifted historically from Middle Atlantic and Chesapeake areas (during 1940's) to the South Atlantic (primarily NC in 1980 and 1981) (Mercer 1983). 5. Fishing seasons: (a) SC - greatest landings in January; (b) NC - greatest landings in February; (c) VA and DE - in May and October; (d) NJ and NY - in May or June and October; (e) RI and MA - in August; (f) MD - no spring peak, landings peak strongly in late fall (Mercer 1983). 6. North of Chesapeake Bay, fishing season extends from April or May to November or December; harvested throughout the year in NC with highest landings from December through March by offshore trawl fishery; caught year round off SC, GA, FL with lowest catch in March (Mercer 1983).
Spot (*Leiostomus xanthurus*)	1. In Chesapeake Bay commercial catches begin in spring, during April or May, and continue until September and October when fish leave the Bay (Pacheco 1962b). 2. Chief commercial fishery centered in VA and NC region; bulk taken from August to October while migrating out of Chesapeake Bay; during winter are incidentally taken off Cape Hatteras region (Pacheco 1962b). 3. Almost entire harvest of commercial food fish comes from South Atlantic and Ches. Bay areas; from early 1960s to present, a dramatic shift in landings from Ches. Bay to the South Atlantic: in 1979, 3/4 of total landings came from South Atlantic (Wilk 1981).
Croaker (*Micropogonias undulatus*)	1. Geographic distribution of food fish catches have shifted from one area to another during past 40 years; catches were primarily from the Ches. region during 1940s; during period of peak catches in 1950s, landings were high both in Ches. and Gulf of Mexico areas, and to a lesser degree in South Atlantic; most recent peaks attributed to increases in Gulf and South Atlantic landings and some in Ches. region; Middle Atlantic region has not contributed significantly to the total food fish catch at any point during the past 40 years (Wilk 1981). 2. Larger croaker support major commercial fishery between Chesapeake Bay and southern NC, also occur offshore in central Gulf of Mexico (Ross 1985).

Appendix I cont'd.

Species	Fishery Locations/Season
Black Seabass (Centropristis striata)	1. Has been of major importance to the commercial and sport fisheries in mid-Atlantic Bight (Cape Cod to Cape Hatteras) for more than 50 years (Musick and Mercer 1977). 2. During warmer months active commercial fishery pot fishery and hook and line sport fishery exist in water depths less than 36m; greatest effort in those fisheries is expended between Montauk, NY and Cape Henry,VA; are caught in offshore areas during late fall and winter off VA and NC (Musick and Mercer 1977). 3. Middle Atlantic Bight sampling area (ie. NY, NJ, DE, PA, Ches. area including MD and VA) -- landings reached all-time high in 1952, but dropped sharply after 1965 and have continued to do so (Musick and Mercer 1977). Recent catches show modest increase, but remain at about 25% of early 50's level (McBride and Brown 1980). 4. Most of the exploited black seabass are males; recreational catch is thought to be consistently larger than commercial. In 1970's recreational catch comprised more than 75% of total catch of black seabass (McBride and Brown 1980). 5. Fishing areas: occurs all along east coast from MA to FL; inshore in summer and offshore in winter; distance from shore varies seasonally; trawling occurs in water 50 ft. deep in North Atlantic to 300 ft. in Middle Atlantic; historically most in South Atlantic area taken in pots off Charleston, SC, but in recent years trawling and pot fishing extended all along Carolina coast (Kendall 1977). 6. Seasons: in North Atlantic trawling occurs during two periods -- March to June and September to November; in Middle and South Atlantic trawling most successful from September to March, but occurs throughout the year; traps are fished from May to November in Middle Atlantic, and throughout the year with most landings from September to June in South Atlantic (Kendall 1977).
Atlantic Mackerel (Scomber scombrus)	1. Fished in New England area, Gulf of Maine; inshore in warmer months, offshore in winter (Hog and Clark 1967). 2. Are caught in Atlantic waters from Bay of Fundy to Atlantic coast of Nova Scotia, throughout Gulf of St. Lawrence and periodically on east coast of Newfoundland (Mackay 1967). 3. Is sufficiently abundant for commercial fishery from Chesapeake Capes on the south to Magdalen Islands and the Gaspe Peninsula on the north; during the fishing season it is most abundant in the open waters of the inner third or half of the continental shelf (Sette 1950). 4. Fishing begins in early April off Virginia Capes; off NJ-Long Island coast by May; off southern New England toward end of May; in Gulf of Maine by mid-June (Sette 1950). 5. Are in upper water layers from spring through summer and into autumn; leave coastal areas by end of December (Bigelow and Schroeder 1953).

