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Final Report

**Commercial, Market and Scientific Analyses of the Scarlet Shrimp,
Plesiopenaeus edwardsianus, an underutilized species
in deep waters of the continental shelf from Maine to Virginia**

Fishing Industry Grant No. NA56FK0095

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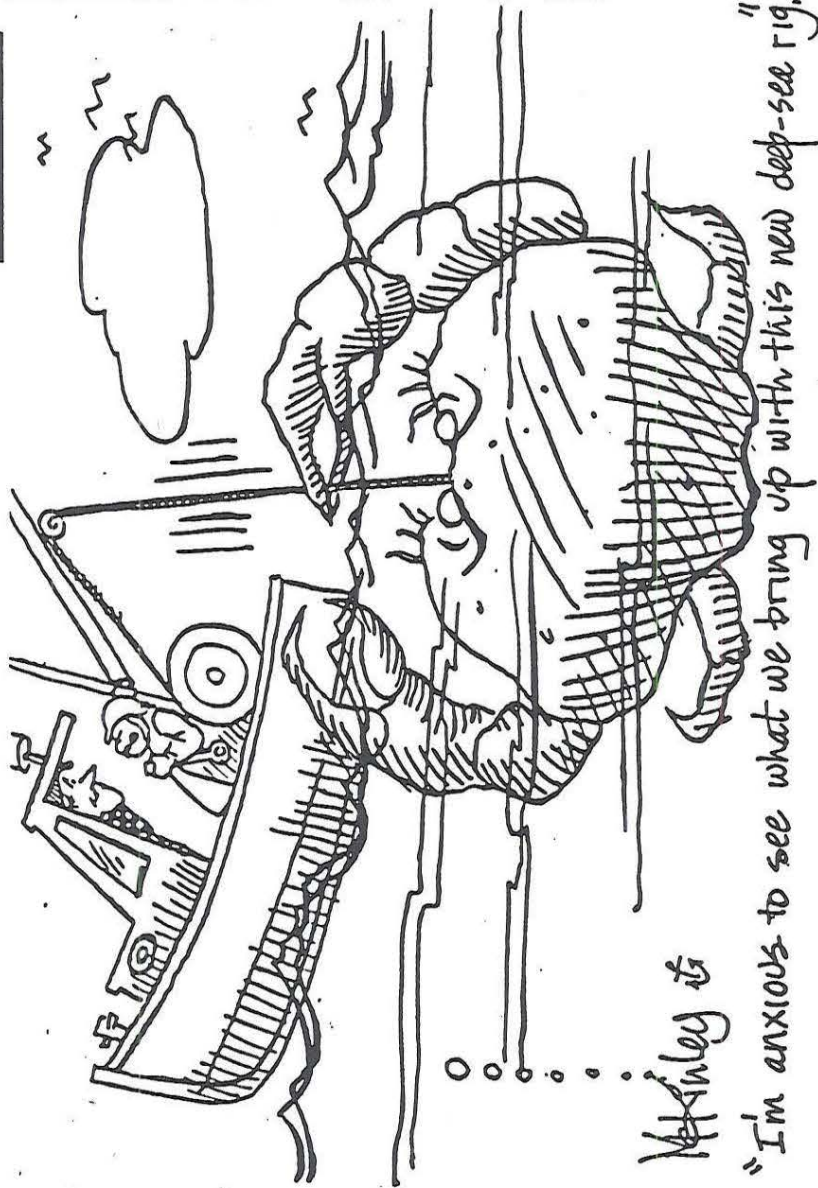
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MCKINLEY



I. Executive Summary

This final report provides a summary of the results of the Fishing Industry Grant project entitled "Commercial, market, and scientific analyses of the scarlet shrimp, *Plesiopenaeus edwardsianus*, an underutilized species in deep waters of the continental shelf from Maine to Virginia," awarded to Clinton Fisheries and Captain William I. Bomster of Stonington, Connecticut (Grant No. NA56FK0095). A description of the exploratory effort undertaken, the biological and catch-per-unit-effort data collected, the processing methods developed, and the results of a market survey completed by purchasers of the shrimp are provided. Bridge logs and graphs of temperature and depth data for some of the tows are provided in appendices.

II. Introduction

The status of sea scallop and groundfish stocks off the New England and mid-Atlantic coasts have forced fishermen that traditionally harvest these species to look for alternative ways to generate income. These alternatives include leaving the fishing industry altogether, modifying their vessel for other marine uses, or searching for new species with commercial potential. This project addressed the latter alternative, one of four Fishing Industry Grant (FIG) programs funded to explore deep sea resources.

There are several key considerations for fishermen moving into deep water. The first is the amount of additional capital investment required to outfit a vessel to tow and haul back from great depths safely and efficiently. The second is to find new species acceptable to seafood consumers and profitable to the fishing operation, factoring in any necessary capital investments, longer distances to the fishing grounds, and amount of processing required. A third is an ecological consideration. Deep water resources of the Northwest Atlantic have not been the targets of fishing pressure. It is important to determine early on whether or not a species can sustain long-term harvest pressure, or whether its growth and reproductive characteristics make it susceptible to overharvesting unless fishing pressure is regulated.

III. Purpose

A. The purpose of this FIG project was to assess the commercial viability of the deep sea scarlet shrimp, *Plesiopenaeus edwardsianus*, during a six-week period, along the upper continental slope off southern New England and the mid-Atlantic. Published reports noted the potential of this species and anecdotal information indicated that this large species of shrimp had been caught in quantities by fishermen targeting other species.

B. More specifically, the six objectives of the project were:

1. Stock Assessment

Assess commercial quantities of scarlet shrimp while conducting a stock assessment, within the limitations of 30 days at sea during the first quarter of 1995.

Examine the feasibility of targeting this deep water species using existing winches, net reel and doors presently on board the F/V Patty Jo, purchasing only new nets and towing wire.

2. Bycatch Assessment

Assess extent of bycatch problem, test performance of Nordmore grate in the deep water shrimp nets to reduce or eliminate bycatch problem.

3. Processing

Develop processing and freezing methods for shrimp, building on successful methods currently used for sea scallops.

4. Marketing

Test the market acceptance of the shrimp in frozen (head on, head off) forms and fresh forms, as well as any bycatch species.

5. Scientific Studies of Shrimp and Bycatch Species

Collect data and samples of the shrimp and bycatch species for scientific analysis.

6. Public Distribution of Project Results

Generate a report from this project, summarizing the results of the commercial stock assessment, the marketing tests, and the biological data for public distribution.

IV. Approach

A. Description of Work

The F/V Patty Jo was outfitted with 1000 fathoms of 5/8" tow wire (per drum) and two 150' sweep shrimp nets with two-inch mesh. The nets were purchased from Billy Barnes of Bayou La Batre, Louisiana, a well-known maker of shrimp nets. While the original plan was to use existing trawl doors, they turned out to be too big for the net. Instead, four-meter Poly-Ice trawl doors, sized for the net and with a good reputation for deep water use, were purchased. A 30" Kerian shrimp sizer and a spray wash system for the on-board conveyor were installed. A machine (Shrimp Pro 2000) to de-vein and butterfly the shrimp was purchased to facilitate the marketing of the smaller count shrimp. A Nordmore grate with two-inch spacing between slats was purchased for use in bycatch comparison studies. Total capital outlay to re-fit the *F/V Patty Jo* for shrimping was about \$50,000 (two nets, mud rollers, doors, wire, Kerian sizer, Nordmore grate, Shrimp Pro). The vessel was already outfitted with a conveyor, Dole plate freezer, and vacuum packer.

Three cruises were made during September and October 1995, between Veatch canyon and the Virginia line (see bridge logs, Appendix I) on sandy or muddy bottom. Seventy-seven tows were made, at an average hauling speed of 2.5 - 2.9 knots per hour. The net was towed at depths ranging from 156 fm to 410 fm (288 m to 757 m) in water temperatures ranging from 7.0°C to 10.7°C. Tows were made with the current, into the current and across the current. A graduate student was hired to serve as the on-board scientist. The scientist's responsibilities included identifying the shrimp species, taking length-weight measurements of the shrimp,

conducting the bycatch study, and collecting unusual deep sea specimens for further study. Two shake-down tows were made on familiar grounds to familiarize crew with the new gear. During two other tows, the net was torn and required repairs, although in one case the damage was minor and the catch was retained in the net. The results reported herein are based on 74 tows.

Tow length (from time trawl hit water to start of haulback) ranged from 45 minutes to 3.5 hours. Time of haulback varied according to depth fished. Data on water temperature and depth at one minute intervals was collected for the majority of tows during the first two cruises (using a computer-interfacing minilog provided by Connecticut Sea Grant that was attached to a casing on one of the doors) (see Appendix II). Computer failure prohibited the collection of similar data during the third cruise.

For each tow, the large monkfish and whiting were separated from the remainder of the catch which was then sorted from the conveyor into baskets. Data was recorded on the pounds of shrimp caught (one bushel basket of shrimp weighs approximately 60 pounds) as well as the pounds of large monkfish and whiting landed. Regulated species including monkfish were returned to sea along with unusable bycatch. Samples of the shrimp were retained for biological studies. The shrimp were processed and frozen on board, using the Dole plate freezer. During the third cruise, comparison tows were made with and without the Nordmore grate and the resulting effects on bycatch were documented.

B. The fishing survey work was carried out by the captains and crew of the *F/V Patty Jo*, which included the grantee, William I. Bomster, his three sons--William J., Joseph, and Michael, and three additional crew members. Venna "Jo" Bomster kept all financial records for the project, and submitted the quarterly reports. Bill and Jo Bomster were responsible for the marketing of the product. John Leamon, a PhD candidate at the University of Connecticut, conducted the on-board data collection. Nancy Balcom, an extension educator with the Connecticut Sea Grant Marine Advisory Program, University of Connecticut, served as scientific advisor to the project, provided the minilog, served as liaison between both NMFS and other fishery scientists and the Bomsters, analyzed the data, and prepared the final report. Balcom will also be preparing and distributing the technical report for public distribution.

Other firms/individuals involved included:

1. Ralph Itchkawich - owner-operator of crane used to changeover gear.
2. Kerian Machine Co. - shrimp sizer
3. Billy Barnes - shrimp net maker
4. Metal Design Inc. - made stainless steel trays for Dole Plate freezer
5. Blue Point, Inc. - Shrimp Pro 2000
6. Geraldine McDonald - originally chosen as on-board scientist; however, when project was delayed to fall, John Leamon was hired instead.

V. Findings

A. Actual Accomplishments and Findings

The results of this project provide limited data on the commercial viability of deep sea shrimp during a contiguous six-week period. The target species for the project was the scarlet

shrimp, *Plesiopenaeus edwardsianus* (Figure 1), however this species was not found in commercial quantities south of Cape Cod at the depths fished. Less than 100 scarlet shrimp were caught during the three cruises. However, commercial quantities of the royal red shrimp, *Pleoticus robustus* (Figure 2), were harvested, and by default, became the target species for the project. (Anecdotal information received prior to the submission of the grant application indicated availability of scarlet shrimp during the summer months, as several Stonington boats brought in red shrimp. They are now suspected to be royal red shrimp, since the common names are similar and interchangeable.) According to *An Illustrated Guide to Shrimp of the World* (Dore and Frimody, 1987), royal red shrimp grow to 225 mm (8.9 inches). They like muddy or silt bottoms at depths of 245 to 730 meters (880 to 2,400 feet), and prefer a temperature range of 7° to 13° C (45°F to 55°F).

Royal reds were caught in quantities of 0 lbs to 500 pounds per tow. The shrimp appeared to be distributed in pockets. They were not found in significant quantities during the second cruise which explored south of Hudson Canyon to the Virginia line. (However, this deepwater peneid has been the subject of a commercial fishery from south of Cape Hatteras to the east coast of South America in depths between 140-300 fathoms (256-549 meters).)

Eleven thousand pounds (heads-on) of shrimp were harvested, with an average catch-per-unit-effort (CPUE) of 61.6 lbs/tow hour (range 0-225 lbs/tow hour; std. dev. = 61.8 lbs/tow hour; N=74). The CPUE was undoubtedly lower than it might have been for a typical commercial operation, because the captain did not stay and work areas where a lot of shrimp were found. Instead, the captain continued to move around, to try and determine shrimp distribution. Shrimp accounted for 0% to 55.6% of each tow, averaging 28.5% (N=37; std. dev. = 14.3).

Biological Data

Oblique carapace length (OCL) were measured on 2,589 royal red shrimp, and weight in lbs (converted to gms) measured on 1,249 in addition to OCL. In addition, some length-weight data was recorded on some of the scarlet shrimp. For both species, weight (gms) is an exponential function of OCL. For the royal red shrimp, the relationship between OCL (mm), described by the equation $Y=16.306\ln(X)-12.151$, where $X = \text{OCL}$ and $Y = \text{weight}$, with an $R^2=0.918$ (Figure 3). For the scarlet shrimp, the exponential relationship is expressed by the equation $Y=19.211\ln(X)-19.634$, $R^2=0.961$ (Figure 4).

A frequency histogram (Figure 5) based on 2,589 OCL measurements reveals a bimodal distribution that breaks in the 41-45 mm size range. This may reflect two year classes and/or may be gender-related. Samples of whole shrimp, currently frozen, will be sexed and measured, to determine if the break in size classes is gender-related. According to scientific literature, female shrimp of this species tend to be larger, and male carapace lengths tend to reach maximum size around 42 mm (*Fishery Bulletin*, 75:2, April 1977.) One female specimen was found with compound spermatophore attached. In the southern fishery, the royal red shrimp spawn throughout the year with a peak between January and May. Recruitment begins when shrimp approach one year of age and are less than 100 mm total length; maturity is reached in about 3 years. Most shrimp on the fishing grounds are mature, with a lifespan of no less than 5 years. It will be important to study the reproductive habits of this species in the northern part of its range.

