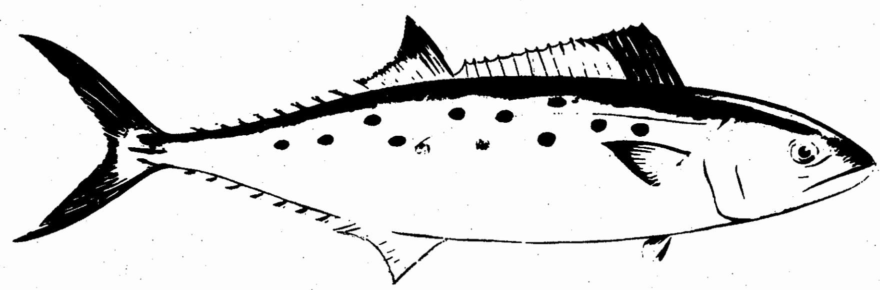
Proceedings:

Colloquium on the Spanish and King Mackerel Resources of the Gulf of Mexico

Eugene L. Nakamura
and
Harvey R. Bullis, Jr.
(Editors)



Gulf States Marine Fisheries Commission

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PROCEEDINGS OF THE MACKEREL COLLOQUIUM

Edited by

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Twenty-Eighth Annual Spring Meeting
Brownsville, Texas
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PREFACE

A colloquium on mackerels of the southeastern United States was held during the annual spring meeting of the Gulf States Marine Fisheries Commission in Brownsville, Texas, on March 16, 1978. The purposes of this colloquium were: (1) to review what was known about the biology, fisheries, and economics of the king mackerel, *Scomberomorus cavalla*, and the Spanish mackerel, *Scomberomorus maculatus*; (2) to discuss the problems encountered by users of these resources and to suggest possible solutions; and (3) to identify and suggest research needs to conserve and manage the mackerel resources. The format of this colloquium was similar to that of the snapper-grouper colloquium held during the 1975 annual fall meeting of the Gulf States Marine Fisheries Commission. This colloquium consisted of three sessions to achieve the above-stated purposes.

The proceedings were recorded on tape and subsequently transcribed. Recordings of some of the proceedings of Session I were faulty, and therefore, transcriptions of these instances were unavailable. Fortunately, the speakers had prepared formal papers, so that their contributions were not lost. Unfortunately, some of the discussions and questions following those presentations were. Authors of two papers in Session I wished to publish their research results elsewhere; therefore, only abstracts of their papers are presented here. The paper entitled "Preservation technology for Spanish mackerel and related species—a literature review" by M. B. Hale was not presented at the colloquium; it has been added, because we believe it is relevant to the subject and purposes of the colloquium. The paper by T. Doi and D. Mendizábal was presented in English by the second author; it is printed here in Spanish with an English summary.

We have edited the questions and comments to enhance clarity and to avoid repetition. Where our efforts failed, please accept our apologies.

Many people were helpful in making this colloquium successful. Charles Lyles and Virginia Herring of the Gulf States Marine Fisheries Commission, Bob Jones of the Southeastern Fisheries Association, Inc., Roger Anderson of the Gulf and South Atlantic Fisheries Development Foundation, Inc., and Terry Leary of the Gulf of Mexico Fishery Management Council were extremely helpful and cooperative in organizing the program, in arranging accommodations, and in providing travel aid. Rita Bloechel, Donna Kiner, and Carl Saloman of the NMFS Southeast Fisheries Center, Panama City Laboratory, were very helpful in providing clerical and drafting services; and Catherine Campbell and Dottie Neely, Gulf Coast Research Laboratory, Ocean Springs, Ms., gave their assistance with the final manuscript. To all of the above, and to all the participants and attendees of the colloquium, we express our thanks and gratitude.

The Editors

INTRODUCTION

Eugene L. Nakamura

About a year ago, Harvey Bullis was asked by Charles Lyles, Executive Director of the Gulf States Marine Fisheries Commission, to put together a colloquium on the mackerels of the southeast region. Harvey asked me to help him, and so we arranged this program for today. I got a telephone call from Harvey last week. He told me he couldn't make this meeting. He's in the U.S. delegation that is now in Guyana conducting some fishery negotiations, and there was no way that he could get out of it, so he sends his regrets to everyone and also his sincere best wishes. He thought it would be much more interesting and fun to come here. Wonder what he meant by fun?

I think that this colloquium is really timely. We have some problems going on in the southeast concerning our mackerel resources. First of all, you all know that the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council have jointly let a contract just recently to Centaur Management Consultants, Inc., of Washington, D.C., to develop a fishery management plan for the coastal pelagic species, and the main species involved in this group are the mackerels. Also, we have some controversies going on between net fishermen and hook-and-line fishermen concerning the harvest of king mackerel along the eastern coast of Florida. These kinds of controversies are not new. We have had them in the Florida Keys, and we certainly have them in other fisheries also. But at this time there is a good bit of controversy going on specifically over the king mackerel. In the northeastern Gulf of Mexico, along the Florida panhandle, we have had two successive years of poor runs of king mackerel. The charter-boat fishery depends to a great extent on this resource. I have personally heard some charter-boat captains implying that commercial fishermen have been overfishing the resource and thus are responsible for the lack of king mackerel to them. Also a private foundation has tried to get a permit from the State of Texas to do some experimental netting for Spanish mackerel in Texas waters. They have not gotten permission to do so. So indeed, we do have some contentious issues to discuss, and we do have them in our southeastern region, so again I say, the timeliness of this colloquium is really super.

The format of our colloquium is going to be very much like the snapper-grouper colloquium that was held back in 1975 in Pensacola Beach. That colloquium was also sponsored by the Gulf States Marine Fisheries Commission. We are going to have three sessions. Session I is a technical session, to be chaired by me. We have some nationally- and internationally-known experts here on this panel, and we are fortunate indeed to have them here to speak to us. In Session II, we are going to have a panel discussion by resource users. That session will be chaired by Jack Brawner, and we have a most distinguished group representing leaders of various user groups: people who are foremost fishermen in the hook-and-line fishery and the gill-net fishery; an expert charter-boat captain; a representative of a sportfishing club; a man that operates a bait-and-tackle shop and who used to operate a marina; and a fellow from a private foundation who is trying to promote the development of some of our mackerel resources.

Session III is a panel discussion of research requirements for management. It is going to be chaired by Dale Beaumariage, and again, we have a most distinguished group. We have people representing the profession of fishery biology, we have a legally-trained expert, and we have an expert economist on that panel.

Finally, we have Dr. Frederick Kalber of the Florida Department of Natural Resources, who is in charge of their laboratory in St. Petersburg, Florida, to summarize the whole colloquium—a most capable fellow, very competent in summarizing. I have heard him summarize other sessions, and he does an excellent job. We are very fortunate to have him.

Now, we'll get started with our first session.

SESSION I

TECHNICAL PRESENTATIONS

Eugene L. Nakamura, Chairman

National Marine Fisheries Service, Panama City, Florida

Proceedings of the Mackerel Colloquium, March 16, 1978, 3–16

AN INTRODUCTION TO THE SPANISH MACKERELS, GENUS *Scomberomorus*

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INTRODUCTION

The purpose of this paper is to begin the mackerel colloquium by introducing you to the Spanish mackerels or seer fishes, a genus of Scombridae that we are currently revising on a worldwide basis. A large variety of meristic, morphometric, morphological and anatomical characters distinguish the approximately 18 species. Our work on Spanish mackerels is similar in approach to that of Gibbs and Collette (1967) on tunas of the genus *Thunnus* and to that of Collette and Chao (1975) on the bonitos of the tribe Sardini.

The Scombridae is a family of about 48 species of epipelagic marine fishes that are important components of both commercial and recreational fisheries all over the world. The family is also an interesting challenge to systematists, physiologists, and to evolutionary biologists. Much of the current research on the family including a summary of the classification along with a discussion of many adaptations is presented in *The Physiological Ecology of Tunas* (Sharp and Dizon, in press).

CLASSIFICATION OF THE SCOMBRIDAE

A tentative classification of the family modified from the diagram presented in Collette and Chao (1975) is presented in Figure 1. The family Scombridae can be divided into two subfamilies. The more primitive subfamily is the Gasterochismatinae, represented by a single peculiar southern hemisphere species, *Gasterochisma melampus.* It has large scales, a huge pelvic fin as a juvenile, and a connection between the swimbladder and inner ear. The other species belong to the subfamily Scombrinae, which can be divided into four tribes: (1) Scombrini, the true mackerels, with two genera and six species; (2) Scomberomorini, the Spanish mackerels, with two genera and 19 species; (3) Sardini, the bonitos, with five genera and eight species; and (4) Thunnini, the tunas and frigate mackerels (or frigate tunas, as suggested by Klawe 1977), with four genera and 13 species.

The best character for distinguishing the Scombridae from other families of fishes is found in the caudal fin region. The caudal fin rays in the family Scombridae completely cover the hypural plate (Figure 2). In closely related families, such as the Gempylidae (snake mackerels), the caudal fin rays only overlap the hypural plate for a short distance. The condition in the Scombridae is an adaptation for high-speed swimming. Another characteristic of the Scombridae is the presence of a pair of oblique keels near

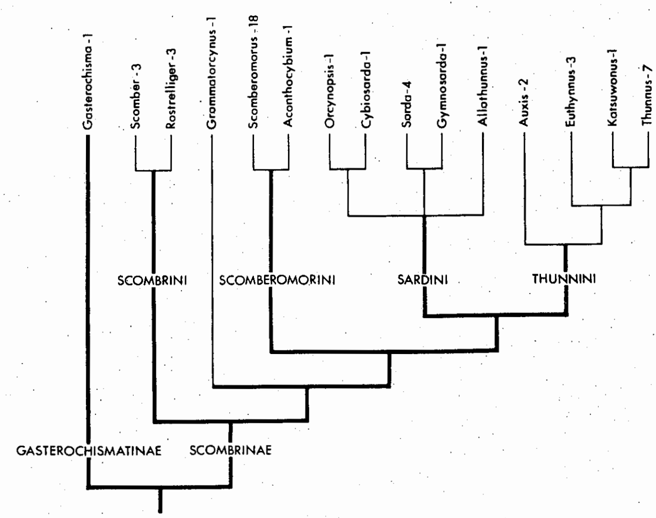


Figure 1. Subfamilies, tribes, and genera of the family Scombridae (modified from Collette and Chao 1975, Fig. 68).

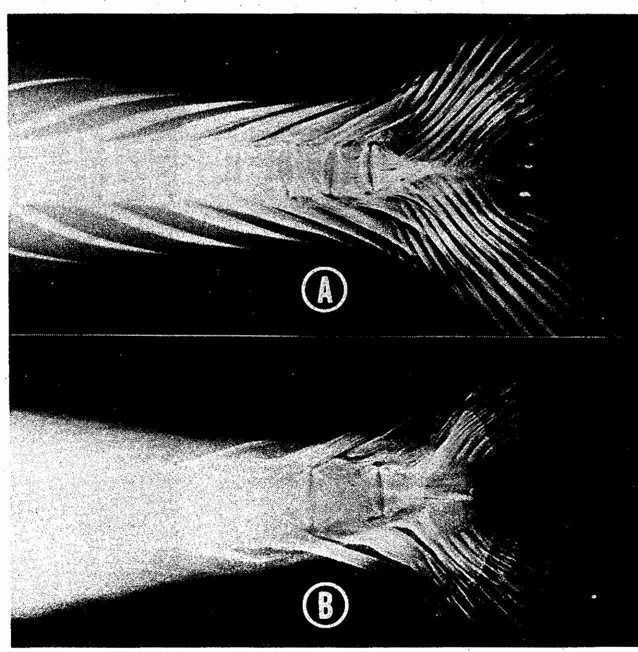


Figure 2. Radiographs of caudal complex in Scombridae (A) and Gempylidae (B). A. *Orcynopsis unicolor* with caudal fin rays covering hypural plate (from Collette and Chao 1975, Fig. 57). B. *Lepidocybium flavobrunneum.*

the end of the caudal fin (Figure 3), which function to direct and accelerate a current of water over the fork of the tail. This is hydrodynamically important and allows scombrid fishes to swim faster.

The three most primitive groups, the subfamily Gasterochismatinae, the mackerels (Scombrini), and the Spanish mackerels (Scomberomorini), can be separated from the two more advanced tribes, the Sardini and the Thunnini by means of another caudal fin character (Figure 4). Most fishes have four or five separate bones in the hypural complex, but in the Scombridae, as an adaptation to high-speed swimming, the four major bones are fused into a single plate. In the more primitive group, there is a notch, which is the remnant of the last fusion of hypurals 1 and 2 below with hypurals 3 and 4 above. In the more advanced group, fusion is complete and there is no notch. The mackerels (Figure 3A) have only a single pair of oblique caudal keels. The other three tribes each have an additional midlateral keel (Figure 3B–D). Internally a broad, lateral, bony keel on the posterior vertebrae (Figure 5) supports the fleshy keel of higher scombrids. The five genera of bonitos have a variably developed bony keel, that is incomplete, with a gap in it, or weakly developed. The Spanish mackerels and the true mackerels lack bony caudal keels.

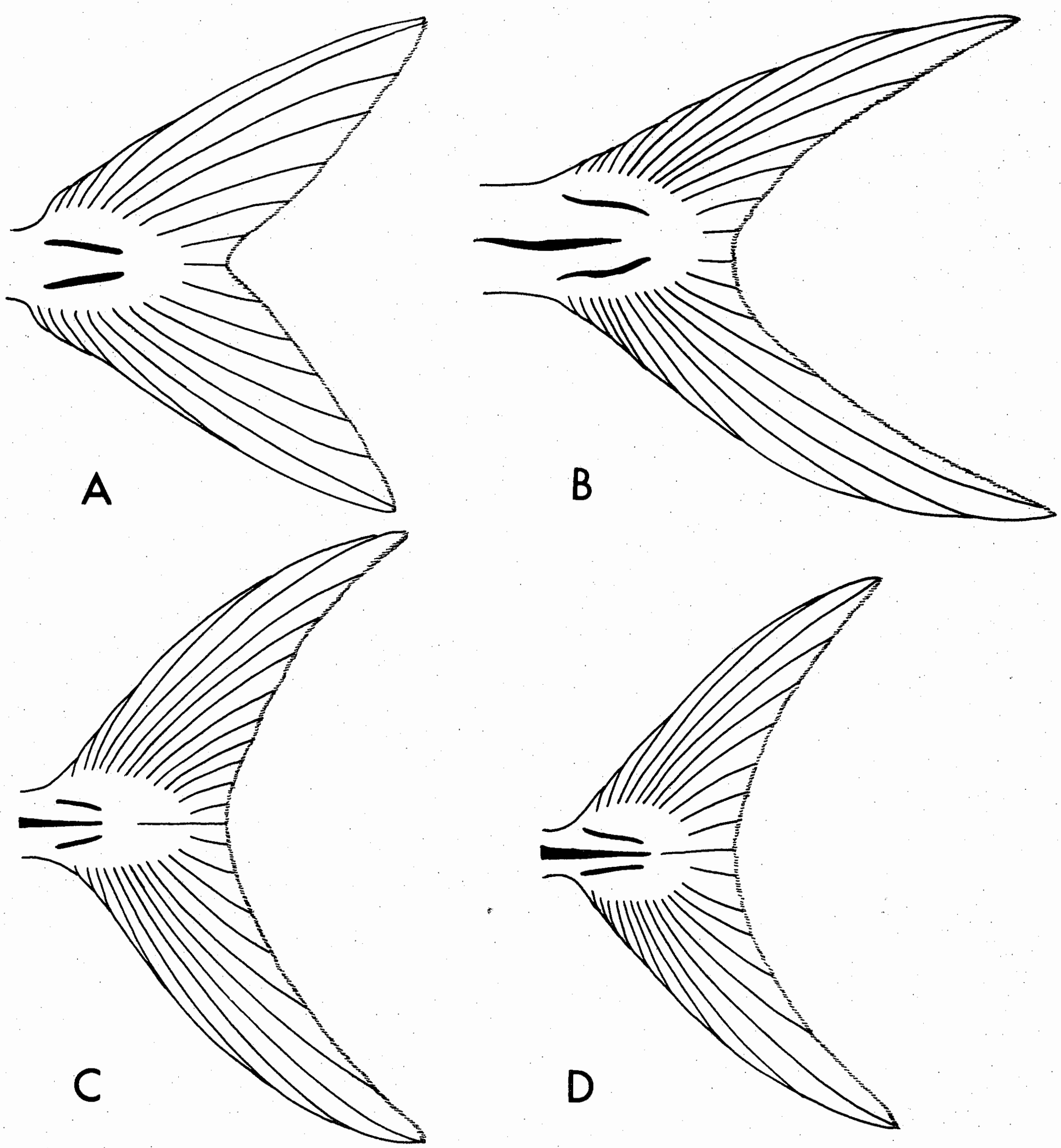


Figure 3. Caudal fins and caudal peduncle keels in Scombridae. A. ***Scomber scombrus.*** **B.** ***Scomberomorus regalis.*** **C.** ***Sarda sarda.*** **D.** ***Euthynnus affinis.*** **(from Collette, in press, Fig. 4).**

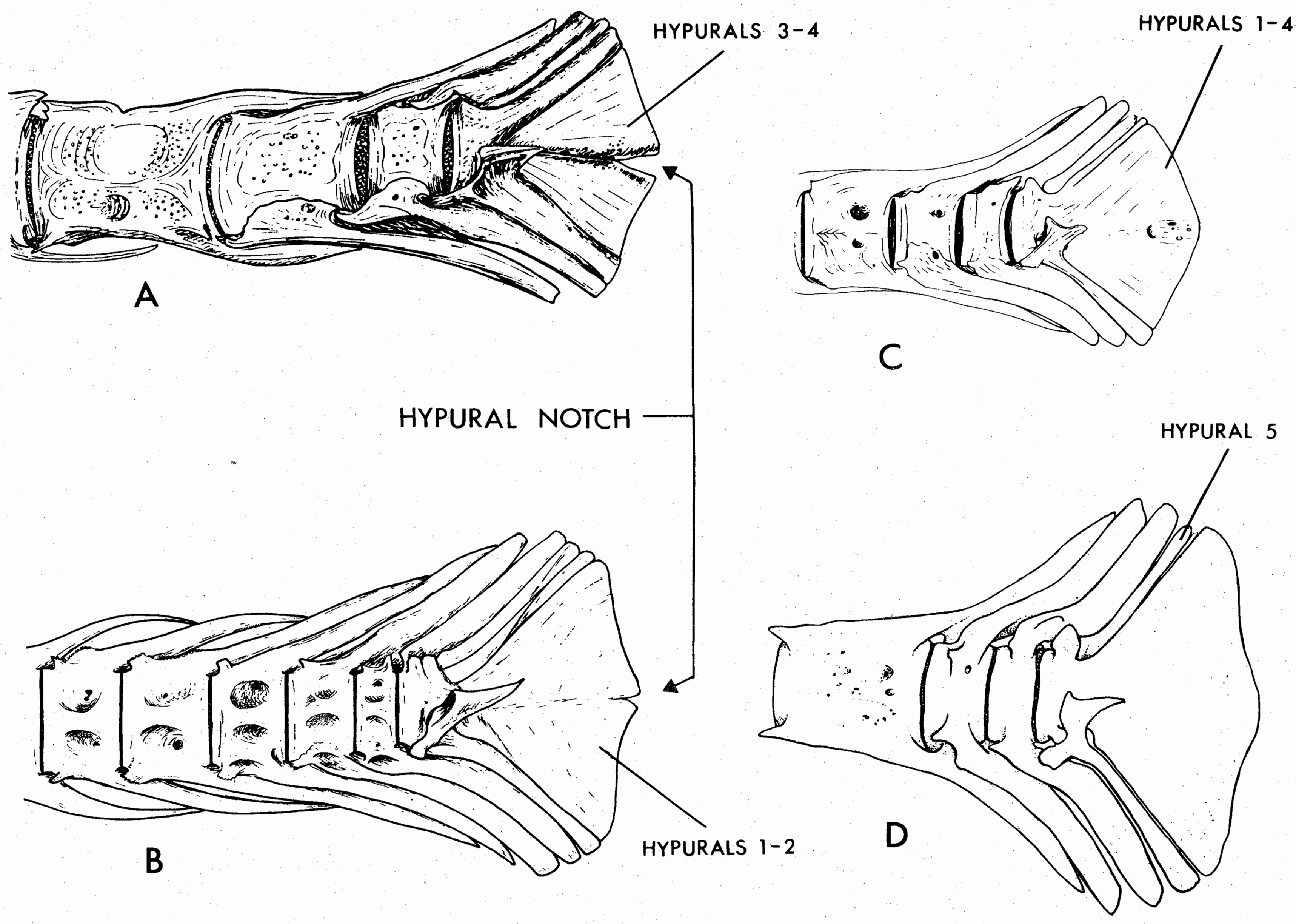


Figure 4. Caudal complex in representatives of the four tribes of Scombrinae. Note hypural notch in A and B. A. Scombrini, *Scomber scombrus*, Delaware, after Monod 1968, Fig. 735. B. Scomberomorini, *Scomberomorus semifasciatus*, Papua-New Guinea, 510 mm FL. C. Sardini, *Orcynopsis unicolor*, Tunisia, 573 mm FL, from Collette and Chao 1975, Fig. 56b. D. Thunnini, *Thunnus atlanticus*, 504 mm FL, after Potthoff 1975, Fig. 13.

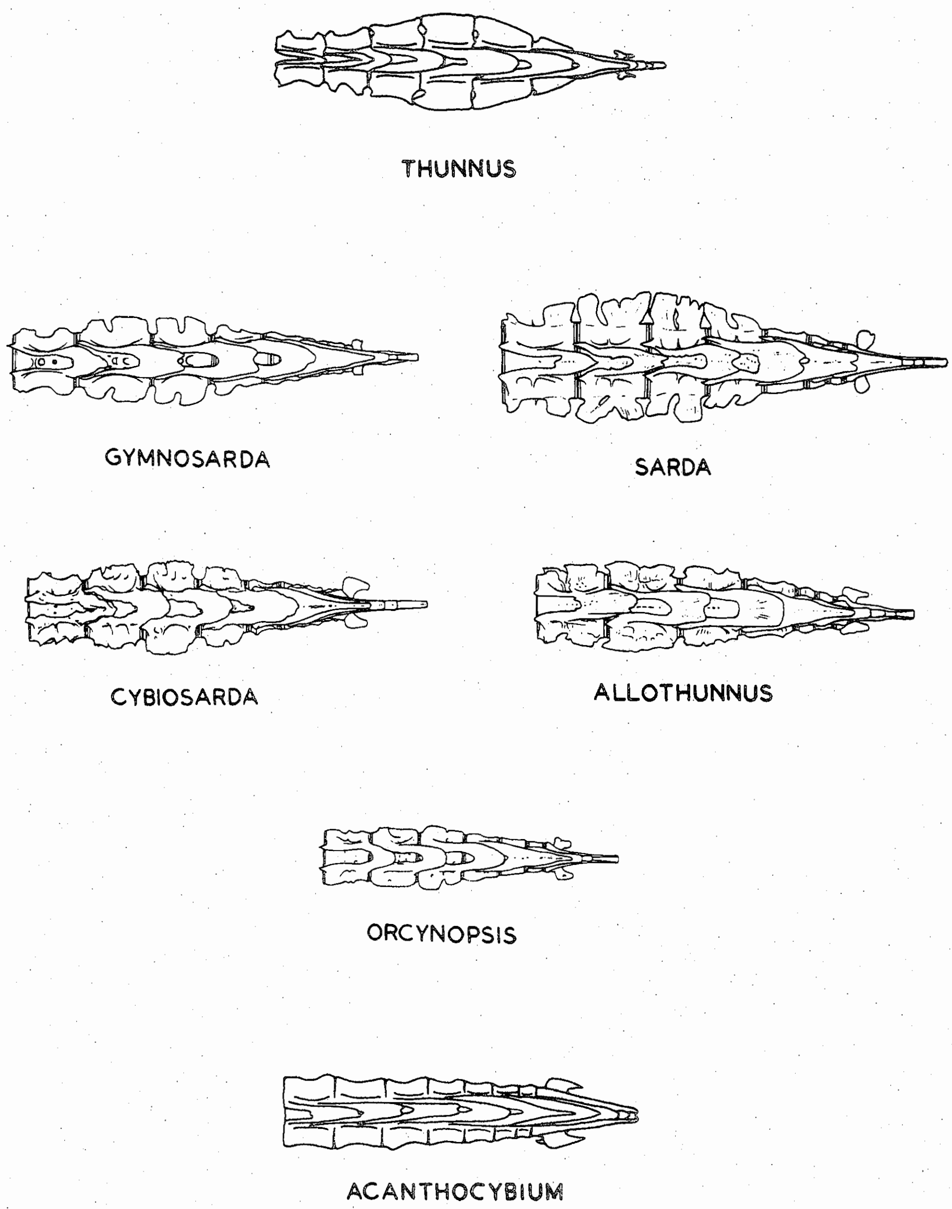


Figure 5. Dorsal view of last seven or eight preural centra to show structure of bony caudal keels in seven genera of Scombridae (from Collette and Chao 1975, Fig. 55).

The Scomberomorini have three external caudal keels on each side, but there is no bony support underlying the mid-lateral keel. *Scomberomorus* differs from the other genera of the family in 29 osteological characters (Devaraj 1977: 48–51). The wahoo, *Acanthocybium,* is the most closely-related genus to the Spanish mackerels. It is osteologically most similar to the *Scomberomorus cavalla – S. commerson* group of species in *Scomberomorus* (Devaraj 1977:Table 4). *Acanthocybium* generally resembles a king mackerel, *S. cavalla*, with an elongated snout, a high number of dorsal spines and vertebrae, and no gill rakers.

Although the genus *Grammatorcynus* has been referred to the Scomberomorini (Collette, in press), we are not yet sure if it belongs to the Scombrini or Scomberomorini or in a group by itself. *Grammatorcynus* has some characters of both the true mackerels and the Spanish mackerels. It is called the double-lined mackerel because, in addition to the lateral line that runs underneath the dorsal fin, there is another lateral line that runs along the ventral surface of the fish. The functional significance of the additional lateral line is not known, but it is distinct in the family.

SYSTEMATIC CHARACTERS IN *SCOMBEROMORUS*

Four categories of characters are used to separate the species of Spanish mackerels: (1) meristic (for example, numbers of vertebrae and fin rays); (2) morphometric (measurements of body parts); (3) external (such as color pattern and the course of the lateral line); and (4) internal (such as the pattern of intestinal folds and shape of the skull bones).

MERISTIC CHARACTERS

Gill rakers (Table 1). *Scomberomorus commerson,* the Indo-Pacific relative of the western Atlantic king mackerel, *S. queenslandicus,* an Australian species, and *S. multiradiatus,* a New Guinea species, all have very few gill rakers. *S. concolor,* from the Gulf of California, on the other hand, has 21 to 27 gill rakers, the highest number of gill rakers of any of the species of *Scomberomorus. S. cavalla* has fewer gill rakers than do *S. sierra* or *S. maculatus.* However, there is much overlap, so that number of gill rakers is not an absolute character to differentiate these species.

Vertebrae (Table 2). Another useful character in distinguishing species of Spanish mackerels is the number of vertebrae. Some species such as *S. cavalla* and *S. sinensis* have few vertebrae. *S. multiradiatus,* with the fewest gill

TABLE 1.

Range in total number of gill rakers on the first arch in species of *Scomberomorus*

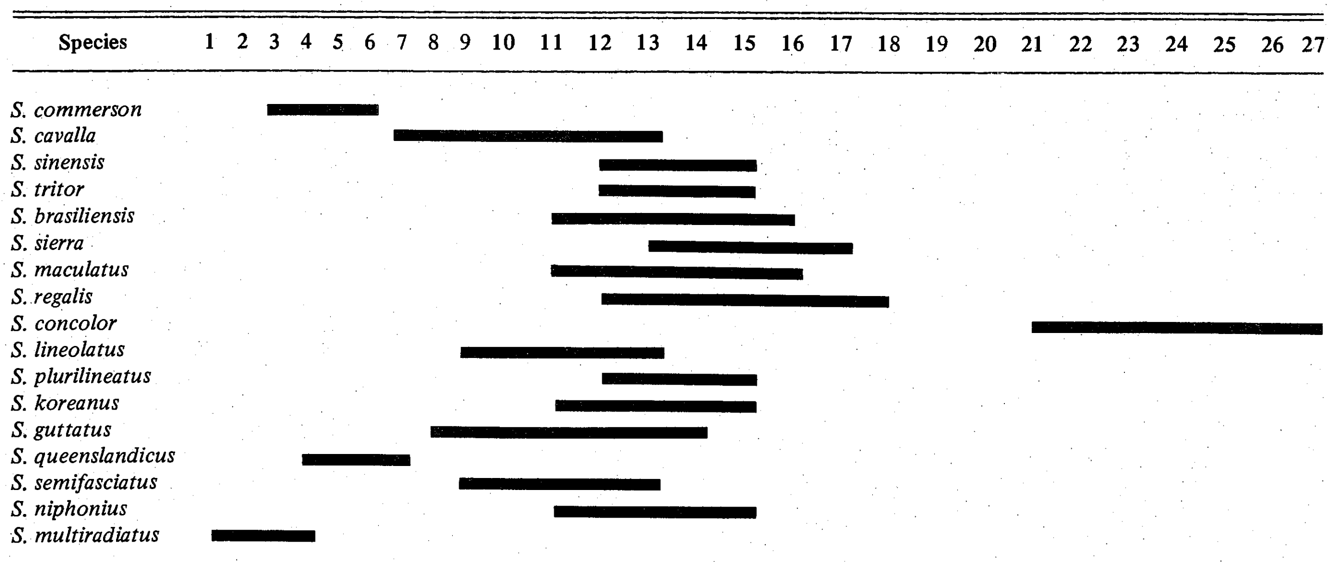
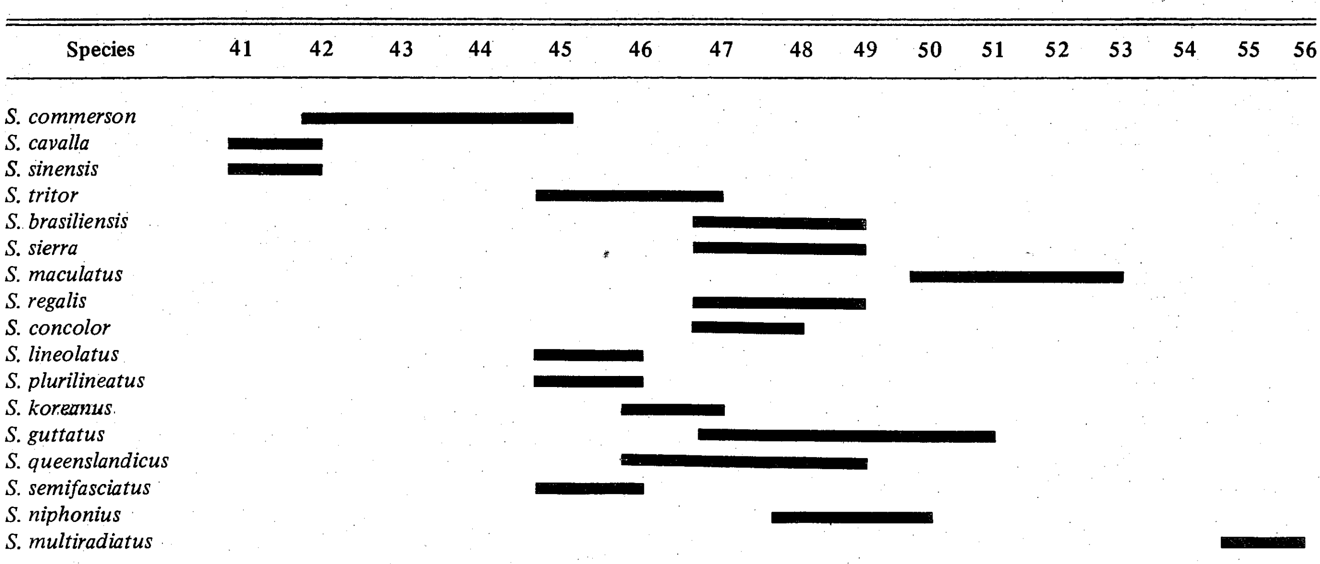


TABLE 2.

Range in total number of vertebrae in species of *Scomberomorus*



rakers (Table 1), has the most vertebrae and is completely separated from the rest of the genus.

Perhaps more interesting are the differences among western Atlantic Spanish mackerels. The species that has been called *S. maculatus*, the Spanish mackerel from Maine to Brazil, is in fact two species. The true *S. maculatus* has 50 to 53 vertebrae; the species off the Caribbean coast of Central America and the Atlantic coast of South America which we have just described (Collette et al. 1978) as *S. brasiliensis*, has only 47 or 48, or (rarely) 49 vertebrae. It is completely separated from *S. maculatus* and probably is more closely related to *S. sierra* than to *S. maculatus*. Using only vertebral counts, the Spanish mackerel can be distinguished from the eastern Pacific *S. sierra*, the South American *S. brasiliensis*, the eastern Atlantic *S. tritor*, the cero mackerel *S. regalis* and the other eastern Pacific species *S. concolor*. Number of vertebrae is a useful character not only in adults, but also in larval fishes. It provides a method of distinguishing *S. maculatus* from related species simply by counting the number of myomeres, which equals the number of vertebrae.

Pectoral fin rays (Table 3). *S. brasiliensis* usually has 22 or 23 pectoral fin rays, whereas *S. tritor* in the Gulf of Guinea, *S. sierra* in the eastern Pacific, and the true *S. maculatus* usually have 21 pectoral fin rays, but there is much overlap in this character. Other meristic characters also show similarities between some species and differences among others.

TABLE 3.

Number of pectoral fin rays in five species of *Scomberomorus*

		Pectoral fin rays					
Species	**Number of samples**	**20**	**21**	**22**	**23**	**24**	**X̄**
S. tritor (E. Atlantic)	29	1	19	9			21.3
S. brasiliensis (W. Atlantic)							
Central, Northern and South America	31		6	13	11	1	22.2
Brazil	40		2	24	14		22.5
S. sierra (E. Pacific)							
Mexico	30	7	16	7			21.0
Central and South America	32	4	18	7	1	1	21.3
S. maculatus (W. Atlantic)							
Eastern United States	20	2	13	5			21.2
Gulf of Mexico	14		13	1			21.1
S. regalis (Caribbean)	36		15	17	4		21.7

MORPHOMETRIC CHARACTERS

Differences in head length, height of the second dorsal and anal fins, body depth and other such proportions distinquish some species, for example, pelvic fin lengths relative to fork lengths (FL) (Figure 6). *S. brasiliensis* has a shorter pelvic fin than do *S. maculatus, S. tritor, S. sierra,* and *S. regalis*. Some overlap exists, but there is a distinct difference.

EXTERNAL MORPHOLOGY

Lateral line. There are two important characters involving the lateral line. Three species have a prominent dip in the lateral line, the king mackerel, *S. cavalla*, its Indo-West Pacific relative *S. commerson*, and an Oriental species, *S. sinensis*. *S. cavalla* and *S. commerson* have the dip under the second dorsal fin but *S. sinensis* has it under the first dorsal fin. Two species, *S. koreanus* and *S. guttatus*, resemble each other in having fine branches extending from the anterior part of the main lateral line.

Color pattern. Spanish mackerels can also be divided into groups based on their color patterns. There are barred species, such as *S. commerson* and *S. semifasciatus*, an Australian species. There are spotted species such as *S. guttatus, S. koreanus, S. niphonius, S. maculatus, S. brasiliensis,* and *S. sierra*. Some of these have large spots, some have small; some have spots in regular rows, some are irregularly dispersed. Three species have a combination of spots and lines: the Indo-West Pacific *S. lineolatus* and *S. plurilineatus* and the West Indian cero, *S. regalis*. Two species lack any pattern of bars or stripes, at least as adults: *S. multiradiatus* and the eastern Pacific *S. concolor*.

ANATOMICAL CHARACTERS

Anatomical characters have proved to be vital to understanding the systematics of the Scombridae (see Collette, in press). Important information is included in studies about a number of species of *Scomberomorus* from four regions: Japan (Kishinouye 1923); Australia (Munro 1943); Gulf of Mexico and Caribbean Sea (Mago Leccia 1958); and India

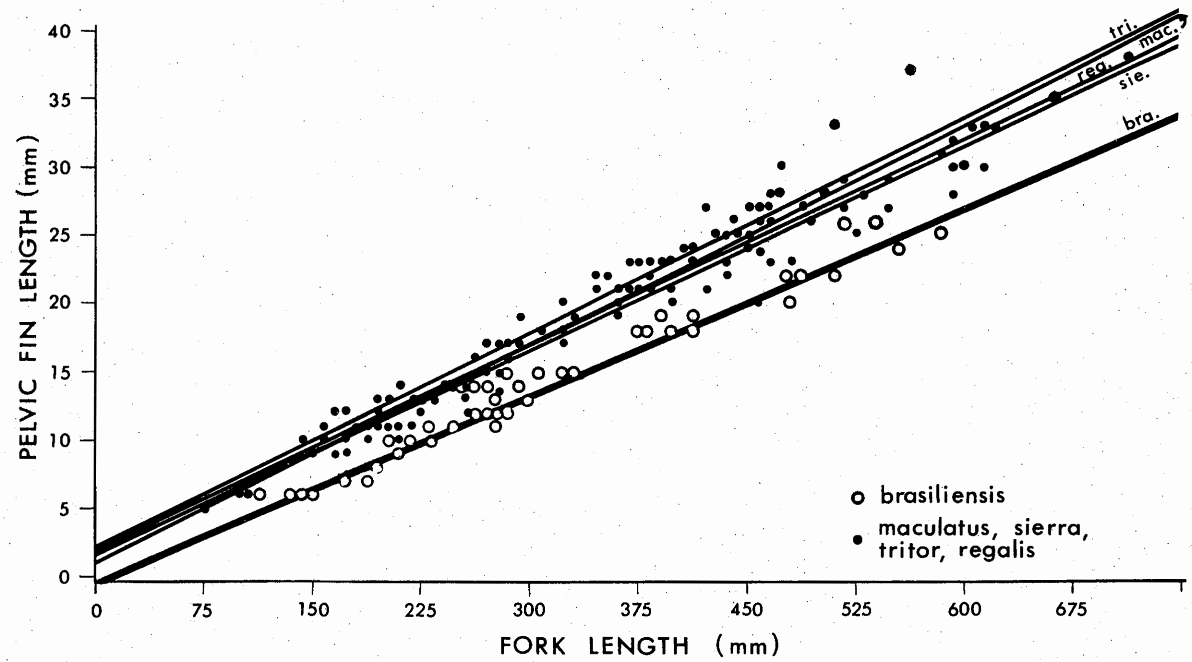


Figure 6. Regression of pelvic fin length on fork length (FL) in five species of *Scomberomorus*. The regression line for *S. brasiliensis* is significantly different from those for *S. maculatus*, *S. sierra*, *S. tritor* and *S. regalis*. The regression lines for these four species do not differ significantly from each other so the same symbol is used for plotting specimens of the four species. (From Collette et al. 1968, Fig. 1).

(Devaraj 1977). One example concerns variation in the number of folds in the intestine. This character is very consistent as no variation in the number of folds has been found in individuals of one species. *S. niphonius* has a straight gut (Figure 7A), not folded back on itself. *S. koreanus* has three folds and four distinct limbs to the intestine (Figure 7C), a much longer intestine. The other species all have two folds to the intestine (Figure 7B). This is a significant character, particularly in the Indo-West Pacific, where Munro (1943) illustrated what he called *S. niphonius* but his figure shows two folds in the intestine; therefore, his *S. "niphonius"* from Australia is not the same as *S. niphonius* from Japan, but in fact represents another undescribed species.

Several osteological characters separate species of *Scomberomorus*. For example, *S. koreanus* and *S. guttatus* differ from other species in having the median ridge of the skull (formed by the frontals and the supraoccipital crest) much higher and generally better developed. The lateral margin of the frontals when viewed from above is more or less straight from the sphenotic to the ethmoid bones in *S. cavalla* and *S. commerson* whereas in other species of *Scomberomorus* the frontal bends abruptly inward where it joins with the nasals anterior to the lateral ethmoid. Mago Leccia (1958) reported that the anterior end of the vomer is drawn out into a spatulate process which is noticeably thicker in *S. cavalla* than in *S. maculatus* or *S. regalis*. Devaraj (1977) demonstrated that the posterior margin of the preopercle is convex in *S. commerson* and concave in *S. guttatus*, *S. koreanus*, and *S. lineolatus*. More information is presented by Kishinouye (1923), Mago Leccia (1958), and Devaraj (1977).

SPECIES OF *SCOMBEROMORUS*

The 17 described species of *Scomberomorus* are listed below alphabetically. A few diagnostic characters and a summary of the range (Figures 8, 9, 10, and 11) of each species are also given. Common names follow Klawe (1977).

***S. brasiliensis* Collette, Russo, and Zavala-Camin 1978.** Serra Spanish mackerel. A large (reaching 1,250 mm fork length) spotted species with a short pelvic fin (3.6 to 5.9% fork length), few vertebrae (47–49), and many pectoral fin rays (modally 22 or 23). Atlantic and Caribbean coasts of Central and South America from Belize to Rio Grande do Sul, Brazil (Figure 8).

***S. cavalla* (Cuvier 1829).** King mackerel. A large species (reaching 1,680 mm FL) with a prominent dip in the lateral line under the second dorsal fin, few vertebrae (41–42), and few gill rakers, (1–3 on the upper arch) + (6–10 on the lower arch) = total of 7–13. Western Atlantic from Massachusetts to Rio de Janeiro (Figure 9).

***S. commerson* (Lacépède 1800).** Narrow-barred king mackerel. A very large (reaching 2,200 mm FL) barred species with a prominent dip in the lateral line under the

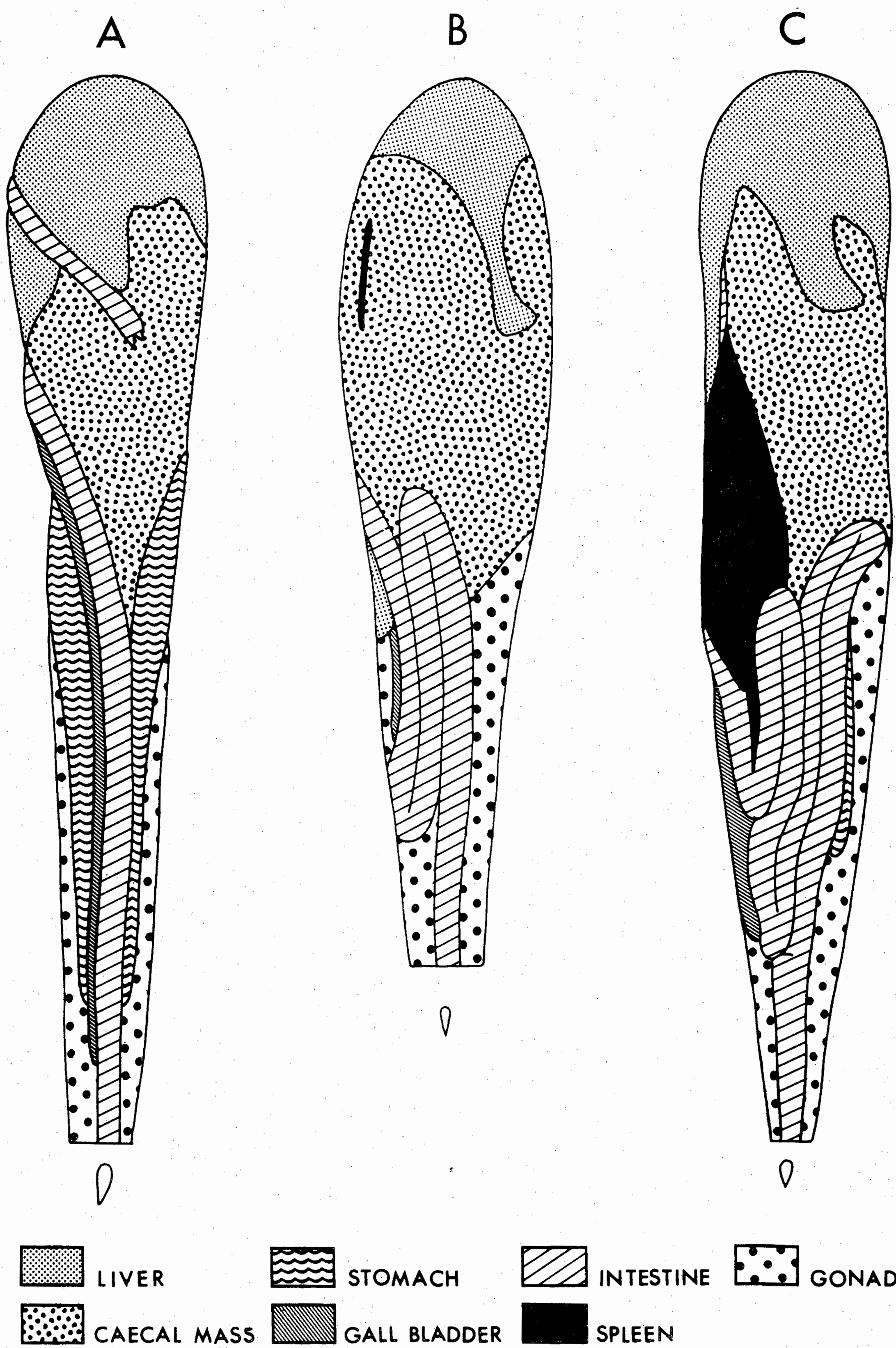


Figure 7. Ventral view of viscera in three species of *Scomberomorus*. A. *S. niphonius* B. *S. brasiliensis* C. *S. koreanus*.

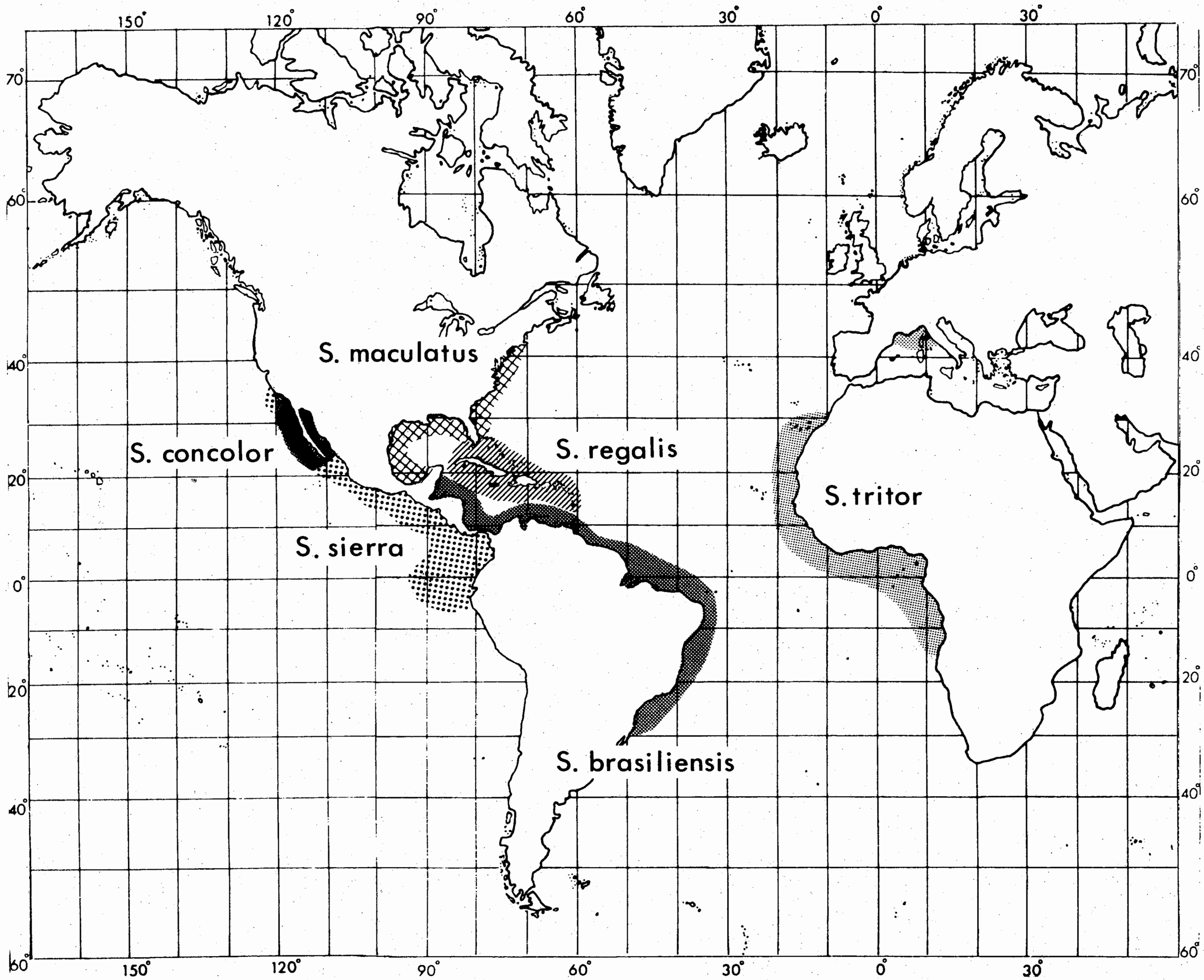


Figure 8. Ranges of five Atlantic and eastern Pacific species of *Scomberomorus: S. tritor, S. maculatus, S. regalis, S. brasiliensis, S. sierra,* and *S. concolor.*

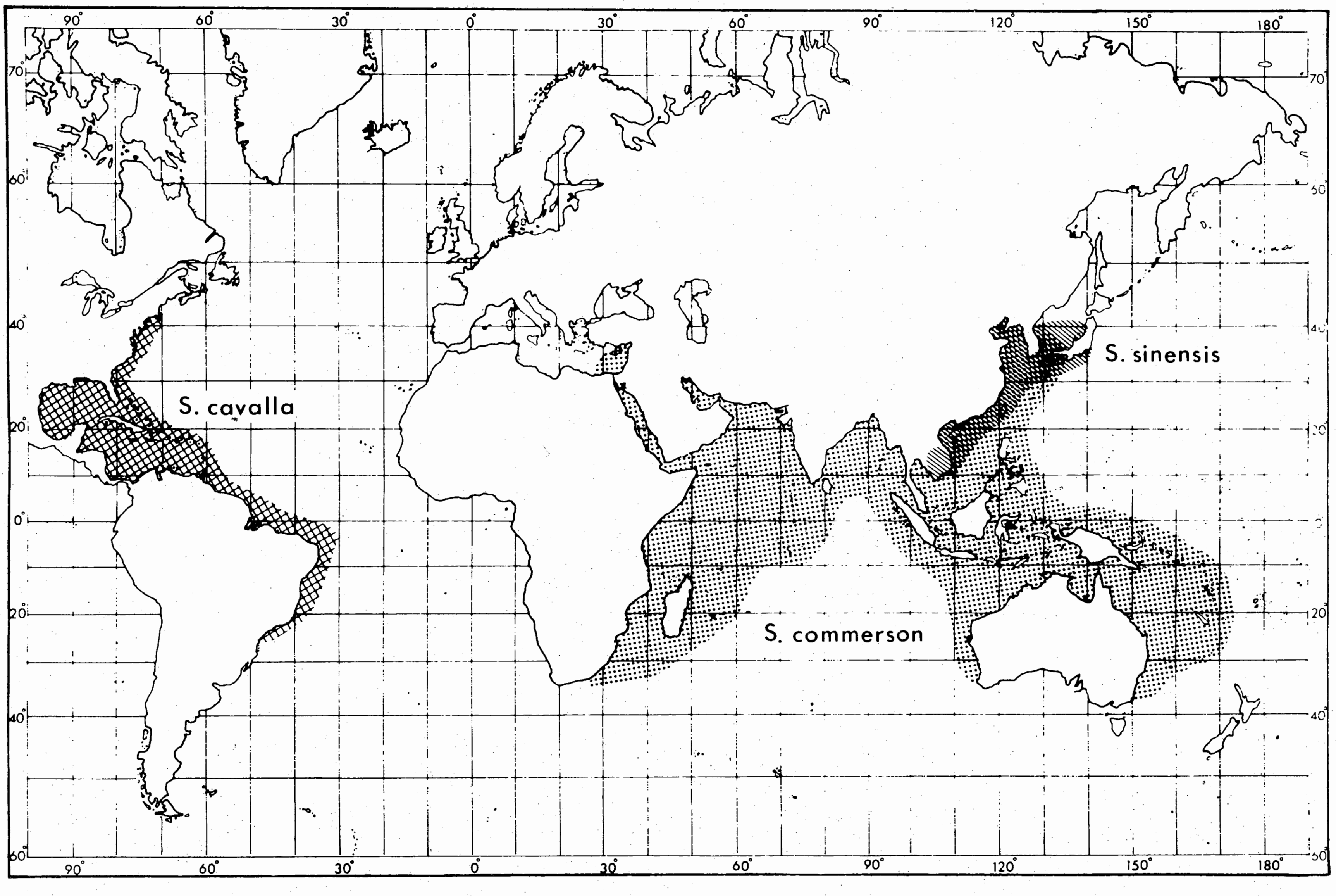


Figure 9. Ranges of *Scomberomorus cavalla*, *S. commerson*, and *S. sinensis*.

second dorsal fin, few vertebrae (42–45), and few gil rakers (0–1) + (3–6) = 3–6. Widespread throughout the Indo-West Pacific from South Africa and the Red Sea east through the Indo-Australian Archipelago to Australia and Fiji and north to Hong Kong, Formosa, and Japan (Figure 9). A recent immigrant to the eastern Mediterranean Sea by way of the Suez Canal.

