An Annotated Bibliography For Economic Evaluations Of The Aquaculture Of Selected Crustaceans And Mollusks

by

Warren E. Johnston and Don W. Collinsworth

University of California

University of California
Institute of Marine Resources
P.O. Box 7529
La Jolla, California 92037

UC-IMR Reference No. 74-3
Sea Grant Publication No. 2

AN ANNOTATED BIBLIOGRAPHY FOR ECONOMIC EVALUATIONS OF THE AQUACULTURE OF SELECTED CRUSTACEANS AND MOLLUSKS

by

Warren E. Johnston

and

Don W. Collinsworth

This work is a result of research sponsored by NOAA Office of Sea Grant, Department of Commerce, under Grant # 04-3-158-22. The U.S. Government is authorized to produce and distribute reprints for governmental purposes, notwithstanding any copyright notation that may appear hereon.

August 1973

Available from:
University of California
Institute of Marine Resources
P.O. Box 1529
La Jolla, California 92037

UC-IMR Reference No. 74-3
Sea Grant Publication No. 2

An Annotated Bibliography for Economic Evaluation of the Aquaculture of Selected Crustaceans and Mollusks

by

Warren E. Johnston and Don W. Collinsworth*

PREFACE

This report represents a selective, working bibliography of sources of economic data and of previous economic analyses relating to the aquaculture of selected crustaceans and mollusks. It is primarily focused on the Northen lobster, but it also contains selected references for the spiny lobster, and certain species of crabs, oysters, shrimp and prawns. We circulate this report at this time because of the keen interest in aquaculture and our feeling that it may be useful to those with similar interest within Sea Grant institutions, in public agencies, and in the private sector.

This bibliography was prepared in the first year of the University of California's Sea Grant project, "Economics of Aquaculture" and is therefore preliminary, selective, and highly ameniable to continued augmentation in the next days and years. Indeed, we would be most grateful for additional references from readers of this report which we will add to our working bibliography. (Please send to: W. E. Johnston, Department of Agricultural Economics, University of California, Davis, California 95616).

We wish to express particular appreciation for the assistance of Miss Pat Powell, Librarian, of the California Department of Fish and Game's Marine Resources Information Center, Long Beach; to Mr. Clemens Bribitzer, Regional Economist, NMFS, Terminal Island; and to Mr. Bayford Butler who assisted in the early preparation of this working bibliography.

---

*W. E. Johnston is Associate Professor of Agricultural Economics and Associate Agricultural Economist in the Experiment Station and on the Giannini Foundation. D. W. Collinsworth is Sea Grant trainee. Both are in the Department of Agricultural Economics, University of California, Davis, California 95616.

An Annotated Bibliography for Economic Evaluation of the Aquaculture of Selected Crustaceans and Mollusks

Table of Contents

SECTION 1: BIBLIOGRAPHIES

1.1: General Aquaculture

1. George Washington University Biological Science Communication Project, Bibliography of Aquaculture, Wilmington: Coastal Plains Center for Marine Development, Publication 71-4, 1971.

   A bibliography on the culture of marine and freshwater fishes, marine and freshwater crustaceans and molluscs. It is divided into the following sections: 1. General, 2. Biological Factors, 3. Detrimental Factors, and 4. Technical Factors.

2. Magnolia, L. R., Aquaculture: An Introductory Bibliography, Redondo Beach: TWR Systems Group Special Literature Survey No. 58 016.5 U.S., second edition, July 1972.

   Presents a collection of 244 references on aquaculture. The majority were published between 1965 and March 1972.

1.2: Specific Species

Lobsters:

3. Dawson, C. E., Bibliography of the Lobster and Spiny Lobster, State of Florida, Board of Conservation, 1954.

4. Lewis, R. D., A Bibliography of the Lobster, Genus Homarus, U.S. Fish and Wildlife Service, Special Scientific Report - Fisheries No. 591, 1970.

5. Scattergood, Leslie W., A Bibliography of Lobster Culture, U.S. Department of Interior, Fish and Wildlife Service Special Report No. 64, 25 pp., 1949.

6. Sims, Harold W., Jr., An Annotated Bibliography of the Spiny Lobster, State of Florida, Board of Conservation Technical Series No. 48, June 1966.

Crabs:

7. Butler, T. H., A Bibliography of the Dungeness Crab, "Cancer Magister" Dana Ottawa: Fisheries Research Board of Canada, Technical Report No. 1, 1967.

8. Tagatz, Marlin E. and Ann Bowman Hall, Annotated Bibliography on the Fishing Industry and the Blue Crab, U.S. Department of Commerce, National Marine Fisheries Service, NOAA Technical Report NMFS SSRF - 640, August 1971.

Shrimp:

9. Scrievenen, J. C. and T. H. Butler, A Bibliography of Shrimp of the Family Pandalide, Emphasizing Economically Important Species of the Genus Pandalus, Ottawa: Fisheries Research Board of Canada, Technical Report No. 241, 1971.

1.2: Specific Species (Continued)

Other:

10. United Nations, A bibliography of Brackish-Water Fish Culture, Rome: Food and Agriculture Organization, Fisheries Circular No. 21, September 1965.

Bibliography includes known references on the culture of fish, prawns and shrimp.

SECTION 2: ABSTRACTS/INDEXES

11. Pollution Abstracts Inc., Oceanic Abstracts (Formally; Oceanic Index), La Jolla: Oceanic Library and Information Center, Published Bi-monthly.

    Covers the entire spectrum of oceanic research. Includes sections dealing with marine and aquaculture economics.

12. United Nations, FAO Department of Fisheries List of Publications and Documents 1948-1969, Rome: Food and Agriculture Organization, Fisheries Circular No. 100 (Rev. 1), 1969.

    Lists all FAO fishery publications and main documents, as well as some working papers. It is updated to December 1, 1969. The revised circular is complementary to the FAO Documentation Centre's "Index of Fisheries Publications, 1948-66", and the associated semi-annual and monthly current indexes.

13. United Nations, World List of Periodicals for Aquatic Sciences and Fisheries, Rome: Food and Agriculture Organization, Fishery Resources and Exploitation Division, Fisheries Technical Paper 19.1, Vol. 1, 1962, 266 pp., Supplement 1, 1963, 56 pp., Supplement 2, 1964, 32 pp., Supplement 3, 1966, 44 pp.

