Pelagic Clupeoid and Carangid Resources for Fishery Development in the Gulf of Mexico and Caribbean Sea

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RESUMEN

Las principales pesquerías subdesarrolladas en el Atlántico Central Occidental son la de peces de cardúmenes pequeños, principalmente sardinas, arenques, "scads," "bumpers," y marcarelas. Este conjunto diverso de animales se encuentran cerca de la superficie, o a profundidades medias, generalmente en cardúmenes monoespecíficos de individuos de tamaño semejante. La mayor parte de las especies son de corta vida, alcanzan la madurez sexual en su primer o segundo año, y pocos pasan de 3 o 4 años. El tamaño de la población, la densidad, y distribución de estos peces, depende de la concentración planctónica de alimento y de la predación de peces carnívoros, aves acuáticas y mamíferos marinos, y presenta grandes variaciones espaciales, estacionales y anuales.

La región del Atlántico Central Occidental que se trata en este informe, es en base a la Principal Estadística Pesquera de la FAO en el área 31, del Cabo Hateras, Carolina del Norte, a 5° Lat. N., con énfasis particular en el Golfo de México y Mar Caribe, e incluye el Océano Atlántico Occidental a lo largo de las islas de Sotavento y Barlovento en las Antillas y las Bahamas.

Las sardinas, anchoas y arenques son los peces más abundantes en esta área, pero no son los más apetecibles o valiosos como alimento y tienen demanda limitada como carnada. Generalmente son peces pequeños, muy oleaginosos, de muchas espinas, y requieren métodos especiales de pesca, manipulación y procesamiento para ser empleados bien como alimento humano, para enlate, para harinas de pescado o industrias de extracción de aceites.

Los arenques, sardinas y anchoas se encuentran principalmente a lo largo de las márgenes continentales de la América del Norte, Central y del Sur. En las Antillas, cardúmenes localizados de sardinas escamudas y arenques pequeños son estacionalmente abundantes, pero tienen uso limitado como alimento. Los arenques pequeños son apropiados como carnada viva en la pesca con vara del atún y en la pesca con palangre, sin embargo, la presencia del atún y su abundancia es errática. El desarrollo artesanal de la pesca del arenque no es factible en tanto no exista una mayor demanda que absorba la captura para su empleo como alimento, para plantas de harinas o enlatadoras.

Los "scads," "bumpers," "runners" (cojinúa), "jacks," las macarelas y el bonito son las piezas más prometedoras para la pesca artesanal. Estas tienen demanda como alimento, y son apropiadas para salar, secar o ahumar.

El "round scad" o "Cigarfish" se encuentran en todo el Golfo y Caribe. Su abundancia es estacional, generalmente en las márgenes continentales, o en las islas cerca de los canales o a lo largo de la parte occidental de las islas de Sotavento y Barlovento. Pueden ser capturadas en chinchorros, redes de cerco, o jamos de noche, atraidos por la luz. El "bigeye scad" y el "rough scad" se encuentran en toda esta zona, pero no se ha podido localizar en abundancia.

La pesca de muchos de los peces pelágicos pequenos depende del desarrollo de métodos de pesca económicos y nuevos, mayor información de su abundancia estacional y geográfica e incremento del empleo y demanda del mercado.

A lo largo de la costa de la América Latina y las Antillas, se necesita una pesca diversificada capaz de obtener diferentes peces con diferentes aperos. En toda el área del Caribe se necesitan embarcaciones capaces de pescar con equipos manuales variados, como currican, palangre, nasas, chinchorros de seno, trasmallos, a ser empleados de día y noche dentro de un radio de acción seguro con respecto a un puerto pesquero.

Mayores necesidades son (1) facilidades portuarias con servicios de reparación y salidas de mercado; (2) servicio de información con respecto a la presencia de peces por estación y localidad; (3) entrenamiento en la confección, uso y reparación de equipos de pesca.

The principal underdeveloped fisheries of the Gulf of Mexico and Caribbean Sea that have the highest potential for expansion are those for the small schooling fishes, mainly the anchovies, sardines, herrings, scads, bumper, and chub mackerel. These fisheries are underdeveloped because the clupeoids and smaller carangids are not highly regarded as food and are difficult to catch. In addition, the occurrence and abundance of these fishes are highly variable and their utilization requires processing, canning or the production of fish meal and oil.

