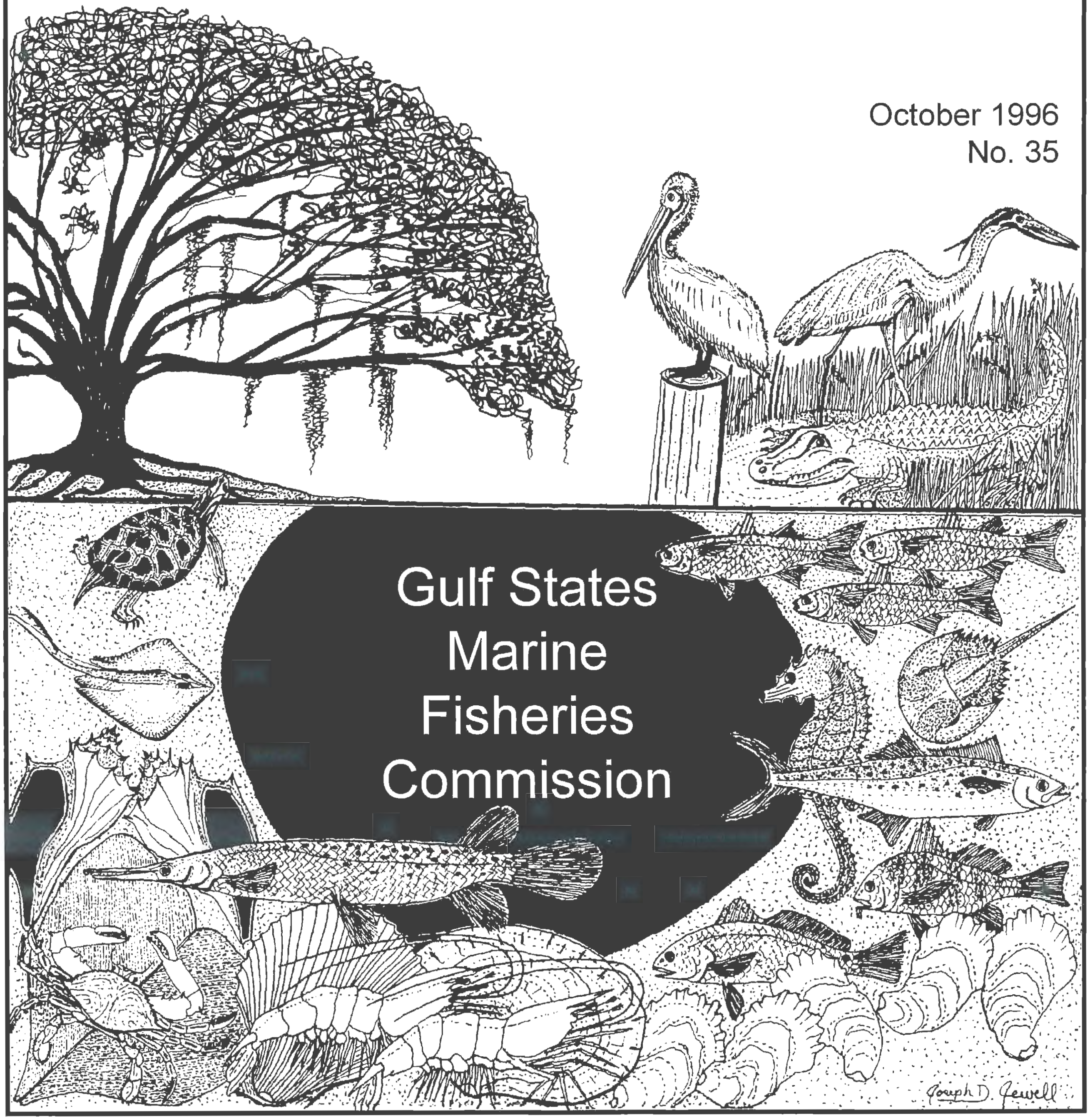
# USES OF FISHERY-INDEPENDENT DATA GENERAL SESSION PROCEEDINGS

October 1996
No. 35



# GULF STATES MARINE FISHERIES COMMISSION GENERAL SESSION

# USES OF FISHERY-INDEPENDENT DATA

Sponsored by SEAMAP

Gulf States Marine Fisheries Commission
Ocean Springs, Mississippi

## TABLE OF CONTENTS

# INTRODUCTION

In a very general sense, fishery-dependent data tell you where you've been, relative to the status of the fishery stocks, and fishery-independent data tell you where you are and where you will be in regard to the status of the fishery stocks. Fishery-independent data is not biased by management regimes, price of the product, weather, or reliability and accuracy of the fisherman/dealer, and if handled in a cooperative manner among the various management regimes, is less expensive to obtain than fishery-dependent data.

Approximately 15 years ago Walter Nelson and Andy Kemmerer came to the Claude Peteet Mariculture Center in Gulf Shores to discuss an innovative cooperative program that they would like introduced to the Gulf of Mexico. Synoptic sampling with compatible sampling gear throughout the Gulf of Mexico was the basis of the program. Those ideas sounded like an extension of the old Gulf of Mexico Estuarine Inventory that took place about a decade earlier. While you have to credit all of the Southeast Area Monitoring and Assessment Program (SEAMAP) representatives for the success of the program in the Gulf of Mexico, certainly Drs. Nelson, Kemmerer, and Fox developed the concept, and pushed the program to its present success. Currently, the Gulf of Mexico portion of SEAMAP is the premiere program in the country. As a matter of fact, most of the state/federal cooperative programs that are still functioning in the Southeast Region, have taken pages out of the SEAMAP in their development.

This document displays presentations that demonstrate the value of fishery-independent data collection programs for fisheries management and while SEAMAP is not the only program of this nature taking place in the Southeast Region, it is certainly the most important. Our current fishery-independent sampling program is not a panacea, but it is going in the right direction. If proper funding is available and the same cooperative nature exists in the future as it has in the past with SEAMAP, a data base for enhancing fisheries management in the Gulf of Mexico and the states which border it, will be the end result.

# OVERVIEW OF FISHERY-INDEPENDENT DATA USE FOR MANAGEMENT/RED SNAPPER ASSESSMENT

Scott Nichols

National Marine Fisheries Service
Southeast Fisheries Science Center
Mississippi Laboratories
P.O. Drawer 1207
Pascagoula, MS 39568-1207

The National Marine Fisheries Service (NMFS) main goal is to provide information concerning a variety of species on a year to year basis. An attempt is made to intercept any given species during two points in its life cycle: new recruits and spawning stocks. This is done for as many stocks as possible. The overall strategy is not geared toward a single species although most of the interpretations focus on single species. Some of the additional information gained from the fishery-independent sampling include: species distribution, environmental data, abundance, and species interpretations. Fishery-independent data focusing on a system level. It provides a wealth of samples and specimens for use in the assessment process, for stock identification, and for age/growth analysis.

There are several principles of fishery-independent sampling. One of the requirements is mapping or acquiring a synoptic view of the Gulf of Mexico. The sampling should cover as much of the stocks as possible. Clearly, it is not possible to take an instantaneous sample of the entire Gulf of Mexico; however, the closer the sampling gets, the better the data will be for assessments. The trade-off between acquiring a decent mapping and the requirement that it be stock wide essentially sets the number of stations that will be sampled. It is also necessary to have well-defined and consistent sampling techniques or methodologies. Most of the scientific discussions revolve around trying to meet these principles.

In SEAMAP, the NMFS' current strategy includes the Fall Shrimp/Groundfish Survey which covers the near shore waters and provides information on groundfish and shrimp including red snapper and mackerels. This survey has been ongoing since 1972 and has covered the entire Gulf of Mexico since the 1980's. The Summer Shrimp/Groundfish Survey was essential in determining the size, composition and distribution of brown shrimp for the Texas closure and was expanded almost immediately to include the area from Mobile Bay to Brownsville. This survey also provides information on red snapper and mackerel. The September plankton survey initially targeted mackerels and red drum but collections include as many species as possible. The Spring plankton survey, commonly called the Bluefin Tuna survey, is also under the SEAMAP umbrella. The primary purpose of this survey is to assess the bluefin tuna stock. For the last few years, SEAMAP has conducted a trap/video survey which is directed at adult reef fishes. A video camera system is mounted on a fish trap and records the relative abundance of reef fishes within a designated "reef site". The information obtained from this survey appears to be very useful and its value will increase as time goes on.

The next step would be to increase the funding for the fishery-independent sampling programs. It appears there is a good possibility that will occur since fishery-independent sampling is an essential part of fishery management and assessment. Some of the possible surveys that will be initiated with the increased funding include sampling of oil rig habitat, sampling sharks using long lines, sampling during the winter for plankton, and assessment of deep water reef fish.

## RED SNAPPER ASSESSMENT

For red snapper, the majority of data comes from the trawl surveys in fall and summer and are used for trend variations, virtual population analysis (VPA) tuning, bycatch, distribution, etc. NMFS is also beginning to get data from the trap/video and plankton surveys. The NMFS is currently examining trends and using that for the assessment of red snapper stock. As new technologies and methods are developed, this may change; however, presently there are no direct methods for fisheries management based solely on fishery-independent surveys.

A red snapper index and other information are examples of the types of data used by the Gulf of Mexico Fishery Management Council (GMFMC) members to consider fluctuations in red snapper. It was noted that the catch per effort in the fall survey was tightly tied to the recreational harvest, indicating that the fishery-dependent and fishery-independent data are providing complimentary information by reinforcing each other. The stock assessment personnel were provided data from the summer and fall surveys for red snapper assessment. It turned out that the fall survey was not ideal for stock assessment purposes because there are two age classes: newly recruited age zero fish and larger fish within the samples. The summer survey is a little more potent for stock assessment purposes since the samples consisted of one year class of fish. It is necessary to derive an index for stock assessments from the raw data. Through a variety of methods used by stock assessment professionals, an index is derived from data provided by the fall and summer surveys.

The red snapper mean weight data prior to 1985 for the fall survey was used to resolve and establish the calibration between the fall and the summer based on regression. The calibration produces a derived index which is used to further the stock assessment for individual year classes. That derived index has made applications of VPA. The problem with VPA is that it is a catchall for a number of things, but is basically the foundation for most of the stock assessments that take place today. From VPA, scientists attempt to extract the population size in numbers and the fishing mortality rates. The trick of VPA is if one knows the fishery mortality rate or the population number of one age, then one knows them all. In the past, VPA has been subjective, however, the method of tuning is now being used to refine the numbers. Fishery-independent data, specifically SEAMAP data, is very important to this process. For modeling in the future, fishery managers need to know the recent improvements. VPA is less reliable for the most recent year classes. Fishery managers have been using red snapper year class as index for the SEAMAP data in projecting future populations.

The SEAMAP data also have a role in the estimation of bycatch. The research vessel catch per effort definitely is not representative of the shrimp fishery. There is a valuable abundance of data that can be used to address this issue. There is also an ongoing study through the NMFS, Gulf and South Atlantic Fisheries Development Foundation and the fishing industry. There are two separate sources of data: one fishery-dependent and one fishery-independent that can be used to estimate bycatch. A general linear model (GLM) is used to calculate this estimate. A ratio is established between the commercial catch per effort and the research vessel catch per effort and that is used to predict the commercial catch rates in locations where data is not available. These predicted commercial catch rates for shrimping effort and bycatch form a time series which can be utilized for stock assessment. The data have been very sparse and unbalanced, particularly in the older studies. The older studies worked in one area one year and another area the next year. Fishery-independent data enables scientists to merge this data into a useful form. Although the catch rates on research vessels are not particularly representative of shrimping rates, the SEAMAP and other fishery-independent data do a fairly good job of representing the size/catch data for red snapper assessment by filling in the holes of the progression of size and age in the bycatch composition.

As discussed earlier, the trap/video survey attempts to obtain a relative abundance of important reef fish species in the Gulf of Mexico. Based on 1992 sampling, there were about 150 stations and the data were analyzed in terms of their utility for stock assessments. The analysis shows that the data are fully adequate for vermillion snapper, red snapper, and amberjack. If an additional 12 more sea days could be added to survey, the data would be fully adequate for stock assessment purposes for a variety of other important reef fish species. The precision of the estimates are fairly reliable and as the survey develops, the data will be very useful for examining the adult reef fishes in terms of catch per effort and virtual population analysis.

Specimens taken from the plankton surveys have been used for stock identification. It appears that the summer survey will be the most useful for red snapper, during which plankton samples are piggybacked. The early summer plankton survey and the September plankton survey need to provide the size of the catches. Currently, most specimens are identified only to the family level. Researches must examine the archived samples to determine which contain red snapper. One of the functions of SEAMAP has been to provide plankton sample archiving. Currently the samples are housed in the Florida Marine Research Institute. Currently, red snapper have been identified down to about 3.5 millimeters. There is the potential to develop an index on red snapper based on plankton samples. Given high priority status, it would require approximately one year to produce such an index. Currently, no decision has been made because NMFS is trying to evaluate their overall strategy.

## INDICES OF LARVAL BLUEFIN TUNA, *THUNNUS THYNNUS*, ABUNDANCE IN THE GULF OF MEXICO[1]

Stephen C. Turner

National Marine Fisheries Service
Southeast Fisheries Science Center
Miami Laboratory
75 Virginia Beach Drive
Miami, FL 33149-1003

### INTRODUCTION

Northern bluefin tuna, *Thunnus thynnus*, are a large (up to 304 cm and 679 kg) oceanic pelagic scombrid species that are found in the Atlantic and Pacific Oceans. Northern bluefin in the western Atlantic are found from Labrador and Newfoundland south into the Gulf of Mexico and the Caribbean Sea, and also off Venezuela and Brazil. In the eastern Atlantic, they occur from off Norway south to the Canary Islands, in the Mediterranean Sea and off South Africa (Collette and Nauen, 1983). Atlantic bluefin tuna are known to spawn in the Mediterranean Sea and in the Gulf of Mexico.

Most estimators of indices of stock size for Atlantic bluefin tuna are fishery dependent, and thus do not benefit from statistical design. Alternately, we derived a fishery independent index of western Atlantic stock size from ichthyoplankton surveys conducted by the National Marine Fisheries Service, and since 1982 under the Southeast Area Monitoring and Assessment Program (SEAMAP). Larval abundance indices developed from these surveys (McGowan and Richards, 1986, 1987) have been used to corroborate trends in fishery dependent estimates of stock size, as well as to tune the virtual population analysis (McGowan and Richards, 1987; Anon., 1991).

In the eastern Atlantic Ocean and Mediterranean Sea bluefin tuna have been fished for thousands of years, while in the western Atlantic catches were not substantial until the 1960's when Japanese longline vessels and U.S. and Canadian purse seine vessels accounted for much of the catch (Anon., 1991). Managers became concerned about the status of the stock during the late 1960's and early 1970's. The International Commission for the Conservation of Atlantic Bluefin Tunas (ICCAT) adopted a regulation to limit fishing mortality to recent levels in 1975. In 1982, 1983 and most recently 1992 catch restrictions were enacted and modified by ICCAT. International assessments of the status of the western Atlantic bluefin resource, conducted annually by scientists from ICCAT member nations, have indicated a large decline in abundance. Virtual population analysis (VPA) has been the primary stock assessment method, and indices of abundance from fishery catch rates or fishery independent surveys have been an integral part of those analyses.

### METHODS AND MATERIALS

Ichthyoplankton surveys have been conducted in the Gulf of Mexico during April and May since 1977. Surveys in 1977-1981 covered much of the Gulf of Mexico (7.3-8.8 x $10^{11}$ $m^2$ , Richards and Potthoff, 1980; McGowan and Richards, 1986); while surveys since then have concentrated on a smaller area (2.2-4.6 x $10^{11}$ $m^2$) within the northern and eastern Gulf of Mexico that consistently produced catches of larvae. Plankton sampling was conducted both day and night with 61 cm bongo gear using oblique tows and 1 x 2m neuston nets at stations at the intersection of whole degrees of longitude and latitude. Additional tows, either bongo and neuston or just neuston, were made along the cruise track at 30-min intervals. Usually, one of the two bongo nets from each station was processed

[1]Primarily from a paper by G.P. Scott, S.C. Turner, C.B. Grimes, W. J. Richards, and E.B. Brothers: "Indices of larval bluefin tuna, *Thunnus thynnus*, abundance in the Gulf of Mexico; modelling variability in growth, mortality, and gear selectivity". Published in the Bulletin of Marine Science, 53(2):912-929, 1993.

(sorted and identified). Bongo samples from 1977 and 1978 cruises were processed at the Southeast Fisheries Center. Since 1981, all selected samples preserved in formalin have been processed at the Polish Sorting and Identification Center in Szczecin, Poland. Each year the identification of all scombrid and scombrid-like larvae, as well as, all unidentified fish are reviewed by senior scientist, Dr. William J. Richards of the Southeast Fisheries Science Center, Miami Laboratory.

Routinely only larval lengths are measured during the identification process in Poland. Therefore, a model describing the observed mean trend in larva size at otolith daily increment count was developed to estimate a probability of age-at-length matrix for ageing captured larvae based primarily on data from Brothers et al. (1983). Daily loss rates (Z) were estimated through regression analysis of the larval catch curves. Estimates of average annual larval abundance at first daily increment formation per 100 $m^2$ were used to index total annual larval abundance.

## RESULTS AND DISCUSSION

Estimated larval survey index values using the probability of age-at-length matrix for ageing larvae have been used by the ICCAT Standing Committee on Research and Statistics for tuning the western Atlantic bluefin VPA since 1989 (Table 1, Figure 1). ICCAT has used the index based on May sampling, rather than sampling in April-June, because of more consistent coverage during May and because catch rates are usually quite low until the end of April. Prior to 1989 an alternative formulation (McGowan and Richards, 1987) was used by ICCAT.. That there is a high level of uncertainty associated with the larval index is not unexpected because of the need to make assumptions about such characteristics as loss and growth rates, and because of the small numbers of larvae caught per year for a time series (10-227, Table 1). One consequence of the high degree of variability in estimates of larval density when relatively few (ie., 10 or fewer) larvae are sampled in the standard survey grid is that the statistical power for discriminating interannual differences in the index is low. Because of this, comparison of the mean values in isolation of their associated variances could lead to incorrect inference about change in the biomass that spawned the larvae.

For the 1990 western Atlantic bluefin assessment, two other indices of abundance of large bluefin were available: the rod and reel fishery for large bluefin (>200 cm straight FL) off the northeast U.S. in 1983-1989 (Cramer and Brown, 1991); and the Canadian tended line fishery for even larger bluefin in 1981-1989 (Clay et al., 1991). Comparison of these with the larval index shows that they follow a trend similar to larval index and each other. The annual mean index values from all three indicate relatively higher catch rates in the early 1980's than in later years while the larval index mean values show a relative increase in the late 1980's not reflected in the other indices. These differences between index series in recent years are not statistically significant.

ICCAT assessment working groups have used a larval index to identify trends in the abundance of large bluefin tuna in the western Atlantic Ocean. That the index is fisherey independent and based on the results of spawning in the Gulf of Gulf Mexico is useful because other indices available for large bluefin in the western Atlantic are derived from fishery data which could conceivable include catches of fish which had migrated from the eastern Atlantic. Indices of abundance have been used to calibrate VPA's of bluefin and other species (Parrack, 1986; Gavaris, 1988; Conser and Powers, 1990). The indices are used to determine the most likely population trend from the wide range of trends that can be estimated from the catch at age. Scientists from ICCAT member nations calibrate bluefin tuna VPA's using multiple indices of abundance, including the larval index.

## LITERATURE CITED

Anonymous. 1991 ICCAT SCRS report for the biennial 1990-91. Part II(190). Int. Comm. Conserv. Atl. Tunas.

Brothers, E.B., E.D. Prince and D.W. Lee. 1983. Age and growth of young-of-the-year bluefin tuna, *Thunnus thynnus*, from otolith microstructure. Pages 49-60 *in* E.D. Prince and L.M. Pulos, eds. Proceedings of the international workshop on age determination of oceanic pelagic fishes: tunas, billfushes, and sharks. NOAA Tech. Rep. NMFS 8. 211 pp.

Clay, D., T. Hurlbut and J.M. Porter. 1991. National report of Canada. Report for the biennial period 1990-1991. Part I(1990). Int. Comm. Conserv. Atl. Tunas. Pp. 412-418.

Collette, B.B. and C.E. Nauen. 1983. Scombrids of the world. FAO, Fish. Syn. 125(2): 137 pp.

Conser, R. J. and J.E. Powers. 1990. Extensions of the ADAPT VPA tuning method designed to facilitate assessment work on tuna and swordfish stocks. ICCAT. Col. Vol. Sci. Pap. 32(2):461-468.

Cramer, J. and C.A. Brown. 1991. Standardized catch rates of large bluefin tuna in the New England (U.S) rod and reel/handline fishery. ICCAT. Col. Vol. Sci. Pap. 35(2).

Gavaris, S. 1988. An adaptive framework for the estimation of population size. Can.Atl. Fish. Soc. Adv. Comm. (CAFSAC) Res. Doc. 88/29. 12 pp.

McGowan, M.F. and W.J. Richards. 1986. Distribution and abundance of bluefin tuna (*Thunnus thynnus*) larvae in the Gulf of Mexico in 1982 and 1983 with estimates of the biomass and population size of the spawning stock for 1977, 1978, and 1981-83. ICCAT. Col. Vol. Sci. Pap. 24: 182-195.