    Lists periodicals (including serials, monographs series, and series of meetings documents) whose contents are relevant, completely or partially to aquatic sciences and fisheries. References from these periodicals have been entered in the "Current Bibliography for Aquatic Sciences and Fisheries." The World List includes all periodicals known to FAO which are searched for "World Fisheries Abstracts" as well as other abstracting journals in these fields. It supersedes the "World List of Periodicals for Fisheries Science."

14. U.S. Department of Commerce, Commercial Fisheries Abstracts, Washington: National Marine Fisheries Service, (G.P.O.), published monthly since 1948.

    Contains summaries of selected articles from trade, engineering, and scientific journals dealing with the entire spectrum of fishery science.

15. U.S. Department of Commerce, Sea Grant News Letter Index, 1968-1971, U.S. Environmental Science Information Center, NOAA Technical Memorandum EDS-ESIC-6, September 1972.

    Lists all Sea Grant Newsletters from 1968-71.

16. U.S. Department of Commerce, Sea Grant Publication Index, 1968-1971, U.S. Environmental Sciences Information, NOAA Technical Memorandum EDS-ESIC-4, September 1972.

    Lists all Sea Grant Publications.

SECTION 3: STATISTICAL SOURCES

3.1: FAO

17. United Nations, FAO Yearbook of Fishery Statistics, Rome: Food and Agriculture Organization, Fisheries Division Publication, (annual).

    First published in 1947, and then annually thereafter. The 1947 publication covered years 1930-1946. Contains statistics on catch and landings, utilization, production of preserved and processed commodities, and fishing craft, as well as available figures on imports and exports of fishery products. Since the 1952-53 edition, the Yearbook has been published in two volumes, Part I containing production data, and Part II dealing with trade.

3.2: United States Government

18. U.S. Department of Commerce, Chart Book of U.S. Fishery Supplies, 1960-70, Current Fishery Statistics (CFS), National Marine Fisheries Service.

    U.S. landings and imports of: lobsters, shrimp, crab, clams, and oysters for a 10 year period 1960-1970.

19. U.S. Department of Commerce, Fisheries of the United States, Current Fishery Statistics (CFS), National Marine Fisheries Service, (Published annually), (prior to 1961 published in Fish Leaflet Series (393).

    Annual summary of U.S. catch, import-export, employment, consumption, value, price, and utilization data.

20. U.S. Department of Commerce, Fishery Statistics of the United States, Statistical Digest, National Marine Fisheries Service, (Published annually 1939-1968).

    This report contains a review of the fishery statistics for each year. Data is collected by Division of Statistics and Market News. These statistics include data on the volume and value of the landings of fishery products, employment in fisheries, quantity of gear operated, number of fishing craft employed, on the volume and value of the production of processed fishery products, cold storage freezings and holdings, and on foreign trade in fishery products.

21. U.S. Department of Commerce, Frozen Fishery Products, Current Fishery Statistics (CFS), National Marine Fishery Service, (since 1944 published monthly with annual review).

    Freezings and holdings of fish and shellfish, including lobsters, crabs, oysters, and shrimp.

3.2: United States Government (Continued)

22. U.S. Department of Commerce, Shellfish, Situation and Outlook, Current Economic Analysis (CEA), National Marine Fisheries Service, (Published monthly with annual review), (under present title since 1966).

    Economic statistics and outlook for the following species of shellfish: shrimp, scallops, Northern lobster, spiny lobster (tails), and West Coast crabs.

23. U.S. Department of Interior, Historical Statistics: Frozen Fishery Trade, Fish and Wildlife Service, Bureau of Commercial Fisheries.

    Includes holdings of frozen lobster tail from 1938 to date by month.

24. U.S. Department of Interior, Historical Statistics: Prices Received by Fisherman, Fish and Wildlife Service, Bureau of Commercial Fisheries.

    Includes ex-vessel prices of Northern lobsters from 1939 to date, by month.

25. U.S. Tariff Commission, Summaries of Trade and Tariff Information, Vol. 3, Fish Products, Shellfish and Shellfish Products, Washington, D.C., U.S. Tariff Commission Publication No. 283, 1969, 173 pp., appendices.

    Contains rates of customs duty on imported shellfish and crustacean species. Also statistics on 1963-1967 U.S. exports, U.S. imports, and world trade in shellfish, primarily taken from U.S. Department of Commerce or Bureau of Commercial Fisheries information.

3.3: State Agencies

26. California Department of Fish and Game, California Marine Fish Catch, Fish Bulletin (Series ranging from 1929 to date).

    Gives landing and shipment data for commercial and sports fisheries in California by area (6 divisions). Other data, such as the value of landings, number of fishermen and number of registered fishing boats, are given. (For example, the 1967 report (Bulletin No. 144) gave annual landings and catch data for years 1916-1967.

27. California Department of Fish and Game, California Ocean Shrimp Report, Marine Resources Region, 1957-1971 Seasons, 1972.

    A collection of 15 seasons' reports on the California ocean shrimp catch by permit area.

3.3: State Agencies (Continued)

28. Maine Department of Sea and Shore Fisheries, Yearly Report of Fish Brought Into Maine Ports, (Published annually).

Maine ex-vessel prices for lobster by month.

3.4: Other

29. Scattergood, Leslie W. and D. Arthur McKorun, "United States Lobster and Spiny Lobster Production (1921-49) and Imports (1920-1949)," Commercial Fisheries Review, 13 (12), 1951, pp. 1-11.

Data included in this report encompasses: 1. Domestic lobster production (Homarus americanus), 2. Lobster imports from Canada and Newfoundland, 3. Domestic production of spiny lobster, 4. Spiny lobster imports, 5. The economic effects of imports, and 6. Outlook. Data is for years 1921-1949 for production and 1920-1949 for imports.

SECTION 4: AQUACULTURE

4.1: General/Descriptive

30. Bardach, John E., et al., Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms, New York: Wiley-Interscience, a division of John Wiley and Sons Inc., 1972.