Appendix I cont'd.

Species	Fishery Locations/Seasons
Bluefish (<u>Pomatomus saltatrix</u>)	1. More than 50% of US commercial catches during 1973-1980 came from Middle Atlantic area (NJ - Cape Hatteras) (Vaughn 1982). 2. Season and area: (a) southern New England to Delaware Bay - May through November, peak August or September; (b) NC - sometimes all year long, but usually April through December, peaks in May, July, and September; (c) east coast of Florida - September to early May, peaks between October and April; (d) west coast of Florida - irregular from year to year, but generally in late fall through spring from Tampa south, spring through fall from Tampa north (Wilk 1977).
Scup (<u>Stenotomus chrysops</u>)	1. Is caught throughout its range but distribution of fishing area changes seasonally following migration: inshore in summer, offshore in winter (Morse 1978). 2. Summer trawl fishery inshore from Cape Cod to NC (north of Cape Hatteras); winter trawl fishery offshore from Cape May, NJ to Cape Hatteras, NC to 100 fathoms (Morse 1978). 3. Caught in bays, sounds, and estuaries in summer, and offshore about 50-70 miles in winter (Morse 1978). 4. Areas of greatest abundance during summer from central NJ to Nantucket; during winter from MD to Cape Hatteras, NC (Morse 1978). 5. Depth ranges - bathymetric contour from 1-100 fathoms (Morse 1978). 6. Most of the recent increases (1979-80) in scup catches attributable to increased fixed gear and otter trawl landings in southern New England-NJ area. Overall, scup is probably being fully exploited with southern stock more so than northern stock (Vaughn 1982).
Silver Hake (<u>Merluccius bilinearis</u>)	1. Stocks inhabiting continental shelf waters off northeast coast of US have supported active commercial fishery since 1930's (Anderson et al. 1980) 2. Are abundant in offshore area between Nova Scotia shelf and NY Bight (Anderson et al. 1980). 3. Principal silver hake port since end of WWII has been Gloucester, MA; principal states catching hake in northeast are ME, MA, RI,, NY, NJ (1968-77) (Anderson et al. 1980). 4. Seasonal character of fishery: (a) ME - primarily summer fishery, conducted mainly from June to October; (b) MA - bulk of landings from July to October; (c) RI - 2 principle seasons: April - June and November - January; (d) NY and NJ - landings almost all during November - May when silver hake are most abundant in NY Bight (Anderson et al. 1980). 5. Trends by stock: (a) Gulf of Maine - bulk of US landings May - December in inshore areas; in last several years inshore fishery has begun in April, during 1978-79 significant catches taken in deep overwintering area January-April; (b) Georges Bank - areas including Cultivator Shoal most productive, primarily June - July most years (Anderson 1980). 6. Georges Bank and southern New England - Middle Atlantic stocks are high in abundance with fish available in inshore waters and on shoal portions of Georges Bank during warm months and further offshore along edge of continental shelf during cold months (Anderson et al. 1980).

Appendix II. Reproductive life history information for selected mid-Atlantic commercial species.

		Spawning		Larvae		Juveniles	
Species	Range	Location	Season	Location	Season	Location	Season
Grey Seatrout *Cynoscion regalis*	Southern FL to MA Bay occasionally to Nova Scotia. Generally most abundant from NC to NY	Nearshore along beaches, in mouths of inlets and estuaries	May to Oct (peak in May and June)	Estuaries	For first summer	Estuaries	For 1st summer
Scup *Stenotomus chrysops*	South Carolina to Sable Island, Nova Scotia. Uncommon north of Cape Cod	Inshore	Generally May to Aug, early April in Ches. Bay area	Inshore/Bays/ shallow waters within bays and and estuaries	Summer/early fall?	Shallow waters within bays and estuaries	Summer/ early fall?
Silver Hake *Merluccius bilinearis*	SC to Newfoundland, most abundant in offshore waters extending from NY to Cape Sable, Nova Scotia. In US waters, abundant from Me to NJ	Shallow waters	Mar to Nov, occurs earlier on Georges Bank and further southward with peak in mid to late June	Major concentration in southwest Georges Bank and adjacent waters off southern southern New England (Silverman 1982)	Spring and summer	Information not available	
Croaker *Micropogon undulatus*	Gulf of Maine to Bay of Campeche; range may extend as far south as Argentina or Brazil	Offshore	Fall-winter (peak in Oct between Cape Hatteras and Block Island, RI)	Estuaries	Late winter/ spring?	Estuaries	Spring-summer

Appendix II. cont'd.