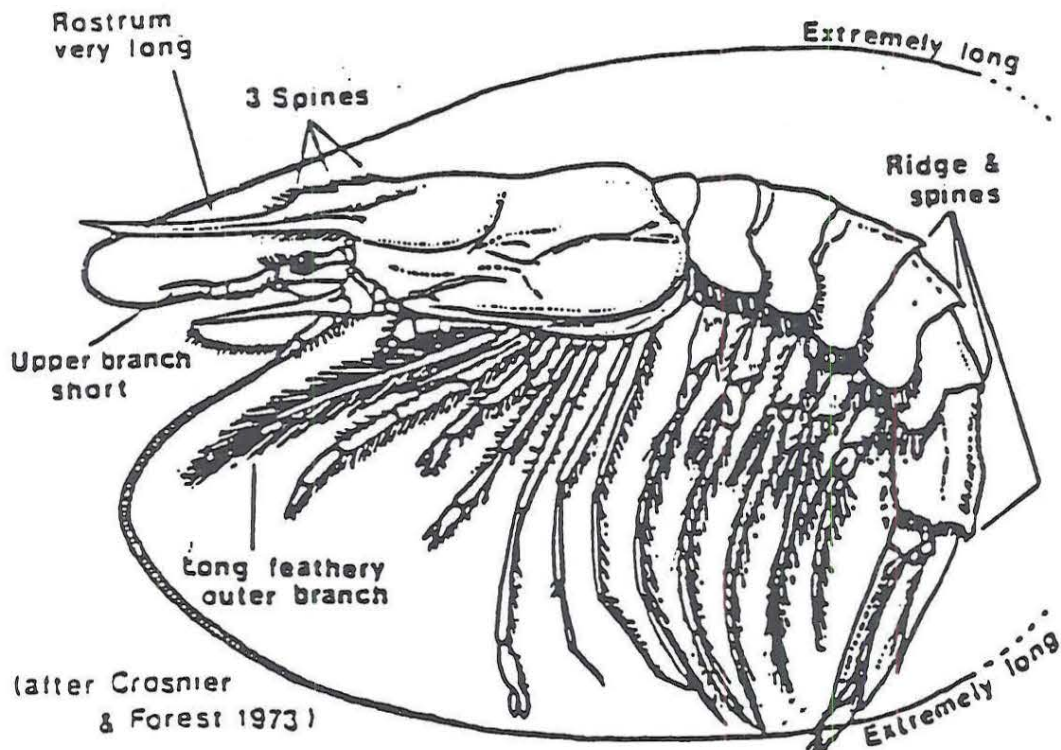
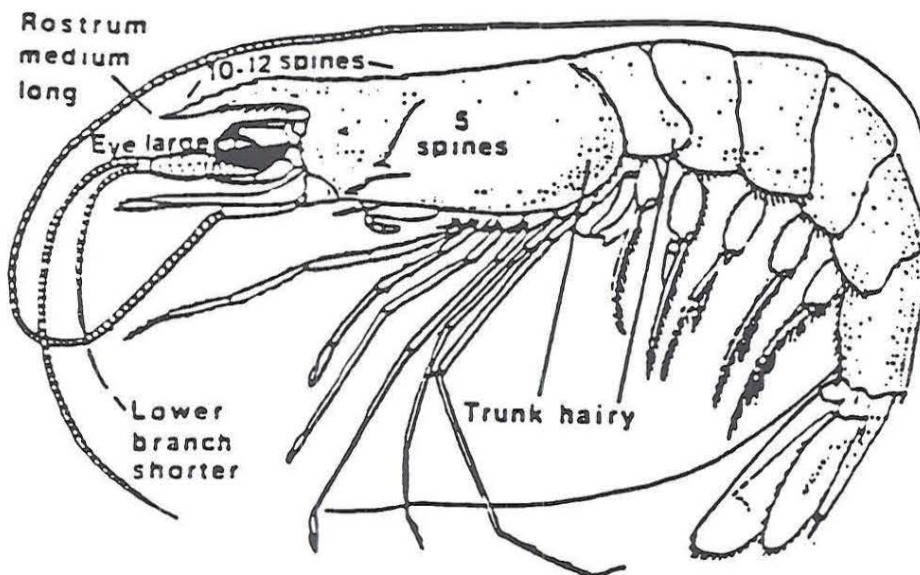


Figure 1. Scarlet shrimp, *Plesiopenaeus edwardsianus* (above)

Figure 2. Royal red shrimp, *Pleoticus robustus* (below)



(after Perez Farafante 1988)

Figure 3.

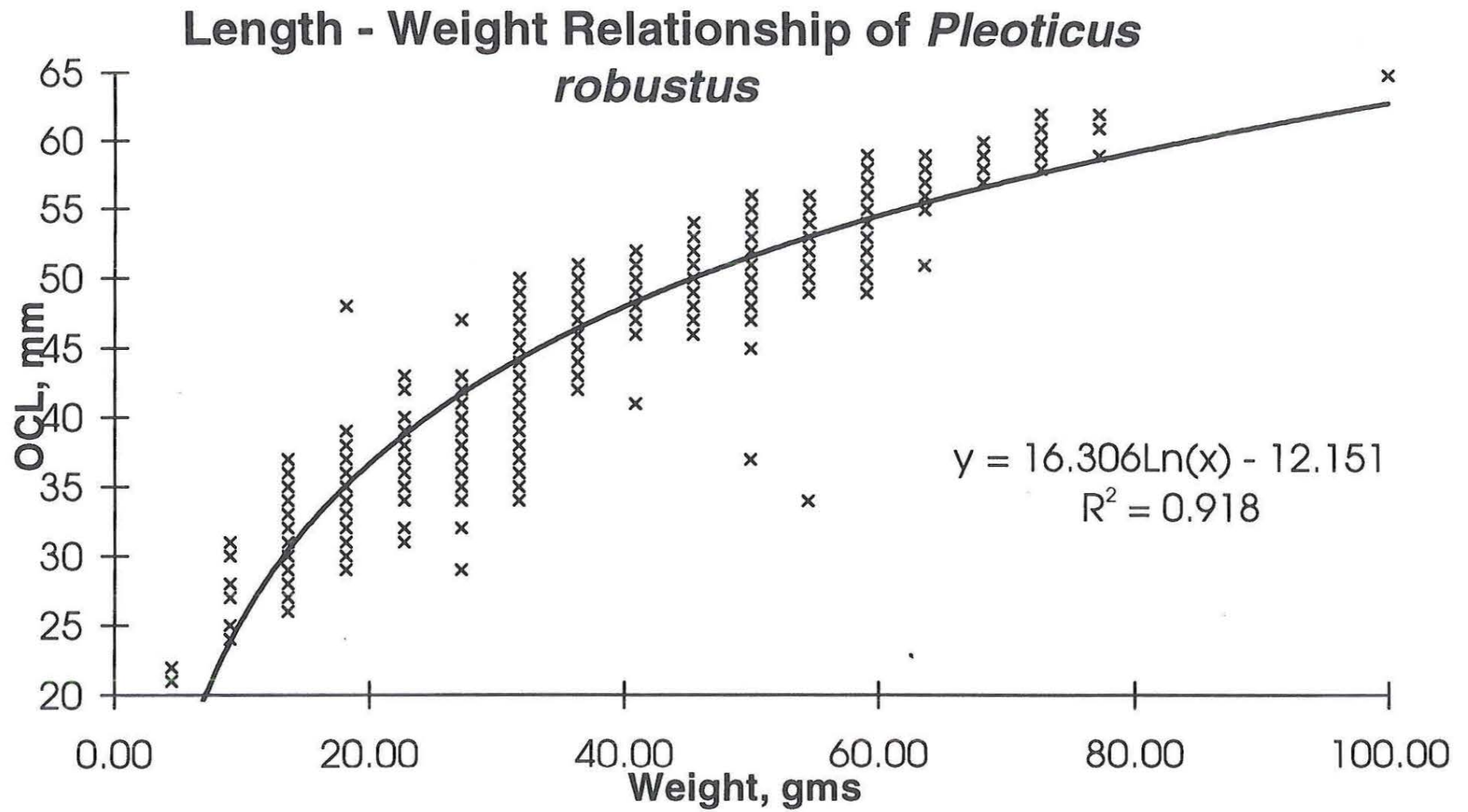


Figure 4.

Length - Weight Relationship of *P. edwardsianus*

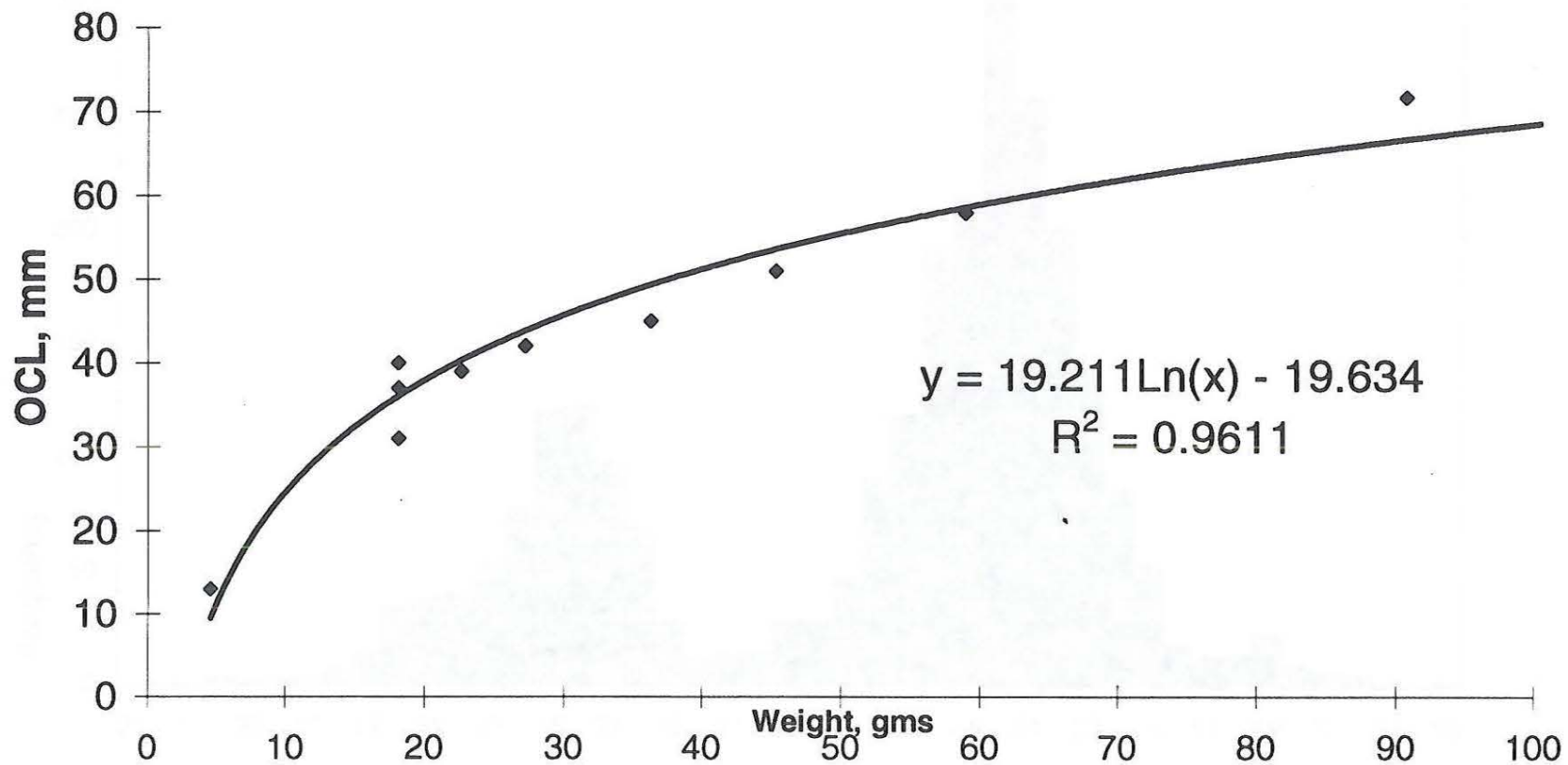
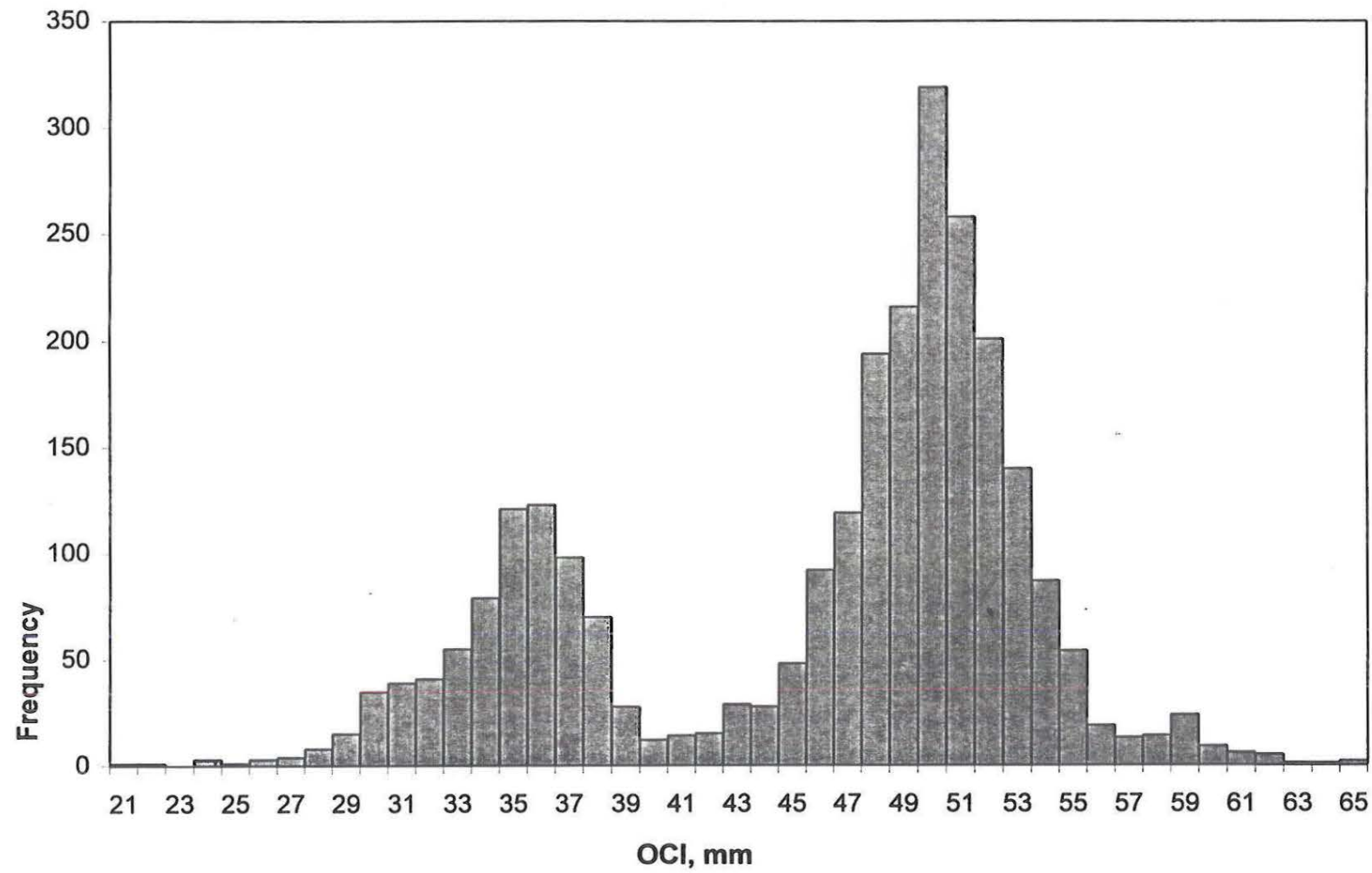


Figure 5.

Size Classes of *Pleoticus robustus*



Bycatch Studies

During the third cruise, a bycatch retention study was conducted using the Nordmore grate (Figure 6). It was immediately apparent that the grate reduced the catch of monkfish to almost zero. Unfortunately, some of the tows with the grate installed were made in areas where few shrimp were caught, which makes the data appear as if nothing was retained during some tows using the grate. However, the catch increased during that last few tows when the grate was installed as the vessel was brought in close to the outer edge of where lobster pots had been set. It is anticipated that when that area is cleared and the lobster traps are moved inshore, it may be possible to harvest larger quantities of the shrimp in these areas.

Large monkfish accounted for 4.8% to 35.7% of each tow without the grate. The Nordmore grate reduced monkfish take to 0% to 3.7% of each tow. Appendix III provides the data on the actual tow comparisons. The first and last bushel of bycatch (after shrimp, large whiting and monkfish were first separated out) were kept and sorted into general categories, which were then weighed. From this information, percent of total catch was calculated. Figures 7a-c illustrate this breakdown of the total catch into general categories, such as monkfish, large and small whiting, shrimp, crustaceans, blackbellied rosefish, flatfish and miscellaneous. (Figure 7a shows the harvest breakdown with the Nordmore grate installed, Figure 7b shows the catch breakdown with the grate removed, and Figure 7c breaks out the total catch by category.

