The International Development Research Centre is a public corporation created by the Parliament of Canada in 1970 to support research designed to adapt science and technology to the needs of developing countries. The Centre's activity is concentrated in five sectors: agriculture, food and nutrition sciences; health sciences; information sciences; social sciences; and communications. IDRC is financed solely by the Parliament of Canada; its policies, however, are set by an international Board of Governors. The Centre's headquarters are in Ottawa, Canada. Regional offices are located in Africa, Asia, Latin America, and the Middle East.
Fish By-Catch... Bonus from the Sea

Report of a Technical Consultation on Shrimp By-Catch Utilization held in Georgetown, Guyana, 27–30 October 1981

Jointly sponsored by:
The Food and Agriculture Organization of the United Nations and International Development Research Centre
The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the United Nations or the Food and Agriculture Organization of the United Nations concerning the legal or constitutional status of any country, territory, or sea area, or concerning the delimitation of frontiers.
Contents

Preface 5

Introduction W.H.L. Allsopp 7

Summary 9

Conclusions and Recommendations 17

Background
Utilization of the Shrimp By-Catch Joseph W. Slavin 21
Use of Fish By-Catch from Shrimp Trawling: Future Development W.H.L. Allsopp 29
By-Catch for Human Consumption E.R. Pariser 37

Assessment of the Resources
By-Catch from Shrimp Trawling in Guyanese Waters Donald J. Furnell 43
Fish Discards from the Southeastern United States Shrimp Fishery Gilmore Pellegrin Jr 51
Yields and Composition of By-Catch from the Gulf of California J. Perez Mellado, J.M. Romero, R.H. Young, and L.T. Findley 55

Processing at Sea
Handling Mixed Catches Karsten Baek Olsen and Poul Hansen 59
Strategies to Avoid By-Catch in Shrimp Trawling V. Sternin and W.H.L. Allsopp 61
Handling and Storage of Shrimp By-Catch at Sea K. Crean 65

Processing on Shore
The Guyana Project: Industrial Use of By-Catch E. Ettrup Petersen 69
Effects of Acetic-Acid Aided Evisceration on Deboned Minces from By-Catch Fish Nigel H. Poulter and Jorge E. Treviño 77
Salting of Minced Fish E.G. Bligh and Roseline Duclos 81
Concentration and Preservation of Mechanically Recovered Fish Flesh Poul Hansen 84
Processing of By-Catch into Frozen Minced Blocks (Surimi) and Jelly Products Tan Sen Min, Tatsuru Fujiwara, Ng Mui Chng, and Tan Ching Ean 89
Development of a Salted, Minced Product from Mexican Shrimp By-Catch  
R.H. Young  93
Canned, Frozen, and Dried Products from By-Catch Fish  
Nigel H. Poulter  96
Acceptability and Storage Characteristics of Frozen, Minced Products from Mexican By-Catch  
M.A. Tableros and R.H. Young  99
Pepepez — a New, Frozen Minced Product  
Productos Pesqueros Mexicanos  101
Fish Silage from By-Catch  
J.E. Treviño, R.H. Young, A. Uvalle, K. Crean, D.H. Machin, and E.H. Leal  103

Marketing, Economic, and Resource-Management Aspects
Possibilities of Marketing Shrimp By-Catch in Central America  
Miguel S. Peña  107
Financial Projections for Industrial Production of Minced By-Catch Fish  
R.H. Young  110
Optimization of Processing of Three Underutilized Fish Species  
John W. Brown and Melvin E. Waters  113
Economic Profiles for Three Products Made from By-Catch  
I. Misuishi  118
Management of Shrimp Fisheries  
J.F. Caddy  120