    An 868 page volume which provides a world-wide, species by species illustrated description of all aquatic plants and animals that are cultivated for food. Methods of cultivation are described. The authors include biological and ecological considerations of the organisms, the current and projected state-of-the-art of their cultivation and yields, diseases, and other problems. General principles and economics are dealt with in the first chapter.

31. Brett, J. R., et al., A Brief on Mariculture, Ottawa: Fisheries Research Board of Canada, Technical Report No. 301, 1972.

    This is a collection of research papers dealing with the marine aquaculture of fish and invertebrates, its present status and potential.

    One paper deals specifically with the culturing of lobsters (Homarus americanus), summarizing findings in this way: "Some preliminary answers to questions bearing on decisions to engage in a study of lobster culture are available. Lobsters can be mated, hatched, and reared in captivity. However, their rate of growth is slow, and mortality on a mass culture basis is high. There is evidence indicating that both can be improved by manipulation of the animal and the environment but there are some important economic factors to be considered: 1. Cost of production (cost estimates are given in the body of the paper) using present methods is much too high. Better engineering, biological and environmental optimizing are realistic objectives, 2. Selling price is about $0.50/lb. to the East Coast fisherman and around $1.00 to $1.50/lb. to West Coast wholesale distributor, 3. Demand will probably exceed supply by 20 million pounds per year or more over the next decade." Included in the report (p. 43) is a partial listing of major companies and consultants actively engaged in mariculture programs (exclusive of oyster growers).

32. Cole, H. A., "The Scientific Cultivation of Sea Fish and Shell Fish," Fish News International, 7 (6), (1968), pp. 20-28.

    A survey (nontechnical) of shellfish cultivation in England and Wales as it stood in 1968.

4.1: General/Descriptive (Continued)

33. Davidson, Jack R., "Economics of Aquaculture Development," Proceedings: Fourth National Sea Grant Conference, Madison, Wisconsin, University of Wisconsin, Sea Grant Publication WIS-SG-112, October 12-13, 1971, pp. 75-82.

    Discusses economic studies needed as aquaculture develops especially emphasizing the importance of the development of good economic data from the beginning of an aquaculture project.

34. Davis, H. C., "Shellfish Hatcheries - Past and Future," Trans-American Fish Society, (4), (1969), pp. 743-50.

    The history of the development of shellfish hatcheries. Studies of the salinity, temperature, PH tolerances, and food requirements for clam and oyster larvae are cited to show the factors that govern the location and operation of successful shellfish hatcheries.

35. Ebert, Earl E., Mariculture in California, Marine Resources Technical Report No. 18, California Department of Fish and Game, 1973.

    Covers the past (historical review), present (gives a complete listing of private maricultural enterprises in California), and future (current research and development) of mariculture in California.

36. Fisheries Research Board of Canada, Annual Report, Ottawa: Fisheries Research Board of Canada, (Annually 1939-1973).

    Lists the highlights of current research, by region, under three main categories:

    1. Commercial and recreational fisheries
    2. Environmental research
    3. Products and processing research

    Prior to 1965, each annual report has a listing of FRB publications and reports, plus a bibliography with numerous references.

37. Gaucher, Thomas A. (Editor), Aquaculture: A New England Perspective, Narragansett, Rhode Island: New England Marine Resources Information Program, 1971, 119 pp.

    A report based on recommendations and key documents from a 1970 conference conducted by the Research Institute of the Gulf of Maine to plan for aquaculture in Northern New England. State-of-the-art of cultivation, favorable and unfavorable characteristics for commercial culture, and consumption estimates to the year 2,000 are given for molluscs, crustacea and selected finfish. Legal aspects are also discussed. Excellent appendix of references.

4.1: General/Descriptive (Continued)

38. Iverson, E. S., Farming the Edge of the Sea, London: Fishing News (Books) Ltd., 1968.

    A non-technical survey to inform persons interested in sea farming of the present status of the practice. The book describes many of the farmed species and gives a brief look at the biology of each species considered. It describes the farming procedures used, emphasizes the problems encountered and discusses the future and possibilities of farming other species not presently being farmed.

39. Jones, Walter, "Commercial Fish Farming: How to Get Started," The American Fish Farmer, Little Rock, Arkansas: Vol. II No. 2, January 1970, (also in December 1972).

    Convenient checklist of economic, management, marketing, production and physical factors which are important to the commercial success of an aquacultural enterprise.

40. Landis, Robert C., A Technology Assessment Methodology Mariculture (Sea Farming), MTR 6009, Vol. 5, PB202778-05, Washington: the Mitre Corporation, June 1971.

    A general technology assessment methodology is used to determine the impacts of mariculture on developing countries. The technology is confined to applications in coastal and brackish waters. A quantitative impact analysis of economic options are offered and a revised forecast is given for increased impact on the malnutrition problem. The constraints on accelerated mariculture development are analyzed, and a forecast of 20 million tons of mariculture production in 1985 is made. A subjective probability analysis of which countries will apply mariculture is also developed.

41. McNeil, William J., Marine Aquaculture, Selected Papers, Conference on Marine Aquiculture OSU Marine Service Center, 1968, Corvallis: Oregon State University Press, 1970.

    The primary emphasis of this series of papers is biological. The one economic paper deals with common property problems. (See Scott, Anthony citation next page).

42. Moore, Remedios W. (Editor), Progress in Fishery and Food Science, University of Washington, Fiftieth Anniversary Symposium, University of Washington Publication in Fisheries, New Series, Vol. 5, 1972.

    Contains a section on "Priorities in Aquacultural Science," (includes a bibliography).

4.1: General/Descriptive (Continued)

43. O'Farrell, R. C., Lobsters, Crabs, and Crawfish, London: Fishing News (Books) Ltd., 1966.

    A general survey of lobster, crabs, and crawfish. It deals with the fishery, biology, history, culture, etc. of each species.

44. Prudden, T. M., About Lobsters, Freeport, Maine: The Bond Wheelwright Co., 1967.

    An interesting general survey of lobster fishing, regulation, biology, history, culture, etc.