The captain and crew found the Nordmore grate tricky to maneuver. At one point the net hung up and tore and the grate was retained only because a bullrope had been attached to it. Two inch slats seem adequate to reduce larger fish and overall bycatch. The Bomsters indicate that they will use the grate whenever they are shrimp fishing, not only because the bycatch is reduced, but also because monkfish tend to ruin the shrimp with their weight and eating habits. However, they may look into the use of a soft TED, which will wrap around the net drum.

A list of the unusual bycatch species retained for further study will be provided to NMFS by Sea Grant once the specimens have been keyed out and identified. Some of the specimens are still in the freezer; others are being fixed in formalin and then preserved in ethanol.

Processing and Marketing

The shrimp were washed as they were sorted from the conveyor belt into bushel baskets. The shrimp were then put through the Kerian grader for sizing, which broke the product into two counts based on size: 20 count (21-25 per pound) and 40 count (36 -40 per pound). The shrimp were supercooled in an ice brine chill tank at which time they were treated with EverFresh, a melanosis inhibitor for shrimp blackspot prevention. During the first cruise, 2,700 pounds were brought in fresh, but the remainder of the shrimp was frozen during all subsequent cruises. Shrimp were vacuum packed and frozen with heads on during the first cruise, but for subsequent cruises, the shrimp were headed by hand, individually quick frozen (IQF) on trays in the Dole plate freezer and boxed. IQF was the preferred product form of buyers, particularly attractive to chefs.

In addition to selling some of the shrimp to the wholesale company, SeaRich, the Bomsters marketed the royal red shrimp through their own wholesale/retail company, Stonington

Figure 6.

Comparison of Catch with and without Nordmore Grate

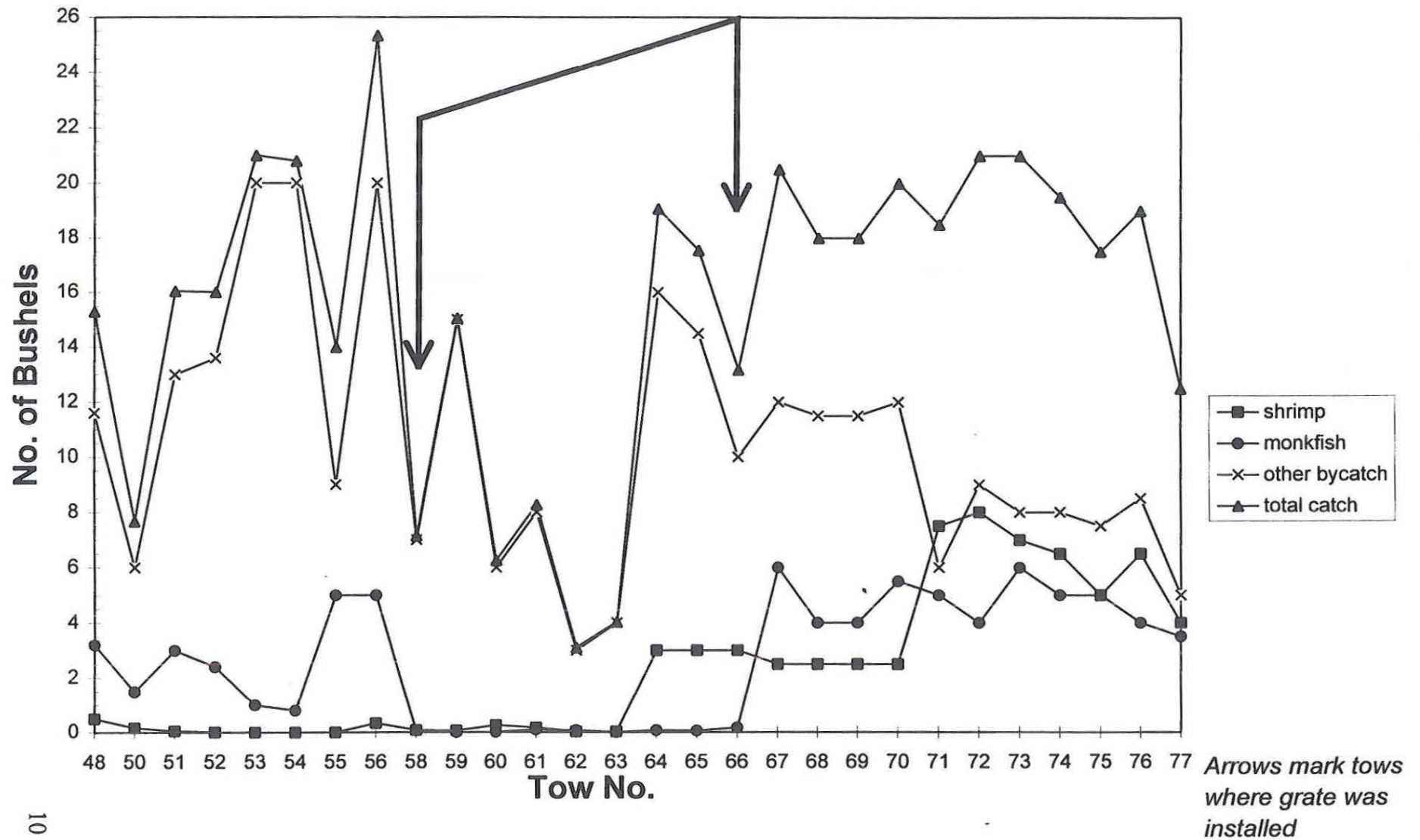
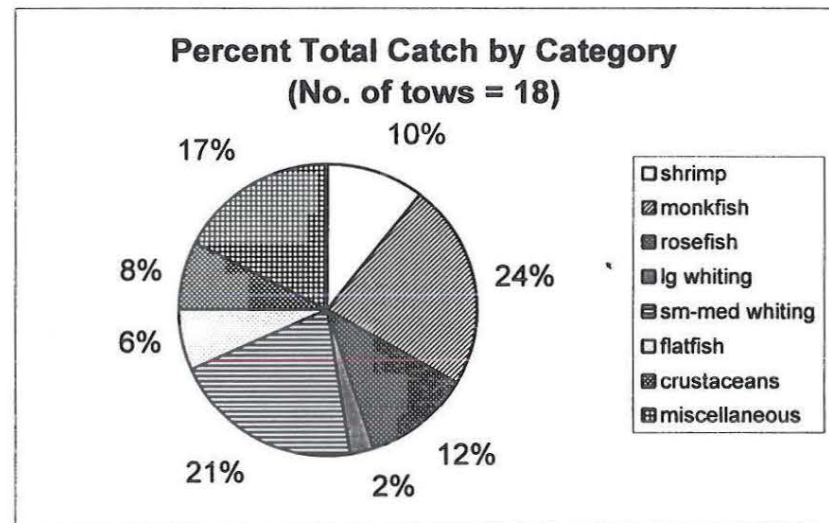
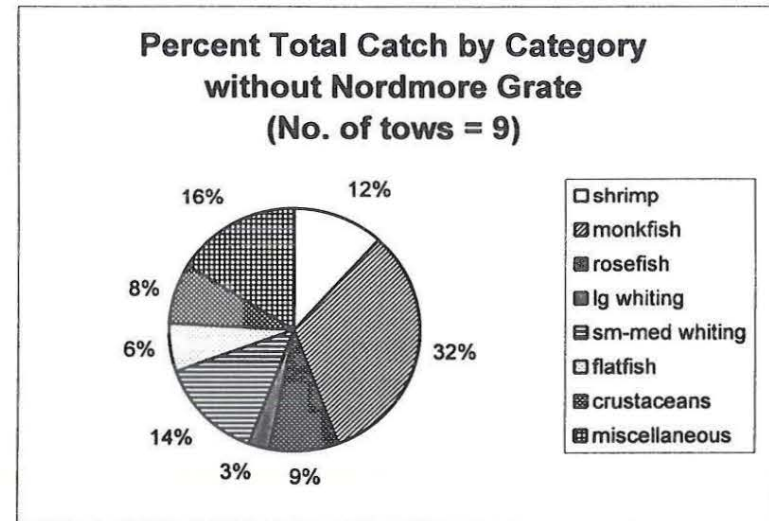
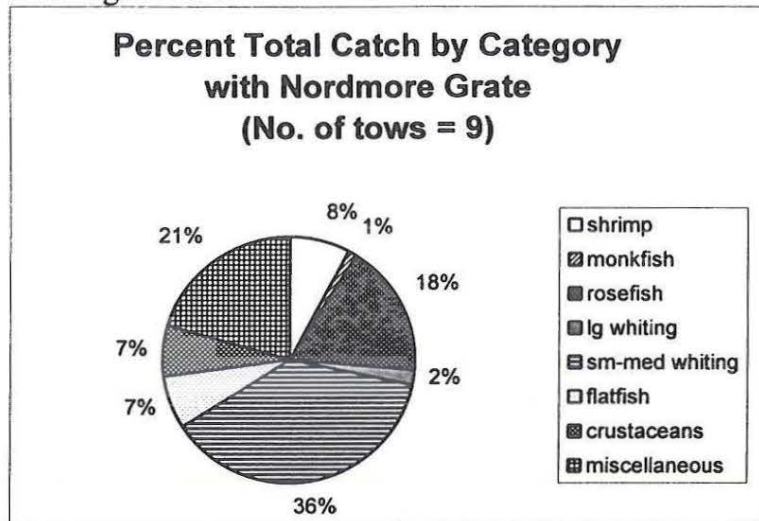


Figure 7a-c.



Seafood Harvesters, Inc., as "Stonington Reds". They marketed the shrimp to their existing customer base for scallops, often personally demonstrating the product and providing tips on preparing it. In some cases, they gave the shrimp away to generate interest in trying out the product. They found it difficult to sell the smaller count (36-40) shrimp at first. They purchased a Shrimp-Pro 2000, a power shrimp cutter and deveiner. By de-veining and butterflying the smaller shrimp, they were more attractive to chefs. This additional processing step will be done at sea in the future.

Ex-vessel prices from wholesalers for the shrimp was \$2.00 /pound for fresh shrimp, and ranged from \$4.25 - \$5.00 per pound for the IQ frozen, headed shrimp (both counts). All shrimp purchasers were given a questionnaire to fill out and return to Connecticut Sea Grant in a stamped envelope. The questionnaire (Appendix IV) polled the purchasers' opinions on the product, to help determine market acceptability of the shrimp. Forty-eight questionnaires were returned (nearly 100%) and the results are summarized in the following tables.

Table I. *Breakdown of respondents to market survey, N=48.*

Buyer Description	No.
Personal Use Buyers	37
Chef/Buyer for restaurant	9
Seafood retailer/wholesaler	2

Table 2. *Preferred form of shrimp by buyers, N=43.*

Product Form	No.
Heads off, frozen	23
Heads off, fresh	12
Heads on, fresh or frozen	2
Heads off, fresh or frozen	2
Heads on, fresh	1
Heads on, frozen	1
Frozen, heads on or off	1
Heads on, fresh; heads off, frozen	1

Respondents were asked to indicate the price range they were willing to pay for three count ranges (10-count, 20-count and 30-count). Unfortunately, this question was designed with the larger scarlet shrimp in mind, and as such, no 40-count prices were sought. For royal red shrimp, it can be assumed that the 20-count prices and the 30-count prices more closely fit potential market return. The responses received regarding for prices willing to pay for frozen product probably reflect expectation for IQF form. Although the question did not specifically address this, the majority of customers purchasing frozen product received it in IQF form.

Customers were also asked to rate the quality and organoleptic properties of the shrimp. The responses indicated that most felt the quality was excellent or good, the taste delicious, sweet, succulent and mild; the texture firm; and the scent mild. Only one response rated the product as poor, and one chef indicated that the shrimp was too mild and had no flavor. Some found the product texture soft. This shrimp does need to be handled quickly and carefully, and to be kept superchilled--a consideration for fishermen considering targeting the shrimp during the hot summer months.

Table 3. *Survey results indicating average and range of prices market is willing to pay for Royal red shrimp by product form. (Frozen product prices probably reflect expectation for IQF form.)*

Product Form	10-count	20-count	30-count
Heads on, fresh	\$8.00/lb \$2.00 - \$12.99/lb N=8	\$7.50/lb \$5.99 - \$12.00/lb N=7	\$5.92/lb \$2.50 - \$8.00/lb N=6
Heads on, frozen	\$6.33/lb \$1.50 - \$11.99/lb N=6	\$6.50/lb \$4.99 - \$7.99/lb N=6	\$5.50/lb \$5.00 - \$6.00/lb N=4
Heads off, fresh	\$8.22/lb \$2.50 - \$14.00/lb N=10	\$7.31/lb \$3.50 - \$10.00/lb N=8	\$5.31/lb \$2.00 - \$8.00/lb N=8
Heads off, frozen	\$7.51/lb \$2.25 - \$12.99/lb N=10	\$7.35/lb \$3.00 - \$10.99/lb N=15	\$6.06/lb \$2.00 - \$9.00/lb N=11

Survey participants were asked if the shrimp product was available, would they consider buying it on a regular basis? Forty-seven said "yes", and only one said "no". On average, chefs surveyed were liable to use 275 pounds per week, with a range of 0 to 2,000 pounds per week (N=9). The seafood retailers and wholesalers surveyed (N=2) averaged about 100 pounds per week, and the personal use buyers averaged slightly more than 2 pounds per week, with a range of .25 pounds to 10 pounds per week (N=23). One personal use buyer indicated he/she would use 100 pounds, but it is unlikely that would reflect a weekly buying average. Other personal use buyers indicated

that they would purchase shrimp 2-3 times per year, particularly for special occasions and holidays.

Tables 4a-d. *Summary of responses to questions on quality and organoleptic properties of royal red shrimp.*

Table 4a. *Quality*

Rating	Excellent	Good	Average	Poor
Number	31	14	1	1

Table 4b. *Taste (respondents were asked to check all that applied).*

	Delicious	Sweet	Rubbery	Mealy
Number	30	23	5	2
	Succulent	Mild	Strong	Other
Number	11	15	3	1 (gritty)

Table 4c. *Texture*

	Firm	Soft / Mushy
Number	40	7 (3-soft)

Table 4d. *Scent (respondents were asked to check all properties that applied).*

	Mild	Strong	Pleasant	Unpleasant
Number	27	0	29	0

Processing the shrimp through sorting, grading, chilling, heading, de-veining, and butterflying to freezing and boxing is labor intensive, but it can all be done on board the fishing vessel between tows as part of crew costs. In comparing crew costs versus profit margin, Bill

Bomster indicated that if they had stayed and fished where the shrimp were, rather than moving around as they did during the project to get an idea of the range and extent of the shrimp stocks, the profit was there to make targeting the shrimp worthwhile. It is unclear at this time whether it will be profitable for vessels to target these shrimp if they cannot freeze or process on board. The royal red shrimp is soft-fleshed and requires quick and careful handling to maintain its quality.

B. Significant Problems

Target Species Not Commercially-Viable

The shrimp species targeted by this project, *Plesiopenaeus edwardsianus*, was not found in commercially-viable quantities south of Cape Cod. In fact, fewer than 100 specimens were captured. One report in the literature that was found after the proposal was written indicates that the scarlet shrimp have not been reported south of Martha's Vineyard. While it appears that they can be caught occasionally south of this geographic region, they are by no means common at the depths fished. It is possible that they may be found deeper, beyond the capability of the *F/V Patty Jo*, as currently outfitted. However, since a different shrimp species was being caught in quantities (*Pleoticus robustus* or royal red shrimp) and had been well-received by the market, it seemed appropriate to focus the same project goals on this species instead.