A survey reported by Fiedler, Lobell, and Lucas (1947) concluded, in part, that the Caribbean Sea was not a greatly productive area for marine fishes but that pelagic fishes offered the greatest opportunities for fishery development. The Region has proven to be considerably more productive, however, than was believed 30 years ago. Shrimp, tuna, reef fishes, sardines, croakers, and mackerels are examples of some fisheries that have shown greater productivity than were surmised at that time. Except for menhaden and Spanish sardine fisheries, which are localized off the United States and Venezuela, the great majority of the pelagic schooling fishes considered potential resources of the Region remain underutilized.

Reviews of the fishery resources of the Gulf of Mexico and Caribbean Sea by Simpson and Griffiths (1967), Griffiths and Simpson (1968), Simpson (1969), Bullis, Carpenter, and Roithmayr (1971), Gulland (1971), Klima (1971, 1976, 1977), and Juhl (1976) have included these species or groups of species and have given broad estimates of standing crop or potential yield for them.

There are several reasons for the popularity of clupeoids and carangids as potential resources. First, schools which are visisble from aircraft and vessels, appear very abundant at times. Second, these species appear commonly in the incidental catch of other fisheries and in the food of carnivores. Third, experimental or exploratory fishing with midwater trawls, lights, and acoustical detectors indicate large concentrations of fish. Fourth, very similar species of herrings, sardines, anchovies, and scads support large fisheries in other parts of the world.

In the Gulf of Mexico and Caribbean Sea, only two species support large directed fisheries: Gulf menhaden off the U.S. coast and Spanish sardine off Northeastern Venezuela. The Gulf menhaden catch is at or near maximum; the landings of 820,000 metric tons (mt) in 1978 established a new record. In Venezuela, the Spanish sardine catch of 37,000 mt in 1977 was at about the 10-year mean.

Lists of species available for expanded production have been prepared many times and often contain the same ones. Bullis (1978) stated that improvements in harvesting technology, appropriately linked to handling, processing, and marketing, are needed for fishery development. Alone, increased harvesting capabilities do not lead to increased production and utilization. A better understanding of fishing units and of channels of distribution, utilization, and trade is needed for successful fishery development.

Before a fishery development program is started, fishery scientists should provide information on (1) the species of fish available, (2) their size, (3) their geographical distribution, (4) their seasonal abundance, and (5) their stock size and yield. The first three are relatively easy to provide. Reports listing the species that occur in the Region and the species that support fisheries in other parts of the world have appeared regularly during the past 30 years. Size range of juveniles and adults and their geographical distribution often are known. Seasonal abundance, availability, stock identity, and stock assessment, factors critical to fishery development, ususally are not known for most unfished resources.

HERRINGS, SARDINES AND ANCHOVIES

Herrings and their allies contribute a large portion of world fishery production. For example, nearly half the fishery production of the United States and Venezuela, the two largest producing countries in the Region, is of this group. Consequently, whenever fishery development programs are discussed, the herring-like resources are considered as those with the greatest potential for expansion. Of the 20 or more species of herrings and anchovies reported from the Region, 8 species or species groups are considered in this report.

Menhaden

Three species of menhaden occur along the Gulf Coast of the United States. Gulf menhaden, *Brevoortia patronus,* are fully exploited by the U.S. purse-seine fishery in the northern Gulf of Mexico. In 1978, 820,000 mt were caught by a fleet of 80 carrier vessels, each vessel with two purse boats. Catches are landed at 11 reduction plants, 8 in Louisiana and 3 in Mississippi.

Yellowfin menhaden, *B. smithi,* and finescale menhaden, *B. gunteri,* occur occasionally in Gulf menhaden purse-seine landings but the stocks apparently are small. Yellowfin menhaden are caught for bait along the west coast of Florida and finescale menhaden are caught for bait to a limited extent along the Texas and Mexico coasts. In the vicinity of Vera Cruz and Alvarado they are caught for blue crab bait. A reduction plant was operated during 1960 at Cuidad del Carmen but the supply of menhaden was so small that purse-seine vessels caught Atlantic anchoveta, *Cetengraulis edentulus,* instead.