Species	Range	Spawning Location	Spawning Season	Larvae Location	Larvae Season	Juveniles Location	Juveniles Season
Spot *Leiostomus xanthurus*	Along Atlantic and Gulf coasts from Gulf of Maine to Bay of Campeche. Abundant from TX - NY.	Offshore/continental shelf shelf waters	Cooler months Sep through Apr depending on location	Marsh/ estuaries	Late winter, early spring	Marsh/ estuaries	Late winter,
Bluefish *Pomatomus saltatrix*	Cape Cod to Brazil, captured as far south as Argentina and as far north as Nova Scotia. Greatest concentration off coast of mid Atlantic states and Cape Hatteras	Continental shelf water Cape Hatteras to Cape Cod	Summer primarily Jun through Aug	Offshore	Summer?	Coastal areas/ estuaries	Late summer to mid fall
Black Seabass *Centropristis striata*	Common from Cape Cod to Cape Canaveral, FL, also along northern and eastern coastal areas of Gulf of Maine, but is rare	Between Chesapeake Bay and Montauk, Long Island in depths of 18-45 m (open ocean)	Summer and spring	Offshore	Spring/ summer?	Estuaries	Spring/ summer?
Atlantic Mackerel *Scomber scombrus*	Cape Hatteras to Newfoundland or Labrador to Cape Lookout. Open sea species but rarely found beyond waters overlying continental shelf	Southern group spawns from NC to MA (Cape Hatteras to Cape Cod), occurs in open waters from nearshore to as far as 80 mi to sea, but mostly 10-30 mi from shore	Spring and summer mid-Apr to Jun	Offshore	Spring/ summer?	Found most consistently along shore from Long Island to Cape Ann inshore inshore locations	Summer, late fall and early winter. Disappears from coastal waters in early winter.

Appendix III. Selected overview of general life history characteristics of some mid-Atlantic commercial species.

A. Black Sea Bass

1. Data suggest there are two stocks of black sea bass; one north of Cape Hatteras, NC, and one south of Cape Hatteras (Mercer 1978; Waltz et al. 1979).

2. The northern stock is migratory, wintering off VA and Currituck, NC, in 30-50 fathoms; moving inshore and northward along the coasts of the mid-Atlantic states as far north as southern New England in spring and summer; become resident in shallow water in summer; migrate southward and offshore in fall (Mercer 1978; Waltz et al. 1979).

3. Spawning occurs earlier in year on southern part of range; late May off Chesapeake Bay and early summer off southern New England; females are found ripe in early April off NC (Kendall 1977).

B. Atlantic Mackerel

1. Migrates seasonally (Sette 1950).

2. Southern contingent migrates from offshore winter habitat towards VA, MD, and NJ coasts in April, then migrates northeastward to occupy western part of the Gulf of Maine in summer; first appears in early April in waters of continental shelf between Cape Hatteras and off of Delaware Bay (about 30-50 miles offshore); moves inshore occupying inner 1/3 or 1/2 of continental shelf; moves northeastward and reaches southern New England in May; migrates to Gulf of Maine for summer during end of June or early July; migrates offshore in fall, retracing spring migration inland - moves southeastward from Gulf of Maine past Cape Cod (September or October) (Sette 1950).

3. See Berrien (1978) for information on eggs and larvae.

C. Atlantic Croaker

1. Basically a southern species, important in the Gulf of Mexico and South Atlantic Bight (Diaz and Cordes 1982), uncommon north of NJ (Lassuy 1983).

2. Migration of adults from coastal and estuarine waters to spawn (Powles 1981).

3. Adults make fall and spring migrations: spring migration to shallow water feeding grounds/estuaries; fall migrations offshore to spawning grounds/coastal waters (Hildebrand and Cable 1930; Diaz and Cordes 1982).

4. Croaker north of Cape Hatteras have a spawning season that starts earlier (July or August-December) and may end earlier with peak spawning occurring by mid-fall (White and Chittenden 1977).

5. Juvenile is dominant life stage occurring in estuarine habitats; after about one year most juveniles leave estuary for nearshore marine waters (Diaz and Cordes 1982).

