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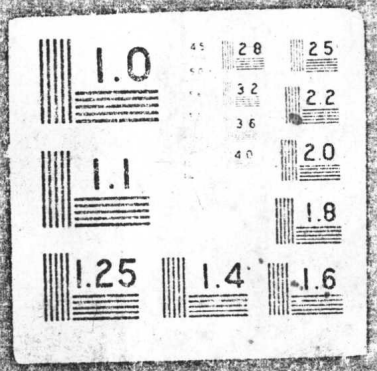

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A SYSTEMS ANALYSIS OF SPECIFIED TRAWLER OPERATIONS: VOLUME I--EXECUTIVE SUMMARY

Marine Technology, Inc., Division of Litton Industries

July 1968

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A SYSTEMS ANALYSIS OF SPECIFIED TRAWLER OPERATIONS:

VOLUME 1--EXECUTIVE SUMMARY

Marine Technology, Inc.
Division of Litton Industries

July 1968

Prepared for the National Council on
Marine Resources and Engineering Development
Executive Office of the President

This study was financed by a contract with the National Council on Marine Resources and Engineering Development, Executive Office of the President. However, the findings, recommendations, and opinion in the report are those of the contractor and not necessarily those of the Council, nor do they imply any future Council study, recommendations, or position. It is hoped that this study will contribute to the full discussion of problem areas and issues in marine science affairs.

FOREWORD

The research described in this report was performed for the Marine Sciences Council, Executive Office of the President, by Marine Technology, Inc., a division of Litton Industries, and is submitted in fulfillment of Contract No. MSC-67-021.

This volume, Volume I, has been prepared as a brief summary of the overall study. Volume II contains detailed technical discussions of all aspects of the study, the Integrated Systems Program description, operating write-up, detailed flow charts, and FORTRAN listings.

The study was undertaken by a combination of two Litton divisions: prime responsibility residing with Marine Technology, Inc., with Mellonics Systems Development as main subcontractor. This arrangement is very typical of the kinds of successful arrangements that has been made in the past, when the technical expertise of several of the Litton divisions have been pulled together to provide the customer with the best available talent to be brought to bear on a particular customer's needs.

The following individuals contributed directly to the research and preparation of Volumes I and II.

Project Director –	
W. F. Connell	Marine Technology, Inc.
Principal Investigator –	
R. B. McClellan	Marine Technology, Inc.
Biological Consultant –	
S. B. Saila	University of Rhode Island
Senior Operations Research Specialist –	
P. V. Apkenas	Mellonics Systems Development
Senior Economics Advisor –	
R. S. Lawson	Marine Technology, Inc.
Senior Financial Advisor –	
C. A. Harris, Jr.	Marine Technology, Inc.
Senior Economic Specialist –	
T. O. Ozenne	Mellonics Systems Development
Senior Programmer –	
J. P. Gleiter	Mellonics Systems Development
Programmer –	
H. M. Hoffman	Mellonics Systems Development

William F. Connell
President
Marine Technology, Inc.

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A. Marine Sciences Council

Mr. H. A. Arnold
Administrative Officer

Mr. E. L. Dillon
Contracting Officer

Dr. N. J. Wilimovsky
Marine Biologist

B. Bureau of Commercial Fisheries, U. S. Department of the Interior

Mr. J. T. Gharrett
Regional Director, Region 3

Dr. H. W. Graham
Laboratory Director
Woods Hole Biological Laboratory

Dr. R. C. Hennemuth
Fishery Biologist, Research
Woods Hole Biological Laboratory

Mr. J. A. Holston and Staff
Laboratory Director
Technological Laboratory

Mr. K. A. Smith
Base Director
Exploratory Fishing and Gear Research Base

Mr. L. Van Mier
Assistant Director for Economics

Dr. V. J. Norton and Staff
Chief, Branch of Economic Research

Mr. J. J. O'Brien and Staff
Program Coordinator, Market News

C. Other Government Agencies

Dr. F. W. Bell
Regional Economist
Federal Reserve Bank of Boston

D. Educational Institutions

Dr. H. C. Lampe
Associate Professor
Department of Food and Resource Economics
College of Agriculture
University of Rhode Island