Spanish Sardine

Spanish sardine, *Sardinella anchovia,* is a foremost potential fishery resource in the Region. In Venezuela landings have averaged nearly 40,000 mt annually for the past 15 years and probably could be doubled to 80,000 (Gulland, 1970). The fishery is localized in the Cariaco area, near Isla Margarita and the Araya Peninsula. Most of the catch, made with beach seines operated

by 20 men from small boats, is processed into canned sardines (Simpson and Gonzalez, 1967, Ginés, 1976). In west Florida a small directed fishery annually lands about 1,000 tons for bait and food for captive sea mammals. In the southwestern Gulf, Mexico reported 1,157 mt landed in 1976.

Sokolova (1965) reported Spanish sardine abundant in trawl catches from Campeche Banks during Soviet-Cuban explorations. She reported that 42% of the largest trawl catch in August were sardines and that in all "half the catches were Spanish sardine and round scad." In November, Spanish sardine were 3, 5, 22, 26, and 75% in five trawl catches out of six reported.

Atlantic Thread Herring

Atlantic thread herring, *Opisthonema oglinum*, occur more generally throughout the Region than any other clupeid. In the United States, they are caught for bait and incidentally by the menhaden reduction fishery. Estimated landings probably do not exceed 20,000 mt annually. In Venezuela, where thread herring are used to some extent for food but mainly for fish meal and oil, reported landings are about 5,000 mt annually. They are caught commonly in the Caribbean and usually are more abundant along the Continental margins and near the larger islands of Cuba, Hispaniola, Puerto Rico, Jamaica, and Trinidad.

Scaled Sardines

Scaled sardine, or razorbelly, are common names for a number of similar species of *Harengula* that occur abundantly nearshore throughout the Region. They are surface-schooling fish usually found in bays, lagoons, and coastal waters less than 50 m deep. They form many small schools and rarely occur in dense concentrations. Reported landings are about 2,000 mt from Cuba and Dominican Republic. An estimated 500 mt are caught for bait in Florida.

Round Herring

Round herring, *Etrumeus teres*, occurs along the edge of the Continental Shelf in the northern Gulf of Mexico and along the outer edge of Campeche Banks. Round herring have been reported from deeper waters off Colombia and Venezuela. Because they rarely occur nearshore, they are not familiar to the coastal fishermen. Sokolova (1965) reported small catches from trawling on Campeche Banks. There are no reported landings in the Region.

Dwarf Herring

Dwarf herring, *Jenkinsia lamprotaenia*, are one of the more common small schooling fishes of the Caribbean. They typify the enigma of short-lived fish that appear in great numbers by season and locality and disappear as quickly. They are very difficult to utilize for food or bait because of their small size. Although they can be eaten either fresh or sun-dried, commercial interest is for tuna live bait.

Anchovies

Anchovies, *Anchoa* and *Engraulis* species, are considered the most abundant fish in the Region. Several species occur in nearshore waters, but they are

small and difficult to use for food or bait. A specialized fishery using specific gear to find and catch anchovies would be required, and a technical industry would have to be developed for their utilization. Anchovies may be a future fishery, but for the present their role as forage for fishes currently used by man seems to be the acceptable one.

Atlantic Anchoveta

One species of anchovy, the Atlantic anchoveta, *Cetengraulis edentulus,* is larger than the *Anchoa* species, forms greater schools, and can be caught with nets that catch herrings, sardines, and scads. It is not very suitable for food without salting or canning and its greatest potential is for production of fish meal and oil. Anchoveta occur in the Gulf of Campeche, along the coats of South America, and to a lesser extent in the Caribbean Islands. The only reported landings are from Venezuela where annual catches from 1,000 to 5,000 mt are used in fish meal production.

SCADS, BUMPER, AND CHUB MACKEREL

The smaller members of the carangid family, including the round scad, rough scad, bigeye scad and bumper, and the scombrid, chub mackerel, are important undeveloped resources of the Region. They are suitable for canning, salting, drying, smoking, and as fresh foodfish. Although more acceptable than herrings for human food because of their larger size, fewer bones, and less oil, they present many of the same problems to fishery development. They are highly variable in occurrence and abundance in the Gulf of Mexico and Caribbean Sea. They frequently form mixed schools with Spanish sardine when feeding on accumulations of crustaceans, other invertebrates, and young fish in plankton-rich water.