McGowan, M.F. and W.J. Richards. 1987. Atlantic bluefin tuna spawning and larval index of spawning stock 1977-1986. University of Miami, Rosenstiel School of Marine and Atmospheric Science, TR-88-003. 12 pp.

Parrack, M.L. 1986. A method of analyzing catches and abundance indices from a fishery. ICCAT. Col. Vol. Sci. Pap. 24:209-221.

Richards, W.J. and T. Potthoff. 1980. Distribution and abundance of bluefin tuna larvae in the Gulf of Mexico in 1977 and 1978. ICCAT. Col. Vol. Sci. Pap. 9(2):433-441.

Scott, G.P., S.C. Turner, C.B. Grimes, W. J. Richards, and E.B. Brothers. 1993. Indices of larval bluefin tuna, *Thunnus thynnus*, abundance in the Gulf of Mexico; modelling variability in growth, mortality, and gear selectivity. Bulletin of Marine Science, 53(2):912-929.

Scott, G.P. and S.C. Turner. 1996. An updated index of bluefin tuna (*Thunnus thynnus*) spawning biomass from Gulf of Mexico ichthyoplankton surveys. ICCAT Coll. Vol. Sci. Pap. XLV(2): 220-221.

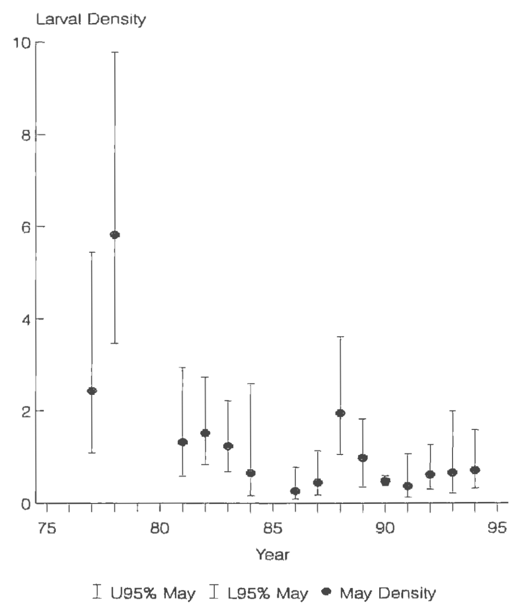



**Figure 1**. Bluefin tuna index of abundance from Gulf of Mexico larval surveys with 95% confidence intervals.

Table 1. Summary of the updated larval survey data used in estimating the annual larval index values and associated variances.

| YEAR | 77 | 78 | 81 | 82 | 83 | 84 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 502-512 | 502-530 | 501-526 | 415-525 | 422-523 | 421-512 | 423-522 | 418-521 | 420-525 | 426-519 | 421-630 | 417-521 | 422-521 | 426-615 | 428-531 |
| LEN | 3.4- 8.1 | 2.4- 9.5 | 2.7- 7.0 | 2.0-10.7 | 2.0- 6.8 | 2.9- 6.0 | 3.5- 6.0 | 2.3- 9.2 | 2.3- 7.0 | 2.5- 8.0 | 2.6- 7.5 | 2.4- 6.0 | 2.5- 9.0 | 3.0- 6.2 | 2.3-8.9 |

| YEAR | 77 | 78 | 81 | 82 | 83 | 84 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STATS | 19 | 70 | 32 | 127 | 92 | 75 | 74 | 78 | 73 | 76 | 144 | 79 | 83 | 113 | 74 |
| TOWS | 19 | 91 | 32 | 127 | 92 | 97 | 74 | 78 | 73 | 76 | 144 | 79 | 83 | 113 | 74 |
| POS STAT | 8 | 35 | 6 | 22 | 16 | 9 | 7 | 5 | 15 | 10 | 10 | 4 | 13 | 6 | 9 |
| POS TOWS | 8 | 44 | 6 | 22 | 16 | 9 | 7 | 5 | 15 | 10 | 10 | 4 | 13 | 6 | 9 |
| TOT CATCH | 22 | 281 | 20 | 76 | 68 | 16 | 12 | 10 | 71 | 36 | 23 | 7 | 36 | 23 | 24 |
| MEAN LEN | 4.7 | 4.1 | 4.6 | 4.1 | 3.5 | 4.2 | 4.9 | 5.0 | 3.5 | 4.1 | 3.9 | 3.8 | 3.5 | 5.1 | 4.4 |

| YEAR | 77 | 78 | 81 | 82 | 83 | 84 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *MAY STATIONS* | | | | | | | | | | | | | | | |
| STATS | 19 | 70 | 32 | 69 | 70 | 33 | 51 | 48 | 42 | 63 | 53 | 50 | 57 | 75 | 67 |
| POS STATS | 8 | 35 | 6 | 15 | 16 | 4 | 3 | 4 | 14 | 10 | 8 | 4 | 12 | 6 | 9 |
| $LN(I_s)$ | 1.367 | 1.765 | 1.815 | 1.660 | 1.377 | 0.623 | 1.414 | 1.620 | 1.426 | 1.151 | 1.105 | 1.272 | 0.671 | 1.456 | 1.330 |
| $V(LN(I_s))$ | 0.925 | 1.448 | 0.328 | 0.612 | 0.672 | 3.439 | 0.231 | 0.132 | 0.743 | 1.074 | 0.088 | 0.690 | 0.897 | 1.707 | 0.783 |
| $L/100m^2$ | 2.435 | 5.824 | 1.317 | 1.514 | 1.235 | 0.653 | 0.261 | 0.445 | 1.946 | 0.798 | 0.474 | 0.365 | 0.614 | 0.658 | 0.711 |
| V(L/100) | 1.113 | 2.518 | 0.323 | 0.222 | 0.145 | 0.274 | 0.025 | 0.051 | 0.403 | 0.123 | 0.003 | 0.047 | 0.055 | 0.163 | 0.092 |

Notes: DATE, range of sampling dates in mdd format (502-512 indicates sampling between May 02 and May 12)
LEN, length range (mm) of bluefin larvae sampled
STATS, Stations sampled in year
TOWS, Number of net tows made in year
POS STAT, Number of stations with bluefin larvae
POS TOWS, Number of tows with bluefin larvae
TOT CATCH, Number of bluefin larvae captured over all stations
MEAN LEN, Mean length (mm) of larvae measured
LN(I), Mean of ln(larvae/100m) for positive stations
V(LN(I)), Variance of ln(larrvae/100m) over positive stations
$L/100m^2$, Delta distribution mean larval density, the index value applied
V(L/100m), Estimated variance of the index

## DETERMINING THE TEXAS CLOSURE USING FISHERY-INDEPENDENT DATA

Terry J. Cody and Billy E. Fuls

Texas Parks and Wildlife Department
Coastal Fisheries Division
702 Navigation Circle
Rockport, TX 78382

I was invited to this workshop on the "uses of fishery-independent data" to explain how the Texas Parks and Wildlife Department (TPWD) sets the dates for the Texas Closure. Most of the people here are familiar with the Texas Closure, but for those who aren't I'll try to give a little background on the Texas Closure and the fishery-independent sampling program we use in Texas to collect the data necessary to set the dates of the closed season. Next I'll try to explain the approach we use to actually set the dates for the closing and reopening of Gulf waters off Texas. And finally, I'll discuss briefly some of the fishery-independent data and fishery-dependent data used to monitor and evaluate the Closure.

### INTRODUCTION

Brown shrimp management in Texas is designed to accommodate all users (bait, small food shrimp and large food shrimp fishermen) while protecting the resource and minimizing waste. The supply of large shrimp is ensured by regulating harvest in the bays and simultaneously delaying harvest in the gulf until emigrants reach a larger, more valuable size. Prior to May 1990 shrimp were managed by the Texas Legislature through the Shrimp Conservation Act of 1959. This Act established a 45 day closed season in the Texas Territorial Sea (TTS) (≤9 nautical miles from shore) from June 1-July 15 each year. In 1975 the Texas Legislature authorized the Texas Parks and Wildlife Commission (TPWC) to adjust closing and opening dates as long as the total closure was 45-60 days. In April 1978 the Commission delegated this authority to the TPWD Executive Director. In November 1989 the Texas Shrimp Fishery Management Plan was adopted by the Texas Parks and Wildlife Commission which transferred to the Commission the authority to regulate the catching, possession, purchase, and sale of shrimp. Effective May 1990 the Commission amended the Texas Parks and Wildlife Code to mandate a closure of the TTS beginning 30 minutes after sunset on 15 May to 30 minutes after sunset on 15 July. However, the reopening date of 15 July could still be altered by the Executive Director using sound biological data.

The purpose of the annual closure is to protect small shrimp from fishing pressure until they reach a larger, more valuable size (Goal : ≥112 mm mean TL) and to minimize waste caused by discarding smaller shrimp during gulf harvest. Texas has closed the TTS for over 30 years; since 1982 the traditional 1 June-15 July season has been adjusted 11 times. Although small shrimp were protected in the TTS by closures prior to 1981, large numbers of small shrimp were still captured and discarded in waters beyond Texas' jurisdiction.

In 1976, the United States Congress enacted the Magnuson Fishery Conservation and Management Act. This act extended national jurisdiction from the Territorial Sea of each state (9 nautical miles in Texas) out to 200 miles. This Act required the preparation and implementation (in accordance with national standards) of fishery management plans designed to achieve and maintain, on a continuing basis, the optimum yield from each fishery. Regional fishery management councils were established to formulate the plans. The Gulf of Mexico Fishery Management Council's Shrimp Fishery Management Plan was adopted in 1980 and implemented in 1981. Among other options, the plan called for closure of U. S. waters from 9-200 miles off Texas to complement the traditional Texas closed season.

This mutual closure of the EEZ (Exclusive Economic Zone) at the same time as Texas waters are closed has become known as the Texas Closure. It probably is the most controversial of the original 11 management measures adopted by the Gulf Council even though it has resulted in an increased yield of brown shrimp off Texas during each closure year.

It's important at this time to remind you that when I talk today about the Texas Closure I'm talking about both the state waters and the federal waters off Texas. The concept of closing Gulf waters to shrimping while small shrimp are emigrating from the bays, in order to conserve the resource and encourage the harvest of larger shrimp has been a part of the Texas shrimp management strategy since at least 1960. Even back then this season could be adjusted 15 days earlier or later if current sampling (i.e. fishery-independent data collected by biologists) indicated a need. Over the years more flexibility was built into the system by the Texas Legislature and the Texas Parks and Wildlife Commission.

The maximum duration of the closed season was first extended to 60 days and eventually to 75 days in 1995 with the consistent provision that the closing and opening dates be "based on sound biological data." In order to collect the fishery-independent data required by Texas law, the Texas Parks and Wildlife Department has adopted a routine monitoring program (partially supported by SEAMAP) where state biologists analyze standard shrimp samples collected systematically along the coast from Sabine Lake to the Texas/Mexico border.

TEXAS' FISHERY-INDEPENDENT SAMPLING

The Texas Parks and Wildlife Department relies on fishery-independent, long-term monitoring programs for our management decisions. A typical year provides the following samples from our routine programs and many more from special studies.

Texas Sampling - 1994

- 2292 bag seines
- 3288 bay & Gulf trawls
- 1080 oyster dredges
- 760 gill nets
- 252 beach seines
- 1014 creel survey days
  - 11,353 private boat interviews
  - 26,890 private boat fishermen

The Texas coastline is approximately 375 miles long and is characterized by large estuaries from Sabine Lake south through Corpus Christi Bay. The remaining coast is a long, narrow lagoon called the Laguna Madre. The total estuarine area and coastal lagoon encloses 2,100 square miles. Sabine Lake, the smallest major estuary, covers 70 square miles. Galveston Bay, the largest major estuary, covers about 530 square miles. Shrimp during their early life find sanctuary in these large, fertile regions where they feed, grow, and when large enough, enter the Gulf of Mexico where over a billion are caught commercially each year.

Bag seines are used in the shallow, shoreline bay waters to monitor the appearance, growth and abundance of juvenile shrimp. The seine is extended perpendicular to the shoreline and pulled a standard distance to collect each sample at predetermined randomly selected sites. Organisms are measured and counted to provide an index of individuals captured per hectare.

Trawl samples are collected in bay waters one meter or deeper to monitor shrimp that have left the shallow shoreline areas. Each trawl site is randomly selected, and the net is towed for a standard period of time. Organisms are measured and counted to produce catch indices which enable biologists to make comparisons with shrimp catch rates of previous years. Movements of brown shrimp from the bays to the Gulf of Mexico are verified by trawl samples collected with mid-sized trawlers in five areas of roughly 300 square miles each offshore of Sabine Lake, Galveston, Matagorda and Aransas Bays, and the lower Laguna Madre.

Using biological data obtained from these two sample gears management decisions can be made - including setting the seasons for penaeid shrimp.

The monitoring of brown shrimp during the spring must be accurate and completed by the end of April because these data are used to predict the time of emigration of brown shrimp from the bays into the Gulf. The results of these studies are used to set the starting date of the closed season in the Gulf. Accurate information is essential because a good prediction will allow a large portion of the brown shrimp population to attain a larger, more profitable size; a poor prediction could deprive shrimpers of income. Local changes in ecology caused by floods, excessive rainfall, sudden cold fronts and tides may affect the size and time of emigration; hence, up-to-date climatological and hydrological data are also collected with each sample.

## METHODS

To make recommendations for the closing and opening dates of the season, shrimp samples are collected monthly with 60 ft bag seines at randomly selected stations in each of Sabine Lake, Galveston, East Matagorda, Matagorda, San Antonio, Aransas and Corpus Christi Bays, and the upper and lower Laguna Madre to determine the relative abundance and size of brown shrimp along the bay shorelines. Samples also are collected monthly with 20-foot trawls in all of the above bay systems to determine the relative abundance and size of shrimp in the deeper portion of the bays and in the five offshore areas.

Catch is expressed as no./ha (bag seines) and no./h (trawls). The coastwide mean catch (number and length) in bag seines is weighted by the shoreline distance in each bay system (Matlock and Ferguson 1982). Bay trawl data are weighted according to the percentage each bay system's surface area in water $\geq$1 m deep contributed to the coastwide area. Gulf trawl data are weighted by the number of grids within each gulf sampling area. Mean shrimp lengths are weighted by the total number caught in each sample. Projected growth rates for combined bays are based on the von Bertalanffy model from Parrack (1979). Sexes are assumed equal since gender is not determined in all samples.

The criteria for determining the beginning date of the Texas Closure are :

1. Mean number of brown shrimp/ha (transformed to $Log_{10}$) captured in bag seines during April is compared to the index (mean catch rate + 2 mean SE) when the season was closed 1 June (1978-80 and 1987-89). Relatively large numbers of shrimp captured in April is interpreted as indicating good survival and/or early recruitment of post-larvae and, therefore, a probable earlier than 1 June emigration from the bays to the Gulf.

2. Percentage of samples in which brown shrimp occur is compared to previous years. A relatively high percentage of samples containing shrimp is interpreted to mean that shrimp are well distributed along the coast and give confidence in the relative abundance catch rate.

3. Mean length of shrimp collected during April is determined. When the number of shrimp indicates early emigration, Parrack's growth model is used to estimate the date shrimp captured in April would reach a mean length of 90 mm. Growth rate is calculated from 15 April.

4. Periods of maximum duration of nocturnal ebb tides are determined from NOAA Tide Tables for Galveston Bay. King (1971) found that shrimp approximately 90 mm in length emigrate to the Gulf through passes, near the surface, mainly at night in association with long ebb tide flows. The date of the major period nearest to the date shrimp were projected to reach 90 mm is considered for the closure date.

The criteria for determining the reopening date at the end of the Texas Closure are:

1. Mean number and mean length of brown shrimp caught in bag seines during June are compared to those caught in previous years. If substantial numbers (2 SE greater than the average since 1979) of small shrimp are still found along shorelines, the season could be extended to the full 75 days authorized. If the mean number of shrimp was 2 SE less than average, the closed season could be shortened.

2. Catch rates of brown shrimp in bay trawls are compared to previous years. These samples reflect those shrimp that will most likely move to the Gulf in June/July and will be on the shrimping grounds when the season opens in July. If catch rates are similar to past years the date when shrimp are predicted to reach a mean of 112 mm (calculated from 15 June) is considered for the reopening date.

3. Trawl samples in the Texas Territorial Sea are collected during June to determine abundance and size of brown shrimp recruited to the Gulf. If recruitment to the gulf shrimping grounds has occurred, mean lengths are obtained and growth rates projected to help determine the recommendation for the opening date. The criterion is that a substantial portion of brown shrimp on the fishing grounds average $\geq$112 mm when the season reopens.

4. Periods of maximum duration of nocturnal ebb tides are determined from NOAA Tide Tables for Galveston Bay. The date of the period nearest to the date shrimp in the Gulf are projected to reach 112 mm is considered for recommendation as the end of the Texas Closure.

DISCUSSION

Techniques used to establish a closed season based on current fishery-independent data should be simple because they must be employed in a timely manner. The last possible dates for collection of bag seine samples are 30 April and 30 June, respectively. Calculations must be made and results presented and approved by the TPWD Executive Director who has been delegated authority by the TPWC to set season dates. The law requires 72 h and 24 h, respectively, for public notice for closing and opening dates (State of Texas 1995). The approved season dates must be published in the Texas Register and public notice and news releases prepared. The National Marine Fisheries Service (NMFS) is notified so that public notice can be provided concerning the closing and opening of U. S. waters and NMFS can go through their in-house procedure which requires a minimum of three days notice prior to the effective closing or opening date.

Fishery managers do not always have the luxury of an extensive data analysis. The time lapse from the last day of data collection through approval and public notice is only a few days. In the case of setting the dates for the Texas Closure using fishery -independent data we have several requirements:

- dates are based on sound biological data
- data collection and processing has quick turn around
- data analysis is relatively easy to calculate
- entire process must be simple and timely.

A large amount of fishery-independent data is analyzed each year by TPWD to set the dates for the Texas Closure:

- Bag seines - March, April, May, June, July
  - 170 samples per month
- Bay trawls - May, June, July
  - 140 samples per month
- Gulf trawls - May, June, July
  - 80 samples per month.

The process relies on good coordination and communication. For each of these samples we forward the following brown shrimp data to our lead biologist -- usually on a daily basis:

- bay system
- date collected
- station
- number caught
- mean total length
- temperature and salinity

The data are added to a rather complicated spreadsheet that performs the following calculations:

- number per hectare (or hour) plus logs
- weighted coastwide mean no./ha plus SE
- per cent of samples with brown shrimp
- weighted coastwide mean length plus SE.

By updating the spreadsheets daily, TPWD can stay up-to-date on the status of brown shrimp in Texas waters and monitor progress of several critical factors through the season.

Additional sources of fishery-independent and fishery-dependent data are also considered during the process when available:

- SEAMAP trawls by NMFS and other states
- special samples are taken when the need arises
- NMFS landings before, during and after the Closure.

As an example of how the process works I'll take you through a brief summary of the fishery-independent data TPWD used to set the dates for the 1995 Texas Closure.

Closing Date

1. The mean catch rate index during April 1995 was 1.83/ha $\pm$ 0.22 (Table 1). Compared to the bag seine catch rate index of 1.36 /ha, the rate was above the long term average indicating good early recruitment to the shoreline areas (Figure 1a).

2. Brown shrimp were caught in 65 % of the bag seine samples during April 1995 (Figure 1b) indicating good distribution. The average for non-June 1 closures is about 59 % while years when the season closed on June 1 average only 32 %.

3. The coastwide weighted mean length for April 1995 was 52 mm (Figure 1c) -- about average for bag seines in April (51 mm) indicating normal growth rates and movement patterns. Growth models indicate these shrimp should average 90 mm about May 16.

4. The periods of maximum nocturnal ebb tidal flow (when major movements of shrimp from bays to the Gulf occur) were May 6-9 and May 19-23.

All these factors indicated a change from the May 15 date established by the Texas Parks and Wildlife Department was not warranted for 1995. The TPWD staff recommended that the 1995 Gulf season closure begin 30 minutes after sunset on May 15.

After closing the season we then direct our attention to the reopening. Bag seine and trawl data are submitted as soon as collected to the lead biologist throughout May and June. This is what we saw in 1995:

<u>Reopening Date</u>

1. The catch rate in June 1995 bag seines was not significantly different from the 16-year average $\pm$ 2 SE (Figure 2a). The average index for 1979-1994 was 2.13 $\pm$ 0.25/ha compared to 2.02 $\pm$ 0.19/ha in June 1995 (Table 2). Mean size was slightly above average. These shrimp would be partially protected by the closure of Texas Gulf waters within 7 fathoms at night if the Gulf reopens 15 July.

2. The mean number of shrimp in the deeper portion of bays during June 1995 was not significantly different than the average during June 1982-1994 (Figure 2b). Catch rates were 1.33 $\pm$ 0.24/h compared to a mean of 1.34 $\pm$ 0.09/h during June 1982-1994 (Table 3). The mean length of 83 mm calculated from 15 June indicated they should be 112 mm on 15 July.

3. Samples collected in the Texas Territorial Sea from Sabine Lake to Port Isabel during June 1995 showed populations were about average compared to years 1986-1994 (mean log = 0.97/h), and that recruitment had occurred (Figure 2c). The mean length (99 mm) indicated they should be larger than 112 mm by the opening date in July (Table 4).