S. concolor **Lockington 1879.** Monterey Spanish mackerel. A medium-sized (reaching 770 mm FL) plain species with the highest number of gill rakers in the genus (6–8) + (15–19) = 21–27. Eastern subtropical Pacific, now largely restricted to the Gulf of California (Figure 8).

S. guttatus **(Bloch and Schneider 1801).** Indo-Pacific king mackerel. A medium-sized (reaching 760 mm FL) spotted species (spots about equal in size to eye diameter) with auxillary branches off the anterior part of the lateral line. Greatest body depth less than or equal to head length. Continental Indo-West Pacific from Hong Kong south to the Gulf of Thailand and west to the Persian Gulf (Figure 10).

S. koreanus **(Kishinouye 1915).** Korean seerfish. A medium-sized (reaching 750 mm FL) spotted species with auxillary branches off the anterior part of the lateral line and four loops to the intestine. Greatest body depth greater than head length. Continental Indo-West Pacific from Japan and China south to Singapore and Sumatra and west to Bombay, India (Figure 10).

S. lineolatus **(Cuvier 1831).** Streaked seerfish. A medium-sized (reaching 800 mm FL) species with a pattern of spots and dashes on the sides and the distance from the origin of the second dorsal fin to the base of the caudal greater than the distance from the second dorsal origin to the tip of the snout. Found from the Gulf of Thailand and Java west to India (Figure 11).

S. maculatus **(Mitchill 1815).** Atlantic Spanish mackerel. A medium-sized (reaching 720 mm FL) spotted species with many vertebrae (51–53), a moderate number of pectoral fin rays (modally 21 or 22) and gill rakers (1–4) + (9–13) = 11–16, and a comparatively long pelvic fin (4.6 to 5.8% FL). Atlantic coast of the United States from Cape Cod to Miami and Gulf of Mexico coast from Florida to Yucatan, Mexico (Figure 8). Replaced by *S. regalis* in the Bahamas and West Indies.

S. multiradiatus **Munro 1964.** Papuan seerfish. A small (reaching 300 mm FL) plain species with the most vertebrae (55–56) and fewest gill rakers (1–4) of any species in the genus. Restricted to the Gulf of Papua off the mouth of the Fly River in Papua-New Guinea (Figure 10).

S. niphonius **(Cuvier 1831).** Japanese Spanish mackerel. A large (reaching 1,000 mm FL) spotted species with many spines in the first dorsal fin (19–21) and a straight intestine, without any loops. Confined to the temperate and subtropical waters of the western North Pacific, Japan, Korea, and China. Replaced by a superficially similar undescribed species in northern Australia and Papua-New Guinea (Figure 11).

S. plurilineatus **Fourmanoir 1966.** Kanadi kingfish. A medium-sized (reaching 900 mm FL) species with a pattern consisting mostly of broken lines and some spots. East Africa from Kenya to Natal and Madagascar (Figure 11).

S. queenslandicus **Munro 1943.** Queensland school mackerel. A medium-sized (reaching 770 mm FL) spotted species (spots as large or larger than the diameter of the eye) with relatively few gill rakers (0–2) + (4–7) = (4–7). Largely confined to northern Australia from Sharks Bay, western Australia to Sydney, New South Wales (Figure 10). Several juveniles apparently referable to this species were recently taken at Fiji.

S. regalis **(Bloch 1793).** Cero. A medium-sized (reaching 820 mm FL) species with rows of spots and broken lines on its sides. Pectoral fins covered with scales. Moderate numbers of vertebrae (47–49), pectoral fin rays (modally 21–22), and gill rakers on the first arch (12–18, usually 15 or 16). Pelvic fin relatively long (4.4 to 6.3% FL). Concentrated in the Bahamas and West Indies but there are scattered records from southern Florida, the Gulf of Mexico, and northern Brazil (Figure 8).

S. semifasciatus **(Macleay 1884).** Broad-barred king mackerel. A large (reaching 1,150 mm FL) barred species with few dorsal spines (13–15) and moderate counts of gill rakers (9–13) and vertebrae (45–46). Confined to northern Australia (Queensland and the Northern Territory) and southern Papua-New Guinea (Figure 10).

S. sierra **Jordan and Starks 1895.** Sierra. A medium-sized (reaching 630 mm FL) spotted species with moderate numbers of vertebrae (48–49), gill rakers (13–17), and pectoral fin rays (modally 21). Eastern Pacific from La Jolla in southern California to Payta, Peru (Figure 8). Also found in the Galapagos Islands.

S. sinensis **(Lacépède 1800).** Chinese seerfish. A very large (reaching 2,000 mm FL) species with one or two rows of large spots on the sides and a prominent dip in the lateral line under the first dorsal fin. Very few vertebrae (41–42) and moderate numbers of gill rakers (12–15). Western Pacific from Japan and China south to Cambodia where it enters the Mekong River (Figure 9).

S. tritor **(Cuvier 1831).** West African Spanish mackerel. A large (reaching 980 mm FL) spotted species with relatively few vertebrae (45–47) and moderate numbers of pectoral fin rays (modally 21) and gill rakers (12–15). Pelvic fin relatively long (5.0 to 7.1% FL). Eastern Atlantic, concentrated in the Gulf of Guinea from the Canary Islands and Dakar south to Angola (Figure 8). Rare in the Mediterranean Sea.

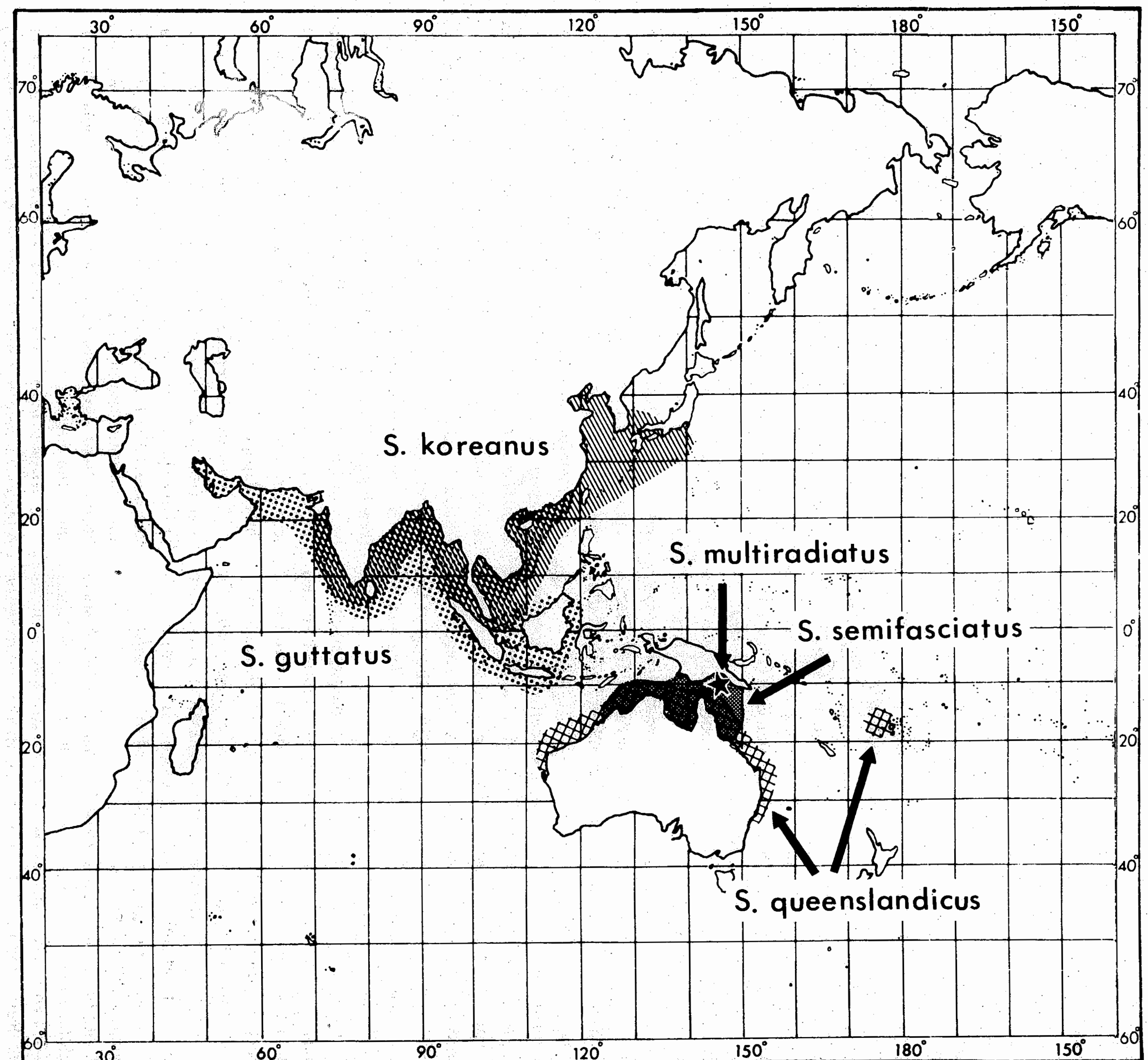


Figure 10. Ranges of five Indo-West Pacific species of *Scomberomorus: S. guttatus*, *S. koreanus*, *S. semifasciatus*, *S. queenslandicus*, and *S. multiradiatus*.

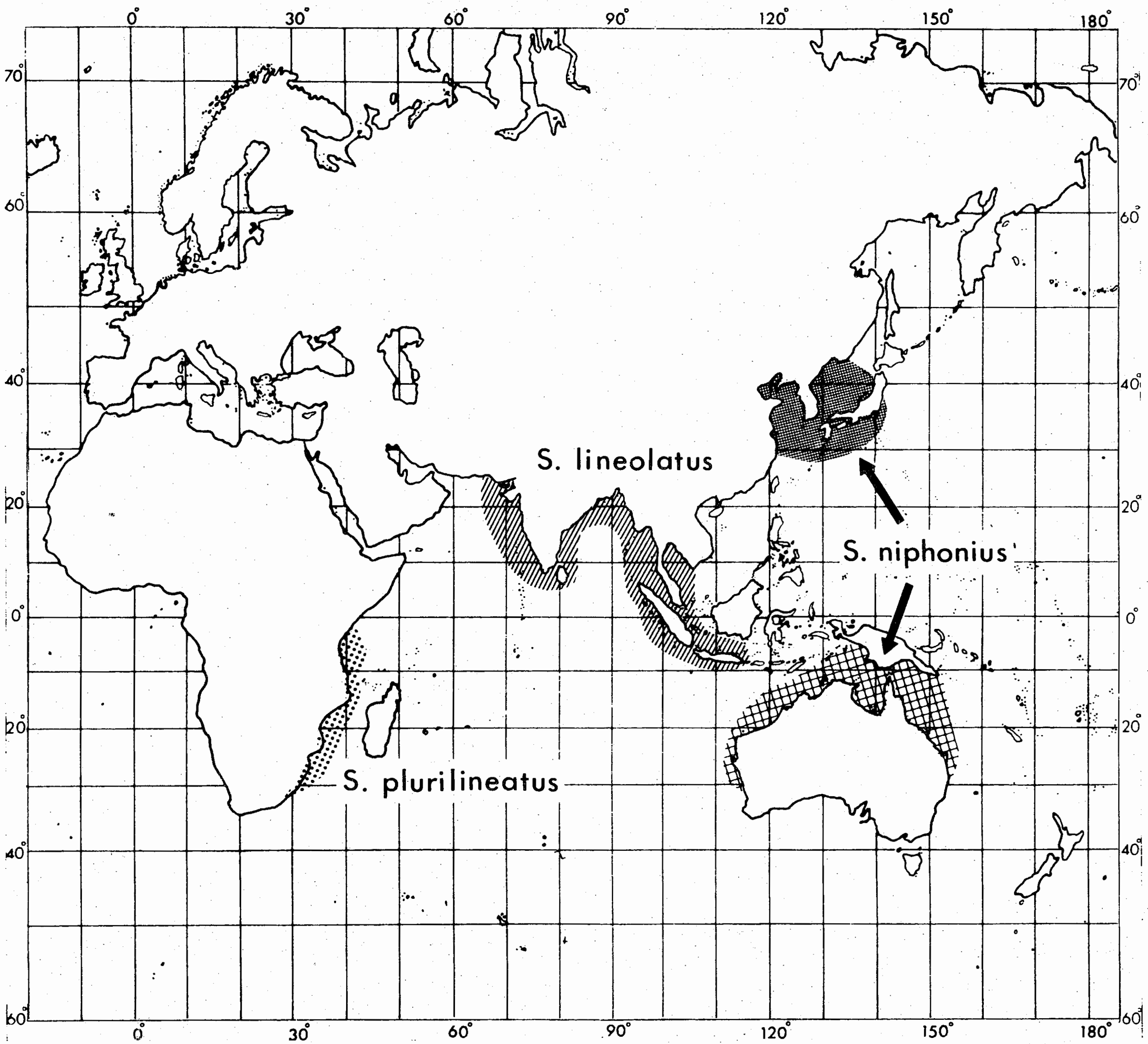


Figure 11. Ranges of four Indo-West Pacific species of *Scomberomorus: S. lineolatus, S. plurilineatus, S. niphonius* (NW Pacific), and *S.* sp. (Australia and Papua-New Guinea, currently called *S. niphonius*).

KEY TO THE ATLANTIC AND EASTERN PACIFIC SPECIES OF *SCOMBEROMORUS*

1a. Lateral line straight or gradually descending posteriorly; gill rakers on first gill arch 11 or more 2

1b. Lateral line abruptly curving downward below second dorsal fin; gill rakers on first gill arch usually 10 or fewer (western Atlantic) . . . . *S. cavalla*

2a. Gill rakers on first arch fewer than 20; yellow to gold spots usually present along sides. 3

2b. Gill rakers on first gill arch 21 or more; sides of body uniform silvery grey (Gulf of California) . . . . *S. concolor*

3a. Small scales on pectoral fin base, not extending a great distance on fin; rows of spots on sides of body but no broken lines; maxilla extending to or beyond a point under the posterior margin of the fleshy orbit 4

3b. Pectoral fin covered with scales; rows of spots and broken lines on sides of body; maxilla extending to a point under the posterior margin of the pupil or the posterior margin of the fleshy orbit (West Indies and Bahamas). . . . *S. regalis*

4a. Total vertebrae 49 or less 5

4b. Total vertebrae 50–53 (Gulf of Mexico and western north Atlantic from Cape Cod, Massachusetts to Yucatan) . . . . *S. maculatus*

5a. Total vertebrae 47–49 6

5b. Total vertebrae 45–46, rarely 47 (eastern Atlantic) . . . . *S. tritor*

6a. Pelvic fin 3.6 to 5.9% fork length (western Atlantic from Belize to southern Brazil) . . . . *S. brasiliensis*

6b. Pelvic fin 4.7 to 6.4% fork length (eastern Pacific from southern California to Peru). . . . . *S. sierra*

REFERENCES CITED

Collette, B. B. In press. Adaptations and systematics of the mackerels and tunas. in: *The Physiological Ecology of Tunas.* Gary Sharp and Andrew Dizon, ed. Academic Press. N. Y.

________, J. L. Russo & L. A. Zavala-Camin. 1978. *Scomberomorus brasiliensis,* a new species of Spanish mackerel from the western Atlantic. *U.S. Natl. Mar. Fish. Serv. Fish. Bull.* 76(1):273–280.

________ & L. N. Chao. 1975. Systematics and morphology of the bonitos (*Sarda*) and their relatives (Scombridae, Sardini). *U.S. Natl. Mar. Fish. Serv. Fish. Bull.* 73(3):516–625.

Devaraj, M. 1977. Osteology and relationships of the Spanish mackerels and seerfishes of the tribe Scomberomorini. *Indian J. Fish.* 22(1–2):1–67.

Gibbs, R. H., Jr. & B. B. Collette. 1967. Comparative anatomy and systematics of the tunas, genus *Thunnus. U.S. Fish. Wildl. Serv. Fish. Bull.* 66(1):65–130.

Kishinouye, K. 1923. Contributions to the comparative study of the so-called scombroid fishes. *J. Coll. Agric. Imp. Univ. Tokyo* 8(3):293–475.

Klawe, W. L. 1977. What is a tuna? *Mar. Fish. Rev.* 39(11):1–5.

Mago Leccia, F. 1958. The comparative osteology of the scombrid fishes of the genus *Scomberomorus* from Florida. *Bull. Mar. Sci. Gulf Caribb.* 8(4):299–341.

Monod, T. 1968. Le complexe urophore des poissons teleosteens. *Mem. Inst. Fond. Afrique Noire* No. 81, 705 pp.

Munro, I. S. R. 1943. Revision of Australian species of *Scomberomorus. Mem. Queensl. Mus.* 12(2):65–95.

Potthoff, T. 1975. Development and structure of the caudal complex, the vertebral column, and the pterygiophores in the blackfin tuna (*Thunnus atlanticus,* Pisces, Scombridae). *Bull. Mar. Sci.* 25(2):205–231.

Sharp, G. & A. Dizon, eds. In press. *The Physiological Ecology of Tunas.* Academic Press. N.Y.

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COMMERCIAL AND RECREATIONAL FISHERIES FOR SPANISH MACKEREL, *Scomberomorus maculatus*

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ABSTRACT Commercial landing data are summarized and fishing gears discussed for Spanish mackerel, *Scomberomorus maculatus*, in the United States from 1880 to 1976. The commercial fishery began along the middle Atlantic and Chesapeake Bay areas before 1850, and by 1880 about 86% of the total U.S. catch of 1.9 million pounds was landed in the Chesapeake Bay area. Before 1920 the fishery had become centralized in Florida. Since 1950, over 92% of the total U.S. catch each year was landed in Florida. Spanish mackerel landings in the United States ranged between 5.0 and 12.1 million pounds from 1950 through 1975, increasing from about 11.3 million pounds in 1975 to about 18.0 million pounds in 1976. Dockside values of the landings fluctuated between $0.5 and $0.9 million from 1950 through 1965, generally increased from 1966 through 1975, and abruptly increased to $3.2 million in 1976. Prices paid per pound increased from $0.13 in 1972 to $0.18 in 1976.

The Spanish mackerel commercial fishery began as a troll fishery, went through a period where gill nets and pound nets caught most of the fish, and later became mostly dependent on gill nets. From 1950 to 1974 the average percentages of the total landings taken by each gear were: gill nets, 87; haul seines, 6; lines, 5; trammel nets, 1; and other, 1.

Recreational-catch statistics representing broad geographic areas of the United States are limited to data from the angling surveys conducted in 1960, 1965, and 1970. Based on these surveys, the most productive fishing areas for Spanish mackerel were along the south Atlantic and east Gulf of Mexico; most were caught in the ocean as opposed to bays and sounds; mainly small boats were used to capture mackerel, but mackerel were also caught from charter boats, piers, jetties, bridges, and beaches. In the 1970 survey, an estimated 536,000 recreational fishermen caught about 15 million Spanish mackerel. The value of the recreational fishery for Spanish mackerel in 1970 was estimated between $15 and $46 million. Valid comparisons of total catch or catch per-unit-of-effort between survey periods could not be made; the reasons are discussed.

Fishing effort and age composition data are needed to evaluate the status of the stocks and, in addition, socio-economic data are needed to determine optimum yields.

INTRODUCTION

The Spanish mackerel, *Scomberomorus maculatus*, a member of the family Scombridae, is closely related to the king mackerel, *S. cavalla*, the cero, *S. regalis*, and the recently-described Brazilian Spanish mackerel, *S. brasiliensis*. All except the latter are widely distributed throughout the western U.S. Atlantic with centers of abundance in Florida. The Spanish mackerel supports important commercial and recreational fisheries in the U.S. south Atlantic and Gulf of Mexico (Figure 1). It is prized as a food item and as a highly desirable recreational fish. The direct economic value of the Spanish mackerel resource is considerable. In 1976, about 18 million pounds valued at about $3.2 million were landed by commercial fishermen in the United States. In 1970, it was estimated that about 23 million pounds were landed by recreational fishermen in the mid-Atlantic, south Atlantic, and Gulf of Mexico. In this paper we review historical landings and the development of the fishing gear used in the Spanish mackerel commercial fishery, describe the present-day commercial and recreational Spanish mackerel fisheries, and discuss factors that are required to evaluate the status of the stocks and fisheries.

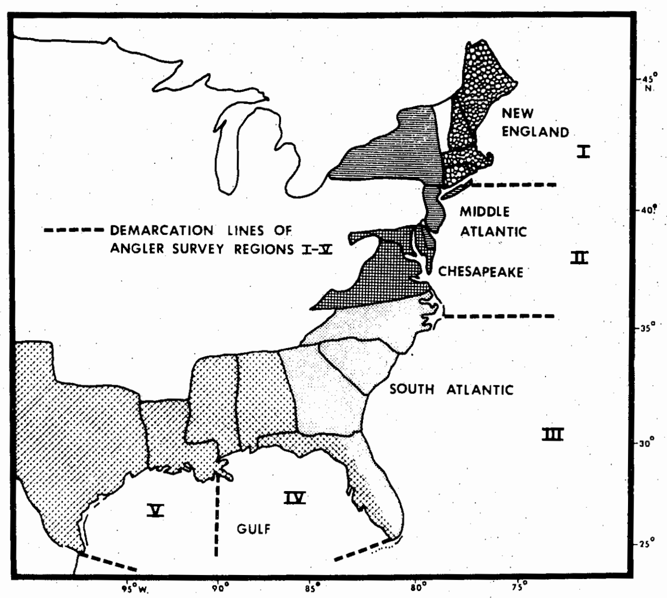

Figure 1. Geographic areas (commercial) and regions (recreational) used for reporting fishery statistics along the Atlantic coast of the United States (Fishery Statistics of the United States 1977 and Deuel 1973).

COMMERCIAL FISHERY LANDINGS

The commercial fishery for Spanish mackerel in the

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United States began before 1850 along the Long Island and New Jersey coasts and was well established in the mid-Atlantic and Chesapeake Bay areas by the late 1870s (Earll 1887). Catch statistics for this fishery in 1880 showed that the Chesapeake Bay area produced about 86% of the total catch of about 1.9 million pounds (Table 1). In 1880, less than 2% of this catch was recorded from the south Atlantic and Gulf of Mexico. Spanish mackerel (or probably a closely-related species – see Collette, Russo, and Zavala-Camin 1978) were first reported in the landings on the Pacific coast in 1904 when 615,000 pounds were landed. The Pacific coast fishery declined since its beginning as indicated by the following landing statistics: 1908, 349,000 pounds; 1915, 397,000 pounds; 1918 through 1951, less than 44,000 pounds landed each year; 1952 through 1974, none reported. Landing statistics for Spanish and king mackerels in the United States were summarized through 1967 by Lyles (1969). Landings from 1967 through 1976 are summarized in Appendix Tables 1 through 4 (data from Fishery Statistics of the United States 1971–77 and Fisheries of the United States 1967–77).

TABLE 1.

Pounds of Spanish mackerel landed by area and state in 1880 (Earll 1887).

Area and state	Pounds	Percent of total
New England		
Maine	0	
New Hampshire	0	
Massachusetts	60	
Rhode Island	2,000	
Connecticut	1,200	
Subtotal	3,260	0.17
Middle Atlantic		
New York	25,000	
New Jersey	200,000	
Delaware	0	
Subtotal	225,000	11.92
Chesapeake		
Maryland	18,000	
Virginia	1,609,663	
Subtotal	1,627,663	86.24
South Atlantic		
North Carolina	10,000	
South Carolina	1,000	
Georgia	0	
East Florida	500	
Subtotal	11,500	0.61
Gulf of Mexico		
West Florida	*	
Alabama	*	
Mississippi	*	
Louisiana	*	
Texas	*	
Subtotal	20,000	1.06
TOTAL	1,887,423	100.00

*Data not available

The areas of major production changed during the 1880s, and by 1897 about 64% of the Spanish mackerel produced by commercial fishermen in the United States was landed in the south Atlantic and gulf states (Figure 2). This trend in greater proportionate landings of Spanish mackerel in the south continued, and in 1945 over 97% of the total production on the Atlantic coast occurred in the south Atlantic and gulf areas. Florida landings accounted for over 92% of the Spanish mackerel produced in the United States each year from 1950 through 1976 (Table 2).

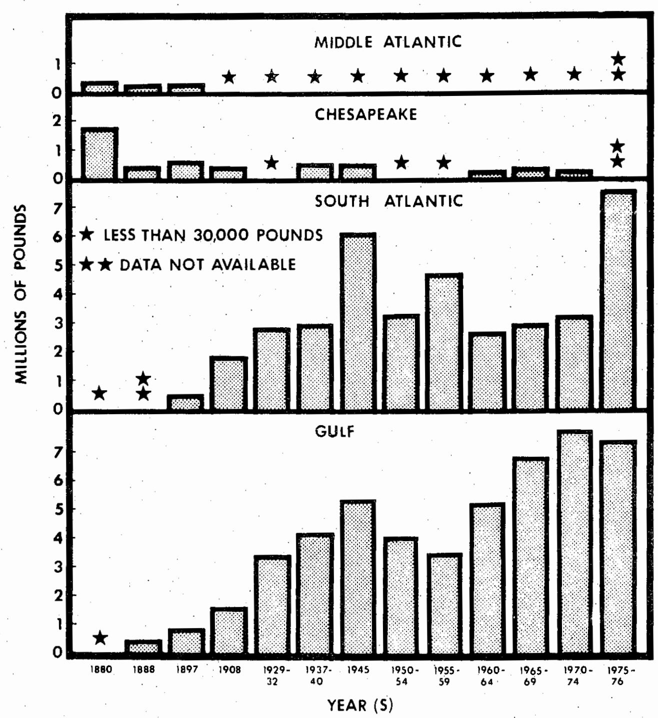

Figure 2. Total or mean total commercial landings of Spanish mackerel from the Atlantic coast of the United States by area and year(s) that comparative data were available, 1880–1976 (Lyles 1969 and Appendix Table 1).

TABLE 2.

Mean annual landings of Spanish mackerel by state in the south Atlantic and gulf areas, 1950–1976 (Lyles 1969 and Appendix Tables 3 and 4).

State	Subtotal	Annual mean	Percent of total
	Thousands of pounds		
North Carolina	3,535	130.9	1.4
South Carolina	186	6.9	9.1
Georgia	27	1.0	0.0
Florida – East	91,967	3,406.2	37.7
Florida – West	143,745	5,323.9	58.9
Alabama	1,900	70.4	0.8
Mississippi	1,691	62.6	0.7
Louisiana	914	33.8	0.4
Texas	19	0.7	0.0
TOTAL	243,984	*	100.0

*Not computed

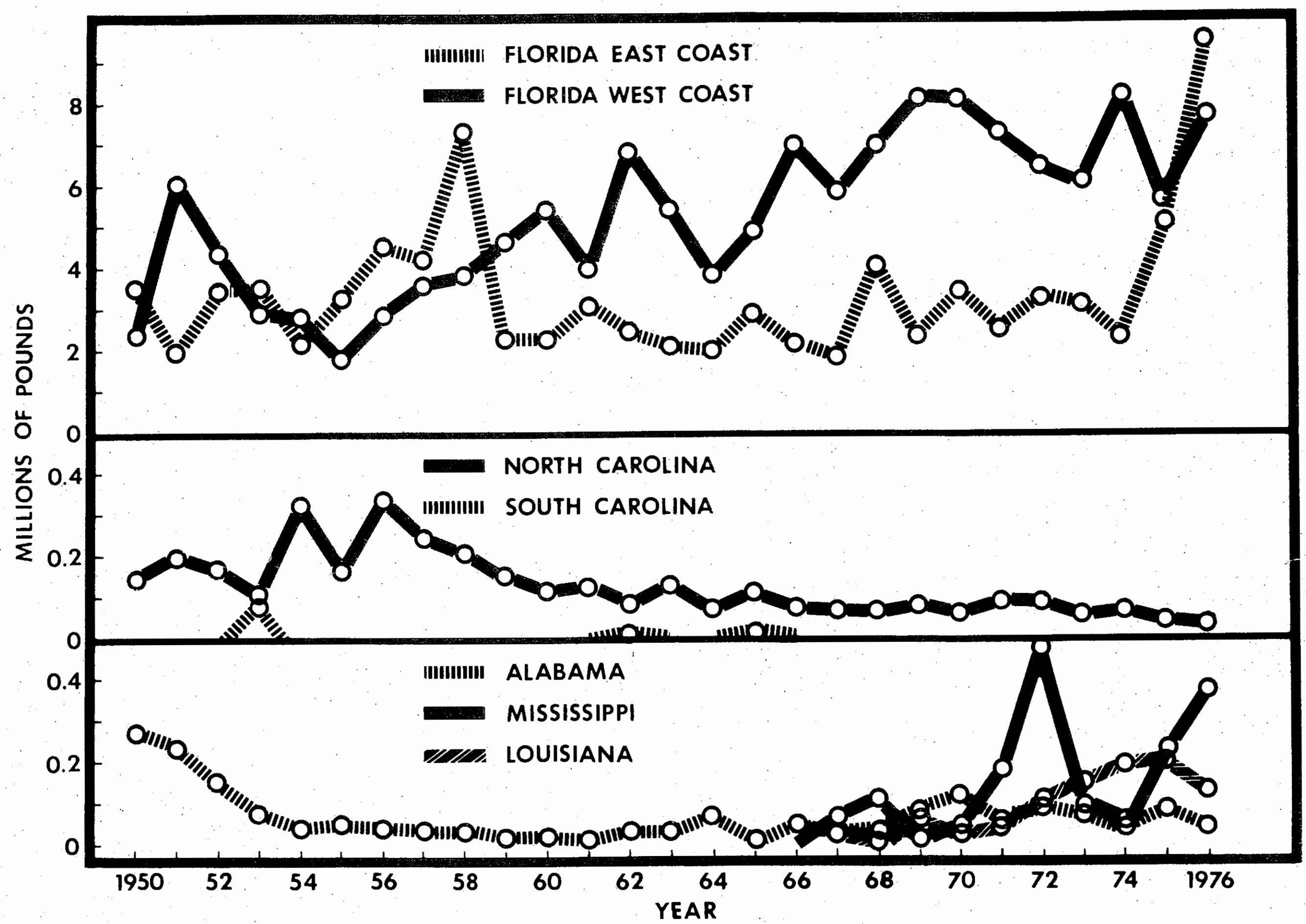

Figure 3. Total annual commercial landings of Spanish mackerel by state or coast of Florida in the south Atlantic and gulf areas for those states and years that 10,000 pounds or greater were landed, 1950–1976 (Lyles 1969 and Appendix Tables 3 and 4).

Trends in the annual landings of Spanish mackerel in the south Atlantic and Gulf of Mexico during the last 27 years are shown in Figure 3 for all states except Georgia and Texas where landings averaged less than 2,000 pounds per year (Table 2). Landings in North Carolina were distinctly higher during the 1950s than during the 1960s and 1970s. On both coasts of Florida, landings of Spanish mackerel fluctuated considerably during the 1950s. From 1960 through 1974, landings on the west coast remained higher, and increased at a higher rate than on the east coast. During 1975 and 1976, an abrupt change occurred; landings on the east coast increased from 2.3 million pounds in 1974 to 9.5 million pounds in 1976, and for the first time in 18 years were higher than on the west coast. Landings in Alabama were higher in 1950–51 than before. Landings of above 50,000 pounds in Mississippi occurred for the first time in 1967 and were highest in 1972 and 1976. Landings in Louisiana have been generally increasing since 1968.

Over 86% of the Spanish mackerel landings in Florida occurred in eight counties during the period 1966–76 (Table 3 and Figure 4). Three of the counties – St. Lucie, Martin, and Palm Beach – are located in the Fort Pierce area along the Atlantic coast and accounted for about 30% of the Florida landings. Monroe, Collier, and Lee counties – located on the southwest side of Florida and including the Keys – accounted for about 49% of the Florida catch. Gulf and Bay counties, located in the northwest area of Florida, accounted for about 8% of the total catch. No other coastal county contributed more than 2% of the total landings.

Trends in the annual landings of Spanish mackerel in the Fort Pierce, southwest, and northwest areas of Florida from 1966 through 1976 are shown in Figure 4. Annual landings in the Fort Pierce area ranged from about 1.5 to 4.1 million pounds from 1966 to 1974 and then increased about 5-fold from 1974 to 1976. Landings in the southwest area fluctuated greatly between 1966 and 1976 from a low of about 3 million pounds to a high of about 7.2 million pounds. Landings in the northwest area gradually increased from 1966 to 1972 and then declined annually through 1976.

Seasonality of Spanish mackerel landings varies in relation to geographic area. In Florida, most of the landings in the Fort Pierce and southwest areas occur between October and May, whereas in the northwest area most of the landings occur during the spring (April – May) and fall (September – October) (Figure 5).

The dockside values of Spanish mackerel landed by commercial fishermen in the Gulf and south Atlantic areas exceeded $1 million only in one year (1945 – $1.4 million) before 1950 (Lyles 1969). Landing values remained between $0.5 and $1 million per year from 1950 through 1965, generally increased from 1966 through 1975, and abruptly increased during 1976 (Figure 6). The large increase in value in 1976 resulted from increased prices coupled with increased landings (Figure 7). Prices paid per pound fluctuated between $0.08 and $0.12 from 1950 through 1972 and then increased to a high of $0.18 in 1976. It appears that the higher level of prices that began in 1973 was caused by increased demand and that commercial fishermen had geared up by 1976 to fill this demand. An economic analysis of production and marketing trends for Spanish and king mackerels during recent years was conducted by Prochaska and Cato (1977).

TABLE 3.

Total landings of Spanish mackerel by county in Florida, 1966–1976 (Fisheries of the United States, 1976–1977).

County or countries	Thousands of pounds	Percent of total
Nassau	17	0.01
Duval	99	0.08
Putnam	0	0.00
St. Johns	30	0.03
Volusia	518	0.44
Brevard	2,369	1.99
Indian River	671	0.57
St. Lucie	11,763	9.92
Martin	12,607	10.64
Palm Beach	11,191	9.44
Broward	1	0.00
Dade	1,290	1.09
Monroe	42,577	35.92
Collier	9,612	8.11
Lee	6,114	5.16
Charlotte	884	0.75
Sarasota	1,375	1.16
Manatee	2,010	1.70
Hillsborough	29	0.02
Pinellas	1,813	1.53
Pasco, Hernando, and Citrus	108	0.09
Levy	98	0.08
Dixie and Taylor	100	0.08
Wakulla	80	0.07
Franklin	238	0.20
Gulf	4,078	3.44
Bay	5,114	4.31
Walton	14	0.01
Okaloosa	1,649	1.39
Santa Rosa	9	0.01
Escambia	2,070	1.75

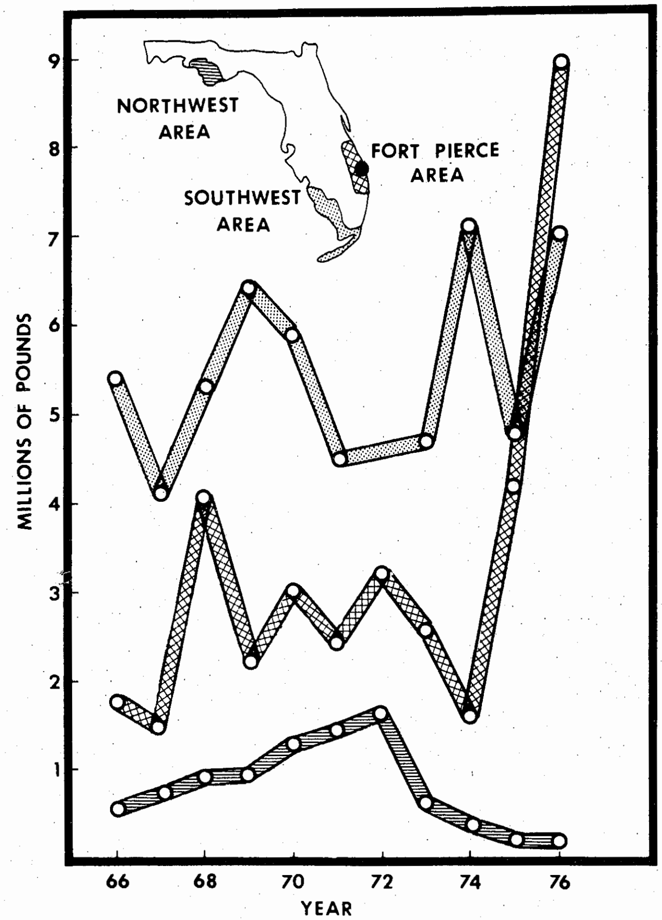

Figure 4. Total annual commercial landings of Spanish mackerel for the most productive geographic areas in Florida, 1966–76 (Florida landings, 1967–1977).

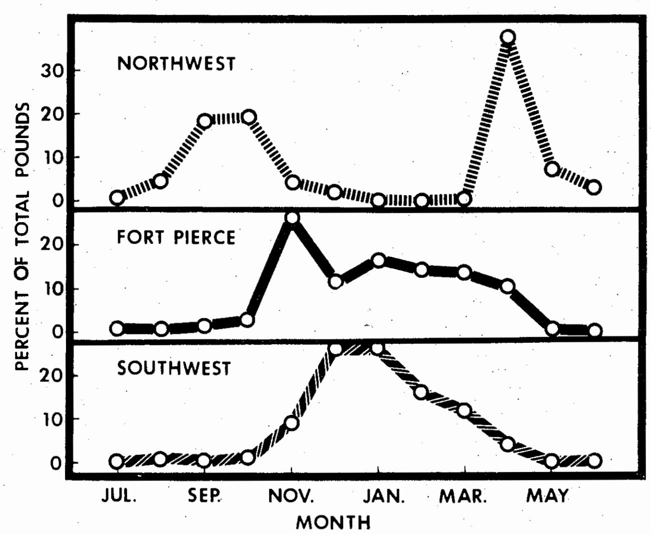

Figure 5. Seasonality of landings in the commercial Spanish mackerel fishery in three areas (Figure 4) of Florida (Florida landings monthly 1968–1971).

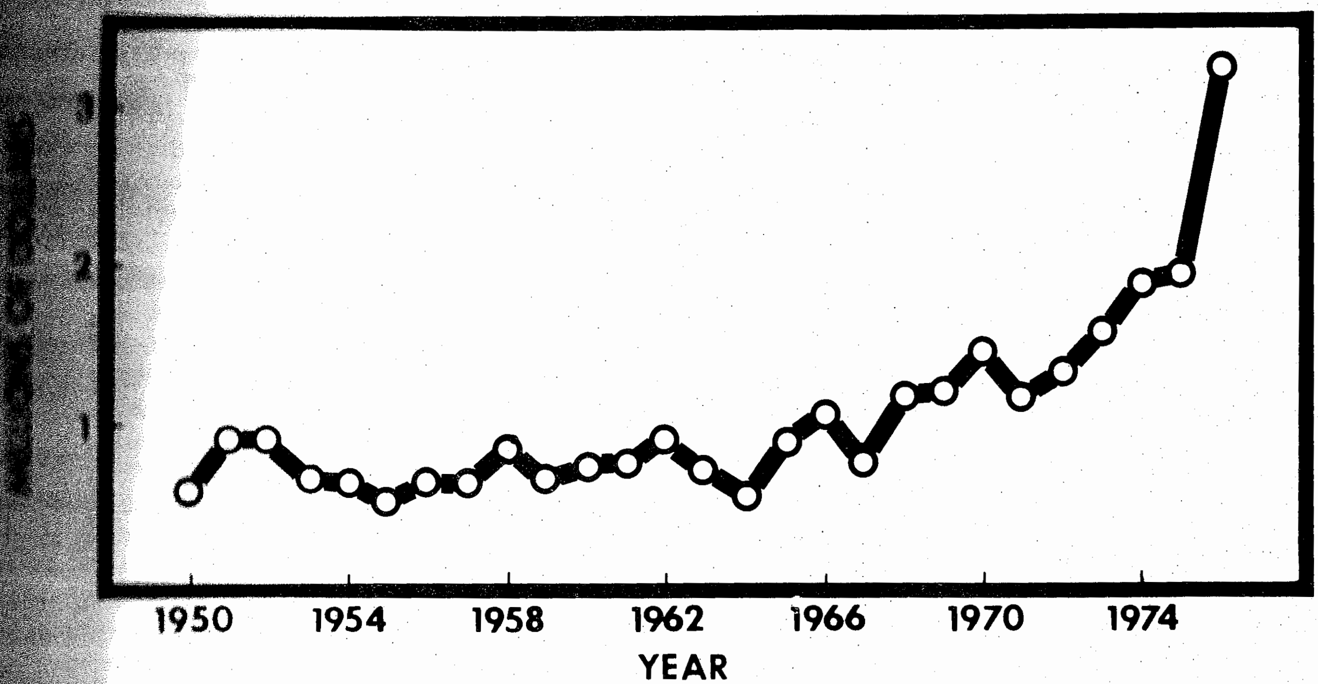

Figure 6. Dockside values of Spanish mackerel landed by commercial fishermen in the south Atlantic and Gulf areas, 1950–1976 (Lyles 1969 and Appendix Table 1).

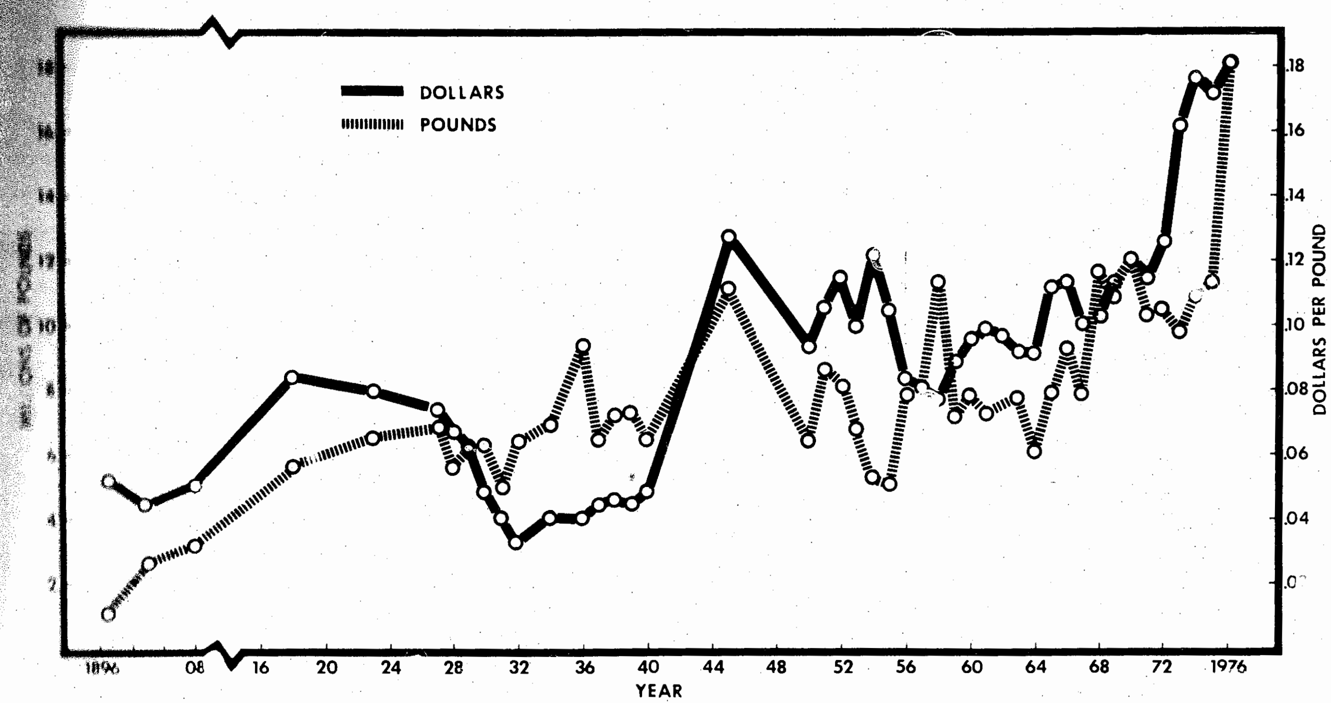

Figure 7. Total pounds and mean dockside values per pound of Spanish mackerel landed by commercial fishermen in the south Atlantic and Gulf areas, 1896–1976 (Lyles 1969 and Appendix Table 1).

COMMERCIAL FISHING GEAR AND TECHNOLOGY

During the nineteenth century three types of gear (troll lines, gill nets, and pound nets) were used in the Spanish mackerel commercial fishery. Troll lines were used first and introduced into the Long Island and New Jersey areas during the early 1800s. For some time, trolling was the most important fishing method (Earll 1887). The trolling lures, or "squids," varied greatly. Some were made of bright metal to resemble fish and others were made of strips of colored cloth to resemble squid. The lures had one to three hooks and were attached to lines several fathoms long. Four or five of these lines were towed behind a sailing boat at two to four miles per hour.

Gill nets were first used for capturing Spanish mackerel in 1866 in Sandy Hook, New Jersey, but were inefficient until about 1872 when it was discovered that the mackerel would gill more readily in nets set to present sharp angles (Earll 1883). Gill nets were then introduced into Chesapeake Bay and quickly gained acceptance. The gill nets were 150 to 200 yards long, 100 meshes deep, and had stretched-mesh sizes of 3–1/2 to 4 inches. The webbing was of tarred cotton twine. The nets were fished single or in "gangs" (two or more nets tied together) in two ways. In the first method, the fishermen would stake or anchor a pair of nets (single or in gangs) so that the longer net of the pair served mostly to lead the fish into the shorter net. This shorter net, located at one end of the lead net, created walls of webbing at various angles to the lead net. These nets were first fished from daylight to early afternoon, but it was later learned that the nets caught more fish from mid-afternoon until midnight. The other method involved encircling the mackerel schools and frightening the fish into the meshes by splashing with oars inside the circle. This method was efficient only at night.

Pound nets were first introduced into the Sandy Hook region about 1855, in the inshore areas, but the nets were relatively unsuccessful in capturing Spanish mackerel until about 1873 when a large pound net was placed along the ocean shore; then their importance in the Spanish mackerel fishery was established (Earll 1887). By 1880, pound nets were being used throughout the middle Atlantic and Chesapeake Bay states and accounted for most of the Spanish mackerel landings.

By 1920, the center of the Spanish mackerel fishery had shifted from Chesapeake Bay to south Florida. Although purse seines made occasional large catches and trolling lines contributed a small amount to the total catch, the gill net had become the principal capture gear (Schroeder 1924). The typical gill net was 7 yards deep, 150 to 175 yards long, had stretched-meshes of 3–3/8 to 3–5/8 inches, and the webbing was 6-thread tarred cotton twine. Often the nets were joined to form one that was 500 to 1,800 yards long. The boats in the fishery were 30 to 50 feet long, gasoline-powered, and carried a large searchlight. Schools of mackerel were found at night and rapidly surrounded with the net. Lanterns were mounted along the floatline to indicate the location of the net. After closing the net, dories encircled the floatline, and the fishermen splashed water to frighten the fish into the net. Because the bottom of the net was open, the fish could have easily escaped by sounding, but apparently they remained at the surface and either gilled themselves or jumped the corkline (Schroeder 1924). Catches by the gill-net boats were generally picked up by a run boat and delivered to the dealer, thereby enabling the net boats to remain on the fishing grounds.

Gill nets have remained the dominant gear in the commercial Spanish mackerel fishery and during the past 25 years have accounted for over 83% of the total catch during each 5-year period in the South Atlantic and Gulf of Mexico (Table 4 and Figure 8). The runaround or strike gill net is much more important than are the drift, anchor, set, or stake gill nets in this fishery. Haul seines have been second in importance over this period, lines (hand and troll) have been third, followed by trammel nets, otter trawls, pound nets, and purse seines. Percents of the total catch during each time interval (Figure 8) have remained about the same between time periods with gill nets, have increased with time with haul seines, and have generally decreased with time with lines and trammel nets.

The Spanish mackerel gill-net fishery in Florida was categorized by Austin, Browder, Brugger, and Davis (1978) into (1) shallow water, and (2) deep water. In the shallow-water fishery, many of the boats were 30 to 40 feet long, cost about $25,000, were equipped with power rollers and strong engines, and were fished mostly along the Florida Keys and southwest coast. Spanish mackerel were also caught from smaller boats (19 to 25 feet long) in the above areas and in the Fort Pierce and northwest Florida areas. The smaller boats were used to catch several species (e.g., mackerel; mullet *Mugil cephalus*; and bluefish *Pomatomus saltatrix*) depending on availability and value In the deep-water fishery, the boats were 42 to 63 feet long and cost from $40,000 to $160,000 and were sometimes used to catch king mackerel. Austin et al. (1978) estimated that about 250 shallow-water and [illegible] deep-water vessels were involved in the Spanish mackerel fishery in Florida in 1977.

Nets used in the shallow-water fishery are worth on the average about $1,500, are made of monofilament webbing, and are variable in length, depth, flotation, and mesh size depending on the intended use (Austin et al. 1978). Strike or runaround nets are about 800 yards long and have stretched-mesh sizes of about 3–5/8 inches. The nets are set around mackerel schools, and the fish are excited to charge the net. Drift nets are up to 1,500 yards long, have stretched-mesh sizes between 3–7/8 and 4–1/4 inches, and often have panels with different mesh sizes for catching other species such as pompano *Trachinotus carolinus*. These nets are set perpendicular to the expected path of the fish and to the tide. Both strike and drift nets are about seven yards deep, have sufficient flotation to maintain the float

TABLE 4.

Mean total landings of Spanish mackerel in the south Atlantic and Gulf areas by gear type and time period, 1950–1974 (Fishery Statistics of the United States, 1953–1977).

	Time period									
	1950–1954		1955–1959		1960–1964		1965–1969		1970–1974	
Gear type	1,000 lbs	Percent	1,000 lbs	Percent	1,000 lbs	Percent	1,000 lbs	Percent	1,000 lbs	Percent
Gill nets										
Runaround	6,176	87.9	6,321	80.2	6,480	84.3	8,167	85.0	8,727	81.3
Drift, other	68	1.0	565	7.2	378	4.9	96	1.0	41	0.4
Anchor, set, or stake	18	0.3	3	0.0	4	0.1	6	0.1	170	1.6
Haul seines	157	2.2	214	2.7	342	4.4	728	7.6	1,079	10.1
Lines										
Troll	194	2.8	416	5.3	221	2.9	205	2.1	237	2.2
Hand	208	3.0	186	2.4	188	2.4	176	1.8	211	2.0
Trammel nets	136	1.9	174	2.2	64	0.8	103	1.1	148	1.4
Otter trawls	4	0.1	*	*	1	0.0	34	0.3	114	1.1
Pound nets	65	0.9	*	*	9	0.1	9	0.1	4	0.0
Purse seines	*	*	*	*	*	*	79	0.8	*	*

*None landed

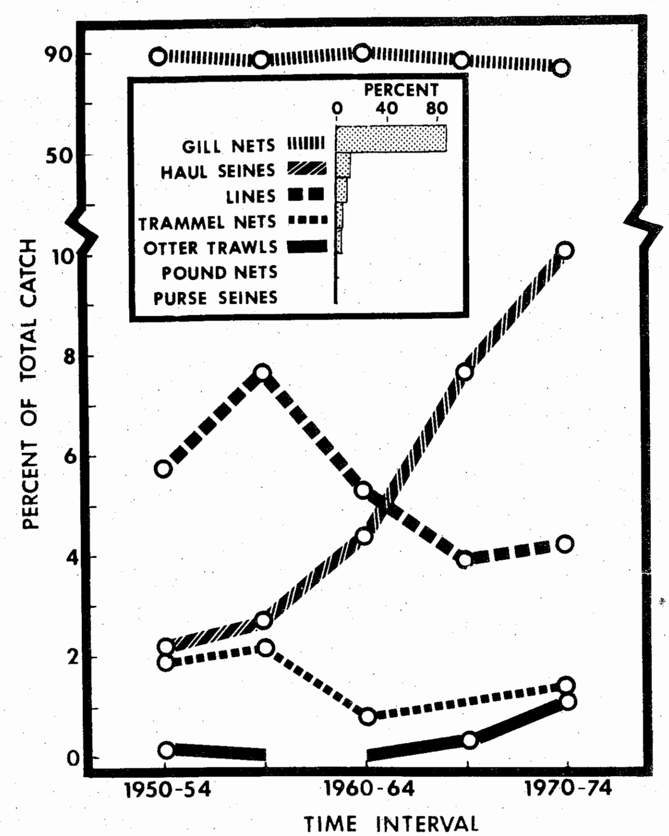

Figure 8. Percents of the total landings of Spanish mackerel in the south Atlantic and Gulf areas in relation to capture gear and time period (Fishery Statistics of the United States, 1953–1977).

line at the surface, and are usually fished in water depths of 8 to 10 feet. Stab nets are up to 1,500 yards long, about 3 yards deep, and usually have stretched-mesh sizes of 4–1/4 inches. They have fewer floats and more lead than strike or drift nets and sink beneath the surface. The nets are set with the tide rather than across it.