Round Scad

Three species, *Decapterus punctatus, D. macarellus,* and *D. tabl* (Berry, 1968) are reported from the area and will be discussed together in this report. The only reported landings in the Region are approximately 1,000 tons by the United States and Guadeloupe. Although unquestionably all landings are not reported, very large unreported landings are unlikely since there is no directed fishery for scads. Round scad were caught regularly in trawls on Campeche Banks during Soviet-Cuban activities but only accounted for 2% of the catch (Sokolova, 1965). Round scad may occur abundantly in some localities in some years, but there is little likelihood of a reliable fishery resource in the Region except in the northern Gulf of Mexico or off Venezuela.

Rough Scad and Bigeye Scad

Rough scad, *Trachurus lathami,* and bigeye scad, *Selar crumenophthalmus,* occur throughout the Region but are reported in the landings only from Venezuela and Grenada. In no locality do they constitute an established fishery, although they appear in markets throughout the Region. Catches exceed the reported landings, probably by 5 or 10-fold.

Bumper

Bumper, *Chloroscombrus chrysurus*, are highly variable in abundance and occurrence throughout the Region. The major consideration for utilizing the bumper resource is the same as for the scads. Stock assessment and some estimates of stock size and geographical, depth, and seasonal availability are the greatest needs. Leak (1977) reported a sizable biomass off western Florida without giving numerical estimates. Robins (1978) listed bumper as one of the more abundant fishes in the Gulf of Uraba off Colombia.

Chub Mackerel

Chub mackerel, *Scomber japonicus*, occur commonly along the Gulf coast of the United States, Campeche Banks, and the northern coasts of Colombia and Venezuela. Small mackerel often occur in mixed schools of Spanish sardine, round herring, and scads. Reported landings in the Region have been negligible.

STOCK ASSESSMENT

An essential contribution by fishery scientists to pelagic fishery development in the Gulf of Mexico and Caribbean Sea is reliable stock assessment for each species or group of related species that form a fishing unit. For an unfished stock, geographic range, seasonal appearance and apparent abundance are about all of the initial information that would be available.

This is not sufficient knowledge for fishery development. Some estimates of stock size, potential yield, and size and age composition are required, as well as geographic, depth, and seasonal distributions. For an initial stock assessment, the information may consist of a broad estimation of stock size or yield, approximate size and age composition, and a general description of geographical, depth, and seasonal distributions.

Biomass or potential yield, size composition, depth of occurrence, and seasonal distribution are refinements that may not be available until the results of extensive surveys are analyzed or a fishery has been developed.

During the past 10 years, a number of speculative estimates of standing crop or biomass and potential yields have appeared. Most of these estimates have been for the herrings, sardines, and anchovies, excluding the menhaden, in the Gulf of Mexico. Potential yield of these has ranged from 4,000,000 mt (Bullis and Carpenter, 1968) to 1,200,000 mt (Gulland, 1970) for the western Central Atlantic. Houde (1973, 1976) estimated that potential yields of round herring, thread herring, and scaled sardine combined ranged from 156,000 to 237,000 mt for the northeastern Gulf of Mexico. He speculated that Spanish sardine yield would range from 60,000 to 120,000 mt, equal that of thread herring.

There are several ways to obtain an estimate of stock size when there is no established fishery. Some methods give a wide range for the estimates. All depend on certain assumptions and many rely on the adequacy of sampling. I am going to list these briefly, for each is a topic for lengthy discussion.

Experimental or Trial Fishing

Experimental or trial fishing is a direct method using the same type of gear

that would be used if a fishery were started. Usually, for pelgic fishes, fishing is done in conjunction with visual surveys, both surface and aerial, and acoustical observations. Trial fishing may survey a large area by briefly sampling according to a pattern or grid. Production trial fishing would find the more promising locality and depth and fish in a manner that would give the greatest catch in the shortest time.

Visual and Acoustical Survey

Visual and acoustical survey is a direct method that can provide information on the number, sizes and density of schools. Identification of the kinds of fish depends on the visual and acoustical appearance of the schools. Productive areas can be located and seasons of abundance can be determined. Species and sizes of fish cannot be determined, at the present time, by acoustical information alone.