Mr. J. F. Farrell
Instructor
Department of Food and Resource Economics
College of Agriculture
University of Rhode Island

E. Fishing Operators

Mr. Thomas Fulham
President
Boston Fish Market Corporation
Boston, Massachusetts

Mr. Barnie Finn
Executive Vice President
O'Donnell-Usen Fisheries Corporation
Boston, Massachusetts

Mr. Richard S. Usen
Vice President, Engineering
O'Donnell-Usen Fisheries Corporation

F. Others

Mr. William Franks
Underwriter, P & I Insurance
American Universal Insurance Company
Boston, Massachusetts

Mr. Ernest D. Smith
Superintendent, Ocean Marine Department
The Hartford Insurance Group
Boston, Massachusetts

VOLUME I
EXECUTIVE SUMMARY

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Section I
INTRODUCTION

The United States traditionally has been one of the world's major producers of fishery products. Before World War II and until 1959, the United States ranked second only to Japan in size of catch. Then, the United States dropped to third place, behind the expanding fisheries of Communist China. In 1960, Peru and the Soviet Union surged ahead, and the United States dropped to fifth place among the fishing nations of the world. This trend has continued – in 1966, the United States was relegated to sixth place by Norway.

This nation, with coastal waters among the richest in the world, has not kept pace or shared equitably in the doubling of the world's seafood harvest in the past decade. Domestic demand for fishery products has reached a point where the value of imports now exceeds that of domestic production. Since 1957, imported fish products have added more than $2.5 billion to the nation's balance-of-payment deficit.

The Georges Bank haddock fishery off the coast of Massachusetts presents a typical example of the state of this nation's fishing industry and was used as the principal source of data for this study. Georges Bank is considered to be one of the richest fisheries in the world. Until 1961, this was virtually a U. S. preserve. Canada took a few haddock and sea scallops. Since 1960, Canada – and, more particularly, the rapidly-expanding and technologically-advanced fishing fleet of the U. S. S. R. – have increased their catches from this area until, in 1966, the U. S. catch was reduced to only 32 percent of the total.

The economic, political, and social implications of this situation to our nation, ranging from such immediate, practical problems as the economic health of a billion-dollar American industry and a steadily-worsening balance-of-payments deficit, to the longer-range problem of our continuing leadership around the world, demand increased efforts aimed at upgrading America's fishery technology.

In recognition of this need, the Marine Sciences Council has initiated this investigation of the applicability of Systems Analysis techniques to marine resources planning and development. These techniques have been demonstrated successfully in many government departments as well as in numerous American enterprises. The study has been conducted by Marine Technology, Inc., a Division of Litton Industries, with the cooperation of the Marine Sciences Council and the Bureau of Commercial Fisheries, U. S. Department of the Interior.

The research results provide a systematic basis for the analysis and evaluation of methods of revitalizing an industry which, unfortunately, has been declining in the United States for many years. In addition, this research should serve to motivate individuals in both the private and public sectors of the economy to investigate the applicability of other advanced technological tools to the more effective utilization of marine resources.

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Section II
RESEARCH OBJECTIVES

The overall objective of this research has been to develop a generalized approach to dealing with the problems of the fishing industry through identification of the various factors which bear upon the success or failure of a given fishing system. The methodology employed has been that of Systems Analysis, of which a basic ingredient is the creation of a mathematical model of the system to be studied and the manipulation of the model in an effort to optimize one or more of the systems' elements in terms of certain specified conditions.