Gill nets used for deep-water fishing are strike nets about 600 yards long and up to 30 yards deep and can be fished in water depths of 60 feet. The deep-water nets have webbing made of monofilament about 7 yards deep in the middle of the net and are bounded above and below by multifilament nylon webbing. Mesh sizes are about 3–1/2 inches. The nets are set as in the shallow-water fishery, except that the larger boats use spotter planes to locate fish and direct the setting of the nets. The deeper nets came into use about 1973.

Data on the relation between the mesh sizes of gill nets and the sizes of captured Spanish mackerel were reported by Klima (1959), Powell (1975), and Trent and Pristas (1977); the studies, with the exception of Powell's, clearly showed that the mean or modal lengths of Spanish mackerel increased with an increase in mesh size (Table 5). Although a direct relation exists between the mesh size and the mean size of captured mackerel, this relation is not particularly useful in determining, by the selection of mesh sizes, the sizes of Spanish mackerel that will be caught or protected from being caught (Figure 9). The size ranges of mackerel that are caught by different mesh sizes overlap greatly. The reasons for this overlap are that the girth of a Spanish mackerel

TABLE 5.

Mean or modal lengths of Spanish mackerel caught in gill nets in relation to the mesh size.

Stretched-mesh size (inches)	Mode		Mean
	Klima (1959)	Powell (1975)*	Trent and Pristas (1977)
	(Fork length in centimeters)		
2.5	†	†	33
2.75	†	†	34
3.0	†	†	36
3.13	38	45	†
3.25	†	45	38
3.37	†	45	†
3.5	43	45	40
3.75	†	†	42
4.0	†	†	44
4.25	†	†	46
4.5	†	†	47
4.75	†	†	45
5.0	†	†	49

*Reported in standard length and converted to fork length using the equation by Powell (1975).
†No data.

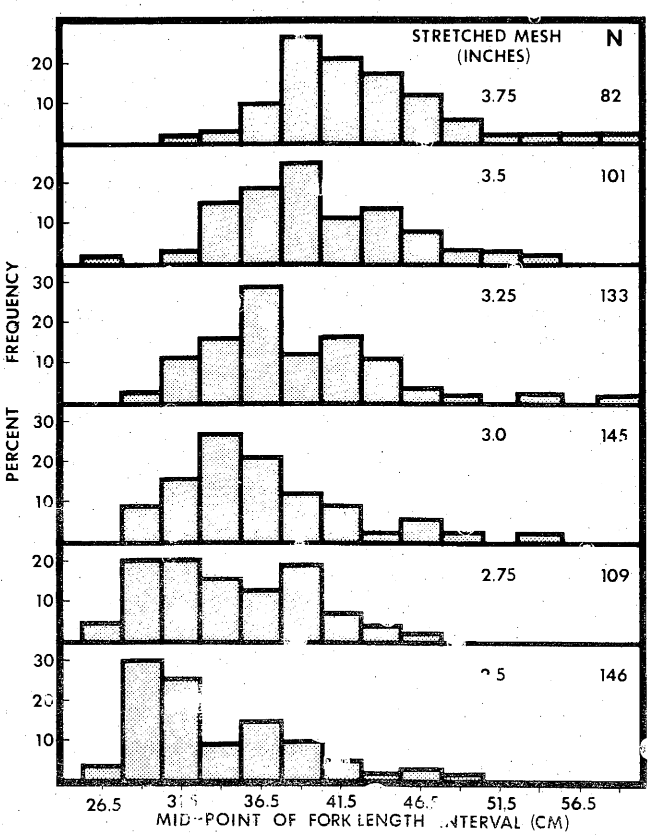

Figure 9. Length-frequency distributions of captured Spanish mackerel in relation to the mesh sizes of gill nets (Trent and Pristas 1977).

increases gradually and provides several gilling points of different sizes, and many individuals become entangled by teeth, maxillaries, or tail.

Since the beginning of the fishery, major technological changes have occurred to increase the efficiency of capturing Spanish mackerel with gill nets. In the 1800s, gasoline engines and powerful spotlights were not readily available, and fishermen were limited to using staked gill nets or inefficient techniques in setting strike nets. Webbing was made of cotton and was not as efficient as multi- or monofilament nylon for (1) getting fish to charge the net, especially during the daytime, and (2) entangling fish once they contact the net. By 1920, the fishery's boats were powered by gasoline engines and equipped with spotlights for night fishing. Techniques changed little from 1920 to the late 1950s, according to Klima's (1959) account of fishing during 1958. Strike nets made of cotton webbing were still being used, and most of the fishing still occurred at night. Stab gill nets had, however, come into use to catch mackerel in deep water. Fishing gear and methods presently used are considerably different from those of the 1950s. Larger vessels entering the fishery have power-rollers to mechanically retrieve the nets and almost all the nets are made of nylon. Much of the fishing occurs during the daytime; airplane spotter pilots locate the fish and help direct the fishing operation.

RECREATIONAL FISHERY

Based on statistics collected during the 1965 and 1970 Salt-water Angling Surveys (Deuel and Clark 1968, Deuel 1973), the most productive recreational fishing area for Spanish mackerel in the United States was along the south Atlantic coast (Cape Hatteras, North Carolina, to and including the Florida Keys) (Table 6 and Figure 10). Other areas, in decreasing order of production were: east Gulf of Mexico (Florida Keys to and including the Mississippi River delta); west Gulf of Mexico (Mississippi River delta to the Mexican border): middle Atlantic (New Jersey to Cape Hatteras). In some years, sizable catches were made as far north as Long Island, N. Y. (Berrien and Finan 1977), although catches were not reported from this area during the survey years of 1960, 1965, and 1970 (Clark 1962, Deuel and Clark 1968, Deuel 1973).

A survey of the recreational anglers and the numbers of Spanish mackerel caught in each state in the south Atlantic and Gulf of Mexico was made in 1975 by the National Marine Fisheries Service (John P. Wise personal communication). The 1975 data showed that more Spanish mackerel were caught in the Gulf of Mexico than along the south Atlantic coast, and that Florida produced about 67% of the landings (Table 7).

Recreational anglers catch Spanish mackerel from boats while trolling or drifting, and from boats, piers, jetties, and beaches by casting, livebait fishing, jigging, and drift fishing. Lures and baits less than five inches long are usually used.

TABLE 6.

Estimated numbers and weights of Spanish mackerel* and the numbers of recreational fishermen that caught them, by area and year (Clark 1962, Deuel and Clark 1968, Deuel 1973, and John P. Wise, personal communication).

Year	Middle Atlantic	South Atlantic	East Gulf	West Gulf	Gulf	Total
			Thousands of fish			
1960	†	7,380	†	†	5,149	12,529
1965	278	7,548	1,187	521	1,708	9,534
1970	350	4,967	2,314	479	2,793	8,110
1975	†	733	†	†	3,012	3,745
			Thousands of pounds			
1960	†	24,830	†	†	11,330	36,160
1965	167	18,186	2,984	1,299	4,283	22,636
1970	946	14,623	7,200	608	7,808	23,377
1975	†	1,633	†	†	7,029	8,662
			Thousands of anglers			
1960	†	242	†	†	190	432
1965	8	202	121	46	167	377
1970	32	245	228	31	259	536
			Mean weight (pounds) per fish			
1960	†	3.4	†	†	2.2	
1965	0.6	2.4	2.5	2.5	2.5	
1970	2.7	2.9	3.1	1.3	2.5	
1975	†	2.2	†	†	2.3	

*King mackerel (*Scomberomorus cavalla*) and cero (*S. regalis*) included in the catches in 1960 and cero included in 1965 and 1970.
†Data not available or not taken such that it could be combined by the geographic areas used in the 1965 and 1970 surveys.

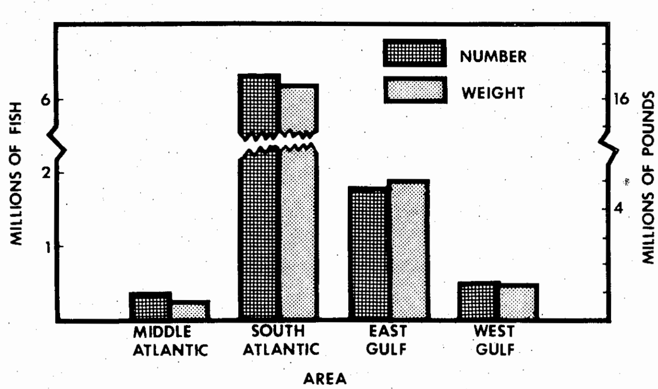

Figure 10. Estimated mean number and mean total weights of Spanish mackerel and cero caught by recreational fishermen during 1965 and 1970 by area (Deuel and Clark 1968, and Deuel 1973).

TABLE 7.

Estimated numbers and pounds of Spanish mackerel caught by recreational fishermen by state in the south Atlantic and Gulf areas in 1975 (John P. Wise, personal communication).

State	Thousands of fish	Thousands of pounds
North Carolina	377	725
South Carolina	95	176
Georgia	*	*
Florida (east)	261	732
Total	733	908
Florida (west)	2,260	5,148
Alabama	380	942
Mississippi	225	555
Louisiana	147	384
Texas	*	*
Total	3,012	7,029

*Too few to estimate.

Most Spanish mackerel are caught in the ocean; the estimated percentages of catch in the ocean, as opposed to bays and sounds, ranged from 62% in the south Atlantic to 99% in the middle Atlantic (Table 8). More Spanish mackerel were caught from small boats than all combined platforms in each area except the middle Atlantic, where most mackerel were caught from larger charter or party boats (Figure 11).

TABLE 8.

Estimated numbers of Spanish mackerel caught by recreational fishermen by fishing area, fishing platform, geographic area, and year (Deuel and Clark 1968, and Deuel 1973).

Geographic area and year	Fishing area: Ocean	Fishing area: Sound	Fishing platform: Private or rented boat	Party or charter boat	Bridge, pier, or jetty	Beach or bank
			Thousands of fish			
Middle Atlantic						
1965	278	*	29	249	*	*
1970	346	4	40	300	*	10
South Atlantic						
1965	3,796	3,752	4,880	1,149	1,424	95
1970	3,919	1,048	3,447	317	628	575
East Gulf						
1965	1,098	89	566	328	244	49
1970	1,701	613	1,188	534	488	104
West Gulf						
1965	463	58	367	73	81	*
1970	371	108	218	189	8	64

*No catch reported.

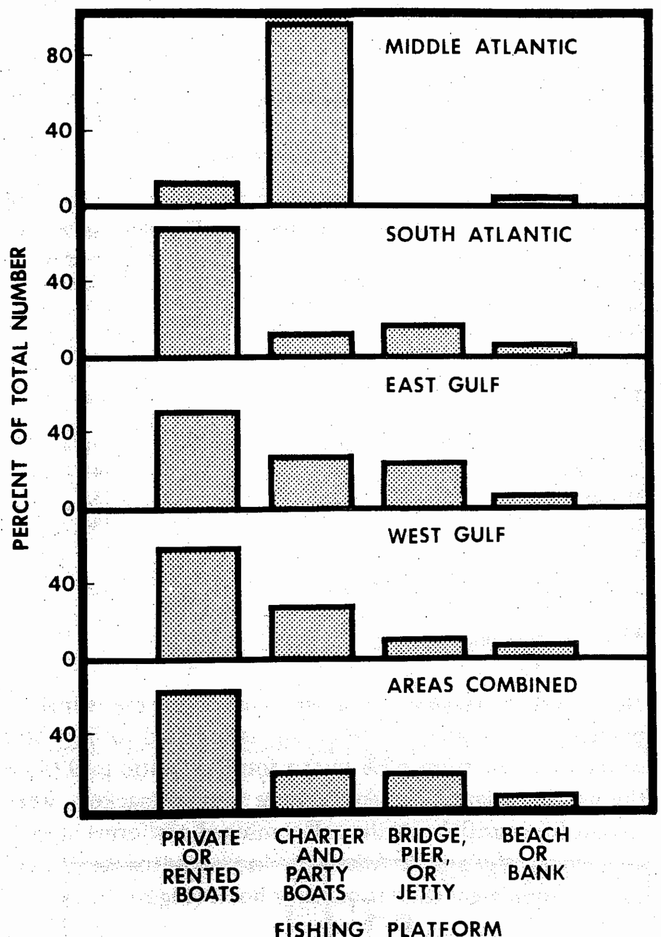

Figure 11. Percents of the total numbers of Spanish mackerel caught in each area in relation to fishing platform (Deuel and Clark 1968, and Deuel 1973).

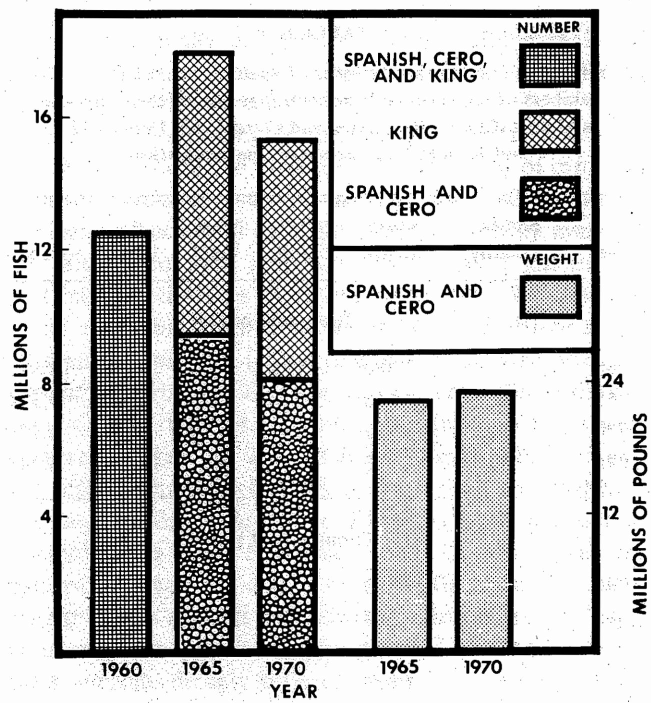

Figure 12. Estimated numbers and total weights of mackerel caught by recreational fishermen (king mackerel and cero included with Spanish mackerel during 1960 and cero only included during 1965 and 1970).

Based on the available recreational fishery statistics, significant changes in the total landings and catch per unit effort in the recreational Spanish mackerel fishery between survey periods cannot be determined with any degree of certainty. Estimated total landings of Spanish mackerel, king mackerel, and cero by recreational anglers for 1960, 1965, and 1970 are shown in Figure 12. Data on these species cannot be separated to make meaningful comparisons, because all three were reported as Spanish mackerel in 1960, and cero were reported as Spanish mackerel in 1965 and 1970. Total landings of the combined three species ranged between 12.5 and 17.9 million fish and were highest in 1965 and lowest in 1960. This difference of 5.4 million fish is small, because a conservative estimate of the probable magnitude of one standard error is between 3.7 and 5.6 million fish (Deuel 1973).

The estimated numbers of anglers that caught both or all three species of mackerels by area and year are shown in Table 6. These numbers, along with catch data, cannot be used to compute valid estimates of catch per unit effort, because the number of anglers that fished for, but did not catch, these species is unknown, as is the number of times that each angler fished for the species.

Several methods have been used to estimate values of recreational fisheries; all have their shortcomings. For this discussion, we will assume that the use of expenditure data is a reasonable valid technique for estimating the value of a recreational fishery. In 1970, the number of recreational anglers who caught Spanish mackerel in the United States was estimated at 536,000 (Deuel 1973). In the 1970 National Survey of Fishing and Hunting (U.S. Department of Interior 1972), the average annual expenditure of an angler in the south Atlantic and gulf regions was estimated at $143.00. Assuming that the percentage of the expenditure specifically for Spanish mackerel was between 20 and 60% of the annual average, the 536,000 anglers spend between $15.3 million (536,000 x $28.60) and $46.0 million (536,000 x $85.80) fishing for Spanish mackerel.

DISCUSSION

This paper contains a summary of what is known about the landings of Spanish mackerel in the United States and how the fish were captured. With these data we can tell little, however, about the well being of Spanish mackerel stocks. The greatest single-year increase in commercial landings – over 6 million pounds – occurred between 1975 and 1976 (Figure 7). Does this mean that the maximum sustained yield has been surpassed? Did the large price increase from $0.13 per pound in 1972 to $0.18 in 1976 make the taking of Spanish mackerel so profitable that the resource will be over-harvested in the near future? Or are the stocks fluctuating within normal limits and recent harvests merely represent catches during a peak abundance period? These questions cannot be answered with the presently available information. The potential for exhausting the Spanish mackerel resource was explored by Shaw and Warner (in press) by reviewing case histories of several pelagic fisheries. These authors examined the expansion of the Spanish mackerel fishery and the expansions and declines of the Pacific mackerel *Scomber japonicus*, Pacific sardine *Sardinops sagax*, and Atlantic menhaden *Brevoortia tyrannus*, fisheries. Importantly, the population declines could not be predicted based on the data that were available at the time.

We are not presently collecting the types of data that are required to estimate maximum allowable harvest (MAH). To estimate MAH we must as a minimum, (1) have accurate effort, catch, and catch-per-unit-effort (CPUE) estimates, and data on the size and age composition of the catch, or (2) use some other type of data to estimate the size or relative size of the stocks from year to year.

The method presently used to obtain catch and effort statistics on commercial fisheries only provides total landings by type of gear and total numbers of units of each gear within geographic areas. What is lacking, in regard to estimating CPUE, is the number of "standard units of fishing effort" exerted to catch a particular species of fish. The problem of effort standardization applies to the gathering of recreational effort statistics also, but with the additional problem of having to estimate total landings.

A standard unit of fishing effort can be defined as an amount of fishing, with a specific type of gear, that will capture an unknown but constant proportion of fish population per unit time; this amount when quantified is called the "fishing power" of the gear. A single standard unit of effort cannot be defined for the Spanish mackerel fishery. Further, it is extremely difficult to define a standard unit of effort for any of the numerous types (gill nets, haul seines, small-boat trolling, pier fishing, etc.) of fishing that occur in this fishery. Variations in the strike gill net fishery illustrate the difficulties in defining a standard unit of effort. In theory, fishing power is constant in a standard unit of fishing effort, and in practice the variability in fishing power should remain low within a gear type. Within the strike gill net fishery, however, the fishing power of a boat will vary by: size of boat; equipment and number of people aboard; length, depth, and mesh size of nets; degree of concentration on capturing a single species; hours fished per day; whether a spotter plane is used; restrictions on pounds landed per day; and other factors. From a sampling standpoint the solution to estimating total fishing effort is extremely costly. Thus tremendous amounts of resources must be spent to design and conduct surveys to obtain estimates, or valid estimates of total effort will not become available. These effort estimates, in conjunction with total catch data, are required to determine if overfishing is occurring. The availability of necessary funds in the near future for significant improvement in estimating total effort is difficult to foresee.

Methods other than the collection of catch and effort statistics have been proposed to monitor and estimate sizes of fish stocks, e.g., the use of egg and larval data from plankton collections (Houde 1977) and the use of aerial and satellite remote sensing (Kemmerer, Benigno, Reese, and Minkler 1974). These techniques are not, however, sufficiently advanced at this time for determining the status of Spanish mackerel stocks.

Based on the present economic constraints, the best short-term solution to the assessment of Spanish mackerel stocks is to continue monitoring commercial landing data and begin sampling the size and age composition of the stocks. If additional funds become available they should be used to (1) improve the methods of total catch and effort estimation in the recreational fishery, and (2) develop methods to estimate total effort in the commercial fishery. These data, if obtained annually, would greatly improve our capability of determining, on a timely basis, if overfishing is occurring.

Accurate catch and effort statistics, and size and age composition of the catch, represent only a part of the required data to manage the Spanish mackerel fisheries for optimum yields. Additional factors requiring data or definition include: sociological profiles of the fishermen (Austin et al. 1978, Ditton 1977); economics of the fishery and systems of processing, distribution, and marketing (Prochaska and Cato 1977); and interactions among the harvesting sectors (Austin et al. 1978).

REFERENCES CITED

Austin, C. B., J. A. Browder, R. Brugger & J. C. Davis. 1978. Mackerel workshop report. *Univ. Miami Sea Grant Publ.* No. 14. 156 pp.

Berrien, P. & D. Finan. 1977. Biological and fisheries data on Spanish mackerel *Scomberomorus maculatus* (Mitchill). *U.S. Dep. Commer. Natl. Mar. Fish. Serv.*, Sandy Hook Lab., *Tech. Ser. Rep.* No. 9. 52 pp.

Clark, J. R. 1962. The 1960 salt-water angling survey. *U.S. Fish. Wildl. Serv., Bur. Sport Fish. Wildl. Circ.* 153. 36 pp.

Collette, B. B., J. L. Russo & L. A. Zavala-Camin. 1978. *Scomberomorus brasiliensis*, a new species of Spanish mackerel from the western Atlantic. *U.S. Natl. Mar. Fish. Serv. Fish. Bull.* 76:273–280.

Deuel, D. G. 1973. 1970 salt-water angling survey. *U.S. Natl. Mar. Fish. Serv. Fish. Stat.* 6200. 54 pp.

———— & J. R. Clark. 1968. The 1965 salt-water angling survey. *U.S. Bur. Sport Fish. Wildl. Resour. Publ.* 67. 51 pp.

Ditton, R. B. 1977. Human perspectives in optimum sustainable yield fisheries management. Proc. 2nd Annual Marine Recreational Fisheries Symposium. Sport Fishing Institute. Washington, D.C. Pp. 29–42.

Earll, R. E. 1883. The Spanish mackerel, *Cybium maculatum* (Mitch.); its natural history and artifical propagation, with an account of the origin and development of the fishery. U.S. Commissioner of Fish and Fisheries, Report for 1880. Pp. 395–426.

________. 1887. The Spanish mackerel fishery. Pp. 543–552 in G. B. Goode (ed.), *The Fisheries and Fishery Industries of the United States.* Section 5, vol. 1. U.S. Commission of Fish and Fisheries. Washington, D.C.

Fisheries of the United States. 1967–77. Current Fisheries Statistics - Florida Monthly Landings. *U.S. Dep. Commer. NOAA, NMFS* (before 1968 by *U.S. Dep. Inter. Fish. Wildl. Serv.*). Washington, D.C.

Fishery Statistics of the United States. 1953–1977. Statistical Digest Nos. 27, 30, 34, 36, 39, 41, 43, 44, 51, 53, 54, 65–68. *U.S. Dep. Commer. NOAA, NMFS* (before 1968 by *U.S. Dep. Inter. Fish. Wildl. Serv.*). Washington, D.C.

Houde, E. D. 1977. Abundance and potential yield of Atlantic thread herring, *Opisthonema oglinum,* and aspects of its early life history in the eastern Gulf of Mexico. *U.S. Natl. Mar. Fish. Serv. Fish. Bull.* 75:493–512.

Kemmerer, A. J., J. A. Benigno, G. B. Reese & F. C. Minkler. 1974. Summary of selected early results from the ERTS–1 menhaden experiment. *U.S. Natl. Mar. Fish. Serv. Fish. Bull.* 72:375–390.

Klima, E. F. 1959. Aspects of the biology and the fishery for Spanish mackerel, *Scomberomorus maculatus* (Mitchill), of southern Florida. *Fla. Board Conserv. Mar. Res. Lab. Tech. Ser.* No. 27. 39 pp.

Lyles, C. H. 1969. The Spanish and king mackerel fisheries. *U.S. Fish. Wildl. Serv. Curr. Fish. Stat.* No. 4936. 19 pp.

Powell, D. 1975. Age, growth, and reproduction in Florida stocks of Spanish mackerel, *Scomberomorus maculatus. Fla. Mar. Res. Publ.* 5. 21 pp.

Prochaska, F. J. & J. C. Cato. 1977. Economic analyses of production and marketing of Florida east coast king and Spanish mackerel. In *Mackerel Workshop Report,* Austin et al. (eds.), Univ. Miami Sea Grant Publ. No. 14:97–119.

Schroeder, W. C. 1924. The fisheries of Key West and clam industry of southern Florida. *U.S. Bur. Fish., Rep. U.S. Commer. Fish.* 1923. Append. 12. 77 pp.

Shaw, D. A. & R. E. Warner. In press. Mackerel resources of Monroe County and adjacent areas. *Marine Resource Inventory.* Fla. Coop. Extension Service.

Trent, L. & P. J. Pristas. 1977. Selectivity of gill nets on estuarine and coastal fishes from St. Andrew Bay, Florida. *U.S. Natl. Mar. Fish. Serv. Fish. Bull.* 75:185–198.

U.S. Department of the Interior. 1972. 1970 National survey of fishing and hunting. *U. S. Sport Fish. Wildl. Resour. Publ.* 95. 106 pp.

APPENDIX TABLE 1.

Spanish and king mackerel landings by area in the United States, 1968–1976

	Middle Atlantic		Chesapeake		South Atlantic		Gulf		Total United States	
Year	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	(Thousands of pounds and thousands of dollars)									
	Spanish mackerel									
1968	*	*	60	10	4,484	391	7,232	812	11,776	1,213
1969	*	*	124	18	2,452	266	8,342	759	10,918	1,243
1970	*	*	201	31	3,639	468	8,298	972	12,138	1,471
1971	*	*	52	9	2,381	323	7,658	858	10,391	1,190
1972	*	*	23	4	3,475	441	7,222	893	10,720	1,338
1973	*	*	50	9	3,276	548	6,457	1,027	9,783	1,584
1974	2	*	24	4	2,422	468	8,554	1,480	11,002	1,952
1975	*	*	62	12	5,210	911	6,138	1,040	11,410	1,963
1976	*	*	80	13	9,627	1,766	8,342	1,466	18,049	3,245
	King mackerel**									
1968	*	*	3	1	2,594	505	3,604	464	6,201	970
1969	*	*	2	*	2,961	603	3,242	415	6,205	1,018
1970	*	*	5	1	4,351	1,018	2,372	320	6,728	1,339
1971	*	*	7	1	2,923	823	2,738	472	5,668	1,296
1972	*	*	2	*	3,499	1,054	1,378	255	4,879	1,309
1973	*	*	7	1	3,749	1,549	2,217	597	5,974	2,147
1974	*	*	15	4	4,317	1,706	6,133	1,594	10,465	3,304
1975	*	*	13	4	3,806	1,780	2,622	640	6,441	2,424
1976	*	*	9	4	4,989	2,654	2,802	891	7,800	3,549

*Less than 500 pounds or $500.
**Includes the catch of cero *Scomberomorus regalis*
NOTE: These tabulations do not include a negligible production in New England.

APPENDIX TABLE 2.

Spanish and king mackerel landings in the middle Atlantic and Chesapeake states, 1968–1976

	New York		New Jersey		Total		Maryland		Virginia		Total	
Year	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
					(Thousands of pounds and thousands of dollars)							
					Spanish mackerel							
1968	*	*	*	*	*	*	2	*	58	10	60	10
1969	**	**	**	**	**	**	1	*	123	18	124	18
1970	*	*	*	*	*	*	1	*	200	31	201	31
1971	*	*	*	*	*	*	1	*	51	9	52	9
1972	*	*	*	*	*	*	*	*	23	4	23	4
1973	*	*	*	*	*	*	*	*	50	9	50	9
1974	*	*	*	*	*	*	*	*	24	4	24	4
1975	*	*	*	*	*	*	*	*	62	12	62	12
1976	*	*	*	*	*	*	*	*	80	13	80	13
					King mackerel							
1968	*	*	*	*	*	*	*	*	3	1	3	1
1969	*	*	*	*	*	*	*	*	2	*	2	*
1970	*	*	*	*	*	*	*	*	5	1	5	1
1971	*	*	*	*	*	*	*	*	7	1	7	1
1972	*	*	*	*	*	*	*	*	2	*	2	*
1973	*	*	1	*	1	1	*	*	7	1	7	1
1974	*	*	*	*	*	*	*	*	15	4	15	4

*Less than 500 pounds or $500.
**Data not available.
NOTE: Production is limited to New York and New Jersey in the middle Atlantic states.

APPENDIX TABLE 3.

Spanish and king mackerel landings in the south Atlantic states, 1968–1976

	North Carolina		South Carolina		Georgia		Florida East Coast		Total	
Year	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	(Thousands of pounds and thousands of dollars)									
	Spanish mackerel									
1968	69	8	8	1	1	*	4,406	382	4,484	391
1969	89	12	4	1	*	*	2,359	253	2,452	266
1970	63	9	2	*	*	*	3,574	459	3,639	468
1971	95	14	4	1	*	*	2,582	308	2,681	323
1972	96	13	5	1	5	1	3,369	426	3,475	441
1973	64	9	4	*	5	1	3,203	538	3,276	548
1974	73	9	2	*	1	*	2,346	459	2,422	468
1975	49	7	10	2	6	1	5,145	901	5,210	911
1976	31	5	4	1	3	1	9,589	1,777	9,627	1,784
	King mackerel									
1968	8	2	*	*	*	*	2,586	503	2,594	505
1969	16	4	2	*	*	*	2,943	599	2,961	603
1970	12	3	*	*	1	*	4,338	1,015	4,351	1,018
1971	9	2	6	1	1	*	2,907	820	2,923	823
1972	9	3	1	*	*	*	3,489	1,051	3,499	1,054
1973	26	7	11	5	*	*	3,712	1,537	3,749	1,549
1974	40	24	4	2	6	2	4,267	1,678	4,317	1,706
1975	100	60	8	4	1	1	3,697	1,715	3,806	1,780
1976	156	109	8	5	4	2	4,821	2,538	4,989	2,654

*Less than 500 pounds or $500.

APPENDIX TABLE 4.

Spanish and king mackerel landings in the gulf states, 1968–1976

Year	Florida West Coast		Alabama		Mississippi		Louisiana		Texas		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	(Thousands of pounds and thousands of dollars)											
	Spanish mackerel											
1968	7,066	797	39	3	114	11	10	1	3	*	7,232	812
1969	8,175	946	85	6	12	1	70	6	*	*	8,342	959
1970	8,100	939	126	26	43	5	29	2	*	*	8,298	972
1971	7,383	830	56	5	179	20	40	3	*	*	7,658	858
1972	6,532	816	91	9	485	57	114	11	*	*	7,222	893
1973	6,194	999	76	6	98	14	89	8	*	*	6,457	1,027
1974	8,267	1,444	54	6	41	6	192	24	*	*	8,554	1,480
1975	5,621	961	92	11	225	39	200	29	*	*	6,138	1,040
1976	7,783	1,360	45	5	379	82	135	19	*	*	8,342	1,466
	King mackerel											
1968	3,604	464	*	*	*	*	*	*	*	*	3,604	464
1969	3,242	415	*	*	*	*	*	*	*	*	3,242	415
1970	2,372	320	*	*	*	*	*	*	*	*	2,372	320
1971	2,738	472	*	*	*	*	*	*	*	*	2,738	472
1972	1,378	255	*	*	*	*	*	*	*	*	1,378	255
1973	2,217	597	*	*	*	*	*	*	*	*	2,217	597
1974	6,133	1,594	*	*	*	*	*	*	*	*	6,133	1,594
1975	2,622	640	*	*	*	*	*	*	*	*	2,622	640
1976	2,802	891	*	*	*	*	*	*	*	*	2,802	891

*Less than 500 pounds or $500.

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RECREATIONAL AND COMMERCIAL FISHERIES FOR KING MACKEREL, *Scomberomorus cavalla,* IN THE SOUTH ATLANTIC BIGHT AND GULF OF MEXICO, U.S.A.

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Abstract United States commercial landings of king mackerel, *Scomberomorus cavalla,* have been recorded fairly regularly since 1880. Catches over the last 17 years have averaged 5.6 million pounds (2,541 metric tons) valued at $1.3 million. The largest catch in recent years was made in 1974 – 10.5 million pounds (4,764 metric tons). The bulk of the landings was made in Florida by hook-and-line and gill nets.

Recreational-catch statistics are insufficient from a managerial standpoint. Most studies have been limited by being too local or of short duration. Species catch data from national surveys made in 1965, 1970, and 1975 are viewed with skepticism by most fishery scientists. Ratios of recreational-to-commercial (R/C) landings are 19.7, 9.3 and 1.3 ($\bar{X}$ = 9.1) for the three years. Anglers capture king mackerel from charter boats, small private boats, piers and bridges, by trolling, casting, or float fishing.

Certain biotic and abiotic factors influencing use and management of the resource include: growth rate, longevity, age and size at sexual maturity, fecundity, feeding, natural mortality, migrations, and habitat characteristics.

INTRODUCTION

The king mackerel, *Scomberomorus cavalla,* is important to both commercial and recreational fisheries in the western Atlantic. It is a rather widely distributed coastal pelagic species ranging from the Gulf of Maine (occasionally) to Brazil, including the Caribbean and Gulf of Mexico (Randall 1968) (Figure 1). *S. cavalla* is the largest member of the genus, certainly in the western Atlantic (up to 5.5 feet and 100 pounds), and its size led to the species name derived from the Spanish word for horse (Jordan and Evermann 1896). Fish in the 40- to 50-pound class are fairly common off North Carolina and also in the Gulf of Mexico, particularly off Louisiana (Lee Trent, personal communication).

Like other members of the coastal pelagic community, the king mackerel is a highly transitory species. Migrations appear to be more complex than the typical temperate zone pattern of southward in fall and winter, and northward in spring and summer. It is a spring, summer, and fall visitor along the southeastern United States north to North Carolina and Virginia and rarely up to New England. Migration patterns are not as clear in the Gulf of Mexico where tagging studies reveal a winter movement of fish tagged in the northern gulf to the keys, and also some exchange between stocks of the southeastern gulf states.

It is during these seasonal visitations that king mackerel attract the interests of commercial and recreational fishermen. Millions of pounds are landed annually in Chesapeake, south Atlantic, and gulf ports, generating millions of dollars in revenue. In 1974, 10.5 million pounds (4,764 metric tons) were landed commercially, valued at $3.3 million (Bell and FitzGibbon 1977). Recreational catches have greatly exceeded commercial landings as indicated by Deuel and Clark's (1968) estimate of 90.4 million pounds (41,016 metric tons) for 1965.

Considering the importance of the species, it should come as no surprise that much as been written about the fish. An annotated bibliography by Manooch et al. (in press) on western Atlantic *Scomberomorus* includes several hundred references to king mackerel, most of which merely mention the species incidental to others. However, biological and catch-and-effort information has been provided recently by Brazilian scientists, and from the United States by Beaumariage (1973). But Manooch et al. (in press) points out in reference to North American research, "There are deficiencies or gaps of knowledge in recreational catch and effort, migration patterns and stock identity, and large scale life history studies all of which are essential in formulating management plans for this important fishery resource".

The primary objectives of this paper are to (1) review briefly aspects of the life history and habitats of king mackerel, (2) discuss commercial and recreational fisheries, and (3) discuss the constraints that the environment and biological characteristics of the species place on its management.

ENVIRONMENTAL AND BIOPROFILE REVIEW

Coastal pelagic ecosystem. The king mackerel is but one of many species of coastal pelagic fishes. Several of the more prestigious to fishery interests, besides *S. cavalla,* are Spanish mackerel *S. maculatus,* cero *S. regalis,* little tunny *Euthynnus alletteratus,* and bluefish *Pomatomus saltatrix.* These large predators roam the coastal waters off the southeastern and gulf states, composing a dynamic, seasonally fluctuating subsystem. They occur in the neritic zone, or intertidal to shelf break waters, and therefore are generally

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Figure 1. Distribution of king mackerel.

shoreward of the oceanic species, such as dolphin and billfishes.

The availability of the resource is dictated by abiotic conditions such as temperature, depth, photoperiod, currents, salinity, and perhaps turbidity, in addition to the occurrence of food. Munro (1943) stated that temperature and depth limited the distribution of members of the genus *Scomberomorus;* 20°C was the minimum and species generally did not occur deeper than 40 fathoms. Also, they preferred medium salinity, neither low as in oligohaline estuaries, or high as in open ocean waters. Annual production in the coastal (neritic) zone is fairly low, sandwiched by fertile estuaries and the relatively sterile oceanic waters. Odum (1971, p. 51) ranked various ecosystems by the gross primary productivity (g C/m^2/yr). Estuaries were highest, 2,000, open areas lowest, 100, and coastal zones produced 200 g C/m^2/yr. Energy sources to the system are diversified. In addition to migrating organisms (fishes, crabs, shrimp, etc.), euphotic zone fixation, watershed runoff, and transport from offshore waters are important.

Reproduction. *S. cavalla* is a heterosexual species; a fish is either male or female. The majority of the females collected off Florida spawn for the first time at Age IV and males at Age III (Beaumariage 1973). Lengths and weights for these two ages are 819 mm SL (5.0 kg) and 718 mm SL (3.2 kg). Ivo (1972) found that king mackerel taken from Brazilian waters first attain sexual maturity between Ages V and VI.

Spawning presumably occurs at sea and not in immediate coastal waters or associated estuaries. Beaumariage (1973) reported protracted spawning from April through November, and Ivo (1972) suggested that spawning took place throughout the year. This protracted reproductive activity has been substantiated by Dwinell and Futch (1973) who found larvae in June, August, and September off northwestern Florida.

Females are capable of producing millions of eggs each year. Using equations derived by Ivo (1974), I calculated fecundity as 1.3 million eggs for a fish 100 cm TL, 1.5 million at Age X, and 2.3 million for a fish weighing 9,080 g (20 lbs) using the equation provided for length, age, and weight.

Age and Growth. Although king mackerel may live for at least 13 years, fish older than VII were seldom sampled from the Florida fishery (Beaumariage 1973). Females appear to grow more rapidly than males, and growth for both sexes is rapid for the first four years. Back-calculated lengths (mm SL) for Ages I, IV, and VII for males and females were: I – 433, 464; IV – 702, 798; and VII – 781, 958. Theorectical growth equations for *S. cavalla* vary drastically between the sexes and geographic areas:

Florida (Beaumariage 1973):

$$l_t = 840\ [1 - e^{-0.35\ (t + 2.5)}]\text{, for males}$$

and

$$l_t = 1{,}150\ [1 - e^{-0.21\ (t + 2.4)}]\text{, for females.}$$

Brazil (Nomura and Rodrigues 1967):

$$l_t = 1{,}160\ [1 - e^{-0.18\ (t + 0.22)}]\text{, for males,}$$

and

$$l_t = 1{,}370\ [1 - e^{-0.15\ (t + 0.13)}]\text{, for females.}$$

Instantaneous mortality rates (Z) have been estimated and range from 0.65 to 0.77 (Rodrigues and Bezerra 1968, Beaumariage 1973).

Foods. The king mackerel has been accurately described as a voracious carnivore. It is common to see kings attacking schools of forage fishes, at times pushing the "bait" right up to the water's surface. Availability of food and water temperature are probably the two most important factors affecting migrations of *S. cavalla.* As small fishes move along the coast the predators follow, and as forage fishes migrate out of the estuaries in spring and fall, king mackerel and other piscivorous species prey upon them.

Analysis of stomach contents indicate that the species feeds on a variety of foods, but is mainly piscivorous. Menezes (1969) found fish, crustaceans, mollusks, and some plant material in the digestive tracts of *S. cavalla* landed in Brazil. The thread herring, *Opisthonema oglinum,* a clupeid fish was the most frequently encountered food. Knapp (1950), in a Texas study, reported fish and shrimp to be most important in the diet. Clupeids occurred in 59% of the stomachs containing food. Invertebrates (shrimp, squid) were of secondary importance. A study in Onslow Bay, North Carolina, of 205 king mackerel again revealed the piscivorous nature and also seasonal trends in the diet (DeVane 1978). Fish, mainly Atlantic menhaden, *Brevoortia tyrannus,* and thread herring, were identified in 100% of the stomachs in spring, 98% in summer, and 94% in fall. Clupeids were eaten frequently in spring and summer, but only rarely in the fall as the forage fishes were more diversified.

FISHERIES

The following discussion on aspects of the commercial and recreational fisheries for king mackerel is a synthesis of information provided by other authors (Beaumariage 1973; Austin et al. 1978; Berrien and Finan 1977; and Manooch, in press).

Commercial. A variety of fishing gear is used to catch king mackerel. According to the U.S. Fishery Digests commercial fishermen use gill nets (anchored, drifting, and runaround), trolled lines, hand lines, haul seines, trammel nets, pound nets, and otter trawls. Most of the landings in recent years have been made by hook-and-line and gill-net fishermen. Runaround gill nets are used almost exclusively in Florida and are relatively new (since 1963). The nets are

400 to 700 yards long, about 200 meshes deep, and have a stretch mesh of 4-3/4 inches. They are capable of fishing in water 70 feet deep and are retrieved with power blocks. An average set may yield 8,000 to 10,000 pounds and catches from 30,000 to 50,000 pounds per set have been made. Spotter aircraft are sometimes used to assist fishermen in locating schools of fish and direct setting of the nets. This technological development could have an impact on the resource. Besides these runaround gill nets, other nets are allowed to float free in the currents or are anchored in place, often perpendicular to shore.

The traditional method of commercial fishing is by hook and line. Lines with spoons or feathered jigs (sometimes with strips of mullet or squid) are trolled behind boats and are retrieved manually or with hydraulic or electrical reels. North Carolina fishermen usually use 300-pound monofilament line trolled on the surface or at various depths by using planers or weights. Catches of 1,000 to 2,000 pounds per boat-day are not unusual for boats fishing off the North Carolina Capes in spring and fall. Florida commercial handliners usually use No. 9 trolling wire and may land 2,000 to 4,000 pounds per boat-day and 50,000 pounds per year.

Although kings are landed commercially from the Chesapeake, south Atlantic, and gulf regions, there are four major areas: North Carolina; Port Salerno, Florida to Sebastian, Florida; Florida Keys; and in the vicinity of Naples, Florida. There is no commercial fishery for king mackerel in the northern Gulf of Mexico, even though there is a thriving recreational fishery there. The species ranks tenth in pounds landed in the south Atlantic and fourth in value, and for the gulf, eighth in pounds and seventh in value (Table 1). Florida contributes almost all of the commercial landings in the United States. In 1976, 96.5% of the king mackerel caught commercially along the east coast were landed in Florida and 100% of the fish landed in the Gulf of Mexico were caught off Florida's west coast (Table 2).

TABLE 1.

Ranking of the most important species of finfish landed by commercial fishermen in the south Atlantic and Gulf of Mexico, 1974 (Fishery Statistics of the United States 1974).

South Atlantic			Gulf of Mexico		
Species	10^3 pounds	10^3 dollars	Species	10^3 pounds	10^3 dollars
Menhaden	133,837	3,288	Menhaden	1,295,680	48,341
Catfish and bullheads	13,467	3,533	Black mullet	27,748	3,363
Flounders	12,142	2,928	Croaker	14,539	1,864
Spot	7,729	926	Spanish mackerel	8,554	1,480
Alewives	6,297	250	Red snapper	8,432	5,586
Croaker	6,195	619	Spotted trout	7,040	2,366
Gray trout	6,187	657	Grouper	6,458	2,165
Black mullet	5,749	571	King mackerel	6,133 (8th)	1,594 (7th)
Thread herring	4,448	126			
King mackerel	4,317 (10th)	1,706 (4th)			

TABLE 2.

Commercial landings of king mackerel by state and region, 1976.

East Coast			Gulf Coast		
State	Pounds	Percent	State	Pounds	Percent
Maryland	*	0.00	Texas	*	0.00
Virginia	9,000	0.18	Louisiana	*	0.00
North Carolina	156,000	3.12	Mississippi	*	0.00
South Carolina	8,000	0.16	Alabama	*	0.00
Georgia	4,000	0.08	Florida	2,802,000	100.00
Florida	4,821,000	96.46			
Total	4,998,000	100.00		2,802,000	100.00

*Less than 500 pounds.

Commercial landings are influenced by seasonal migrations; generally northward in spring and summer and southward in fall and winter. In Florida the seasonal distribution of the catch is clearly defined (Figure 2). Beaumariage (1973) divided the state into five areas and graphed the cube root of the landings of king mackerel by month for each area. Peak catches in south Florida are made in winter and early spring (about 10 weeks; January through March) and in northwest Florida in summer and fall. On the east coast of the state, catch and effort peaks from December through March. Kings are caught off North Carolina primarily in the spring, April and May, and in the fall, September through November.

United States commercial landings have been recorded since 1880 (U.S. Fishery Statistics) and a paper by Trent and Anthony (in this colloquium) presents these data through 1976. The largest catch in recent years, 1960 through 1976, was made in 1974; 10.5 million pounds valued at $3.3 million (Table 3). Commercial catches have averaged 5.6 million pounds annually for the past 17 years and are fairly evenly divided between the south Atlantic region ($\overline{X}$ = 3 million pounds) and the gulf region ($\overline{X}$ = 2.6 million pounds). The Chesapeake region contributes a relatively minor portion of the total commercial catch. Although no trends in the overall landings are evident, catches from 1974 through 1976 have been high, and the 1977 catch is reported to have been good. It is unfortunate that we have no way of knowing what the level of fishing effort was during these years.

Recreational. Recreational anglers fish for king mackerel from charter boats,* party or headboats,** large and small private boats, piers, bridges, and occasionally from the surf. Three basic techniques are used to catch this species. Fishermen aboard boats often troll at or below the surface using lures similar to those used by the commercially-trolled lines fishery. Trolling is usually done in a haphazard fashion until fish are hooked, and then the boats circle the area until the catch rate diminishes. Another technique is to cast baits at schools of mackerel from a fixed platform (bridge or pier) or boat. The lure is retrieved with a jerking motion and is referred to as jigging. The third technique is float fishing; interest in this method has increased drastically over the past several years. This type of fishing is usually done from a drifting or anchored boat, although it can be accomplished from a fixed platform. Hooks are baited with live fish (pinfish, bluefish, seatrout, etc.) suspended 10 to 15 feet below the surface with a float. Fishermen along the west coast of Florida frequently use injured scaled sardines to chum kings and then troll the area.

*Charter boats furnish fishing trips at a fixed daily rate regardless of the number of passengers, usually less than eight.

**Headboats furnish fishing trips and charge on a per passenger basis. Headboats are larger than charter boats, and carry from 15 to 150 anglers.

Fishing areas and seasons are almost identical to the commercial fishery. A notable exception is the northern Gulf of Mexico which supports a recreational but not a commercial fishery.

The sport catch appears to be large; probably 2 to 10 times greater than the commercial landings (various personal communications). Unfortunately catch statistics for the recreational segment of the fishery are inadequate for management. There have been numerous studies, localized and of short duration, which at best indicate the *potential* magnitude of the sport catch. Large scale or national surveys, in 1965, 1970 and 1975, present species catch data which are viewed with skepticism by most fishery scientists. These surveys were made by telephone and depended on a long recall period (up to 12 months). They often totally missed significant species and landings for a given geographical area. The surveys do indicate enormous catches of fishes by anglers. Ratios of recreational-to-commercial (R/C) landings for 1965, 1970, and 1975 ranged from a high of 27.6 for the south Atlantic in 1965, to a low of 0.5 for the same geographical area in 1975. The overall average was 9.1 (Table 4). It is necessary to view these data with caution and refrain from using them just because they constitute the only data available at this time. Coordinated, regional surveys of the recreational fishery will be required to develop the information necessary for decisions by those responsible for management of the stock(s).

FACTORS WHICH MAY AFFECT MANAGEMENT

There are numerous abiotic factors which could affect the wise use of the king mackerel resource. The major abiotic factors are water temperature and depth which have been referred to previously in this paper. Biotic factors include both extrinsic factors related to the biological segment of the fish's physical environment and intrinsic factors characteristic of the physiological and behavioral responses of individuals. Both types of biotic factors will be discussed here.

The coastal pelagic species compose a dynamic, seasonally fluctuating subsystem which migrates through the coastal waters of the South Atlantic Bight and the Gulf of Mexico. While other finfish communities important to recreational and commercial fisheries are often limited to available habitat and localized production, mackerels are not. Should local conditions deteriorate, the species can migrate. Populations tend to be large and capable of sustaining relatively large catches. As migratory stocks move from one geographical area to another, often vastly different types of areas, they utilize seasonal pulsations in productivity. This is particularly obvious in temperate zones where the predatory species capitalize on the migrations of forage fishes in and out of estuaries in the fall and spring. Migrating stocks are incorporated into the energy cycle of an area, become an active part of that cycle, and then break away and emigrate.

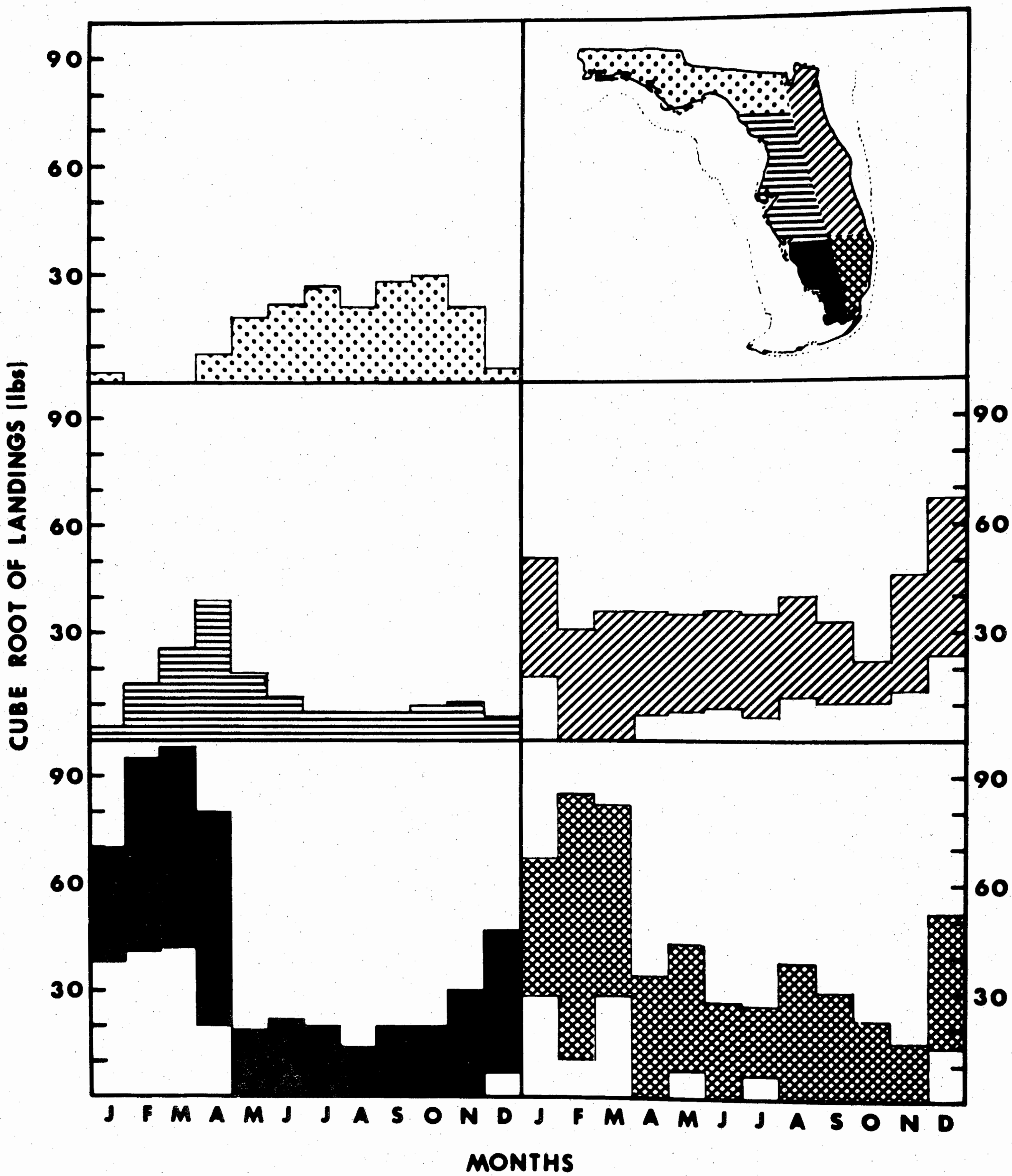

Figure 2. Seasonal Florida landings of king mackerel (from Beaumariage 1973).