45. Ryther, John H. and John Bardach, The Status and Potential of Aquaculture Particularly Invertebrate and Algae Culture, Vol. I, Part I, "The Status and Potential of Aquaculture"; Part II, "Invertebrate and Algae Culture," PB 1777 767, U.S. Department of Commerce, National Technical Information Service, May 1968.

    The report deals with the status of aquaculture in today's world with remarks on its potential contribution to the war on hunger. Aquaculture may not only be greatly expanded, but its yields will be increased appreciably by use of modern science and technology.

46. Scott, Anthony, "Economic Obstacles to Marine Development," Marine Aquiculture, William J. Mc Neil (Editor), Corvallis, Oregon: Oregon University Press, 1970, pp. 153-167.

    Discusses three chief impediments to the economic development of marine aquaculture: 1. Absence of strong demand for high cost aquaculture products except for luxuries, 2. Absence of property or sovereignty institutions in national waters, 3. Absence of property or sovereignty or sovereignty institutions in international waters.

47. Shapiro, Sidney, (Editor), Our Changing Fisheries, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, (U.S. Government Printing Office), 1971.

    Non-technical survey of U.S. fisheries, including a section on fish and shellfish cultivation.

48. United Nations, Directory of Fish Culture Research Institutions, Rome: Food and Agriculture Organization, Fisheries Technical Paper No. 85, (Rev. 1), 119 pp., 1971.

    A directory listing institutions (world-wide) that have continuing programs of research related to the culture of fish and other aquatic organisms. Includes a brief description of each research institution, such as; location, postal address, name and description of officer in charge, number of scientists employed, physical facilities, current research programs, and publications.

4.1: General/Descriptive (Continued)

49. United Nations, FAO Aquaculture Bulletin, Rome: Food and Agriculture Organization, Department of Fisheries, Fisher Resource Division, (Published quarterly).

    A quarterly news digest of aquaculture research and development. It is largely prepared on the basis of contributions from correspondents and research and development agencies. Each issue carries a section on recent publications; each entry is annotated. (Previously FAO Fisheries Bulletin), (Quarterly since January 1, 1954).

50. Webber, Harold H., "Mariculture," Bioscience, 18 (10), (1968), pp. 940-5.

    A non-technical essay which describes the potential of mariculture of molluscs, crustaceans, and finfish. The author reviews current major culture projects throughout the world.

51. Webber, Harold H., "The Design of an Aquacultural Enterprise," Proceedings of the Gulf and Caribbean Fisheries Institute Twenty-fourth Annual Session, Miami, Florida: University of Miami, School of Marine and Atmospheric Science, November 1971, pp. 117-125.

    Convenient checklist of ecological, economic, political, legal and social factors which are important in selecting a site for an aquaculture project.

52. Yee, W. C., "Thermal Aquaculture: Engineering and Economics," Environmental Science and Technology, 6 (3), (1972), pp. 232-7.

    The essay discusses the potential of warm water aquaculture, using thermal effluents from electric power stations. Some estimates of cost of production of such facilities are included, however, derivation of the estimates is not explicitly defined. The author deals principally with shrimp culture.

4.2: Specific Species

Lobsters:

53. Ghelardi, R. J. and C. T. Shoop, "Culturing Lobsters (Homarus americanus) in British Columbia," A Brief on Mariculture, J. R. Brett, J. R. Caloprice, R. J. Ghelardi, W. A. Kennedy, D. B. Quayle and C. T. Shoop, Nanaimo, British Columbia: Fisheries Research Board of Canada, Technical Report No. 301, 1972, pp. 33-42.

    Discusses experience in hatching and raising Homarus lobster at the Fatty Basin lobster hatchery in British Columbia. Temperature, growth, feed, habitat, survival and cost data are given.

4.2: Specific Species (Continued)

54. Hughes, John T. and George C. Matthiessen, Observations on the Biology of the American Lobster, (Homarus americanus), Boston, Massachusetts: Massachusetts Division of Marine Fisheries, Technical Series No. 2, 1967, 20 pp.

    Describes the hatching, rearing and breeding of Homarus lobster at Martha's Vineyard Island. All fry but those held for breeding purposes are released into the sea after their fourth molt. Survival rates to fourth molt (pg. 6) and a food conversion figure of 15 lbs. of food to produce 1 lb. of lobster (pg. 16) are noted. Shleser and Brown (University of California, Davis), in a forth-coming manuscript suggest that food conversion ratios from 8.5: 1 to 4:1 (on a food-fed basis) are more likely.

55. Kensler, Craig B., "The Potential of Lobster Culture," The American Fish Farmer, Vol. 1, No. 11, October 1970, pp. 8-12, 27.

    An interesting, non-technical, descriptive essay on the past, present, and future of lobster culture.

56. McLeese, D. W., Initial Experiments on Growth of the American Lobster in Captivity, Ottawa: Fisheries Research Board of Canada, Technical Report No. 320, 1972.

    A report on the Canadian experiments which were started in 1963 to study the growth of lobsters (Homarus americanus) weighing from 0.6 to 1.0 lbs. through at least one moult in captivity. Main factors investigated were temperature, feeding rate, diet, sex, and protection for individual lobsters. Their conclusion was that it is not economically feasible to grow spring-caught lobster of 0.6 to 1.0 lb. through a moult in captivity. For culture to be economically feasible, better methods are required to virtually eliminate mortality and mutilations, to produce maximum weight increments following a moult, to promote early moulting and to maintain maximum moulting frequency.

57. Mundey, G. R., "Highlands Lobster Farm in Operation," World Fishing, 18, No. 9, (September 1969), pp. 38-9.

    A non-technical descriptive essay (with photos) of the lobster production taking place at the underwater farm of Kenlachbervie Shellfish Company in Scotland.

Oysters:

58. Barret, E. M., The California Oyster Industry, Fish Bulletin No. 128, California Department of Fish and Game, 1963.

    A comprehensive status and historical report (1850-1963) on the California Oyster industry.

4.2: Specific Species (Continued)

Prawns:

59. Shang, Yung Cheng, Economic Feasibility of Fresh Water Prawn Farming in Hawaii, Honolulu, Hawaii: University of Hawaii, Economic Research Center, June 1972, 49 pp.