6. Larvae move up estuary to areas of brackish water where transition to juvenile occurs (Diaz and Cordes 1982).

D. <u>Bluefish</u>

1. Some juveniles inhabit estuaries in late summer; more juveniles seem to remain along shore; all juveniles move southward and out of Mid Atlantic Bight in mid-fall; distribution in late fall and winter unknown (Kendall and Walford 1979).

2. Early larval development occurs near surface in ocean (Wilk 1977; Kendall and Walford 1979).

3. Adults migrate seasonally: northward in spring and summer; southward in fall and winter (Wilk 1977).

4. Two major areas and seasons of spawning along US, South Atlantic Bight and North Atlantic Bight, may represent different populations (Wilk 1977; Kendall and Walford 1979).

E. <u>Gray Seatrout</u>

1. Principle spawning areas from Chesapeake Bay to Montauk, Long Island, NY (Mercer 1983).

2. Larvae have also been collected from nearshore to 70 km offshore (Mercer 1983).

3. Juveniles distributed along coast from Long Island to North Carolina at depths of 9-18 m during late summer and fall (Mercer 1983).

4. Young migrate south as far as Florida in late fall, return in spring (Bulloch 1983).

5. Adults occur in estuarine and oceanic waters exhibiting inshore-offshore, north-south migration pattern (Mercer 1983).

6. Young adults (<4 years) migrate north in spring and summer, and south and offshore along coast in fall and winter. Older adults (>4 years) move south along coast, but further offshore, rarely south of NC and return to northern inshore grounds in spring (Wilk 1979; Bulloch 1983).

7. Adult wintering grounds may be on continental shelf from Chesapeake Bay to Cape Fear, NC - exact location unknown (Mercer 1983).

F. Spot

1. During spawning, adults migrate from coastal waters offshore to continental shelf waters where spawning and egg development occur (Powles 1981).

2. Post-larvae migrate from marine environment into estuaries in winter and spring where they develop into juveniles (Stickney and Cuenco 1982).

3. Juveniles move into marine habitat in fall (Stickney and Cuenco 1982).

G. Scup

1. Continental shelf species occurring primarily in Mid-Atlantic Bight from Cape Hatteras, NC, to just north of Cape Cod, MA (Morse 1978; Vaughn 1982).

2. Extensive seasonal migrations of adults from inshore summer grounds to offshore winter grounds (Morse 1978).

3. In summer, fish $\geq$ 4 years tend to stay in ocean or near mouth of larger bays, younger fish enter shallow areas of bays (Morse 1978).

4. Late October, adults begin to move offshore to depths of 40-100 m (Griswold and McKenny 1984).

5. Possibility of a southern New England stock and another stock extending south from NJ (Vaughn 1982) with differing migration patterns (Morse 1978):
   a. one stock summers in southern New England waters and winters off central and southern NJ (Morse 1978);
   b. one stock summers in Sandy Hook, NJ, area and migrates within 10 fathoms along the coast, wintering offshore between Cape May, NJ, and Cape Hatteras, NC (Morse 1978).

6. Spawning season and area:
   a. Narragansett Bay, RI - May to July, peak in June (Griswold and McKenny 1984; Morse 1978).
   b. Vineyard Sound - June (Morse, 1978).
   c. Woods Hole and Sandy Hook Bay - June to July, peak in June (Morse 1978).
   d. Eastern Long Island - May to August, peak in June (Morse 1978).
   e. Long Island Sound - May to July, peak in June (Morse 1978).
   f. Southern New England - May to July, peak in June (Morse 1978).
   g. Peconic Bays, NY - May to June (Morse 1978).

H. Silver Hake

1. Grouped into three stocks - Gulf of Maine, Georges Bank, and southern New England - Middle Atlantic (Anderson et al. 1980).
2. Fish in southern New England - Middle Atlantic area undergo seasonal inshore-offshore migrations (Anderson et al. 1980).
3. Undergo extensive migrations, overwintering in deep waters of Gulf of Maine and along continental shelf and slope, south and west of Georges Bank (Vaughn 1982).
4. Upper limit is the tide line; have been trawled as deep as 150-400 fathoms on continental shelf off southern New England and as deep as 296 fathoms off North Carolina (Bigelow and Schroeder 1953).
5. Eggs taken in fair numbers off Woods Hole in July and August; nearshore off Long Island in June and July with eggs as far south as off of Cape May; young fry caught off NY from spring to autumn (Bigelow and Schroeder 1953).
6. Fahey (1974) found no evidence that silver hake depend on or utilize estuarine areas during their early life history.