TABLE 3.

Commercial United States landings of king mackerel (*S. cavalla*) by regions in thousands of pounds and value in thousands of dollars, 1960–1976.

	Chesapeake		South Atlantic		Gulf		Total	
Year	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
1960	5	1	1,857	236	1,785	182	3,647	419
1961	18	3	2,120	279	1,683	175	3,821	457
1962	8	1	2,129	313	2,021	218	4,158	532
1963	10	1	2,231	259	2,817	296	5,058	556
1964	37	5	2.108	292	1,314	110	3,459	407
1965	6	1	2,688	402	1,898	232	4,592	635
1966	7	1	1,881	342	2,633	320	4,521	663
1967	3	1	3,012	502	3,080	351	6,095	854
1968	3	1	2,594	505	3,604	464	6,201	970
1969	2	*	2,961	603	3,242	415	6,205	1,018
1970	5	1	4,351	1,018	2,372	320	6,728	1,339
1971	7	1	2,923	823	2,738	472	5,668	1,296
1972	2	*	3,499	1,054	1,378	255	4,879	1,309
1973	7	1	3,749	1,549	2,217	597	5,973	2,147
1974	15	4	4,317	1,706	6,133	1,594	10,465	3,304
1975	13	4	3,806	1,780	2,622	640	6,441	2,424
1976	9	4	4,989	2,654	2,802	891	7,800	3,549
Mean	9	2	3,013	842	2,608	443	5,630	1,287
							1,736	991

*Less than $500.

TABLE 4.

Comparison of commercial and recreational catches (10^3 pounds) of king mackerel from south Atlantic and gulf states, 1965, 1970, and 1975.

	South Atlantic			Gulf			
	1965	1970	1975	1965	1970	1975	Total
Commercial	2,688	4,351	3,806	1,898	2,372	2,622	17,737
Recreational	74,132	34,942	2,014*	16,299	27,459	6,649	161,495
Ratio: Recreational/Commercial	27.6	8,0	0.5	8.6	11.6	2.5	9.1

*No recreational catch record for Florida east coast in 1975.

The impact is immense in terms of energy transfer by death, waste products, reproduction, and food consumption. The productivity of one location, whether Texas, Florida, Louisiana, etc., becomes the productivity of another location linked by the migratory species.

While habitat is not limiting to king mackerel in the usual sense of rigid geographical confinement the fact that the species is gregarious and forms dense schools could be limiting. Schools are often visible to fishermen and therefore may be subjected to heavy fishing pressure. Susceptibility is drastically increased with the use of airplanes to locate fish and direct the deployment of commercial fishing gear.

The principal intrinsic factors of concern are growth characteristics, natural mortality rates, and reproductive characteristics. For this discussion I have chosen to compare the king mackerel, representing the coastal pelagic species, with the snapper-grouper complex (Table 5 and Figure 3). Both of these groups have received a high priority status by

TABLE 5.

A comparison of some biological and environmental factors of *S. cavalla* (coastal pelagics) versus reef fish (snapper-grouper complex) and possible affects on management strategies.

Factor	Fish community	
	King mackerel (coastal pelagics)	Reef fish (snapper-grouper complex)
Habitat	Entire continental shelf to 100 fathoms (relatively nonrestricted)	High and low profiles; live bottom, shelf break, wrecks, etc.
Migrations	Highly migratory	Relatively sedentary (located, relocated, and overfished)
Schooling	Dense schools, often visible from the surface (possibility of overexploitation)	Aggregations
Juvenile habitat	No coastal or estuarine dependency	Some of the species young are found inshore, even estuarine (subject to man's influence)
Recruitment of young	Pelagic-pelagic	Pelagic-demersal (probably limited by habitat availability)
Rate of growth	Fast	Slow (population slow to recover after exploitation)
Longevity	Relatively short-lived	Long-lived (as above)
Age recruited by fishery	Generally before they are sexually mature	Mature fish
Fecundity	Produce many eggs	Moderate
Hermaphroditism	No evidence	Some (serranids, sparids)

South Atlantic and Gulf Fishery Management Councils.

Pelagic species attain their maximum size very rapidly. They are not only fast growing but are also relatively short-lived and experience high annual mortality rates compared with some other species. Fishery science has demonstrated that species displaying these growth-related characteristics can be fished fairly heavily without overexploitation; stock replenishment should be rapid.

Although the maximum age for king mackerel has been reported as Age XIII, very few individuals older than VII were sampled from the fishery, and theoretical and back-calculated growth were obtained by using fish of Age VIII (Beaumariage 1973). Management of the resource will certainly require close analysis of age and growth data and the derivation of yield per recruit models using a range of instantaneous rates of fishing.

Reproductive strategies such as high fecundity and protracted spawning have definite advantages, because eggs and larvae are not highly susceptible to short-term environmental degradation. Also, juvenile king mackerel are not estuarine dependent. While currents, temperatures, and other occurring conditions can adversely affect spawning or survival of young, man's negative influence is presently minimal on offshore nursery areas. An aspect which may be working to the detriment of the resource is the removal of potential spawners by fishing from the stock(s) before they can reproduce for the first time. Recruitment to both commercial and recreational fisheries occurs at Ages II and III, and these two age groups provide the bulk of the landings (Beaumariage 1973).

In summary, the king mackerel, because of its speed, is able to avoid the hazards of barren ocean areas and can move wherever temperature and food supply favor its existence. Most of the South Atlantic Bight and Gulf of Mexico, and much of the western Atlantic is available to *S. cavalla*, and population sizes tend to be much larger and nonrestricted compared to relatively sedentary species. Speed and mobility are dependent on body size and shape; thus, selection favors rapid growth with its associated cost in decreased longevity. Short-lived, fast-growing fishes offer more opportunity for fisheries utilization than slow-growing species. Commercial catch statistics reveal an increase in landings over the past several years. We still have much to learn before proper management, including allocation of the resource, can be formulated. As mentioned in the introductory comments, future research should be directed at collection and analysis of recreational catch-and-effort data for the entire fishery, stock(s) identification and clarification of migration patterns, and large-scale life history studies carefully directed to complement ongoing and completed research.

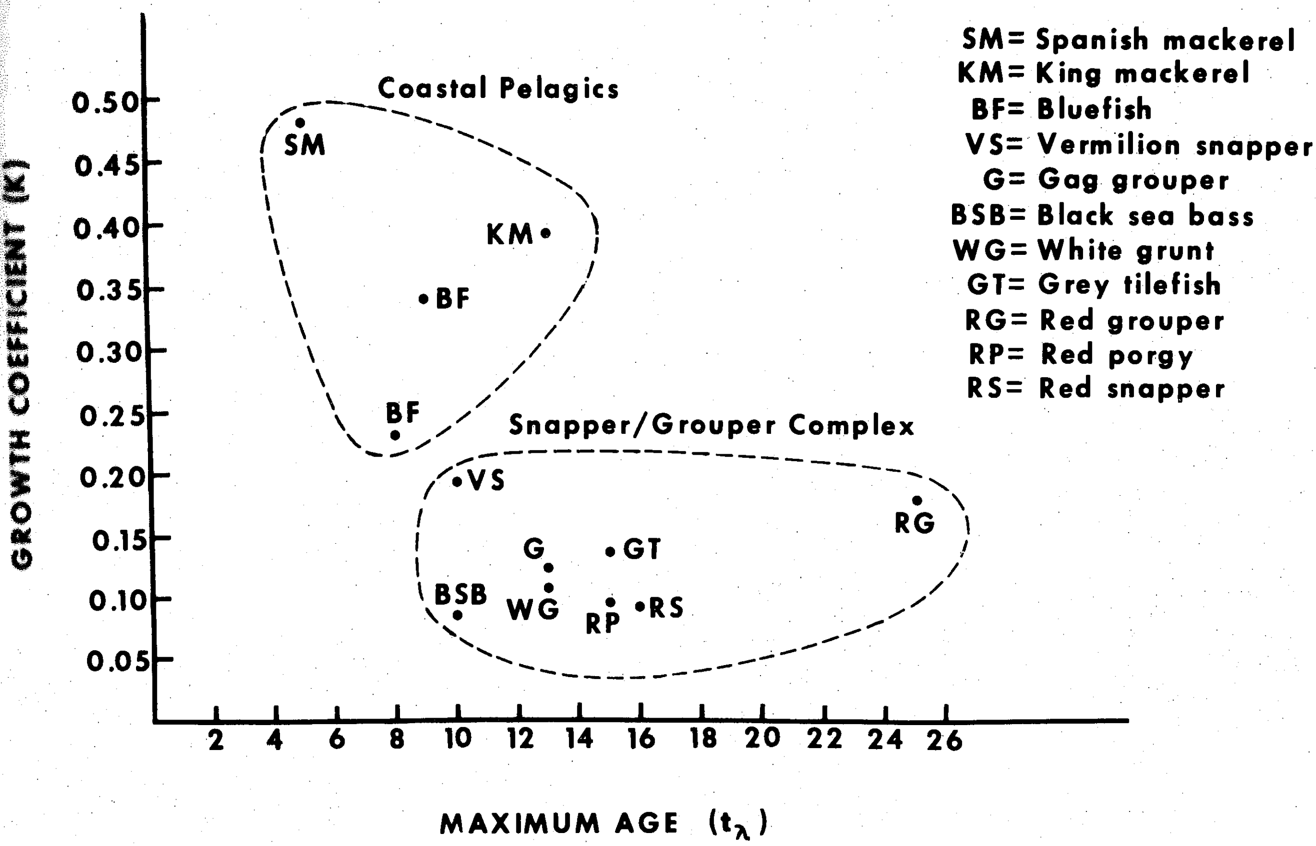

Figure 3. Plot of maximum age and growth coefficient for selected marine species of fish.

REFERENCES CITED

Austin, D.B., J. A. Browder, R. Brugger & J. C. Davis. 1978. Mackerel workshop report. *Univ. Miami Sea Grant Publ.* No. 14. 156 pp.

Beaumariage, D. S. 1973. Age, growth, and reproduction of king mackerel, *Scomberomorus cavalla,* in Florida. *Fla. Mar. Res. Publ.* 1.45 pp.

Bell, T. I. & D. S. FitzGibbon. 1977. Fishery statistics of the United States, 1974. *U.S. Natl. Mar. Fish. Serv. Stat.* 68. 425 pp.

Berrien, P. & D. Finan. 1977. Biological and fisheries data on king mackerel, *Scomberomorus cavalla* (Cuvier). *U.S. Dep. Commer. Natl. Mar. Fish. Serv.,* Sandy Hook Lab., *Tech. Ser. Rep.* No. 8. 40 pp. Highlands, N.J.

Deuel, D. G. & J. R. Clark. 1968. The 1965 salt-water angling survey. *U.S. Fish. Wildl. Serv. Resour. Publ.* 67. 51 pp.

DeVane, J. C. Jr. 1978. Food of king mackerel, *Scomberomorus cavalla,* in Onslow Bay, North Carolina. *Trans. Am. Fish. Soc.* 107(4):583–586.

Dwinell, S. E. & C. R. Futch. 1973. Spanish and king mackerel larvae and juveniles in the northeastern Gulf of Mexico, June through October 1969. *Fla. Dep. Nat. Resour. Mar. Res. Lab. Leafl. Ser.* 4(1), No. 24. 14 pp.

Ivo, C. T. C. 1972. Epoca de desova e idade na primerira maturacao sexual da cavala, *Scomberomorus cavalla* (Cuvier), no Estado do Ceará (in Portuguese, English summary). *Arq. Ciên. Mar.* 12(1): 27–29.

________. 1974. Sôbre a fecundidade da cavala, *Scomberomrous cavalla* (Cuvier), em águas consteiras do Estado do Ceará (Brazil) (in Portuguese, English summary). *Arq. Ciên. Mar.* 14(2):87–89.

Jordan, D. S. & B. W. Evermann. 1896. The fishes of North and Middle America, Pt. 1. *U.S. Natl. Mus. Bull.* 47:875–876.

Knapp. F. T. 1950. Menhaden utilization in relation to the conservation of food and game fishes of the Texas gulf coast. *Trans. Am. Fish. Soc.* 79:137–144.

Manooch, C. S. III. (In press). Survey of the North Carolina charterboat fishery, 1977. *U.S. Natl. Mar. Fish. Serv. Mar. Fish. Rev.*

________, E. L. Nakamura & A. B. Hall. (In press). Annotated bibliography of four Atlantic scombrids: *Scomberomorus brasiliensis, S. cavalla, S. maculatus,* and *S. regalis. U.S. Dep. Commer. Natl. Mar. Fish. Serv. Spec. Sci. Rep. Fish.*

Menezes, M. F. 1969. Alimentacao da cavala, *Scomberomorus cavalla* (Cuvier), em águas costerias do Estado do Ceará (in Portuguese, English summary). *Arq. Ciên. Mar.* 9(1):15–20.

Munro, I. S. R. 1943. Revision of Australian species of *Scomberomorus. Men. Queensl. Mus.* 12(1):65–95.

Nomura, H. & M. S. S. Rodrigues. 1967. Biological notes on king mackerel, *Scomberomorus cavalla* (Cuvier), from northeastern Brazil. *Arq. Estac. Biol. Mar. Univ. Fed. Ceará.* 7(1):79–85.

Odum. E. P. 1971. *Fundamentals of ecology.* W. B. Saunders Co., Philadelphia. 574 pp.

Randall, J. E. 1968. *Caribbean reef fishes.* T. F. H. Publ., Jersey City, N.J. 318 pp.

Rodrigues, M. S. S. & R. C. F. Bezerra. 1968. Nota sôbre a mortalidade da cavala e da serra no Estado do Ceará (in Portuguese, English summary). *Arq. Estac. Mar. Univ. Fed. Ceará.* 8(2): 157:161.

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EVALUACION PRELIMINAR DE LA POBLACION DE SIERRA, *Scomberomorus maculatus* (MITCHILL), FRENTE A LAS COSTAS DE VERACRUZ

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ENGLISH SUMMARY. The National Institute of Fishery, with the assistance of the Program of Scaled Fish, initiated the study of Spanish mackerel fisheries in 1973 by establishing a basis of operation in the ports of Veracruz and Alvarado. This is a very important commercial fishery which, because of its seasonal abundance, effects the lowering of prices of other species in local markets. Of all the fish resources exploited in the Gulf of Mexico and the Caribbean, Spanish mackerel is the second in volume, following the red grouper, caught on the Campeche Banks. Eighty percent of the Spanish mackerel are produced by the State of Veracruz, and the remainder by Campeche (15%) and Yucatan (5%). Average annual production from 1968 to 1976 was 4,900 metric tons. The greatest annual production of 6,500 metric tons was recorded in 1973, and the least was 3,300 in 1971.

Two major capture seasons are recognized. During March and April, while they are migrating north, 45% of the annual production is realized. From October through December, coincident with the southerly migration, 30% of the catch is taken. The lowest production corresponds with the end of spring and during summer.

Coastal fishermen usually employ beach seines (chinchorros playeros), gillnets (redes agalleras), trolling spoons (curricanes), and for part of 1969, almadrabas (trap nets). The beach seining operation requires 1½ to 2 hours. Approximately three sets are made per day, during the morning. The gillnet is set up in the late afternoon and gathered the following morning with the catch requiring about 1 hour. The almadraba fishes continually; fish are collected three times a day – in the morning, at noon, and in the late afternoon. Trolling with spoons is generally successful in the morning.

The number of fishermen participating in the fishing operations is variable. Groups of 15 to 25 fishermen tend the beach seines and almadrabas, while 2 or 3 handle gillnets and spoons. Fishing boats constructed of wood and fiberglass are 20 to 25 feet long, and have outboard motors of 25 to 45 horsepower.

Coastal fisheries census data on the number of fishermen, fishing gear and boats would be difficult to establish because there are many groups of fishermen scattered along the coast.

From November 1973 through August 1976, weight and length measurements were obtained from 4,755 individuals. An age/length distribution key was developed by age interpretation of otoliths from 323 specimens. All population dynamic estimates generated from this study are based on the fishery analytical methods developed by the senior author. Total length (L) and age (x) were related in the growth equation: $L = 95.6 - 75.35\, e^{-0.140x}$ and the relationship of length to weight is: $W = 0.00629\ L^3$. Similarly, coefficients of total mortality ($Z = 0.903$), natural mortality ($M = 0.693$) and fishing mortality ($F = 0.210$) were computed by this method. Using this information, the exploitation rate ($E = 0.138$) and the population estimate ($P = 36 \times 10^3$ metric tons) were calculated. Vulnerability to fishing pressure (Q) was estimated at 34% for age I, the remaining of ages II through VI are completely vulnerable to capture.

Presently Spanish mackerel are not being overfished based on the comparison of actual to virginal numbers of adults by age which yielded the decrement rate of the stock at 0.84. According to our maximum sustainable yield estimate, actual capture could be doubled to $F = 0.85$ without seriously affecting the reproductive potential, provided that the age distribution of captured fishes remained unchanged.

INTRODUCCIÓN

El Instituto Nacional de Pesca a través del Programa de Pesca de Escama, inició en noviembre de 1973 el estudio de la pesquería de sierra, teniendo como base de operaciones los puertos de Veracruz y Alvarado. Esta pesquería es muy importante comercialmente, ya que su abundancia estacional determina una baja en al precio de otras especies en los mercados locales. Después del mero que se pesca en la plataforma de Yucatán, la sierra ocupa el segundo lugar en volumen de captura entre los recursos de pesca que se explotan actualmente en el Golfo de México y el Mar Caribe, correspondiendo al Estado de Veracruz el 80 por ciento. Otros Estados del Golfo que participan de la captura son Campeche con el 15 por ciento y Yucatán con el 5 por ciento restante.

El promedio anual dentro del período de 1968 a 1976, fue de 4,900 toneladas registrándose la mayor producción en 1973 con 6,500 toneladas y la menor en 1971 con 3,300 toneladas.

Se reconocen dos temporadas de mayor captura. El primer período con el 45 por ciento del volumen anual, se obtiene en los meses de marzo y abril. Durante este período la especie se encuentra migrando hacia el norte; una segunda temporada aporta el 30 por ciento en los meses de octubre a diciembre, cuando se encuentra migrando hacia el sur. Las menores capturas corresponden al término de la primavera y el verano.

Los pescadores ribereños comúnmente emplean chinchorros playeros, redes agalleras, curricanes y, a partir de 1969, almadrabas. Los sistemas en operación son poco selectivos con excepción de la red agallera y el curricán.

En la operación de pesca del chinchorro playero se emplean de 1½ a 2 horas por lance, realizándose en promedio tres veces al día durante la mañana. La red agallera se instala por la noche, y por la mañana se recoge la red y el producto; en cada operación se ocupa un tiempo de una hora aproximadamente. En el caso de la almadraba, que es un arte fija y de operación continua, el producto se recoge tres veces al día, en la mañana, al medio día y por la tarde. La pesca con curricán se realiza por la mañana con la embarcación en marcha.

El número de pescadores que participa en las operaciones de pesca es variable. En el manejo de chinchorros y almadrabas intervienen grupos de 15 a 25 pescadores; en el caso de la red agallera y del curricán, de 2 a 3 pescadores. Las embarcaciones son de madera o de fibra de vidrio de 20 a 25 pies de eslora y con motor fuera de borda de 25 a 48 h.p.

Por lo antes mencionado, se podrá considerar que los métodos, artes de pesca y embarcaciones, se agrupan dentro de la categoría de pesca artesanal en la que intervienen numerosos grupos de pescadores ribereños en diversas localidades, lo cual ha dificultado establecer el censo de pescadores, artes y embarcaciones que integran la pesquería.

MATERIAL Y METODOS

Los datos utilizados en el presente informe, fueron obtenidos de ejemplares muestreados en las plantas de recepción de producto y en las principales localidades de pesca del estado de Veracruz, provenientes de capturas con chinchorro playero, red agallera y almadraba durante los meses de noviembre de 1973 a agosto de 1976.

Durante el período de estudio se midieron 4,755 ejemplares en longitud total agrupándose por frecuencias de talla con intervalos de un centímetro. Para el mismo período se considera la clave edad/longitud total.

El crecimiento en longitud total se expresa mediante la ecuación $L = a - be^{-Kt}$ y la relación peso-longitud total mediante la expresión $W = aL^3$, en base a la interpretación de la edad calendario a partir de otolitos, presentada por uno de los autores (Mendizábal, 1976).

RESULTADOS Y CONCLUSIONES

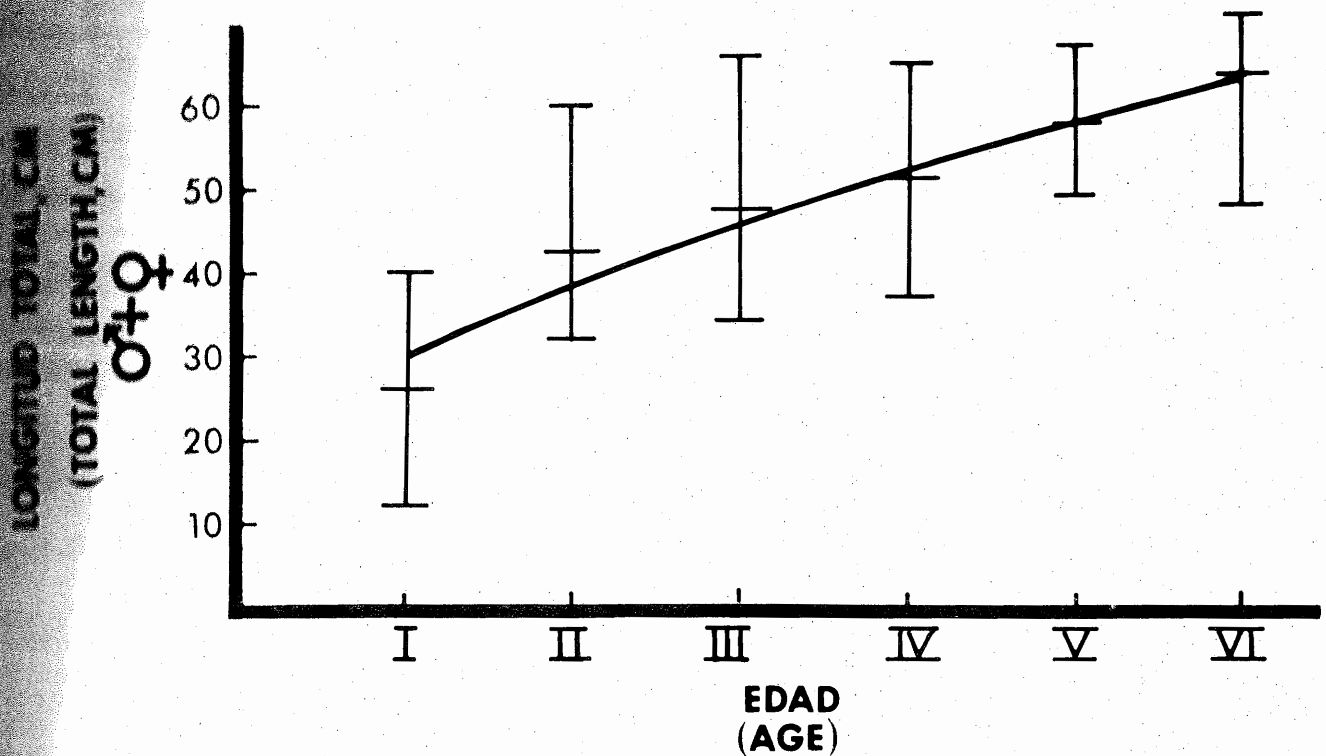
1. Parametros Poblacionales

1.1 ***Clave edad/longitud y crecimiento.*** En la tabla 1 se muestra la clave edad/longitud para 323 ejemplares y a partir de la media obtenida en cada edad, se presenta en la gráfica 1a y 1b el crecimiento observado y calculado en longitud total, mediante la expresión $L = 95.6 - 75.35\, e^{-0.140X}$ y para la relación peso-longitud $W = 0.00629\, L^3$.

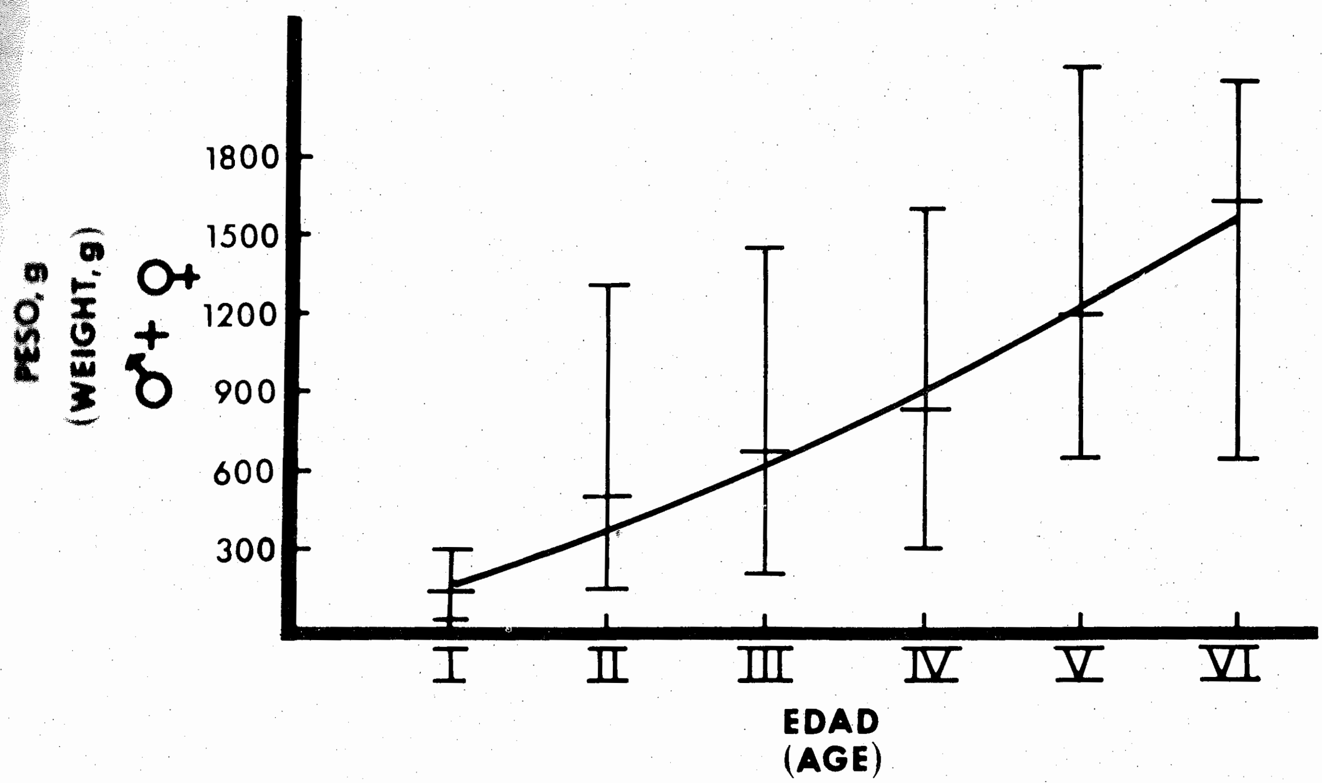
TABLA 1.

Clave edad/longitud total

Longitud cm	Edad I	II	III	IV	V	VI	Total	Longitud cm	Edad I	II	III	IV	V	VI	Total	Longitud cm	Edad I	II	III	IV	V	VI	Total
12	1						1	33	3	2					5	54		2	1	1			4
13								34	2		1				3	55			1	4			5
14								35	2	3	1				6	56		1		2			3
15	2						2	36	1	6					7	57				2			2
16	2						2	37	1	8		1			10	58				4	3		7
17	1						1	38		5		1			6	59			2	2			4
18	3						3	39		8					8	60		2	2		1		5
19	5						5	40	1	8	1				10	61				1			1
20	4						4	41		7	1				8	62				1			1
21	2						2	42		6	5				11	63				1			1
22	1						1	43		4	6	2			12	64					2		2
23	1						1	44		6	8	1			15	65				1			1
24	1						1	45		7	12	4			23	66				1			1
25	2						2	46		6	5	6			17	67			1		1	1	3
26	5						5	47		9	5	3			17	68					1		1
27	6						6	48		3	5	3		1	12	69							
28	10						10	49		3	7	2	1		13	70						1	1
29	8						8	50		1	3	1	1		6	71						1	1
30	2						2	51			7	2	3		12	Total no.	73	100	81	52	13	4	=323
31	4						4	52		2	4	4			10	%	22.60	30.96	25.08	16.10	4.02	1.24	
32	3	1					4	53			3	3			6	$\bar{x}$	26.2	42.6	47.5	51.2	57.5	63.8	



Gráfica 1a. Crecimiento en longitud total.



Gráfica 1b. Relación peso longitud.

1.2 *Tasa de sobrevivencia (S) y coeficiente de mortalidad total (Z).* A partir de la distribución de la edad en cada mes, se presentan en la tabla 2 los valores mensuales de la sobrevivencia estimada por el método de la edad promedio. El promedio anual en el período considerado es de S = 0.4053 o $S = e^{-(0.903)}$, que corresponde a un coeficiente de mortalidad total de Z = 0.903.

1.3 *Coeficiente de mortalidad natural (M).* En la tabla 3 se muestran los cálculos para las distintas tasas de sobrevivencia compredidas entre los valores teóricos de 0.1 a 0.9 y el peso teórico calculado en cada una de las edades observadas. En la gráfica 2 se aprecian las curvas correspondientes de la biomasa relativa.

Siguiendo el criterio de que la sobrevivencia en la población virgen es mayor a la de la población capturable, se considera que la primera podría situarse al nivel de S = 0.5, que expresado como coeficiente de mortalidad natural, resulta ser de M = -ln S = 0.693 y si consideramos que Z = M + F = 0.903, entonces la mortalidad por pesca quedará expresada por el valor de F = 0.903 - 0.693 = 0.210.

TABLA 2.

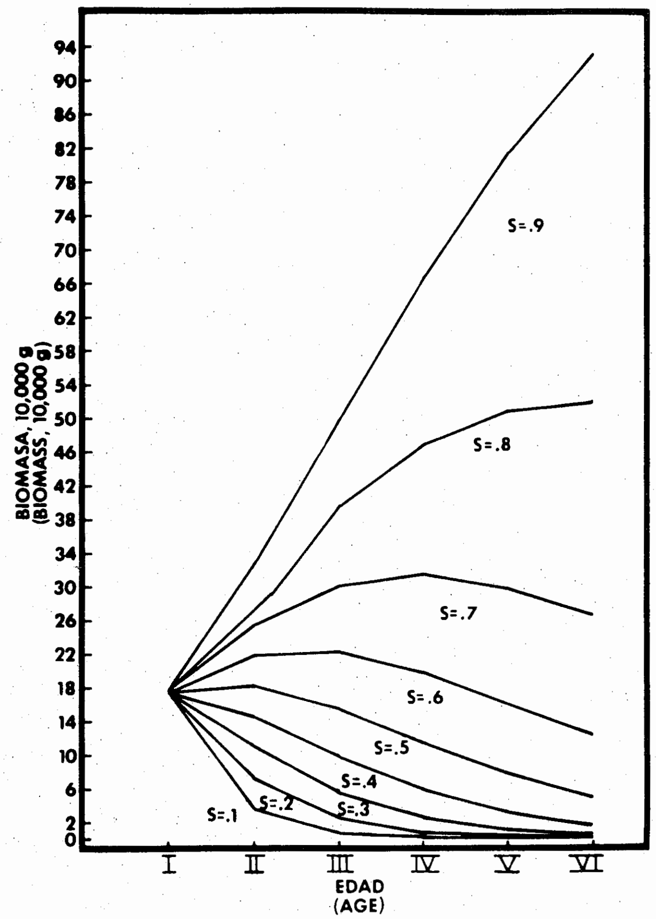
Tasa de sobrevivencia (S) y coeficiente de mortalidad total (Z).

Mes/Ano		Mínima Edad (A_{min})	Máxima Edad (A_{max})	Promedio Anual ($\bar{x}$)	$\bar{x} - A_{min} = K$	$e^{-Z} = S$	$-\ln S = Z$
noviembre	1973	2	6	2.7758	0.7758	0.4725	0.7497
abril	1974	2	6	2.6061	0.6061	0.3957	0.9272
mayo	1974	2	6	2.7011	0.7011	0.4395	0.8221
julio	1974	3	5	3.3801	0.3801	0.3297	1.1095
septiembre	1974	2	5	2.3856	0.3856	0.2933	1.2266
octubre	1974	2	6	2.5554	0.5554	0.3711	0.9914
noviembre	1974	3	6	3.5926	0.5926	0.4182	0.8718
diciembre	1974	2	6	3.0358	1.0358	0.5826	0.5403
enero	1975	2	6	2.6158	0.6158	0.4004	0.9154
febrero	1975	3	6	3.6601	0.6601	0.4581	0.7807
marzo	1975	2	6	2.7434	0.7434	0.4584	0.7799
abril	1975	2	6	2.3087	0.3087	0.2379	1.4358
mayo	1975	2	5	2.3880	0.3880	0.2949	1.2212
junio	1975	2	4	2.4911	0.4911	0.4265	0.8523
julio	1975	3	6	3.4648	0.4648	0.3420	1.0731
agosto	1975	3	6	3.4562	0.4562	0.3367	1.0886
septiembre	1975	2	6	2.4700	0.4700	0.3281	1.1144
octubre	1975	2	6	2.6250	0.6250	0.4046	0.9049
noviembre	1975	2	6	2.9350	0.9350	0.5407	0.6149
diciembre	1975	2	6	2.8940	0.8940	0.5233	0.6476
enero	1976	2	6	2.9661	0.9661	0.5538	0.5910
agosto	1976	2	6	2.4337	0.4337	0.3092	1.1737

TABLA 3.

Sobrevivencia y biomasa relativa.

Edad	Peso (teórico)	S = 0.1	S = 0.2	S = 0.3	S = 0.4	S = 0.5	S = 0.6	S = 0.7	S = 0.8	S = 0.9
1		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
2		100	200	300	400	500	600	700	800	900
3		10	40	90	160	250	360	490	640	810
4		1	8	27	64	125	216	343	512	729
5		0.1	1.6	8.1	26	63	130	240	410	656
6		0.01	0.32	2.4	10	31	78	168	328	590
1	172	172,000	172,000	172,000	172,000	172,000	172,000	172,000	172,000	172,000
2	364	36,400	12,800	109,200	145,600	182,000	218,400	254,800	291,200	327,600
3	616	6,160	24,640	55,440	98,560	154,000	221,760	301,840	394,240	498,960
4	914	914	7,312	24,678	58,496	114,250	197,424	313,502	467,968	666,306
5	1,239	124	1,982	10,036	32,214	78,057	161,070	297,360	507,990	812,784
6	1,579	16	505	3,790	15,790	48,949	123,162	265,272	517,912	931,610



Gráfica 2. Sobrevivencia y biomasa relativa por edad.

2. Tamaño de la Población

2.1 *Tasa de explotación (E).* La tasa de explotación se calcula a través de la siguiente ecuación

$$E = F/(M + F)\ [1 - e^{-(M+F)}]$$

Substituyendo valores, se tiene:

$$E = 0.210/(0.693 + 0.210)\ [1 - e^{-(0.693+0.210)}]$$

$$E = 0.233\ (0.595)$$

$$E = 0.138$$

2.2 *Abundancia en peso de la población en el mar (P).* Si la captura anual promedio en el período de 1968 a 1976 fué de 4,966 toneladas, la abundancia en peso que está presente en el mar es de P = captura/E.

Substituyendo valores, se tiene:

$$P = 4{,}966/0.138 = 35{,}986 = 36 \times 10^3 \text{ toneladas.}$$

2.3 *Disponibilidad (Q).* Se calcula la fracción de la población Q como disponible a la pesquería a la edad de un año, considerando como fracción no disponible la que pertenece a la población virgen I - Q; a partir del número de ejemplares correspondientes a la edad de un año (N_1) y a la edad de 2 años (N_2), que se presentan en la clave edad/longitud:

$$N_1 Q \qquad S = e^{-(M+F)} = 0.4053$$

$$N_1\ (I\text{-}Q) \qquad S_V = e^{-M} = 0.5$$

Entonces; $N_2 = N_1 QS + N_1\ (1 - Q)\ S_V$

$$N_2 = N_1\ [QS + (1 - Q)\ S_V]$$

Si sabemos que $N_2 = 100$ y $N_1 Q = 73$, entonces $N_1 = 73/Q$.

Substituyendo, se tiene:

$$\begin{aligned} 100 &= 73/Q\ [Q(0.4053) + (1 - Q)\ 0.5] \\ 100\,Q/73 &= 0.4053Q + 0.5 - 0.5Q \\ -0.5 &= Q\ (0.4053 - 0.5 - 1.37) \\ -0.5 &= Q\ (-1.4647) \\ Q &= -0.5/-1.4647 = 0.3414 \\ Q &= 34\% \end{aligned}$$

3. Diagnosis de la Pesqueria

3.1 *Talla mínima de captura.* A partir de los datos de la tabla 3, se procedió a elaborar la serie de curvas de biomasa relativa conforme a la edad y la sobrevivencia (inicialmente los valores se emplearon para estimar el coeficiente de mortalidad natural M). Observando la gráfica 2, se advierte que los incrementos máximos de biomasa para la sierra se alcanzan a la edad de dos años para valores de $S_V = 0.5$. La curva con este valor se sitúa dentro de los límites de longevidad registrados para la especie y guarda estrecha relación con la edad de seis años, que fué el máximo crecimiento representado en los muestreos.

3.2 *Tasa de decremento de los adultos reproductores.* Con base en el porcentaje de maduración observado para cada edad, durante los meses je julio y agosto, se calcula el número de adultos en la población capturable y en la población virgen de acuerdo a la sobrevivencia correspondiente a cada uno. Enseguida se relacionan los valores obtenidos, resultando una tasa de decremento de 0.84 para la población actual, que equivale al 84 por ciento como se ilustra en la tabla 4. Si se adopta el criterio de que el mecanismo de reproducción se altera si la captura va mas allá del 50 por ciento de la tasa de decremento de los adultos reproductores, podemos decir que si el 84 por ciento de la población actual es mayor que la limitante de 50 por ciento, entonces el estado actual de la pesquería se mantiene dentro de un nivel moderado de explotación.

TABLA 4.

Tasa de decremento de los adultos reproductores.

Capturable* Edad	% de Madurez	Estock Capturable No.	Estock Capturable No. adultos	Estock Virgen No.	Estock Virgen No. adultos
1	0	1000	0	1000	0
2	83.3	500	417	500	417
3	100	203	203	250	250
4	100	82	82	125	125
5	100	33	33	63	63
6	100	13	13	31	31
Total		1831	748	1969	886
% de decremento			84%		

*Nota: S = 0.4053 (Z = 0.903); M = 0.693 (S = 0.5); F = 0.210

3.3 ***Rendimiento máximo sostenible (M.S.Y.) a la edad actual de captura.*** Se calcularon índices relativos del porcentaje de decremento de los adultos reproductores, índice de la captua teórica con relación a la mortalidad por pesca y captura teórica en peso para diferentes coeficientes de mortalidad por pesca, que variaron de 0.1 a 0.9 como se observa en la tabla 5. Con los valores de edad, peso, disponibilidad en la población capturable y a partir de la edad actual de captura, se elaboró la gráfica 3. El rendimiento máximo sostenible se encuentra en F = 0.85, a este nivel se duplica la captura, pero la captura por unidad de esfuerzo disminuye a un poco mas de la mitad de la actualmente obtenida.

3.4 ***Rendimiento máximo sostenible (M.S.Y.) bajo diferentes condiciones de captura.*** Se resuelve de manera similar que en el inciso anterior, pero en este caso varía la disponibilidad según sea la edad de primera captura para 1, 2, o 3 años. Las cifras finales de peso total, porcentaje de decremento e índice de captura por mortalidad de pesca que aparecen en la parte inferior de las tablas 6, 7 y 8, se utilizaron para trazar las curvas de isopletas que se muestran en la gráfica 4.

Se observa que el rendimiento máximo sostenible está situado cercano a la edad actual de captura. Lo que resulta favorable, ya que de otra manera sería difícil regular las artes de pesca que operan actualmente. De mantenerse la tasa de decremento de adultos reproductores con valores superiores al 50 por ciento y si la edad de primera captura se considera por arriba de la edad actual, es posible estimar que el incremento del esfuerzo de pesca significará un aumento en la captura que de manera preliminar duplicaría el promedio anual registrado en los últimos años.

REFERENCES CITED

Beaumariage, D. S. 1973. Age, growth, and reproduction of king mackerel, *Scomberomorus cavalla*, in Florida. *Fla. Mar. Res. Publ. Fl. Dep. Nat. Res.* No. 1, 45 pp.

Doi, T. 1975. Análisis matemático de poblaciones pesqueras. Compendio para uso práctico. *Inst. Nac. Pesca Ser. Informe.* 12. México.

Escudero, F. 1976. Artes y métodos de pesca empleados en la captura de sierra en la jurisdicción pesquera del puerto de Veracruz (1974–75). *Memorias de la Reunión sobre los Recursos de Pesca Costera.* pp. 255–269.

Food and Agriculture Organization of the United Nations (FAO). 1974. *Manual of Fisheries Science.* Part 2 – Methods of resource investigation and their application. FIRS/+ 115 (Rev. 1), MFS–Resource Investigation. 214 pp.

Instituto Nacional de la Pesca. 1978. Compilación y representación gráfica de información pesquera. Periodo 1970–74 (en preparación). Oficina de Consultación e Información Técnica. Dep. de Pesca. México, D.F.

Klima, E. F. 1959. Aspects of the biology and the fishery for Spanish mackerel, *Scomberomorus maculatus* (Mitchill), of southern Florida. *Fla. Board Conserv. Mar. Res. Lab. Tech. Ser.* 27:1–39.

Marquez, R. 1974. Informe sinóptico de la sierra, *Scomberomorus maculatus* (Mitchill), del Golfo de México. *Inst. Nac. Pesca Ser. Informe.* 14. México.

Mendizábal, D. 1976. Determinación de edad y crecimiento de la sierra, *Scomberomorus maculatus* (Mitchill), del Golfo de México. *Memorias de la Reunión sobre los Recursos de Pesca Costera* (sin publicar).

Mendoza, A. 1968. Consideraciones sobre la biología pesquera de la sierra, *Scomberomorus maculatus* (Mitchill), en el estado de Veracruz, México. Tesis Profesional. Instituto Politécnico – Nacional.

Vasconcelos, J. 1976. Observaciones sobre reproducción, fecundidad y factor de condición de la sierra, *Scomberomorus maculatus* (Mitchill), en las costas del estado de Veracruz. *Memorias de la Reunión sobre los Recursos de Pesca Costera.* pp. 239–252.

TABLA 5.

Rendimiento máximo sostenible a la edad de captura actual ($X_c = 1.7$).

			E = 0			E = 0.0691					E = 0.132				
			Estock Virgen			F = 0.1	Z = 0.793		S = 0.452		F = 0.2	Z = 0.893		S = 0.409	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Número	Número Adultos	Biomasa	Estock Disponibilidad (Peso)	Captura Teórica	Número	Número Adultos	Biomasa	Estock Disponibilidad (Peso)	Captura Teórica
1	172	0.34	1000	0	172,000	1000	0	172,000	58,480	4,041	1000	0	172,000	58,430	7,719
2	364	1	500	417	182,000	484	403	176,176	176,176	12,174	469	391	170,716	170,716	22,535
3	616	1	250	250	154,000	219	219	134,904	134,904	9,322	192	192	118,272	118,272	15,612
4	914	1	125	125	114,250	99	99	90,486	90,486	6,253	78	78	71,292	71,292	9,411
5	1239	1	63	63	78,057	45	45	55,755	55,755	3,853	32	32	39,648	39,648	5,234
6	1579	1	31	31	48,949	20	20	31,580	31,580	2,182	13	13	20,527	20,527	2,710
Total				886			786			37,825		706			63,221
% de decremento				100			88.7					79.7			
Captura/esfuerzo										378					316

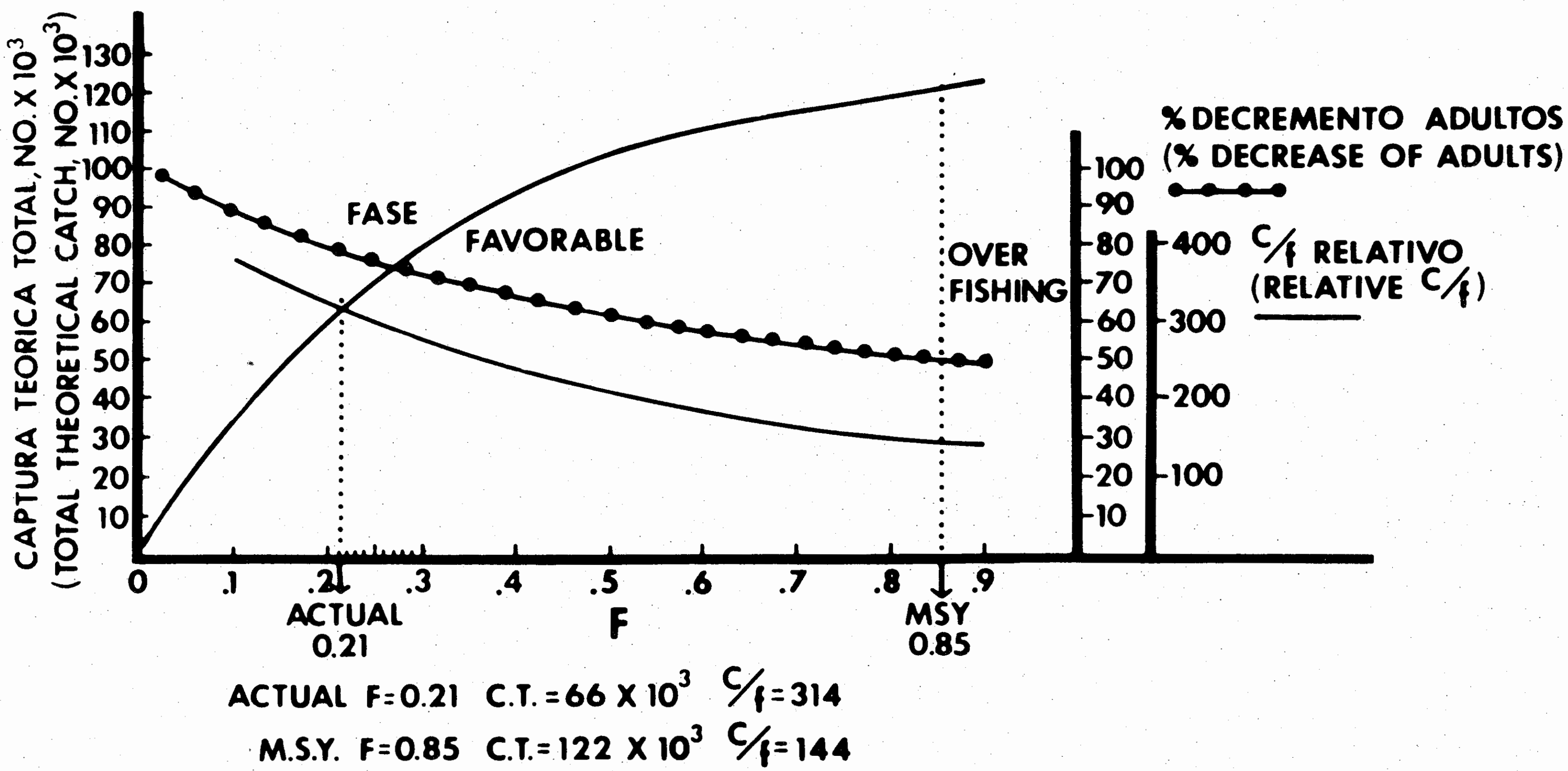
			E = 0.190					E = 0.243				
			F = 0.3	Z = 0.993		S = 0.370		F = 0.4	Z = 1.093		S = 0.335	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponibilidad (Peso)	Captura Teórica	Número	Número Adultos	Biomasa	Estock Disponibilidad (Peso)	Captura Teórica
1	172	0.34	1000	0	172,000	58,480	11,111	1000	0	172,000	58,480	14,211
2	364	1	456	380	165,984	165,984	31,537	444	370	161,616	161,616	39,273
3	616	1	169	169	104,104	104,104	19,780	149	149	91,784	91,784	22,304
4	914	1	62	62	56,668	56,668	10,767	50	50	45,700	45,700	11,105
5	1239	1	23	23	28,497	28,497	5,414	17	17	21,063	21,063	5,118
6	1579	1	9	9	14,211	14,211	2,700	6	6	9,474	9,474	2,302
Total				643			81,309		592			94,313
% de decremento				72.6					66.8			
Captura/esfuerzo							27					236

TABLA 5. – Continuación

Edad	Peso (g)	Disponibilidad (Q)	E = 0.292 (F = 0.5, Z = 1.193, S = 0.303) Número	Número Adultos	Biomasa	Estock Disponibilidad (Peso)	Captura Teórica	E = 0.337 (F = 0.6, Z = 1.293, S = 0.274) Número	Número Adultos	Biomasa	Estock Disponibilidad (Peso)	Captura Teórica
1	172	0.34	1000	0	172,000	58,480	17,076	1000	0	172,000	58,480	19,708
2	364	1	433	361	157,612	157,612	46,023	423	352	153,972	153,972	51,889
3	616	1	131	131	80,696	80,696	23,563	116	116	71,456	71,456	24,081
4	914	1	40	40	36,560	36,560	10,676	32	32	29,248	29,248	9,857
5	1239	1	12	12	14,868	14,868	4,341	9	9	11,151	11,151	3,758
6	1579	1	4	4	6,316	6,316	1,844	2	2	3,158	3,158	1,064
Total				548			103,523		511			110,357
% de decremento				61.9					57.7			
Captura/esfuerzo							207					184

Edad	Peso (g)	Disponibilidad (Q)	E = 0.378 (F = 0.7, Z = 1.393, S = 0.248) Número	Número Adultos	Biomasa	Estock Disponibilidad (Peso)	Captura Teórica	E = 0.416 (F = 0.8, Z = 1.493, S = 0.224) Número	Número Adultos	Biomasa	Estock Disponibilidad (Peso)	Captura Teórica
1	172	0.34	1000	0	172,000	53,480	22,105	1000	0	172,000	58,480	24,328
2	364	1	414	345	150,696	150,696	56,963	406	338	147,784	147,784	61,478
3	616	1	103	103	63,448	63,448	23,983	91	91	56,056	56,056	23,319
4	914	1	25	25	22,850	22,850	8,637	20	20	18,280	18,280	7,604
5	1239	1	6	6	7,434	7,434	2,810	5	5	6,195	6,195	2,577
6	1579	1	2	2	3,158	3,158	1,194	1	1	1,579	1,579	657
Total				481			115,692		455			119,963
% de decremento				54.3					51.4			
Captura/esfuerzo							165					150

Edad	Peso (g)	Disponibilidad (Q)	E = 0.450 (F = 0.9, Z = 1.593, S = 0.203) Número	Número Adultos	Biomasa	Estock Disponibilidad (Peso)	Captura Teórica
1	172	0.34	1000	0	172,000	58,480	26,316
2	364	1	399	332	145,236	145,236	65,356
3	616	1	81	81	49,896	49,896	22,453
4	914	1	16	16	14,624	14,624	6,581
5	1239	1	3	3	3,717	3,717	1,673
6	1579	1	1	1	1,579	1,579	711
Total				533			123,090
% de decremento				48.9			
Captura/esfuerzo							137



Gráfica 3. Rendimiento máximo sostensible a la edad de captura actual.