Gear Conflict

The Bomsters did run into several potential conflict situations with fixed gear during their experimental cruises. The first was with bottom-tending longlines set in areas they wished to fish or cross. Radio contact was made with some of the longliners and discussions held as to where each were planning to fish. However, at times, an area clear during the day was set with longlines during the night, with an inadequate numbers of radar reflectors or strobe lights. This could easily lead to a fishing vessel cutting through a longline set without even knowing it is there.

The second area of conflict were lobster pots. In some areas, the best shrimping appeared to be at the outer range of the offshore lobster pots. The Bomsters could not tow those waters, but as they moved in toward the line of pots, shrimp CPUE increased. The Bomsters anticipate being able to fish those waters when the lobster pots are set shallower (i.e. when the pots are moved seasonally according to the Gear Conflict Resolution adopted by the New England Fishery Management Council on October 2, 1995). However, it does appear that the pots will be set in shallower waters during scalloping season, and in the deeper waters during the time of year when scallopers are looking to target other species.

VI. Evaluation

A1. The original project goals were to conduct an exploratory number of cruises seeking commercially-viable quantities of a deep sea shrimp species along the upper continental slope from New England to the Mid-Atlantic; to collect biological data on this species as well as try to identify some of the bycatch and retain some specimens for further study; to develop on-board

processing methods for the shrimp and survey market acceptance of the product; and to test the effectiveness of a Nordmore grate in reducing bycatch retained in the net.

A2. The goals were measurable and quantifiable in the following ways: A commercially-viable species of shrimp was found, harvested and processed on board. Data collected facilitated the calculation of CPUE, length-weight relationships, and the effects of the grate on reducing bycatch. Unusual bycatch specimens were retained for additional study and identification. A market survey form and an addressed, stamped return envelope were given to each purchaser of the shrimp. The return rate approached 100%. A minilog recorded temperature and depth measurements for tows on two out of three cruises. Bridge logs were maintained. Much of this was possible due to the interest and cooperation of the captains and crew members, and was facilitated by the presence of a scientist on board who could take the time to collect and record data.

A3. There were two modifications to this project. The first was that the project dates were shifted from late winter to early fall, primarily because the delay in receiving the grant funds pushed the Bomsters right up to the beginning of their allotted scalloping days. Since scallops are their primary income source, the Bomsters requested permission to move the dates of the cruises to early fall so that they could focus on scalloping during the spring and summer. The second modification was a change in target species of shrimp. Since the original targeted species was not found in viable quantities, but a different one was, it made sense to focus on the one they could harvest. It is believed that boats in the southern New England region that have landed shrimp during the past few years were bringing in royal red shrimp. Scarlet and royal red shrimp look quite similar and their common names could easily be interchanged.

A4. The goals of this project were attained. The Bomsters showed that with a minimal capital investment in additional towing wire, new nets and new doors, they could go out and harvest commercial quantities of royal red shrimp along the upper continental slope. They processed the shrimp on board, and received a profitable price for the shrimp. They believe that they can continue to harvest shrimp profitably, particularly when they can stay and concentrate on areas where larger quantities are caught. The shrimp can be targeted during slack periods when they cannot scallop or monkfish. While the shrimp seem to require careful handling and extensive processing to achieve a good price, the processing can be done on board between tows, time that crew members are already being paid for, so no additional labor costs need be incurred.

B1. The specific information produced by this project is CPUE data for royal red shrimp in a variety of locations (Lat/Long provided in bridge logs); biological data on the relationship of oblique carapace length to weight for two species of shrimp; a breakdown of market opinion of the product and prices that could be obtained for various market forms; and data to support the use of a Nordmore grate to reduce bycatch, particularly monkfish. Forthcoming will be information on total length to oblique carapace length relationships, breakdown of gender to length, and a list of some of the bycatch species caught, as soon as Sea Grant can finish working up the samples. In addition, the information contained in this report will be printed up and

distributed to interested industry members by Connecticut Sea Grant and the National Marine Fisheries Service (several requests have already been received). Information will also be provided through presentations at conferences and seminars. The first presentation was April 2 at the 52nd Annual Conference of The Northeastern Association of Fish and Wildlife Agencies in Farmington, CT.

B2. The information generated by this project will be printed in technical report form. This should assist any fisherman who is considering harvesting this shrimp species in terms of the type of capital investment required, the general location of the shrimp, the type of processing required to meet market demands (particularly since this is a soft-fleshed shrimp); the prices the market might be willing to pay for various product forms, and the amount of labor involved.

B3. The product of the project meets the goals and objectives as outlined in the body of the text

B4. The value of this project is that it provides a lot of information about a new type of fishery that may provide an opportunity for additional income to some fishermen in southern New England, to make up for income lost to closures, reduced quotas and limited days at sea. It is a fishery for larger vessels capable of fishing deeper waters, and can be entered without extensive capital investment in new winches and hydraulics. A shift of fishing pressure by some boats to this shrimp fishery on a part-time basis may help alleviate some pressure on coastal and nearshore fisheries, opening up more opportunities there for smaller vessels.

An additional benefit to the industry is that there are several deep sea trawling exploratory efforts on-going (Captains Bomster, Kilhaug, Loftes, and Allyn) and the deep water longline operation off the coast of Maine that are complementary. As information and data are shared, there may be important discoveries of new species that can support commercial fisheries as well as provide rare and unusual deep sea specimens for scientific study.

C1. The industry will be able to receive the complete report on this project upon request from Connecticut Sea Grant and the National Marine Fisheries Service. Its availability will be advertised as widely as possible through a variety of means. Several requests for this information have already been received.

C2. Some faction of the fishing industry will be able to use this information to help them decide whether deep sea shrimping is an appropriate alternative to supplement their income. Researchers at universities will benefit from the rare and unusual species of deep sea fish and invertebrates that are becoming available for study. Fishery managers may be able to use the biological, CPUE, and bycatch data to determine additional informational needs in order to properly manage this emerging fishery.

C3. In the future, the projects' results will be used by members of the industry to gauge what potential this new fishery may have for them and whether the cost to enter the fishery will be exceeded by the profits returned.

C4. These project results may foster interest in additional scientific studies of deep sea resources. These studies will be important in managing this shrimp fishery and any other deep sea fishery that emerges as a result of these exploratory grants. An added benefit to the fishing industry is that scientists may collaborate with commercial fishing vessels outfit to trawl in these waters to conduct their scientific studies. The data gathered will benefit all.

D1a. The economic benefits were demonstrable to the fishing industry in that information on a new fishery is now available. In addition to learning about this shrimp species, the Bomsters were able to process and market the shrimp at a profit. Other fishermen who are able to outfit their vessels appropriately and process the shrimp in a similar manner should be able to make a profit on this species. It is less clear whether the profits are attainable for a shrimp product that cannot be sized, headed, and individually-quick-frozen on board, particularly because of its soft-flesh and the fact that its head is a significant portion of the total shrimp (takes up a lot of space). This shrimp needs to be kept chilled and handled quickly and carefully in order to maintain quality and profit margin.

VII. Conclusions

A. It can be concluded from this project that:

1. Scarlet shrimp, *Plesiopenaeus edwardsianus*, are not found in commercial quantities off the upper continental slope off southern New England .
2. Royal red shrimp, *Pleoticus robustus*, can be commercially harvested from the upper continental slope waters (200 - 400 fathoms) of southern New England and the mid-Atlantic. Their distribution seems to be in pockets.
3. Royal red shrimp, particularly when they are sized, headed, and individually-quick-frozen, have strong market acceptance, and can bring a profit. Ex-vessel prices range from \$2.00 to \$5.00 per pound, depending on product form and quality. Survey responses indicate that even greater returns may be possible.
4. A Nordmore grate used in conjunction with the shrimp net significantly reduces bycatch, especially eliminating the retention of large whiting and monkfish.

B. All participants in this project agree that the project was successful in meeting its goals and objectives, and had provided as much scientific information as the circumstances allowed.

C. Further work that needs to be done is to review the literature for more biological and fishery information on this species which is target of a commercial fishery from Cape Hatteras to the coast of Brazil. In addition, a more thorough stock assessment should be conducted, covering all seasons. It is unclear whether this species spawn year round in northern waters or has a particular breeding period. Several soft-shell shrimp were caught as well as one specimen with a

spermatophore attached. Little can be inferred from this project regarding seasonal distribution of the shrimp and whether they move in and out of depths depending on season, temperature, current activity, etc. A thorough investigation of the life history of the royal red shrimp in northern waters should be conducted before the species is the target of extensive and intensive fishing pressure. By all indications, there are a lot of fishing vessels from New Bedford to Stonington interested in shrimping, and many are currently preparing to enter the fishery. The Bomsters have indicated their interest in being a collaborator on any grants to study this shrimp further.

Appendix I - Bridge Logs

F/V PATTY JO HAUL FORMS - SHRIMP STOCK ASSESSMENT TOWS

Cruise No. 1 Dates: 9/15 - 9/20/ 95

Date	Tow No.	Minilog Tow No.	Position - Trawl in Water		Position - Gear Haulback		Haul Depth (fm)	Avg. Haul Depth Temp °F	CPUE (catch per tow hour)	Total Catch (lbs)
			Lat/Long	Time	Lat/Long	Time				
9/16/95	1		39-57-56 70-46-20	6:15	39-57-37 70-53-18	8:15	220		—	0
	2		25-5-84 43-3-15	9:25	25-5-98 43-3-19	10:00	156-164		—	100 lbs; no shrimp
	3	001	14-5-30 43-2-91	11:05	14-5-01 43-2-89	12:05	217-222	44-46	20	20 lbs shrimp; 50% whiting, 20% red crab, 8 monkfish, 500 lbs total
	4	002	14-5-06 43-2-80	1:20	14-5-30 43-2-83	2:50	248	42	0	no shrimp; 500 lbs total; 75% whiting, 15% red crab, 19 monkfish
	5	003	14-5-09 43-2-95	4:10	14-4-98 43-2-96	6:05	200	44	156	20 monkfish; 15 grenadiers 300 lbs Royal Red shrimp; 700 lbs total
	6	no data	25-5-21 43-2-91	6:45	25-5-59 43-2-96	8:30	195-203		85.7	150 lbs Royal Red shrimp; 300 lbs total; 30% whiting, 40% monkfish
9/17	7	no data	14-4-70 43-2-95	3:25	25-5-69 43-3-01	6:00	182-190		153.8	25 monkfish; 7 bu Royal Red shrimp (400 lbs)
	8	004	25-5-60 43-2-97	6:30	25-5-10 43-2-90	9:40	190	46	109.4	350 lbs R.R. shrimp; 40% whiting, 20% monkfish, 15% red crab, 1000 lbs
	9	005	39-58-37 70-52-84	4:25	39-58-21 70-44-84	7:25	190	44-45	166.7	500 lbs R.R. shrimp; 900 lbs total-squid, whiting, red crab, galatheid, batfish

F/V PATTY JO HAUL FORMS - SHRIMP STOCK ASSESSMENT TOWS

Cruise No. 1 Dates: 9/15 - 9/20/ 95

Date	Tow No.	Minilog Tow No.	Position - Trawl in Water		Position - Gear Haulback		Haul Depth (fm)	Avg. Haul Depth Temp °F	CPUE (catch per tow hour)	Total Catch (lbs)
			Lat/Long	Time	Lat/Long	Time				
9/17	10	006	39-57-79 70-44-98	8:30	39-58-43 70-53-27	11:05	200-210	44-46	76.9	200 lbs R.R. shrimp; 1000 lbs total; 25% ling, 30% whiting, 25% grenadiers
9/18	11	007	39-58-20 70-52-15	12:00	39-58-21 70-44-62	2:30	190-197	46	180	450 lbs R.R. shrimp; 1000 lbs total
	12	008	39-58-12 70-44-30	3:30	39-58-36 70-52-37	6:10	190-200	45	129.6	350 lbs R.R. shrimp; 800 lbs total
	13	009	39-58-31 70-52-41	6:50	39-58-26 70-44-65	9:30	190-195	44	129.6	350 lbs R.R. shrimp; 700 lbs total; 40% ling, 30% monkfish, 15% whiting
9/19	14	010	39-58-22 70-44-66	10:15	39-58-43 70-53-36	12:15	190	46	150	300 lbs R.R. shrimp
	15	010	39-68-55 70-55-21	1:30	39-58-23 70-44-31	4:00	190-195	44	140	350 lbs R.R. shrimp; 700 lbs total
	16	010	39-58-60 70-44-01	5:00	39-58-35 70-52-89	7:45	195-200	44	90.0	250 lbs R.R. shrimp; 700 lbs total
	17	011	39-58-40 70-52-27	8:40	39-58-15 70-45-10	11:30	190-195	45-46	89.3	250 lbs R.R. shrimp; tore up net

F/V PATTY JO HAUL FORMS - SHRIMP STOCK ASSESSMENT TOWS

Cruise No. 2 Dates: 9/23 - 10/01/95

Date	Tow No.	Minilog Tow No.	Position - Trawl in Water		Position - Gear Haulback		Haul Depth (fm)	Avg. Haul Depth Temp °F	CPUE (catch per tow hour)	Total Catch (lbs)
			Lat/Long	Time	Lat/Long	Time				
9/24	18	012	39-53-79 71-27-31	6:45	39-51-99 71-33-55	8:45	200-210	44	0	75 monkfish; no shrimp; red crabs, blkbellied rosefish, squid, gren
	19	013	59-50-32 71-35-36	10:05	39-48-82 71-39-30	11:20	240-310	42-44	0	17 monkfish; 6 scarlet shrimp; viperfish, 17 snipe eels, whiting
	20	014	39-43-98 71-43-98	1:00	39-40-02 71-47-80	1:45	280-320	42	0	17 monkfish; 24 scarlet shrimp
	21	014	39-38-10 71-57-09	4:35	39-36-84 71-58-63	5:15	160	46	7.5	5 lbs R.R. and scarlet shrimp (3); 18 monkfish, BB rosefish, lobsters
9/25	22	015	39-20-64 72-12-13	4:30	39-16-71 72-16-47	6:20	190-200	44	7.7	65 monkfish; 14 lbs R.R. shrimp; whiting, squid, ling, octopi, bb rosefish
	23	no data	39-12-31 72-24-70	7:45	39-11-64 72-28-02	8:45	200-260	42	0	15 royal & 6 scarlet shrimp; 8 monkfish, grenadiers, viperfish
	24	017	39-07-40 72-35-44	10:15	39-05-38 72-38-06	11:10	410-460	40	0	Hung net; 2 scarlet shrimp, 12 unidentified shrimp, red crabs, grenadiers, blowfish
	25	018	38-52-76 72-52-99	3:10	38-50-17 72-55-86	4:20	190-205	44-45	0	4 monkfish; 6 R.R. shrimp
9/26	26	no data	38-03-04 73-49-82	1:10	38-00-48 73-52-53	2:10	178-200		0	2 monkfish; 12 R.R. shrimp