Appendix IV. Selected References for the Biochemical Composition of Some Mid-Atlantic Commercial Species

Bonnet, J. C., V. D. Sidwell, and E. G. Zook. 1974. Chemical and nutritive values of several fresh and canned finfish, crustaceans, and mollusks. Part II: Fatty acid composition. Marine Fisheries Review. 36(2):8-14.

Dingle, J. R. 1976. Technology of mackerel fishery - bibliography and survey of literature. Dept. of the Environment, Fisheries, and Marine Science. Ottawa, Canada. Miscellaneous Special Publication No. 30, 63 pp.

Ernst, R. C. Jr. 1981. Applications of refrigerated and chilled seawater systems to southeast U.S. fisheries: a project overview and progress report. Pp. 225-232. In: International Institute of Refrigeration. Advances in technology in the chilling, freezing, processing, storage and transport of fish, especially underutilized species.

Exler, J. 1985. Personal communication. Nutritionist. U.S.D.A., Human Nutrition Information Service, Nutrition Monitoring Division, Federal Building, Hyattsville, MD

________, J. E. Kinsella, and B. K. Watt. 1975. Lipids and fatty acids of important finfish: new data for nutrient tables. J. American Oil Chemist's Society. 52:154-159.

Hiltz, D. F., B. S. Lall, D. W. Lemon, and W. J. Dyer. 1976. Deteriorative changes during frozen storage in fillets and minced flesh of silver hake (*Merluccius bilinearis*) processed from round fish held in ice and refrigerated seawater. J. Fish. Res. Bd. Can. 33:2560-2567.

Jhaveri, S. N., S. S. Lew, and S. M. Constantinides. 1982. Atlantic mackerel (*Scomber scombrus* L.): shelf life in ice. J. Food Sci. 47(6):1808-1810.

Lanier, T. C. 1984. Suitability of red hake *Urophycis chuss*, and silver hake *Merluccius bilinearis*) for processing into surimi. Mar. Fish. Rev. 46(2):43-48.

Lemon, D. W. and L. W. Regier. 1977. Holding of Atlantic mackerel (*Scomber scombrus*) in refrigerated seawater. J. Fish. Res. Bd. Can. 34(3): 439-443.

Leu, S. S., S. N. Jhaveri, P. A. Karakoltoidis, and S. M. Constantinides. 1981. Atlantic mackerel (*Somber scombrus* L.): seasonal variation in proximate composition and distribution of chemical nutrients. J. Food Sci. 46(6):1635-1638.

Rasekh, J. G., M. E. Waters, and V. D. Sidwell. 1980. The effect of washing on the quality characteristics of minced fresh croaker, Micropogon undulatus, held in frozen storage. Mar. Fish. Rev. 42(11):26-30.

Sidwell, V. D., J. C. Bonnet, and E. G. Zook. 1973. Chemical and nutritive values of several fresh and canned finfish, crustaceans, and mollusks. Part I: Proximate composition, calcium, and phosphorus. Mar. Fish. Rev. 35(12):16-19.

________, D. H. Buzzell, P. R. Foncannon, and A. L. Smith. 1977. Composition of the edible portion of raw (fresh or frozen) crustaceans, finfish, and mollusks. Part II: Macroelements: sodium, potassium, chlorine, calcium, phosphorus, and magnesium. Mar. Fish. Rev. 39(1): 1-11.

________, P. R. Foncannon, N. S. Moore, and J. C. Bonnet. 1974. Composition of the edibbl portion of raw (fresh or frozen) crustaceans, finfish, and mollusks. Part I: Protein, fat, moisture, ash, carbohydrates, energy value, and cholesterol. Mar. Fish. Rev. 36(3): 21-35.

________, A. L. Loomis, P. R. Foncannon, and D. H. Buzzell. 1978. Composition of the edible portion of raw (fresh or frozen) crustaceans, finfish, and mollusks. Part IV: Vitamins. Mar. Fish. Rev. 40(12): 1-16.

________, A. L. Loomis, K. J. Loomis, P. R. Foncannon, and D. H. Buzzell. 1978. Composition of the edible portion of raw (fresh or frozen) crustaceans, finfish, and mollusks. Part III: Microelements. Mar. Fish. Rev. 40(9):1-20.