4. Except for those shrimp still found along shorelines which would not reach the minimum count size until the end of July, most shrimp on the fishing grounds should be 112 mm or larger on or before 15 July 1995. Longer tidal durations, when major movements of shrimp from the bays to the Gulf occur, were predicted for June 30-July 3 and July 14-17.

At this time we try to slow down, catch our breaths, and look at additional sources before we make "The Big Decision"! We look at available data from several additional fishery-independent sources and also evaluate fishery-dependent data and other information gathered from the shrimp fishing industry:

- SEAMAP trawls by NMFS and other states play an important role
- extra samples are taken when the need arises
- NMFS landings with size information are considered when available
- additional information from the fishing industry

During 1995 everything looked like the best decision was to stick with the July 15 reopening set by the TPWD Code.

DOES IT WORK ?

We think so! I'll briefly discuss our reasoning on two levels:

Short Term: "Does it work to set the season dates? ", and

Long Term: "Does it work to accomplish the goals of the Texas Closure ?"

<u>Short term</u>

The example given above shows that the season can be set with the fishery-independent data collected by the well-established, long-term, routine monitoring program conducted by TPWD and supported by Federal Grant Programs like SEAMAP.

Real-time, fishery-independent data from the SEAMAP program provides the best snapshot of the brown shrimp population structure on the Texas fishing grounds during the Texas Closure. Samples collected by NMFS and Texas vessels during June and July 1995 indicate most of the shrimp were 39 count (112 mm) or larger when the season reopened (Figure 3a). The overall brown shrimp count size for all SEAMAP samples off Texas during 1995 was 36.

Long term

From 1981 through 1985 and during 1989-1995, United States waters (9-200 miles) were closed in conjunction with the closing of Texas waters through the Gulf of Mexico Fishery Management Council's Shrimp Management Plan. During 1986, 1987 and 1988, U.S. waters were closed out to 15 nautical miles. The GMFMC Plan calls for a closure of the Gulf shrimping grounds until a substantial number of shrimp in the Gulf of Mexico reach 39 shrimp (heads-on) to the pound - a uniform length of approximately 112 mm.

Each year the Gulf of Mexico Fishery Management Council receives a briefing on the results of the previous Texas Closure. Because of the controversial nature of the Closure there have been many variations in those reports and much debate. The bottom line always indicated positive economic and biological results - especially when Texas and Federal waters are considered together.

The Texas Closure has been successful at protecting small shrimp and reducing discards in Texas waters and there is increasing evidence that the Closure may also protect juvenile red snapper and influence the recruitment of juvenile brown shrimp the following year.

In 1995 data was presented to the Gulf Council that indicated when the 200-mile closure was in effect there were significant increases in the number of juvenile red snapper found in the TTS and in the number of juvenile brown shrimp found in the estuaries during the following April. The data for 1995 support those conclusions (Figures 3b & 3c).

Whether setting the dates for the Texas Closure or making other resource management decisions, the fisheries management program in Texas depends heavily on fishery-independent data systematically collected in well-designed, long-term monitoring programs.

LITERATURE CITED

King, B.D., III. 1971. Study of migratory patterns of fish and shellfish through a natural pass. Technical Series No. 9. Texas Parks and Wildlife Department, Coastal Fisheries Branch. Austin, Texas. 54 p.

Matlock, G. C. and M. F. Osborn (Ferguson). 1982. Shallow-water surface areas and shoreline distances on the Texas coast. Management Data Series No. 37. Texas Parks and Wildlife Department, Coastal Fisheries Branch. Austin, Texas. 10p.

Parrack, M. L. 1979. Aspects of brown shrimp, *Penaeus aztecus,* growth in the northern Gulf of Mexico. Fishery Bulletin. 76(4): 827-836.

State of Texas. 1995. Texas Parks and Wildlife Laws: State of Texas 1995-1996. West Publishing Company, St. Paul, Minnesota. 470p.

Table 1. Mean catch rate[a], mean length and percent frequency of brown shrimp collected with 60ft bag seines in nine coastal Texas bay systems during April 1978-1995.

| Year | Number of samples | Log No./ha ± 1 SE | Mean length (mm) | Percent of samples containing shrimp |
|---|---|---|---|---|
| 1978[b] | 42 | 0.68 ± 0.41 | 48 | 33 |
| 1979[b] | 42 | 0.58 ± 0.38 | 48 | 31 |
| 1980[b] | 42 | 0.37 ± 0.25 | 49 | 21 |
| 1981 | 41 | 2.03 ± 0.50 | 54 | 76 |
| 1982 | 70 | 1.77 ± 0.35 | 52 | 64 |
| 1983 | 80 | 1.42 ± 0.36 | 43 | 56 |
| 1984 | 80 | 1.68 ± 0.28 | 57 | 66 |
| 1985 | 80 | 1.35 ± 0.46 | 52 | 44 |
| 1986 | 90 | 2.01 ± 0.16 | 58 | 67 |
| 1987[b] | 90 | 1.09 ± 0.26 | 47 | 36 |
| 1988[b] | 108 | 0.93 ± 0.23 | 47 | 36 |
| 1989[b] | 108 | 1.04 ± 0.22 | 46 | 38 |
| 1990 | 144 | 1.84 ± 0.27 | 53 | 63 |
| 1991 | 144 | 1.84 ± 0.32 | 57 | 60 |
| 1992 | 170 | 1.45 ± 0.29 | 53 | 48 |
| 1993 | 170 | 1.37 ± 0.26 | 50 | 52 |
| 1994 | 170 | 1.63 ± 0.24 | 55 | 55 |
| 1995 | 170 | 1.83 ± 0.22 | 52 | 65 |

[a](No./hectare + 1) transformed to $Log_{10}$

[b]Years with 1 June closure.

Index = 1.36/ha (Mean catch rate + 2 mean SE for 1978-80 and 1987-89)

Table 2. Mean catch rate and mean length (mm) of brown shrimp (*Penaeus aztecus*) collected with 60 ft. bag seines in nine Texas coastal bay systems during June 1979-1995.

| Year | Log No./ha ± 1 SE | Length (mm) ± 1 SE |
|---|---|---|
| 1979 | 2.01 ± 0.58 | 62 ± 4 |
| 1980 | 2.43 ± 0.26 | 63 ± 3 |
| 1981 | 1.93 ± 0.45 | 60 ± 3 |
| 1982 | 2.31 ± 0.39 | 68 ± 3 |
| 1983 | 2.32 ± 0.33 | 63 ± 4 |
| 1984 | 2.21 ± 0.35 | 69 ± 3 |
| 1985 | 2.35 ± 0.40 | 64 ± 3 |
| 1986 | 1.62 ± 0.37 | 69 ± 5 |
| 1987 | 1.68 ± 0.42 | 65 ± 3 |
| 1988 | 2.13 ± 0.38 | 71 ± 2 |
| 1989 | 2.38 ± 0.24 | 59 ± 2 |
| 1990 | 1.86 ± 0.22 | 65 ± 2 |
| 1991 | 2.19 ± 0.32 | 66 ± 3 |
| 1992 | 2.02 ± 0.23 | 58 ± 1 |
| 1993 | 2.35 ± 0.21 | 62 ± 1 |
| 1994 | 2.23 ± 0.19 | 67 ± 2 |
| 1995 | 2.02 ± 0.19 | 65 ± 2 |
| 1979-1994 | 2.13 ± 0.25 | 64 ± 4 |

Table 3. Mean catch rate (No./h + 1 transformed to $\log_{10}$) and mean length (mm) of brown shrimp (*Penaeus aztecus*) collected with 20 ft. trawls in the deeper (≥ 1 m) water of nine coastal Texas bay systems during June 1982-1995.

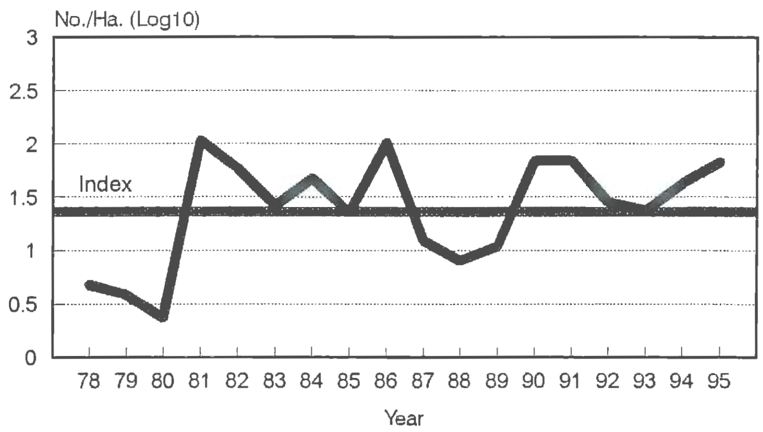
| Year | Log No./ha ± 1 SE | Length (mm) ± 1 SE |
|---|---|---|
| 1982 | 1.36 ± 0.21 | 92 ± 2 |
| 1983 | 1.30 ± 0.17 | 96 ± 2 |
| 1984 | 1.45 ± 0.16 | 101 ± 3 |
| 1985 | 1.38 ± 0.18 | 91 ± 2 |
| 1986 | 1.33 ± 0.18 | 95 ± 2 |
| 1987 | 1.52 ± 0.18 | 90 ± 4 |
| 1988 | 1.28 ± 0.19 | 91 ± 2 |
| 1989 | 1.43 ± 0.24 | 86 ± 2 |
| 1990 | 1.23 ± 0.24 | 97 ± 2 |
| 1991 | 1.22 ± 0.20 | 90 ± 2 |
| 1992 | 1.32 ± 0.20 | 83 ± 5 |
| 1993 | 1.34 ± 0.15 | 91 ± 4 |
| 1994 | 1.25 ± 0.16 | 94 ± 4 |
| 1995 | 1.33 ± 0.24 | 83 ± 2 |
| 1982-1994 | 1.34 ± 0.09 | 92 ± 5 |

Table 4. Mean catch rate (No./h + 1 transformed to $log_{10}$ ) and mean length (mm) of brown shrimp (*Penaeus aztecus*) collected with 20 ft. trawls in five areas of the Texas Territorial Sea during June 1986-1995.

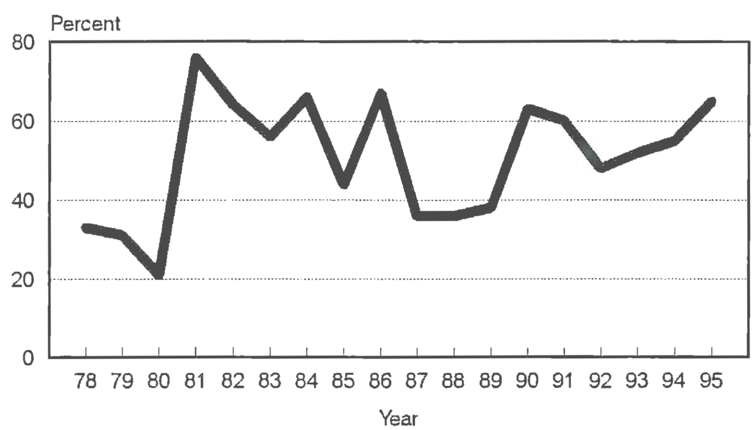
| Year | Log No./ha ± 1 SE | Mean length (mm) ± 1 SE | Mean lengths (mm) adjusted to 6/30 |
|---|---|---|---|
| 1986 | 0.74 ± 0.2 | 107 ± 3 | 120 |
| 1987 | 1.00 ± 0.2 | 104 ± 2 | 117 |
| 1988 | 1.29 ± 0.2 | 105 ± 3 | 119 |
| 1989 | 1.89 ± 0.3 | 99 ± 3 | 113 |
| 1990 | 1.03 ± 0.2 | 108 ± 2 | 120 |
| 1991 | 1.00 ± 0.1 | 97 ± 6 | 111 |
| 1992 | 0.63 ± 0.1 | 92 ± 5 | 105 |
| 1993 | 0.73 ± 0.2 | 101 ± 3 | 114 |
| 1994 | 0.43 ± 0.1 | 100 ± 3 | 113 |
| 1995 | 0.90 ± 0.3 | 99 ± 4 | 113 |

# April Bag Seines

## Catch Rate




## Samples with Shrimp




## Mean Length

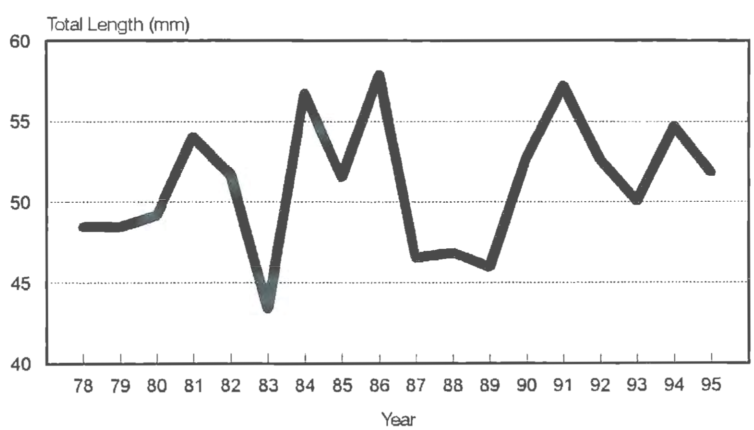



Figure 1. Fishery-independent bag seine data from nine Texas bays used to set the closing date of the Texas Closure.

# June Catch Rates

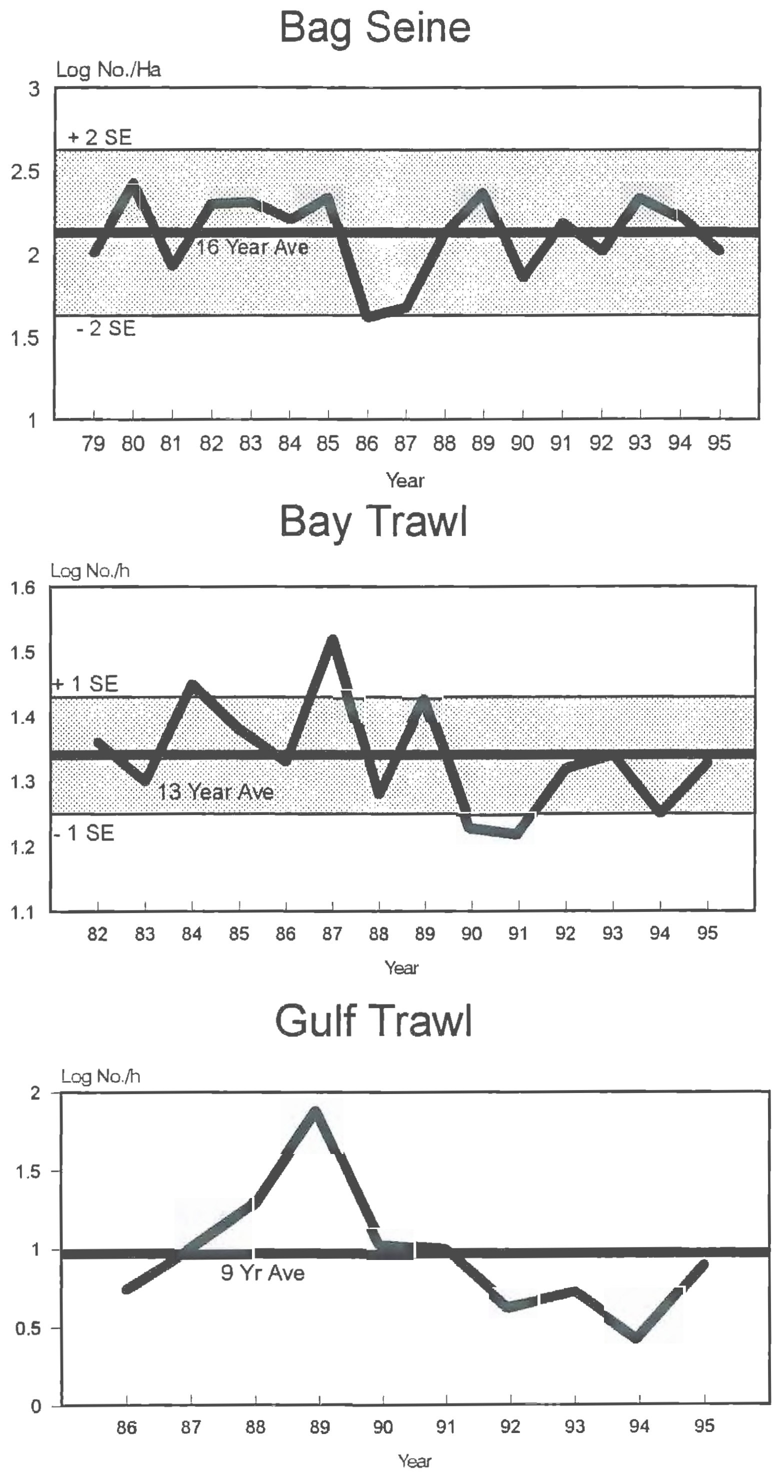
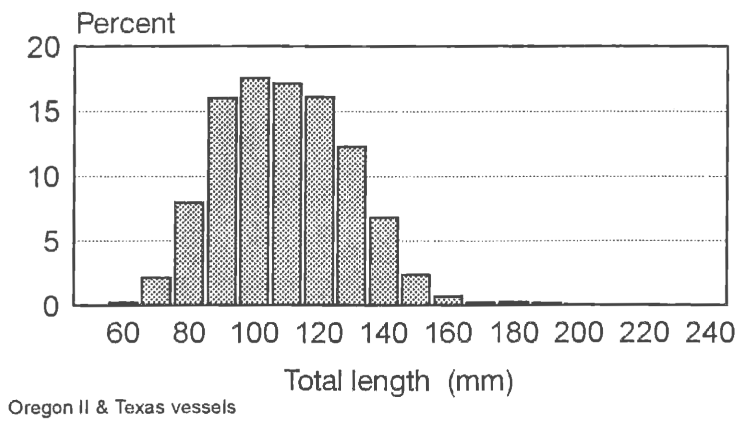



Figure 2. Fishery-independent bag seine and trawl data used to set the reopening date of the Texas Closure.

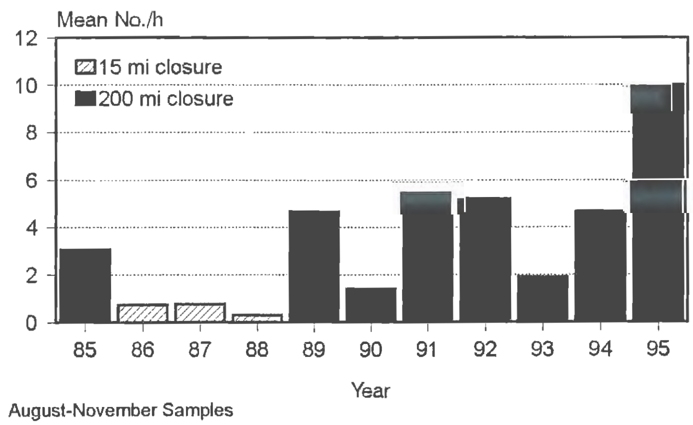
## 1995 SEAMAP DATA

Brown Shrimp




## Red Snapper in the TTS

TPWD Gulf Trawls




## Brown Shrimp - April

TPWD Bag Seines

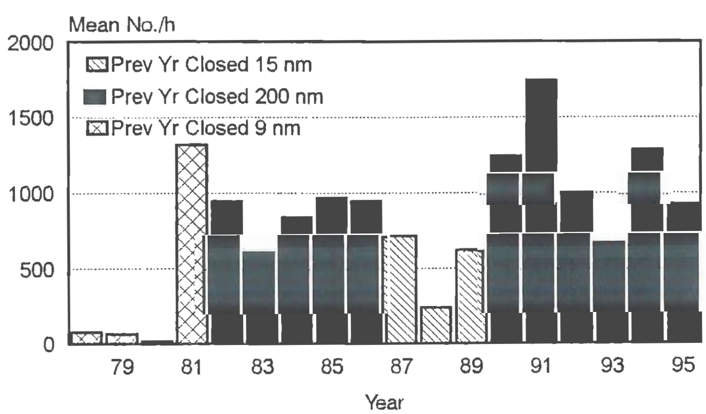



Figure 3. Fishery-independent data that supports the short term and long term benefits of the Texas Closure.

# ALABAMA'S COLLECTION AND USE OF FISHERY INDEPENDENT DATA

Stevens R. Heath

Alabama Department of Conservation and Natural Resources
Marine Resources Division
P. O. Box 189
Dauphin Island, AL 36528

The Alabama Department of Conservation and Natural Resources, Marine Resources Division has collected fishery independent data since the 1960's. The use of this data is critical to effective management. The mission of the Marine Resources Division is to manage the Alabama's marine resources for the continued use of the citizens of Alabama now and in the future. This requires maintaining a careful balance of consumption and conservation. In order to maintain this balance, it is necessary to obtain timely data to determine the status of each fishery. In addition, this data must be collected independent of the commercial and recreational harvest in order to obtain a complete picture of the size, distribution and condition of the resource.

The first fishery independent data from Alabama's marine resources were collected in the late 1960's during the cooperative program known as the Gulf of Mexico Estuarine Inventory. Since then fishery independent data have been collected annually though the scope of information collected has increased with the introduction of data collection in additional fisheries.