F/V PATTY JO HAUL FORMS - SHRIMP STOCK ASSESSMENT TOWS

Cruise No. 2

Dates: 9/23 - 10/01/95

Date	Tow No.	Minilog Tow No.	Position - Trawl in Water		Position - Gear Haulback		Haul Depth (fm)	Avg. Haul Depth Temp °F	CPUE (catch per tow hour)	Total Catch (lbs)
			Lat/Long	Time	Lat/Long	Time				
9/27	27	019	39-59-29 70-59-14	3:00	39-58-10 71-08-47	6:00	180-220	44-46	50	150 lbs R.R. shrimp; 700 lbs total
	28	020	39-58-26 71-07-46	6:30	39-58-96 70-58-74	9:30	180-210	45-46	50	150 lbs R.R. shrimp; 50 monkfish, 700 lbs total
	29	021	39-58-41 70-57-21	10:05	39-58-55 70-46-32	12:05	190-200	45	125	3 monkfish; 250 lbs R.R. shrimp
	30	021	39-58-47 70-45-79	2:15	39-58-47 70-51-36	5:50	180-195	44-46	83	4 monkfish; 300 lbs R.R. shrimp; 700 lbs total; red crab, rosefish, slime eels
	31	022	39-58-04 70-57-52	6:30	39-58-32 70-47-10	9:30	200	44-46	66.7	200 lbs R.R. shrimp; 600 lbs total
9/28	32	023	39-58-00 70-47-58	10:15	39-58-43 70-57-65	1:15	190-220	44-46	58.3	175 lbs R.R. shrimp
	33	023	39-58-18 70-58-11	2:40	39-58-42 70-46-76	6:10	180-200	46	35.7	125 lbs R.R. shrimp; 500 lbs total; anemones, lobsters, crabs
	34	024	39-57-79 70-44-49	7:25	39-58-49 70-55-80	10:50	190-210	45-46	44.1	150 lbs R.R. shrimp; red crabs
	35	025	39-57-59 70-55-78	11:35	39-58-18 70-46-34	2:35	200-215	45	25	75 lbs R.R. shrimp

F/V PATTY JO HAUL FORMS - SHRIMP STOCK ASSESSMENT TOWS

Cruise No. 2

Dates: 9/23 - 10/01/95

Date	Tow No.	Minilog Tow No.	Position - Trawl in Water		Position - Gear Haulback		Haul Depth (fm)	Avg. Haul Depth Temp °F	CPUE (catch per tow hour)	Total Catch (lbs)
			Lat/Long	Time	Lat/Long	Time				
9/28	36	025	39-58-10 70-46-26	3:15	39-58-99 70-56-49	6:15	180-195	45-46	50	150 lbs R.R. shrimp
	37	026	39-59-08 70-55-68	7:15	39-50-43 70-47-01	10:15	180-195	45-46	33.3	100 lbs R.R. shrimp
9/29	38	027	39-59-15 70-58-96	12:15	39-58-31 71-08-57	3:15	190-240	45	41.7	125 lbs R.R. shrimp
	39	027	39-58-12 71-08-62	3:50	39-59-73 70-59-58	6:40	190-200	45	71.4	200 lbs R.R. shrimp; 20 monkfish; 700 lbs total
	40	028	39-59-34 70-59-41	7:15	39-58-36 71-07-73	9:50	190-230	45	57.7	150 lbs R.R. shrimp; 700 lbs total; lots of small grey sole
	41	029	39-51-91 71-08-25	10:30	39-59-91 70-58-61	1:30	185-205	45	83.3	250 lbs R.R. shrimp
	42	029	40-06-09 70-58-62	2:25	39-58-24 71-09-04	5:45	180-200	46	75.8	250 lbs R.R. shrimp; 700 lbs total, lots of small lobsters
	43	030	39-58-20 71-08-73	6:20	39-59-72 70-59-35	9:30	190-200	45	46.9	150 lbs R.R. shrimp; lots of small lobsters
9/30	44	031	39-59-71 70-58-58	10:10	39-58-47 71-08-63	1:10	180-220	44-45	33.3	100 lbs R.R. shrimp

F/V PATTY JO HAUL FORMS - SHRIMP STOCK ASSESSMENT TOWS

Cruise No. 3

Dates: 10/07 - 10/15/95

* Computer failure prevented collection of temperature and depth data via minilog

Date	Tow No.	Position - in Water		Position - Haulback		Haul Depth (fm)	CPUE (catch per tow hour)	Total Catch (lbs)
		Lat/Long	Time	Lat/Long	Time			
10/8	48	39-19-26 72-14-82	6:15	39-16-16 72-18-58	7:45	170-178	20	320 lbs monkfish; 30 lbs shrimp; 60 lbs large whiting; 11 bu bycatch
	49	39-15-43 72-19-22	8:30	39-18-34 72-14-83	10:00	183-187	13.3	250 lbs monkfish; 20 lbs shrimp
	50	39-18-64 72-14-26	11:00	39-15-18 72-19-05	12:30	194-195	6.7	150 lbs monkfish; 10 lbs shrimp; 6 bu bycatch
	51	39-14-44 72-19-70	1:45	39-17-71 72-14-18	3:15	213-230	2	300 lbs monkfish; 3 lbs shrimp; 13 bu bycatch, mostly red crabs
	52	39-17-87 72-13-54	4:35	39-14-78 72-17-70	6:05	223-225	0	240 lbs monkfish; 60 lbs whiting; 13 bu bycatch; 12 scarlet and 12 royal red
10/9	53	39-15-47 72-15-65	6:15	39-12-96 72-19-77	7:45	279-282	0	1 bu monkfish; 1 bu large whiting; 19 bu bycatch; 7 scarlet shrimp
	54	39-11-11 72-20-00	8:45	39-12-23 72-16-79	10:30	391-410	0	80 lbs monkfish; 50 lbs skate; 8 scarlet shrimp; 19 bu bycatch
	55	39-18-84 72-15-39	12:45	39-15-81 72-19-44	2:30	165-167	0	5 bu monkfish; 9 bu bycatch; no shrimp
	56	39-18-40 72-15-34	4:10	39-15-29 72-19-96	6:00	175-176	11.1	5 bu monkfish; 1 bu large whiting; 19 bu bycatch; 20 lbs shrimp

F/V PATTY JO HAUL FORMS - SHRIMP STOCK ASSESSMENT TOWS

Cruise No. 3 Dates: 10/07 - 10/15/95

* Computer failure prevented collection of temperature and depth data via minilog

Date	Tow No.	Position - Trawl in Water		Position - Gear Haulback		Haul Depth (fm)	CPUE (catch per tow hour)	Total Catch (lbs)
		Lat/Long	Time	Lat/Long	Time			
10/10 Nordmore grate in	57						—	Tore net
10/10 New net w/grate in	58	39-18-59 72-14-34	1:45	39-15-27 72-18-72	3:15	191-200	3.3	6.75 lbs monkfish; 1 bu whiting; 5 lbs shrimp; 6 bu bycatch
	59	39-14-88 72-19-26	4:15	39-17-71 72-14-11	6:15	204-214	1.8	no monkfish; 15 bu bycatch; 3.5 lbs shrimp
10/11	60	39-18-37 72-14-56	6:00	39-15-59 72-18-51	7:30	192-195	10	no monkfish; 15 lbs shrimp; 6 bu bycatch
	61	39-14-93 72-18-94	8:15	39-17-32 72-15-60	9:45	200-213	6.7	10 lbs monkfish; 8 bu bycatch; 10 lbs shrimp; 2 red crabs
	62	39-14-89 72-18-62	10:45	39-17-60 72-13-87	12:15	220-224	1.3	7 lbs monkfish; 2 lbs shrimp; 3 bu bycatch
	63	39-18-12 72-13-78	1:15	39-15-21 72-18-57	2:45	207-213	1.0	no monkfish; 4 bu bycatch; 1.5 lbs shrimp
10/12	64	39-58-96 72-57-12	7:05	39-58-20 70-45-86	10:05	182-202	60	7 lbs monkfish; 16 bu bycatch; 3 bu shrimp (180 lbs)
	65	39-58-20 70-45-92	10:45	39-58-97 70-56-17	1:45	180-199	60	3 bu shrimp (180 lbs); 5 lbs monkfish; 14.5 bu bycatch

F/V PATTY JO HAUL FORMS - SHRIMP STOCK ASSESSMENT TOWS

Cruise No. 3 Dates: 10/07 - 10/15/95

* Computer failure prevented collection of temperature and depth data via minilog

Date	Tow No.	Position - in Water		Position - Haulback		Haul Depth (fm)	CPUE (catch per tow hour)	Total Catch (lbs)
		Lat/Long	Time	Lat/Long	Time			
10/12	66	39-59-05 70-36-35	3:00	39-58-69 70-14-09	6:00	180-185	60	3 bu shrimp (180 lbs); 17 lbs monkfish; 10 bu bycatch
10/13 Grate removed	67	39-58-75 70-56-47	6:05	39-58-29 70-47-20	9:05	185-199	50	6 bu monkfish; 2.5 bu shrimp (150 lbs); 12 bu bycatch
	68	39-58-48 70-46-42	9:40	39-58-99 70-56-55	12:40	180-192	50	4 bu monkfish; 2.5 bu shrimp (150 lbs); 11.5 bu bycatch
	69	39-59-18 70-57-24	1:15	39-57-95 70-48-05	3:15	180-210	75	2.5 bu shrimp (150 lbs); 4 bu monkfish; 11.5 bu bycatch
	70	39-57-83 70-47-05	4:40	39-58-89 70-56-37	7:30	183-212	53.6	2.5 bu shrimp (150 lbs); 5.5 bu monkfish; 12 bu bycatch
	71	39-58-86 70-54-54	8:15	39-59-42 70-47-83	10:15	169-182	225	5 bu monkfish; 6 bu bycatch; 7.5 bu shrimp (450 lbs)
10/14	72	39-59-29 70-46-67	12:15	39-58-91 70-53-20	2:30	172-182	213	8 bu shrimp (480 lbs); 4 bu monkfish; 9 bu bycatch
	73	39-59-19 70-46-20	4:15	39-58-92 70-53-21	6:20	173-181	200	6 bu monkfish; 8 bu bycatch; 7 bu shrimp (420 lbs)
	74	39-59-36 70-53-91	7:00	39-59-37 70-45-96	9:20	170-180	169.6	8 bu bycatch; 5 bu monkfish; 6.5 bu shrimp (390 lbs)

F/V PATTY JO HAUL FORMS - SHRIMP STOCK ASSESSMENT TOWS

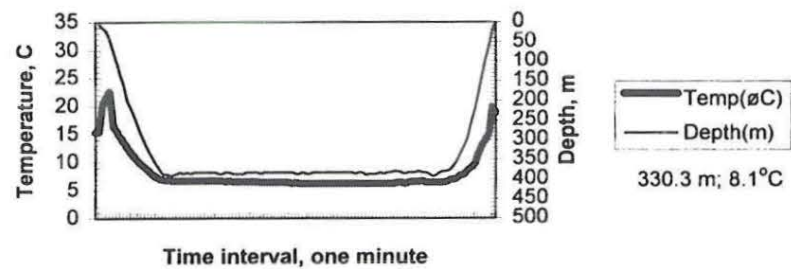
Cruise No. 3 Dates: 10/07 - 10/15/95

* Computer failure prevented collection of temperature and depth data via minilog

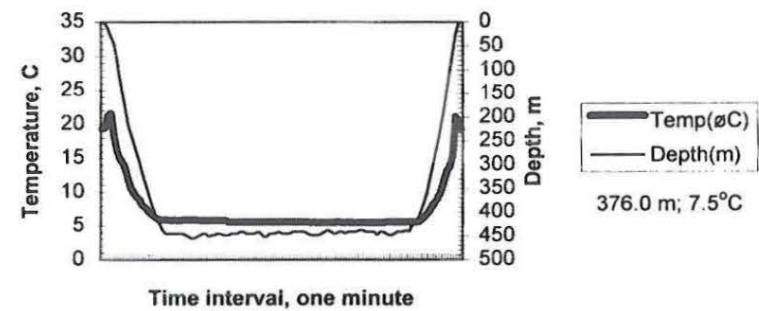
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		Lat/Long	Time	Lat/Long	Time			
10/14	75	39-59-50 70-46-25	10:00	39-58-86 70-53-58	12:00	167-181	150	5 bu monkfish; 7.5 bu bycatch; 5 bu shrimp (300 lbs)
	76	39-58-94 70-53-80	12:30	39-59-21 70-46-19	2:30	173-183	195	4 bu monkfish; 8.5 bu bycatch; 6.5 bu shrimp (390 lbs)
	77	39-59-28 70-46-05	3:50	39-58-81 70-52-83	6:10	171-183	104.3	3.5 bu monkfish; 5 bu bycatch; 4 bu shrimp