Evaluation of economic feasibility of Macrobrachium Rosenbergii production in Hawaii. Cost studies for the hatchery were done for two sources of water supply, three production levels and five discount rates. Capital and operating costs are calculated for 10, 50, 100 and 150 acre rearing facilities. Estimates of potential market demand and price are also made.

Shrimp:

60. Anderson, Lee G. and Durbin C. Tabb, "Some Economic Aspects of Pink Shrimp Farming in Florida", Gulf and Caribbean Fisheries Institute, Proceedings of the 23rd Annual Session, University of Miami, Coral Gables, Florida, June 1971, pp. 113-24.

Study estimates the internal rate of return for each of six types of operations of various land characteristics. Estimates were made for both food and bait markets for shrimp. Study concludes that currently food shrimp farming is not profitable at any level of operation at any land prices. Included is a section on the effects of shrimp farming on the price of shrimp, using demand elasticities for shrimp computed by Bureau of Commercial Fisheries in 1970.

61. Broom, Jerry G., "Shrimp Culture," Proceedings of the First Annual Workshop World Mariculture Society, James W. Avault, Jr., Edmond Boudreaux, Edmonde Jaspers (Editors), Baton Rouge, Louisiana: Division of Continuing Education, Louisiana State University, 1971, pp. 63-68.

Review of Penaeid shrimp culture including culturing practices, stocking sizes and rates, feeds and feed conversion ratios, growth rates, production, water quality, predators, mortality and harvesting.

62. Hull, E. W. Seabrook, (Editor), Ocean Science News, Vol. 13, No. 50, December 10, 1971.

An article on the shrimp harvest of Marifarms Inc., Panama City, Florida. Marifarms has invested 6 million dollars in 3100 acres of ponds. In the Fall of 1971, they had harvested 500,000 lbs. of shrimp. Has an interesting description of Marifarms operation.

4.2: Specific Species (Continued)

63. Sielken, R. L., et al., Extended Results on Optimal Investment Strategies in Shrimp Farming, TAMU-SG-72-211, Sea Grant Program, Texas A&M University, December 1972.

A method of obtaining optimal investment strategies for the shrimp fisherman is developed and illustrated. Basis for the method is a deterministic optimal control model of shrimp fishing firm. The method may be used to obtain guidelines for the shrimp industry in general or an individual firm. Computer costs to an individual seeking guidelines for his specific fishing environment and initial asset position should generally be less than $25 per year. Three numerical examples are discussed.

64. Subrahmanyam, C. B. and C. H. Oppenheimer, "The Influence of Feed Levels on the Growth of Grooved Penaeid Shrimp in Mariculture," Proceedings of the First Annual Workshop, World Mariculture Society, James W. Avault Jr., Edmond Boudreaux, Edmonde Jaspers (Editors), Baton Rouge, Louisiana: Division of Continuing Education, Louisiana State University, 1971, pp. 91-95.

Various sizes of grooved penaeid shrimp were fed 5 and 10 percent of their body weight. Discusses weight and length increases, mortality and conversion ratios. An economical, "best growth" feed level is discussed.

SECTION 5: NATURAL FISHERIES AND FISHERIES WITH POTENTIAL FOR AQUACULTURE

5.1: General/Descriptive

65. Bell, Fredrick W., et al., The Future of the World's Fishery Resource, Working paper No. 71-1, Washington, D.C.: National Marine Fisheries Service, Division of Economic Research, December 1970.

    Forecasts demand, supply, and prices, for selected fisheries, to the year 2000, with a discussion of implications for public policy. (Forecasts for lobster fisheries are included).

66. Bell, Fredrick W., et al., The Future of the World's Fishery Resource, Working Paper No. 71-7, Washington, D.C.: National Marine Fisheries Service, Division of Economic Research, December 1970.

    Appendix to "The Future of the World's Fishery Resource". Forecasts are made for demand, supply, and prices for selected fisheries to the year 2000.

67. Bell, Fredrick W. and J. E. Hazelton, Recent Developments and Research in Fisheries Economics, New York: Published for the New England Economic Research Foundation by Oceana Publications, Inc., 1967.

    A series of papers presented at a conference on fisheries economics in 1965, sponsored by the Federal Reserve Bank of Boston. The book is divided into three topical areas: 1. Demand for fish products, 2. Cost and yield of capital, and 3. Labor resources and industry problems.

68. Carrigan, Thomas D., An Economic Analysis of the Major Shellfisheries of the Chesapeake Bay, Working Paper No. 78, National Marine Fisheries Service, Division of Economic Research, February 1971.

    A doctoral dissertation prepared by Thomas Carrigan while at the Department of Agricultural Economics, University of Maryland. The paper covers the oyster, clam, and crab fisheries in the Chesapeake Bay. Simulation techniques are employed to evaluate the explanatory properties of the estimated systems and to project specie landings, employment, prices, and net incomes into the future.

69. Kenoshita, Richard K. and Fredrick W. Bell, Major Economic Trends in Selected U.S. Master Plan Fisheries: A Graphical Survey, Working Paper No. 37, Bureau of Commercial Fisheries, Division of Economic Research, December 1969.

    A graphical presentation of the major economic trends for selected U.S. Master Plan Fisheries (lobsters included). The figures illustrate the trend in landings, imports, per capita consumption, ex-vessel price index, fisherman, and vessels and boats.

5.1: General/Descriptive (Continued)

70. Organization for Economic Co-operation and Development, Review of Fisheries in OECD Member Countries, Paris: Organization for Economic Co-operation and Development, Annual, 1967.

Annual analysis of major occurrences in the fisheries industries of member countries. Preliminary annual statistics are given by country. Topics discussed for each country are government action, production and catch, and internal and external marketing. Major new investment is also noted. Most shellfish landings data is by species, though some countries designate only crustacea and molluscs. Import-export data generally groups all shellfish species under "shellfish".

71. O'Rourke, A. D. and D. B. De Loach, The California Fresh and Frozen Fishery Trade, California Agricultural Experiment Station, Bulletin No. 850, 1971.

Study describes the structure of the California fresh and frozen fish and shellfish industry from fishing through the retailing operation.