Fishery independent data are collected for Alabama's oyster fishery using divers and transect lines, annually or following catastrophic meteorological events such as floods or hurricanes. Samples are collected by divers swimming along 100 yard transects and taking all the surface material on the reef within a square yard grid placed beside burlap sacks randomly placed along the line. Samples are returned to the laboratory and the material is separated and data collected on oysters, spat, boxes, halfshell and oyster drills present. Data are then extrapolated for the entire reef. This data is used to create a general index of the population from year to year. It has also been used to document loss of resources catastrophic events in order to obtain federal funding for rehabilitating the reefs.

An assessment and monitoring program has existed for Alabama's shrimp and crab resources since 1977. The program was expanded to include finfish and other marine life in 1980. Samples are collected using beam plankton trawls, seines and otter trawls in order to assess the animals at various stages in their life cycles within Alabama's estuaries and territorial sea. The data is used to create indices for each of the more important animals and create long term data bases on all species collected. Bottom water temperature, salinity and dissolved oxygen data are collected with all biological samples. Sampling is monthly or more often as necessary to address particular management problems.

One of the most important uses of the assessment and monitoring information in Alabama is to enable fisheries managers to effectively open and close the waters to shrimping. Shrimp are sampled monthly throughout the year until April. Then they are sampled weekly to determine the size, distribution and growth rate. As shrimp smaller than the legal harvestable size, 68 shrimp per pound, begin to appear in collections from waters open to shrimping, those waters are closed by regulation. Alabama closes and opens its waters based upon average shrimp size and can open and close sections as necessary to protect small shrimp. Sampling continues weekly until the average size in samples equals the legal size and then the areas are reopened.

During the closed period, usually May to early June, the average size of the shrimp in a day's samples is entered into a computer data base and an exponential curve equation predicts the date that the shrimp will reach legal size. The rate of change of shrimp count, shrimp per pound, is used to compute the growth rate. Since 1977 Marine Resources Division administrators have used this data to make decisions about what waters to open and when to open. They have also used this data to coordinate with administrators in Mississippi to try to simultaneously open their adjoining waters of Mississippi Sound. This is of benefit to the shrimp fishermen because it provides greater area for the boats to operate and of benefit to enforcement because with both states' waters open, the closure boundary at the unmarked state line does not have to be determined.

Often the mix of sizes of shrimp and the distribution make it difficult to determine exactly which waters will be ready to open on a particular date. In addition, shrimp movement particularly under conditions of high freshwater inflow can increase the concern that a large portion of the shrimp will move into the Gulf of Mexico before the bay waters are open. This often results in increased discard by the Gulf fleet. Therefore, careful monitoring of the nearshore Gulf waters is necessary to determine if emigration is occurring. The SEAMAP program has greatly enhanced this ability.

In recent years, the dates of Alabama's SEAMAP summer shrimp/groundfish cruise have coincided closely with the predicted opening of the brown shrimp season. This has enabled division biologists to collect data to provide information about the number and size of shrimp in the nearshore Gulf waters. Table 1 lists the dates of the summer shrimp/groundfish cruises along with the opening dates of the brown shrimp season in Alabama since 1990. The cruises have occurred shortly before the opening date except in 1990. Table 2 shows the shrimp catch per hour by species for the period 1990-95. Comparison of the number of brown shrimp in the samples from year to year provides information about whether the current year crop is emigrating.

This proved to be particularly helpful in 1995. As the predicted date for opening waters to shrimping for the brown shrimp season approached, it became obvious that the area where the shrimp were legal size in Mobile Bay was very small. The general distribution of shrimp within the estuarine area indicated that the shrimp were moving in response to the above average freshwater discharge from the Mobile Delta. The small area where the shrimp were legal was in the mouth of Mobile Bay, further indicating that the shrimp were on the verge of moving into the Gulf.

Alabama's summer shrimp/groundfish cruise was scheduled for June 6, 1995 and the predicted opening date was June 8, 1995. Therefore the Director of the Marine Resources Division asked that biologists contact him immediately as soon as samples were collected and analyzed from the nearshore Gulf waters. These samples showed that the number of brown shrimp collected was many times higher than in other years (Table 2). The size was comparable to that just inside the estuaries indicating that the current year crop was emigrating to the Gulf of Mexico. This information was relayed to the director.

Based upon this data, the director decided that the situation warranted opening the small area in the mouth of Mobile Bay, thus allowing access to the shrimp before they emigrated into the Gulf (Figure 1). If this emigration had not been known, the area would probably not have been opened because its size would have been considered too small to open by itself due to the crowding of the boats trying to work the area (Figure 2).

Though landings can not be obtained from an area as small as the mouth of Mobile Bay and the adjacent nearshore Gulf waters, reports from the port agents and directly from shrimpers indicated that the decision was a good one and the resultant catch much better than would have otherwise been experienced.

Fishery independent sampling is an important part of Alabama's marine fisheries program. The data collected is necessary for a complete picture of the health of the resources. It is the only way to fully manage the resources in the face of rapidly changing conditions. The SEAMAP program is extremely important in Alabama's assessment and monitoring program. Hopefully, the funding for SEAMAP will continue and even increase in years to come. The full potential for fishery independent sampling in Alabama and the Gulf of Mexico can not be reached without increased funding.

Table 1. Dates of Alabama SEAMAP Summer Shrimp/Groundfish cruises and corresponding brown shrimp openings 1990 - 1995.

| Year | Date Shrimp Season Opened | Dates of Summer SEAMAP Cruise |
|---|---|---|
| 1990 | 06/05/90 | 06/07/90, 6/11/90 |
| 1991 | 06/18/91 | 06/03/91, 6/15/91 |
| 1992 | Lower Mobile Bay and Mississippi Sound never closed | 06/04/92, 6/08/92 |
| 1993 | 06/27/93 | 06/03/93, 6/11/93 |
| 1994 | 06/08/94 | 06/02/94, 6/09/94 |
| 1995 | 06/08/95 | 06/06/95 |

Table 2. Catch/hour of shrimp in samples from Alabama's SEAMAP Summer Shrimp/Groundfish cruises 1990 - 1995.

| Year | Brown Shrimp Number/hour | Pink Shrimp Number/hour | White Shrimp Number/hour |
|---|---|---|---|
| 1990 | 4 | 18 | 1 |
| 1991 | 8 | 45 | 0 |
| 1992 | 0 | 16 | 2 |
| 1993 | 0 | 30 | 1 |
| 1994 | 24 | 79 | 4 |
| 1995 | 189 | 76 | 1 |
| Average 1990-94 | 7 | 35 | 2 |
| Average 1990-95 | 38 | 39 | 1 |

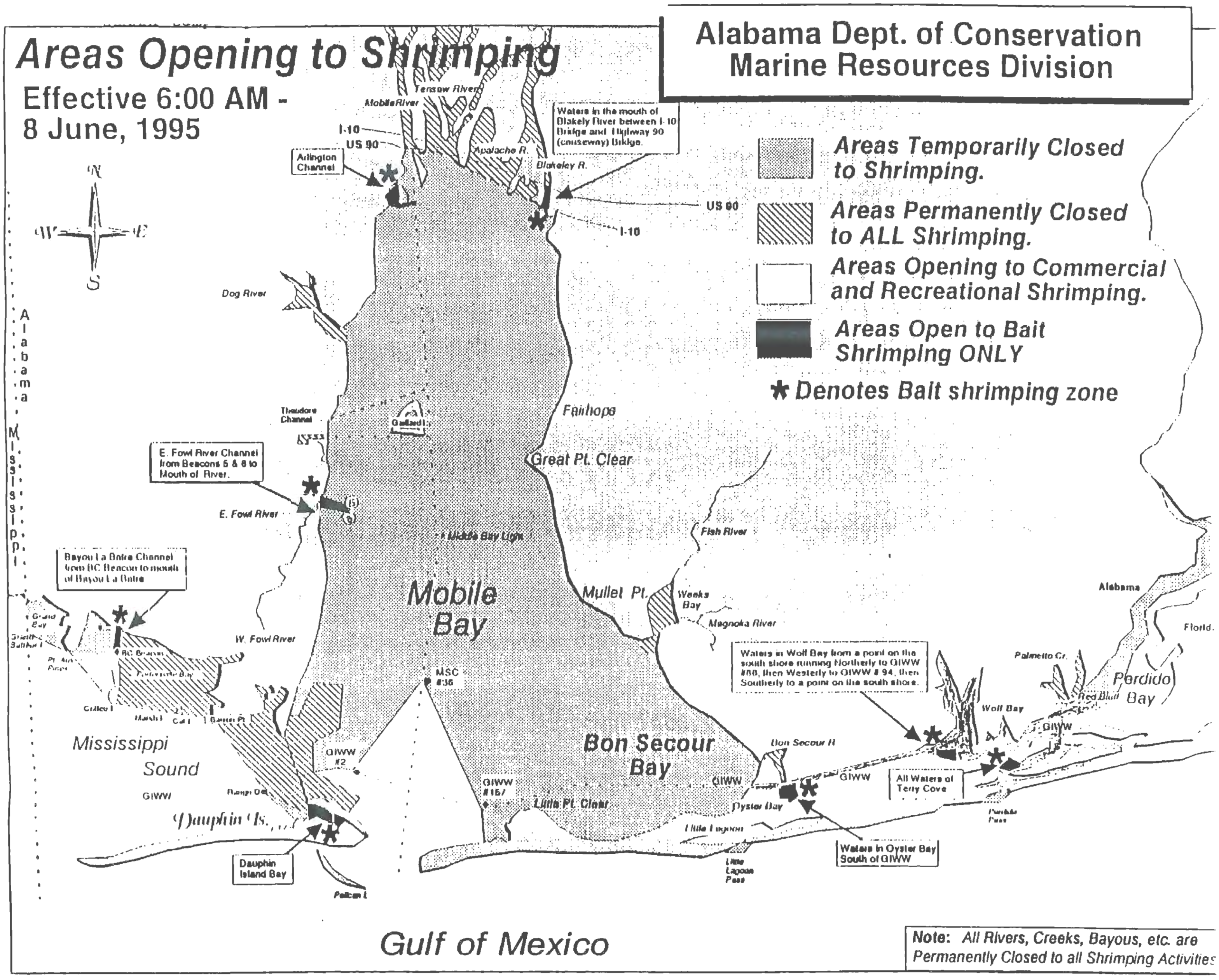



Figure 1. Area opened to shrimping on June 8, 1995 as a result of SEAMAP sampling on June 6, 1995.


Figure 2. Area planned for opening to shrimping prior to SEAMAP sampling on June 6, 1995.

# ICHTHYOPLANKTON DATA SUMMARIES FROM SEAMAP SUMMER SHRIMP/GROUNDFISH SURVEYS

Joanne Lyczkowski-Shultz and Rosanne Brasher

National Marine Fisheries Service
Southeast Fisheries Science Center
Mississippi Laboratories
P.O. Drawer 1207
Pascagoula, MS 39568-1207

## ABSTRACT

Preliminary data summaries are presented for snapper, king mackerel and Spanish mackerel larvae collected in bongo net samples during SEAMAP Summer Shrimp/Groundfish Surveys from 1986 through 1993. Larvae of the mackerels can be identified to the species level, however, species identification of snapper larvae is difficult and only recently has been made possible for specimens larger than 3.5 mm in length. Therefore, larval snapper data summaries given here are based on identification to the family level only. Precision of mean abundance estimates as indicated by the ratio of the standard error of the mean to the mean suggest that larval abundance for these three taxa could be of potential use in following trends in population levels.

## INTRODUCTION

Since SEAMAP's inception in 1982 the goal of plankton activities in the Gulf of Mexico has been to collect data on the early life stages of fishes and invertebrates that will complement and enhance the fishery-independent data gathered during surveys of the adult life-stage. Plankton surveys are a very cost effective way to gather abundance and distribution data on a wide diversity of marine organisms. A single and relatively simple gear type, the plankton net, can be used to catch the young of reef fishes, bottomfishes, macroinvertebrates, and coastal migratory pelagic fishes. Plankton surveys have been used in the detection and appraisal of fishery resources; in the determination of spawning seasons and areas; in investigations of early survival and recruitment mechanisms; and in estimation of the abundance of a stock based on its spawning production.

SEAMAP provides platforms and equipment for collections from both "piggybacked' and dedicated plankton cruises. SEAMAP funds are used for sample sorting and identification at the Sea Fisheries Institute, Plankton Sorting and Identification Center, in Szczecin, Poland, through a Joint Cooperative Studies Agreement that has been in place with NMFS since 1974. The Louisiana Department of Wildlife and Fisheries has, since 1987, sorted and identified it's own SEAMAP plankton collections. SEAMAP also operates two archives where specimen identification data are entered and updated; and where specimens are curated and loaned to interested scientists. Over 100,000 lots of identified fish larvae are housed at the SEAMAP Archiving Center (SAC) at Florida's Marine Science Institute, St. Petersburg, FL. Unsorted samples are stored and the planktonic stages of Gulf macroinvertebrates are sorted, identified, and archived in the SEAMAP Invertebrate Plankton Archiving Center (SIPAC) at the Gulf Coast Research Laboratory in Ocean Springs, MS. SIPAC's holdings include over 3,000 unprocessed samples and over 5,000 lots of sorted and identified specimens. Data entry and management software and support for SEAMAP are provided by the Southeast Fisheries Science Center, Mississippi Laboratories, Data Management Group.

## METHODS AND MATERIALS

The original goal of SEAMAP was to collect plankton samples from open, shelf and coastal waters of the Gulf of Mexico during each season. This goal has been met only partially in that each season has been surveyed but not each of the three major habitats (Table 1). Standard

SEAMAP gear, methods and protocols are used to collect samples during all SEAMAP surveys (see SEAMAP Operations Manual for Collection of Data, revision No. 3, September 1993). During the annual SEAMAP Summer Shrimp/Groundfish Survey in June and July bongo (60 cm diameter and 0.335 mm mesh) net and neuston (1 by 2 m mouth opening and 0.947 mm mesh) net samples are taken at stations in a 30 nm grid pattern from Brownsville, Texas to the mouth of Mobile Bay as weather and trawling operations permit; ie. plankton collections are "piggybacked" during this survey. Participants of the summer survey that take plankton samples are the National Marine Fisheries Service (Mississippi Laboratories), Louisiana Department of Wildlife and Fisheries, and the Gulf Coast Research Laboratory (representing the Mississippi Department of Marine Resources).

Recent examination of data from surveys in 1986 through 1993 resulted in the preliminary summaries presented here (Figure 1). Information from the 1993 survey year is incomplete since data from 11 samples have yet to be received from Poland. Examination of ichthyoplankton data from the earlier years, 1982 to 1985, was not completed in time for this workshop.

## RESULTS AND DISCUSSION

Total number of plankton samples taken during summer surveys ranged from 74 to 37, with larvae from over 100 taxa being represented each year (Figure 1). The larvae of only about 10% of the over 2,000 species of fishes occurring in the Gulf of Mexico and adjacent waters can be identified to the species level. Therefore, many larval specimens can be identified only to higher order categories such as family or genus. One such group are snapper larvae that, until recently, could not be confidently identified beyond the family level at stages prior to advanced fin development (Richards et al. 1994; Rielly, ; Clarke et al. ). Reexamination of archived SEAMAP specimens using new information on larval snapper development will render these data more useful in assessments of important snapper species.

**Lutjanidae (Figures 2-5; Table 2):** Mean abundance of lutjanid larvae captured during SEAMAP Summer Shrimp/Groundfish surveys in 1986 through 1993 ranged from 1 to 6 larvae per 10 $m^2$ sea surface. Coefficients of variation of the mean; ie, the ratio of the standard error of the mean to the mean, were generally <0.6, indicating precision levels on estimates of mean abundance that would make them useful in following population trends. Distribution maps showing the occurrence of snapper larvae during surveys in 1986, 1990 and 1992 suggest that snapper larvae are most commonly taken at the more offshore stations of the sampling grid.

***Scomberomorus cavalla*** **(Figures 6-9; Table 3):** Mean abundance of king mackerel larvae captured during SEAMAP Summer Shrimp/Groundfish surveys in 1986 through 1993 ranged from over 1.5 to 5.5 larvae per 10 $m^2$ sea surface. Coefficients of variation of the mean; ie, the ratio of the standard error of the mean to the mean, were generally <0.6, indicating precision levels on estimates of mean abundance that would make them useful in following population trends. Distribution maps showing the occurrence of king mackerel larvae during surveys in 1986, 1990 and 1992 show that larvae of this species are widely distributed throughout the survey area.

***Scomberomorus maculatus*** **(Figures 7-10; Table 4):** Mean abundance of Spanish mackerel larvae captured during SEAMAP Summer Shrimp/Groundfish surveys in 1986 through 1993 ranged from 0.5 to 13.0 larvae per 10 $m^2$ sea surface. Coefficients of variation of the mean; ie, the ratio of the standard error of the mean to the mean, were generally <0.6, indicating precision levels on estimates of mean abundance that would make them useful in following population trends. Distribution maps showing the occurrence of Spanish mackerel larvae during surveys in 1986, 1990 and 1992 show that larvae of this species are widely distributed throughout the survey area.

***Thunnus, Thunnus atlanticus,*** **and** ***Rachycentron canadum*** **(Figures 7&9):**
Occurrences of tuna and cobia larvae were rare and confined to offshore most stations off Texas in the case of tuna larvae; and near the Mississippi River mouth for cobia.

## LITERATURE CITED

Clarke, M.E., M.L. Domeier, and W.A. Laroche. 1995. Development of larvae and juveniles of the mutton snapper (*Lutjanus analis*), lane snapper (*Lutjanus synagris*), yellowtail snapper (*Ocyurus chrysurus*), and hybrid yellowtail x lane snapper (Pisces, Lutjanidae). Bull. Mar. Sci.

Richards, W.J., K.C. Lindeman, Joanne Lyczkowski-Shultz, J.M. Leis, A. Ropke, M.E. Clarke, and B.H. Comyns. 1994. Preliminary guide to the identification of the early life history stages of lutjanid fishes of the western central Atlantic. NOAA Technical Memorandum, NMFS-SEFSC-345. 49 pp.

Riley, C.M., G.J. Holt, and C.R. Arnold. Growth and morphology of larval and juvenile captive bred yellowtail snapper, *Ocyurus chrysurus*. Fishery Bulletin 93:179-185.