Appendix II - Temperature/Depth Graphs

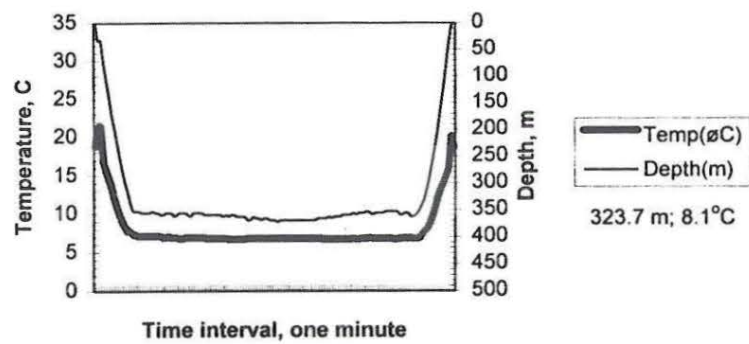
Cruise 1, Tow #3, 9/16/95



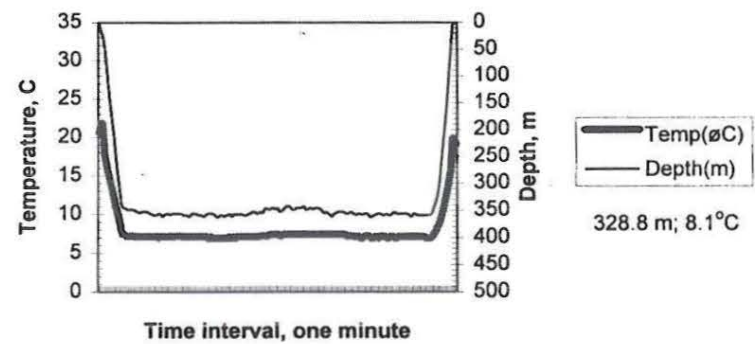
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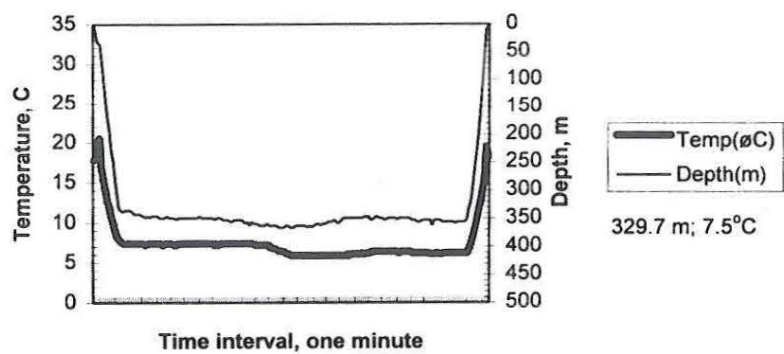
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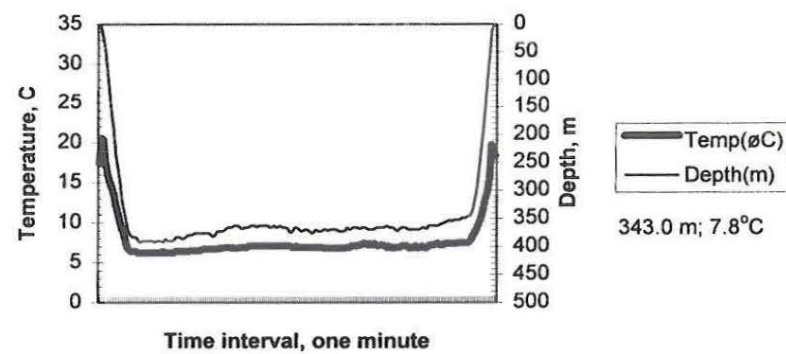
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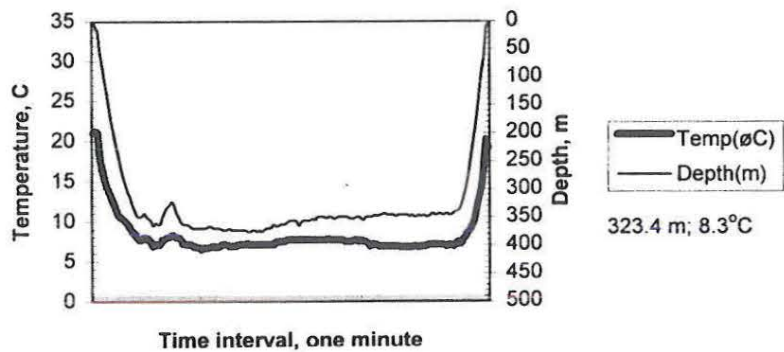
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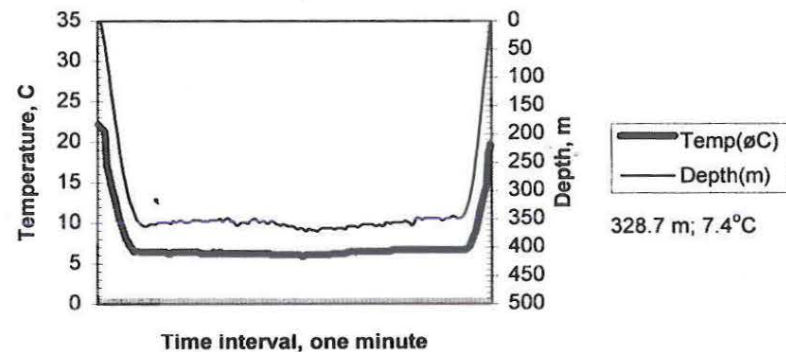
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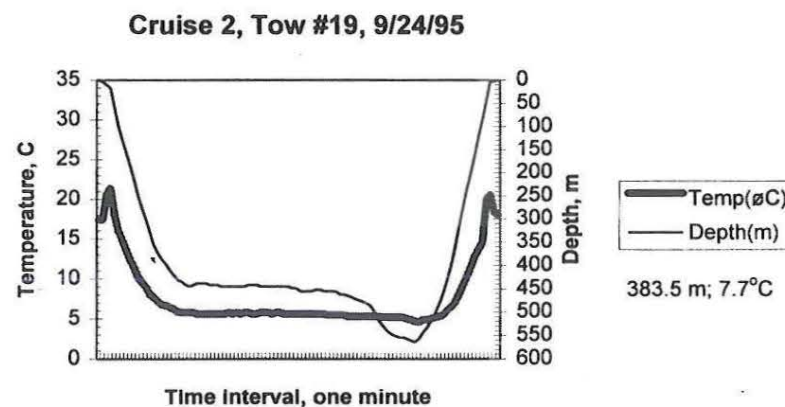
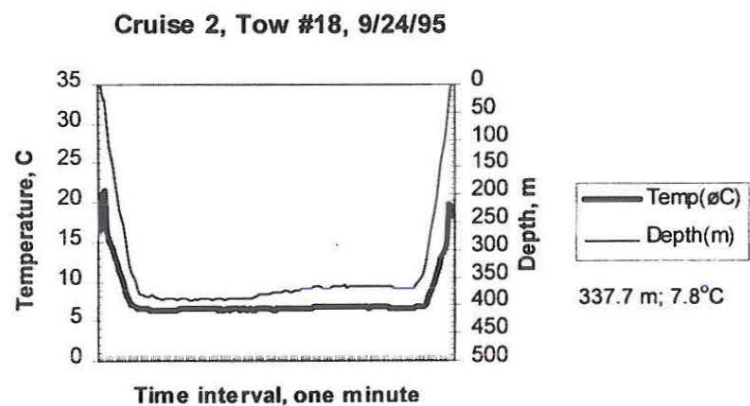
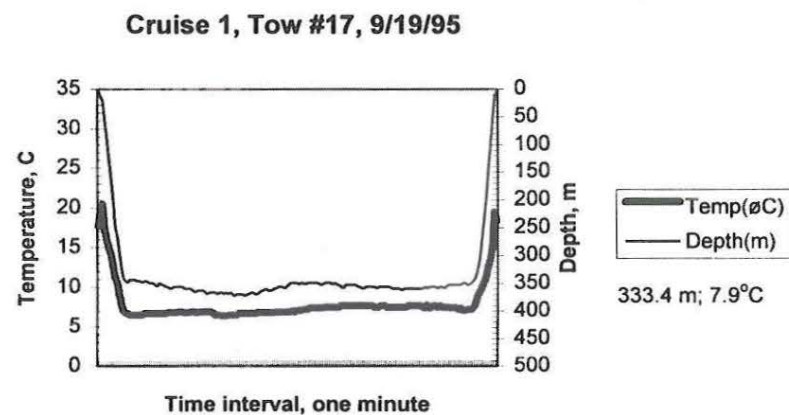
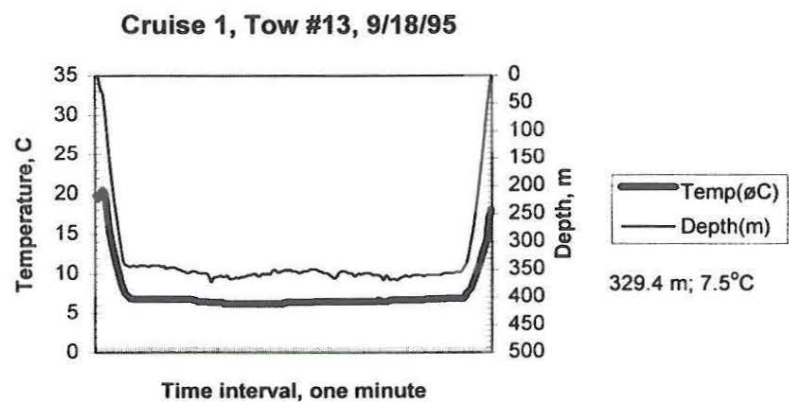


Cruise 1, Tow #11, 9/18/95

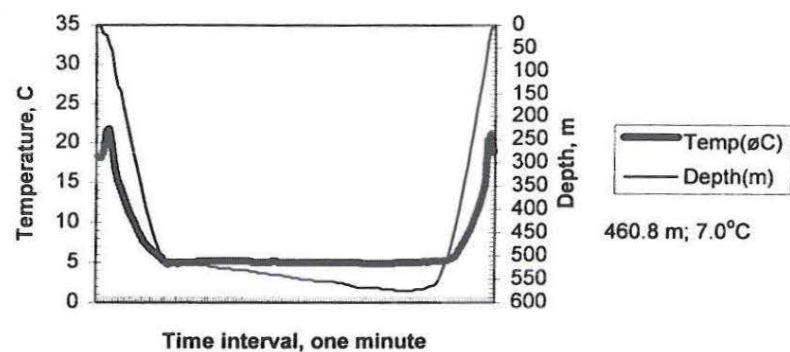


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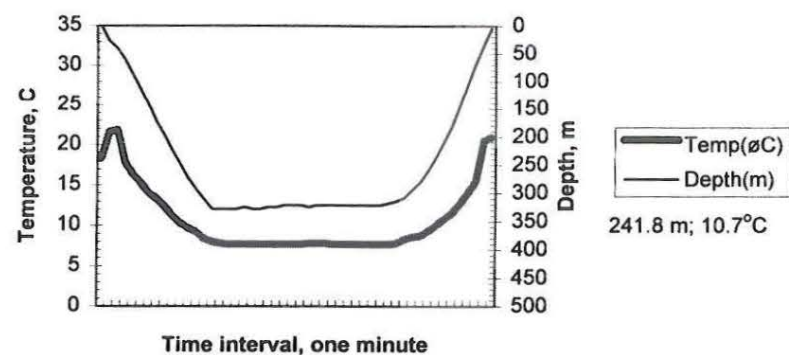




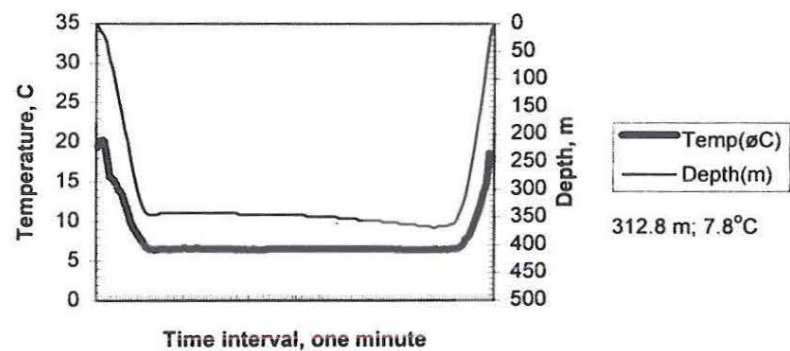
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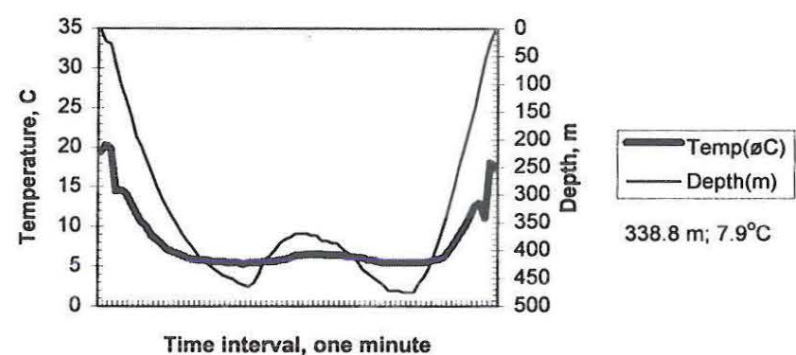
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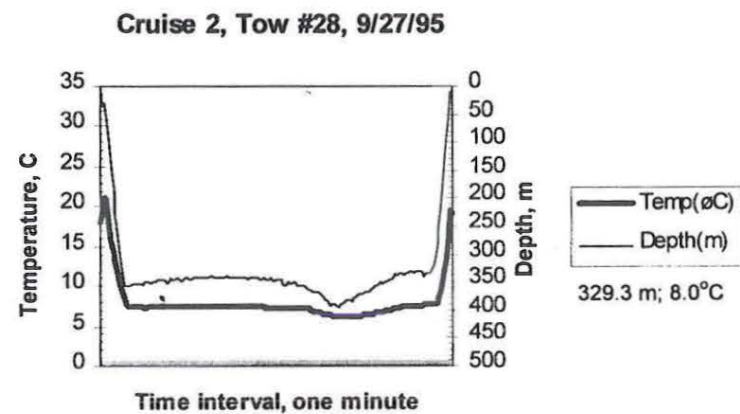
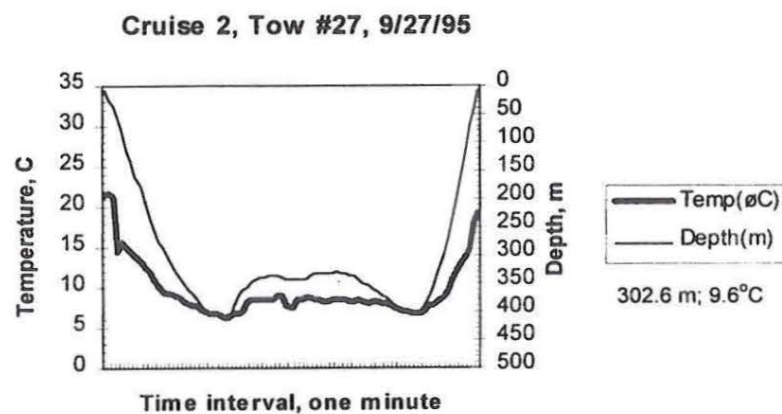
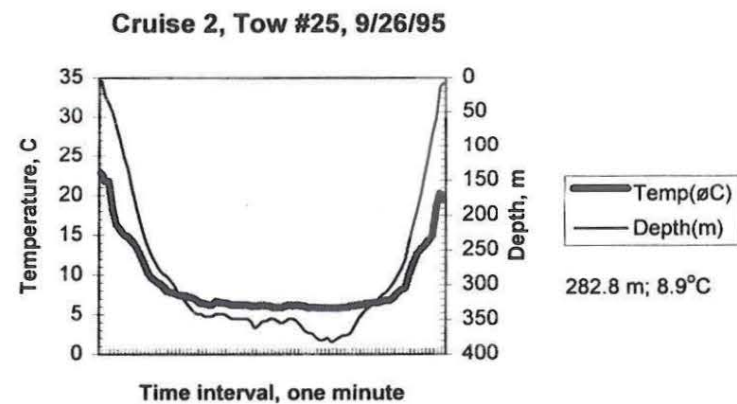
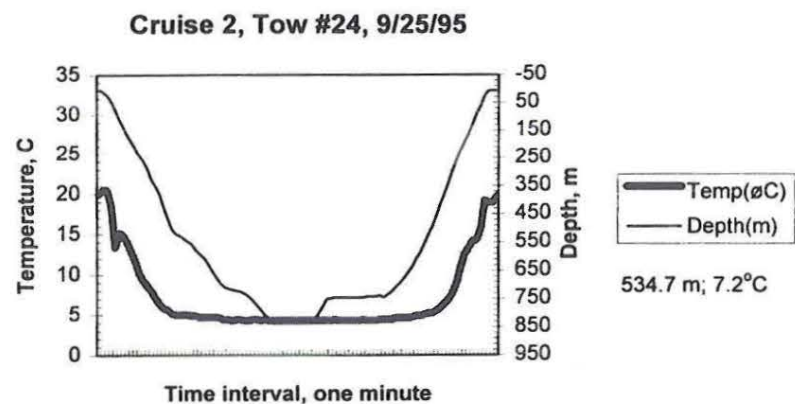