72. Sokoloski, A. A., Cost, Earnings and Borrowing Capacity for Selected U.S. Fisheries, Unpublished Manuscript, National Marine Fisheries Service, Division of Economic Research.

Profit and loss, net worth and returns on investment for selected U.S. Fisheries.

73. Turvey, R. and J. Uliseman, (Editors), The Economics of Fisheries, Proceedings of a Round Table Organized by the International Economics Association, Sponsored by FAO, Rome: 1957, reprint 1959.

A collection of papers dealing with the economics of fisheries including topics such as: 1. Fishermen's remuneration, 2. Optimal control and utilization of controls on fisherman, 3. Marketing of fishery products. Does not deal specifically with aquaculture or mariculture.

74. United Nations, Inventory of Biological Statistics for Fish Stock Assessment, Rome: Food and Agriculture Organization, Fisheries Resource Division, Fishery Data Centre, Fisheries Circular No. 123, 1970.

This document was prepared as a first step towards obtaining an inventory of data relevant to fish stock assessment. A questionnaire on biological statistics of fish stock assessment was circulated to fisheries institutions around the world. This circular contains a preliminary summary of the replies received. It includes both finfish and shellfish.

5.2: Specific Species

Lobsters:

75. Chace, Fenner A., Jr. and William H. Aumont, "Spiny Lobsters - Identification, World Distribution and U.S. Trade," Commercial Fisheries Review, 11 (5), (1949), pp. 1-12.

    Describes the various spiny lobster species, their distribution and the degree of their exploitation.

76. Dow, Robert L., "Some Factors Influencing Maine Lobster Landings," Commercial Fisheries Review, 23 (9), (1961), pp. 1-11.

    Study finds that, "major long-term fluctuation in Maine lobster landings can be attributed to variations in fishing effort of which the number of traps being fished is the most consistent index.

77. Dow, Robert L., "Supply, Sustained Yield, and Management of the Maine Lobster Resource," Commercial Fisheries Review, Vol. 26, No. 11a, (November 1964), pp. 19-26.

    Biological, environmental, and economic data are assembled for presentation of their relevancy to an understanding of the Maine lobster fishery. The purpose is to demonstrate the use of biological, economic, and environmental information to: 1. Forecast relative abundance and available supply, 2. Monitor changes in population, and 3. Recommend a type of management which would permit sustained annual yields at or near optimum levels.

78. Ennis, G. P., Lobster (Homarus americanus) Fishery and Biology in Bonavista, Newfoundland 1966-1970, Ottawa: Fisheries Research Board of Canada, Technical Report No. 289, 1971.

    A report on studies conducted in Bonavista Bay during the period 1966-1970. In 1960 a program was initiated to study the biological characteristics of regionally isolated lobster populations around the coast of Newfoundland (Squires, 1970). The nature and extent of the fisheries on these isolated populations and other factors influencing them are examined. A good bibliography on biology and habits of the lobster (Homarus americanus) is included with the report.

79. Kenoshita, Richard K., Basic Economic Indicators: Northern Lobster, Working Paper No. 53, Washington D.C.: National Marine Fisheries Service, Division of Economic Research, April 1970.

    An excellent source of economic data on the Northern lobster. It includes demand indicators and analyses, industry performance indicators, demand projections, domestic production, domestic employment, vessels and effort, biological stock assessment, trade, foreign production, etc.

5.2: Specific Species (Continued)

80. Lindberg, Robert G., Growth, Population Dynamics, and Field Dynamics, and Field Behavior of the Spiny Lobster "Panulirus Interruptus," Berkeley: University of California Press, 1955.

Reports the result of in-the-field research which made use of shallow-water diving techniques, as well as standard trapping procedures and aquarium studies to better define the ecology of the spiny lobster and to test the reliability of trap data as a true index of lobster abundance.

81. Rutherford, J. B., et al., An Economic Appraisal of the Canadian Lobster Industry, Ottawa: The Fisheries Research Board of Canada, Bulletin No. 157, 1967.

Survey of Canadian lobster fishing, regulations, catch, and financial costs and returns of lobster fishing enterprises.

82. Wilson, Robert C., A Review of the Southern California Spiny Lobster, California Department of Fish and Game, Vol. 34, No. 2, (January 30, 1948), pp. 71-80.

Reviews the history of the Southern California Spiny lobster fishery and the status of the fishery as of 1946.

Crabs:

83. U.S. Department of Commerce, Basic Economic Indicators: Blue Crabs, Master Plan Fishery 50-10-30, Working Paper No. 58, Washington, D.C.: Bureau of Commercial Fisheries, Division of Economic Research, May 1970.

An excellent source of economic data on the blue crab. It includes demand indicators and analysis, industy performance indicators, demand projections, domestic production, domestic employment, vessels and effort, biological stock assessment, trade, foreign production, etc.

84. U.S. Department of Commerce, Basic Economic Indicators: King and Dungeness Crabs, Master Plan Fishery 50-10-33, Working Paper No. 58, Washington, D.C.: Bureau of Commercial Fisheries, Division of Economic Research, May 1970.

An excellent source of economic data on the King and Dungeness crabs. It includes demand indicators and analysis, industry performance indicators, demand projections, domestic employment, domestic production, vessels and effort, trade, foreign production, biological stock assessment, etc.

5.2: Specific Species (Continued)

85. Youde, James G. and John R. Wix, Economics of the Dungeness Crab Industry, Corvallis, Oregon: Agricultural Experiment Station, Oregon State University, Circular of Information 627, December 1967, 24 pp.

Analysis of Oregon's Dungeness crab industry with comments on the effect of Alaskan King crab entry into Dungeness markets. Discusses production, catch-price relationships, processing firm structure, firm product mix, markets, price analysis and problems facing the industry. Recommends: 1. Establishing an industry-wide Dungeness crab commission to advertise and promote the product, 2. Expansion of market areas, 3. Change in season opening date, 4. Improved processing and 5. Establishment of grade and quality standards.

Oysters:

86. Morse, N. W., An Economic Study of the Oyster Fishery of the Maritime Provinces, Ottawa: Fisheries Research Board of Canada, Bulletin 175, 1971.