Regional and Country Developments
Fishery Development: the Latin American Model Revisited  
Julio Luna  125
French Guiana  
M. Lemoine  128
Guatemala  
Etienne Matton  130
Guyana  
Ronald M. Gordon  131
Sabah, Malaysia  
Datuk Chin Phui Kong  135
Mexico  
José Manuel Grande Vidal and María Luz Díaz López  137
Mozambique  
H. Pelgröm and M. Sulemane  139
Sri Lanka  
S. Subasinghe  141
Thailand  
Bung-orn Saisithi  143

Bibliography  147

Participants  161
Yields and Composition of By-Catch from the Gulf of California

J. Perez Mellado, J.M. Romero, R.H. Young, and L.T. Findley
ITESM/TPI Project, Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM), Guaymas, Sonora, Mexico, and Tropical Products Institute (TPI), London, England

We carried out systematic studies of the variability in the yield and composition of by-catch from shrimp trawling in the Gulf of California to assess the potential of the catch as a food resource. Throughout the 2-year study, the mean by-catch/shrimp ratio for commercial operations was 9.8:1, with an average by-catch yield of 90 kg/hour. However, the yields of by-catch during the warm seasons were much greater than those obtained in colder periods. About 105 species of fish from 52 families were observed in samples recovered during the study. Of these, 9 species or groups of closely related species constituted 65% of the fish examined. Demersal fish predominated, and pelagic species were noted relatively infrequently. Although the size of the fish ranged from 6 cm to 65 cm, the vast majority measured 8–14 cm. These fish are too small for normal marketing and are difficult to clean. Moreover, the frequent observation of the bullseye puffer (Sphoeroides annulatus), a toxic fish, in the by-catch from the region indicates the necessity for caution in the use of the resource for human consumption.

The initial phase of the ITESM/TPI shrimp by-catch program included an evaluation of the variability in yield and composition of the resource in the Gulf of California near northwestern Mexico. This basic information was required before any attempts could be made to use the resource. Existing data from the region were sparse, although previous reports had suggested that the Gulf of California by-catch was a significant fishery resource (Chavez and Arvizu 1972; Rosales 1976). Our studies were undertaken aboard commercial shrimping vessels in the region between August 1977 and March 1979, i.e., two consecutive fishing seasons. The by-catches contained in a total 365 shrimp trawls were examined (Young and Romero 1979; Perez Mellado 1980).

Methods

Collection of shrimp by-catch was carried out along the continental shelf of the coasts, corresponding to the states of Sonora and Sinaloa, from Puerto Penasco in the north to Macapule in the south. Some sampling was also undertaken along a small section of the coast of Baja California between Santa Rosalia and Muleje. Short voyages (2–5 days) were completed aboard different commercial vessels registered at Guaymas, Sonora. More lengthy voyages (up to 3 weeks) were undertaken aboard the research vessels Marsep IV and Marsep V of the Centro de Educación en Ciencia y Tecnología del Mar (CECITEM). The parameters recorded at sea for each trawl were sampling date and time, duration of tow, depth of trawl, location, surface-water temperature, weight of shrimp, and weight of by-catch.

Shrimp was weighed routinely by the crew, and the weight of by-catch was assessed from the total volume of the catch: the trawl contents were placed in baskets, weighing about 20 kg when filled with fish, and the total weight was calculated from the number of containers required for the entire catch. Samples of by-catch were collected immediately after the contents of the trawl net were released on deck. Approximately 10% of the catch was sampled at random and stored in sacks, either frozen or iced, for subsequent study in the laboratory. Each fish recovered in the trawl samples was identified according to existing taxonomic keys and the personal experience of one of our team (L.T.F.).

Results

During the study, a total $1.17 \times 10^4$ kg shrimp and $1.15 \times 10^5$ kg by-catch fish were
landed aboard the vessels. The ratio of by-catch/shrimp was, therefore, 9.83 : 1. As the total trawling time was 1274.4 hours, the capture rates for shrimp and by-catch were 9.18 kg/hour and 90.27 kg/hour, respectively. The data varied considerably in different trawls. Nevertheless, 95% of the portions measured fell within the range 1.3 : 1 - 36 : 1. The quantities of by-catch in the trawls fell toward the end of the season (February-April). This variation appears to reflect changes in the water temperature, the higher water temperatures (existing during the initial phase of the shrimping season) promoting increased yields of by-catch from shrimp fisheries. The results support data that indicate by-catch is more significant in warm waters than in cooler areas.