Juvenile Fish Survey

Juvenile fish survey is an indirect method of assessing the fishable stock by sampling on the nursery grounds to estimate the abundance of pre-recruits. The method relies on some knowledge of life history and the distribution of juveniles.

Egg and Larval Survey

Egg and larval survey is an indirect method that depends on collections during the known time of spawning. An estimate of adult biomass for a fish stock can be obtained if the number of eggs spawned can be estimated and if the sex ratio, and relative fecundity (eggs produced per gram of adult female per year) are known.

An estimate of potential yield for an unfished stock can be obtained if the biomass and natural mortality coefficient are estimated or known.

The only numerical estimates of potential yield for any of the pelagic schooling fishes, based on a scientific procedure, are the reports by Houde (1977a,b,c) and Leak (1977).

Incidental Catch in Another Fishery

Incidental catch in another fishery is an indirect method that can be used to estimate the size and distribution of an unfished stock that is caught incidentally in an established fishery for another species. By knowing the catch composition of an established fishery and estimating the numeric efficiency for that gear to catch the species to be assessed, a catch/effort curve can be constructed. From this curve the stock size can be deduced.

Occurrence as Food in Predator

Occurrence as food in predator is an indirect method that can used to estimate the stock size if the stock size of the predators, the percentage composition of the food, and the trophic relationship are known. This method is not reliable for an open marine system where there is a wide selection of predators and prey. However, if a dependency on forage stock can be established for the predators, a closed system can be assumed.

Trophic Dynamic Simulation

Trophic dynamic simulation is an indirect method that is a wider extension of the predator/prey relation. This method assumes that the system is entire and each trophic role is filled. From the known components in the system, the unknown elements can be estimated. Laevastu and Favorite[1] propose assessment from the top of the trophic scheme rather than from primary productivity.

SOVIET-CUBAN FISHERY RESEARCH

Soviet-Cuban fishery research, started in 1962, is important for two significant reasons: first, it confirmed the list of potential species and their distribution in the Region; and second, it did not result in a productive fishery for any of the species, indicating that no major concentrations were found.

Sal'nikov (1965) summarized and reviewed the early results of Soviet-Cuban fishery research, which confirmed previous observations of U.S. research vessels **Oregon** and **Oregon II** that the more productive regions were the northern Gulf of Mexico, Campeche Banks, and Northeastern Venezuela. The waters around the Caribbean Islands were less productive than the continental margins along the western Caribbean coast of Central America, Panama, and Colombia. As many of the conclusions were based on trawling, the availability of suitable grounds was a major factor. Sokolova (1965) reported that Spanish sardine, round herring, scaled sardine, thread herring, scads, chub mackerel, and bumper were frequently encountered while trawling on Campeche Banks. She ranked them among the more abundant fishes of the area. It was noteworthy that anchovies, particularly the anchoveta, were not taken by trawling.

The Soviet fleet has had a productive fishery in the Eastern Central Atlantic for Spanish sardine, scads, and chub mackerel since the early 1960s. In 1976 they caught 566,000 mt of Spanish sardine, 365,000 mt of scads, and 127,000 mt of chub mackerel. It is reasonable to speculate that the Soviet-Cuban efforts were directed towards the development of similar fisheries in the Western Central Atlantic. That no fishery for any of these fishes developed implies that no concentrations were found.

Kravanja (1972) reported that the Soviet catch increased in the Caribbean area to more than 30,000 mt in 1966. Most of the fish were marketed in Cuba through a nationalized marketing system. After the Cubans acquired trawlers in 1966, their catch increased while the Soviet catch declined. Cuban landings averaged about 70,000 mt, 1967 to 1976. Kravanja comments on the reason for the decline: "The withdrawal from the Caribbean Sea and the Gulf of Mexico of the Soviet fishing fleets after 1966 probably was due to the ineffectiveness of fishing techniques and gear. Soviet fleets are organized to catch large schools of fish with standardized gear and methods. In the waters surrounding Cuba there are only a few large schools of fish, and they are mostly in areas fished traditionally by the Mexicans and the Americans, lying close to

[1]Fish biomass parameter estimations, T. Laevastu and F. Favorite, Northwest and Alaska Fisheries Center, Seattle, Processed Report, 12p.

the shores of these two countries and protected by the twelve-mile fishing zones. Fishery resources generally found in the Caribbean are scattered in small shoals, and only very primitive or highly sophisticated techniques appear to be economically feasible."