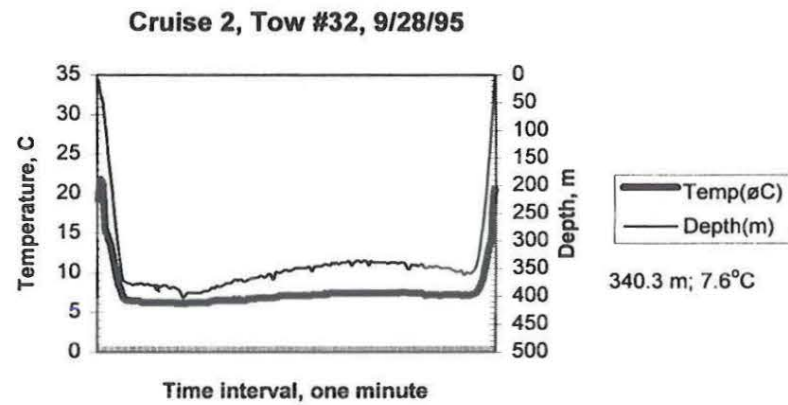
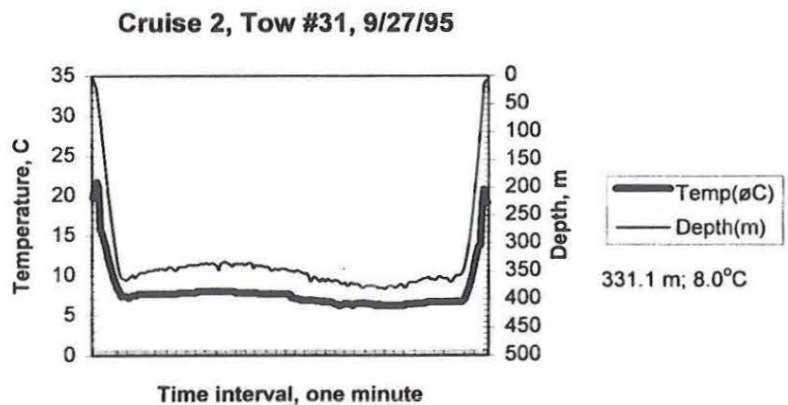
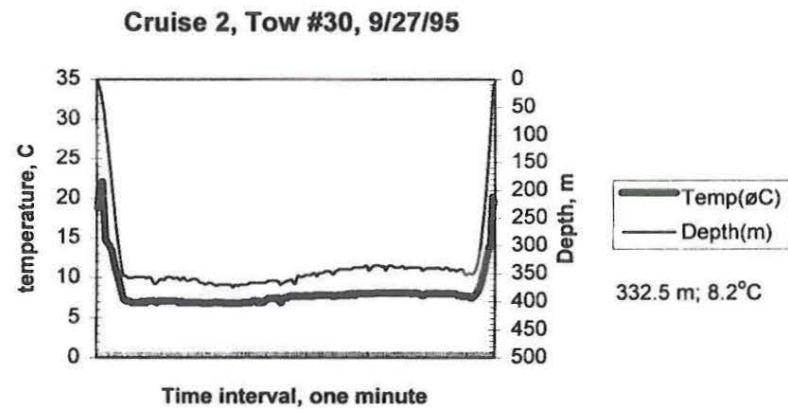
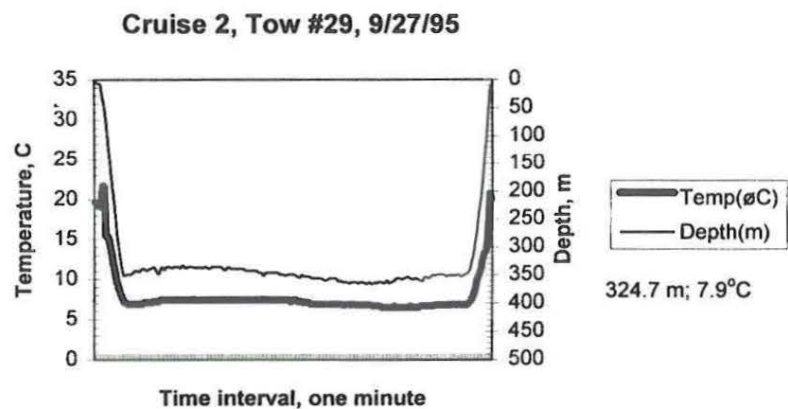
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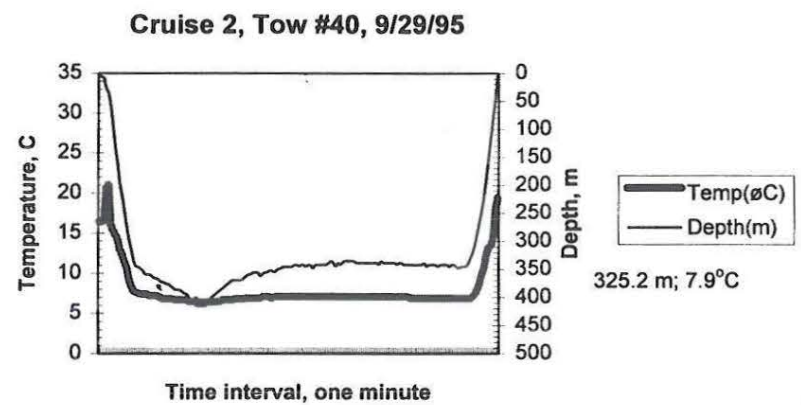
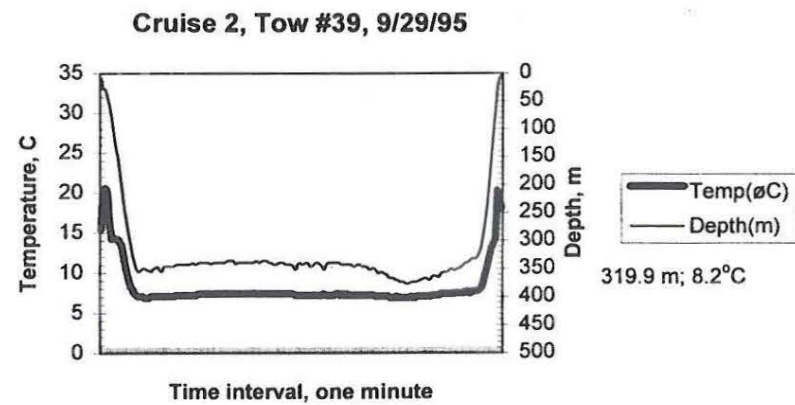
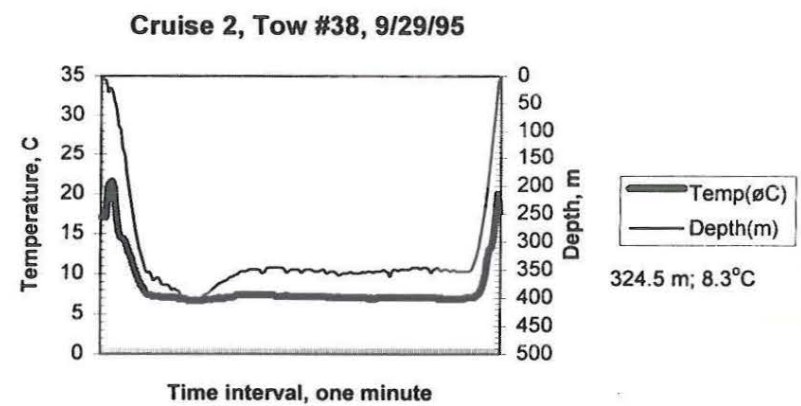
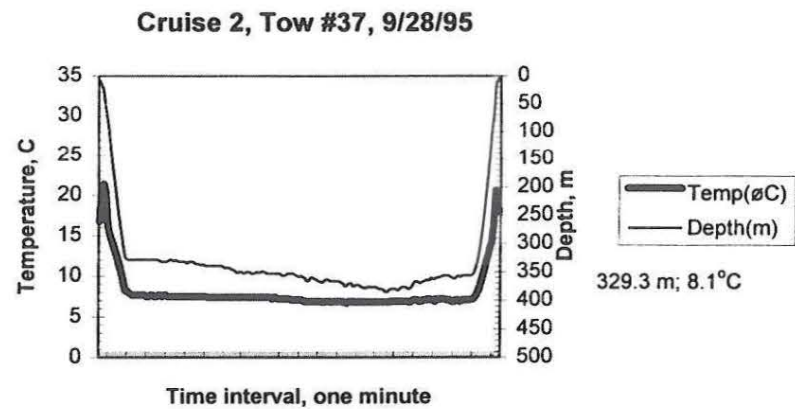


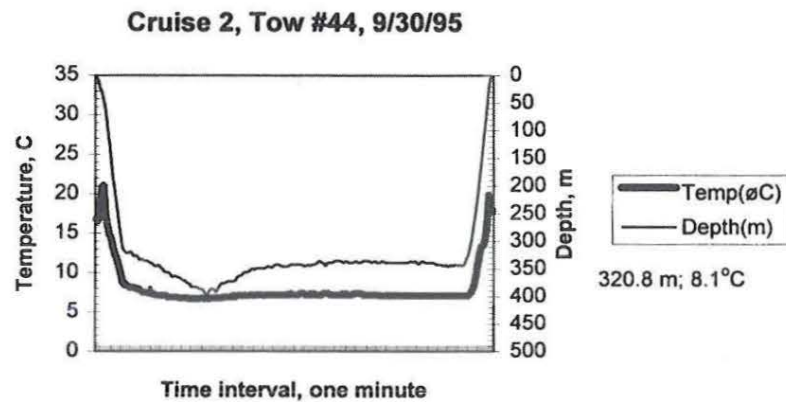
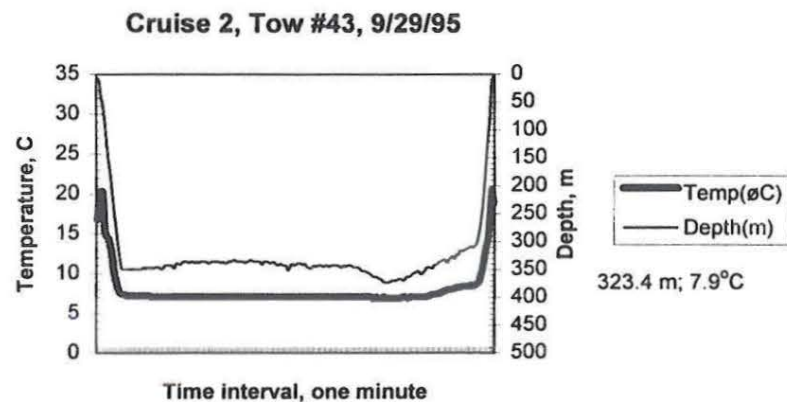
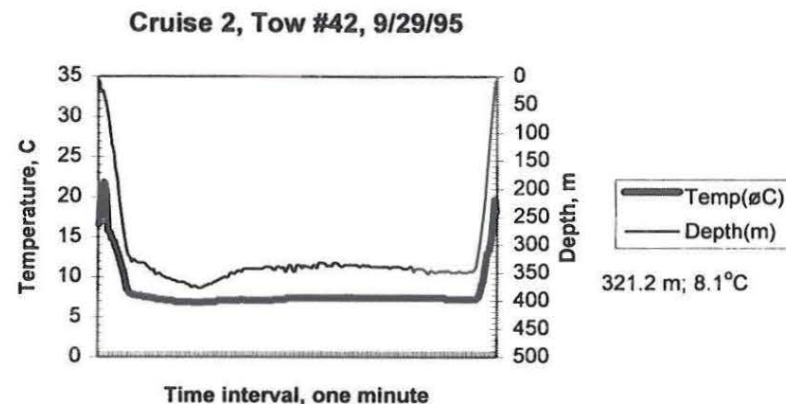
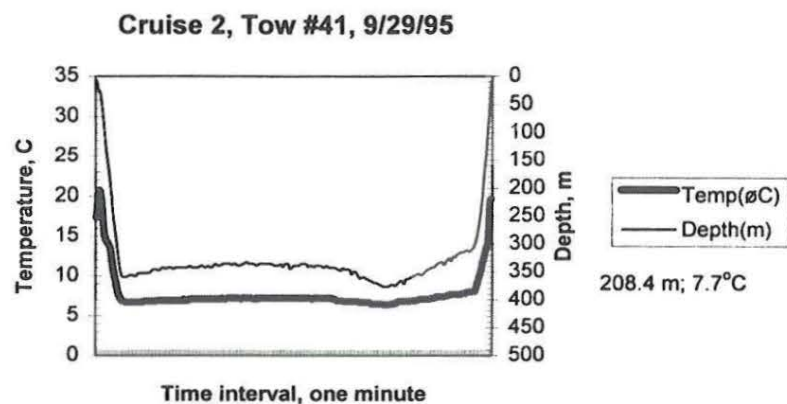
Cruise 2, Tow #23, 9/25/95



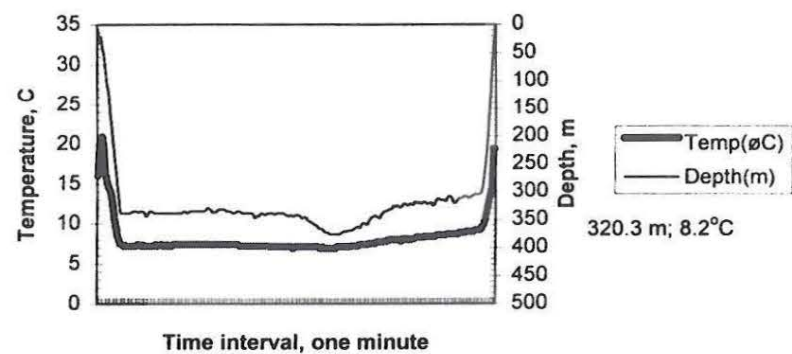




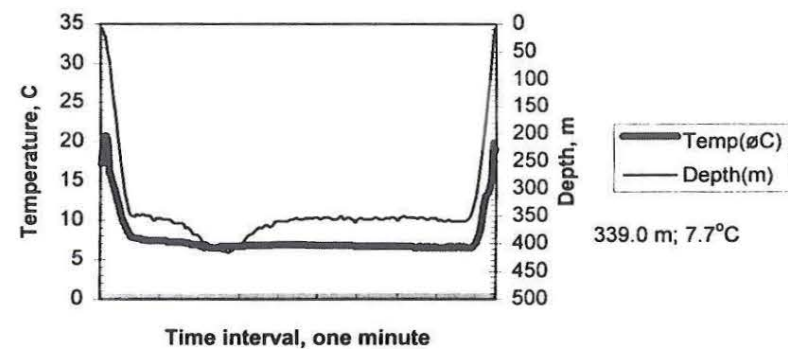




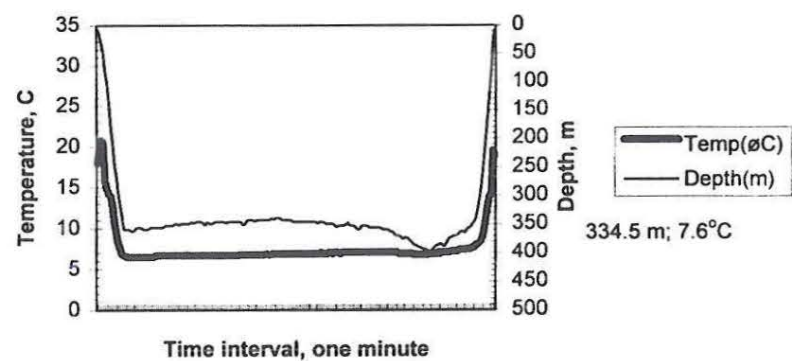
Cruise 2, Tow #45, 9/30/95



Cruise 2, Tow #46, 9/30/95



Cruise 2, Tow #47, 9/30/95



Appendix III - Bycatch Species Composition

F/V Patty Jo - Bycatch Species Com. Station
Cruise No. 3

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
48-A	Misc - Shortnosed greeneye; grenadiers squid	14.37	146.8	7.4
GRATE OUT	Crustaceans - Galatheid crabs; rock crabs; red crabs	1.14	18.5	1.8
	Whiting - small & medium	10.16	144.8	14.1
	Flatfish	2.84	34.2	3.3
	Redfish (Black bellied rosefish)	30.9	271.6	26.5
48-B	Misc - Shortnosed greeneye; grenadiers; squid	13.34		
	Crustaceans	2.35		
	Whiting - small 7 medium	17.17		
	Flatfish	3.61		
	Redfish	20.35		
Total catch	Monkfish		320	31.2
	Whiting - large		60	5.9
	Shrimp		30	2.9
	Bycatch (11 bu)		616	60.0
	Total overall catch tow 48		1026	