Sohn, B. I., J. H. Carver, and G. F. Mangan Jr. 1961. Composition of commercially-important fish from New England waters. Part I: Proximate analyses of cod, haddock, Atlantic ocean perch, butterfish, and mackerel. Comm. Fish. Rev. 23(2):7-10.

Stansby, M. E. and J. M. Lemon. 1941. Studies on the handling of fresh mackerel, Scomber scombrus. Fish and Wildlife Service. Research Report. 1:1-46.

Townley, R. R. and T. C. Lanier. 1981. Effect of early evisceration on the keeping quality of Atlantic croaker (Micropogon undulatus) and gray trout (Cynoscion regalis) as determined by subjective and objective methodology. J. Food. Sci. 46(3):863-867.

Vinogradov, V. I. 1985. Fat content of muscle, gonads, and liver of silver hake (Merluccius bilinearis) and red hake (Urophycis chuss) from the continental shelf off southern New England in late winter. Northwest Atlantic Fisheries Organization. Scientific Council Studies No. 8. P. 5760.

Waters, M. E. 1983. Chemical composition and frozen storage stability of weakfish, *Cynoscion regalis*. Mar. Fish. Rev. 45(7-9):27-33.

________. 1982. Chemical composition and frozen storage stability of spot, *Leiostomus xanthurus*. Mar. Fish. Rev. 44(11):14-22.

Appendix V. Selected References on Life Histories of Some Mid-Atlantic Commercial Species

Atlantic Croaker

Diaz, R. J. and C. L. Cordes. 1982. Habitat suitability index model: juvenile Atlantic croaker. U.S. Fish and Wildlife Service. OBS-82/10.21. 22 pp.

Hildebrand, S. F. and L. E. Cable. 1930. Development and life history of fourteen teleostean fishes at Beaufort, NC. Bull. U.S. Bureau of Fisheries. 46:383-488.

Lassuy, D. R. 1983. Species profiles: Life histories and environmental requirements (Gulf of Mexico). Atlantic croaker. U.S. Fish and Wildlife Service. OBS-82/11.3. 12 pp.

Ross, S. W. 1985. Age, growth, and mortality of the Atlantic croaker in North Carolina with comments on population dynamics. Fish. Bull. (in press).

White, N. L. and M. E. Chittenden, Jr. 1977. Age determination, reproduction, and population dynamics of the Atlantic croaker, *Micropogonias undulatus*. Fish. Bull. 75(1):109-123.

Wilk, S. J. 1981. The fisheries for Atlantic croaker, spot, and weakfish. Pp. 15-27. In: Proceedings of the Sixth Annual Marine Recreational Fisheries Symposium. H. Clepper, ed. Sport Fishing Institute. Washington, DC.

Atlantic mackerel

Berrien, P. L. 1978. Eggs and larvae of *Scomber scombrus* and *Scomber japonicus* in continental shelf waters between Massachusetts and Florida. Fish. Bull. 76(1):95-115.

Bigelow, H. B. and W. C. Schroeder. 1953. Fishes of the Gulf of Maine. Fish. Bull. 53:1-577.

Hog, D. L. and G. M. Clark. 1967. Atlantic mackerel fishery, 1804-1965. U.S. Fish and Wildlife Service. Fishery Leaflet No. 603. 9 pp.

Mackay, K. T. 1967. An ecological study of mackerel, *Scomber scombrus* (Linnaeus), in the coastal waters of Canada. Fish. Res. Bd. Can. Technical Report No. 31. 127 pp.

Sette, O. E. 1950. Biology of the Atlantic mackerel (*Scomber scombrus*) of North America. Part II: Migrations and habits. Fish. Bull. 51:251-358.

Black Sea Bass

Kendall, A. W. Jr. 1977. Biological and fisheries data on black sea bass, *Centropristis striata* (Linnaeus). NOAA, NMFS, Northeast Fisheries Center, Highlands, NJ. Technical Series Report No. 7. 35 pp.

McBride, M. M. and B. E. Brown. 1980. The status of the marine fishery resources of the northeastern United States. NOAA Technical Memorandum. NMFS-F/NEC-5. 29 pp.

Mercer, L. P. 1978. The reproductive biology and population dynamics of black sea bass, *Centropristis striata*. Ph. D. Dissertation. Virginia Institute of Marine Science, School of Marine Science, School of Marine Science, College of William and Mary. 196 pp.