TABLA 6.

Rendimiento máximo sostenible a la edad de captura de 1 año (X_c = 1).

			E = 0.0691				
			F = 0.1	Z = 0.793		S = 0.452	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	1	1000	0	172,000	172,000	11,885
2	364	1	452	377	164,528	164,528	11,369
3	616	1	204	204	125,664	125,664	8,683
4	914	1	92	92	84,088	84,088	5,810
5	1239	1	42	42	52,038	52,038	3,596
6	1579	1	19	19	30,001	30,001	2,073
Total				734			43,416
% de decremento				82.8			
Captura/esfuerzo							434

			E = 0.132				
			F = 0.2	Z = 0.893		S = 0.409	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	1	1000	0	172,000	172,000	22,704
2	364	1	409	341	118,876	118,876	19,652
3	616	1	167	167	102,872	102,872	13,579
4	914	1	68	68	62,152	62,152	8,204
5	1239	1	28	28	34,692	34,692	4,579
6	1579	1	11	11	17,369	17,369	2,293
Total				615			71,011
% de decremento				69.4			
Captura/esfuerzo							355

			E = 0.190				
			F = 0.3	Z = 0.993		S = 0.370	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	1	1000	0	172,000	172,000	32,680
2	364	1	370	308	134,680	134,680	25,589
3	616	1	137	137	84,392	84,392	16,034
4	914	1	51	51	46,614	46,614	8,857
5	1239	1	19	19	23,541	23,541	4,473
6	1579	1	7	7	11,053	11,053	2,100
Total				522			89,733
% de decremento				58.9			
Captura/esfuerzo							299

			E = 0.243				
			F = 0.4	Z = 1.093		S = 0.335	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	1	1000	0	172,000	172,000	41,796
2	364	1	335	279	121,940	121,940	29,631
3	616	1	112	112	68,992	68,992	16,765
4	914	1	38	38	34,732	34,732	8,440
5	1239	1	13	13	16,107	16,107	3,914
6	1579	1	4	4	6,316	6,316	1,535
Total				446			102,081
% de decremento				50.3			
Captura/esfuerzo							255

			E = 0.292				
			F = 0.5	Z = 1.193		S = 0.303	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	1	1000	0	172,000	172,000	50,224
2	364	1	303	252	110,292	110,292	32,205
3	616	1	92	92	56,672	56,672	16,548
4	914	1	28	28	25,592	25,592	7,473
5	1239	1	8	8	9,912	9,912	2,894
6	1579	1	3	3	4,737	4,737	1,383
Total				383			110,727
% de decremento				43.2			
Captura/esfuerzo							221

			E = 0.337				
			F = 0.6	Z = 1.293		S = 0.274	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	1	1000	0	172,000	172,000	57,964
2	364	1	274	228	99,736	99,736	33,611
3	616	1	75	75	46,200	46 200	15,569
4	914	1	21	21	19,194	19,194	6,468
5	1239	1	6	6	7,434	7,434	2,505
6	1579	1	2	2	3,158	3,158	1,064
Total				332			117,181
% de decremento				37.5			
Captura/esfuerzo							195

			E = 0.378				
			F = 0.7	Z = 1.393		S = 0.248	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	1	1000	0	172,000	172,000	65,016
2	364	1	248	207	90,272	90,272	34,123
3	616	1	62	62	38,192	38,192	14,437
4	914	1	15	15	13,710	13,710	5,182
5	1239	1	4	4	4,956	4,956	1,873
6	1579	1	1	1	1,579	1,579	597
Total				289			121,228
% de decremento				32.6			
Captura/esfuerzo							173

			E = 0.416				
			F = 0.8	Z = 1.493		S = 0.224	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	1	1000	1	172,000	172,000	71,552
2	364	1	224	187	81,536	81,536	33,919
3	616	1	50	50	30,800	30,800	12,813
4	914	1	11	11	10,054	10,054	4,182
5	1239	1	3	3	3,717	3,717	1,546
6	1579	1	1	1	1,579	1,579	657
Total				252			124,669
% de decremento				28.4			
Captura/esfuerzo							156

			E = 0.450				
			F = 0.9	Z = 1.593		S = 0.203	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	1	1000	0	172,000	172,000	77,400
2	364	1	203	169	73,892	73.892	33,251
3	616	1	41	41	25,256	25,256	11,365
4	914	1	8	8	7,312	7,312	3,290
5	1239	1	2	2	2,478	2,478	1,115
6	1579	1	0	0	0	0	0
Total				220			128,421
% de decremento				24.8			
Captura/esfuerzo							140

TABLA 7.

Rendimiento máximo sostenible a la edad de captura de 2 años (X_c = 2).

			E = 0.0691					E = 0.132					E = 0.190				
			F = 0.1	Z = 0.793		S = 0.452		F = 0.2	Z = 0.893		S = 0.409		F = 0.3	Z = 0.993		S = 0.370	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	0	1000	0	172,000	0	0	1000	0	172,000	0	0	1000	0	172,000	0	0
2	364	1	500	417	182,000	182,000	12,576	500	417	182,000	182,000	24,024	500	417	182,000	182,000	34,580
3	616	1	226	226	139,216	139,216	9,620	205	205	126,280	126,280	16,669	185	185	113,960	113,960	21,652
4	914	1	102	102	93,228	93,228	6,442	84	84	76,776	76,776	10,134	68	68	62,152	62,152	11,809
5	1239	1	46	46	56,994	56,994	3,938	34	34	42,126	42,126	5,561	25	25	30,975	30,975	5,885
6	1579	1	21	21	33,159	33,159	2,291	14	14	22,106	22,106	2,918	9	9	14,211	14,211	2,700
Total				812			34,867		754			59,306		704			76.626
% de decremento				91.6					85.1					79.5			
Captura/esfuerzo							349					297					225

			E = 0.243					E = 0.292					E = 0.337				
			F = 0.4	Z = 1.093		S = 0.335		F = 0.5	Z = 1.193		S = 0.303		F = 0.6	Z = 1.293		S = 0.274	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	0	1000	0	172,000	0	0	1000	0	172,000	0	0	1000	0	112,000	0	0
2	364	1	500	417	182,000	182,000	44,226	500	417	182,000	182,000	53,144	500	417	182,000	182,000	61,334
3	616	1	168	168	103,488	103,488	25,148	152	152	93,632	93,632	27,341	137	137	84,392	84,392	28,440
4	914	1	56	56	51,184	51,184	12,438	46	46	42,044	42,044	12,277	38	38	34,732	34,732	11,705
5	1239	1	19	19	23,541	23,541	5,720	14	14	17,346	17,346	5,065	10	10	12,390	12,390	4,175
6	1579	1	6	6	9,474	9,474	2,302	4	4	6,316	6,316	1,844	3	3	4.737	4,737	1,596
Total				666			89,834		633			99,671		605			107,250
% de decremento				75.2					71.4					68.3			
Captura/esfuerzo							225					199					179

			E = 0.378					E = 0.416					E = 0.450				
			F = 0.7	Z = 1.393		S = 0.248		F = 0.8	Z = 1.493		S = 0.224		F = 0.9	Z = 1.593		S = 0.203	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	0	1000	0	172,000	0	0	1000	0	172,000	0	0	1000	0	172,000	0	0
2	364	1	500	417	182,000	182,000	68,796	500	417	182,000	182,000	75,712	500	417	182,000	182,000	81,900
3	616	1	124	124	76,384	76,384	28,873	112	112	68,992	68,992	28,701	102	102	62,832	62,832	28,274
4	914	1	31	31	28,334	28,334	10,710	25	25	22,850	22,850	9,506	21	21	19,194	19.194	8,637
5	1239	1	8	8	9,912	9,912	3,747	6	6	7,434	7,434	3,093	4	4	4,956	4,956	2,230
6	1579	1	2	2	3,158	3,158	1,194	1	1	1,579	1,579	657	1	1	1,579	1,579	711
Total				582			113,320		561			114,669		545			121,752
% de decremento				65.7					63.3					61.5			
Captura/esfuerzo							162					147					135

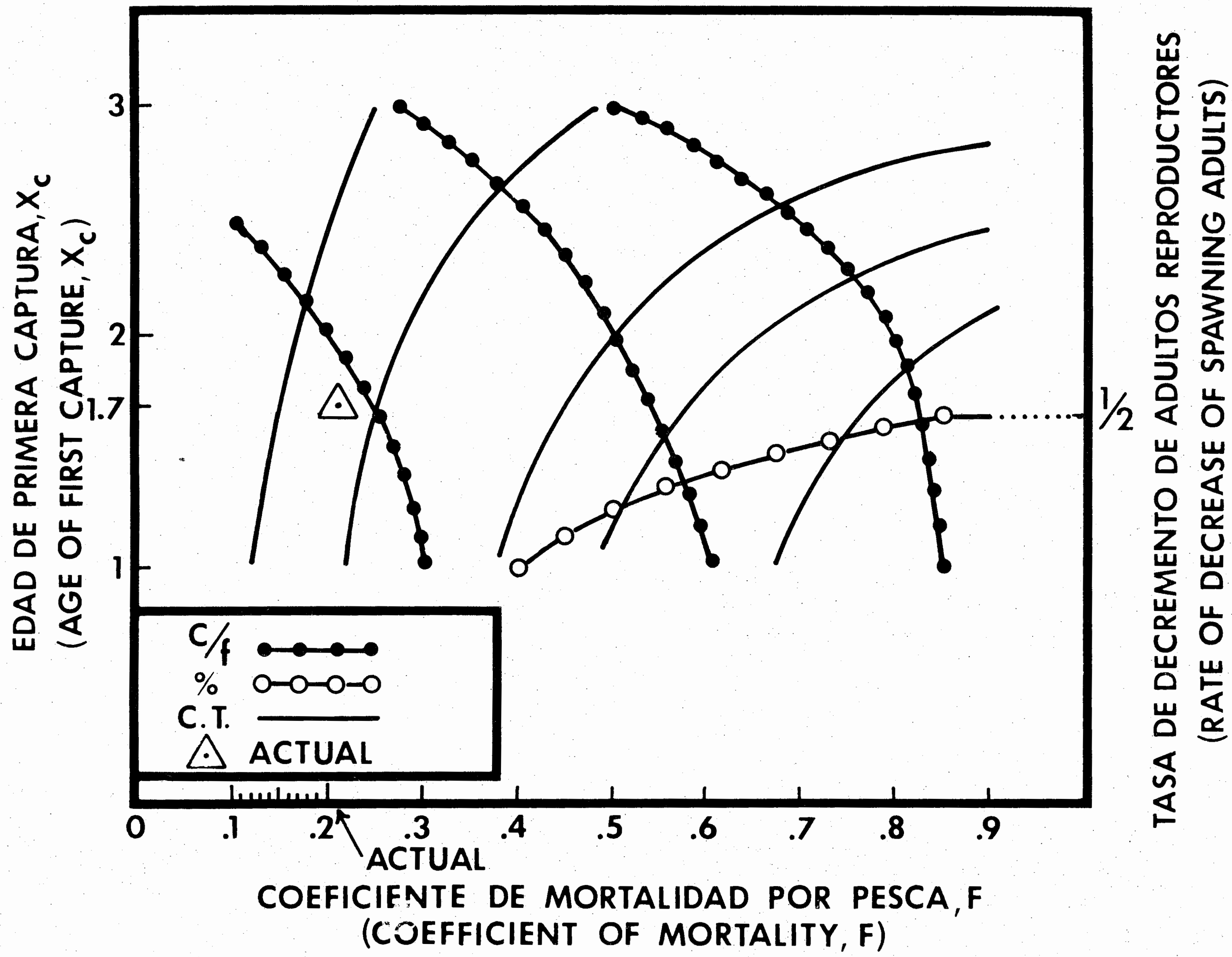
TABLA 8.

Rendimiento máximo sostenible a la edad de captura de 3 años ($X_c = 3$).

			E = 0.0691					E = 0.132					E = 0.190				
			F = 0.1	Z = 0.793		S = 0.452		F = 0.2	Z = 0.893		S = 0.409		F = 0.3	Z = 0.993		S = 0.370	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	0	1000	0	172,000	0	0	1000	0	172,000	0	0	1000	0	172,000	0	0
2	364	0	500	417	182,000	0	0	500	417	182,000	0	0	500	417	182,000	0	0
3	616	1	250	250	154,000	154,000	10,641	250	250	154,000	154,000	20,328	250	250	154,000	154,000	29,260
4	914	1	113	113	103,282	103,282	7,137	102	102	93,228	93,228	12,306	93	93	85,002	85,002	16,150
5	1239	1	51	51	63,189	63,189	4,366	42	42	52,038	52,038	6,869	34	34	42,126	42,126	8,004
6	1579	1	23	23	36,317	36,317	2,510	17	17	26,843	26,843	3,543	13	13	20,527	20,527	3,900
Total				854			24,654		828			43,046		807			57,314
% de decremento				96.4					93.5					91.1			
Captura/esfuerzo							247					215					191

			E = 0.243					E = 0.292					E = 0 337				
			F = 0.4	Z = 1.093		S = 0.335		F = 0.5	Z = 1.193		S = 0.303		F = 0.6	Z = 1.293		S = 0.274	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	0	1000	0	172,000	0	0	1000	0	172,000	0	0	1000	0	172,000	0	0
2	364	1	500	417	182,000	0	0	500	417	182,000	0	0	500	417	182,000	0	0
3	616	1	250	250	154,000	154,000	37,422	250	250	154,000	154,000	44,968	250	250	154,000	154,000	51,898
4	914	1	84	84	76,776	76,776	18,657	76	76	69,464	69,464	20,283	69	69	63,066	63,066	21,253
5	1239	1	28	28	34,692	34,692	8,430	23	23	28,497	28,497	6,321	19	19	23,541	23,541	7,933
6	1579	1	9	9	14,211	14,211	3,453	7	7	11,053	11,053	3,227	5	5	7,895	7,895	2,661
Total				788			67,962		773			76,799		760			83,745
% de decremento				38.9					87.2					85.8			
Captura/esfuerzo							170					154					140

			E = 0.378					E = 0.416					E = 0.450				
			F = 0.7	Z = 1.393		S = 0.248		F = 0.8	Z = 1.493		S = 0.224		F = 0.9	Z = 1.593		S = 0.203	
Edad	Peso (g)	Disponibilidad (Q)	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica	Número	Número Adultos	Biomasa	Estock Disponible	Captura Teórica
1	172	0	1000	0	172,000	0	0	1000	0	172,000	0	0	1000	0	172,000	0	0
2	364	1	500	417	182,000	0	0	500	417	183,000	0	0	500	417	182,000	0	0
3	616	1	250	250	154,000	154,000	58,212	250	250	154,000	154,000	64,064	250	250	154,000	154,000	69,300
4	914	1	62	62	56,668	56,668	21,421	56	56	51,184	51,184	21,293	51	51	46,614	46,614	20,976
5	1239	1	15	15	18,585	18,585	7,025	13	13	16,107	16,107	6,701	10	10	12,390	12,390	5,576
6	1579	1		4	6,316	6,316	2,387	3	3	4,737	4,737	1,971	2	2	3,158	3,158	1,421
Total				748			89,045		739			94,029		730			97,273
% de decremento				84.4					83.4					82.4			
Captura/esfuerzo							127					118					108



Gráfica 4. Rendimiento máximo sostenible bajo diferentes condiciones de captura.

ABSTRACT: KING MACKEREL MIGRATIONS

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A tag and recapture investigation of seasonal migratory patterns of king mackerel, *Scomberomorus cavalla,* was initiated in January 1975 by the Florida Department of Natural Resources, Marine Research Laboratory in St. Petersburg, Florida, and by the National Marine Fisheries Service laboratories in Panama City, Florida, and Port Aransas, Texas. By March 1978, over 14,000 king mackerel had been tagged at locations from Jacksonville, Florida to Port Isabel, Texas. Over 625 tags have been returned.

King mackerel tagged along the southeastern Florida coast (below Cape Canaveral) during each of the past four winters migrated southward during that winter, eventually reaching the Gulf of Mexico. In spring they entered the gulf and moved northward along the west Florida continental shelf, and then westward in the northern gulf. Many fish migrated as far as Galveston and Port Aransas, Texas. Seventeen king mackerel recaptured off Texas during the summers of 1976 and 1977 had been tagged in Florida at locations off Sebastian, Ft. Pierce, Boynton Beach, Islamorada, Key West, and Naples. In auturmn there is apparently a return migration from the northern gulf to southeastern Florida as shown by four winter recaptures in southeastern Florida of fish tagged off Texas during the summers of 1976 and 1977. Likewise, fish tagged off Panama City in summer and fall have been recaptured off Key West and Ft. Pierce the following winter.

King mackerel tagged in southeastern Florida during spring in 1975, 1976, and 1977 generally migrated northward, some as far as North Carolina and Virginia. Only a small percentage of spring-tagged fish moved into the Gulf of Mexico. Paradoxically, some of the fish tagged the previous winter are still in southeastern Florida in spring, yet these fish do not move into the mid-Atlantic with the other spring fish. The winter-tagged fish which are still in southeastern Florida in spring generally remain south of Cape Canaveral even in summer. Possibly the small percentage of spring fish moving into the gulf are the stragglers left from the previous winter.

The fact that most spring fish move northward during summer while winter fish do not (even though some are still in southeastern Florida in spring) is evidence for separate stocks but with some intermingling. We believe most spring fish enter southeastern Florida from the north, probably from the Cape Canaveral to Cape Hatteras area. Most are sexually mature and have probably moved into this area to spawn. Unpublished data from larval collections in the Florida Straits confirm that some spawning occurs there.

There appears to be a differential migration of king mackerel by size, the larger fish making the longer migrations. Among fish tagged in southeastern Florida during winter, larger fish undergo summer migrations into the northern and western gulf, while smaller fish remain in southeastern Florida. Similar size separation is shown by the fish marked during spring, the larger fish being captured during summer and fall in North Carolina and Virginia while the smaller fish remain in the south.

The migration of a Spanish mackerel, *Scomberomorus maculatus,* tagged off Port Aransas, Texas, in September 1975 and recaptured off Vera Cruz, Mexico, the following January stands as a noteworthy contrast to the direction of migration of king mackerel tagged off Texas.

ABSTRACT: DISTRIBUTION, SEASONALITY AND ABUNDANCE OF LARVAL KING AND SPANISH MACKERELS IN THE NORTHWESTERN GULF OF MEXICO

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Larvae of the king and Spanish mackerels, *Scomberomorus cavalla* and *S. maculatus*, respectively, were collected from 1975 through 1977 off the Texas coast. Larvae of both species were captured from May through September. The king mackerel was relatively more abundant of the two species and occurred most frequently over the outer continent shelf (42 to 183 m). At least 50 percent of the larvae each year were captured in September, the final month of sampling. More king mackerel larvae were captured during the night than during the day and with a 333 μm mesh than with a 505 μm mesh net. Abundance estimates of king mackerel larvae were less in 1977 than in 1976, and this difference corresponded with lower water temperatures over the survey area in 1977 than in 1976. The Spanish mackerel larvae occurred most frequently over the inner continental shelf (12 to 34 m) and were more frequently captured with a 333 μm mesh than with a 505 μm mesh net. Abundance estimates were greater for Spanish mackerel larvae in 1977 than in 1976 despite lower temperatures encountered over the survey area in 1977. Length of larvae of both species ranged from about 1.8 to 12 mm SL. Many larvae were estimated to be less than three days old; thus, distribution of larvae provided estimates of spawning locality and intensity of the two species. The king mackerel spawns from May through September, with the greatest spawning intensity occurring over the outer continental shelf and during September. The Spanish mackerel spawns from May through September over the inner continental shelf, but spawning is less intensive and more irregular than for the king mackerel. The two species may respond differently to water temperatures, because the king mackerel larvae were relatively less abundant in 1977, when temperatures were colder, than in 1976, when temperatures were warmer, whereas the Spanish mackerel showed a reciprocal relationship. Both species may begin spawning off south Texas in early spring and then along the northeastern coast during the summer, as evidenced by the low abundance of larvae off north Texas during the spring. Abundance estimates of king mackerel larvae in the northwestern Gulf of Mexico were comparable to values given for it in the northeastern gulf, while abundance estimates of Spanish mackerel were less in the northwestern gulf than in the northeastern gulf. Thus, larval data suggest that king mackerel is as abundant in the northwestern gulf as in the northeastern gulf, while Spanish mackerel appears less abundant in the northwestern gulf than in the northeastern gulf.

Proceedings of the Mackerel Colloquium, March 16, 1978, 61–66

HEAVY METAL CONTAMINATION OF SPANISH MACKEREL, *Scomberomorus maculatus*, AND KING MACKEREL, *S. cavalla*

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Charleston, South Carolina

ABSTRACT Heavy metals in the edible tissues of Spanish mackerel, *Scomberomorus maculatus,* and king mackerel, *S. cavalla,* may place constraints on the utilization of these migratory coastal pelagic species and on the development of the associated fisheries. Data are presented on heavy metal concentrations found in individual mackerels taken from ten locations in coastal waters of southeastern United States, with emphasis on the occurrence of mercury and methylmercury. The interrelationships between mercury levels and fish sizes are described quantitatively. The results of this in-depth survey are discussed in light of recent events impacting upon application of mercury guidelines for fish.

INTRODUCTION

The National Marine Fisheries Service (NMFS) retains a special interest and responsibility in ensuring the quality and safety of seafood reaching the U.S. consumer. During the past several years, for example, the College Park Laboratory (now Charleston Laboratory) of the Southeast Fisheries Center (SEFC) has been engaged in a program to provide basic information on the occurrence and significance of contaminants, chiefly metals, in the edible tissues of a wide variety of fishes and shellfishes.

Several important commercial and recreational species common to the Gulf of Mexico and U.S. south Atlantic have been studied in detail, among them Spanish mackerel, *Scomberomorus maculatus,* and king mackerel, *S. cavalla.* In this paper, I impart some of the heavy metal data so far obtained on these two species, with more importance placed on mercury in comparison with other metals.

An important feature of resource management planning is an awareness of the constraints that might be placed on the development and/or utilization of a fishery as a result of chemical contamination of the marine environment. Briefly the possible consequences of heavy metal contamination of the resource are: (1) an implied public health hazard; (2) loss of consumer confidence; (3) an economic impact on fisheries and associated industries; and (4) loss of an important food source.

Clearly, there is the implication of a threat to consumer health. The toxic properties of elements – mercury, lead, cadmium, and arsenic – in a variety of chemical combinations are well documented, as are cases of chronic poisoning in humans who have ingested relatively large amounts of these materials, often as a result of exposure to industrial sources. With few exceptions, however, little is known about the toxicity of metals occurring in fish tissues. Moreover, until recently there was a general lack of information on contaminant levels in marine fish. This situation, together with a lack of detailed knowledge on U.S. fish consumption patterns, has made it difficult to estimate the potential hazards associated with eating "contaminated" fish.

Mercury is the only metal for which there exists a regulatory guideline. The guideline level of 0.5 parts per million (ppm) is based on several assumptions, one of which is that mercury in marine fish is predominantly in its most toxic form, namely, methylmercury. Although there has not been a single proven case of methylmercury poisoning resulting from eating marine fish in the United States, adverse publicity arising from reports of mercury contamination, however unsubstantiated, may lead to loss of consumer confidence in seafood products and thus threaten the economy of the fishing industry.

Individual fish of the two mackerel species, taken from selected locations in the U.S. south Atlantic and Gulf of Mexico, were analyzed for heavy metal content. The data presented here were obtained during the course of two major surveys, as part of the NMFS Microconstituents Program: (1) a resource survey, in which the concentrations of 15 elements were determined in more than 200 species taken from U.S. coastal waters, and (2) an in-depth study directed primarily towards determining the amount of mercury and selenium in six south Atlantic and gulf species (SAGS). Fishes collected for the SAGS survey were taken from designated sites shown as hatched areas on the map in Figure 1.

Methylmercury concentrations also have been determined in the muscle tissues of Spanish and king mackerels for a representative subsampling of the larger collection analyzed for mercury and selenium.

Mercury (Hg), selenium (Se), lead (Pb), cadmium (Cd) and arsenic (As) data are summarized for the mackerels in Tables 1 and 2. With the exception of Hg, heavy metal concentrations in the muscle tissues of these animals were found to be similar to the mean values found for finfishes in general (determined from the results of the resource survey).

Contribution No. 78–37C, Southeast Fisheries Center, NMFS, NOAA.

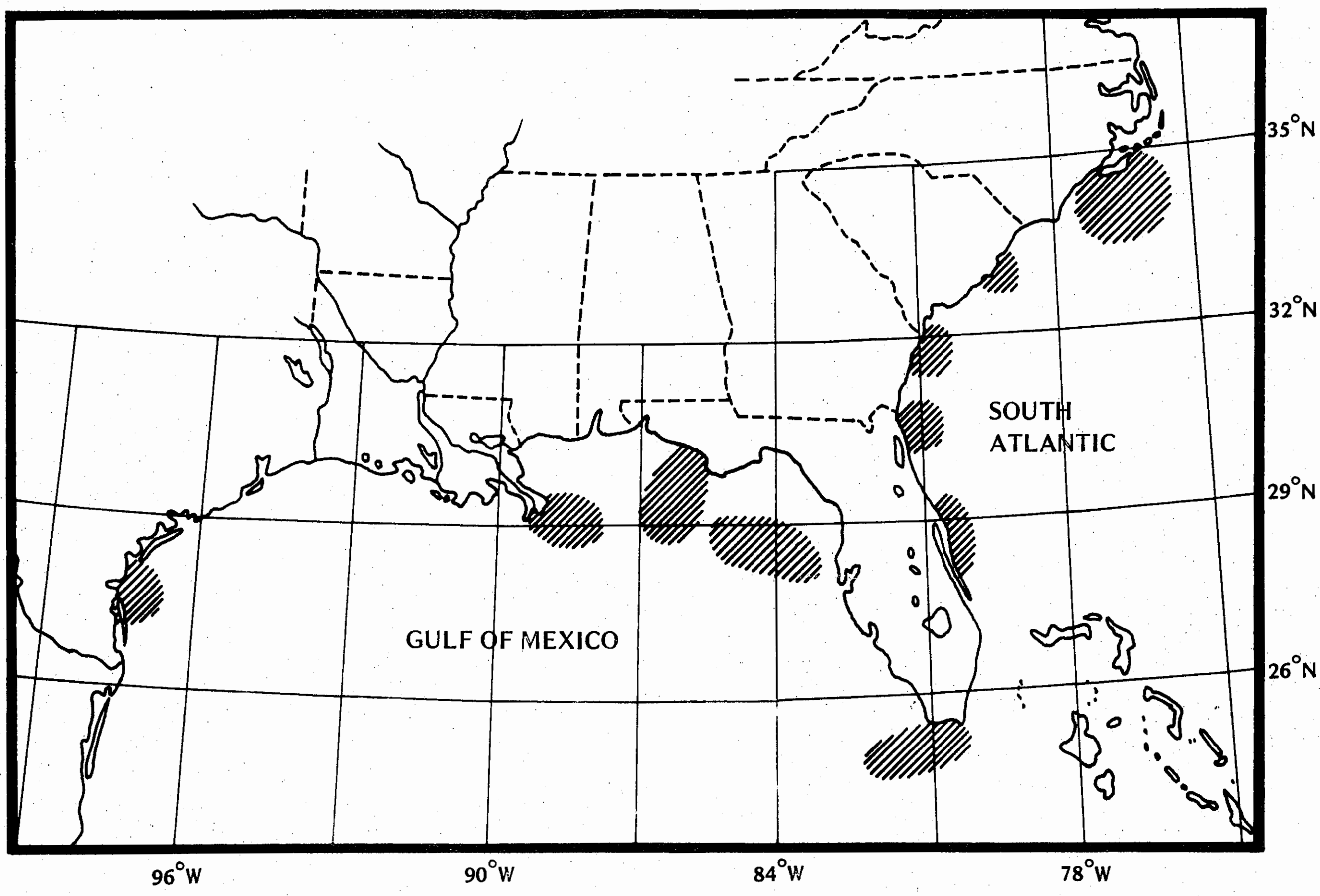

Figure 1. Location of sampling in SAGS survey.

Table 1.

Heavy metal concentrations (ppm) in king mackerel.

Metal	Number	$\bar{x}$	Standard Deviation	Minimum	Maximum
Mercury, Hg	835	0.70	0.52	0.02	2.90
Selenium, Se	792	0.76	0.27	0.09	3.40
Lead, Pb	105	0.49	0.25	8.06	1.44
Cadmium, Cd	91	0.068	0.027	0.020	0.170
Arsenic, As	102	3.24	0.62	0.72	17.55

Table 2.

Heavy metal concentrations (ppm) in Spanish mackerel.

Metal	Number	$\bar{x}$	Standard Deviation	Minimum	Maximum
Mercury, Hg	987	0.36	0.30	0.01	2.47
Selenium, Se	949	0.66	0.35	0.02	3.02
Lead, Pb	103	0.46	0.23	0.06	1.06
Cadmium, Cd	89	0.035	0.089	0.010	0.690
Arsenic, As	104	3.77	2.57	0.20	14.00

To illustrate the point, the distributions of mean concentrations of Hg and Pb in 159 finfish species are shown in Tables 3 and 4. For Hg, approximately two-thirds of the examined species, representing 57% of the U.S. catch intended for human consumption, contained less than 0.2 ppm. This value may be compared with the 0.76 ppm mean found for king mackerel and 0.36 ppm for Spanish mackerel. For Pb, on the other hand, most of the same 159 species were clustered in the range 0.3 to 0.7 ppm. Mean Pb concentrations in both mackerels fall in the middle of this range.

Additional details of Hg and Se levels found in samples of each species are shown in Figures 2 through 11.

A significant correlation between total Hg concentration and fish weight was found for king mackerel. Five regression lines were tested to fit the data: linear, semi-log (2), exponential, and quadratic. The exponential line usually provides the best fit for both individual and combined sites, although the differences between lines are small (Figure 2).

Statistically, several sites differ significantly from combined sites. Site SB5 shows a much higher slope, indicating higher Hg levels for fish of a given size (Figure 3).

King mackerel usually weigh less than 15 kg and average about 5 kg, but they can range up to 40 kg. The samples

Table 3.

Distribution of mean mercury concentrations in finfish species.

Range (ppm)	Number of species	Percent U.S. catch intended for human consumption
< 0.1	45	30.7
0.1 - 0.2	49	26.1
0.2 - 0.3	18	3.9
0.3 - 0.4	15	2.2
0.4 - 0.5	1	*
0.5 - 0.6	8	0.7
0.6 - 0.7	3	*
0.7 - 0.8	4	0.1
0.8 - 0.9	3	*
0.9 - 2.0	8	*
2.0 - 3.0	4	*
4.0 - 5.0	1	*
Total	159	63.9

* Denotes less than 0.05%

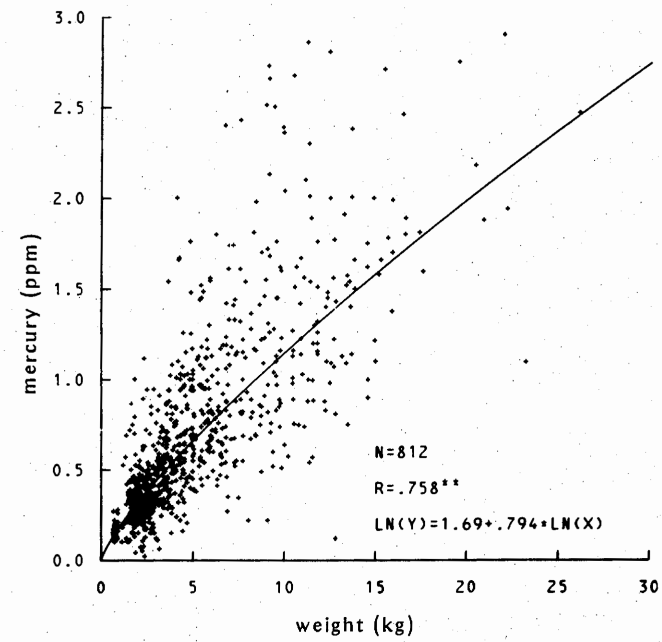

Figure 2. Mercury to weight relationship in king mackerel, *Scomberomorus cavalla.*

Table 4.

Distribution of mean lead concentrations in finfish species.

Range (ppm)	Number of species	Percent U.S. catch intended for human consumption
0.1 - 0.2	1	*
0.2 - 0.3	4	*
0.3 - 0.4	33	9.9
0.4 - 0.5	59	33.8
0.5 - 0.6	35	9.4
0.6 - 0.7	16	10.7
0.7 - 0.8	5	*
0.8 - 1.0	2	*
1.0 - 2.0	3	*
2.0 - 3.0	1	1
Total	159	63.9

*Denotes less than 0.05%

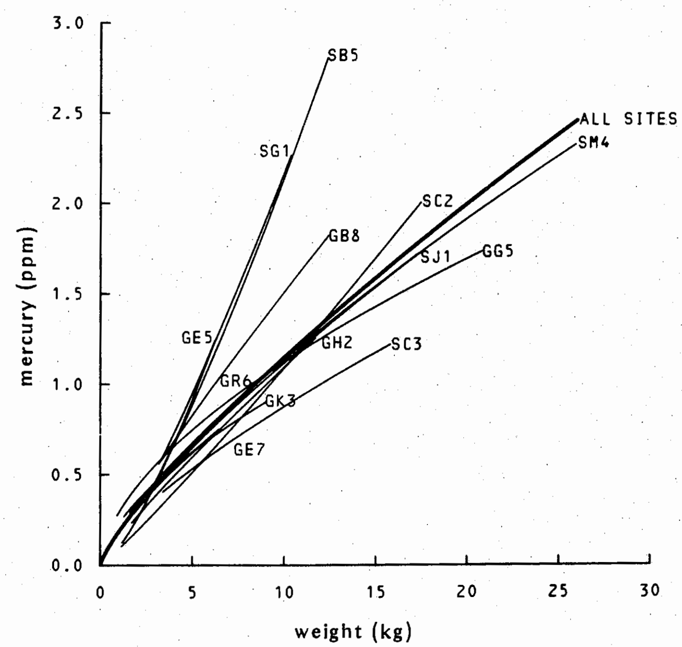

Figure 3. Exponential regressions for mercury to weight in king mackerel, *Scomberomorus cavalla,* by site.

collected for this study have a weight distribution close to lognormal and seem to fit the real world population closely. Data from many of the individual sites also appear to fit lognormal distributions.

From the exponential regression equation for all sites, king mackerel weighing 3.5 kg or more may be expected to contain more than 0.5 ppm Hg. For individual sites, this weight limit ranged from 2.3 to 4.9 kg. About 55% of the samples appear to fit the same distribution as the actual catch, it is not unreasonable to suggest that the same percentage of caught fish would have more than 0.5 ppm Hg.

A total of 54 king mackerel, ranging in size from 0.85 kg to 17.57 kg, was collected from all sites and analyzed for methylmercury. The mean methylmercury concentration was 0.65 ppm, with a range of 0.16 to 1.92 ppm. As for total mercury, a high degree of correlation was found between methylmercury content and fish weight (Figure 4).

In contrast, no significant correlation between total Se concentration and fish weight was found. As can be seen from Figure 5, Se values are scattered around a value of approximately 0.7 ppm for almost the entire weight range.

For Spanish mackerel, where the mean Hg concentration was found to be somewhat lower, fish weight was significantly correlated with mercury concentration for combined and individual sites (Figures 6 and 7). Most sites showing a higher intercept, however, had a lower slope to the regression line, and vice versa.

The weight distribution of the samples appeared bimodal

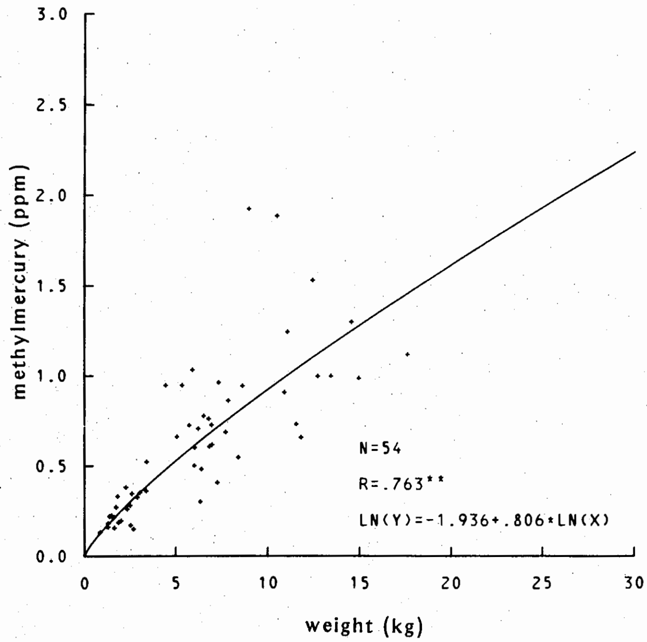

Figure 4. Methylmercury to weight relationship in king mackerel, *Scomberomorus cavalla*.

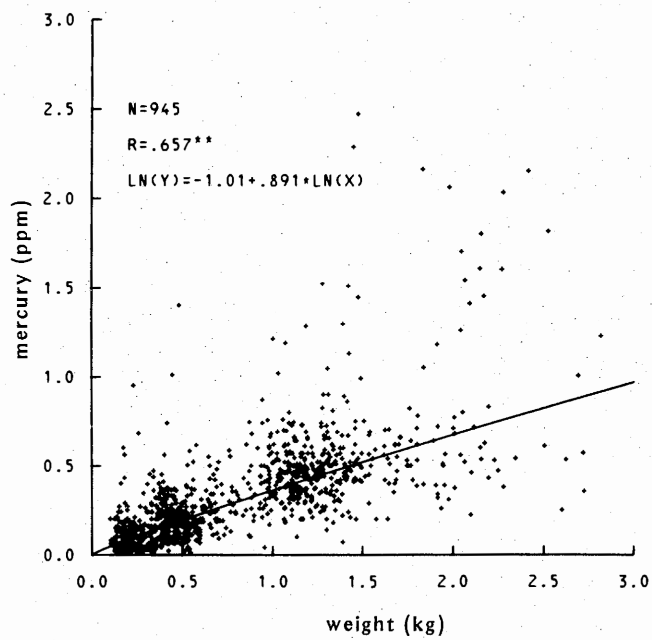

Figure 6. Mercury to weight relationship in Spanish mackerel, *Scomberomorus maculatus*.

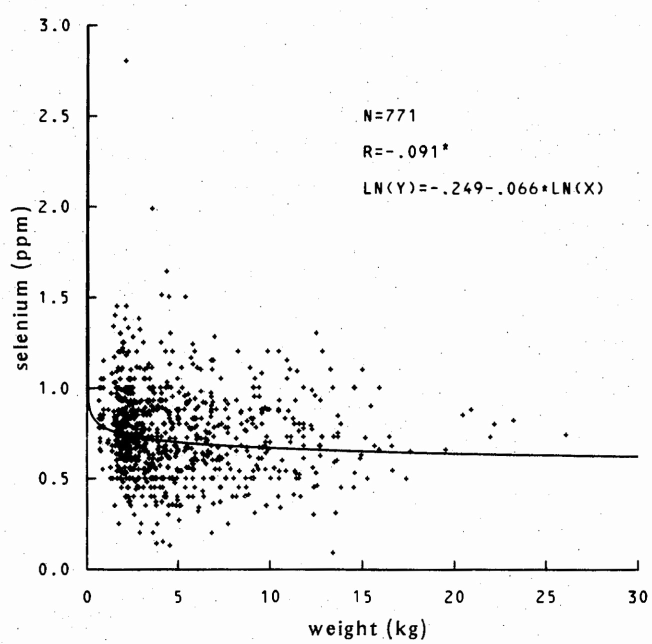

Figure 5. Selenium to weight relationship in king mackerel, *Scomberomorus cavalla*.

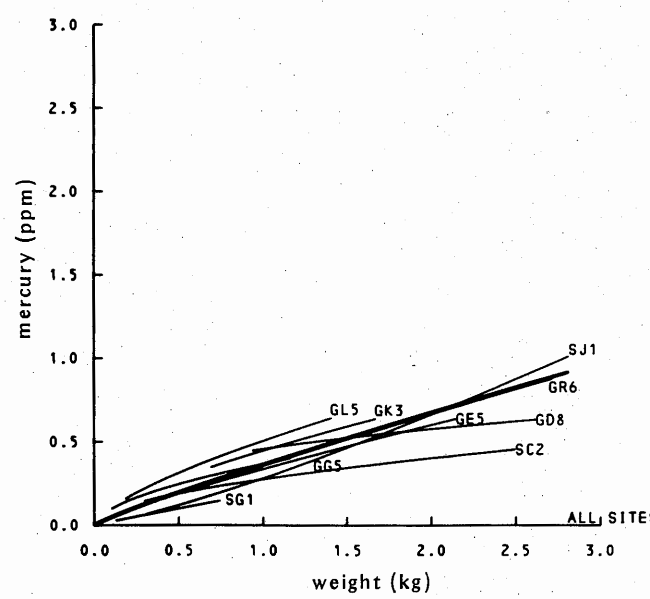

Figure 7. Exponential regressions for mercury to weight in Spanish mackerel, *Scomberomorus maculatus*, by site.

with modes at 0.4 and 1.1 kg. Most Spanish mackerel were caught in the weight range of 1 to 3 kg, with 1.5 kg being the average and 11 kg the maximum size.

Fish weighing 1.4 kg appeared to contain more than 0.5 ppm Hg. Exponential estimates of this cutoff weight for individual sites ranged from 1.0 to 3.0 kg. Unfortunately, the collection of samples contained many small fish that were below the average catch size. Although most of the fish contained less than the guideline concentration, it would be misleading to suggest that other than a considerable proportion of Spanish mackerel caught for food consumption may contain more than 0.5 ppm Hg.

Thirty samples of Spanish mackerel, ranging in weight from 0.4 to 2.81 kg, were analyzed for methylmercury. The mean level was 0.32 ppm with values ranging from 0.01 to 1.0 ppm. An exponential regression equation provides the best fit for the data, and indicates a significant correlation between methylmercury content and fish weight (Figure 8).

A pattern similar to that found for king mackerel emerges from statistical analysis of the Se data, with no significant correlation between total Se concentration and fish weight (Figure 9).

The proportion of methylmercury relative to total Hg found in Spanish and king mackerels is shown in Table 5. A wide variation was found among individual animals of both species, ranging from approximately 35 to 100%. However, there is also a high degree of correlation between total mercury and methylmercury content (Figures 10 and 11).

The main purpose of this paper has been to report some of the contaminant information being developed through one of the research programs of the NMFS Southeast Fisheries Center. There is now a substantial data base on the occurrence of several heavy metals, not only in the two mackerel species under discussion, but in many other fishes representing a wide range in the marine food chain.

With the exception of mercury, the degree of heavy metal contamination of Spanish and king mackerels appears to differ little from that found for the majority of other species. In this sense there are no apparent public health problems associated with the finding of small quantities (parts per million or less) of these metals in the edible tissues of the mackerels.

Mercury is a potential problem, however, solely because of the existence of a safe-level regulatory guideline of 0.5 ppm in fish. As you know, 0.5 ppm is the benchmark against which mercury levels are measured in deciding whether a fishery product is adulterated within the meaning of the Food, Drug and Cosmetic Act of 1975, Section 402(a)(1).

Considerable disagreement exists as to what constitutes adulteration of fish with mercury. This particular metal is widely distributed in the marine environment and may be

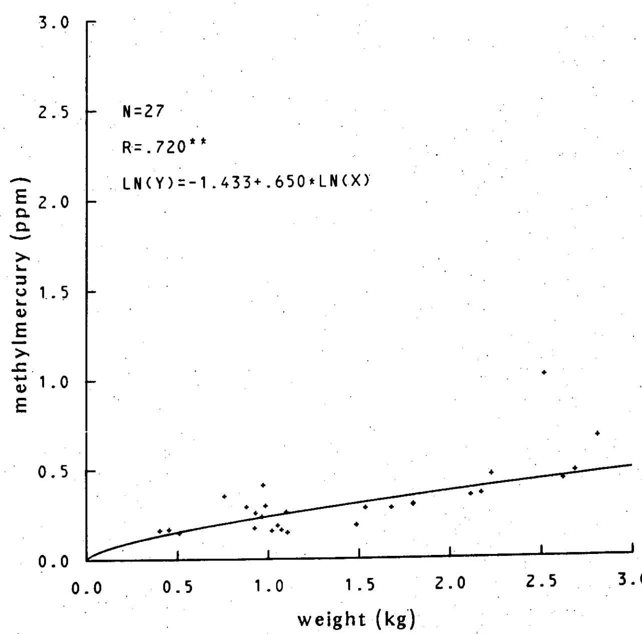

Figure 8. Methylmercury to weight relationship in Spanish mackerel, *Scomberomorus maculatus*.

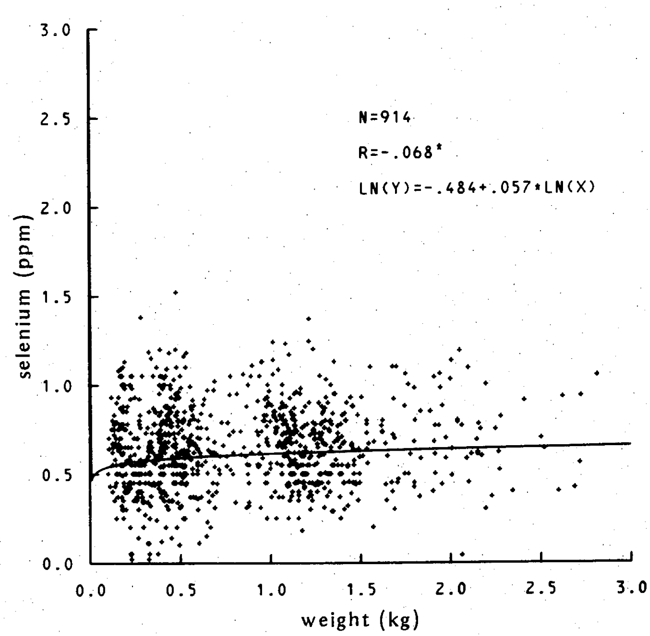

Figure 9. Selenium to weight relationship in Spanish mackerel, *Scomberomorus maculatus*.

Table 5.

Methylmercury concentrations (ppm) in mackerels.

	Number	MeHg	Total Hg	MeHg/Total Hg (%)
S. maculatus	30	0.32	0.55	61.9
		0.15 – 1.01	0.15 – 1.88	35.2 – 106.7
S. cavalla	54	0.62	0.92	72.2
		0.13 – 1.92	0.18 – 2.82	36.2 – 98.7

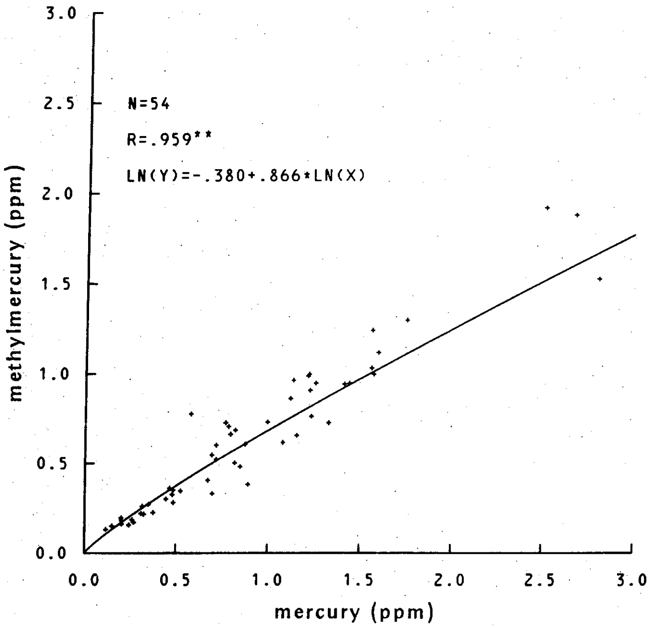

Figure 10. Methylmercury to mercury relationship in king mackerel, *Scomberomorus cavalla*.

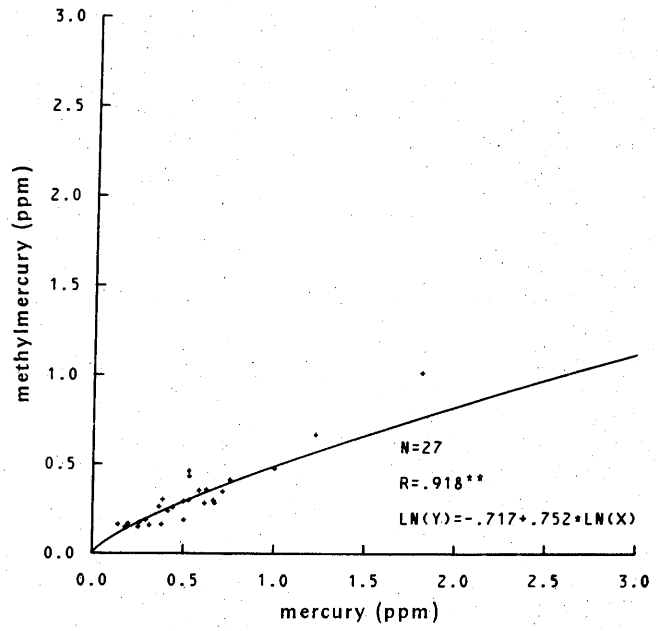

Figure 11. Methylmercury to mercury relationsnip in Spanish mackerel, *Scomberomorus maculatus*.

considered, at least to some degree, as a natural contaminant of marine animals resulting from the passage of mercury through the aquatic food chain following methylation in sedimentary materials. Clearly, the determination of the proportion of mercury attributable to the acts of man in this overall biological system is not possible. Any definition of adulteration, therefore, should be regarded as arbitrary when applied to the consideration of mercury as an "added substance" under the act.

A recent decision by a U.S. District Court in Florida, relating to mercury contamination in swordfish, is important in this regard. The court, in its final judgment of the case, ruled that swordfish containing 1.0 ppm or less mercury *cannot* be deemed to be adulterated within the meaning of the Act. Insofar as swordfish has been a prime target for regulatory action because of its uniformly high mercury content, the court's ruling may be regarded as a positive step towards a rational reinterpretation of the disputed statutory terms of the act.

In conclusion, I mention briefly a recently completed study by the Seafood Quality and Inspection Division of the NMFS Office of Fisheries Development on the dietary intake of mercury by U.S. consumers of seafoods. Using a computer simulation model, data on mercury contamination of fish and shellfish have been combined with data on seafood consumption to determine the statistical chance of consumers exceeding the current acceptable daily intake (ADI) of 30 microgram Hg per 70 kg body weight.

The results of the study demonstrated that with no regulatory controls applied, 99.81% of the panelists participating in the consumptive survey had an "upper limit daily intake" of mercury lower than their personal ADI. The results also showed that action levels of 0.5 and 1.0 ppm provide essentially equal levels of protection to seafood consumers.

A report on the study has been presented to the Commissioner of the Food and Drug Administration for that agency's consideration in reassessing the current interim action level for mercury in seafoods. This very positive action on the part of the NMFS to assure the development of regulatory guidelines based on factual evidence and rational argument is an excellent example of the kind of effort required to protect the legitimate interests of the nation's fishing industry in its negotiations with the FDA.

The new SEFC Charleston Laboratory will continue to acquire information on the occurrence and significance of contaminants in fish and shellfish, including important commercial and recreational species under consideration by management and development regimes in the southeast. Further, this information will be made available, as required, to the Regional Fishery Management Councils and the fishing industry to assist in formulating the emerging strategies for managing and utilizing latent species of the south Atlantic and Gulf of Mexico.

Proceedings of the Mackerel Colloquium, March 16, 1978, 67–70

ANALYSIS OF FLORIDA ATLANTIC KING MACKEREL MONTHLY DOCKSIDE PRICES

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INTRODUCTION

The king mackerel industry, like other food commodity industries, has a need for information explaining the effect of economic factors on prices paid at dockside. This is especially true on the Florida Atlantic coast where changes in the number of fish buying and marketing firms have occurred in the last few years and legal judgments have been rendered against some firms for violation of laws concerning price collusion. The objective of this paper is to determine the functional relationship between market prices and marketing margin, volume marketed, change in market structure and the cost of marketing services.