Table 1. Seasonal and areal coverage of SEAMAP plankton collections in the Gulf of Mexico. (*=dedicated plankton survey)

| SEASON | MONTH/YEAR | HABITAT/AREA |
|---|---|---|
| Winter | *December 1983 | open & north central Gulf |
| | *December 1984 | open & north central Gulf |
| | December/November 1985 to present | coastal Louisiana |
| | January/February 1993 | open Gulf |
| Spring | *April/May/June 1982 to present | open Gulf & south Florida shelf edge |
| | *May/June 1982 | shelf & coastal southern Gulf (Mexico) |
| | March/April(May) 1986 to present | coastal Louisiana |
| | May/June 1986 | shelf edge south Texas to north Florida |
| Summer | June/July 1982 to 1985 | shelf & coastal south Texas to north Florida |
| | June/July 1986 to present | shelf & coastal south Texas to Alabama |
| | June/July 1982 to present | coastal Louisiana |
| | *August 1984 | shelf & coastal Gulfwide |
| | July/August 1985 | shelf edge south Texas to Florida |
| | (May)June/July 1992 to present | natural hardbottom Gulfwide |
| Fall | *(August)September/October 1986 to present | shelf & coastal Gulfwide |
| | September/October 1985 to present | coastal Louisiana |
| | October/November 1982 to 1985 | shelf & coastal Texas to north Florida |
| | October/November 1985 to present | shelf & coastal Texas to Alabama |
| | October/November 1983 to present | coastal Louisiana |

Table 2. Mean abundance of Lutjanidae larvae taken during SEAMAP Summer Shrimp/Groundfish Surveys, 1986 to 1993. CV = the ratio of standard error of the mean to mean abundance

| YEAR | Collections | MEAN Larvae under $10m^2$ | CV |
|---|---|---|---|
| 1986 | 73 | 2.3 | 0.34 |
| 1987 | 74 | 1.8 | 0.21 |
| 1988 | 37 | 1.1 | 0.47 |
| 1989 | 39 | 1.8 | 0.42 |
| 1990 | 37 | 2.6 | 0.53 |
| 1991 | 46 | 5.9 | 0.38 |
| 1992 | 49 | 4.7 | 0.27 |
| 1993* | 41* | 2.1* | 0.42* |

*incomplete

Table 3. Mean abundance of King mackerel larvae taken during SEAMAP Summer Shrimp/Groundfish Surveys, 1986 to 1993. CV = the ratio of standard error of the mean to mean abundance

| YEAR | Collections | MEAN Larvae under $10\ m^2$ | CV |
|---|---|---|---|
| 1986 | 73 | 1.7 | 0.34 |
| 1987 | 74 | 0.8 | 0.45 |
| 1988 | 37 | 0.4 | 0.80 |
| 1989 | 39 | 1.8 | 0.61 |
| 1990 | 37 | 1.3 | 0.42 |
| 1991 | 46 | 0.5 | 0.40 |
| 1992 | 49 | 2.3 | 0.34 |
| 1993* | 41* | 5.3* | 0.46* |

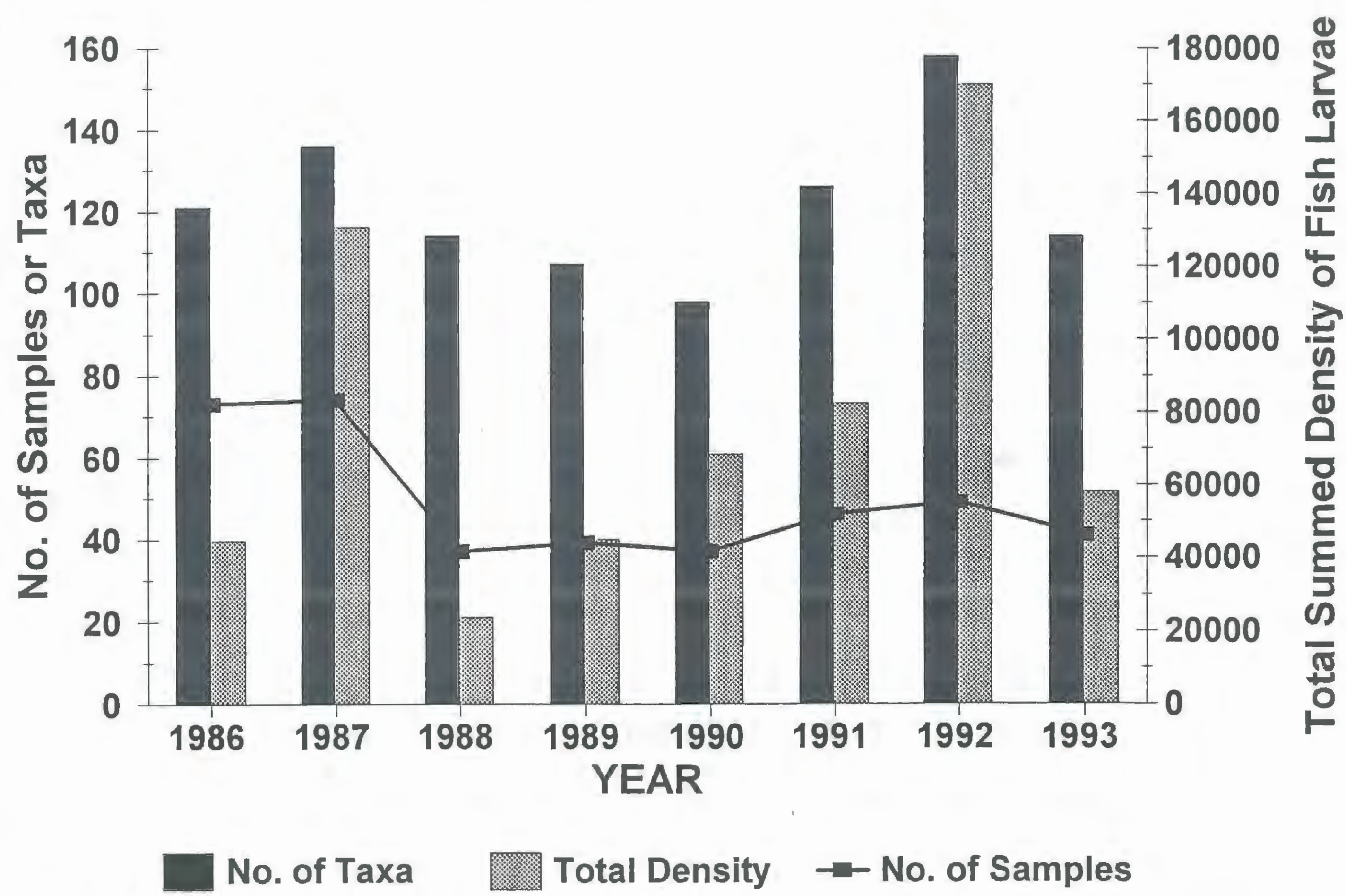
*incomplete

Table 4. Mean abundance of Spanish mackerel larvae taken during SEAMAP Summer Shrimp/Groundfish Surveys, 1986 to 1993. CV = the ratio of standard error of the mean to mean abundance

| YEAR | Collections | MEAN Larvae under 10 $m^2$ | CV |
|---|---|---|---|
| 1986 | 73 | 1.1 | 0.36 |
| 1987 | 74 | 4.7 | 0.25 |
| 1988 | 37 | 2.1 | 0.65 |
| 1989 | 39 | 2.6 | 0.25 |
| 1990 | 37 | 2.5 | 0.29 |
| 1991 | 46 | 3.8 | 0.84 |
| 1992 | 49 | 13.0 | 0.47 |
| 1993* | 41* | 4.8* | 0.53* |

*incomplete

**Figure 1: Bongo net sample summary from Summer Shrimp/Groundfish Surveys.**



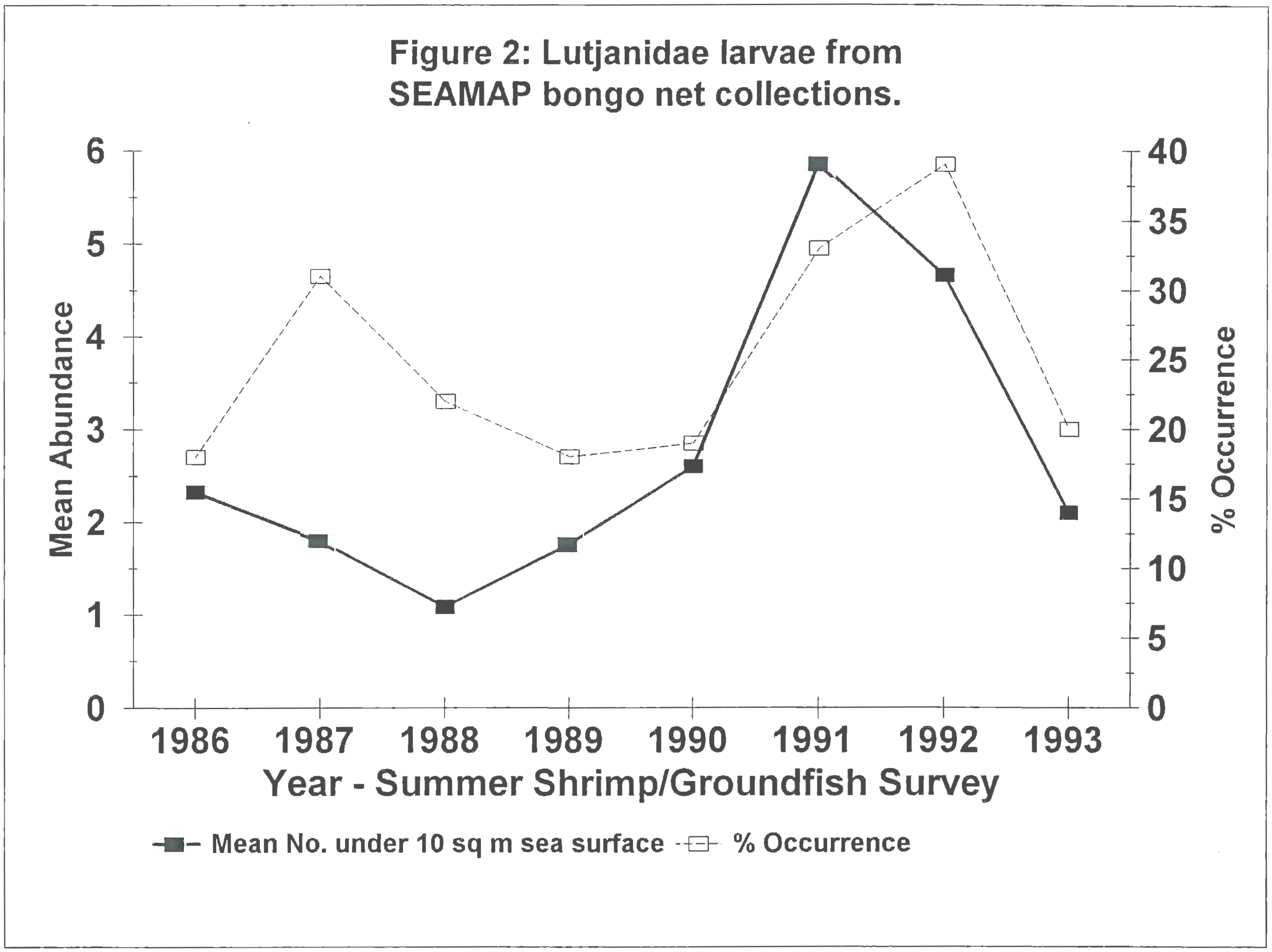


Figure 2: Lutjanidae larvae from
SEAMAP bongo net collections.
Mean Abundance
% Occurrence
0
1
2
3
4
5
6
0
5
10
15
20
25
30
35
40
1986
1987
1988
1989
1990
1991
1992
1993
Year - Summer Shrimp/Groundfish Survey
Mean No. under 10 sq m sea surface
% Occurrence

Figure 3

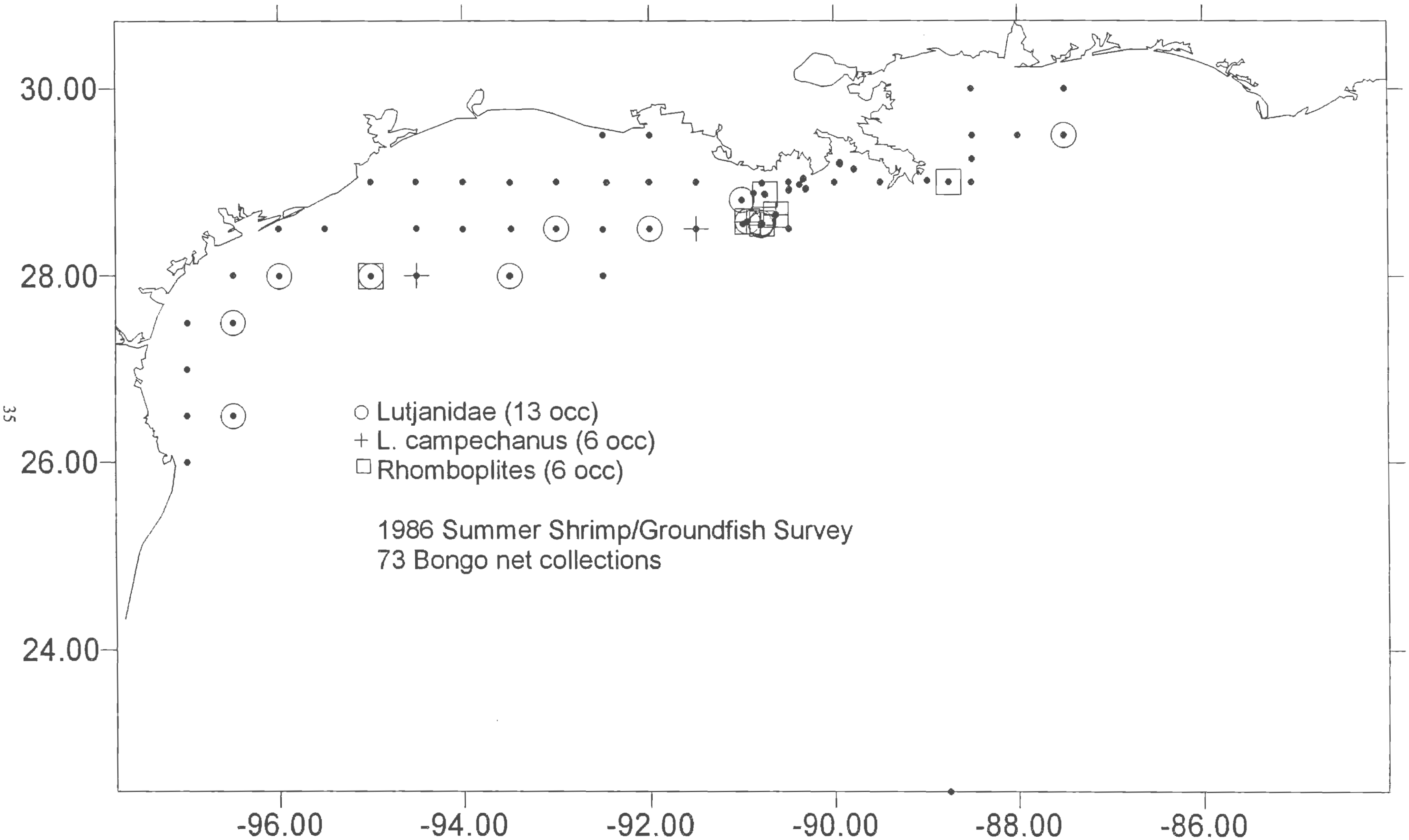
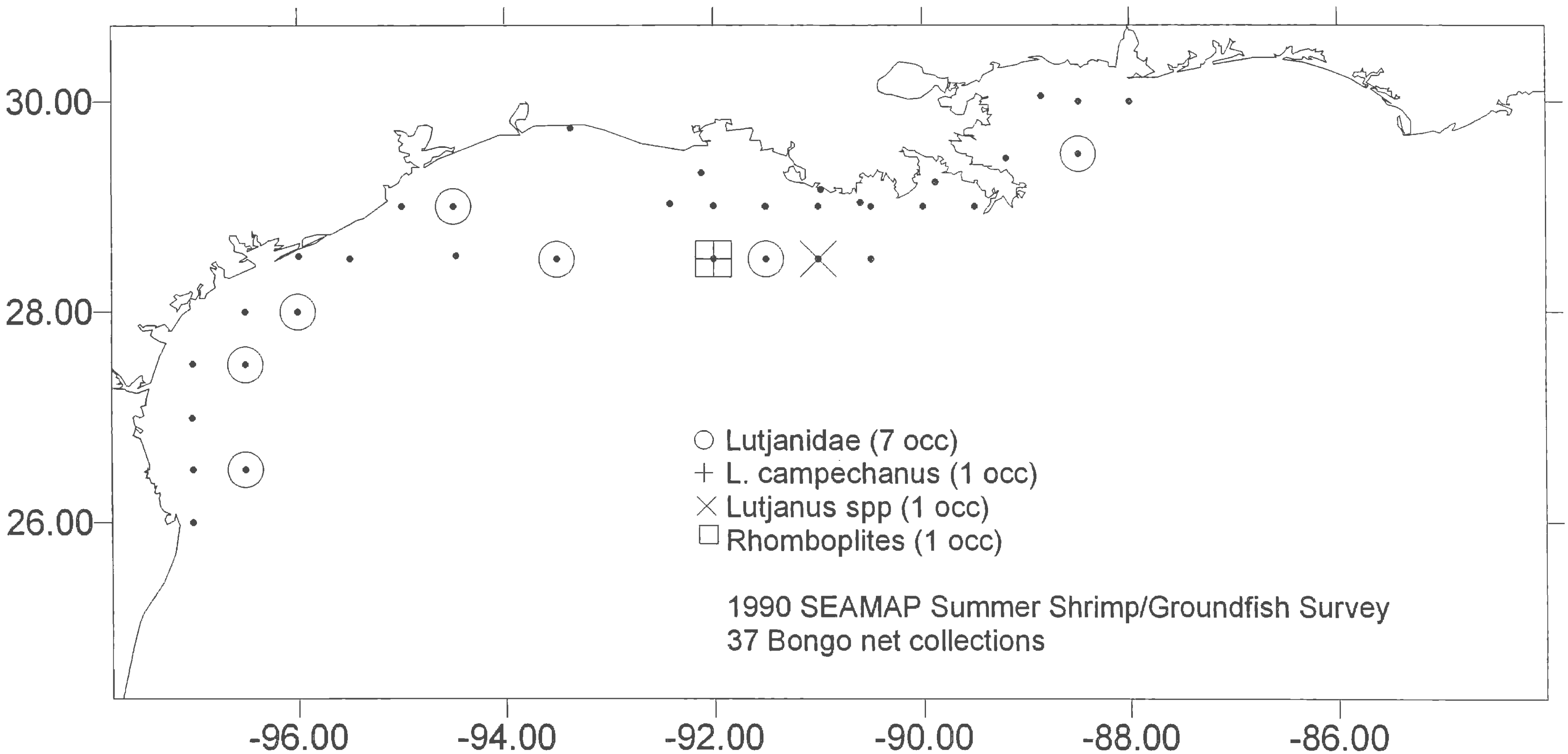

○ Lutjanidae (13 occ)
+ L. campechanus (6 occ)
□ Rhomboplites (6 occ)
1986 Summer Shrimp/Groundfish Survey
73 Bongo net collections
30.00
28.00
26.00
24.00
-96.00
-94.00
-92.00
-90.00
-88.00
-86.00

Figure 4


30.00
28.00
26.00
-96.00
-94.00
-92.00
-90.00
-88.00
-86.00
Lutjanidae (7 occ)
L. campechanus (1 occ)
Lutjanus spp (1 occ)
Rhomboplites (1 occ)
1990 SEAMAP Summer Shrimp/Groundfish Survey
37 Bongo net collections

# Figure 5

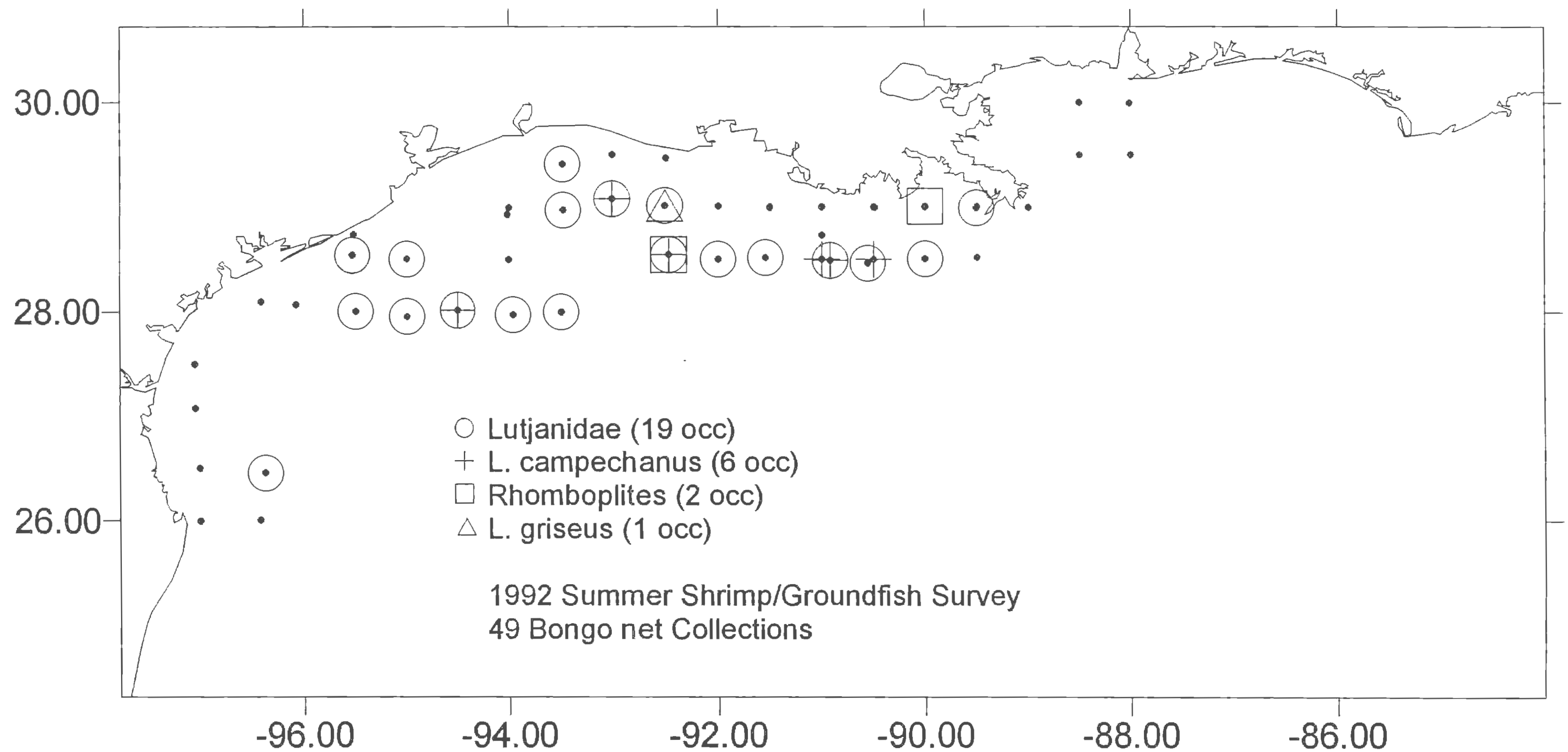

30.00
28.00
26.00
-96.00
-94.00
-92.00
-90.00
-88.00
-86.00
Lutjanidae (19 occ)
L. campechanus (6 occ)
Rhomboplites (2 occ)
L. griseus (1 occ)
1992 Summer Shrimp/Groundfish Survey
49 Bongo net Collections

Figure 6: King mackerel larvae from SEAMAP bongo net collections.