Musick, J. A. and L. P. Mercer. 1977. Seasonal distribution of black sea bass, *Centropristis striata*, in the Mid-Atlantic Bight with comments on the ecology and fisheries of the species. Trans. Amer. Fish. Soc. 106(1):12-25.

Vaughn, A. 1982. Status of the fishery resources off the northeastern United States for 1981. NOAA Technical Memorandum, NMFS-F/NEC-12. 116 pp.

Waltz, W., W. A. Roumillat, and P. K. Ashe. 1979. Distribution, age structure, and sex composition of the black sea bass, *Centropristis striata* sampled along the southeastern coast of the United States. SC Marine Resources Center. Technical Report No. 43. 18 pp.

Bluefish

Kendall, A. W. Jr. and L. A. Walford. 1979. Sources and distribution of bluefish, *Pomatomus saltatrix*, larvae and juveniles off the east coast of the United States. Fish. Bull. 77(1):213-227.

Vaughn, A. 1982. Status of the fishery resources off the northeastern United States for 1981. NOAA Technical Memorandum, NMFS-F/NEC-12. 116 pp.

Wilk, S. J. 1977. Biological and fisheries data on bluefish, *Pomatomus saltatrix* (Linnaeus). NOAA, NMFS, Northeast Fisheries Center, Highlands, NJ. Technical Series Report No. 11. 64 pp.

Gray Seatrout

Bulloch, D. K. 1983. Marine gamefish of the middle Atlantic: weakfish. Underwater Naturalist. 14(3):20-22.

Mercer, L. P. 1983. A biological and fisheries profile of weakfish, *Cynoscion regalis*. NC Dept. of Natural Resources and Community Development. Division of Marine Fisheries, Morehead City, NC. Special Scientific Report No. 39. 107 pp.

Wilk, S. J. 1979. Biological and fisheries data on weakfish, Cynoscion regalis (Bloch and Schneider). NOAA, NMFS, Northeast Fisheries Center, Highlands, NJ. Technical Series Report No. 21. 59 pp.

Scup

Griswold, C. A. and T. W. McKenney. 1984. Larval development of the scup, Stenotomus chyrops (Pisces: Sparidae). Fish. Bull. 82(1):7784.

Morse, W. W. 1978. Biological and fisheries data on scup, Stenotomus chyrops (Linnaeus). NOAA, NMFS, Northeast Fisheries Center. Highlands, NJ. Technical Series Report No. 12. 41 pp.

Vaughn, A. 1982. Status of the fishery resources off the northeastern United States for 1981. NOAA Technical Memorandum. NMFS-F/NEC-12. 116 pp.

Silver Hake

Anderson, E. D., F. E. Lux, and F. P. Almeida. 1980. The silver hake stocks and fishery off the northeastern United States. Mar. Fish. Rev. 42(1):12-20.

Bigelow, H. B. and W. C. Schroeder. 1953. Fishes of the Gulf of Maine. Fish. Bull. 53:1-577.

Fahay, M. P. 1974. Occurrence of silver hake, Merluccius bilinearis, eggs and larvae along the middle Atlantic continental shelf during 1966. Fish. Bull. 72(3):813-834.

Powles, H. 1981. Eggs and larvae of North American sciaenid fishes. Pp. 99-109. In: Proceedings of the Sixth Annual Marine Recreational Fisheries Symposium. H. Clepper, ed. Sport Fishing Institute. Washington, DC.

Spot

Pacheco, A. L. 1962a. Age and growth of spot in lower Chesapeake Bay, with notes on distribution and abundance of juveniles in the York River system. Chesapeake Science. 3(1):18-28.

________. 1962b. Movements of spot, Leiostomus xanthurus, in the lower Chesapeake Bay. Chesapeake Science. 3(1):18-28.

Powles, H. 1981. Eggs and larvae of North American sciaenid fishes. Pp. 99-109. In: Proceedings of the Sixth Annual Marine Recreational Fisheries Symposium. H. Clepper, ed. Sport Fishing Institute. Washington, DC.

Stickney, R. R. and M. L. Cuenco. 1982. Habitat suitability index model: juvenile spot. U.S. Fish and Wildlife Service. OBS-82/10.20. 12 pp.

Wilk, S. J. 1981. The fisheries for Atlantic croaker, spot, and weakfish. Pp. 15-27. In: Proceedings of the Sixth Annual Marine Recreational Fisheries Symposium. H. Clepper, ed. Sport Fishing Institute. Washington, DC.