Significant effort was expended by Soviet-Cuban fishery research from 1963 to 1972, to evaluate and understand the fishery resources of the Region. Some of the results were published (Bogdanov 1965, 1968, 1971, 1974; Iankovskaya 1966, 1968). Cruise reports with the results of experimental, trial, and production fishing have not be available.

BIOMASS AND YIELD ESTIMATES

The most significant recent publications concerning the undeveloped fishery resources of the Gulf of Mexico were three by Houde (1977a,b,c) and a Master's Thesis, University of Miami, by his student, Leak (1977). They examined plankton collections from the west coast of Florida, 1971-1974, for eggs and larvae of three species of herrings and two of scads. From this information they calculated the adult biomass that would be required to produce the total number of eggs or larvae they estimated were in the area during the spawning season. By assuming a natural mortality, with a probable range from 0.4 to 1.0 on an unfished stock, they estimated the following potential yield ranges in metric tons:

Round herring	50,000 to 250,000
Atlantic thread herring	60,000 to 120,000
Scaled sardine	46,000 to 92,000
Round scad	70,000 to 85,000
Rough scad	12,000 to 14,000

Houde did not estimate the adult biomass or yield of Spanish sardine but he did speculate from the abundance of eggs and larvae that it might be as great as the Atlantic thread herring.

These reports by Houde and Leak are notable because they gave the first potential yields that were based on a statistical procedure. Prior estimates had been based on observations, surveys, exploratory and experimental fishing, and incidental catches that were not quantitative but were, nevertheless, supportive of general opinions that relatively large unfished stocks occurred in the Northern Gulf of Mexico. The biomass estimates are based on the validity of sampling by plankton nets and assumptions made about the distribution and biological parameters of each stock. Although these values give a basis for fishery yield estimates, they should be confirmed by other quantitative information before they are depended upon for fishery allocations and management decisions.

It is conceivable that the fishery productivity of reef fishes and the large pelagic fishes, such as mackerels, tunas, and jacks on Campeche Banks, depends upon a forage base that consists of small schooling pelagic fishes. If so, fishery managers must decide whether a fishery producing large quantitites of forage species or a fishery producing a smaller quantity of carnivores is wanted. In highly productive regions, such as the west coasts of North and South America, and Africa, the North Atlantic Banks, the Southern Ocean,

the Western Pacific, and the Bering Sea, the amount of forage exceeds temporal demands so that both forage species and the carnivores that feed upon them can be taken in moderately large quantities. In less productive regions, such as the Western Tropical Atlantic, this may not be true.

CONCLUSIONS

1) We need improved landing statistics for the Region to provide information on geographical and seasonal distribution. Current estimates are that less than 10% of the catch of schooling clupeoids and carangids are being reported.
2) Stock assessment is required, including estimated standing stock or biomass values with their seasonal and geographical distributions.
3) Soviet-Cuban fishery research apparently did not locate fishable stocks of Spanish sardine, round scad, chub mackerel, or any other species discussed here. If they had it is very likely they would have developed fisheries for these species.
4) Small-schooling fishes are not usually suitable for artisanal or small-scale fisheries because of their low market demand and the costly equipment usually needed in catching them.

Perhaps we need a wiser and more conservative view of the pelagic resources of the Region. Identifying the species involved and knowing the areas of greater abundance are not enough information upon which to develop and manage new fisheries. We also must estimate stock size and seasonal variations in abundance. To be more conservative does not necessarily mean to estimate smaller fishable stocks. It does mean that the estimates should be qualified by locality and time so that the amounts estimated do not mislead fishermen and the fishing industry into expecting more than can be caught. Some of the larger estimates may come from reports of phenomenal occurrences or concentrations that do not represent the sustained stocks.

There are unfished stocks of clupeoids and carangids in the Region. Their distribution is not uniform within the Region and their abundance is highly variable between seasons and years. With reliable assessment, fisheries can be developed in some localities for many of the species or species groups identified in this report.

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