The main goal of this economic study is to probe into the various dimensions of the fishery to reveal interconnections among its biological, economic, institutional and other aspects. Leasing policies and limited access rights are discussed.

87. U.S. Department of Commerce, Basic Economic Indicators: Oysters, Master Plan Fisheries 50-10-21, Working Paper No. 56, Washington, D.C.: Bureau of Commercial Fisheries, Division of Economic Research, May 1970.

An excellent source of economic data on oysters. It includes demand indicators and analysis, industry performance indicators, demand projections, domestic production, domestic employment, trade, foreign production, etc.

88. Wheatley, John J., Charles L. Quittmeyer and Lorin A. Thompson, The Economic Implications of the York River Oyster Industry, Charlottesville, Virginia, University of Virginia, Bureau of Population and Economic Research, 1959, 119 pp.

An economic study of the structure and problems of the York River Oyster industry, containing data from 1880 through 1956. Information on both leased public grounds and private grounds is included. Gives historical information on socio-economic characteristics of the area and the industry as well as information on production and marketing costs, consumer demand and price movements. Recommendations to the industry and to the government agencies involved conclude the study.

5.2: Specific Species (Continued)

Shrimp:

89. Gillespie, William C., James C. Hite and John S. Lytle, An Econometric Analysis of the U.S. Shrimp Industry, Clemson, South Carolina: Clemson University, South Carolina Agricultural Experiment Station, Economics of Marine Resources No. 2, December 1969, 78 pp.

    Presents an economic model of the shrimp industry which includes equations for wholesale, ex-vessel and export demand for wholesale supply, for supply of imports, for supply of landings and for supply of vessels.

90. U.S. Department of Commerce, Basic Economic Indicators: Pacific Shrimp, Joint Plan Fishery 50-10-27, Working Paper No. 64, Washington, D.C.: National Marine Fisheries Service, Division of Economic Research, December 1970.

    An excellent source of economic data on the Pacific shrimp. It includes demand indicators and analysis, industry performance indicators, demand projection, domestic production, domestic employment, vessels and effort, biological stock assessment, trade, foreign production, etc.

91. U.S. Department of Commerce, Basic Economic Indicators: Shrimp, Master Plan Fishery 50-10-27, Working Paper No. 57, Washington D.C.: Bureau of Commercial Fisheries, Department of Economic Research, May 1970.

    An excellent source of economic data on shrimp. It includes demand indicators and analysis, industry performance indicators, demand projections, domestic production, domestic employment, vessels and effort, biological stocks assessment, trade, foreign production, etc.

SECTION 6: MARKETING

6.1: General Market Demand

92. Cassady, R., Jr., "The Marketing of Fishery Products in the United States," Paper No. 8 of The Economics of Fisheries, Edited by Turvey and Uliseman, Rome: Food and Agriculture Organization of the United Nations, 1957, Reprinted 1959.

    A case study of marketing and consumption behavior in the United States with possible applications to other countries.

93. Doll, John P., An Econometric Analysis of the U.S. Shrimp Market, Working Paper No. 79, Washington, D.C.: National Marine Fisheries Service, Division of Economic Research, February 1971.

    A two-stage and three-stage least squares econometric model is developed to simultaneously determine the impact of landings, beginning stocks, imports, and consumer income on prices, consumption, and ending stocks. The study accomplishes two things: 1. It generally confirms the price and income elasticities obtained in least squares analysis, thus indicating the identification problem is not serious, and 2. It permits a number of inferences to be made including the effect of imports and lagged influences in the market.

94. Gaide, Harold W., Jr. and David Storely (Department of Agriculture and Food Economics, University of Mass.) An Analysis of Consumer Purchases of Seafood in Springfield, Mass. Metropolitan Area, Agricultural Experiment Station, University of Massachusetts, Amherst: Bulletin No. 579, October 1969.

    A study to determine how often different types of seafood are purchased and the relation of household characteristics to different seafood purchase plans. Included are the effects of the no-fish on Friday rule of the Catholic Church.

95. Gilbert, DeWitt, (Editor), The Future of the Fishing Industry of the United States, University of Washington Publications in Fisheries, New Series, Vol. 4, 1968.

    Economic and institutional factors affecting the demand for fish and shellfish (pp. 185-203).

96. Hamlisch, R. and R. A. Taylor, "The Demand for Fish as Human Food," Part 5 (pp. 385-410), of Fish in Nutrition, Edited by Heen, E. and R. Kreuzer, FAO, London: Fishery News Ltd., 1962.

Summarizes the principal trends in the demand for fish as a human food in Western Europe, in North America, and in developing countries. Available evidence suggests that the average consumption levels in Western Europe and North America are not likely to change materially in the foreseeable future. The outlook appears to the authors to be favorable for selected products in the "luxury" class characterized by high income elasticities. Consumption of less valued fish, on the other hand, may substantially decline with improvements in levels of real income.

97. Miller, Morton M. and Darrel A. Nash, Regional and Other Related Aspects of Shellfish Consumption--Some Findings From the 1969 Consumer Panel Survey, Working Paper No. 74, Bureau of Commercial Fisheries, Division of Economic Research, September 1970.

Includes geographic concentration and distribution patterns of consumption for selected shellfish (includes lobsters), seasonality factors, consumption at home and away, relationship between income and consumption and effects of age on consumer preference. Includes a technical note on the characteristics of the sample survey households.

98. Nash, Darrel A. and F. W. Bell, An Inventory of Demand Functions For Fishery Products, Working Paper No. 10, Bureau of Commercial Fisheries, Division of Economic Research, July 1969.

Describes statistical demand relationships which have been computed by various researchers. These demand equations, in general, mathematically relate fish consumption by species (including functions for Northern lobsters) to various demand determinants such as per capita income and prices.

99. Nash, Darrel A., A Survey of Fish Purchases by Socio-Economic Characteristics, First Quarterly Report - February 1969, March, April, Unpublished, Second Quarterly Report - May, June, July, Unpublished, Third Quarterly Report - August, September, October, Working Paper No. 41, Fourth Quarterly Report - November, December, January, 1970, Working Paper No. 49, Bureau of Commercial Fisheries, Division of Economic Research.