The analysis is limited to king mackerel, *Scomberomorus cavalla,* landed on the Florida Atlantic coast. U.S. king mackerel are produced in the southeastern states from Texas through North Carolina. Florida king mackerel landings were valued at $2.4 million in 1975 (NOAA, *Curr. Fish. Stat.* 1971–75) and accounted for 93% of U.S. landings. The Atlantic coast of Florida produced over 54% of U.S. landings.

PRIMARY MARKET SYSTEM

Fishermen sell king mackerel to coastal wholesalers commonly called fish dealers or fish handlers. These wholesalers receive the product in gutted form and box and ice the fish for shipping. The boxes of fish are then transported primarily by independent truckers to buyers. A personal survey of Florida Atlantic coast wholesale fish dealers showed that 65% of their king mackerel were shipped to the New York Fulton Fish Market in 1974. Secondary wholesalers on the New York market buy king mackerel from Florida wholesalers for resale or sell them on the market for Florida wholesalers on a commission basis. In this system, king mackerel actually do not change product form from the time they are unloaded from the fishing boats until they pass through the New York market.

Considerable changes occurred in the Florida Atlantic coast finfish marketing system during 1973. A law suit was initiated for price collusion between two fish dealers. A class action suit of fishermen versus a fish dealer was also initiated. A third suit involved prosecution of a fish dealer by the U.S. Department of Justice. In addition, a group of king mackerel fishermen formed a marketing association during June 1973, and a marketing cooperative opened for business in December 1974. Fishermen considered this an effort to increase fishermen prices or reduce marketing margins. One of the primary purposes of this paper is to identify the effects of these structural changes in the marketing system for king mackerel.

A complete examination of prices and margins requires data for each level of the market system. Unfortunately, prices for each marketing level in the finfish marketing system are not available. The only available prices are at the producer level (sometimes referred to as the fishermen price, dockside price or the ex-vessel price) and for the New York Fulton Fish Market. The New York price level represents the price received by secondary wholesalers as they sell to other wholesalers and retailers.

THEORETICAL CONSIDERATIONS

An equation to explain what affects prices for king mackerel was developed and is given as:

$$P_t^f = a_1 + b_1 P_t^{ny} + b_2 Q_t + b_3 C_t + b_4 D + b_5 DT + b_6 DT^2 \quad (1)$$

where:

P_t^f = dockside price per pound received by fishermen on the Florida Atlantic coast

P_t^{ny} = price received at the New York Fulton Market

Q_t = quantity or pounds landed of king mackerel on the Florida Atlantic coast

C_t = cost of inputs and services to market king mackerel

D = shifter to measure changes in the market structure

T = months after initial change in the market sturcture

t = time period in months.

The coefficient a_1 estimates the level of dockside price that is not a function of other variables included in the model. Estimates of b_1 indicate the change in fishermen price (P_t^f) associated with a per unit change in prices received in New York. Estimates of b_2 indicate the expected price change at the fisherman level for given changes in king mackerel landed (Q_t). The cost of marketing inputs and services also change the marketing margin and prices paid to fishermen at dockside. The coefficient b_3 represents this effect.

Coefficients b_4, b_5 and b_6 represent the effect of the change in market structure on dockside prices. The total effect on dockside prices is hypothesized to be related to the time period after the change in market structure. Price is expected to change with time due to the level of success of a change in market structure such as a new marketing association or marketing cooperative. The effects of lengthy court procedures in the price collusion cases also should influence fishermen prices. The total effect TE of the structural change in dockside prices derived from Eq. 1 is represented by Eq. 2:

$$TE = b_4 + b_5 T + b_6 T^2 \qquad (2)$$

A negative (positive) sign for b_4 suggests changes in the market structure decrease (increase) dockside prices. Whether prices continue to decrease (increase) depends on the relative size and signs of coefficients b_5 and b_6. For a complete development of the theoretical model and supporting statistical analyses and considerations, see Prochaska (1978).

EMPIRICAL RESULTS

The data base used for the ordinary least squares regression estimates contained monthly observations for the 60-month period from January 1971 through December 1975. Monthly average prices (cents per pound) for Florida Atlantic coast king mackerel sold on the New York Fulton Market were computed as a weighted average of daily prices reported in NOAA, *Fish. Mark. News Rep.* (1971–75). Fishermen prices were computed from monthly volume and value of landings reported for the Florida Atlantic coast (NOAA, *Curr. Fish. Stat.* 1971–75). The monthly volume (millions of pounds) of king mackerel landings on the Florida Atlantic coast was used for monthly values of Q_t. A quarterly index of costs of intermediate goods and services used by food marketing firms was used as a proxy for C_t (USDA 1971–75).

June of 1973 was chosen as the date for the initial shift in the market structure. The marketing association was formed at this time and was hypothesized to have its initial effect. The exact date at which the structural change occurred is uncertain, because publicity before the actual formation of the association could have initiated changes or there could have been a lagged effect. The marketing cooperative began operation in December 1974.* In addition, the price-fixing cases were in progress during the study period after June 1973. The structural shift variable D was assigned a value of zero prior to June 1973 and a value of one for each month after May 1973. The variable representing months T took the values of 1 through 31 consecutively for the months June 1973 through December 1975.

*This does not imply that a cooperative was necessary to cause a shift in the market structure. The same effect could have occurred from the entrance of any new firm that had the ability to encourage fishermen to sell their king mackerel to the new firm.

Empirical estimates of coefficients and standard errors, shown in parentheses, for the price model represented by Eq. 1 are presented in Eq. 3.

$$\begin{array}{lllll} P_t^f = & 23.7642 & + 0.4957\,P_t^{ny} & - 7.2129\,Q_t & - 0.1470\,C_t \\ & (26.2196) & (0.0766) & (3.6538) & (0.2335) \end{array}$$

$$\begin{array}{lll} + 13.7105\,D & - 0.7433\,DT & + 0.0305\,DT^2 \\ (3.3421) & (0.8090) & (0.0157) \end{array} \qquad (3)$$

The model explained approximately 85% ($R^2 = 0.8438$) of the monthly variation in fishermen prices. The margin model was estimated by subtracting Eq. 3 from New York market prices P_t^{ny} and is presented in Eq. 4.

$$M_t = -23.7642 + 0.5043\,P_t^{ny} + 7.2129\,Q_t + 0.1470\,C_t$$

$$- 13.6105\,D + 0.7433\,DT - 0.0305\,DT^2 \qquad (4)$$

The estimated coefficients in Eqs. 3 and 4 are equal in absolute values for all variables except P_t^{ny}. The coefficient for P_t^{ny} in the price equation equals one minus the coefficient b_1 in the margin equation.

Price changes in the New York market for Florida king mackerel have a significant and approximately equal effect on both the margin and the price received by fishermen. A one cent increase in New York prices is estimated to increase the marketing margin by 0.5043 cent and increase the fishermen prices by 0.4957 cent per pound. All of the price changes are not directly passed on to fishermen.

Quantity landed by Florida producers also had a highly significant statistical effect on both the marketing margin and prices received by Florida fishermen. A change in monthly landings of 1 million pounds resulted in a 7.2129-cent per pound change in prices Florida fishermen received at dockside. This price change, however, was totally absorbed in the marketing margin. Equation 4 shows a change in the margin of 7.2129 cents per pound for each million-pound change in landings. Since New York price P_t^{ny} is included as an independent variable in both Eqs. 3 and 4, the estimated margin and fishermen price effects due to a change in landings are estimated after adjustments for New York prices. Additional margin and price effects of quantity landed by the Florida Atlantic coast fishermen may exist if there is a relationship between New York prices and Florida quantity landed. Repeated attempts using various equations have not shown a statistically significant relationship between Florida landings and New York prices.

Costs of intermediate goods and services used in marketing food products did not have a significant statistical effect on the margin or fishermen prices. The signs, however, were as expected. An increase in C_t was positively correlated with M_t and negatively related with P_t^f. The insignificant coefficient probably reflects the limited amount of substitution between marketing inputs and fresh fish.

Changes in market structure had a highly significant effect on marketing margins and prices received by fishermen. Equation 2 was evaluated for certain months after the structural change. Expected increases in fishermen prices due to the market structure changes are presented in Table 1 and illustrated as demand shifts in Figure 1. The price increase to fishermen was 12.9 cents during the first month after the shift. This is illustrated as a price increase from P_1 to P_2 for a quantity of one million pounds in Figure 1. The price increase then decreased to a low of 9.6 cents 13 months after the shift (P_3 - P_1) but then climbed to 23.8 cents by December 1975 (P_4 - P_1). The upward trend in prices after the thirteenth month coincides with the marketing cooperative beginning operation in the fourteenth month. The increase in latter months may also be due to the court cases which were settled in 1976 and 1977. This change is significant considering average fishermen price during the 60-month period was 42 cents per pound. Average price before the shift was 34 cents per pound and 50 cents per pound afterward. A simple comparison of the predicted increases in prices with the overall mean price suggests monthly dockside price increases ranged from 25 to 50% due to the shift.

An alternative method of demonstrating the effects of changes in market structure concerns examination of changes in the marketing margin. The size of the marketing margin as a percent of New York prices tended to be cyclical in nature in 1972 and 1973 (Figure 2). The margin comprised a larger percentage of New York prices during high production winter months when prices were normally lower and a lower percentage of New York prices during low production summer months. The effect of a law suit alleging price collusion can be seen where the margin as a percent of New York prices fell to a lower than normal level several months after the suit was filed in February 1973. The margin did not reach the same level during the high production period of late 1973 and early 1974 as it did in the two earlier years. A marketing association was formed in June 1973 and a

TABLE 1.

Estimated effect of structural shift in market structure on fishermen prices in cents per pound.

Time period (month)*	Estimated increase in fishermen price	Time period (month)*	Estimated increase in fishermen price
1	12.9018	17	10.9738
3	11.6920	19	11.9784
5	10.7590	21	13.2652
7	10.1028	23	14.8180
9	9.7238	25	16.6530
11	9.6208	27	18.7648
13	9.7950	29	21.1534
15	10.2640	31	23.8188

*Month 1 is June 1973.

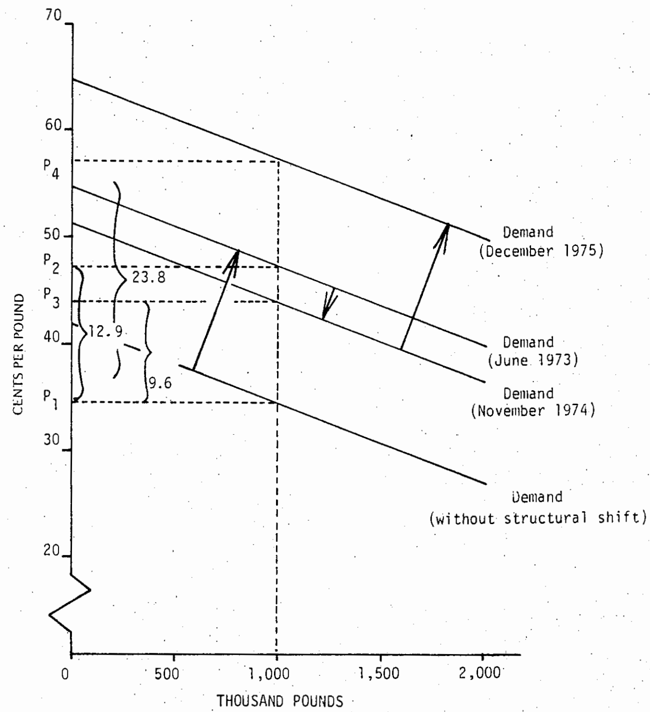

Figure 1. Monthly demand functions at dockside for Florida Atlantic coast king mackerel, June 1973 to December 1975.

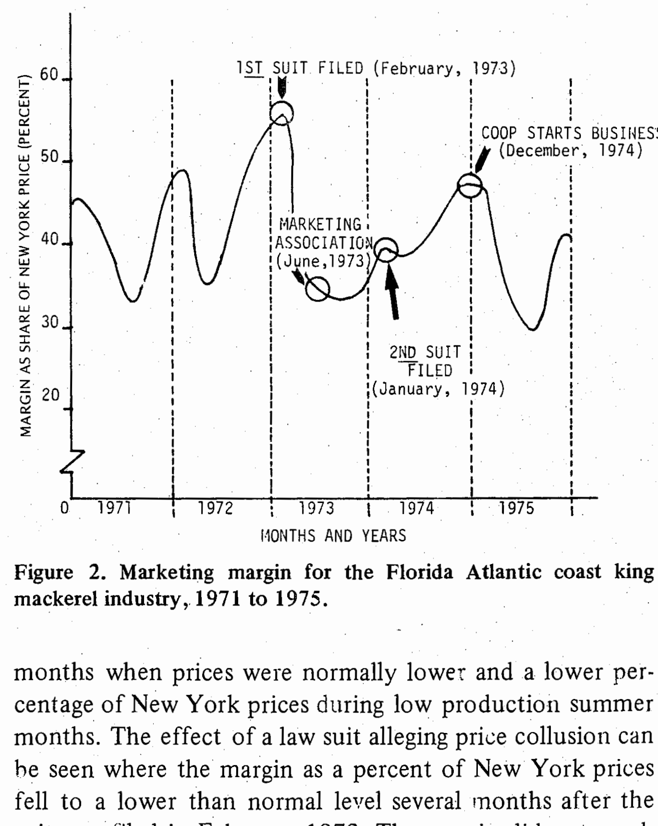

Figure 2. Marketing margin for the Florida Atlantic coast king mackerel industry, 1971 to 1975.

second law suit filed in Feburary 1974. The normal upward trend in the margin as a percent of New York prices continued into the winter of 1974–75. A production and marketing cooperative began operation in December 1974. The margin, as a percent of New York prices, began its normal decline but reached its lowest point in the five-year period. This is probably a sign of increased price and service competition from existing firms in the industry.

CONCLUSIONS

Changes in terminal market prices for fresh king mackerel are shared equally between market middlemen and Florida Atlantic coast fishermen. In addition, there is a significant positive relationship between fishermen supply and the size of the marketing margin. Fishermen prices move in the opposite direction of marketing margins when the supply of fish changes. The supply of marketing inputs had a positive but insignificant statistical effect on marketing margins which was probably due to limited substitution between fresh fish and marketing inputs and services.

Changes in the market structure, which occurred to the dissatisfaction among fishermen with respect to marketing margins and fishermen prices, appear to have been successful in influencing price and the marketing margin. Highly significant increases in fishermen prices and decreases in marketing margins were achieved since the structural change. The initial decrease in margins declined for the first thirteen months after the structural change but since then the margin has continued to decline significantly.

REFERENCES CITED

Fisheries of the United States. 1971–75. Current Fisheries Statistics - Florida Monthly Landings, January 1971–December 1975. *U.S. Dep. Commer. NOAA, NMFS* (before 1968 by *U.S. Dep. Inter. Fish. Wildl. Serv.*). Washington, D.C.

Fisheries of the United States. 1971–75. Fishery Market News Reports (New York), January 1971–December 1975. *U.S. Dep. Commer. NOAA, NMFS* (before 1968 by *U.S. Dep. Inter. Fish. Wildl. Serv.*). Washington, D.C.

Prochaska, F.J. 1978. Prices, marketing margins and structural change in the king mackerel marketing system. *South. J. Ag. Ec.* 10(1):105–109.

U.S. Dep. Agriculture. 1971–75. *Marketing and Transportation Situation*. Economic Research Service.

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REVIEW OF SOCIO-ECONOMIC WORKSHOP ON MACKERELS

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In April 1977, the Southeast Fisheries Center of the National Marine Fisheries Service sponsored a workshop to examine the mackerel fishery. Prior to the workshop, some computer modeling of the socio-economic aspects of the fishery had been started, and it was found that additional information was needed. Commercial data were readily available but recreational data were insufficient. The commercial fisheries data were categorized as biological and economic and social, with more biological data than socio-economic. The first necessary thing was to bring participants in the fishery together – producers, processors, scientists, government administrators, etc. The initial premise was that these people who are not actually in the economic workings of the fishery really do not understand how the fishery works. Approximately 25 people from the industry attended the workshop.

A background report of soft-type data was prepared and submitted to the attendees for correction of any misinterpretations of the data. Much of the information received from the participants was helpful. For example, a marketing chain for both king and Spanish mackerels was put together. For the king mackerel, 315 hand-line and 35 net boats were identified that operated out of approximately 30 local fish houses and 3 large secondary wholesalers. The product was then followed through the market – frozen to Puerto Rico, or fresh into the market locally, or to New York. For Spanish mackerel, 250 small gillnet boats and possibly 67 larger gillnet boats were identified, although not all of them were fishing. These boats operated out of approximately 16 fish houses.

There are several methods of obtaining missing information, or extracting expert opinion: the Delphi method, the American Assembly format, etc. It is essentially taking available information, putting it together, and then asking for corrections. We found the participants were eager to correct misinformation, but reticent in advancing new information.

As fishery management plans proceed, people who are in the fisheries should meet with those who study the fisheries, before actual plans are formulated. The fishery management councils have scientific and advisory panels, but this is different: i.e., before a plan is formulated, the "doers" who are actually in the fishery must have a way to directly contribute their knowledge of socio-economics to the plan rather than review the plan after it has already been formulated. This workshop was a good first-step in that direction. Additional workshops of this nature are certainly needed to bring those who are actively engaged in the fishery into the reviewing and inputting of socio-economic data during the formulation of a management plan.

It can be done. It is not cheap. First, all available information must be put together and submitted for review. Simply trying to obtain information without presenting any will not work. Second, meetings must be scheduled so that maximum attendance is possible.

Our report is available to anyone who would like to have it. Generally, it contains soft-type data – number of boats, names of fish houses, marketing chains, catch destinations, etc. It gives some understanding to regional catch fluctuations. Certainly, statistics by themselves can be misinterpreted, for example, when considering gear controversy or price determinations, if the exact institutional arrangements at that time are not known. To have proper evaluation of relevant factors, all participants in the fisheries, people actually engaged in the economic activities, must be brought together.

Economists must have the cooperation of fishermen and processors in order to obtain meaningful information. The difficulty is that most fishermen and processors are intelligent enough to realize that this information ultimately ends up in the hands of those who pass regulations affecting their livelihood. Whether those regulations would be for the better or worse could only be determined after the fact. Therefore, it is necessary to convince the participants in the fishery that the gathered information will be used in the best interest of all. This is not easy to do. At present, not enough time has been spent in reassuring the participants and it is felt that future workshops will help accomplish this. Until we do that, it will be difficult to collect the required socio-economic information.

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PRESERVATION TECHNOLOGY FOR SPANISH MACKEREL AND RELATED SPECIES – A LITERATURE REVIEW

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ABSTRACT Published data on the composition, processing and preservation technology of Spanish mackerel, *Scomberomorus maculatus*, and king mackerel, *Scomberomorus cavalla*, are very limited, although there is extensive technical literature on the Atlantic mackerel, *Scomber scombrus*, and the chub mackerel, *Scomber japonicus*, of the Pacific. This review is based on: (1) the limited literature pertaining to the technology of the *Scomberomorus* species; (2) selected items from a bibliography and review of mackerel, *Scomber* spp., technology by another author, covering literature published through 1974; and (3) additional papers on mackerel technology, mostly published since 1974. The principal subjects covered are processing technology, frozen storage stability, rancidity development and chemical composition of mackerel species.

INTRODUCTION

The major commercial fisheries for Spanish mackerel, *Scomberomorus maculatus*, and king mackerel, *S. cavalla*, are located off the western coast of Florida. U.S. commercial landings for both species set new records in 1976 (NMFS 1977). A total of 14.1 million pounds of Spanish mackerel were landed (a 20% increase over 1975) with a value of \$3.2 million (up 59%). The 8.94 million pounds of king mackerel worth \$3.9 million represented an increase of 31.5% in volume and a tremendous 126% increase in total landed value. The Atlantic mackerel, *Scomber scombrus*, also showed increased landings but the \$703 thousand value was far below that of either of the *Scomberomorus* species.

Lyles (1969) published historical statistics of the fisheries, concluding that catch size was determined by demand rather than stock availability. The 11.6 million pounds of Spanish mackerel landed in the war year of 1945 set a record that was not approached for more than a quarter of a century. Lyles declared that "the resource is not fully utilized and the problem of long-term storage needs to be attacked."

Although published data on the composition, processing and preservation technology of the *Scomberomorus* species is very limited, there is a relatively large technical literature base on the Atlantic mackerel and also on the chub mackerel, *Scomber japonicus*, of the Pacific. Oxidative problems during frozen storage may not be as severe for Spanish and king mackerels as it is for the *Scomber* species, but the problem must be overcome if a reliable supply of top-quality products is to further penetrate national markets. Farragut (1972) reported on the effects of certain antioxidants and chelating agents on the development of rancidity in Spanish mackerel during frozen storage, but no other comparable work has been published on this species. Much work has been done on the composition and preservation technology of Atlantic mackerel notably by Ke and coworkers of the Canadian Fisheries Service, and on chub mackerel by Japanese researchers. Dingle (1976) prepared an excellent bibliography and literature review on the technology of these species, covering publications through 1974.

My review covers: (1) the limited literature pertaining to the technology of *Scomberomorus* species; (2) selected items from the review by Dingle (1976); and (3) additional papers on mackerel technology, mostly those published since 1974. The principal subjects are processing technology, frozen storage characteristics, rancidity, and chemical composition of mackerel species.

PROCESSING AND HANDLING

Normal processing methods for finfish harvested from the Gulf of Mexico have been outlined by Cox and Nickelson (1976), who list both Spanish and king mackerels among the top-10 table fish species from the Gulf of Mexico. Quality control laws in Florida require that fish be iced aboard the vessel. This is often not done in other gulf states and fish quality suffers. Some processors in Florida brine-freeze mackerel in the round and then fillet them while the fish are still frozen. Cox and Nickelson (1976) recommend the application of information available on other species to the solution of problems of gulf species for which very little technological information exists.

Some publications are available on the preservation technology of seer fish, *Scomberomorus guttatus*. Perigreen (1968) found that seer fish could be stored in insulated boxes for four days after freezing at -30°C and then kept an additional two to three days on ice. Changes in peroxide value, volatile acid number, free fatty acids (FFA) and organoleptic quality were measured. Shenoy and James (1974) evaluated the iced storage of seer fish. Chemical and organoleptic tests demonstrated a longer shelf life during iced storage for samples wrapped in polyethylene film. The Standards Institution of India has published standards that prescribe the requirements and methods of sampling and testing frozen (India 1971a) and fresh (India 1971b) seer fish *Scomberomorus* spp.

Contribution No.78–33C, Southeast Fisheries Center, NMFS, NOAA.

Much more has been published on the preservation technology of other mackerel species, particularly the Atlantic mackerel, and much of the information could apply to Spanish or king mackerels. Stansby and Lemon (1941) reported on the handling of fresh mackerel. The advantage of eviscerating and packing mackerel in crushed ice over some of the then common handling and transportation practices was discussed. Fraser et al. (1968) correlated flavor deterioration in iced mackerel with measurements of inosine monophosphate (IMP) and hypoxanthine. They described a relatively simple ultraviolet (UV) absorption test that correlated with IMP content and was also a very good index of progressive quality loss.

Hardy and Smith (1976) studied the development of histamine and rancidity in mackerel. Rancid flavors were detected in vacuum-packed fillets only after 69 weeks at -14°C or after 75 weeks at -21°C or -29°C. Other packaging methods resulted in rancid flavors at 22 to 44 weeks, depending on storage temperature. The correlation between peroxide values and taste panel results was not very good. Significant amounts of histamine were not detected until stored mackerel (iced or ambient temperature) were putrefied. Hardy and Smith (1976) also discussed the toxicity of histamine and other amines.

Olsen (1955) recommended the freezing of mackerel or other fatty species in an alginate jelly to prevent rancidity. Stoloff et al. (1948) stated that the frozen storage life of mackerel fillets was extended by dipping them in a solution containing carrageenin and several different chemical antioxidants.

The pretreatment of mackerel fillets by microwave heating before frozen storage is not advisable according to Ke et al. (1978). The generation of free radicals by microwaves accelerated lipid oxidation, resulting in shortening frozen life by as much as 60% relative to control samples.

A two-stage process for smoking mackerel has been described (Anon. 1972). References to other smoking and salting processes for mackerel and to various canning procedures and results are included in the review by Dingle (1976). Canning is not likely to be applied to Spanish or king mackerels, however, because of the low-canned value compared to the value of fresh, frozen, or smoked products.

FROZEN STORAGE

The only extensive frozen storage study with Spanish or king mackerels was that of Farragut (1972). In Phase I of his study, Spanish mackerel fillets were either dipped or injected with antioxidant solutions. Butylated hydroxyanisole (BHA), butylated hydroxytoluene, propyl gallate, and the chelating agent ethylene diamine tetra-acetate (EDTA) were included in various treatments. Peroxide values and free fatty acids were measured and organoleptic tests performed. Results were variable and not well correlated; however, the EDTA treated samples had superior flavor and texture scores after 9 months of frozen storage at -10°F (-23°C). In Phase II of Farragut's study, several different chemical forms of EDTA were tested at three different concentration levels. The treatments with disodium EDTA and tetrasodium EDTA were judged to be most effective in preserving the quality of the mackerel fillets.

Ke et al. (1976) reported on quality preservation in frozen Atlantic mackerel. Mackerel of initial good quality could be stored satisfactorily for 4 months at -26°C. Vacuum packaging extended the mackerel storage life to more than 1 year at -26°C and to at least 6 months at -18°C.

The Atlantic mackerel's frozen storage life was estimated by Pottinger (1951) to be 2 months at 15°F (-9°C) and about 4 months at 0°F (-18°C) or 10°F (-23°C). No particular adverse effect was measured when the storage temperature was purposely fluctuated at intervals between 0°F and -10°F or between 0°F and 15°F. Almy (1939) reported an extensive mackerel frozen storage study for his Ph.D. thesis. He concluded that mackerel could be kept for 10 months at a temperature of -21°C to -15°C.

The advantages of using ascorbic acid to retard rancidity and prevent color changes in mackerel and other species has been reported (Anon. 1948). Liljemark (1964) found that either dipping mackerel or herring fillets into a 2% ascorbic acid solution or vacuum packaging would improve quality retention about as much as reducing the storage temperature from -20°C to -30°C.

Keay et al. (1972) and Sreenivasan et al. (1976) investigated the frozen storage stability of *Rastrelliger neglectus*. Keay et al. (1972) used a variety of analyses and chemical tests plus a sensory evaluation in studying the quality changes in mackerel during frozen storage. They attempted to compare experimental oxygen absorption values with theoretical oxygen absorption values based on peroxide values, thiobarbituric acid (TBA) numbers, iodine values, UV absorption, and fatty acid analyses. The wide variations in calculated results showed that lipid oxidation could not be explained in terms of simple autoxidation theory. Sreenivasan et al. (1976) investigated protective treatments for Indian mackerel, *Rastrelliger kanagurta*, during frozen storage. Mackerel with a higher fat content maintained a better texture during frozen storage than did leaner fish. The mackerel could be protected from oxidative rancidity for up to 12 months by dipping in an antioxidant solution, glazing and storing in a polyethylene pouch to prevent dehydration. A mixture of ascorbic acid and BHA in combination with either citric acid or monosodium glutamate was most effective for mackerel preservation.

RANCIDITY

Farragut (1972) reported that Spanish mackerel, eviscerated and frozen whole in the normal commercial process, "begin to show signs of rancidity within as little as a 3-month period and are usually rejected by taste-panels between the sixth and ninth months of storage." Spanish mackerel remained in good condition for over 12 months, however, when they were treated with a solution of tetrasodium EDTA and vacuum packaged.

Ke and coworkers have published a number of papers concerning the development of oxidative rancidity in Atlantic mackerel lipids. Ke et al. (1975) measured volatile aldehydes from oxidized mackerel oils by gas liquid chromatography and correlated formation of 2, 4, 7-decatrienals with peroxide value and the polyene ratio. The polyene ratio (18:4W3 + 20:5W3 + 22:6W3)/(14:0 + 16:0 + 18:0) is proposed for following changes in fatty acid composition during the autoxidation of fish oils.

The oxidation of mackerel skin and meat lipids was strongly catalyzed by added divalent copper or iron (Ke and Ackman 1976). The more rapid oxidation of extracted skin lipids at 60°C could not be explained by minor differences in fatty acid composition compared to meat lipids. The presence of one or more pro-oxidants in the skin lipids was postulated. Lipid oxidation rates, measured peroxide value and TBA number, were also much faster for skin lipids than for meat lipids during frozen storage (Ke et al. 1977). The activity of the unknown pro-oxidative substances was detectable at storage temperatures above -40°C, but not below.

Extracted mackerel skin lipids were used by Ke et al. (1977) as an unsaturated fat model system to compare the potency of several antioxidant compounds. Tertiary-butylhydroquinone (TBHQ) was most effective in inhibiting oxidation of the mackerel oil based on a simple method of measuring weight gain of oil during oxidation at 60°C. Also, TBHQ was found to retard the formation of FFA and carbonyls from lipid hydrolysis and secondary oxidation reactions and shows potential for use with a number of fishery products.

A rancidity index based on TBA number (distillation method) for relatively fresh mackerel and peroxide value for more rancid fish was proposed by Ke et al. (1975). The chemical tests were compared with organoleptic test results: mackerel with a molar TBA number of less than 6.0 μ-moles malonaldehyde (MA) per kg of meat (0.43 mg MA/kg) had excellent quality and a peroxide value (POV) of less than 2.0 indicated acceptable quality. A POV in excess of 2.0 for meat or 12.0 for the skin fraction indicates unacceptable quality. The rancidity index was applied to both spring and fall mackerels stored at -26°C. Vacuum packaging greatly extended the storage life of fresh mackerel and those stored on ice or in refrigerated sea water for 2 days.

Vyncke (1975) compared the TBA values for both red and white meats of Atlantic mackerel measured by (1) a distillation method, and (2) a direct extraction method using trichloracetic acid solution. He found very similar changes with time of storage, but the distillation method gave consistently higher values.

Bauernfeind et al. (1948) retarded rancidity development in mackerel fillets and other fish by dipping them in an ascorbic acid solution and wrapping in cellophane. Sreenivasan et al. (1976) recommended a combination of ascorbic acid and BHA to retard oxidation and also recommended wrapping fish in plastic film for protection.

COMPOSITION

Mean proximate compositions with standard deviations and ranges found in the available technical literature have been tabulated by Sidwell et al. (1974) for the edible portions of 154 species of finfish and shellfish. Compositional data for several *Scomberomorus* species were extracted from 13 references. Chemical composition and measurements reported by Ousterhout (1960) included a group of Spanish mackerel. A fillet yield of 58.6% was reported. Data have also been reported on the content of mercury and other heavy metals in Spanish mackerel (Windom et al. 1973) and for both Spanish and king mackerels (Hall et al. 1978).

Proximate compositions for Atlantic mackerel fillets were reported by Sohn et al. (1961). Seasonal variations for mackerel were highly significant. Mannan et al. (1961) reported proximate compositions and nonprotein nitrogen for both the red and white meat portions of Atlantic mackerel. The large differences in composition of the different tissues make sampling of mackerel and related species very difficult.

Hardy and Keay (1972) published an excellent and comprehensive study of seasonal variations in *Scomber scombrus* which included proximate compositions, biometric data and details of the major lipid classes and their constituent fatty acids. Feeley et al. (1972) reported a cholesterol content of 95 mg per 100 gm of mackerel flesh which contained 12.2% total fat.

Dyer et al. (1977) reported a survey of retail frozen fishery products in which proximate analyses, mineral contents and energy values for the edible portions were measured. The dressed Atlantic mackerel samples averaged 18.7% protein and 9.8% fat and, at a calculated cost of $3.50 per pound of protein, was the least-expensive fish surveyed.

Grangaud (1950) prepared a comprehensive review on the vitamin content of fish including data for both Atlantic and Pacific mackerels of the genus *Scomber*. Mackerel flesh is a rich source of vitamins A, D and E. Values for the water-soluble vitamins are also tabulated.

Teeri et al. (1957) analyzed important saltwater species of finfish and shellfish commonly consumed in the New England area for nutritive values. Mackerel excelled in its high contents of protein, nicotinic acid, riboflavin and vitamin B_{12}. Ackman and Cormier (1967) measured the α-tocopherol (vitamin B) contents of several Atlantic fish and shellfish. The mackerel flesh sample contained 310 μg per gm of lipid.

Much pertinent information on mackerel composition is included in a review by Ackman (1974). Fatty acid compositions of *Scomber* from a number of geographical areas were gleaned from nine different references and compared in a single table. Values for major fatty acids of neutral and polar lipid fractions are accompanied by corresponding specifications for (1) oil from light or dark flesh or body oil, (2) lipid content of flesh, and (3) spring or fall harvest. Little difference was found in the lipids and fatty acids of mackerel from different geographical areas and "developments in improved storage techniques would also be generally beneficial to further marketing for food use of catches elsewhere."

Atlantic mackerel lipids and fatty acids were described in detail by Ackman and Eaton (1971). There were sharp differences in lipid content between spring and fall fish and between light and dark tissue. For the dark tissue there were also major differences between males and females. Detailed fatty acid compositions are listed for light and dark flesh, for belly flap tissue and for liver and roe samples.

The fatty acid compositions of dark and white meats of seer fish were reported by Gopakumar and Nair (1972). This *Scomberomorus* species is commercially important in India.

Yamada and Hayashi (1975) described the fatty acid composition of 22 species of fish and mollusk. The chub mackerel was included. Ueda (1976) reported the fatty acid compositions of neutral and polar lipid fractions of 23 different samples of chub mackerel collected over a 1-year period. Fatty acids were statistically analyzed for dependence on season, body length and total lipid content.

CONCLUSION

Spanish and king mackerels are valued food fish and are gaining increasing acceptance in many regions of the United States. Methods for effective control of processing, storage, and marketing of these fish are needed to assure that consumers will not receive products with rancid flavors. Although very little technological information directly applied to the *Scomberomorus* species has been published, the more extensive technical literature on Atlantic mackerel and other mackerel species should be useful for the solution of processing and preservation problems.

REFERENCES CITED

Ackman, R. G. 1974. Marine lipids and fatty acids in human nutrition. *In* R. Kreuzer (ed.), *Fishery Products*, pp. 112–131. Fishing News (Books) Ltd., London.

________ & M. G. Cormier. 1967. α-Tocopherol in some Atlantic fish and shellfish with particular reference to live-holding without food. *J. Fish. Res. Board Can.* 24:357–373.

________ & C. A. Eaton. 1971. Mackerel lipids and fatty acids. *Can. Inst. Food Technol. J.* 4:169–174.

Almy, H. 1939. The composition and nutritive value of fish preserved by cold storage. Ph.D. thesis. Columbia University, New York, N.Y. 25 pp.

Anon. 1948. The use of ascorbic acid in frozen fish products. *Quick Frozen Foods* 11:66.

________. 1972. Mackerel smoked by a new process. *Food Eng. (N.Y.)* 44:112.

Bauernfeind, J. C., E. G. Smith, O. Batcher & G. F. Seimers. 1948. Retardation of rancidity in frozen fish by ascorbic acid. *Quick Frozen Foods* 10(8):139; 10(9):68.

Cox, B. A. & R. Nickelson. 1976. Gulf of Mexico finfishery – harvesting, processing and quality. *Gulf Caribb. Fish. Inst. Proc.* 29:43–52.

Dingle, J. R. 1976. Technology of mackerel fishery – bibliography and survey of literature. *Can. Fish. Mar. Serv. Misc. Spec. Publ.* 30. 63 pp.

Dyer, W. J., D. F. Hiltz, E. R. Hayes & V. G. Munro. 1977. Retail frozen fishery products – proximate and mineral composition of the edible portion. *J. Inst. Can. Sci. Technol. Aliment.* 10:185–190.

Farragut, R. N. 1972. Effects of some antioxidants and EDTA on the development of rancidity in Spanish mackerel (*Scomberomorus maculatus*) during frozen storage. *U.S. Dep. Commer. NOAA Tech. Rep. NMFS SSRF*–650. 12 pp.

Feeley, R. M., P. E. Criner & B. K. Watt. 1972. Cholesterol content of foods. *J. Am. Diet. Assoc.* 61:134–149.

Fraser, D. I., D. P. Pitts & W. J. Dyer. 1968. Nucleotide degradation and organoleptic quality in fresh and thawed mackerel muscle held at and above ice temperature. *J. Fish. Res. Board Can.* 25:239–253.

Gopakumar, K. & M. R. Nair. 1972. Fatty acid composition of eight species of Indian marine fish. *J. Sci. Food Agric.* 23:493–496.

Grangaud, R. 1950. Vitamins of fish. *Cong. Int. d'Etude sur le Role du Poisson dans l'Alimentation.* Paris. pp. 83–98.

Hall, R. A., E. G. Zook & G. M. Meaburn. 1978. National Marine Fisheries Service survey of trace elements in the fishery resource. *U.S. Dep. Commer. NOAA Tech. Rep. NMFS SSRF*–721. 313 pp.

Hardy, R. & J. N. Keay. 1972. Seasonal variations in the chemical composition of Cornish mackerel, *Scomber scombrus*, with detailed reference to the lipids. *J. Food Technol.* 7:125–137.

________ & J. G. M. Smith. 1976. The storage of mackerel (*Scomber scombrus*). Development of histamine and rancidity. *J. Sci. Food Agric.* 27:595–599.

India. 1971a. Specification for seer fish (*Scomberomorus* spp.), frozen. *Indian Standard* 6122–1971. 7 pp.

________. 1971b. Specification for seer fish (*Scomberomorus* spp.), fresh. *Indian Standard* 6123–1971. 7 pp.

Ke, P. J. & R. G. Ackman. 1976. Metal-catalyzed oxidation in mackerel skin and meat lipids. *J. Am. Oil Chem. Soc.* 53:636-640.

________, ________ & B. A. Linke. 1975. Autoxidation of polyunsaturated fatty compounds in mackerel oil: formation of 2, 4, 7-decatrienals. *J. Am. Oil Chem. Soc.* 52:349–353.

________, ________, ________ & D. M. Nash. 1977. Differential lipid oxidation in various parts of frozen mackerel. *J. Food Technol.* 12:37–47.

________, ________ & D. M. Nash. 1975. Proposed rancidity indexes for assessing the storage life of frozen mackerel. *Can. Fish. Mar. Serv. Halifax Lab. New Ser. Circ.* 52. 8 pp.

________, B. A. Linke & R. G. Ackman. 1978. Acceleration of lipid oxidation in frozen mackerel fillet by pretreatment with microwave heating. *J. Food Sci.* 43:38–40.

________, D.M. Nash & R. G. Ackman. 1976. Quality preservation in frozen mackerel. *J. Inst. Can. Sci. Technol. Aliment.* 9:135–138.

________, ________ & ________. 1977. Mackerel skin lipids as an unsaturated fat model system for the determination of antioxidative potency of TBHQ and other antioxidant compounds. *J. Am. Oil Chem. Soc.* 54:417–420.

Keay, J. N., P. Rattagool & R. Hardy. 1972. Chub mackerel of Thailand (*Rastrelliger neglectus*): a short study of its chemical composition, cold storage and canning properties. *J. Sci. Food Agric.* 23:1359–1368.

Liljemark, A. 1964. Cold storage of retail-packed fillets of mackerel and herring. *Food Technol.* 18:122–124.

Lyles, C. H. 1969. The Spanish mackerel and king mackerel fisheries. *U.S. Fish. Wildl. Serv. Curr. Fish. Stat. No.* 4936. 21 pp.

Mannan, D., D. I. Fraser & W. J. Dyer. 1961. Proximate composition of Canadian Atlantic fish. II. Mackerel, tuna and swordfish. *J. Fish. Res. Board Can.* 18:495–499.

NMFS. 1977. Fisheries of the United States, 1976. *U.S. Dep. Commer. Natl. Mar. Fish. Serv. Curr. Fish. Stat. No.* 7200. 96 pp.

Olsen, I. A. 1955. Freezing fish in alginate jelly. *Food Manuf.* 30:267–270.

Ousterhout, L. E. 1960. Technical Note No. 56 – Chemical composition and laboratory fillet yield of 13 species of Middle and South Atlantic fish. *Commer. Fish. Rev.* 22(7):15–16.

Perigreen, P. A. 1968. Studies on transportation of fish. I. Packaging of frozen fish in insulated containers. *Fish. Technol.* 5(2):43–48.

Pottinger, S. R. 1951. Effect of fluctuating storage temperatures on quality of frozen fish fillets. *Commer. Fish. Rev.* 13(2):19–27.

Shenoy, A. V. & M. A. James. 1974. Spoilage of spotted seer (*Scomberomorus guttatus*) during iced storage. *Fish. Technol.* 11(1):67–72.

Sidwell, V. D., P. R. Foncannon, N. S. Moore & J. C. Bonnet. 1974. Composition of the edible portion of raw (fresh or frozen) crustaceans, finfish, and mollusks. I. Protein, fat, moisture, ash, carbohydrate, energy value and cholesterol. *Commer. Fish. Rev.* 36(3):21–35.

Sohn, B. I., J. H. Carver & G. F. Mangan, Jr. 1961. Composition of commercially-important fish from New England waters. *Commer. Fish. Rev.* 23(2):7–10.

Sreenivasan, N., G. G. Hiremath, S. Dhananjaya & H. P. C. Shetty. 1976. Studies on changes in Indian mackerel during frozen storage and on the efficacy of protective treatments in inhibiting rancidity. *Mysore J. Agric. Sci.* 10:296–305.

Stansby, M. E. & J. M. Lemon. 1941. Studies on the handling of fresh mackerel, *Scomber scombrus. U.S. Fish. Wildl. Serv. Res. Rep.* 1. 46 pp.

Stoloff, L. S., J. F. Puncochar & H. E. Crowther. 1948. Curb mackerel fillet rancidity with new dip-and-coat technique. *Food Ind.* 20:80.

Teeri, A. E., M. E. Loughlin & D. Josselyn. 1957. Nutritive value of fish. I. Nicotinic acid, riboflavin, vitamin B_{12} and amino acids of various salt-water species. *Food Res.* 22:145–150.

Ueda, T. 1976. Changes in the fatty acid composition of mackerel lipid and probably related factors – I. Influence of the season, body length and lipid content. *Bull. Jpn. Soc. Sci. Fish.* 42:479–484.

Vyncke, W. 1975. Evaluation of the direct thiobarbituric acid extraction method for determining oxidative rancidity in mackerel (*Scomber scombrus*). *Fette Seifen Anstrichm.* 77:239–240.

Windom, H., R. Stickney, R. Smith, D. White & F. Taylor. 1973. Arsenic, cadmium, copper, mercury and zinc in some species of North Atlantic finfish. *J. Fish. Res. Board Can.* 30:275–279.

Yamada, M. & K. Hayashi. 1975. Fatty acid composition of lipids from 22 species of fish and mollusk. *Bull. Jpn. Soc. Sci. Fish.* 41:1143–1152.

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SESSION I – QUESTIONS AND COMMENTS

Beaumariage: Dr. Collette, I was interested in the examination you made of the Spanish mackerels, *S. brasiliensis* and *S. maculatus*, and the separation of species between the coast of North America and the gulf and the coast of Brazil. I was also interested that you did not show a separation for *S. cavalla.* Have you done the meristics on *S. cavalla,* and are you sure that it is one continuous species along the entire coast of South America?

Collette: The populations of the king mackerel, *S. cavalla,* in the Atlantic, Gulf of Mexico, Caribbean and South America are much more similar to each other than are the Spanish mackerels. There are no obvious meristic, morphometric or anatomical differences. Some differences have been reported in the literature by Bastos, but he did not directly compare Brazilian specimens with Florida specimens. Some of the characters that he gives as different are not valid. Brazilians have standardly omitted the hypural plate in counting vertebrae. Americans have included it. So Bastos found an average of one fewer vertebra, but this is due to different methodology. However, we have not examined sufficient material to be able to say they are the same.

Beaumariage: Are you proceeding to look for differences in *S. cavalla* as you did in the Spanish mackerels? Are you trying to get specimens to once and for all satisfy yourself?

Collette: I would like to be able to be certain that they are the same species, which is the first level of the problem. I would not, probably, be able to answer what you really need, which is, "Are they the same population?"

Beaumariage: No, I think we can handle that, but if we knew we were dealing with the same species, it would make it a little bit easier.

Collette: Additional material from South America would make it easier. We really need frozen specimens for complete data. We've done about three or four hundred *Scomberomorus* all together. It takes a day to make the measurements and counts, and do the dissection of the viscera, and a second day to prepare the skeleton.

Davis: I have two questions for Dr. Trent. First, regarding the sorts of gear used. To what extent are the gears used determined by the fishing technology or by the fisherman's free choice, and to what extent are institutional barriers, that is, laws, outlawing or requiring certain sorts of gear? The other question is, what confidence intervals can be placed on the catch data, both recreational landings and commercial landings?

Trent: Let me answer the second one first. I can at least respond to that one. For your commercial landing data, we assume that we have total landing data, but we don't have estimates on the amount of fishing effort that goes into catching this fish. We know the types of gear that are used, what percent is caught by each type of gear, but not how much effort goes into catching a certain amount of fish. So we can't estimate catch-per-unit-of-effort using our commercial statistics. Now for the sport catch, I can give you some idea—well, I'd say something like 18 million pounds of Spanish mackerel caught by recreational fishermen. I think one standard deviation on these estimates is about 5 or 6 million pounds, and then when these surveys are compared with several other, more intensive surveys, they usually show that the estimates are biased by 200 to 300% – that surveys tend to overestimate the recreational landings. Now, for regulations pertaining to the use of different gears in different waters, I couldn't answer that. If I remember correctly, in the State of Florida the answer is in a book about "that" thick. It varies by county, by city, by side of the bay, and so forth. But there are people here, I imagine, that might have some specifics concerning the regulations in the Spanish mackerel fishery.

Duggan: I wanted to ask one question. With the 1975–76 increase, what happened to the recreational fishing in those years? Did they show an increase also?

Trent: We had angling surveys in 1960, 1965, and 1970, and I don't think the data are in on the '75 survey, but we have an individual following me who will go into more detail. If they are available, they are not published.

Chittenden: Going back to one of the earliest figures, showing that this fishery originated in the middle Atlantic and Chesapeake – this is a fishery that may show long-term fluctuations if you go back into the literature of that time – Earle, Goode, Scott talk about a tremendous increase in abundance of Spanish mackerel in the mid-Atlantic area around 1850 and 1870. Then you go to Smith in 1907, Hildebrand in 1928, and they talk about a great decline in the abundance of Spanish mackerel north of, say, Hatteras. It may be that we have a fishery that periodically extends its range in terms of certain periods of large, long-term fluctuations in abundance of these fishes.

Jones: Lee, are there programs under way or planned to collect the effort data and the age and size composition data that you mentioned were needed?

Trent: There are plans on the boards for getting age and size composition data. And there are plans to obtain better recreational fisheries statistics in the Southeast Region. We're involved in setting up plans to get the size and age composition information, but we at out lab are not involved in the broader scale surveys that will be needed to obtain this information.

Gillespie: I was wondering if there are nonnational vessels fishing that same stock, and if so, what might be an estimate of the catches, so that you might compare our domestic claims against what's being taken by other nationalities?

Trent: I don't know.

Gillespie: Well, do you know if anyone else is fishing that stock other than U.S. vessels?

Trent: No, sir, I don't. Dale, could you help me out on that?

Beaumariage: I think only the Mexicans are fishing in their waters on what is the same species, from the presentation we had this morning. We don't know whether it's the same stock or not. There's only been one tag return of Spanish mackerel south of the border. But I don't believe there are any foreign nationals that are fishing in U.S. waters or in the FCZ [Fisheries Conservation Zone]. If there were, certainly some of the people here from the Council would know about it.

Hildebrand: Why the difference in trend in the panhandle fishery and what appears to be . . . . in the last few years - - -

Trent: Why the difference?

Hildebrand: Yes. You had a downward trend in the panhandle and an upward trend in the Fort Pierce region.

Trent: It's been speculated that the cold winters prevented the fish from going to the Keys, or that they've stayed further north when it's really cold. Now again, I can't really answer that, other than to say it could be weather related in terms of whether the fish are most abundant in the Keys and on the southwest area or on the Atlantic side. It could strictly be a buildup of effort on the east coast – I don't know.

Unidentified: When you showed the slide, Dr. Manooch, of the idealized profile of the bottom, showing the depths of different fishes . . . I read Spanish mackerel 10 to 25. Is that also for king mackerel, or are you saying . . .

Manooch: What I wanted to show primarily in the slide is the relative distance to the shore and the estuarine area. In other words, for king mackerel, it's inshore of oceanic species, yet offshore of esturaine-dependent fishes.

Unidentified: My point is, are you distinguishing water depth between Spanish and king mackerel?

Manooch: No, sir, I was not.

Ayers: What method is commonly used for aging in either species?

Manooch: Otoliths.

Nakamura: Dr. Mendizabal used the word "almadrabas". Let me say that almadraba is a weir. It has a lead of netting, I believe, that goes out . . . how far off shore?

Mendizabal: It is about 2 miles from the coast.

Nakamura: And then there is a holding pen, a trap, so that when the fish come to the barrier, they follow it and go right into a trap. Then the boats go out and empty the fish out of the trap.

Unidentified: Floating, anchored, or what?

Nakamura: Secured to the bottom.

Unidentified: How deep is the water?

Mendizabal: About 20 feet.

Finucane: Is there any commercial king mackerel fishing in Mexico?

Mendizabal: Yes, there is. King mackerel are caught by hook-and-line.

Finucane: Do you have any figures on landings?

Mendizabal: You want to know about the catch of king mackerel? It's about 3,500 metric tons.

Finucane: Are they caught along with Spanish mackerel? With the same type of gear?

Mendizabal: The small ones run together. The big king mackerel are not with the Spanish. They go offshore, not so close to the coast.

Finucane: Do you have any information on early life history of mackerels in your waters – the occurrence of eggs and larvae, for example?

Mendizabal: No.

Finucane: Any idea of where spawning grounds are off Mexico? Off Vera Cruz?

Mendizabal: We have not recognized any spawning places. We have found schools of small mackerel, but we do not know where they were spawned.

Finucane: Why do you have your big variations in catch, with Vera Cruz at the top? I would expect the other way around, actually. Is fishing effort lower off Yucatan – is that why you have the low catch rate?

Mendizabal: I think the effort is low. They have other resources – red grouper and red snapper.

Beaumariage: What is the average size of the Spanish mackerel caught in the various types of gear?

Mendizabal: Forty centimeters in total length.

Beaumariage: And the average size of the king mackerel caught on hand line?

Mendizabal: About 60 or 70 centimeters.

Hildebrand: I don't have a question, but I have a comment. I worked down in Vera Cruz in the early 50s, and the mackerel came in there with the first norther. They are between the reefs and the shore, so you have an area where you can work beach seines quite readily. They'll boil in there with the strong northers. I've seen them catch as many as 14 tons in one beach seine haul. They're transitory there. They fish about 2 months in the fall and 2 months in the spring, and in the summer and mid-winter they catch virtually none.

Nakamura: Thank you, Dr. Hildebrand. I might add that I referred earlier in my introductory remarks to some controversies between commercial fishermen using different types of gear along the east coast of Florida where we have commercial gill-netters and hook-and-liners competing for the same resource. Well, I learned that in the Vera Cruz area, the beach seiners and the almadraba fishermen are competing for the same resource and having some problems amongst themselves.

Weil: Mr. Williams, is there any possibility that king mackerel are going down through the Caribbean and coming up through Yucatan, rather than just going across the current in the gulf?

Williams: It's a possibility. Fish that we tagged in Naples in March of 1976 were migrating north along the west Florida shelf, though. We were getting returns from St. Petersburg, Clearwater, Panama City and so on, so the information we have suggests that they are migrating up along the shelf rather than across the straits there. That's a possibility, but I would rather think that they are cueing on something out there, like current or a certain depth they are looking for, and I would tend to think that they probably didn't cross the straits.

Weil: There's a striking similarity with the tagging results on the sailfish we've done, where they were off Texas in the summer and off the southeast coast of Florida in the winter, or reverse. Do you think those fish might go farther offshore or follow the shelf with the kingfish?

Williams: I think sailfish probably stay a little farther offshore. Japanese catch them on a long-line, and I think in the middle of the Atlantic. Kingfish you can catch way offshore too. You can catch them a hundred miles off St. Petersburg out on the edge of the Loop Current, but I don't think they are probably as abundant out there as sailfish.

Davis: Dr. McEachren, about how many days do larvae remain the size that they are available – that you are catching – few of them larger than six millimeters? What's the growth rate?