Our objective has been to perform this Systems Analysis via construction and testing of a generalized fishing systems model, using a data base derived from Boston otter trawl operations on the Georges Bank haddock fishery. A fishing system, as used in this study, is defined as a collection of equipment that is employed for the purpose of commercial fishing. At minimum, a fishing system would consist of a fishing platform, propulsion machinery, and fish capture and handling gear. A fishing system can also be a group of small subsystems; thus a fleet of trawlers such as those operating out of Boston can be considered to be a fishing system.

The general orientation of the model is economic/financial, although engineering and fishing technology have been used where appropriate. Manipulation of the model has permitted the analysis of hypothetical alternative fishing systems, including analysis of effects of variables such as fishing methods, biological environment, market, and other economic factors. The model is applicable to both public and private marine resources utilization planning. It can also be applied to fisheries other than haddock (e.g., tuna, salmon, shrimp, etc.) when appropriate biological, economic, and fishing systems data are available.

Section III
SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS:

The following is a summary of the general conclusions of Section VIII of this volume.

Based on the results achieved by using mathematical models to analyze fishing systems in this study, it is concluded that the Systems Analysis methodologies, which have proven so valuable in other industries, are applicable to the planning and utilization of marine resources.

The efforts expended in this study have resulted in the establishment of a method whereby one can identify the optimum fishing system for use by Boston-based trawlers engaged in exploiting the Georges Bank haddock fishery. The model developed can be applied in evaluating the operations of single-boat systems as well as multi-boat systems. Time and budget limitations of the study, however, did not permit analyzing all of the fishing systems which could be used in exploiting this haddock fishery. In most cases, systems outside of those we have considered would require engineering data and fishing methodologies that fall far outside the scope of this study. Therefore, the optimum system as identified in this study is only optimum in terms of those systems which have been considered here.

The mathematical models which have been constructed for biological and economic data and for each fishing system are extremely flexible. The assumptions made for each fishing system were enumerated in previous sections for each of the mathematical models used. We feel that the assumptions made in each case will stand the test of plausibility, but we are fully cognizant of the latitude that certain variables could have within the limits of plausibility. Therefore, each return must be looked at and analyzed strictly on the basis of the assumptions made, i.e., the input data that was prepared for each fishing system. Those whose opinions may differ from assumptions we have made will find it easy to modify the input data by making new assumptions which can then be tested using the same model structure as provided by this study.

As outlined in previous sections of this report, we have compared in Phase I the average trawler which now operates out of Boston to a 425-GRT stern trawler and to a 1,435-GRT factory trawler. In Phase II, the multi-boat systems, we have compared the existing trawlers to a group of similar trawlers working in a financial cooperative, and to a group of four standard Boston haddock trawlers operating with a transport boat. For each system an analysis of return on investment was made over a five-year period. As stated in the section on sensitivity analysis, three of the most sensitive variables are the standard fisning day coefficient, a measure of boat efficiency; secondly, the number of days a system is employed fishing in the course of a year; and thirdly, the level of total U. S. fishing effort for the year in the haddock fishery. The returns computed for each system covered three different values for each of these three sensitive variables.

In addition to computing return on investment, we also computed the landed cost of fish under each system, using the fifth year landings and costs. The landed cost per pound is not a true measure of optimality unless considered in relation to the revenues received per pound in each system. Return on investment, ROI, however, measures the relative profit of each system in terms of the level of capital

investment and the working capital required to make the system operable. Therefore, we regard ROI to be the best measure of optimality.

From an analysis of the ROI's calculated for each system (the detailed data is presented in Section VIII of this volume), it is concluded that the optimum system is that which includes four of the standard Boston haddock side trawlers working with a 335-GRT transport boat in a financial cooperative. Of the three single-boat systems studied, it was found that the standard Boston haddock side trawler was by far the optimum system.

B. RECOMMENDATIONS:

The following is a summary of the general recommendations of Section IX of this volume.

During the course of our study, we contacted several organizations and individuals. We found them all to be cooperative, understanding, and willing to provide the data we required if it was available. Our rapport with the Marine Sciences Council and the Bureau of Commercial Fisheries has been excellent, and their cooperation is greatly appreciated.