Working Paper No. 41: Contains the response of 1582 households with a total of 4783 persons. These responses were summarized by major fish products (lobsters included), the measurements of consumption, and socio-economic characteristics; i.e., 1. The number of times the purchase was made for household use, 2. Total number of persons for which the item was purchased, 3. Number of pounds purchased, 4. Total Dollars spent on the item, 5. Price per pound, etc. Includes the number of meals eaten away from home. Working Paper No. 49: Description is the same as that for the third quarter report except for the sample size which was: 1621 households and 4999 persons.

6.1: General Market Demand (Continued)

100. Nash, Darrel A., Preliminary Analysis of a Survey of Buying Patterns for Fresh and Frozen Fish and Shellfish by Household Characteristics, Working Paper No. 46, Bureau of Commercial Fisheries, Division of Economic Research, August 1970.

A consumer panel of 1500 participants, theoretically representative of all U.S. households, were surveyed during one full year (February 1969 to January 1970) to obtain a complete record of fish purchases. This report summarizes the purchase patterns for fresh and frozen fish and shellfish. The more distinct differences in purchases among households appear to be due to race, religion, region, and age of the head of the household.

101. Nowak, W.S. W., The Marketing of Shellfish, London: Fishing News (Books) Ltd., The Whitefriars Press Ltd., 1970.

The book is divided into three parts: 1. Shellfish marketing in U.K. as compared with N.W. Europe, 2. Shellfish marketing in North America, and 3. Future trends. The author attempts to study all important facets of marketing in the areas chosen, as well as the peripheral controls which are likely to interfere with smooth patterns of supply and demand. (A lengthy bibliography is included).

102. Purcell, J. C. and Robert Rauniker, Analysis of Demand for Fish and Shellfish (Atlanta, Georgia Consumer Panel), University of Georgia, College of Agricultural Experiment Stations, Research Bulletin 51, December 1968.

This report is a presentation of the method and results of cross-tabular and statistical analysis relating quantity purchased and expenditure for selected fish and shellfish categories to specified explanatory variates. It is based on quarterly household data generated by Atlanta, Georgian Consumer Panel over a five-year period.

103. Suttor, Richard E. and Parviz Aryan-Nejad, Demand for Shellfish in the United States, College Park, Maryland: University of Maryland, Agricultural Experiment Station, Miscellaneous Publication, July 1969, 28 pp.

Linear demand functions were estimated for clams, crabs, lobsters, oysters, scallops and shrimp using 1948-65 annual time series on prices, consumption and income. Income elasticities of one or greater than one are found for all species except oysters. Oysters may have a negative income elasticity. Demand for all species except clams is shown to be price inelastic. Data problems are discussed.

6.1: General Market Demand (Continued)

104. U.S. Department of Agriculture, The Market for Food Consumed Away From Home: Dollar Value Statistics, Washington D.C.: U.S. Department of Agriculture, Economic Research Service, Statistical Bulletin No. 491, 1971.

Estimated value of food received by kind of business from 1969 survey. Included is data on shrimp, oysters, clams, crabs, lobster and scallops.

105. Waugh, Fredrick V. and Virgil J. Norton, Some Analysis of Fish Prices, Working Paper No. 22, Bureau of Commercial Fisheries, Division of Economic Research, May 1969.

Paper deals with demand analysis (including price elasticity of demand for shellfish), seasonal variations in price competition and develops a cobweb model. (Includes a good bibliography).

6.2: Specific Species

Shrimp:

106. Cleary, D., Demand and Prices for Shrimp, Working Paper No. 15, Bureau of Commercial Fisheries, Division of Economic Research, June 1969.

This study attempts to describe and quantitatively measure the forces determining the level of consumption of shrimp and the price level of shrimp in the United States. Study is concerned primarily with aggregate demand.

107. Doll, John P., "An Econometric Analysis of Shrimp Ex-Vessel Prices, 1950-1968," American Journal of Agricultural Economics, Vol. 54, No. 3, August 1972, pp. 431-440.

A five-equation demand model of the U.S. shrimp market using annual data. Prices, consumption, and ending stocks are the jointly determined variables; predetermined variables are shrimp supplies and consumer income. Ex-vessel price variations are found to be largely a result of variations in domestic landings. Imports reduced the general level of ex-vessel prices, but did not contribute substantially to price variability except in isolated instances.

6.3: Other Marketing

108. Dow, Robert L., et al., "The Role of Holding Pounds in the Maine Lobster Industry," Commercial Fisheries Review, Vol. 21, No. 5, May 1959.

The paper deals with the marketing problems of the American lobster (Homarus americanus). Since most of these crustaceans are sold alive, industry has had to develop means of storing the lobsters from the time they are caught until they enter the retail trade. The authors discuss the important role and the problems associated with lobster holding pounds.

109. Erickson, Scott E., Methods for Calculating Civilian Per Capita Consumption of Fresh and Frozen Shellfish, Working Paper No. 44, Bureau of Commercial Fisheries, Division of Economic Research, February 1970.

Describes in detail the procedures to derive total and per capita consumption of the major commercial shellfish (lobsters included) of the United States. It is an expansion of the computational formats appearing in Statistical Procedures Report No. 6, published by the Bureau of Commercial Fisheries.

110. McLeese, D. W. and D. G. Wilder, Lobster Storage and Shipment, Ottawa: Fisheries Research Board of Canada, Bulletin No. 147, 1964.

About two-thirds of Canada's fifty million pound annual lobster catch (Northern lobster) is shipped live to distant markets. This involves coastal storage in crates, cars, tanks, and tidal pounds for a few days to several months. Mortality from all causes usually exceeds three million pounds. Various methods of storing and shipping are considered in relation to needs and local conditions, some improvements are suggested. The special problems of inland storage are reviewed.

111. United Nations, Computing Human Consumption of Fish, Rome: Food and Agricultural Organization Fisheries Bulletin, Vol. 11, No. 2, March-April, 1949.

Bulletin's main purpose is to tabulate and compare available consumption figures to encourage the use of more uniform methods of data collection in future work on fish consumption statistics. An effort is made to more clearly define concepts to facilitate understanding of terms used.

AUTHOR INDEX