McEachren: Well, according to Dwinell and Futch, the majority of the larvae that we collected were within a week of hatching. And one thing – Dwinell and Futch found much larger larvae than we found. They used a meter net and we used, except for the one cruise, a 61 centimeter bongo net. It is very possible that the mackerel are better able to avoid the smaller bongo net than they are the meter net. I also found that more king mackerel were taken during the night than the day, indicating an escape method due to vision, most likely.

Bernhard: Were you both working at the same depth?

McEachren: Well, this is another difficulty. It's really difficult to quantify the two studies. The methods that we used were the MARMAP ichthyoplankton methods – the double oblique tow to within, oh, three to five meters of the bottom, so the whole water column is sampled. Now, in the study of the northeastern Gulf of Mexico, Dwinell and Futch used surface tows with a neuston net, they used a night light, and they did some oblique tows. It is hard to quantify it exactly, but yes, there were differences in the sampling methods.

Bernhard: Enough differences so that the size of the larvae might be explained in many ways, though?

McEachren: Well, since we sampled the whole water column, except for the bottom – and that wasn't sampled in the eastern Gulf of Mexico, either – I would think that the size of the gear would be the most likely explanation for the differences. Now, in the 1975 baseline survey of the south Texas coast, larger larvae of the Spanish mackerel were taken in that study than with any of the bongo net samples.

SESSION II

PANEL DISCUSSION BY RESOURCE USERS

Jack Brawner, Chairman

National Marine Fisheries Service, St. Petersburg, Florida

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INTRODUCTION

Jack Brawner

It is the view of our scientists that currently the stocks are not overfished. In this regard each year we are required by the State Department to provide that agency with data on any surplus stocks that are available for allocation to foreign fishermen. Our scientists determined last year that in relationship to maximum sustained yield (MSY) we had a 40,000-metric ton surplus. However, we concluded that when considering the economic and sociological aspects of the fisheries, that no surplus exists. In essence we base this on two major factors: (1) an important recreational fishery; and (2) an expanding commercial fishery.

The Gulf of Mexico and South Atlantic Fishery Management Councils are jointly developing a fishery management plan for Spanish and king mackerels. Certainly every member on this panel will be involved in its development. The development of this plan necessarily will involve addressing some very hard issues. Seeking fair and equitable solutions to these hard and complex issues will require both statesmanship and compromise in many areas. At this time I want to surface some of these issues for consideration by the panel. They should make for some rather lively discussions:

1. Should the commercial fishing fleet be allowed to use purse seines to catch Spanish and king mackerels in the Fishery Conservation Zone (FCZ)?
2. Should the states allow this type of gear to be used in the territorial sea?
3. Should recreational fishing licenses be required? How about commercial licenses? Should there be allocations to both commercial and recreational fishermen? If so, what means might be available to achieve allocations?
4. Should there be gear or area restrictions placed on a commercial fleet? Should a bag limit be placed on recreationists?

In posing these type of questions, I am attempting to surface a basic need and that is the critical importance of recreational and commercial interests working together to develop fair and equitable solutions in the best interests of both groups.

I will make just one point to the panel. In fairness to all panel members, each of you will be required to stay within your alloted time so that every panel member will have an opportunity to present his views.

DISCUSSION I

Roger D. Anderson
Gulf and South Atlantic Fisheries
Development Foundation, Inc.
Tampa, Florida

When the Gulf and South Atlantic Fisheries Development Foundation, Inc. was formed, one of the first projects undertaken was to review the mackerel fisheries along both the Gulf of Mexico and south Atlantic. This effort was encouraged by a series of stock surplus projections. Rather than see this resource potentially allocated to foreign interests, the foundation accepted the responsibility of researching the domestic development potentials.

We set out, therefore, to develop and expand the mackerel fishery. Two approaches were taken. First, as Jim Cato has pointed out, the market demand needed bolstering. Using personnel from the Florida Department of Natural Resources, as well as other state agencies and academic institutions in the region, we initiated a program to expand existing, and identify new, marketing channels. We produced a million pieces of point-of-sale promotional material, as well as a million dollars in complimentary advertising to promote Spanish mackerel and other target species. This effort was centered in the midwest.

Next, we examined how to establish a more uniform demand, particularly through the year-round markets of institutional buyers. As there is no domestic mackerel production currently available during the summer months, we centered our work on creating summer fisheries, particularly along the western gulf and south Atlantic. To bring this about, we set out, both in the western gulf and south Atlantic, to establish fishery demonstration projects.

Along the south Atlantic, we contracted with the Marine Advisory Program of Clemson University. This has been a model program. Both the state agency, in this case the South Carolina Wildlife and Marine Resources Department, and the academic institution, Clemson University, have gone out of their way to identify ways in which the mackerel resources could be more fully used. As a result, we will conduct a broad-based mackerel demonstration project, with spotter planes and Florida vessels, in South Carolina this summer. We hope to resolve some of the questions that face the development of a potential commercial fishery. By working with the state, we hope to cooperatively examine, at an early stage, potential regulatory action.

Our work in the western gulf, unfortunately, has not gone as well. Our early interest was to work in Texas. Again, we were looking at complementing the domestic fishery that already exists in Florida. To expedite the Texas effort, we met with and exchanged a great deal of information with the Texas Parks and Wildlife Department. There has, however, been a continued concern registered by the department as to the use of net gear in state coastal waters. As a result, it appears that we will not be allowed to conduct exploratory work off Texas. We are, however, still tyring to reach some accord. Our present strategy is to come up with a plan in which the Texas Parks and Wildlife Department would become the lead agency, with the foundation underwriting costs.

Please note that mackerel, and many other underutilized fishery resources, are purchased and consumed by this nation's low-income families. In a study being conducted by the Florida Department of Natural Resources, it appears that anywhere from 50 to 90% of the retail trade for these products is by minority households. To hinder industry which so directly impacts on the poor, may present unique legal questions. Efforts are already underway to explore these legal ramifications. While this is not the foundation's concern, it is a matter of great interest to the commercial fishing industry.

In summary, we are reluctant to accept a situation in which both recreational and commercial fishermen cannot use the mackerel resource to its fullest. We are committed to the domestic harvester and consumer. Further, we would be embarrassed to see a mackerel surplus offered to foreign concerns. To overcome this possible allocation, the foundation is committed to the wise and careful development of the region's fishery resources.

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DISCUSSION II

B. J. Putnam
Tackle Shop Owner and
Marina Operator
Panama City, Florida

I've got handouts that I will give out a little later on. I'll get a couple of people to help me with them. I wouldn't put them back on the table, because I only have 50 copies. This happened to come out of my resources, and my family has a bad habit of eating, so I couldn't take their money.

I have enjoyed the program this morning. It has been very informative and educational to me. On looking over the program, I think possibly one thing we can do is change the name from colloquium to medical checkup. If you will take your program and look at the morning agenda, it's Dr. Collette, Dr. Trent, Dr. Manooch, and Dr. Prochaska, and in the afternoon it is all patients. The patients are the resource users, and then later in the afternoon we get the final examination by Dr. Chittenden, Dr. Jones, Dr. Knight and doctor so-and-so-forth, so one can really consider it a medical checkup of the resource that we are trying to utilize. My education has been broadened by being associated with the doctors and the scientists in this. In fact, I always thought microconstituents were little bitty fishermen until this morning. I appreciate my education being broadened by this. And also the fact that a 9 to 1 ratio of recreational catch of king mackerel versus commercial catch was the statistic given this morning, I believe. If the council must indeed come down to an allocation of the resource, can we use that ratio, 9 to 1? I catch 9 and let Jim Pace catch one. He'd be mad as hell, I'm going to tell you that. I don't believe he'll go for it.

The point I am trying to make is our recreational catch data are so inadequate. We know a great deal about the fish and by the time we get down to the last two we are going to know *everything* there is about the fish. Management is our problem, not research. How are we going to manage the fish? Who is going to get the fish? Are we going to get them all in recreational and sell them? That's a big resource. The economics of it is astounding as to what it's worth. By the same token, so is the commercial worth. The days of being across the creek, or across the bayou, or across the bay hollering dirty names from commercial fishermen to recreational fishermen are gone. That won't work. You can't sit and holler, "Oh the dirty man that he is or the dirty man that I am."

What we have got to come down to is a reasonable assessment of the resource, what we have. We have all been writing checks on a bank account, and we don't know the balance. Everyone here has been writing checks on the resource of mackerel, yet none of you know the balance in the bank. We don't know how much resource we have, we don't know how much fish we have, but we continuously write checks against that stock. The commercial fishermen wrap them up with a net. The recreational fishermen catch them with a hook and line and some are wasted, maybe we don't know exactly what happens to all of them. We need more research on the management of fisheries. Scientists, I'm sorry, I know research is a very important field and I believe it, but we know a hell of alot more about scientific research than we do about management or stock assessment. That is where the problem lies today.

I hope that we can leave here with a little better understanding of one another, of how we are both resource users. What I would like to do, I would like to start out by answering Jack's questions. I think they are very important. I think they are very timely and if I could, I'll read them to you very carefully again so that you'll understand them.

1. Should the commercial fishing fleet be allowed to use purse seines to catch Spanish and king mackerels in the FCZ?
2. Should the states allow this type of gear to be used in the territorial sea?
3. Should recreational fishing licenses be required?
4. How about commercial licenses?
5. Should there be allocations to both commercial and recreational fishermen?
6. If so, what means might be available to achieve allocation?
7. Should there be gear and area restrictions placed on both commercial and recreational fleets?
8. Should a bag limit be placed on recreational fishermen?

Jack, if I may, these are management questions. I believe you would classify them as that, wouldn't you? Management questions? And if I may, I would like to answer them, not necessarily in the order in which you gave them, if that is alright. I'd like to use the same method that has always been used by national, state, and local officials and often politicians; my answers are:

1. I don't know.
2. Maybe.
3. I think so.
4. Probably.
5. I guess so.
6. More or less.
7. I stand behind my people on this issue.

8. We don't have enough scientific research at this time to be able to give you a credible experienced answer. So that is the best answer possible.

That's what I have heard in the last fifteen years, and it doesn't do a hell of a lot of good for me when I am out there hunting mackerel for my customer. He just doesn't understand credibility answers.

Lee, if you would, I would like for you to help me pass these out. There are only 50 copies, so, Lee, let me have one copy back, I need one. The title is *Recreational and Charterboat Mackerel Catch Statistics for the Gulf of Mexico including Recreational and Charterboat Sales of Mackerel.* I think it is something that we all have a crying need for. I think you will find it most interesting. These are pertinent to any year. I won't show you the inside pages until you get your copy. (Blank sheet of paper under title sheet.) That's it! That's your information, it's from the recreational fisheries that you are operating on. You don't know! We don't know what in the hell we have, but we continuously take. We (the councils) are asked to make management assessments based on undefinable amounts of stock. Gentlemen, I think that day is over with, I won't take up any more of your time. Thank you, I hope you understand our problem.

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DISCUSSION III

A. L. "Hoot" Hilpert
Charter Boat Captain
Destin, Florida

I find it difficult to follow B. J. Putnam, as he covered the subject pretty well. Incidentally, my nickname "Hoot" is not a scientific name for a fish; it really represents something to bird lovers. I operate a charter boat out of Destin, Florida, and hopefully represent the interest of some 80 local charter boats there, plus the interest of countless private boats, mostly small boats. We are the so-called recreational fishermen and some of us simply try to make a living out of it. Most of the information has been pretty well presented this morning, so I am going to try and relate some of this infomation to Destin as we see it. Out of some 500 charter boats on the gulf coast, Destin has the largest fleet of any port and historically has been called a fishing village. This village had a few hundred people with little other source of income until recently. Now we have scores of people coming into motels and condominiums and trying to get sunburned on our beaches and waters.

Even so, the primary interest in Destin is still recreational fishing. Most of our people come there to fish. To give you some idea of the size of the operation, we have some 30 motels with 1,400 rooms, apartments, etc., available. We also have over 600 condominium rentals available. Fort Walton Beach, six miles from Destin, has over 3,000 units. There are 25 restaurants and eating establishments in Destin and about 125 in Fort Walton Beach. We have six marinas and numerous other docking facilities for small boats, and in this respect we have a hoard of boats that come from neighboring states that are trailered in when people come to fish for the mackerel. Last year we had over 12,000 charter trips with fares totalling over $1 million; these are just fares totalling over a million dollars. We estimate that there were over a million pounds of fish caught. Lord knows what the private boats brought in, because we really don't have a count on those, as B.J. well pointed out.

We do know that visiting, out-of-state, private boats exceed locally registered boats by at least 2 to 1. Now this is just an estimation factor. In Panama City, for example, they have a higher percentage than that. I think it is about 75% of the boats were out-of-state-registered boats. We have 8,000 private boats registered in Okaloosa County, and we know that on a weekend day we have well over 200 private, small boats, anywhere from 12 to 40 feet, but most of them in the neighborhood of 15 to 22-23 feet, that are fishing out of Destin. Well, so much for the economic figures. I simply point out that there are numerous motels, food places, places which sell bait, ice, fuel, and on-and-on, that count on this industry.

I figure I'm an average charter-boat operator in Destin, I'm better than most of them, but sometimes I am not very lucky. I do keep detailed records of the fish caught, as well as other business aspects, and in the last five years, 55% of my trips were run solely to catch king mackerel. Many more than that were chartered for king mackerel fishing, but I talked them out of it, because the king mackerel fishing was poor at the time. I do very little bottom fishing. I concentrate on a trolling clientele. Most of the charter boats in Destin are like myself and even troll more so than I do. This simply points out the fact that the king mackerel are "bread and butter" fish. Historically we have relied on the king for our business. Likewise, the average private-boat owner in Destin is out to catch kings. Without the king fish, we are going to be out of business. And 1977 was a pretty hard reminder to us. That was by far the poorest season we have had on kings since the early 60s. As a result, we put extreme pressure on the amberjack, bottom fish, snapper-grouper or anything else that would pull on a line.

These other fish then became scarce and business ultimately suffered. Just for example, I caught about 3.6 mackerel per hour trolling in 1975, and I dropped to 1.7 in 1976 and down to 0.7 in 1977. Which sort of leads me to believe there is something wrong here. Historically before that, I'd average about 2.5 per hour. So we went from a good season in 1975 to extremely poor in 1977. Now I haven't even mentioned the Spanish mackerel because we haven't had enough of them in the last five years to be mentionable. Even Buck Destin and his netboats, where we would get our bait, were not catching enough Spanish to be mentionable.

Again, there was something wrong, badly wrong. There used to be Spanish. I note that the decline in northwestern Florida was sort of proportionate to the increase in mackerel taken in southern Florida. We know that the king and Spanish migrate up and down the coast, and that the northern gulf is the *end of the line.* And I know that the average fisherman in Destin feels that he is sort of at the end of the line, and we're at the mercy of any variation in the pattern of migration of these fish. Our season incidentally commences about the last week of April and ends the first part of November.

So, here are some of the problems as we see them and what we might be able to do. First problem is, "Where are the fish?" So the last three years have seen a considerable increase in pressure on the mackerel fishery. This is not only the commercial fishing in southern Florida, which from the figures I read here, about doubled in the last two or three years; but there is also a great increase in the recreational fishing for mackerel. And it will continue to increase, and the commercial fishing will continue to increase as long as there is a buck to be made in it. There are going to be more and more boats involved, and people are going to build boats, as Dr. Anderson pointed out, and I don't know where it is going to stop.

We believe that the fishery is being fished out, and with the increased efficiency of commercial fishing, especially with spotter planes, and with increased amount of recreational fishing going on, the number of boats, some day we are going to reach the limit. The end solution of the problem, of course, lies in an enforceable management plan for everyone. We should, however, immediately establish some sort of catch control that applies to recreational as well as commercial fishing and not wait until we figure what a sustained yield might be. In other words, we can't wait for all the scientific data that we'd like to have. And, it really worries me when I hear Dr. Anderson say that they are trying to *promote* the commercial boat industry for mackerel fishing. We'd like to see them go the other way. This brings up the foreign fishing industry, and what might happen if we get them into it too. I just can't see this at all. I'm pretty selfish. I think we ought to cease and desist any consideration of the foreign commercial fishery for mackerel until we are doggone sure of what we are talking about.

We believe that aircraft spotting should be outlawed as a control measure. That is for the benefit of the commercial fisherman as well as the recreational fisherman. We know that a fish killed in a net in southern Florida is never going to be caught on a hook and line in the northern gulf, and vice versa, too. But, outlawing aircraft spotting might be a good way of control until we can devise a better means. And I am not against a catch limit in recreational fishing, and the best way to enforce this would be a dock limit. I don't know whether you can enforce a limit per individual or fisherman or not. I haven't looked into it enough to be able to recommend. But a dock limit would be enforceable by the boat, because you can check what the boat brings in on a half-day trip.

O.K., the management plan we feel should provide for greater federal and state government support of the fishery. Now you look at the foreign fisheries, I think the Soviets and Japanese, they pretty well subsidize their fishermen. They even allocate funds for advertisement, propaganda or whatever you might want to call it. I think that we should allocate more funds to support our fishery and the fishermen involved in it. This goes for the commercial fisherman again, as well as the recreational fisherman. So much for that part.

The second problem I think is a decline in the local sea and reef conditions where our recreational fishing is concerned. Our natural reefs are no longer able to support the increased fishing pressure, and we have had to resort to man-made structures. The old ones at Destin have eroded away and there is little left to hold bait and migrating fish. We are attacking this problem by creating new structures. Many individuals are building their own reefs for bottom fishing, and these help some, and help the amberjack, for sure. But we need more structures that will hold bait fish for the migratory critters. We have a Liberty vessel, two steel barges sunk in the area. We have taken the rubble from the old fishing piers, which were blown down by the hurricane, and the rubble from the bridge that is now being torn down, and we are putting that in, and we have established trolling spots. We have a PVC-pipe "Christmas-tree" area that has been installed. This is sort of an experiment, but from the results in South Carolina it should be a great means of holding bait. All these are established trolling areas. These programs must be increased and here again, we need greater financial assistance from state and federal sources. The county is just out of money.

Last year's economic impact we are now facing. We feel the impact of last year's absence of mackerel will show up this year. Some charter-boat captains are trying to sell out, and others have gone into corporate boats. It's tough if you have your own boat and it isn't paid for. So I predict that there is going to be some political pressure, if in fact there is a decline in tourism and visiting fishermen to this area. Again, we point up to a good management plan. And it should ensure, in so far as possible, an equitable migration of mackerel throughout its habitat. We have a host of other smaller problems, but everybody has a lot of small problems.

So, I hope that we are farsighted enough and selfish enough to protect our mackerel fishery in its entirety and ensure a fair share for everybody.

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DISCUSSION IV

Walter C. Thompson
Gill-net Fisherman
Marathon, Florida

The first thing I'd like to say is, I'd like to tell you about an incident which just happened this past Monday to a son of mine. He is 16 years old and he has his own rig. I built it for him and it is 24 feet long and 8 feet wide. He fishes for mullet and pompano. This is all gill-net fishing. We don't use any seines whatsoever. But anyhow, he has two little friends that fish with him. One is 15 and the other is 13. This past Monday evening he called me and he told me, "Dad, you need to come help me, I'm in trouble." "What happened?" He had struck his gill net not on a man-made canal but on a natural canal. This was a creek, down in Marathon in front of a home. He was at least 50 feet from the home. A man, 50 years old, comes out with a shotgun and was going to shoot three little boys because they were gill-net fishing.

You know, anybody that comes in the state of Florida if he says he is a commercial fisherman they give him a license. No matter who he is or where he comes from. He could sell fish at my fishhouse and compete with me. It doesn't make a bit of difference how much money he's got. If he brings ten dozen eggs from where he comes from or 50 pounds of flour he is a fisherman. He doesn't contribute anything but he takes everything out.

But getting back to gill nets, those people might not understand what a gill net is. A gill net doesn't kill anything small, it goes through it. We limit it by the size of mesh that we are allowed to fish with in the state of Florida. The small fish go through our net. We don't tear the bottom up and there are a lot of "ifs" before we catch a bunch of fish. The first thing is finding, the next thing is, is he in good bottom, can you catch them? The next thing is, is it the right-size fish, will he give in or will he smash through it? The next thing, and the most important thing of all, how many sharks are with you, how bad are the sharks? We had one boat so far this season that lost $5,000 worth of gear and hasn't caught 50 cents worth of fish.

Now we hear about fish killed. How many fish with a gill net have we killed? I don't know how many of you ever been around a fishhouse or even been where poison water was or ever heard of fish kills. You know what happens when a fish is dead? After he is dead 12 hours he floats. How many floating fish do they find down there where we fish at? Not the first one. So if he doesn't float, he either wasn't dead to begin with or he was well used if he dropped out of a net. A crab used him or some other predator. He was still used, he wasn't wasted. If he had been wasted he would have floated, and then in a sense he is not wasted then. He floats and the seagulls eat him. But you won't see one fish floating where we fish. Because if we'd kill that many fish that people claim, you'd be able to see them throughout the whole canal where we dock.

You know we've talked about spotter planes. They can spot the bottom; as far as I'm concerned, it doesn't make any difference. You know I ain't much of a commercial fisherman anymore, because I don't fish as hard as I used to, but at one time I was one of the best. I was like the old saying, I could catch them where there wasn't any. But I could still do it if I didn't have to compete with the planes, I'll admit this. But I coast along now, I don't fish as hard. I've fished for 35 years straight, and one place down there I've fished for 35 years, and my father fished there 60 years ago, gill net. We still catch fish today. They haven't run out, they haven't left. In the southeastern gulf down there, they have what we call the Florida Bay. I caught about 60,000 pounds of Spanish mackerel this season. We had plenty of fish this season and we had plenty of fish last season, but we couldn't fish them. Down in No-Man's Land, off of Key West, the Marquesas, we had plenty of them, but the sharks were so bad we couldn't fish them. This past Sunday, one spotter plane found 12 bunches of kingfish, king mackerel, in No-Man's Land that he said all the boats that fish down there could have fished them for three days with no problems. Twelve bunches, but the boats were still at port, the fish are still swimming. Another reason why they were not caught was because there were too many sharks. They had to take the nets back up, or they would gave gotten ruined.

You know there is a lot of things to gill-net fishing that plenty of people just don't see. One is you got to find them, that is the most important thing. I hunt them by night and I hunt them by day. I can tell you about places down there where there used to be king mackerel and used to be Spanish mackerel. Now the Spanish mackerel, I admit was fished. But the king mackerel never had a net put around them. Never had been. Nobody could ever prove that there was ever any in the nets as far as king mackerel were concerned. But today there is not any. Why? Why did they blame us because fish move? Fish are migratory. They are going to move. Striking nets at them doesn't cause them to move. I've fished fish before, three solid weeks and the same place, day and night. They'll never move. Weather conditions, yes, they'll move because of that. The condition gets right, he's going to move on, I don't care who's there, unless you build a wall around him he's going. You are not going to stop him from moving. You can't accuse a man of fishing them and moving them, whether he's trolling or whether he's gill netting. The fish is going to stay so long, and then they are going to move.

When an airplane can't see 9,000 pounds of fish at 3,000 feet, how can a man see one on the bottom dead? Last season I was in No-Man's Land and several planes there couldn't find a fish. I'd seen one fish jump and I decided to see if there was anything to it. Which it was, I marked fish when I got there. I asked one of them airplane pilots if he could see a bunch of fish and he said, "No, there's not a thing there." I struck it anyway and I caught 9,000 pounds of king mackerel. Now if he couldn't see a school that I could catch 9,000 pounds out of, then how can a man standing three feet off the water in a boat and see them on the bottom as we are accused of killing them? He's got good eyesight. If my eyesight was that good, I wouldn't have to worry about how many I could catch, I'd just have to worry about a boat to carry them.

But now we get into purse seines, that's a different thing. You know what happens when you put a purse seine around a bunch of fish? Sharks or no sharks, it doesn't make a bit of difference, he's going to catch them. And not is he going to catch the big ones only, he's going to catch the little bitty ones, too. He's going to catch everything that he puts it around. So before we start telling people that we don't want them to use gill nets, we better be careful about purse seines, because this is the ruination of fishing, these purse seines. It's going to put us all out of business, everyone of us.

I'm not saying that we should put anybody out of business, but I do think that we need some kind of legislation, somebody to separate a bonified commercial fisherman that makes his living from fishing from someone who says that he's a fisherman. If I was to practice medicine, they'd put me in jail, because I can't do it. I'd have to prove it. But you don't have to prove to be a commercial fisherman in the state of Florida. Just your word is good enough, that's all you have to do. If you've got a boat, you're a commercial fisherman. You can compete with anybody and it's not fair. I'm not competing with anybody. I'm just doing it on my own.

I'm the fourth generation that was born in the county and I'm trying hopefully to raise the fifth. But it looks bad for him because everybody is against him. And it takes a lot of money to commercial fish. This season I didn't catch the first kingfish, or king mackerel, whichever you want to refer to, we call them kingfish, I never caught the first one in a gill net this season. So help me God, I haven't even run a net out of my boat this season, not a kingfish net. Now I have caught some Spanish mackerel and would've caught a lot more if the sharks wouldn't have been so bad. But I can't afford to buy, I can't afford to trade it.

But this is what we face and I still say that we need legislation, we need somebody to protect us. But we need to protect everybody that is making a living out of it. Be fair about it, protect the man who is making a living out of it, not just anybody that comes along and says he's a fisherman, no matter how much money he's got. They just fish weekends. I've had people tell me it didn't matter what he got for them. He says if he gets a dollar, it's a dollar more than he had. Because he's got plenty to start with, it doesn't make a bit of difference to him. But, it matters to me because this is my sole livelihood, this is the only thing I know. Nothing else but fishing.

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DISCUSSION V

Tony Stormont
Hook-and-Line Fisherman
Boynton Beach, Florida

That's a hard act to follow. I wish I had the way with words that Mr. Thompson has. I'm a commercial hand-line fisherman, like they say, who's been fishing for twenty-four years catching fish one at a time on a hand line. I've made my sole living out of this. I haven't done anything else, that's the way I hack it.

Roy Williams gave the presentation of the tagging. I've been very interested in that program. I have had more kingfish tagged on my boat than any other boat in the whole program. We've tried to go with them and find out where these fish are going and what they're doing.

Now, getting down to this net fishing and spotter planes. I couldn't agree more with you, Captain Hilpert. I think it's an unfair advantage to the fish. He has no place to go, no place to hide and its just a matter of time before they are all caught. I've often said that the man who knows the least about fishing is a better net fisherman with a spotter plane, because he doesn't need to know anything but left and right.

Now, Mr. Thompson mentioned this fallout rate with these fish on the bottom after the nets are set around them. I have never personally seen them on the bottom, but probably the mesh was just not big enough to accommodate the fish. They simply swam up into the net and suffocated and drowned.

These gill-net boats and their spotter planes have forced the fish off of the southwestern coast of Florida as far as I'm concerned. I fished over there from 1955 until about five years ago, which was the last time I went back over there. Because after they set their nets, we just couldn't catch anything. I don't know whether the fish were gone or what. At first the nets were limited to 38-feet depths and people caught a lot of fish. There was a lot more fish to catch in those days. Now they have nets that go down to 100 feet of water and they've got multinylon lead lines on them of 3/8th and 1/2-inch nylon. I saw one I couldn't even believe. The rocks don't seem to bother them anymore. They just set right on these reefs. The tide will take the net and lead lines and go down the reef; they destroy the whole reef itself and the ecology that is there.

I've been tagging these fish, and I've come to a conclusion that I can hardly explain. But a particular fish comes back to a particular area at a particular time and for some reason. I understand Mr. Thompson when he says that the weather moves them; it does. But these fish are smart and they move on their own accord. Now some of these letters about tag returns that I get – everytime somebody catches a king mackerel that's tagged, they send it in, and the Department of Natural Resources sends them back a form letter; I get one of these letters back as a courtesy – have helped me to learn quite a bit. I've got 45 returns here on fish which were tagged and caught almost to the day, almost to the mile, the year before. Here's one that has been out 367 days, tagged February 6, 1976, north of twelfth buoy off Ft. Pierce in 60 feet of water. Recapture date: 2/8/77 Ft. Pierce, north of 12 buoy, 55 feet of water, days out, 367. I'm not going to read a bunch of them, but they're here, every one of them.

My contention is, if all these fish are caught in this particular area, there's nothing for them to come back to, there's none to come back. Mr. Williams said that they have a homing instinct, and I really believe they do. There's no question about it. They have a pattern of going into an area and maybe staying from 6 to 10 years, and they'll leave that area. They were in Marathon, they were in Miami, they were in Boynton, they were in Sebastian, it's just an evolutionary cycle of some kind, I can't explain it, I'm just a fisherman.

Conservation is what I'm trying to preach. We hear the word over and over now a days. Have we heard it so much that we've lost the meaning? Some people are conservation minded, and I have to be conservation minded. In fact I have to be a conservationist in the finest sense of the word. If I don't, then I have nothing to go to fish for the next day or the next year. I'm an endangered species. In the state of Florida, we used to have a Conservation Department and then they changed the name to the Department of Natural Resources. Well I wish they could be called the Department of Conservation of Natural Resources, because that's what we've got to start doing. Somehow, someway, these people who regulate the fisheries in the federal and the state level have got to come to some kind of understanding; otherwise, nobody is going to have anything. It's much further down the tube than any of you all realize. You've heard a lot of facts and figures here that are history. I'm telling you what's happening today and what happened last week.

We had a big school of kingfish in Ft. Pierce all winter long. We've had them there for the last three years. We had a gentleman's agreement with the net fishermen, so we could live together. They stay there and we stay here. Well, fishing got so bad some maverick just couldn't stand it any longer and broke this gentlemen's agreement. Now they want to negotiate another one, and we talked, and it just got to the point that the majority of the people thought that if they broke one, they were going to break another one. So now, we are going to join with the sports interest and fight for our very livelihood and the livelihood of the fish.

I feel that the king mackerel are our guest in southern Florida in the winter. I don't think that there is any big production anywhere else in the United States or in the southeastern United States that time of year. In the summer, these fish seem to go to Alabama, Mississippi, Louisiana, and Texas. And they're your guest then. I just hope that there is enough fish for me to send you some, that you can send some back to me. I don't want to slight the people in Georgia, South Carolina, North Carolina, or Virginia because they go up there too. But there are not as many that go up there now as I first thought. I though there were big bunches of fish there in the summer; there still might be some offshore somewhere, but I have no proof of this.

I'm also a third-generation fisherman. My grandfather fished on the Virginia capes with pound nets, and he fished himself right out of business. You could just see it happen. There were pound-net rights about which the federal government got a hold of me a few years back. Since these rights were going to expire, I was asked if I still wanted them. I wrote the man back, and I told him that's very nice of you, but I believe I can catch enough to eat out there. Then my father went into the wholesale and retail business and I watched it kill him, so I went back to hand-line fishing. I enjoy it, it's a challenge and it's a good healthy way to make a living, and I just hope we can come up with some way to continue to do it.

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DISCUSSION VI

M. Harvey Weil
Port Aransas Rod and Reel Club
Corpus Christi, Texas

When Eugene Nakamura asked me if I'd come down and be on this panel, I didn't know I was going to be the last up on the batting order. I'm not a clean-up hitter. I asked him what he wanted me to talk about. He said, "Just tell the folks your view of the problems you see in the use of the resource that we'll be talking about."

Well, from the view of the Texas mackerel fishermen, the sport fishermen, I say the problem is the availability of the resource. It's a resource that we've seen in the last few years becoming more and more scarce. When I tell you this I must also tell you my point of view so that you can understand the viewpoint from which I speak. I'm talking only about Texas because that's the fishery I know best. I was born in this area more than 62 years ago. I'm just a country lawyer who spends about five days a week in the office trying to make enough money to buy gas and bait so I can be out on the Gulf of Mexico every weekend. I usually fish in the Port Aransas area and have seen it for many, many years. My secretary tells me I spend about forty days a year on the water, and talking by radio to the boats fishing from Galveston to Port Isabel, I think I have a pretty good feel for it.

I got to wondering what's happened to our mackerel fishing over the years. So I dug in an old file and found a transcript of a presentation I made over 11 years ago, at the Eleventh International Game Fish Conference in New Orleans. It was in November, 1966. At that time Walton Smith had asked me to talk about Texas fishing and someone else to talk about Louisiana fishing. He told us we could ask the scientists questions we wanted to know. I looked to see what I said about mackerel fishing at that time. Listen to what I had to say in 1966.

"In our offshore angling except for bottom fishing on the deep reefs, the fishing is seasonal with a 5-month season stretching roughly from May 15 to October 15. We've got a few successful days before and after such dates with Spanish mackerel runs and a few cobia in March and April. But generally the best months are July, August, and September.

"For those who fish offshore, the king fish is truly king – from one end of the Texas coast to the other. This must be one of the gulf's most prolific fish. It is taken in unbelieveable amounts, literally tons. It is commonplace to see fifty or more boats off Port Aransas day after day bringing in several hundred pounds per boat. I don't see how these fish stand the pressure. I don't know what work our scientists have done on the king fish. I hope, before it's too late, they will let us know how far it can be exploited without harm. I believe most anglers will cooperate. I would hate to see the time come when we have to limit by law the number of fish we can take. I have often wondered if it may not come to that but I believe the sports anglers would be willing to stand by it if necessary.

"We used to fish for kings with spoons and plugs presented at a rapid trolling speed. In recent years, most anglers have switched to light tackle and bait. Few kings seem to be able to resist live perch or live shrimp presented on a one-ought or two-ought hook with fine wire and light monofilament. But in the last few years we have learned that king fish simply go wild over ribbonfish – that's your cutlass fish in Florida. I would venture a guess, that excepting the king fish which take boned mullet rigged and skipping for sail, four out of every five king fish taken during this past summer were taken on ribbonfish."

Now that was a little over 11 years ago. I was worried then about the tons of mackerel being caught and whether we were taking too many. What's happened to us since then? That's best illustrated by a recent conversation with a good friend of mine who asked, "How was your fishing last year?" My reply was, "Well, not so good. It was the first summer in my life when I had two or three days when we'd fish all day and not take one king fish." He said, "So did I. I didn't believe I'd ever see that, but it's happened."

This morning when I heard it said that in 1975 and 1976, there was a tremendous increase in the commercial catch of mackerel in the Florida area, knowing that we had a tremendous decrease in 1976 and 1977, off the Texas coast, I wondered whether these were the same stock. That prompted the question I fired at Gene. I wondered whether this commercial-catch increase had anything to do with our recreational-catch decrease. I heard later this morning that you in northwestern Florida had a decrease also.

There has been a tremendous change in Texas in the way sportsmen view the Spanish and the king mackerel. During prime months we used to be able to catch Spanish mackerel at practically any time we wanted, picking up a few for bait when heading out marlin fishing. That's not so today. When they were plentiful we cared little for them. Today a report of a mackerel run turns out hundreds of recreational anglers.

As to king fish, anglers used to care little about them for the table. It was a fish they caught for fun but didn't take good care of on the boat, leaving them in a barrel without ice. They were hauled to the dump by the ton. King fish were usually always available in the months of June and September. I often take guests who are not offshore anglers and, up until the last few years, have always been able to take such guests fishing in the morning, stopping for a couple of hours and wearing them out on king fish and then say, "Come on, let's go farther out for sails." Having caught kings they'd enjoy the day even if we didn't raise a sail, but had I taken them straight offshore and bumped sailfish baits all day and caught nothing, they wouldn't understand it. The last two summers that one or two hours for our guests has stretched into all day, and maybe they've caught a few kings.

We've also changed our method of handling kings. When caught, they go right on ice. Later on the boat we fillet them, bag them and keep them on ice. They are all used. It's a darned good eating fish. My guests often ask me how to cook king. My reply is, "The same way you cook any fish – broil, fry, bake, make into fish cakes, whatever. They're good." I think that one of the things the National Marine Fisheries Service should do, and probably the sportswriters can help, is to educate the anglers on how edible and delectable king fish is.

The king is undoubtedly the most important offshore fish in our area. I heard today that more than 55% of the boat trips off Destin are targeted for king. I would estimate that in the Port Aransas area probably 75 to 80% of the boat trips are targeted for king.

I know that the Fisheries Service wants catch and economic statistics. To this end, I have what you may find to be an interesting estimate. I was wondering what the retail value of bait sales in our area might be. I called upon my friendship with the principal bait dealers in Port Aransas for the answer. The ones from whom I received information probably supply 90% of the bait sold there. These are their estimates.

In 1977, even though the king and Spanish mackerel catch was relatively low, they estimated that they sold about 120,000 pounds of dead bait shrimp at $1.50 a pound. This is about $180,000 worth. Of this, they estimated 30% was targeted for the mackerels.

They sold about 3,900 gallons of live shrimp at $16 a gallon – some $62,000 worth. Of this, about 30% or $18,700 was targeted at the mackerels.

About 11,000 dozen mullet, caught locally, were sold at $1.50 a dozen – about $16,000. Of this only about 25% or $4,000 was targeted at the mackerels.

They sold approximately 110,000 dozen ribbon (cutlass) fish at $2.00 a dozen. Practically 100% – about $220,000 worth – was targeted for the king fish.

Well, when you total that it comes somewhere in the neighborhood of $297,000 worth of bait sales in the Port Aransas area alone targeted for the mackerels.

If other boats are like mine, for every dollar I spend for bait, I spend an equal dollar for beverages, probably $10 for fuel and an unknown amount for tackle. So it is just as obvious that the recreational fishery for the king mackerel in our area is a very, very important resource.

And, Dr. Anderson, I don't know who you've been talking with at the Parks and Wildlife Department, but since in Texas there has been no commercial fishery for the mackerels and since the catch is becoming smaller and smaller, I strongly suspect that those who have been dragging their heels about suggesting a commercial mackerel fishery be started in Texas, are concerned that there might be some confrontation such as Captain Thompson told us about. This I don't know, but it could be.

Time is short and I just wanted to tell you one short story that I think illustrates what I think we need. It's the story of the little boy who came home from school, downcast, dejected, like he'd taken a whipping. His dad said, "Johnny what's the matter?" He said, "Dad, you know that arithmetic problem you helped me with last night?" – – "Yes, son." – – "Well, Dad, 'a hell of a lot' isn't the answer." I think that what we need is good information and good management. From the Texas viewpoint, it has always been only the recreational fisherman. I think until the resource is built back up, we need to look very carefully before we change it.

It's been a pleasure being with you.

Proceedings of the Mackerel Colloquium, March 16, 1978, 97–100

SESSION II – QUESTIONS AND COMMENTS

Davis: I was intrigued with Captain Thompson's suggestion of limiting commercial fishing to true commercial fishermen and I would like to ask how he would define these and what sort of procedure he'd go by in determining who will be able to fish and how youngsters get started in the fishing operation.

Thompson: Well, I was asked this same thing by the University of Miami this past summer. My suggestion would be that naturally we can't discriminate against anyone. But you'll find in fishing, and I'm talking about true commercial fishing, as a rule, it'll be a man who works from a youngster, he starts on a boat, and he fishes on a boat, and then he gets to the point when he wants to do it himself, and he makes at least 75% of his living fishing. This is what I think should be classified as a commercial fisherman. Not just anybody that hangs a shingle out and says, "I'm it," and he works six days a week or five days a week on land. and then on weekends goes fishing. This is not a commercial fisherman. We have plenty of these in the state of Florida that work all day until 5 o'clock in the evening, and whenever there is a run of fish along the shore, and the commercial fisherman who waits and works hard and struggles to get a chance to see these fish, this fellow jumps in a little boat in the evening and goes out and catches fish and he dumps them on the market for anything that he can get for them, because he is making a living anyway, it doesn't matter to him.

And then we get back to the energy program. We talk about people freezing to death up north, but yet we have people that waste fuel down here while they are freezing to death up there. See? We always talk about what we should do, but yet we don't do none of it. And these same people that's always hopping on the wrong thing, he's the fellow that's doing it. Anytime I burn fuel, I'm burning it to make a living in a very conservative way. I pay 50 cents a gallon for diesel fuel that goes in my boat. I pay road taxes on it. But if I was to carry my boat on the highway they'd put me in jail, because it's too big, they tell me. But yet I pay taxes, more taxes than most people do to drive their automobiles.

But this is what I would suggest as a guideline for a commercial fisherman. If someone has good intentions and wants to be one, put him on probation then. Say he'd commercial fish for two years and if he'd work at it hard and he could make it good, fine, he is legally a commercial fisherman. But not for him to sit on a job six or eight hours a day and then in the evening take off and go and say I'm a commercial fisherman. No way. Does that answer your question?

Bernhard: It was alluded to by one panelist, I don't remember which one, but it was something that I have heard from various other fishermen, too, and that is, does the mackerel population go through a cycle, like in seven years or so? Can someone comment on that, or is this the feeling of the panel?

Brawner: Anybody on the panel care to address that question?

Thompson: Personally I don't think, you mean the cycle like the fish stay and maybe come from nothing up to a point to where they'd be real good and then gradually taper off again? No mam, like I told you, I've fished for 35 years myself in one little place and have caught just as many fish this season as I've caught the first year I ever started. My father did it 60 years ago in the same location in the Florida Bay. So you've got nothing to go by there. Now maybe some years it'll be earlier, some years we catch fish in November, some years we don't catch until after the first of the year, but the fish will be in that area. It's hard to say.

Brawner: Any other panel member care to respond to that question?

Hilpert: Up on the northern gulf coast I'd say the general concensus is that there is some sort of cycle like this and we do confirm that there is and although I don't have the statistics to bear it out, I mean this is a discussion amongst ourselves and we say well it's a good year this year so it's going to decline or it's going to get better next year. I think that there has generally been an up and down but there is no proof for seven years.

Duggan: This cycle that you are talking about is for weather variations that fall in that pattern therefore affecting the migrations of fish, rather than an absolute number of fish available? Do you relate some of your bad years to cold weather or a lot of rough weather that keeps them from moving like they do?

Hilpert: To answer your question, again I can't do it with facts or figures but, no, we feel that there is some sort of variation but as to whether this has to do with spawning or what this has to do with, I'm not sure. It may be a combination of effects.

When the Mississippi River flooded, for example, what was it, 3 or 4 years ago? The salinity of the water went down. Maybe this had to do with the mackerel fishing today, I don't know. It may have, but just all in all, considering the conditions are normal, we still believe there is some sort of a cycle like this. Sailfish are a good example to prove it. We had real good sailfishing for a while and then it went down to where practically there wasn't enough sailfish caught out of Destin one year to even matter. Then they started building back up again gradually, now it's pretty good again.

Perkins: I'd like to address this question to Mr. Putnam. How do you suggest the second page of your handout be filled in?

Putnam: Gary, if I could answer that I wouldn't have handed it out. It's probably the most difficult thing. I think you have to have a basis to start somewhere and I think that base will be the charter-boat fisherman. He is a known creature of habit, he frequents the same dock daily, follows the same pattern annually, and he carries basically the same people. He makes his living totally from that in most cases. You'll never be able to get the gentleman in a 17- or 18-foot batou to turn it in. But under Section 303 of the Fisheries Conservation and Management Act that has just been passed and which we are living under, it requires, we think, that anyone fishing within the fisheries conservation zone, report their catch. The problem is not getting that, it's enforcing it. If indeed that law does read that way. It speculates and legally we haven't gotten an answer to it. But I can give you a seawall lawyer's opinion: I think it should be. That's the only way we know what we got in our bank by getting our bank statement monthly or annually.

Austin: Dr. Anderson, specifically in the Texas experience and also in South Carolina, are you speaking of purse seines, is that the gear that you want to experiment with?

Anderson: The proposal that we've developed calls for the experimental testing of all different gear types in order to collect the scientific information, and there is no commercial harvest intended. It is simply exploratory fishing work and it's fully recognized that the state legislature or regulatory agencies would have the final say if any gear would be, were ever to become acceptable. The idea in our work would be to try the different types of gear and collect, and by trying the different types of gear be able to provide information on the usefulness of the gear and what kind of impact it would have – we'd look at the bottom, water type, etc., as well as be able to tag and collect fish at the same time. So what we propose to do is demonstration and exploratory work, nothing more. In other words, it's looked at as a demonstration activity and recognizing the fact that there are certainly going to be activities by legislatures and regulatory bodies that are going to be the final say on what types of gear are actually implemented.

I think that what we are saying is if you test them all then you got the information to make the best management decision, and it is fully recognized that you are going to have to have a balance between all the different interests represented at this table, but you can't make that decision unless you've got the information.

Austin: One of those gears wasn't mentioned.

Anderson: Yes, we would use a modified gear, probably a bait seine simply for demonstration purposes and the other reason that we might use it is to show its impact on the bottom. But there would be no intention of taking the fish. For example, if we would use a modified bait seine the fish would be released.

Brawner: Question?

Hildebrand: Everybody seems to have some opinion about using airplane spotters but how many additional pounds were landed in Florida because there were airplane spotters? How many fish are you going to save if you could stop this? It seems like any panel member should be able to answer that.

Thompson: If you try to compare it, you mean the fact about spotter planes. There really isn't any comparison. But, now like he said before, you can take anybody that knows his right from his left and put him on a boat and he can catch fish with an airplane. This is the God's truth, and that is what we talked about one time about a quota on fish. Now, me personally in the last two or three years, I have hardly used a plane. I don't care if he even comes out there.

I love to hunt them by myself because I've done it from the time I was a kid, and 99% of the fish that I caught this season I caught at night. Last season I guess, oh, 85% of the fish I caught at night on my own. But back again at this quota business, they said would go basically by what a boat had caught the previous year. Well this would be really discriminating and this would be wrong, because we got greenhorns down there that have caught more fish than I've caught, because he had an airplane to catch them with. Now this would be wrong if you go base the quota by what he caught basically the year before. Because, let him produce what he produces on his own and see how many he would catch. I'm all for stopping these spotter planes. I'm all for it.

Hildebrand: How many additional pounds though?

Thompson: Like I said, I'll give you an example, I caught about 85% of my fish last season that I caught on my own and I caught approximately, I would say, mackerel and king mackerel, Spanish mackerel, I'd imagine somewhere in the neighborhood about 400,000. That's what I caught. And 85% or better I caught on my own, to where there were boats down there that I would imagine that caught, with just airplanes, better than a half of a million pounds on the airplane. Is that what you want?

Hildebrand: Well, I wondered if you did away with the airplane entirely, how much would it drop?

Thompson: It would be a drastic change, it really would. There would be a drastic change in it if you took away the airplanes. I would say, say if there were two million pounds caught down there this season, had it not been the airplane, I would doubt if they would run a million. It would be less than half I would say.

Stormont: May I answer just a little piece of that, too? Like Mr. Thompson says, it's a challenge to go fishing and people go to a job just day in and day out and do the same thing and that's something that we don't have to do. We go out each day and predict your own weather almost, and hunt your own fish, and I don't think that, to a fisherman, any of the old fishermen, net fishermen, want that airplane. What has happened is that the great increase in production of fish is because the airplane came, set these boats, and they made good catches, because it is more efficient; and then the profiteer standing on the dock looked there and said, "Boy, if you can do that, why can't I do it?" And they went out and spent these great sums of money for nets and boats, and put just anybody off the street on there, and it snowballed. Now it's getting to where the only person that is making any money, I think, is the airplane spotter. What does he get, 10%? He's the guy that is really making it. With the sharks, he eats you up. You stand that expense. If he doesn't spot anything he puts in a few gallons of gasoline and goes home, and usually flies home that night to where we go down on that old dank boat to sleep.

Brawner: I would suggest that since we have the Deputy Executive Director of the Gulf Council and the Deputy Executive Director of the South Atlantic Council, that this is one thing that you might include in your catch analysis – before spotting and after spotting, etc.

Pace: Before the bandwagon gets rolling to eliminate spotter planes and purse seiners, I'd just like to recall that this morning it was said in the statistical section of Dr. Lee Trent's speech was that 92% of all mackerel landings came to Florida in the last 25 years and that 80% of the landings were as a result of gill nets, which begins to answer Dr. Hildebrand's question. Rather than saying half the catch comes from the use of spotter planes and purse seines and it's right here in statistics. It might be interesting maybe to suggest to the Florida Board, forgive me because I'm in commercial fisheries myself, that you might look at the possibility of eliminating monofilaments for your nets like they've already done in Louisiana. That would be very interesting for gill netting I believe, too. I'm just wondering, you know, what we are really trying to do. It seems like everyone has decided, this is the enemy, he's responsible. And I leave that, those things for itself.

Brawner: Any comments to those comments from any member of the panel?

Putnam: Yes, I'd like to respond to Jim if I could. Jim, I think as I said earlier, I think the day of standing across the bayou and calling the commercial fishermen a dirty name and he responds the same echoing reply, what a dirty fellow you are for taking them recreationally. I think that day is gone. I think we've got to identify the users of the resource. I don't think I should take nine and you take one. By the same token you better not try to take nine and give me one, cause I won't stand for it. I don't think you're going to try that. If we can come down, and indeed I think there is a possibility that it will, to an allocation, we've got to determine two factors: (1) who is commercial, and (2) who is recreational? A good friend of mine defined recreational fisherman as the guy who takes a picture of him before he sells it. Is that true? Is the recreational fisherman a little bitty short, fat fella or is he a great big tall, skinny fellow? I'd like to ask you the same question I asked the Gulf States Fisheries meeting in, I think it was, Mobile, a year ago, how many commercial people sitting in a room today that fish with gill nets or fish with some form of commercial fishing have ever gone out on a boat, on the side of a creek, a riverbank, on a beach, on a pier or a jetty and fished solely for the pleasure of fishing with the intent that if you caught something you'd take him home and maybe eat him, you, the wife and the kids? Would those people raise their hands? You're a bunch of damn recreational fishermen, too! So we've got a problem of distinguishing who is what and gonna do what to who with what. That's our problem, Jim, and I don't want to belabor the subject, but I think that the truth of the matter is, we've got to all get our portion of the resource no matter whether it's you or I.

Thompson: The only thing I want to say is that there is a difference in a man catching something to take home to eat and a man that catches them to take and sell them. There's a difference. He's really competing when he's taking pictures and selling them. That's what I'm talking about, the competition. If he wants to go catch something to eat, I'll take him.

Kemp: If I could, Roger, I'd like to expand a little bit on your presentation and perhaps end it on a little more optimistic note than most. Roger and I, over time, have discussed the research needed on the Spanish mackerel resource off of Texas. I think that the whole program today referred to in the scientific presentations that there was more research needed. The commercial fisherman feels the same way and the recreational fisherman feels the same way. There are some defined research needs for this resource. We have discussed those. Roger has come over and he defined them. We do have certain restraints; for one thing it is presently illegal to gill net or use anything but haul seines, trolling-those devices that are legal; purse seines can be used only for taking menhaden in Texas waters. That was fine, we proposed to issue a special scientific collection permit. Unfortunately, Roger proposed that some of these fish be sold to help defray the cost of the research. We certainly understand that this research is expensive but under those restraints, we can't issue scientific permits that permit selling fish. But, ending on the optimistic approach I certainly like the tack that we're taking now and I think it will benefit all interested parties, that we will accomplish our research goals.

Branch: I'd like to make a comment to the gentleman from Texas concerning recreational fishing for mackerel. I'm from the state of Georgia, my name is Alan Branch, member of the South Atlantic Council. We do have a pretty good fishery on the coast of Georgia. I haven't heard the state of Georgia mentioned today, so I thought I'd get my two cents in. As a matter of fact, we have a big fishery for Spanish and king mackerel and its increasing by leaps and bounds every year. You said something here about the decrease in the last two years in the catch. Now we all know we've been having some of these problems in our catch. But we also are having some problems in our catch, and we haven't been having good catches in the last two years and in our tournaments we haven't been having too good a catch. But we feel like one of the reasons for this is, we blame it on the weather. We have had some severe winters these past few years. But I also believe that one of the reasons that we aren't catching as many mackerel on the coast of Georgia as we could catch is because we don't have enough artificial reefs, and I'm not here to say anything against commercial or recreational fishing. I represent recreational but we don't have any commercial fishermen in our area for Spanish or king mackerel that I know of. If there is, there is very little, but I don't think we have any. That couldn't have any effect on our decrease in catching the mackerel this time of the year.

Moore: In the very beginning, a particularly unpopular subject was brought up, the salt-water sport-fishing license. I was just wondering and I know it's a bad time to bring it up . . . in the middle of the meeting . . . but I wonder if any of the panel members would especially like to address that. Here as in many other meetings, if anything that comes through it is that there is a need for identification of resource users and the lack of registration.