We did, however, find during our discussions with Bureau of Commercial Fisheries personnel that an integrated, bureau-wide program directed at the revitalization of the Boston haddock fishing industry is badly needed. The program should be one which brings together the Bureau's many talents in biology, economics, operations, etc., and one which culminates in a unified attempt at not only solving the problems, but also identifying new opportunities for the people whose jobs depend on this industry.

Because of the multi-disciplinary nature of this study and the resultant Integrated Systems Program, it is recommended that the Marine Sciences Council suggest that the Bureau of Commercial Fisheries establish a staff consisting of the following membership:

A Biologist
An Economist
A Fishing Systems Designer
A Fishing Systems Operator Representative
A Computer Programmer Analyst

This staff should have the following assignment:

Become familiar with the operational specifics of the Integrated Systems Program.

Structure a plan of action for investigating fishing systems, related design problems, biological and market policies, strategies, and operational methodologies. In short, search for and select those problem areas and opportunity areas related to the New England fishery that are tractable in terms of present knowledge and that have a high likelihood of being implemented, and that will directly benefit both labor and management.

Act as a steering group in the evaluation of proposed fishing systems studies such as the Region 3 "Three-Year Trawl Fishery Improvement Program."

Provide analytical support to the Bureau of Commercial Fisheries during the preparation of the annual program planning budgeting system, PPBS, preparation.

Extend or manage the extension of the work already done in this study into other fisheries and fish products.

Continue or manage the continuance of the development of the Systems Analysis approach to marine resource utilization planning and management through a systematic plan of investigating current and future Operations Research techniques and applications.

During the design of the Phase I and Phase II trade-off studies, we had difficulty in establishing reasonable values for some of the input variables. Dr. F. W. Bell's work, Reference 3, gave us our best yardstick for plausible values for ROI, return on investment. However, Dr. Bell's works did not include all of the systems enumerated in our Phase I and Phase II trade-off studies, and thus could not provide us with complete, basic guideline data.

As a consequence of this situation, we wish to recommend that cost and earnings data be collected on an annual basis and presented in a format similar to that used by the Department of Fisheries of Canada in their annual publication, Cost and Earnings of Selected Fishing Enterprises, Atlantic Provinces.

We recognize that this data would be difficult to collect and difficult to present without divulging proprietary information.

Possibly some form of sampling would be appropriate with a ratio analysis approach as a presentation format. This type of data should be collected for all major U. S. fisheries, such as shrimp, haddock, cod, tuna, and salmon. With data of this type, the marine resource utilization planner would be aware of the historical financial structure of specific fishing industries as well as their current financial performance, both of which would be most valuable for public policy planning.

Recent discussions with the BCF indicate that substantial data of this type has been accumulated on the shrimp fishing industry, most of whose boats are registered as corporations.

Tht Integrated Systems Program has proven, to the study group's satisfaction, that it is a powerful and accurate tool for the purpose for which it was designed. The trade-off studies that have been done to date have been directed by a better understanding of the problems confronting the operators of the Boston haddock side trawler fleet working primarily out of Boston, Massachusetts. The haddock catch comprised some 3 percent of the total value of the U. S. catch, $11.8 million in 1964.

The 1964 statistics on other major U. S. fisheries was as follows:

Specie	% of U. S. 1964 Catch	1964 Dollar Value in Millions of Dollars
Shrimp	18.1	70.4
Salmon	14.1	56.0
Tuna	10.1	39.4

Dr. Saul Saila, Marine Technology's consulting biologist, is of the opinion that available biological data for the shrimp and skipjack tuna fisheries could be used with minor modification to the biological and landings sub-model of the Integrated Systems Program. The nature of the life cycle of the salmon is such that the biological and landings sub-model would have to be extensively redesigned prior to any Systems Analysis studies on this fishery being undertaken. Dr. Virgil Norton of the BCF has informed

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