Previous observations had indicated that the resource primarily comprised teleosts, i.e., finfish (Chavez and Arvizu 1972), and this finding was confirmed in our study, the by-catch generally being 70-100% finfish. The remainder included mainly small crustaceans, molluscs, elasmobranchs, and sponges. Within the teleost group, 105 species or groups of species from 52 families were identified in the samples recovered from shrimp trawls (Young and Romero 1979; Perez Mellado 1980).

When the water temperature was increased during the warm months, not only were the by-catch yields larger but also the variability in by-catch composition was greater than during the cooler months. The diversity of finfish recovered in shrimp trawls depends both on the variety of species available and on the low selectivity of the trawling equipment. Despite the diversity, eight genera accounted for 65-70% of all fish recovered in by-catch samples: Citharichthys (flatfishes), Diplectrum (cabai-cuchos), Orthopristis (grunts), Scorpaena (scorpion fish), Synodus (lizard fish), Eucinos-tomus (mojarras), Porichthys (midshipmen), and Pseudopenaeus (goat fish).

These are all small, lean demersal fish. Oily, pelagic fish are sometimes trapped in the trawl net as it is raised to the water's surface, and a few pelagic species, such as Pacific mackerel (Scomber japonicus), Pacific sardine (Sardinops sagax caerulea), and anchovy (Anchoa sp.) were observed in our study, although their frequency was relatively low.

Mean weights and mean lengths of by-catch fish varied from 7 g to 490 g and 6 cm to 65 cm respectively. However, more than 90% of the fish weighed less than 50 g and measured less than 20 cm. These data demonstrate that the majority of the fish in the trawls from the Gulf of California are well below the size normally considered suitable for food-grade fish. The few commercially valuable fish that were observed during the study were selected on board by the shrimpers for sale when the boat returned to shore. Observations made so far suggest that the percentage of commercial-grade fish in the by-catch from the Gulf of California is only about 2-5.

Fortunately, these studies have indicated that the resource predominantly comprises species that are acceptable for human consumption. Nevertheless, the bullseye puffer (Sphoeroides annulatus) was observed regularly during the study, and this species contains a potent neurotoxin, tetrodotoxin, in its liver and viscera. Recent studies in Mexico have confirmed the extreme toxicity of this puffer species (R.F. Crampton, unpublished data). Poisoning may be avoided by careful gutting of the fish, but such species must be separated from material to be used in human food. Puffer fish can be easily recognized and eliminated on board or during examination of the by-catch on shore.

Conclusions

The potential by-catch in the region is $1.6 \times 10^5$ t/year, the finfish portion being about $1.10-1.25 \times 10^5$ t/year. The variation in yield caused by changing water temperatures underlines the difficulty in extrapolating results to other regions.

Despite the fact that the by-catch comprises a complex mixture of marine organisms, the predominance of fish species from eight genera, which have flesh of similar chemical composition has been demonstrated. If the species varied greatly, it would be difficult to standardize products.

An important finding from the study is that Gulf of California by-catch consists of small fish. The incidence of fish of commercial type and size appears to be minimal, such that by-catch use in the region means more than just promoting increased recovery and sale of whole or filleted fresh fish. In this case, non-traditional techniques are required to convert by-catch fish into acceptable forms for human consumption.
These studies provide biological data that can serve as a basis for industrial processing. We are indebted to the fishing cooperatives and shrimpers of Guaymas without whose cooperation this study would not have been possible. We also much appreciate the assistance of CECITEM of the Secretaría de Educación Pública (SEP) for providing the use of the shrimping vessels Marsep IV and Marsep V for the sampling voyages in this study.