Putnam: Jack, I'd like to jump on that with both my feet if I may. No, I'm going to sit down, because I don't want to put the weight on my feet. I carry a lot of weight around here, that is what I'm trying to say. It has been a crying need. The sportsmen agree, the recreational people agree. It's a problem of how to do it. Let's say that we put on an individual license throughout the gulf coast. You're putting a terrible burden on the charter-boat fisherman. In the area I'm from, Panama City, Florida, we years ago fished a six-hour half-day; we didn't really enjoy it, but we had to, it was demanded by the times. Later we changed that to five hours. In the last four or five years it has been changed to a four-hour half-day, and now because of the long summer hours we can actually run three half-day trips, four hours. If you indeed have to license each individual, if you carry six persons on each trip, you've got to write 18 licenses a day; your time schedule is awfully tight, awfully close trying to go and come, and make it in four hours and still give the man an adequate amount of time to fish. If they could be licensed by the boat and pay a large fee, maybe $100 or $500 or whatever the fee would be, it's entirely possible for them. The need is for statistical data gathering. We cannot continuously write these checks on a bank account and that's the only way. But the fishermen themselves want to know that some of the money, at least half, will go back into the use of preservation and enhancement of the resource. The other half would surely have to go to law enforcement, we understand, and to scientific research, but half of it should go back to the resource. I don't think you'll have a problem selling that to anyone, but he wants the money earmarked as everybody always does, but in this case, it's a crying need for the entire general public.

SESSION III

PANEL DISCUSSION ON RESEARCH REQUIREMENTS FOR MANAGEMENT

Dale S. Beaumariage, Chairman

Florida Department of Natural Resources, Tallahassee, Florida

Proceedings of the Mackerel Colloquium, March 16, 1978, 103–104

DISCUSSION I

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The main work I've done on king and Spanish mackerels in the past couple of years is to develop yield modeling based upon the Beverton-Holt model and its parameters. Comments I'll make are going to be more or less disorganized, because one of the instructions I had was that this was supposed to be an extemporaneous thing. With a 10-minute time limit that doesn't work too well. However, I will discuss in several topic areas biological research needed for mackerel management.

I. In general, the first topic for research and management of any fishery is to specify exactly what we are studying or managing. We have taken some very long strides this morning in the determination of what species we're dealing with. Bruce Collette's work (Collette et al. 1978) on separating the Brazilian Spanish mackerel from the Spanish mackerel of the Gulf of Mexico and Atlantic coast has been a tremendous step. It greatly clarifies the possible movements and migrations of Spanish mackerel. There are still some questions, and Bruce has addressed them, on the identity of king mackerel. There is Brazilian literature (Menezes 1969) that suggests anatomical differences between Brazilian king mackerel and king mackerel from "U.S. waters," if you will. Bruce has already determined that several of these differences are not valid. It will help greatly if we can establish that the king mackerel is one (or more) species.

Carrying the topic further, in managing a fishery we are not necessarily concerned with species *per se*. We manage what have been called stocks, and these have some pragmatic basis. I prefer to carry the idea further, to the category of population, which is a community of individuals interbreeding in a given locality. (The locality may be geographically large.) The population concept leads to an ideal stock and gives some genetic cohesion to the management unit. The next research step then, is to identify the populations or ideal stocks of Spanish and king mackerels.

The king mackerel of "U.S. waters" and king mackerel of "Brazilian waters" apparently are separate populations. Findings in some of the Brazilian papers (Nomura and Rodrigues 1967 is most pertinent) and in Beaumariage (1969, 1973) suggest that there are differences in the characteristics of the otoliths – e.g., Brazilian king mackerel form the *translucent* annulus during the period April to June whereas "U.S." king mackerel form the *opaque* annulus then. If these differences hold true, there is apparently a population(s) in Brazil separate from that (those?) in Gulf of Mexico and U.S. waters.

Beaumariage (1969) and Wollam (1970) have suggested that populations of both king and Spanish mackerels along the Atlantic coast of the U.S. are separate from those of Gulf of Mexico waters. Related to this is another problem that involves the mackerel found off the shores of Mexico. Baughman (1941) originally reported the idea that king mackerel (at least) migrate north along the western coast of Florida and along the coast of Mexico from the area of Yucatan. He suggested that they were probably separate populations.

The question is: "Do we have separate populations in the Gulf of Mexico based upon a western Gulf of Mexico stock and, say, a western coast of Florida stock?" Roy Williams' work suggests the fish that winter off southern Florida largely migrate into the gulf. The population(s) identity of the fish on the Atlantic coast of the U.S., the fish that appear in summer off North Carolina and further north, needs study. In general, these problems of population identity need to be attacked further. I personally have done some work on this, which I don't want to delve into in any great detail. It indicates separate electrophoretic patterns in Spanish mackerel taken off Beaufort, North Carolina, and Port Aransas, Texas. This would indicate separate populations of Spanish mackerel in those two areas. I don't know what happens in between those areas or where the fish "are from."

Ideally, mackerel should eventually be managed on a population-by-population basis as we do with anadromous fishes, for example, on a river-system basis. Until we identify the populations, we are not going to be able to determine the landings from and the amount of effort directed at each of these populations. With the apparent mixing of mackerel that Roy Williams found somewhere off eastern Florida in the winter, these may be difficult things to determine.

II. Further study is needed to describe the movements and distribution of these fishes. That will help clarify the populations that exist and the validity of certain estimates for population dynamics parameters. The movements that Roy Williams has dealt with have largely been what you might call north-south migrations from the southern tip of Florida to someplace "up north." However, Moe (1963) suggested the possibility of onshore-offshore migrations, particularly for Spanish mackerel. Spanish mackerel are found off Texas year-round, although they are distinctly more abundant (inshore at least) in the period, say, May through September or October. Although Spanish mackerel occur off Texas year-round, the question is: "How many?" The ones present in winter apparently are largely found farther out on the continental shelf where there is 20°C water year-round. Hydrographic conditions apparently would permit mackerel to overwinter offshore, but the extent of overwintering further out on the shelf needs study.

Another related problem facing mackerel management is to get good estimates for modeling parameters. The literature indicates that there may be serious problems in making these estimates, because size and age gradients may exist on a north-south basis and on an onshore-offshore basis. Back about 1882 or 1883, Earll suggested that the largest Spanish mackerel move furthest north and the smallest ones remain in more southerly waters. He also suggested that the largest fish are found farther offshore. Beaumariage (1973) made essentially the same observations on king mackerel. The question is then: "What are the population age and size structures as a function of depth and north-south distributions?"

Many scombrids, such as albacore, skipjack, or yellowfin tuna, show gradients in size with depth. They move into deeper waters or colder waters as they grow and get larger. I've done a good bit of work, based on the literature, on estimating growth and mortality parameters for king and Spanish mackerels. My parameters for king mackerel, particularly, are based largely on Beaumariage's (1969, 1973) data. My estimates for W_∞, the maximum average size attained if the fish follow a Von Bertalanffy growth pattern, are on the order of 7.5 to 11.5 pounds. These may not be realistic. We know that there are many king mackerel, or presumably many king mackerel, much larger than 11.5 pounds. The data now on hand may apply largely to what Mago Leccia (1958) called schooling-size mackerel. Interestingly enough, Munro (1943) made similar comments about *Scomberomorus commerson,* which, Bruce Collette has indicated, is very closely related to the king mackerel. There are two size groups of *S. commerson* in Australia – 9 to 12 pounds, and fish about 30 pounds and larger. Work needs to be done on possible size and age gradients of mackerel to indicate the limitations of our parameters: "What do the parameters – and our modeling – apply to?"

III. The next step necessary for management is yield modeling. That is, as far as I can see, the crux of a management plan; because it boils down to: "What can we take?" That question has been alluded to throughout our meeting this morning. Initial interest should be modeling to set boundaries on how mackerel respond to varied growth and mortality parameter values and to estimate maximum sustainable yield. That material would define biological limits (in terms of "growth-overfishing") from which optimum yield can be developed, based on economic and social characteristics.

Two widely used types of models are the surplus production and dynamic pool models. We need a long-term series of catch-and-effort data to apply surplus production models. Effort data need to be standardized for all the various types of mackerel fisheries. Recreational catches, gill-net catches, commercial hook-and-line catches, etc., need to be scaled to a standardized unit of effort. Given these basic catch-and effort data and data on the age composition of the catch, we can apply surplus yield models, estimate the rates of natural and fishing mortality, and, also, describe spawner-recruit relationships to evaluate the possibility of "recruitment overfishing." All are necessary for informed management. However, acquisition of sufficient data of this type will take many years and will be a difficult task.

I personally have been dealing with the Beverton-Holt model, because it can provide valuable insights within a few years. This model has two major types of parameters – those associated with growth and mortality. There are some problems in estimating the growth parameters. Several authors (Klima 1959; Nomura and Rodrigues 1967; Beaumariage 1969, 1973; Power 1975) have published somewhat different methods of age determination and parameter estimation for king and Spanish mackerels. We need to resolve the differences between these workers and methods of age determination to settle on the "best" growth parameters. In addition, mortality parameters are often estimated through age composition, so that age determination again may be a problem. I have many estimates for total mortality. Interestingly enough, based on the published Florida data and statements of Beaumariage (1973) and Powell (1975), my estimates are that king mackerel currently exhibit a higher total mortality rate than Spanish mackerel. This is not the way it should be, because king mackerel have a life span double that of Spanish mackerel. There may be a flag flying here indicating that something is wrong with the data or that king mackerel are currently being very heavily fished. I suggest that king mackerel need immediate research attention.

(Added note by M.E.C., Jr.: After I made these comments, Roy Williams and Dale Beaumariage provided me with Powell's [1975] raw data. Powell's comments [1975, paragraph 1, p. 2] lead to an incorrect mortality estimate. My revised estimates find Spanish mackerel total mortality is quite a bit higher than that for king mackerel, as it should be.)

Let me say in closing that we badly need estimates of the rates of fishing and natural mortality to accurately evaluate where the fishery now stands. These data can be generated through the catch-and-effort and age composition data just mentioned in connection with the surplus production models, but mortality components also can be generated through tagging programs. Tagging programs now underway may be of help to study this and the growth problems.

DISCUSSION II

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National Marine Fisheries Service
Miami, Florida

The members of the Panel on Research Requirements for Management have listened today, along with other members of the audience, to some very interesting papers on king mackerel and Spanish mackerel. Although I, for one, have enjoyed this day immensely and learned a great deal, the question before us now is, "How do we use this information?"

I suggest that how we use the information we have learned today depends on the role we play in the fishery management system. Captain Putnam earlier likened the participants in today's session to the patients (the fishermen) and the doctors (the fishery scientists), with the doctors being in the majority. To expand on this analogy, I believe there are really three groups participating in the fishery management system: the patients (the fishermen), the doctors (the fishery managers) and the interns (the fishery scientists).

Hopefully, the patients (the fishermen) have gained some information today which will be directly helpful to them in their business operations; for example, some special insight that might provide a competitive advantage. Also, the doctors (the fishery managers) should have gained some knowledge that will enable them to make better decisions on the best utilization of renewable natural resources. Finally, the interns (the fishery scientists) have been asked to use the information presented today to chart and direct the research activities for the future.

The Fishery Conservation and Management Act of 1976 has generated a large information requirement. Fishery managers are asking for more information and they are asking for it more quickly. Fishery scientists not only have the obligation to supply the required information for management, but also the obligation to advise fishery managers which of many possible research endeavors may provide the most useful results. While much descriptive and analytical information is required by the Act, there is ample reason to set priority in obtaining it. It is abundantly clear that some of the information is of much greater use in accomplishing the objectives of management than is other information. In addition to *what* information needs to be provided, there is a role for fishery scientists in dealing with *how* the information is treated. New applications to fishery science need to be developed in such areas as systems descriptions and sensitivity analysis. Sound theoretical and quantitative approaches to estimating maximum sustainable yield (MSY) and optimum yield (OY) would provide fishery managers with better information for making decisions.

The specific research requirements for king and Spanish mackerels have been described adequately by the previous panel speakers. Information on stock distribution is important. Bruce Collette has increased our informational level on the distribution of species but we still need to know more about population structure below the species level. We need to continue tagging and continue work in biochemical genetics. Electrophoresis studies, in particular, may give rapid answers to such questions. A second general area in which we need information is population size. We heard different opinions today – "There are a lot of fish out there we aren't using," or "There aren't as many fish as there used to be." Management of the mackerels will not progress far until we estimate population size. A third area in which we need information is the economics of fishing in order to predict the impacts of regulations made to conserve the resource or allocate it among competitive users. These tasks represent a large order that will require the cooperation, teamwork, planning, and conduct of research programs by all available scientific resources.

Fishery scientists serve both fishermen and fishery managers by providing information on the resource and the fishery. Certain kinds of information are needed by fishermen to utilize the resource more efficiently. Other kinds of information are needed by fishery managers to decide on the most effective use for the resource. Fishermen are included as fishery managers in the decision-making process, since they are potential members of the Fishery Management Councils. The information needs of both sets of users must be considered in research programs.

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DISCUSSION III

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I might mention for a program correction that I'm not a doctor. I'm merely a lawyer. A lot of fishermen, fishery managers, and fishery scientists take a rather dim view of lawyers. I don't really understand why.

I guess their attitude is best exemplified by a little story I was told at the cocktail party last night about the biologist and the lawyer standing in the yard, and the biologist says, "Would you look at that dead bird!" and the lawyer, looking up into the sky, says, "Where?" The problem cuts both ways, though. The lawyer does have to learn that dead birds don't fly, but the biologist has to understand the legal, political, and policy reasons behind the necessity for rules and regulations concerning when you can and cannot shoot the bird. It's closing this education gap that's so much fun, being almost the only lawyer involved in a group of fishery managers and scientists.

From the standpoint of needs in legal research, with some exceptions that I'll mention in a minute, I agree pretty much with the wit and wisdom of Billy Putnam, to the effect that the problems aren't really so much in the research area – they are in the management area. We really have enough legal research. The problem is in making decisions. We need a political decision on a system for managing resources within state and territorial waters and integrating that management system with the rules and regulations applicable to the fishery conservation zone, for example, but that doesn't take legal research. That takes congressional, administrative, and political decision-making. We need political decisions on implementation of management systems within the Fishery Conservation and Management Act of 1976. There is a lot of flexibility there. We need those political decisions, but again, you don't need a lot of legal research to make those kinds of decisions. You simply have to make the decision.

I said that there were a couple of exceptions, and I guess that will be my contribution to this colloquium. First, let me distinguish "legal research" from "legal problem-solving." What I mean by "legal research" is substantive, long-term research that's necessary before you can implement a management plan or take some kind of action with respect to a fishery resource. I don't mean the quick answer to a problem. Again to use an example that Billy Putnam raised, is the reporting requirement of the Fishery Conservation Management Act applicable to recreational landings? All the council needs to do is to ask its lawyer or the NOAA general counsel to render an opinion and proceed. Now technically there is legal research involved here – I've got to go to the book if they ask me, but that's not what I'm talking about. Those kinds of problems are decision-making problems. You get a quick opinion and you go forward. But there are a couple of areas where you're going to need some very careful, in-depth research before you can move. There are two areas: one is limited entry, and the other is optimum yield.

On limited entry, you need to draft laws to provide for limited entry if you make the political decision that you want limited entry. You need to draft those laws so that they will stand and can be enforced, and will effectively promulgate the political decision. But I "garontee" that the first limited entry system attempted to be implemented after today will be challenged in court within six weeks of its implementation, and I say that because every other one in history has been, and only one of them has ever been sustained under constitutional challenge. That was the Alaskan one, and I have questions as to whether, if that case ever got to the United States Supreme Court as opposed to the Alaska Supreme Court, it would continue to be sustained. The Alaska Supreme Court has been known to make some rather interesting decisions, but I'll leave that one alone before I get in trouble with my friends from Alaska!

So what needs to be done – and there is a limited entry workshop planned for this summer in Denver, this July, under NMFS sponsorship – is to take a much closer look at limited entry and at the legal problems associated with it. Now, this is the kind of research that has to go on before a political decision is made to implement a limited entry system.

What about optimum yield? The essence of optimum yield – the bottom line of optimum yield – is allocation. That's what you're talking about in the end – allocation. Any time you allocate, somebody's ox gets gored, and the owner of the ox goes to court. It's already happened in *Maine vs. Kreps,* a decision handed down last fall. The Cod Preliminary Management Plan, implemented off the north Atlantic, was immediately challenged. On what basis? That the optimum yield was illegally established! The court held that it was not illegally established, but the court said, "Boy, are we gonna take a close look at the rest of these when they come up before us!" They said in effect, "We're gonna let this one go, but we're gonna take a closer look hereafter." Accordingly, a great deal of legal research needs to go into the determination of optimum yield, because you are dealing with social, economic, environmental and biological factors under the Fishery Conservation and Management Act and the laws of this country (due process, equal protection, privileges and immunities – those magic jargon words of the lawyer that he gets out of the constitution to keep you from doing what you want) apply to the determination of optimum yield. Those arcane provisions are in the constitution for very important social reasons, but they inhibit you in implementing an OY plan, because someone's going to come up and he is going to say, "That doesn't meet the requirement of due process because it wasn't rationally developed;" or, he's going to say, "It discriminates unfairly between me and George over here, and therefore under the equal protection clause of the constitution, you're forbidden from doing that;" or, "Your optimum yield determination unfairly allocates between citizens of Mississippi and citizens of Florida, and under the privileges and immunities clause of the constitution, you can't do that." So, you're going to run into those kinds of things. Therefore, in establishing optimum yield, you need to understand what these constraints are so that you can fashion the OY in such a way that when the court gets this challenge, the court will say, "That's fine, fellas, go ahead and implement your system – good luck!" But if you do not – in both limited entry and optimum yield – have the research foundation for the plans, you are going to be hung up in the courts and never get to implement all of the good data and good decision-making that your system has developed.

So, in closing I would simply make two points: (1) that this sort of research should be done, and (2) from the user's standpoint – and the scientist's and the fisherman's and management's standpoint – please be aware of and sensitive to the problem. The two groups must work together in reasonable harmony to produce an effective, workable fishery management system.

DISCUSSION IV

Glenn F. Ulrich
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Being the next to last person on the program there have been a lot of things already covered, and I may have the distinction of being the first person that wasn't passed a note that my time was almost up, because there's really not a lot that hasn't already been touched on. One of the first things on my list was something that was covered by Mark Chittenden: the need for confirmation of aging techniques on Spanish mackerel, particularly because of the discrepancy of approximately one year in the otolith interpretation by Klima and the work done by Powell. The average size of Spanish mackerel in South Carolina that are taken by shrimp trawlers, primarily during June–September, was 17 cm, with a range from 11 to 28 cm. I assume that these fish were spawned the previous year, which seems to correspond more closely to Klima's estimates of length at age I, which was, as I remember, about 13 to 14 cm. I mentioned the fact that there were a number of Spanish mackerel taken incidentally to the shrimp fishery. There was a study done by Dick Keiser in South Carolina to determine the incidental catch of finfish species by shrimp trawlers, and based on this work, the estimated finfish take by the trawlers may be as high as 33 million pounds annually. On an annual basis, the Spanish mackerel averaged 1.5% of the catch by weight, and during June through September, the percentage was up to 4.7% of the total by-catch. Using the average figure of 1.5% of the annual incidental finfish catch, mackerel taken by the shrimp fishery may approach a half-million pounds of juvenile mackerel, which are largely unutilized because of their small size. Now, I hope that nobody will interpret this as a shot at the shrimp fishery, but I think that in our management work, this is something that might be worthy of consideration, in terms of derivation of fishing mortality estimates, etc.

I think there is a need for additional studies on the effects of environmental factors on fluctuations in abundance. We have heard from a number of people that in the last two years there has been a marked decrease in the number of mackerel in their area, and I think we need more of an understanding as to whether these are environmentally related, whether these are just aberrations, or whether they truly reflect a reduction in abundance of the stocks.

Last, but not least, and I hope I'm not beating what hopefully is a live horse, the development of a regional plan to collect catch-and-effort statistics and institution of monitoring the size-and-age composition of both the recreational and commercial catches are necessary for management of these fisheries.

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DISCUSSION V

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I recently attended a meeting of a multidisciplinary group of people – there were economists, biologists, and a number of other professions represented – and something transpired that I guess bothers me. The group was discussing a review of literature that had been done on a particular fishery. The statement was made that more than 1,200 articles had been written and reviewed on this particular fishery and after some discussion, the group reached a consensus that more data were needed before several important questions could be answered regarding management of the fishery. Now, that bothered me I guess, and that's been the theme that we've heard here today, not only from the biologists, but from the economists and speakers representing all the disciplines. There is a cry for more data and a cry for more people to collect data. The fact that we don't have the right kinds of data on which to do research and on which management decisions can be based is a hard one for nonscientists to believe. A lot of the information we do have falls in the area of basic research, the kind of research that universities usually tend to do. There's nothing wrong with basic research, it's needed. Perhaps what we need now rather than more research, is for the people doing research to put a little different emphasis on the research that is done.

It's the day of management. We need to look at the variables on which management decisions can be based and conduct research designed to define and quantify these variables where possible. Particularly in the king and Spanish mackerel fishery, we need to emphasize in our research programs ways in which we can come up with an index of fishing effort, or ways in which we can put a population number on a stock or ways in which we can decide if we are overfishing a stock. It's going to be hard to do in the mackerel fishery. The effort is so varied – you have the hook-and-line boats, the gill-net boats working with and without spotter planes, you've got the charter fleets, private boats, you've got so many different kinds of effort going into taking fish from the stock it's very difficult to come up with some sort of measure of effort on which you can use the models that we like to use to determine the physical and eocnomic effects of changes in fishing effort.

Something that concerns me as an economist, is the cost of collecting all these data. It doesn't take long to figure out that it may cost more to collect the data than the whole fishery is worth to our economy! We have to stop saying at some point in time that we need more data and come to a rational decision on just how much more we need, determine its cost, get it, and go on with our research and decision making. Maybe some of these are personal biases rather than based on any sort of professional discipline but they need attention.

We need to look at those kinds of information on which management decisions can be made. For example, we talked this morning about many different species of mackerels, some of which are target species and some of which are not. If they form a group on which we expend effort, some of them become target species and the others become incidental catch. We must focus our attention on information about the target species. You can manage the take of the target species, but you can't manage the take of the incidental species because they're going to be in there no matter what. Emphasis should be placed on the target species. We must make ourselves come to the decision on how many fish we can catch. Then, if we're not to a point where we're overfishing, let the economic system work, bound only by the legal system in which we operate. Adam Smith was one of the first people to tell us that we have a pretty good economic system – leave it alone and let it work! Let people use the kinds of fishing methods they want, as long as you don't hurt the stock. Working within the economic system, economists can guide the resource users through firm analysis and market analysis to a more efficient utilization of the resources. If we do get to the point of managed allocation, limited entry and all the things that the decision makers really don't want to talk about (I wouldn't either if I were a decision maker – it's a tough one), then we do need to look at the many kinds of practices that are used in the fisheries.

Looking at the requirements of a fishery management plan, particularly from an economic standpoint, I tried to select a few of the types of information needs according to the plans that we are trying to develop. In many areas we have adequate information, from an economic standpoint, particularly on the commercial fishery. We have to describe, in quantifiable terms, the participating user groups. In almost every category we have a problem with the recreational fishery in these quantitative measures that we've heard all day. We must describe the vessels and the fishing gear, the employment, the fishing and the landing areas, the conflicts – hook-and-line versus the use of purse seines or gill nets or whatever – or geographical fishing areas.

We've got pretty good information on that. I'm not sure how much more we do need. Again, recreation is a problem! If you look in detail at some of these studies and recreational estimates that were discussed this morning, you will find that the number of fish that are caught or are reported as caught by recreationists, as well as the pounds reported, vary widely. If you divide the pounds caught by the number of fish, individual weights vary widely between reporting periods. That gives you some idea of the problems with some of these data.

The value of the catch is not the same problem in commercial as it is in recreational fishing. How do you value the catch? Is it what a guy pays to go fishing, or what he's willing to pay to go fishing, or how much value is put on just the ability to be out there fishing, even if he doesn't catch a fish? There are a lot of problems with them. We have real good information, particularly in Florida on hook-and-line king mackerel boats and on two sizes of Spanish mackerel gill-net boats. We don't have any detailed documented information on large king mackerel gill-net boats although some limited data do exist. We know how much the boats and gear cost, gross income, operating costs, and a lot of the characteristics of the fishing effort. These have been documented in the last couple of years through research projects and studies. We have a fairly good idea of the processing industry. We have a fairly good idea of the prospects for international trade. Here's an area for increased market potential for mackerel if trade is ever normalized with Cuba.

Another field in which we have some information in Florida has to do with the social and cultural characteristics of the people involved in the commercial fishery. We're supposed to describe the age and education profiles of fishermen. We have done this in Florida. Captain Thompson this morning indicated there were a large number of people in Florida who work at other jobs and who could go commercial fishing. A study we did two years ago indicated that only 48% of the commercial fishermen in Florida who called themselves commercial fishermen actually made their full income fishing. So about half the people engaged in commercial fishing range from firemen to policemen to school teachers, all areas where people have other jobs and then commercially fish. We've got some pretty good information on that, but we have a little problem in defining communities. Much of the employment in fishing is often categorized with forestry as fishing, farming, and forestry. I have never understood why that was so in the census data, other than some bureaucrat at some time figured out they all started with an "F", and put them in the same category.

The point I want to leave with you is a serious point. Economists, and, I think, biologists, any kind of professional person, are not going to make the decision for the decision makers. The decision maker has to make the decision as to what will happen in the fisheries. An economist, given objectives set by the decision maker, will tell you or try to help you understand what will happen with a given decision and the alternatives that are available. But don't wait for the professional – the scientists, the technical people – to make the decision for you, because they won't do it. You, as a decision maker, must make that decision and the necessary refinements to the decision as needed.

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SESSION III – QUESTIONS AND COMMENTS

Trent: If we assume that our fisheries are worth $50 million per year in the southeastern region – just a ballpark figure – how much should we spend – percentage-wise – to manage or maintain our resource? I am in agreement with you that we can't spend more money than the resource is worth. What does industry do for maintenance or development or whatever?

Cato: That's a tough question to answer. I am not sure. It would vary between the types of industry in the U.S. as to what the R&D budget is. I can't even venture a guess. In terms of the fisheries, I would say we ought to specify what hard kinds of data are needed. Now, I'm not talking about the exotic kinds, just the kinds we can use to make the decisions, the data that are required for management decisions. Determine the information which the decision maker must take into account when making a decision, specify how much it's going to cost, and determine if the taxpayer is willing to foot the bill. Then let him (the researcher) get that data. If we can't afford to acquire all the information which we would like to have, then we'll have to cut back a little. I really don't know what the R&D budget would be for the fishing industry.

Beaumariage: If I may comment, Texas is spending about a quarter of a million dollars doing monitoring work to figure out how to divide the redfish among the competing user groups. That's some idea of the cost of trying to provide information for allocation decisions – a quarter of a million dollars per year, and they probably will have to spend more as time goes on. What Jim said about letting economics work – I think that it should really be taken with some seriousness. The cheaper way of doing this monitoring work is, of course, to adopt a licensing system. This concept was stated earlier by a couple of people. It would certainly reduce the cost. It would give some continuity to the way those types of management data would flow. Information is needed to determine how much of the resouce should be allocated to (or is used by) sport charter boats, the fish-house operator, who needs to buy fish, and how much should be expected to accrue to the various professional fishermen who wish to participate in using the resource. A license system would probably cut the government cost considerably by requiring that each participant, if he is to retain that license, must truly report his landings. This report is from not only the man that catches them, but from the man that buys and sells those catches. This system will provide the vehicle to define the user universe. It also would reduce the cost to a government agency trying to acquire (for the decision makers) those allocation estimates which must be done on an annual basis.

Nakamura: Mark Chittenden stated that eventually we are going to have to identify the stocks that require management. As you know, the contract that has been let for developing a management plan for the mackerels involves several species. I wonder if you have any thoughts on whether these species can be managed as a single multispecies unit, or will the contractor have to come up with a separate management plan for each species?

Chittenden: The reason I brought up the point that we need to work on a population, or stock, basis is that if we have a discrete number of populations, and we do not know the extent or boundaries of those populations, our fishery could be directed strictly at one. It could be possible that we may be destroying one population, while others are not being touched at all. I don't know what is going to happen. You bring up a very difficult point, especially when you put this on a multi-species basis, such as the ground-fishes. With the mackerel, it may be fairly simple in that we may have two or three stocks of fish to deal with. If it is more than that, it will be a difficult problem. With other pelagic fishes, I don't think the information really exists. They may become an economic problem in the long run. How much money are we willing to put into management? It may be cheaper to buy out the fisheries than to identify all the separate stocks and manage them on a separate-stock basis.

Finucane: In developing models of fish stocks, how do you treat data on egg and larval populations?

Chittenden: I have not been dealing with egg and larval stages at this time. I don't know how you are going to separate eggs and larval stages according to populations.

Finucane: It seems to me that we need to know much more about the stages of the life history – what their mortality rates are, what their movements are, what their spawning characteristics are, etc.

Chittenden: This basically is what I'm getting at. We have to know for each population of mackerel, their migratory habits, where they spawn – follow them essentially throughout their life cycle, and what sort of harvest and fishing efforts are being directed at each of these stocks. If we do not, in the long run, we will end up with some stocks, or portions of them, being overfished and some being underfished.

Finucane: How do present mortality estimates of king mackerel compare with that of Spanish mackerel?

Chittenden: I think that of the two species, based on the available literature at the moment, total mortality rate for Florida king mackerel seems to be larger than that for the Florida Spanish mackerel. [Editor's note: see Chittenden's added note in the next-to-last paragraph of

Discussion I.] Now we run across the problem, is this a data artifact, or is this a possible symptom of very heavy fishing pressure. And how does this actually fit into a yield-model system? Are we overfishing or are we not? It seems to me that one of the things that needs to be considered (when the dollars are spent on future research), should they all be directed mainly on king mackerel? My personal opinion is that it is the most in-danger of being overfished. I think this is one of the things that we do want to address.

Beaumariage: The concept of one state's fish versus another state's fish is something that I would not like to leave you with. It's not "Florida's" king mackerel. Florida has a mackerel fishery during the winter time. It's a very intensive fishery. However, these fish are distributed throughout a wide range. We know more about how they are distributed throughout the Gulf of Mexico than we do along the southern Atlantic coast. You've heard discussion of the separation and segregation of stocks according to respective size taken. All the data which we have to offer Mark Chittenden from which he can calculate mortality estimates are from the Florida king mackerel fishery. This fishery is exploited heavily, especially the younger age groups up to about age VII. However, we don't know the level of exploitation upon or even the relative abundance and distribution of the older age groups, which would primarily (in my opinion) be the bulk of the spawning stock. Prominent spawning sites may, perhaps, be both in the Gulf of Mexico as well as in the upper southern Atlantic region (off Hatteras).

Now, there are two types of overfishing we need to be concerned about. "Growth overfishing," or taking out a biomass that's accumulating at a known growth rate faster than that known growth rate can yield that biomass. The effects of that one are much easier to follow using catch-per-unit-of-effort and relative size of fish landed throughout the region. The other situation (which would be more precipitous) would be to combine with growth overfishing, "reproductive overfishing," where we are taking large numbers of the spawning fish – those older, more fecund fish which should be contributing to the replenishment of those stocks. We definitely need to think about stocks not only in terms of distribution and species but also relative size composition because that's the way our fisheries have been organized.

Chittenden: Most of the modeling I've talked about really assumes the absence of parent-progeny relationships. This is particularly so in the Beverton-Holt dynamic pool models. The surplus production models of Schaefer will incorporate a spawner-recruitment relationship – those of Ricker and another of Beverton-Holt's models, – will ultimately require 20 to 30 years worth of parent-progeny stock relationship data. I think we're a long way down the road from being able to apply parent-progeny type models.

Beaumariage: It might give you some confidence to know that as a consequence of the tagging work, its not going to take 10 to 20 years to get other mortality estimates. We anticipate that mortality estimates from relative success of catches of fish tagged in one year and recaptured in another will be available in the next year. Before we come back to biology, I'd really rather get into another area. We'll come back if you wish, certainly. Some of the things I noted (brought out earlier in the conference) was the concern expressed by the charter-boat fishermen as well as commercial hook-and-line troll fishermen of being assured that within a definite geographic area there would be a continuum of fish returning to a specific region. Hopefully, government scientists, or crystal-ballers, would be able to inform coastal communities (like fishermen at Destin or Fort Pierce), that there would be a number of fish (perhaps even how many) that would be available to them, that would be coming back to those regions. Really, I think that type of prediction would be almost impossible with pelagic fishes. As one of the speakers, Charles Manooch, pointed out earlier today, the distribution of these fish, especially from one place to another around the coastline, is highly variable. We haven't touched a bit on the lack of oceanographic information such as the current patterns that influence the distribution of fishes off of Destin or between, say no-man's land off Key West versus the southeastern coast of Florida which prevents such a prediction from even being attempted. That's one area I see sadly lacking, the relationship between how adult mackerel stocks distribute themselves along discrete current masses. Roy Williams only briefly touched upon the fact that we recognize that some migrations orient according to major ocean currents, i.e., the Gulf Stream or the Loop Current in the Gulf of Mexico. Also, the trophic relationships that are involved in supporting the various size of fishes as they grow. Do their diets change? Do king fish stay off the Louisiana oil rigs and feed on croaker at relatively larger sizes, whereas when they're smaller, they may chase clupeid fishes? We don't know all that much about their diets. Those king mackerel that are available to the intensive Florida fishery often eat clupeid fishes, but certainly their diets might change.

Putnam: You touched all around it, but you skirted that issue real well, i.e., the predator-prey relationship. Do we have enough information at this time to say that the stock of fish are available when the food is available? Or can we turn that around and say that the fish drive the prey off? Do we have any information from stomach sampling or from scientific research to show the true value of the predator-prey relationship?

Beaumariage: The stomach samples were most readable during the summer months – those that were fresher.

They were collected most often from the recreational catch. The winter catch yielded stomachs that were, by and large, empty. This was probably because by the time the fish were examined after they had been dead for several hours, everything had dissolved; or they perhaps regurgitated their food when they were caught on hook and line or snared in the net. However, I think we're pretty confident that the fish are pursuing food and that food is readily available. One gentleman mentioned how nice it would be to have some high rise reefs in certain areas that would attract bait. That would certainly provide specific locations in which you could look for fishes, as the bait was there. However, the distribution of the bait that these king fish feed on is not all that well known. But certainly, common sense tells you that fish are going to move for two reasons: to eat and to spawn.

Thompson: Let me tell you something about large king fish that you people may not be aware of. We have one place down there [Florida Keys] where large king fish seem to congregate every year. Now we never fish them because it's too far out of our way. That's at Pulaski – about 7 miles north of Fort Jefferson. Every year these fish are found there – plenty of them. They are in 100 to 200 feet of water; very common to find 60-pounders. They're there this year – they were there last year. We can't fish them – they're too far away. The water's too deep. The shrimpers often tell us how they lay there in big beds.

Beaumariage: Thank you, Walter. That's one of the advantages of having people who make their living on the water available, they often will tell scientists things we frequently didn't know about.

In the economic area – a major concern to the user groups has been the optimum yield that should be taken from this fishery by nets. Net boats are often operated by independent owners, like Mr. Thompson, but they also can be more easily afforded by large companies. The latter would constitute a vertical integration in which, if you were going to invest in both the search for stocks of fish which lie beyond the known fishable range and you were going to vector fishing vessels to those stocks from the air, you would probably want to vector a fleet of net boats by your aircraft if it was going to cover a vast area in its search. Now that's one way to produce fish. You take a risk, you go out, you gamble, you search for, and you search in an organized way, but when you find them you capture a bunch of them since large net boats have a greater individual capacity. The other way is to have a small owner-operator that consistently produces relatively smaller numbers of fish like Mr. Stormont – 2,000 pounds per day, but over a season, a considerable yield. Now the question I have is, considering the variability in location of the resource, and trying to encourage a consistent production, would the small owner-operator that may be able to move more frequently up and down the coast line or the larger company-supported vessel be most likely to harvest the resource in domestic waters of the U.S. most efficiently in terms of the economic cost of each type of fishing?

Cato: I think I might argue with you that perhaps the larger net boats might be able to move more readily around the coast than would the single owner-operated trolling boats. From a pure economic efficiency standpoint, one could argue that the larger gill-net boat could catch fish at a lower cost per pound. From a pure economic efficient standpoint, that would be the wisest uilitization of the resource. On the other hand, the one person-one boat operation takes more resources (more bait, more ice, more fuel, etc.) for the whole fleet to catch the fish which in turn employs more people in the economy. So it's a tradeoff. From the firm's standpoint, the economic consideration of the individual boat, the large boat is more economically efficient. The fleet of small boats keeps more people employed and probably has more of a dollar impact overall on the economy. On the other hand, you could argue that that's not a wise utilization of the resources. Those resources could be going into some other use. So it's really a tradeoff. You know, if a fleet of people get put out of business by larger boats, these people have to find something else to do. It's a matter of opportunity cost that they have – what job alternatives they have in finding something else to do. It could be argued almost defendably either way as to what might be the correct way from an economic standpoint.

Beaumariage: Thank you, Jim. Those are the types of things our decision makers should consider.

Bernhard: Concerning the tradeoff, could Dr. Cato take it one step further, and get into it from the consumer's standpoint? For the person buying from the local fish market – who is producing the best quality for the consumer at the most efficient cost?

Cato: You know, it's the old argument – the hook-and-line fishermen say that their product is of higher quality. The net fishermen say that theirs is just as high a quality product. Some in the industry say that a higher price is paid for hook-and-line-caught fish, but they go to a different market. The consumers of gill-net fish may not desire a higher quality product. So what's wrong with that? Consumers of hook-and-line-caught fish may demand a higher quality product. So, you know, you're looking at two different markets in effect. Again, it's a tradeoff kind of question.

Stormont: We just had something happen here last week – quite a bit of netted fish were caught off of Fort Pierce – probably a million or two million pounds, I don't think anyone knows exactly, yet. One of the dealer-producers consigned them to New York – The Fulton Fish Market – I don't know this for a fact, but I've heard it from about five different sources, I'm sure you could call New York and find out. They sent 200 boxes to New York and New York put them right back on the same truck and sent them back. They don't want any netted fish.

The price of kingfish last Friday in the Fort Pierce/ Palm Beach areas was 90 cents a pound to the fisherman. I've never heard anything like that, since I've been fishing, in the month of March. It's usually half of that. One gentleman was saying that he doesn't understand the Fulton Fish Market – I don't understand it either, but I do know that it is strictly a supply-and-demand situation and the quality of fish has something to do with price.

These net fish are mostly frozen and exported to Puerto Rico. Everytime we catch more fish than can be shipped to New York, which is 200 to 400 boxes a week, then these fish are frozen and held usually until Lent, and shipped to Puerto Rico, or in some cases they are held until the markets are better. There is a definite price difference between hook-and-line-caught fish and netted fish. It's just physically impossible to leave these big catches of 25 to 50 thousand pounds in one pile on the stern of one boat and expect the fish on the bottom to be any good. We catch one or two thousand pounds a day and can stop and ice these fish during the day.

To me there is no question about the difference in the quality of these fish. One New York dealer called down to the Co-Op [Treasure Coast] and offered us $20,000 to sell him 20,000 pounds of fish for a dollar a pound. Since they had the heavy netting the past few weeks in the Fort Pierce area, we hand-liners haven't caught much fish. Now, I don't know whether those net boats took all those fish home with them, or a lot of them fell to the bottom. I do know that they will not bite our hooks.

Now I know I sound like I'm saying the netters are running me out of business, but we got to use some discretion in the use of this resource.

Cato: I think that there is nothing wrong in producing lower quality fish, if there is a market for them. The people in Puerto Rico may not be able to afford hook-and-line-caught fish because the price is too high. So as long as you have the markets for different qualities of fish, there's nothing wrong with taking advantage of it.

Stormont: Puerto Rico wants to buy out all the hook-and-line-caught fish first. I understand that there are fish in the freezers from last year's net catches that haven't been sold yet.

Beaumariage: I think that obviously there is a need to get into some discussion of the institutionalized ways in which this product is divided up and into which market it goes. I'm going to let Glenn Ulrich comment here, because this is the kind of decision South Carolina will be facing. But I would like to emphasize one point here which we should visit again, this "Puerto Rican connection" certainly stirs in my mind a considerable likelihood of interest in mackerel among Latin American countries.

Ulrich: I didn't really want to comment on that. I wanted to ask a question of the commercial fishermen in the crowd – I've heard that there is a relationship between king mackerel distribution and beach lighting. I was told that on the southwestern Florida coast, areas where king mackerel were previously abundant, that they aren't found there now that the areas are lighted – that the fish have an aversion for lighted-beach areas. Anyone have a comment on that?

Stormont: There's a school of [king] fish right now directly in front of Palm Beach inlet about a mile offshore – 60 to 80 feet thick – in 150 feet of water. There's a 42-story condominium there and other tall buildings. I've heard the same story, but I can't say that in my experience lighting has anything to do with their location.

Beaumariage: I've heard that same thing about Spanish mackerel as the development along southwestern Florida increased. Spanish mackerel historically had been (before the use of spotter planes) taken by fishermen cruising the water looking for phosphorescense in the water at night. With increasing light from southwestern Florida coastal development, the fish tended to move off into deeper and deeper areas.

Williams: I just have one comment on that. Heber Bell told me this. He owns American Freezer in St. Petersburg. He buys a good portion of king and Spanish mackerels landed in Florida. He told me about a year ago that he started out as a fisherman fishing for Spanish mackerel off St. Petersburg. Gradually over the years they had to fish farther and farther offshore for Spanish mackerel. He didn't really know why. They fished mostly for their fish at night, looking for phosphorescense in the water. When World War II came, they started having blackouts along the beach. When that happened, they started catching mackerel back inshore, like they had years before. When the war was over and the beaches were lit-up again, the mackerel moved right back offshore again.

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SUMMARY AND CONCLUSION

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Gene Nakamura said to me earlier this afternoon that I had the hardest job of all here. Thank you, Gene, but I don't think so. It doesn't take any real talent or effort to misquote 28 people after 6 or 7 hours. I did want to say, however, that just as we heard this afternoon about what it takes to get into commercial and sports fishing on a professional basis, I'd like to tell you something of what it takes to become a professional summarizer. You will first have to be a soft touch, and retain that feature. Then, you must be ignorant of the subject to be discussed to avoid bias in reporting, which makes summarizing one of the few situations today in which virginity is a virtue. You'll need a strong liver and a good store of adipose tissue, because you go without lunch while organizing notes. There are other characteristics desirable in a summarizer that I can detail on request, but under more private circumstances.

Now, to tell you what I've seen, heard, and felt today from my position of innocence. I've seen groups of involvement and of interest. While this seems to be an era of categories for everything and everyone, I'm not going to poke any of you into more boxes than those needed to make my point. It's been apparent to me that we've seen three very real kinds of interest areas working together, but retaining their identity, as they should. When similar groups of my staff get together, I hear about "fish people" saying one thing, and "my invertebrate people" saying another, so that you quickly find yourself in a "close encounter of the third kind" sort of conversation. It brings awesome connotations to the imagination, but there really *are* "fish people," and we've heard from some today. They are folks who, up to the last decade or a little less, studied fish for their own sake in rather cloistered fashion, for what was their one and only interest. They are biologists, and that's where they felt their impact ended. It now seems that they are finding that they've only started there, since their work has a lot more meaning than they thought. They have found a real need to interact with people who will use their information, and they are eager to do more as you must have seen today. They are also the group identified as those "who don't need cooperation of fish." How many of you have tried to tag a 10-pound king mackerel?

I also heard from an interest that I've identified as "people-people;" I've got a collection of them sitting next to me now. Al Jones called them interns, which is highly descriptive for many things they do, but I'd like to beg Al's definition a little since they are somewhat more than that. These are mariners who lead a sort of hybrid existence in dealing with mackerel or any fish. On one side of their lives they work with the sea and fish, become very knowledgeable about both, and so are immersible in the regime of biologists. The rest of their time is spent working intensively with people and their interests along waterfronts and beyond, so they come to know a lot about that, too. They see the problems that come from marketing situations and from interactions between interest groups, both of which we heard about from them today. I think all of this puts them well past internship and into practice of the special art of bringing their experience and needs to work with us here.

Watching this interchange made me think of a story told by Congresswoman Smith of Maine. As she went to Congress as a "freshperson" newly out of the rural area of that state, one of her first brushes with international communications made a point that served her well throughout a distinguished career. Delayed by transportation problems, she arrived late in Washington to be told by her new secretary that a "must" diplomatic dinner was scheduled that evening. She hurried there and was hastily seated at the head table without an opportunity to read either place cards or the evening's program. A British envoy was to her right, and an Oriental sat on her left. Her naivete suggested that the latter spoke no English, but her senses of social grace and diplomacy called for attention to him, too. She therefore turned to him as each course was served asking, "Likee soupee? Likee salad?," etc., to which he smiled and nodded. Her pleasure and satisfaction at having handled an awkward situation so well vanished at dinner's end when her Oriental neighbor stood and delivered an address in Oxford-style English since he was Syngman Rhee, then Premier of Korea. By the end of his delivery, Ms. Smith feared the worst in payment for her transgression, but got instead an introduction to the elegance and good humor for which Rhee was noted. He turned to her as the applause died and quietly asked, "Likee speechee?"

That is a sketch of what we've seen today, and will continue to see. Up to the recent past, those I'm calling fish people and people-people haven't been sure how to work with each other. There was uncertainty about what

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each group had to offer the other, and whether there was any real coincidence of interest. This meeting has served to eliminate those uncertainties and to foster a forum of highly productive discussion in which both groups freely participated to the benefit of the fishery and its future. I should tell you too, that unlike the results of entertaining bistro ladies, being a soft touch for summarizing can be rewarding. As soon as I saw the agenda for this session, I agreed to be with you since it promised many satisfying experiences; I have not been disappointed. Let's take a look at the contributions our groups have made here, and the results of putting them together.

From Bruce Collette we found he'd learned the first names of eighteen species of *Scomberomorus* which he translated for us into a picture of a very sophisticated, well-engineered, well-adapted, and cosmopolitan group of fish. They've been working at their business a long time, which probably tells us that they'll stick with us if we handle them properly. Their worldwide distribution seems to tell us that, too. Charles Manooch told us many similar things, among which was the comforting fact that mackerels are heterosexual, which prompted a wag of my acquaintance to point out that this probably explained why some of them are called "kingfish" rather than "queenfish." He went on to wrap up a good deal of the knowledge accumulated about the biology of the group, showing that features such as early fecundity, rapid growth of females, and a pelagic-to-pelagic life cycle are other indications that mackerels are a highly successful group. We also heard from him about the needs for further research to get the data that Cato and other economists say are needed to make called-for decisions about use and protection of the fishery. More needs to be known about the locations, sizes and mobilities of Atlantic and gulf stocks, how much interbreeding happens between them, and what they eat, which was also pointed out by Chittenden.

Williams and Sutherland showed us that mackerels are active tourists along the Atlantic seaboard and gulf coasts. They travel regularly from lower east Florida, at least, to northern gulf sites and as far west as Texas, and return. From some locations along Atlantic Florida they also go north, perhaps beyond Viriginia, which suggests to these biologists that there may be two distinct stocks, each taking a seasonal odyssey. The most significant point about this observation is that these and other stocks of mackerels may be locked into such movement patterns, and could also be showing us a salmon-like characteristic of returning to specific spawning locations. If this is so, it will have considerable bearing on fishing locations and seasonal regulation, so more needs to be learned soon about the phenomenon. Locations of mackerel spawning in the northern gulf were described by McEachren and Finucane, together with characterizations of the temperature ranges in which it occurs. Discussion suggested that these very valuable kinds of investigations might be duplicated elsewhere.

The "people-people" speakers next told us about the history and engineering of the eastern American mackerel fishery. Since mackerel have been fishing for longer than humans, you'd think they'd be ahead in technology. But as *Sportin' Life* said,"T'ain't necessarily so." They outlined the way in which the fishery developed in the northeast during the latter nineteenth century, and sort of drifted down the coast picking up technology and popularity as it went along, much as jazz came down the Mississippi to New Orleans. Mackerel fishing then blossomed in the south Atlantic and gulf giving rise to an incredible array of catch gear and lure hardware that delivers a national harvest worth at least $3 million annually from commercial effort, and $15 to $45 million total earnings each year in the recreational fishery. The varieties and styles of gear used there have highly effective counterparts in Mexican waters as described by our compadres from Instituto de Pesca. It was therefore suggested that enough different and proven gear types are available to permit their selective use by regulation if the complexion of the fishery and efforts in it suggest such a need to managers.

Dr. Meaburn gave us another people-related input when he reported on the content of mercury, methyl mercury, and selenium in mackerels, and showed a somewhat direct relationship between fish size and their content of these compounds. His general conclusion was that there is no real threat to humans according to present public health guidelines and the frequency with which fish are eaten in this country. We next found that the Prochaska-Cato-Austin clan of money people has spent a good deal of time developing and testing methods to find and follow the pulse of the fish supply and demand organism in the marketplace. They have kept track of all they've found and compared it to the same sort of information about other industries to be prepared to help fishermen detect trouble spots and do something about it. They've built and used model systems for these purposes, to predict what is likely to go on in the economics of the fishery, and to be able to identify those data next needed if they are to be able to continue providing this useful service.

I've labeled the third group the wheel-and-rod people since they are the experienced commercial fishermen, recreational fishermen, and charter-boat men. Acting as spokespersons for this group were B. J. Putnam, Capt. Hilpert, Capt. Thompson, Capt. Stormont, and Mr. Weil who gave us the questions they ask, and those they receive from fishhouses, marketplaces, marinas, bait and tackle shops. Queries such as -- "Where are the fish this year, who knows or can know? How soon can we find out? Will there be enough for us? Does the information we have about abundance say that we can let a foreign flag share them?" – are asked of them daily, and they called for attention to them. Further, they brought before us their very valuable observations concerning uses and abuses in the fishery and the realities of using it as a matter of business on which they depend. The delivery of this group brought to focus most of what had gone before and gives rise to a frame on which discussion started to hang issues and answers.

This kind of exchange quickly formed a composite of all of the people groups and caused it to interact in a forum better than most I've seen organized for such purposes. Everyone seemed to feel it was time for come-together action and a lot of it went on, especially in the afternoon panel sessions where the flames of unity were really lighted. A considerable amount of quality effort was spent by all parts of the composite on what managers of the fishery need to know and deciding how such needs could best be satisfied. I identify those as the real results of the meeting, and would like to tell you how I see them. One of the most urgent requirements seems to be better definitions of the numbers of discrete species of mackerels, and ways to identify and locate stocks and their movements. Such information must then be fed to Chittenden, Manooch, Williams, and their colleagues, so that model manipulations can give estimates of MSY and other sorts of quantity and abundance measurements. These can then be used to say "We can catch more at this place, and should, but we ought not to take more from that place or allow anyone to do so."

Next, catch-and-effort statistics and growth and spawning data are clearly needed for further indications of potential changes in trends of abundance and seasonal locations of major parts of the fishery. These results, when put together with those from more extensive studies of life histories, should go far toward identifications of spawning grounds, spawning seasons, and growout areas to reinforce the recruitment data end of model predictions, and perhaps make some suggestions about closure of grounds and limitations of fishing times. It was unanimously decided that all support should be given to the efforts of economists and sociologists who are busy describing the nature of the fisherman as a business-person, his family and their needs, and his place in both commercial and community performances. Applications of the work of these scientists to both identification and solution of problems in the fishery have already shown good results, and we quickly recognized today that the quality of help represented by those in this room and others like them will bring more of the same.

We also saw, and saw serviced, an opening of communications channels as I mentioned earlier. There is, however, a strong need to keep them open and active in two-way conversations between wheel-and-rod men and everyone interested in the welfare of the fishery. There never will be a substitute for experience, and the amount and quality of it represented by their continued input to the decision-making system cannot be gotten elsewhere.

Finally, education crept into a lot of discussion today, but not necessarily so identified. We were repeatedly called upon here to educate each other, and also to deliver what we've learned to each participating group at home. Another issue touched was the need to bring the issues of impact on the fishery to the attention of the public with the message that their help can be useful toward management of a resource that is their legacy as well as ours.

Getting together and working together was clearly the keynote of today's session which was both spoken and used. Bruce Austin identified a time dimension of such cooperative action that I hope will be remembered. He spoke of the urgency of gathering what must be learned, and developing a concert of attitude about how it should be used *before* biologists and fishery representatives are asked by management councils and other policy making bodies to provide what they need to make decisions that the industry will long have to live with in the form of regulations and legislations.

This is the set of major matters that I heard here, but what I felt is, I think, just as important. I consistently got the sensation that the central theme of the meeting was agreement that everyone will get larger and more sustained yields if they pull together on the same end of a line or net.