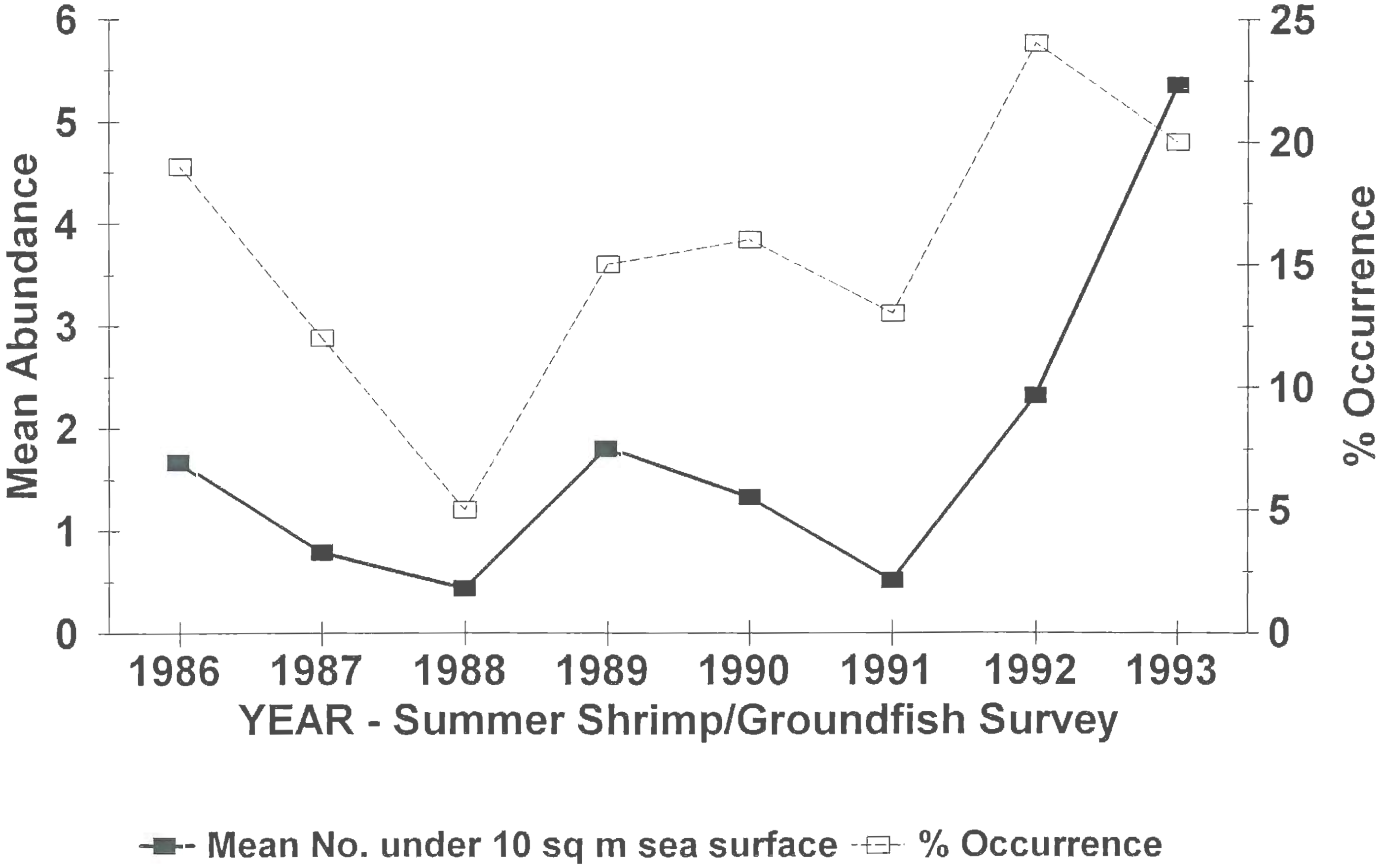


Figure 7

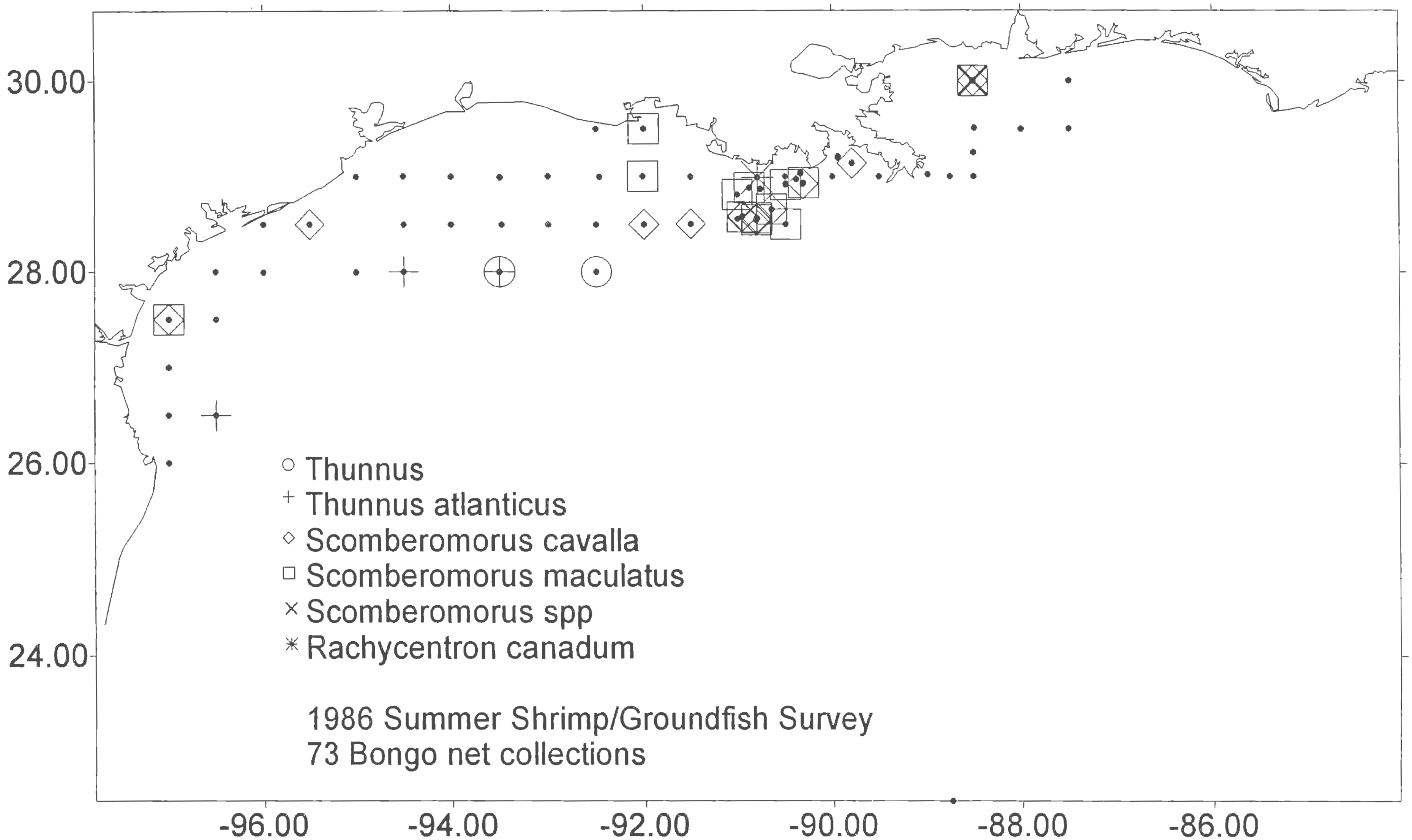

30.00
28.00
26.00
24.00
-96.00
-94.00
-92.00
-90.00
-88.00
-86.00
○ Thunnus
+ Thunnus atlanticus
◇ Scomberomorus cavalla
□ Scomberomorus maculatus
× Scomberomorus spp
✳ Rachycentron canadum
1986 Summer Shrimp/Groundfish Survey
73 Bongo net collections

Figure 8

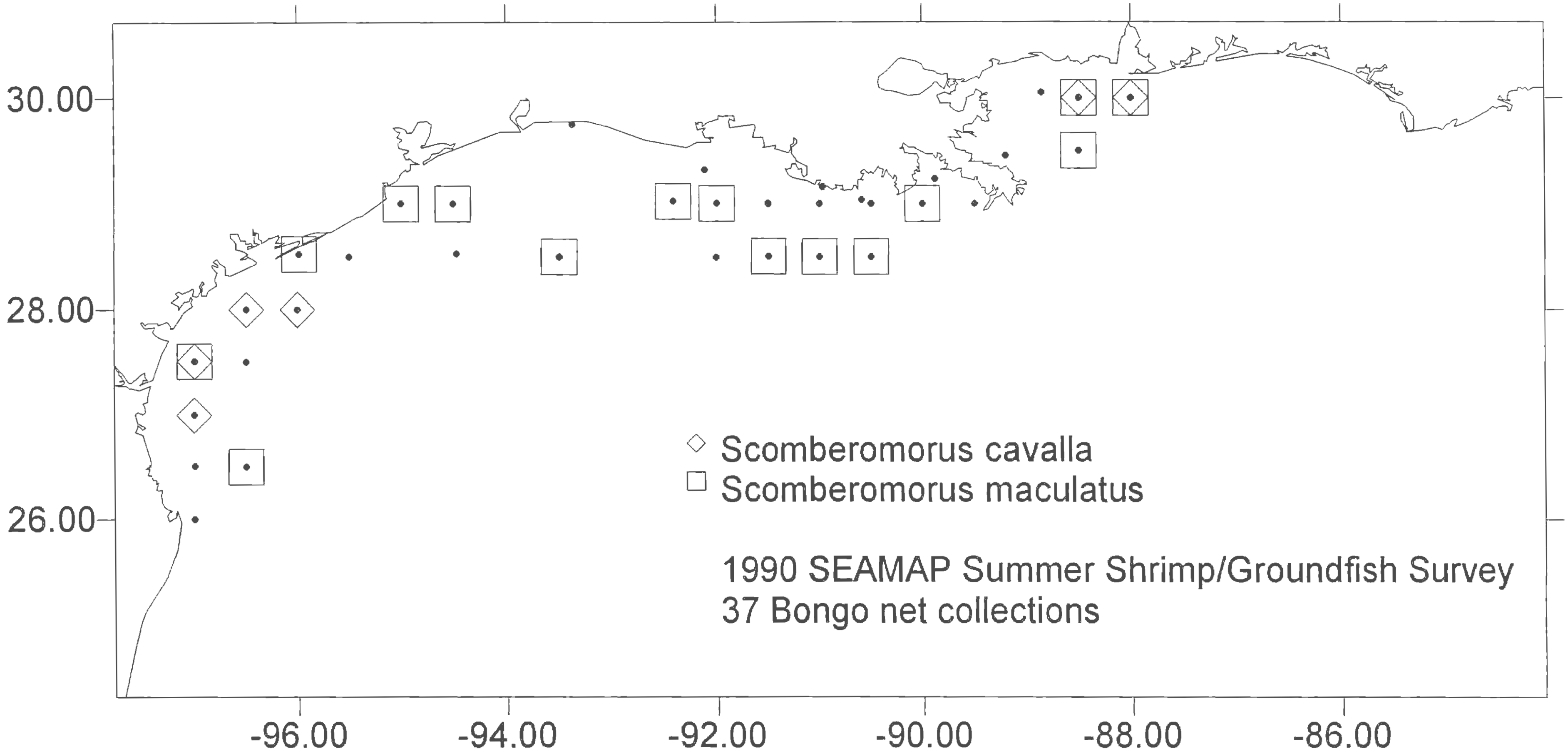
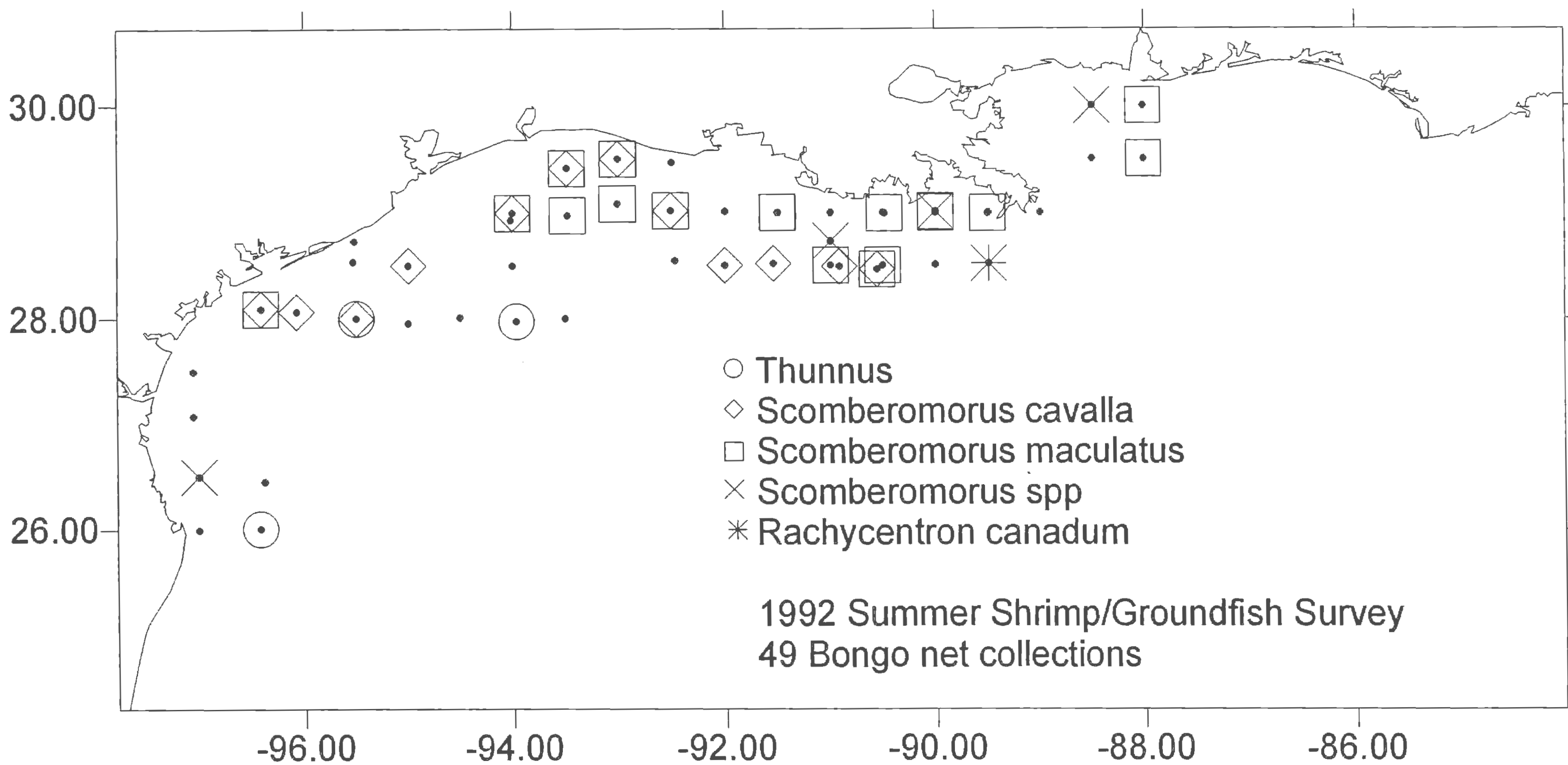

30.00
28.00
26.00
-96.00
-94.00
-92.00
-90.00
-88.00
-86.00
Scomberomorus cavalla
Scomberomorus maculatus
1990 SEAMAP Summer Shrimp/Groundfish Survey
37 Bongo net collections

Figure 9


30.00
28.00
26.00
-96.00
-94.00
-92.00
-90.00
-88.00
-86.00
Thunnus
Scomberomorus cavalla
Scomberomorus maculatus
Scomberomorus spp
Rachycentron canadum
1992 Summer Shrimp/Groundfish Survey
49 Bongo net collections

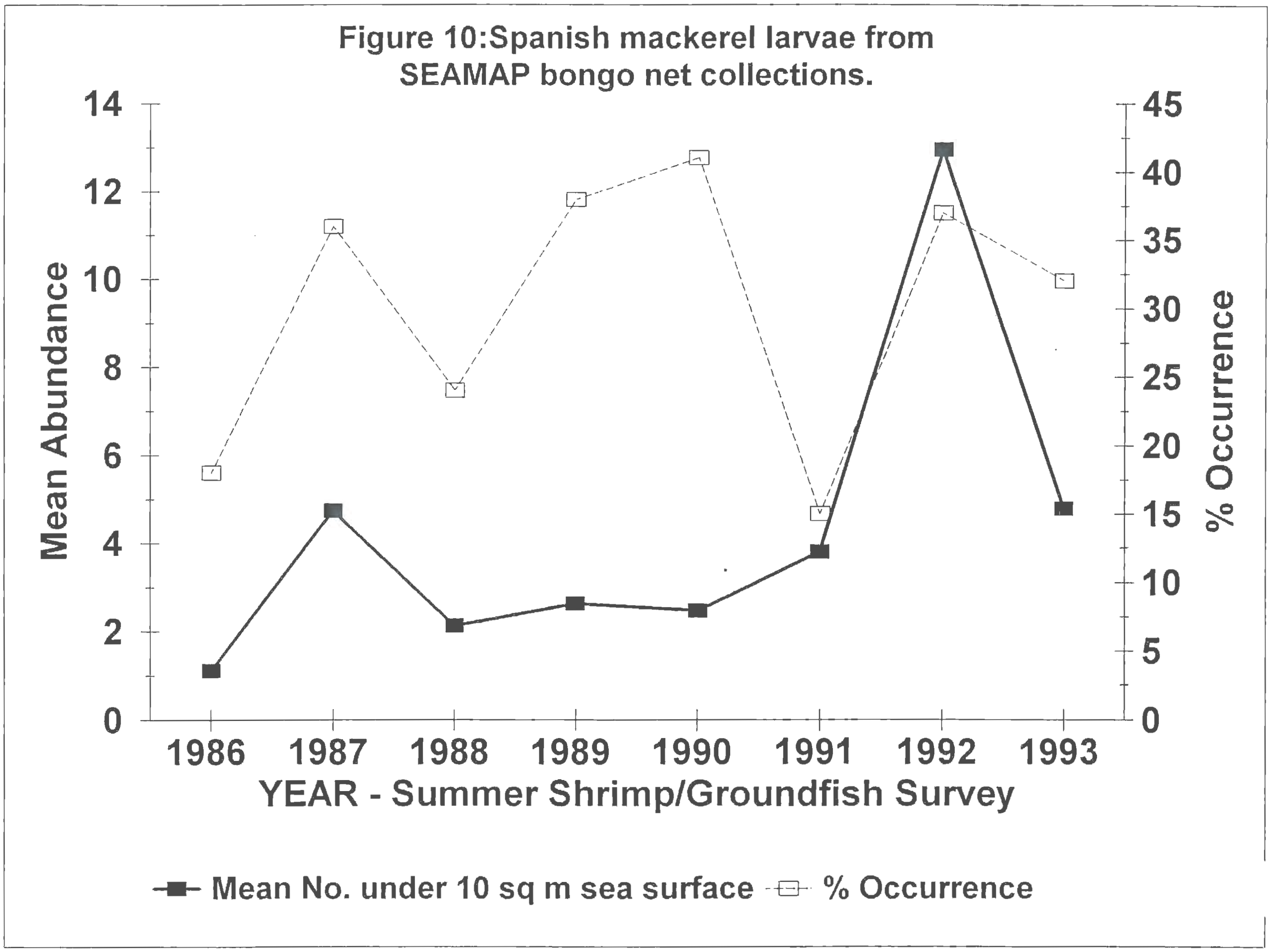


Figure 10:Spanish mackerel larvae from
SEAMAP bongo net collections.
14
12
10
8
6
4
2
0
Mean Abundance
45
40
35
30
25
20
15
10
5
0
% Occurrence
1986 1987 1988 1989 1990 1991 1992 1993
YEAR - Summer Shrimp/Groundfish Survey
Mean No. under 10 sq m sea surface
% Occurrence

# LOUISIANA'S FISHERY-INDEPENDENT MONITORING PROGRAM AND USES FOR MANAGEMENT

Joseph Shepard

Louisiana Department of Wildlife and Fisheries
P.O. Box 98000
Baton Rouge, LA 70898-9000

Louisiana's fishery-independent monitoring program can be divided into shrimp, oyster and finfish monitoring. There is also a fishery-independent research component designed to support management decisions and stock assessments. Both long and short term fishery-independent monitoring has been indispensable in managing Louisiana's valuable fishery resources.

## SHRIMP MONITORING

Shrimp monitoring can realistically be called a trawl-based fishery-independent monitoring program. The program established in 1965 was originally designed to monitor penaeid shrimp size and abundance with the primary intent of setting annual shrimp seasons. Since shrimp aren't the only species caught, it has evolved into a shrimp, crab and groundfish monitoring program. Sampling is conducted at fixed station sites designed to encompass the estuarine system. Six foot trawls are towed for ten minutes in the shallow water areas of the estuary, while sixteen foot trawls are used in the deeper open bay areas. Each sample is sorted to species and length frequencies recorded. Various hydrologic measurements are taken at each site, of primary interest are salinity and water temperature.