F/V Patty Jo - Bycatch Species Con. sition
Cruise No. 3

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
52-A	Crustaceans - red crabs	30.10	265.5	25.8
GRATE OUT	Misc - redfish; whiting; grenadiers; shortnosed greeneye	12.25	193.8	18.9
	Flatfish	7.75	123.9	12.1
	Anemones	13.23	144.7	14.1
52-B	Crustaceans - red crab	15.45		
	Misc - redfish; grenadiers; whiting	21.00		
	Flatfish	13.50		
	Anemones	11.60		
Total catch	Monkfish		240	23.4
	Whiting - large		60	5.8
	Shrimp		24#	0
	Bycatch (13 bu)		728	
	Total overall catch Tow 52		1028	

F/V Patty Jo - Bycatch Species Composition
Cruise No. 3

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
53-A	Anemones	22.75	347.7	27.5
GRATE OUT	Red crab	13.15	304.9	24.1
	Misc - mostly skates; redfish; grenadiers	10.05	222.0	17.6
	Flatfish	12.63	189.4	15.0
53-B	Anemones	11.00		
	Red crab	16.45		
	Misc - skates; redfish; whiting	11.50		
	Flatfish	5.75		
Total catch	Monkfish		100	7.9
	Whiting - large		100	7.9
	Shrimp		7#	0
	Bycatch (19 bu)		1064	84.2
	Total overall catch tow 53		1264	

F/V Patty Jo - Bycatch Species Composition
Cruise No. 3

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first (A) and last bushel (B) baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
56-A	Whiting - small & medium	16.50	210.8	12.5
GRATE OUT	Misc - mostly grenadiers; some greeneyes; few skates	9.41	217.1	12.9
	Redfish	26.79	496.4	29.5
	Flatfish	2.00	59.0	3.5
56-B	Whiting - small and medium	4.85		
	Misc - mostly grenadiers; some shortnosed greeneyes	13.39		
	Redfish	25.34		
	Flatfish	4.20		
Total catch	Monkfish		500	29.7
	Whiting - large		100	5.9
	Shrimp		20	1.2
	Bycatch (19bu)		1064	98.8
	Total overall catch tow 56		1684	

F/V Patty Jo - Bycatch Species Composition
Cruise No. 3

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
58-A	Crustaceans - mostly red crabs	5.00	17.1	3.8
GRATE IN	Redfish	23.98	83.4	18.6
	Misc - mostly greeneyes and grenadiers; some squid	16.45	70.8	15.8
	Flatfish	3.45	15.3	3.4
	Whiting - small & medium	22.95	149.4	33.3
58-B	Crustaceans - red crabs	2.45		
	Redfish	12.45		
	Misc - grenadiers; greeneyes; some squid	14.50		
	Flatfish	3.25		
	Whiting - small	42.35		
Total catch	Monkfish		7	1.6
	Whiting - large		100	22.3
	Shrimp		5	1.1
	Bycatch (6 bu)		336	75
	Total overall catch tow 58		448	

F/V Patty Jo - Bycatch Species Composition
Cruise No. 3

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
59-A	Flatfish	7.15	95.4	11.3
GRATE IN	Misc - mostly squid; some grenadiers	18.60	174.2	20.7
	Whiting - small & medium	25.73	389	46.1
	Crustaceans - red crab	8.06	93.8	11.1
	Redfish	6.40	87.6	10.4
59-B	Flatfish	7.00		
	Misc - mostly squid; grenadiers	7.23		
	Whiting - small & medium	31.95		
	Crustaceans - red crab	5.85		
	Redfish	6.59		
Total catch	Monkfish		0	
	Whiting - large		0	
	Shrimp		3.5	0.4
	Bycatch (15bu)			99.6
	Total overall catch tow 59		843.5	

F/V Patty Jo - Bycatch Species Cor. sition
Cruise No. 3

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
60-A	Flatfish	10.60	38.1	10.8
GRATE IN	Whiting - small	11.62	78.9	22.4
	Crustaceans - Galatheid crabs	2.50	9.2	2.6
	Misc - mostly grenadiers	14.00	89.1	25.3
	Redfish	31.90	120.8	34.3
60-B	Flatfish	4.04		
	Whiting - small	18.71		
	Crustaceans - Galatheid crabs	1.05		
	Misc - mostly grenadiers	20.25		
	Redfish	14.55		
Total catch	Monkfish		1	0.3
	Whiting - large		0	
	Shrimp		15	4.3
	Bycatch (6bu)		336	
	Total overall catch tow 60		352	

F/V Patty Jo - Bycatch Species Com, ition
Cruise No. 3

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
61-A	Whiting - small	8.85	82.1	17.5
GRATE IN	Misc - mostly squid; some grenadiers	26.10	149.3	31.9
	Flatfish	2.90	32.9	7.0
	Redfish	13.45	158.3	33.8
	Crustaceans	1.50	25.5	5.5
61-B	Whiting - small	5.50		
	Flatfish	2.85		
	Redfish	14.23		
	Crustaceans	2.95		
Total catch	Monkfish		10	2.1
	Whiting - large		0	
	Shrimp		10	2.1
	Bycatch (8bu)		448	95.7
	Total overall catch tow 61		468	

**F/V Patty Jo - Bycatch Species Composition
Cruise No. 3**

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
62-A	Misc - mostly squid; some grenadiers & greeneyes	23.70	53.5	30.2
GRATE IN	Crustaceans - Red crab	2.55	7.0	4.0
	Whiting - small & medium	19.25	60.0	33.9
	Flatfish	8.90	18.2	10.3
	Redfish	9.50	29.2	16.5
62-B	Misc - mostly squid	12.98		
	Crustaceans - Red crab; 1 small lobster	2.24		
	Whiting - small & medium	21.86		
	Flatfish	3.58		
	Redfish	10.53		
Total catch	Monkfish		7	4.0
	Whiting - large		0	
	Shrimp		2	1.1
	Bycatch (3 bu)		168	94.9
	Total overall catch tow 62		177	

F/V Patty Jo - Bycatch Species Com, ition
Cruise No. 3

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
64-A	Redfish	15.10	184.5	17.0
GRATE IN	Whiting - small & medium	18.70	403.8	37.3
	Misc - equally anemones; squid; greeneyes and grenadiers	13.60	226.2	20.9
	Crustaceans - mostly Galatheids and rock crabs	3.50	41.7	3.9
	Flatfish	5.00	39.8	3.7
64-B	Redfish	8.07		
	Whiting - small & medium	32.00		
	Misc- equally anemones; squid; greeneyes and grenadiers	14.80		
	Crustaceans - mostly Galatheids and rock crabs	1.73		
Total catch	Monkfish		7	0.7
	Whiting - large		0	
	Shrimp		180	16.6
	Bycatch (16bu)		896	82.7
	Total overall catch tow 64		1083	

F/V Patty Jo - Bycatch Species Com, ition
Cruise No. 3

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
65-A	Redfish	5.50	80.2	9.8
GRATE IN	Whiting - small & medium	34.54	514.3	62.7
	Misc - grenadiers; greeneyes; ling	9.20	128.6	15.7
	Crustaceans - shrimp; Galatheids	1.21	57.0	7.0
	Flatfish	3.40	32.0	3.9
65-B	Redfish	6.04		
	Whiting - small & medium	39.50		
	Misc - greeneyes; grenadiers	9.31		
	Crustaceans - shrimp; red crabs; Galatheids	7.00		
	Flatfish			
Total catch	Monkfish		5	0.6
	Whiting - large		0	
	Shrimp		3	0.4
	Bycatch (14.5bu)		812	99.0
	Total overall catch tow 65		820	

F/V Patty Jo - Bycatch Species Comparison
Cruise No. 3

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
66-A	Flatfish	6.90	66.0	8.7
GRATE IN	Misc - anemones; mixed stuff	10.43	129.9	17.2
	Whiting - small & medium	12.25	175.1	23.1
	Redfish	15.40	121.8	16.1
	Crustaceans - 1 lobster; Galatheid crabs; shrimp		67.1	8.9
66-B	Flatfish	5.27		
	Misc - anemones; greeneyes & grenadiers	13.52		
	Whiting - small & medium	20.03		
	Redfish	7.05		
	Crustaceans - 2 lobsters; Galatheid crabs	7.11		
Total catch	Monkfish		17.5	2.3
	Whiting - large		0	
	Shrimp		180	23.8
	Bycatch (10bu)		560	73.9
	Total overall catch tow 66		757.5	

**F/V Patty Jo - Bycatch Species Composition
Cruise No. 3**

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW#	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
67-A	Whiting - small & medium	20.05	362.2	25.5
GRATE OUT	Redfish	9.30	90.1	6.3
	Crustaceans - 1 lobster; Galatheid crabs; shrimp	5.50	58.8	4.1
	Misc - greeneyes; grenadiers; anemones; ling	7.25	106.2	7.5
	Flatfish	4.95	54.7	3.9
67-B	Whiting - small & medium; 2 large			
	Redfish	3.81		
	Crustaceans - lobsters; Galatheid crabs	3.06		
	Misc - anemones; greeneyes; grenadiers	8.20		
	Flatfish	3.00		
Total catch	Monkfish		600	42.2
	Whiting - large		0	
	Shrimp		150	10.6
	Bycatch (12bu)		672	47.3
	Total overall catch tow 67		1422	

F/V Patty Jo - Bycatch Species Composition
Cruise No. 3

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
69-A	Flatfish	3.43	36.4	3.1
GRATE OUT	Misc - mostly ling; some grenadiers & greeneyes	6.43	111.2	9.3
	Redfish	5.80	60.4	5.1
	Crustaceans - 3 lobsters; shrimp	6.84	69.1	5.8
	Whiting - small & medium	36.90	366.9	30.7
69-B	Flatfish	3.14		
	Misc- 2 large ling; some small ling; some grenadiers & greeneyes	13.65		
	Redfish	5.11		
	Crustaceans - lobsters; Galatheid crabs	5.63		
	Whiting - small & medium	29.33		
Total catch	Monkfish		400	33.5
	Whiting - large		0	
	Shrimp		150	12.6
	Bycatch (11.5 bu)		644	53.9
	Total overall catch tow 69		1194	

F/V Patty Jo - Bycatch Species Composition
Cruise No. 3

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
70-A	Flatfish	9.25	87.4	6.4
GRATE OUT	Redfish	5.23	54.5	4.0
	Whiting - small & medium	15.25	275.4	20.1
	Crustaceans - lobster; Galatheid crabs; shrimp	8.90	88.1	6.4
	Misc - 1 large ling; anemones; greeneyes; grenadiers	10.14	166.6	12.1
70-B	Flatfish	4.40		
	Redfish	3.28		
	Whiting - small & medium	27.76		
	Crustaceans - 1 red crab; Galatheid crabs	4.85		
	Misc - 2 large ling; small ling; grenadiers & greeneyes	15.87		
Total catch	Monkfish		550	40.1
	Whiting - large		0	
	Shrimp		150	10.9
	Bycatch (12bu)		672	49.0
	Total overall catch tow 70		1372	

**F/V Patty Jo - Bycatch Species Composition
Cruise No. 3**

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
71-A	Flatfish	10.21	60.6	4.7
GRATE OUT	Misc - anemones; ling	13.70	111.4	8.7
	Whiting - small & medium	12.90	106.3	8.3
	Redfish		21.3	1.7
	Crustaceans - Galatheid crabs; shrimp	8.09	36.5	2.8
71-B	Flatfish	7.71		
	Misc - 1 large ling; small ling; grenadiers; greeneyes	19.24		
	Whiting - small & medium	18.54		
	Redfish	3.05		
	Crustaceans - Galatheid crabs; lobster	2.70		
Total catch	Monkfish		500	38.9
	Whiting - large		0	
	Shrimp		450	35.0
	Bycatch (6 bu)		336	26.1
	Total overall catch tow 71		1286	

F/V Patty Jo - Bycatch Species Comp lion
Cruise No. 3

Large monkfish, whiting and shrimp separated into bushel baskets first.

Remainder of bycatch placed in bushel baskets.

Bycatch in first and last bushel baskets sorted and weighed.

Avg wgt 1 bu bycatch = 56 lbs; avg wgt 1 bu shrimp = 60 lbs; avg wgt 1 bu monkfish / lg whiting = 100 lbs

TOW #	Species/Group	Weight (lbs) - one bushel	Weight (lbs) - total tow	% of Total Tow
73-A	Flatfish	9.70	90.0	6.1
GRATE OUT	Redfish	5.31	52.5	3.6
	Crustaceans - 2 lobsters; rock crabs; Galatheid crabs	7.27	59.1	4.0
	Misc - anemones; ling; greeneyes; grenadiers	11.21	116.2	7.9
	Whiting - small & medium	16.70	130.1	8.9
73-B	Flatfish	11.00		
	Redfish	6.77		
	Crustaceans - rock crabs; Galatheid crabs; shrimp	6.32		
	Misc - batfish; grenadiers; greeneyes; ling	15.51		
	Whiting - small & medium	13.20		
Total catch	Monkfish		600	40.9
	Whiting - large		0	
	Shrimp		420	28.6
	Bycatch (8bu)		448	30.5
	Total overall catch tow 73		1468	

Appendix IV - Market Survey

Market Survey of Deep Sea Shrimp Species

We'd like to know what you think about this product which was harvested as part of an experimental fishing industry assistance (FIG) grant to explore the commercial harvest and market potential of several deepwater species. Your responses will be included in a report to the National Marine Fisheries Service summarizing the market potential for this species. *Individual responses will remain confidential and anonymous.*

If you are sampling more than one product, please use a separate sheet for each species, and circle the name of the species you are commenting on in the space below. Please return this form in the stamped envelope provided. Thank you for your input.

Bill and Jo Bomster
Stonington Seafood Harvesters, Inc.
83 Cutler Street
Stonington, CT 06378

Nancy Balcom
Sea Grant Marine Advisory Program
1084 Shennecossett Road
Groton, CT 06340-6097

Name of species: ☐ Scarlet shrimp ☐ Royal Red shrimp

Market Form received: ☐ frozen ☐ fresh ☐ headed ☐ heads on

1. What is your *preferred* market form:

- a. ☐ heads on, fresh b. ☐ heads off, fresh
c. ☐ heads on, frozen d. ☐ heads off, frozen

2. List a price range you would be willing to pay for the following market forms:

	10-count	20-count	30-count
a. Heads on, fresh	_____	_____	_____
b. Heads on, frozen	_____	_____	_____
c. Heads off, fresh	_____	_____	_____
d. Heads off, frozen	_____	_____	_____

(continued on back)

3. Check which best describes you:

_____ seafood retailer _____ seafood wholesaler _____ chef/buyer for restaurant
_____ personal use buyer _____ other _____

4. How do you rate the quality of the product you received?

_____ Excellent _____ Good _____ Average _____ Poor

5. What was the taste / texture / scent of the product you received? (Check any that apply)

a. Taste:

_____ Delicious _____ Sweet _____ Rubbery _____ Mealy
_____ Succulent _____ Mild _____ Strong _____ Other: _____

b. Texture:

_____ Firm _____ Soft / Mushy

c. Scent:

_____ Mild _____ Strong _____ Pleasant _____ Unpleasant

6. If this product was available, would you consider buying it on a regular basis? (A positive response does not imply any obligation to purchase this product.)

_____ Yes _____ No

7. If you were to purchase this product on a regular basis, how many pounds per week would you require? (Again, no obligation to purchase--your response will contribute to information on market demand.)

Your input is valued. We thank you for your time and your comments!