As mentioned above, opening and closing Louisiana's shrimp seasons are and have been the primary purpose for sampling. Postlarval brown shrimp recruited to the estuary during the winter and early spring are dependent on suitable habitat to survive and grow. Samples collected during the spring months provide estimates of time of recruitment to the estuary, spatial distribution, relative abundance and growth. The experiences gained from the analysis of this long term database have been used in establishing shrimp management zones, predicting the relative magnitude of the catch and establishing a pattern of growth used to set opening dates. The state's coastal estuary was divided into three shrimp management zones beginning in 1975 after it was found that time of peak recruitment differed by geographic area and riverain influence in certain area's of the state caused brown shrimp in certain years to grow slower and be less abundant than those areas with less riverain influence. Each year, data is presented to managers by zone and they then evaluate the need for differential season openings (Figure 1). Brown shrimp time of recruitment and growth during the early spring months is the key to establishing a season opening. The Department is responsible for predicting when 50% of the shrimp will reach 100 count. Length frequency of shrimp captured in six foot trawls over time (weekly) has been successfully used to predict population growth and therefore an opening date (Figure 2). Catch per unit effort is compared to years of good and bad production to offer some insight into the current year's potential production (Figure 3).

Again, shrimp aren't the only species caught in trawls. A long term fishery independent database may be used to evaluate the relative health of a resource by reviewing long term trends. The long term trend in blue crab catch per effort over the years sampled is presented in figure 4. Relative abundance indices for age 0 menhaden have been used to predict potential production of age 1 fish the following year and also used as recruitment indices in age structured population analysis (Figure 5). Besides menhaden, other recruitment indices have been established for various other species of fish.

## OYSTER MONITORING

The fishery independent oyster monitoring program was established in 1973 and is designed to provide information needed to manage Louisiana's oyster resources. The Department establishes and manages estuarine water bottoms across coastal Louisiana for the production of seed and sack oysters. These areas are referred to as public seed grounds. Currently, there are approximately 2,000,000 acres set aside as public seed grounds. Square meter frame and eighteen inch oyster dredges are used to monitor the relative abundance of both live and recently dead oysters, as well as the abundance of major prey species on public oyster grounds. After collected oysters are sorted by size and categorized into spat (< 1 inches), seed (1-3 inches) and marketable (> 3 inches) oysters. Various hydrologic measures critical to oyster survival such as salinity and water temperature are collected at each site.

Catch per unit effort, measured in oysters per square meter, in conjunction with total reef acreages provide estimates of potential production of seed and sack oysters from each reef (Figure 6). Decisions can then be made based on the distribution and abundance of seed and sack oysters whether to open a given reef to harvest or keep it closed.

The department is responsible for monitoring the impact of the Caenervon freshwater diversion project on fishery resources. Oysters being sessile and unable to avoid hydrologic changes in their environment are ideal organisms for monitoring freshwater introduction.

FINFISH MONITORING

In 1984, the Louisiana Legislature passed a bill establishing a saltwater fishing license with the proceeds going to research and monitoring of marine finfish. The program was fully funded and operational with comprehensive data collection beginning January 1, 1986. Three gear types are used to sample various year classes of estuarine dependent finfish. Small mesh bag seines (50 foot, 1/4 inch mesh) are used to estimate relative abundance of young of the year and to provide basic growth and movement information. Experimental gill nets (750 foot, 150 foot panels of 1, 1¼, 1½, 1¾ and 2 inch bar mesh) are used to sample juveniles, sub-adults and adults and to provide information on relative abundance, year class strength, movement and gonadal condition. Trammel nets (750 foot, 1⅝ X 6 inch bar mesh) are used to provide information on relative abundance, and movement. Seine samples and gill net samples are taken year-round, trammel net samples are taken from October through March. Hydrological measurements (salinity, and water temperature) are taken each time a biological sample is taken. Samples are taken at specific locations arranged in such a manner so as to cover the beach, mid-marsh and upper marsh areas of major bay systems throughout coastal Louisiana.

Biological and hydrological data are summarized monthly to give resource managers information as to the distribution and relative abundance of the resource. These data are used to develop recruitment indices for species of importance (Figure 7). Analytical and predictive models are developed as needed to provide support to age structured population assessments (Figures 8 and 9).

RESEARCH

The marine fisheries research program in Louisiana is composed of short-term projects designed to provide as needed information for stock assessments or fishery management decisions. Many of the current monitoring programs were designed based on research gear evaluation studies. Gillnet selectivity functions aided in the development of Finfish Program, while trawl codend studies helped the Shrimp Program in evaluating the most appropriate codend to use in sampling gear.

The department has for many years planted cultch material on public seed grounds for oysters. Rangia clam shell was the cultch of choice. With the reduction of available clam shell, other types of material were evaluated as to their suitability for setting oysters. As a result, it was found that limestone provided an excellent substrate for setting oysters.

There has been a great deal of emphasis directed toward the development of artificial reefs in recent years with little evaluation of their benefit to the resource. Research projects are currently being developed to evaluate the effect of nearshore artificial reefs on resident fish populations.

Age based stock assessments have opened a new world of research projects. It is now necessary to obtain direct aging, and reproductive potential of fish populations. Age-length keys, annual fecundity and maturation schedules are being developed by the Research Program for various species of state concern.

Fisheries management typically relies on size limits to regulate the harvest of finfish, which often leads to hook release mortality. It then becomes very important to quantify, from a stock assessment standpoint, the mortality of released fish to adequately model fish populations. The department has conducted hook release mortality studies on spotted seatrout and red drum.

Figure 1 - Brown Shrimp Catch per Effort

Week 18 1995

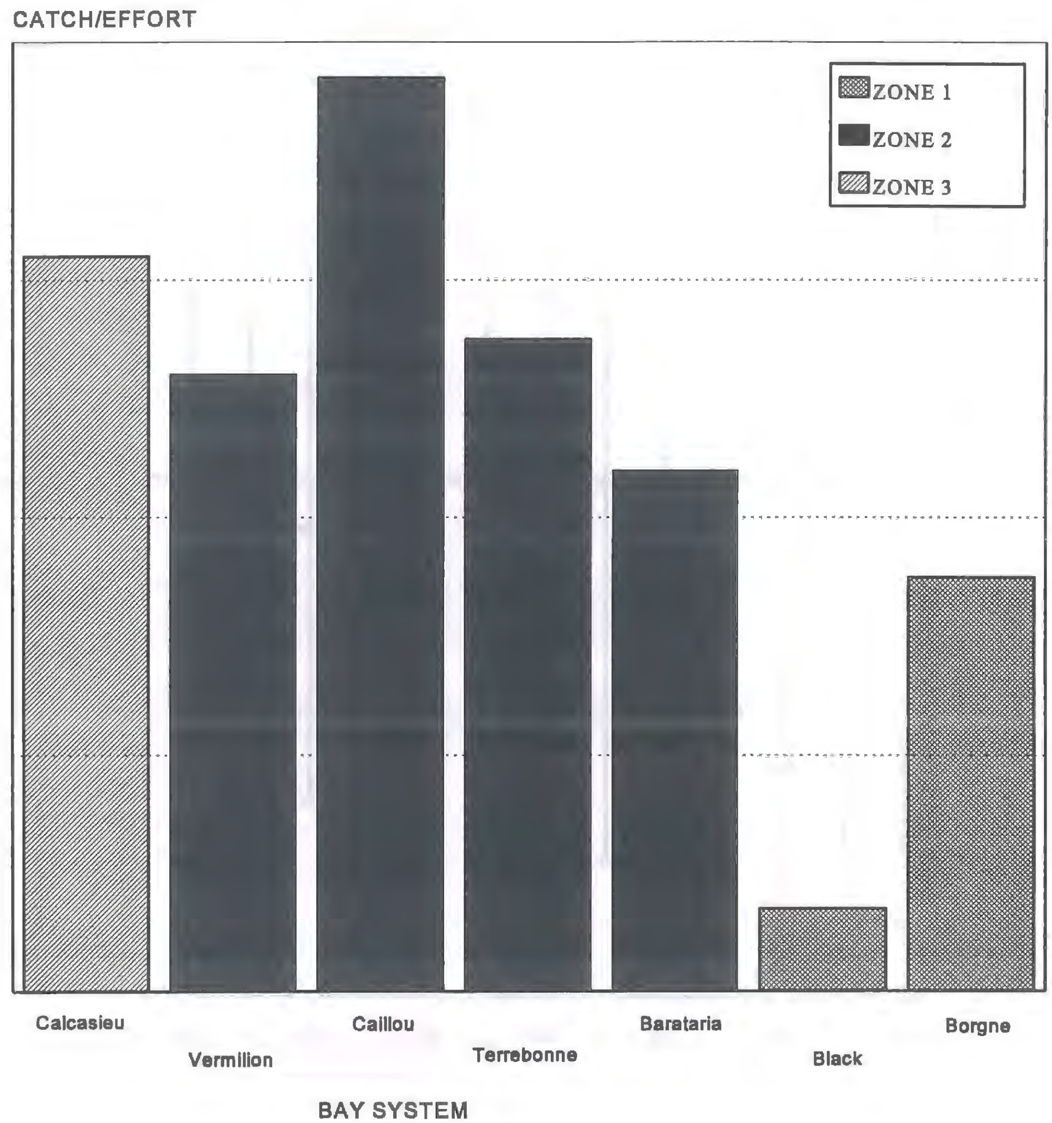
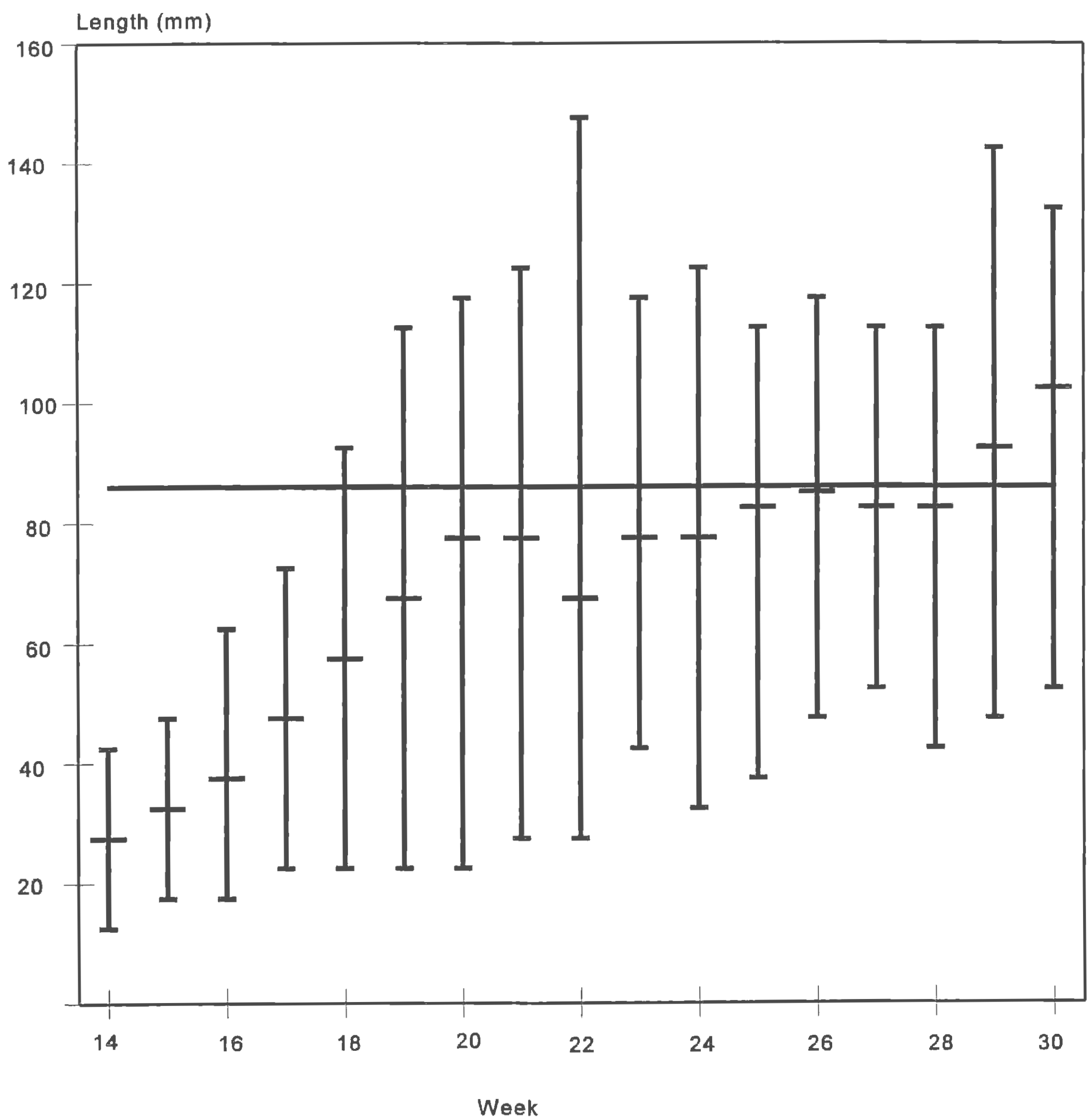


Figure 2 - Size Distribution of Brown Shrimp

by Week in 6 Foot Trawl Samples



## Figure 3 - Catch/Effort of Brown Shrimp

Comparison of Good and Bad Years to Current Year

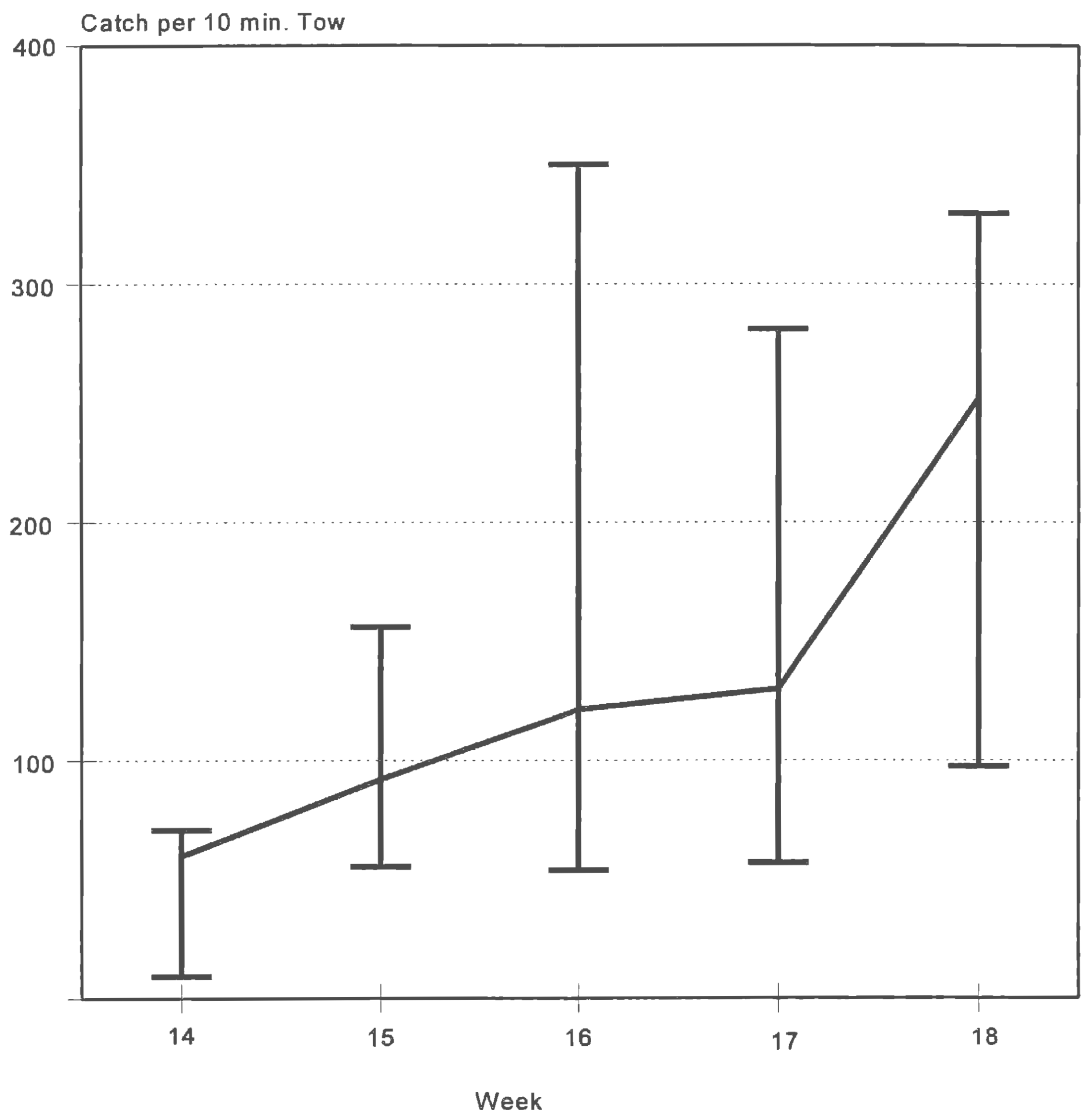


Figure 4 - Catch/Effort of Blue Crab

in 16 Foot Trawl Samples

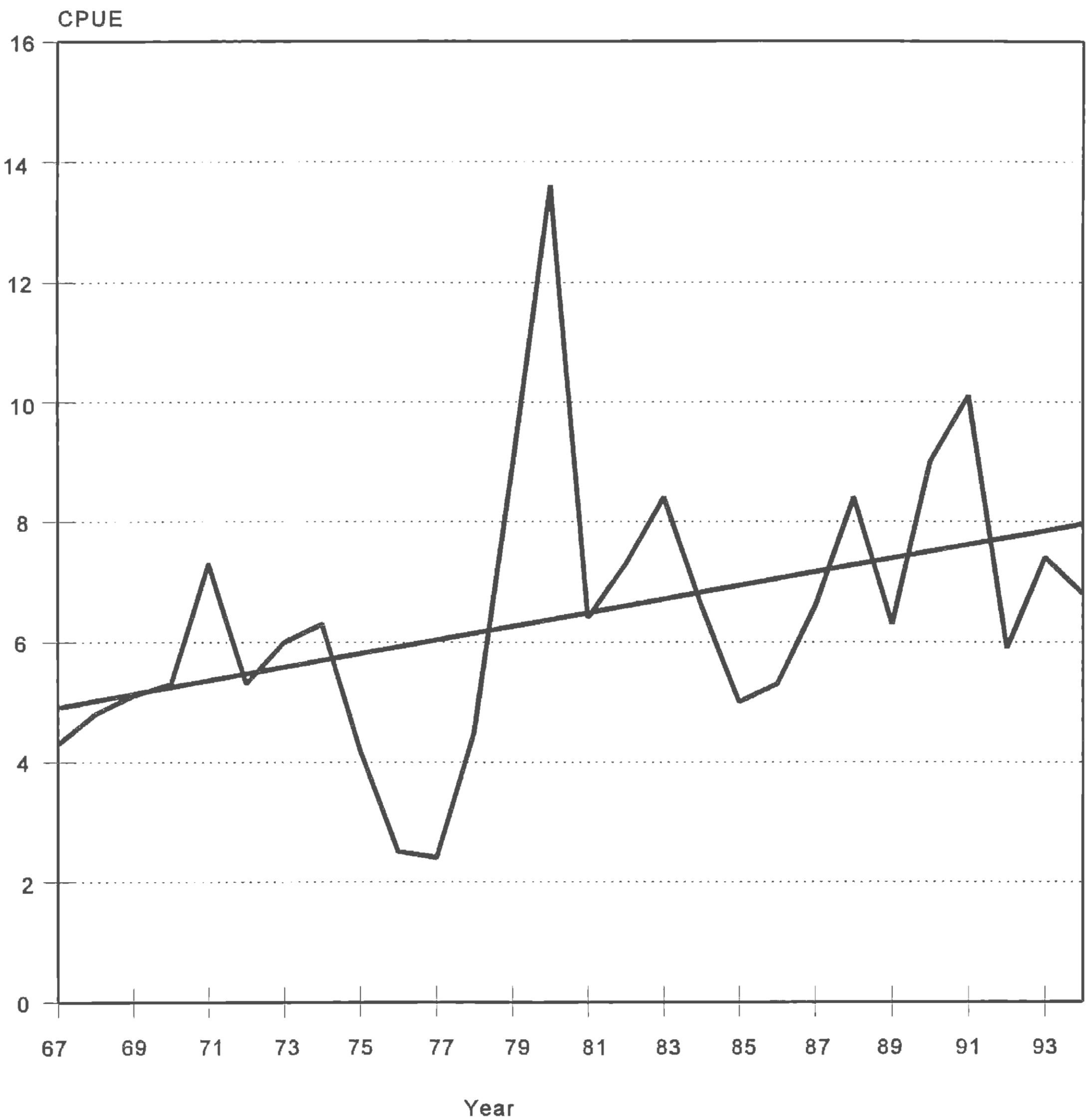


Figure 5 - Menhaden Recruitment Index

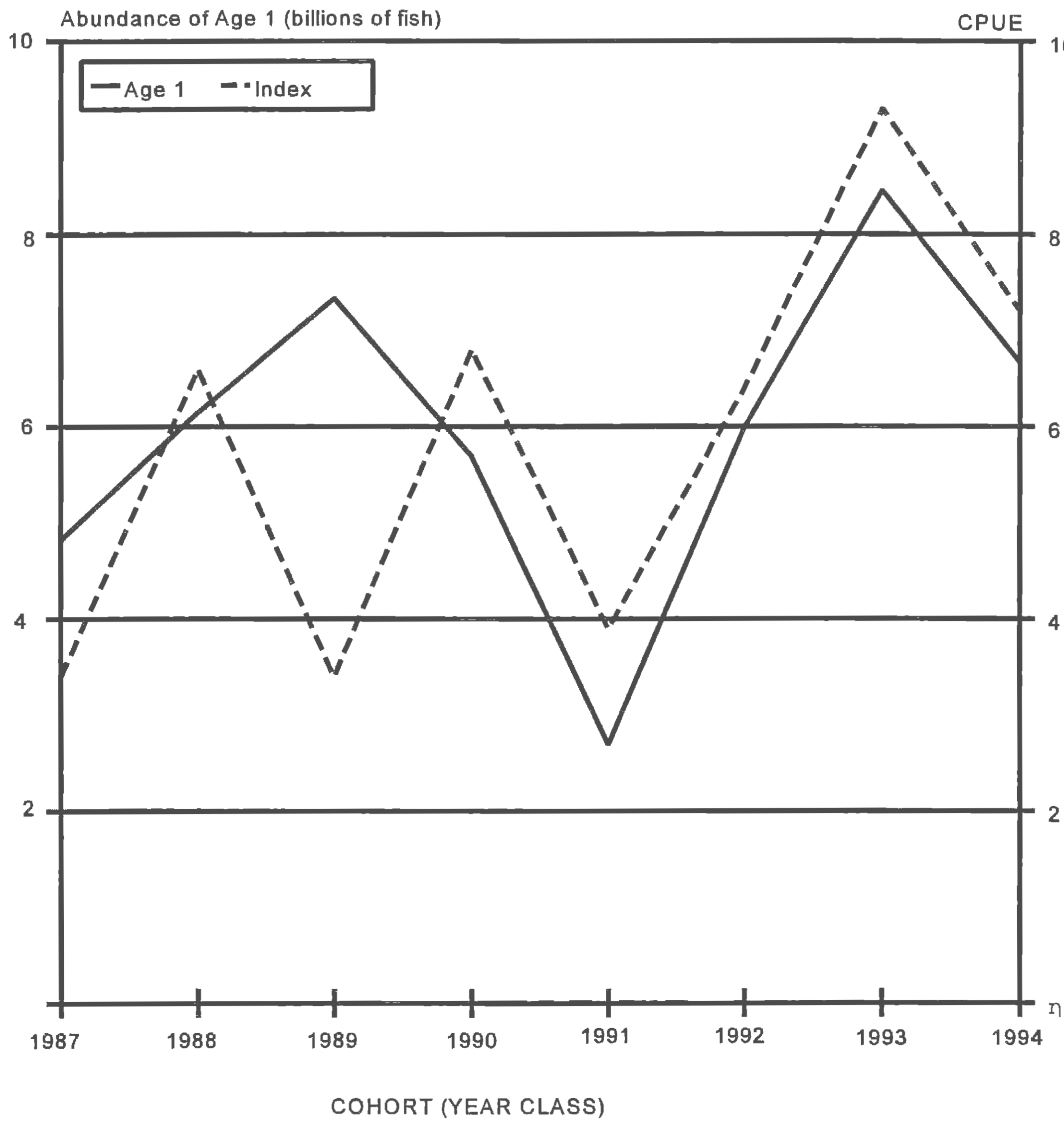
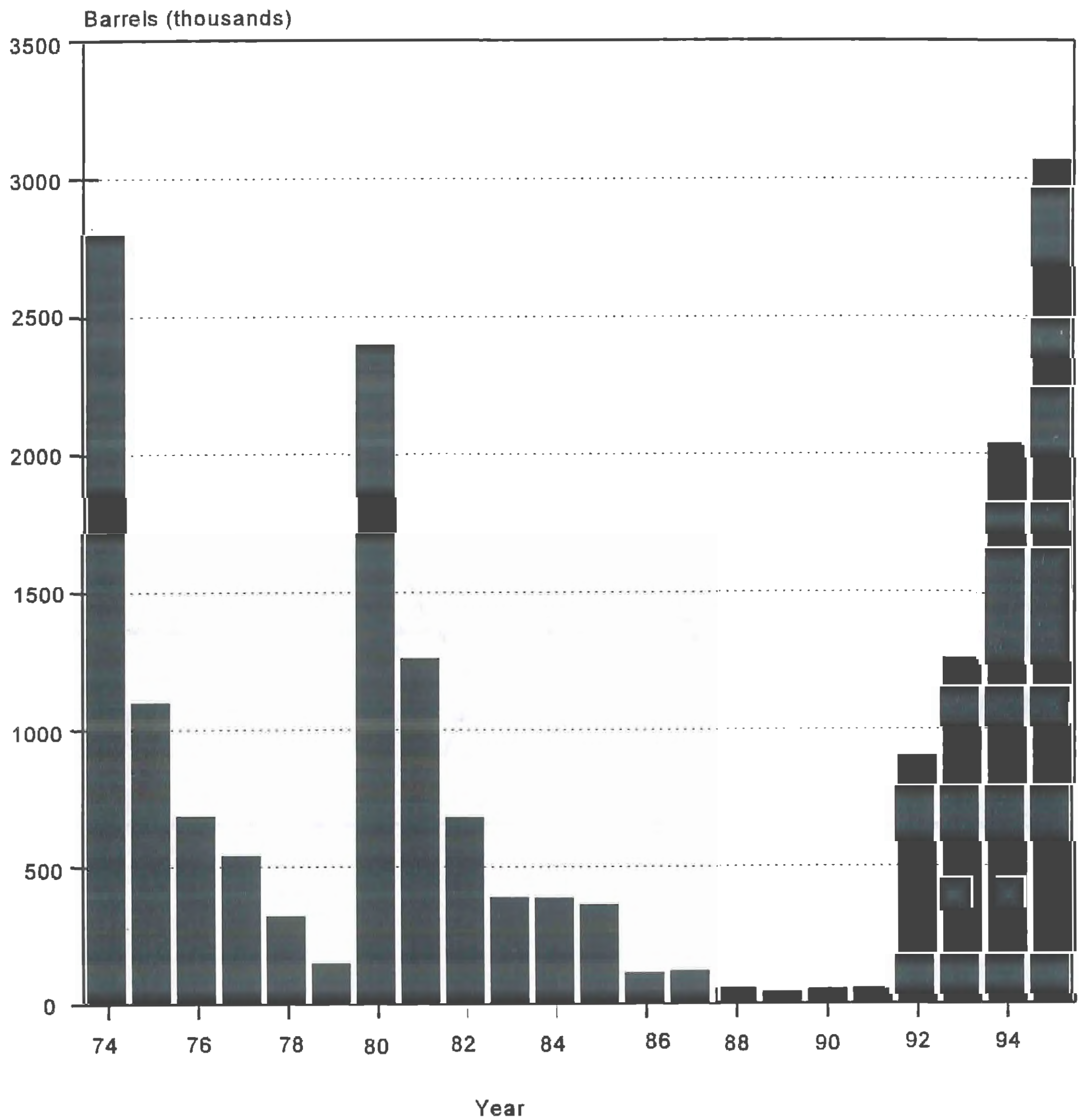


Figure 6 - Oysters Available on Public Grounds

in Breton Sound



## Figure 7 - Red Drum Recruitment Indices

C/E in Trammel and Seine X Recreational Catch of Age 1 Fish

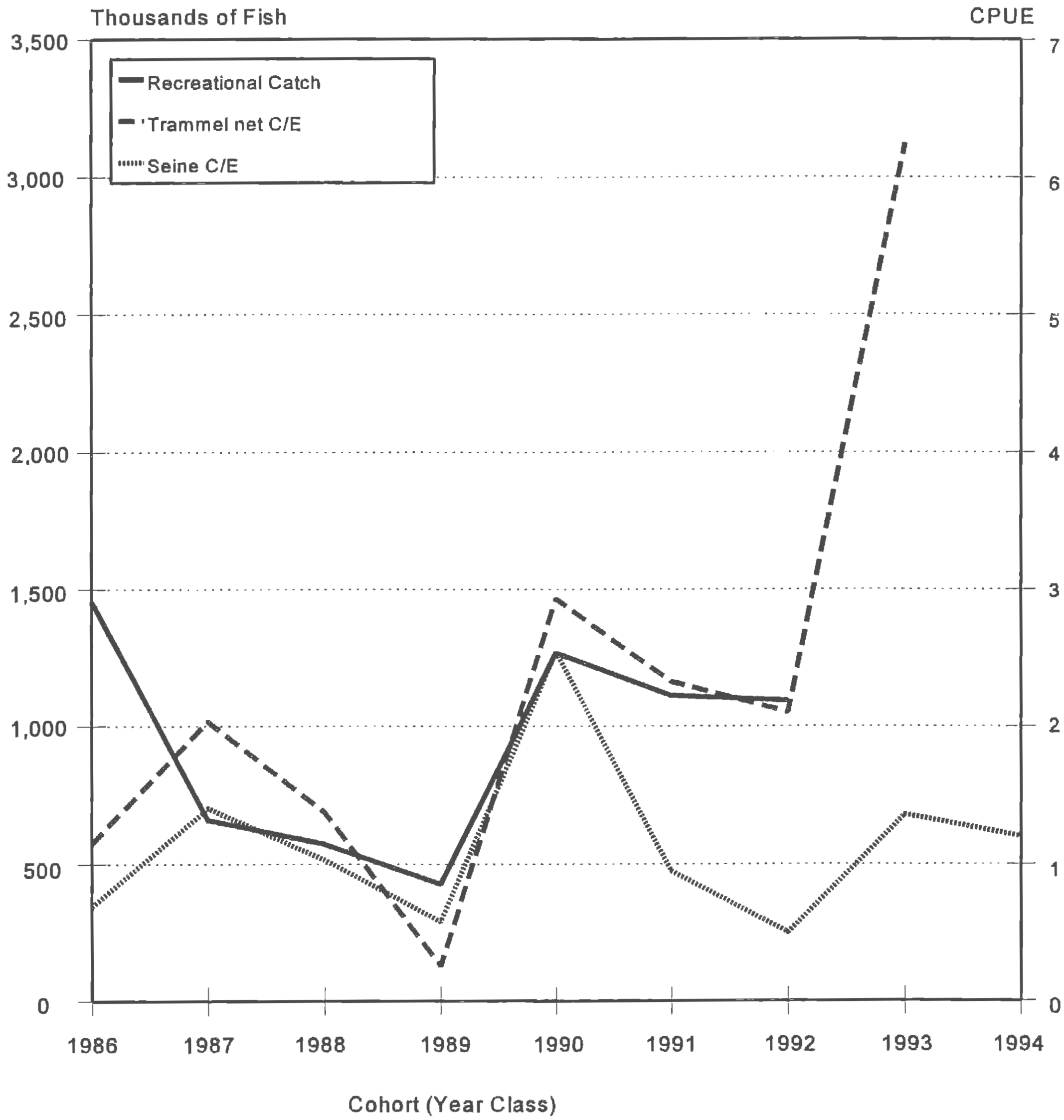


Figure 8 - Observed and Predicted Sex Ratio of Spotted Seatrout for the Years (1986-1994)

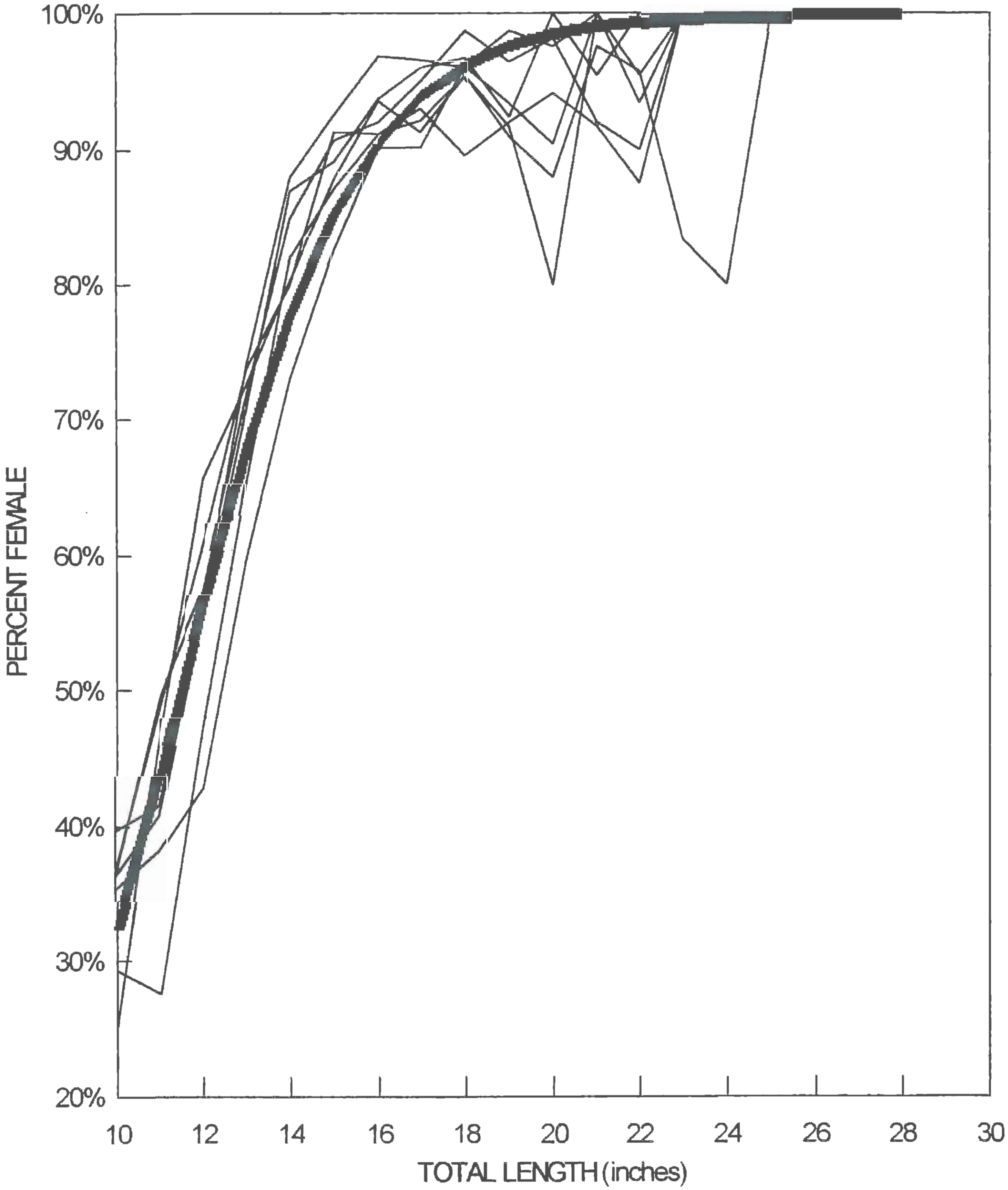
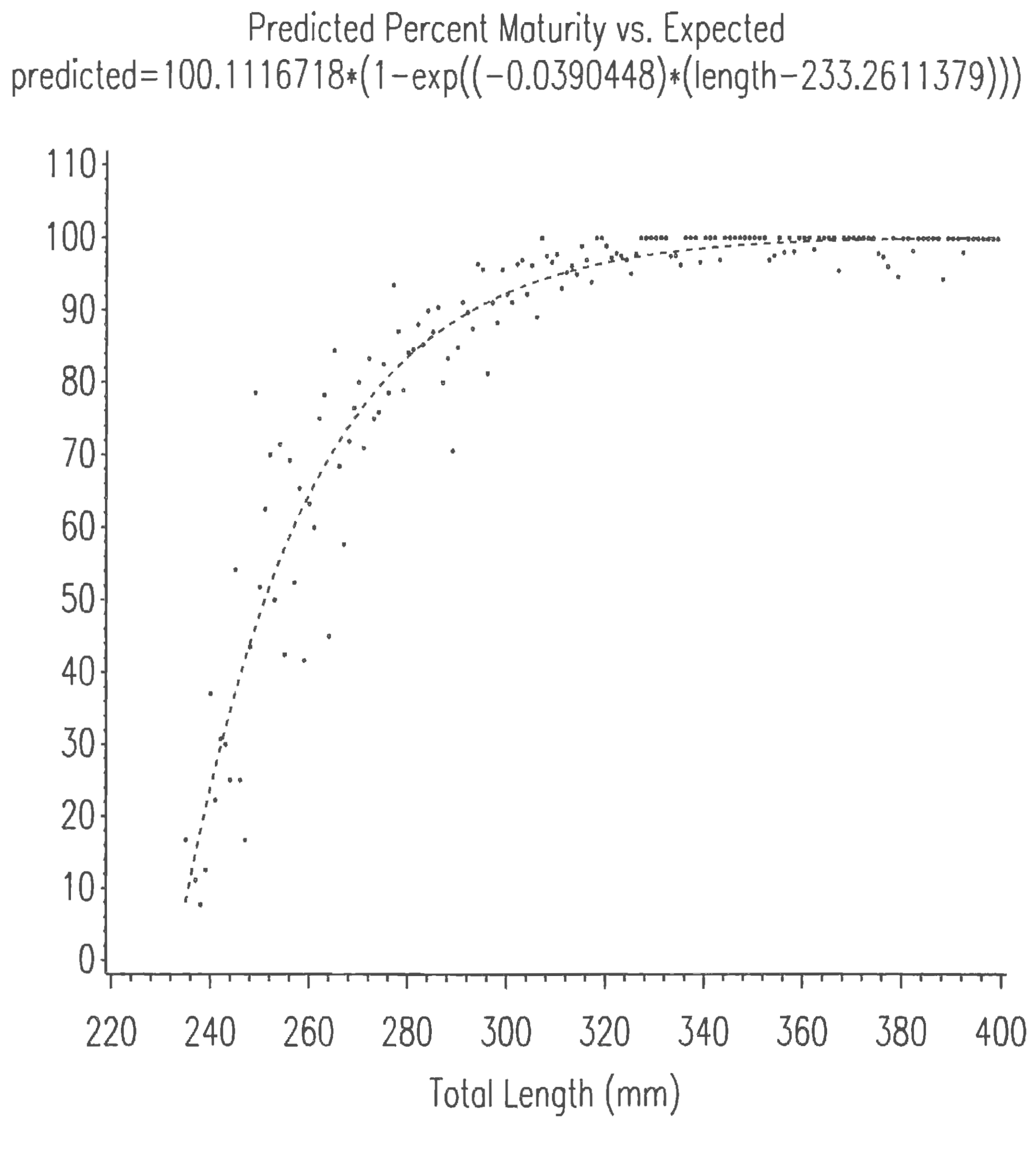


Figure 9



Predicted Percent Maturity vs. Expected
predicted=100.1116718*(1-exp((-0.0390448)*(length-233.2611379)))
110
100
90
80
70
60
50
40
30
20
10
0
220
240
260
280
300
320
340
360
380
400
Total Length (mm)

## APPENDIX A

List of Participants


John Baldwin
Gulf Weather Corporation
Building 1103, Suite 135B
Stennis Space Center, MS 39529
(601) 688-3397

Norman Boyd
Texas Parks and Wildlife Department
Coastal Fisheries Division
P. O. Box 688
Port O'Connor, TX 77982
(512) 983-4425

John Burdon
Louisiana Department of Wildlife and Fisheries
52282 Highway 90
Slidell, LA 70461
(504) 646-6441

Terry Cody
Texas Parks and Wildlife Department
Coastal Fisheries Division
702 Navigation Circle
Rockport, TX 78382
(512) 729-2328
pcampbell@access.texas.gov

David Donaldson
Gulf States Marine Fisheries Commission
P.O. Box 726
Ocean Springs, MS 39566-0726
(601) 875-5912
ddonaldson@southwind.com

Paul Hammerschmidt
Texas Parks and Wildlife Department
Coastal Fisheries Division
4200 Smith School Road
Austin, TX 78744
(512) 389-4650

David Hanisko
National Marine Fisheries Service
Southeast Fisheries Science Center
Mississippi Laboratories
P.O. Drawer 1207
Pascagoula, MS 39568-1207
(601) 762-4591

Stevens Heath
Alabama Department of Conservation and Natural Resources
Marine Resources Division
P. O. Box 189
Dauphin Island, AL 36528
(334) 861-2882

Ron Lukens
Gulf States Marine Fisheries Commission
P.O. Box 726
Ocean Springs, MS 39566-0726
(601) 875-5912
rlukens@southwind.com

Joanne Lyczkowski-Shultz
National Marine Fisheries Service
Southeast Fisheries Science Center
Mississippi Laboratories
P.O. Drawer 1207
Pascagoula, MS 39568-1207
(601) 762-4591
jshultz@triton.nmfs.gov

Debbie Nelson
Gulf Weather Corporation
Building 1103, Suite 135B
Stennis Space Center, MS 39529
(601) 688-3397

Scott Nichols
National Marine Fisheries Service
Southeast Fisheries Science Center
Mississippi Laboratories
P.O. Drawer 1207
Pascagoula, MS 39568-1207
(601) 762-4591
scott_nichols@noaa..gov

Ken Savastano
National Marine Fisheries Service
Southeast Fisheries Science Center
Mississippi Laboratories
Building 1103, Room 218
Stennis Space Center, MS 39529
(601) 688-3103
ken_savastano@noaa.gov