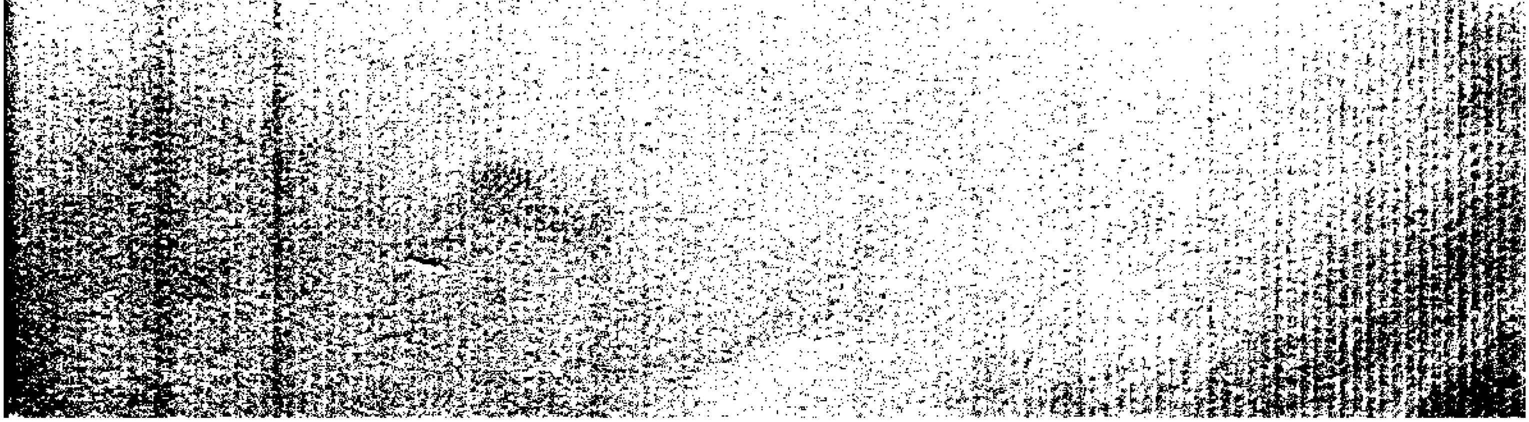
EQUITY AND EFFICIENCY IN STATE COASTAL RESOURCE MANAGEMENT:

by Phillip J. Symonds

An Application to Urban Recreational Boating Policy



EQUITY AND EFFICIENCY IN STATE COASTAL RESOURCE MANAGEMENT: AN APPLICATION TO URBAN RECREATIONAL BOATING POLICY

by

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P.J.S.

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CHAPTER 1

DEFINING STATE POLICY OPTIONS IN MANAGING RECREATIONAL BOATING RESOURCES

1.1 Introduction

Recent intense debate has made commonplace the idea that the coastal zone may play a diversity of roles: an industrial heat sink, a complex marine ecosystem, a multipurpose recreational park, and a pleasing backdrop for summer evening dinner parties. To manage the coastal zone, however, rather than simply talk about it, requires information structured by an analytic framework which permits greater clarity of choice among policy options. This study is designed as an analytic contribution to policy-making for the California coastal zone. It introduces economic and geographical reasoning to lend definition to ideas of equity in distribution and efficiency in use of coastal resources. Within this framework, two questions are addressed: (1) At the present time, who has access to the State's existing water recreational resources? and (2) Can the State predict future demand for new recreational harbors and launching facilities?

The allocation of coastal zone resources among alternative uses is now an important public issue. Industrial, commercial, recreational, and residential activities are often competing, overlapping, and incompatible. Dissatisfaction with the capacity of traditional institutions for managing coastal land and water resources, especially those in the densely urbanized areas, has led to the design and establishment of new forms of governmental structures. In California, the San Francisco Bay Conservation and Development Commission was created in 1965; its apparent success led to legislative attempts to create similar multi-county agencies to have jurisdiction over the entire California coastline. The efforts suffered repeated failure in the legislature but were rewarded at last with the passage, in November 1972, of Proposition 20, The California Coastal Zone Conservation Act of 1972. The Act created a statewide commission and six multi-county regional commissions[1] to have, among them,

[1]See Peter M. Douglas (1973) for an account of recent California coastal politics and for an analysis of the first year of the new commissions.

permit authority over development within a one-thousand-yard-wide strip on the landward side of the coastal mean-high-tide line. As well, the commissions were given planning jurisdiction over all land within 5 miles from the coastline (California, 1972).

These newly created State and regional coastal zone conservation commissions are concerned solely with the formulation of policies and practices for the mediation of coastal boundary conflict. To do so, the Commissions must pay careful attention to problems of equity and efficiency in resource allocation. These concerns necessitate the acquisition and analysis of information on the relative access of various income, age, and ethnic groups to the coastline. The commissions, as agencies of the State, must also ensure that California's resources are not under- or over-utilized. Data to aid in these decisions are not always readily available in forms convenient to answer new questions or to approach old problems in a new context.[2] In this respect, this study is concerned with the use of information in urban policy analysis; it is also a critique of conventional methods of projecting the demand for new recreational harbors along the California coast.

The institutional focus of this study is upon the State as a monopolist, sole owner of certain resources which it supplies to the population according to predetermined policy goals.[3] The State's policy goals are assumed to be the efficient use of its resources and the equitable distribution of access to the resources. In practice, coastal waters are managed by both the Federal and the

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[2]The work reported here has been undertaken in conjunction with several projects which have addressed the immediate concern of providing information and analysis for the consideration of the Commissions and for other participants in the management of the coastline. Emphasis in the design of each document has been on making information available to all potential actors in the decisional process. See, for examples of these analyses, Symonds, Warren, and Stallard (1974), Symonds and Weschler (1972), Rosentraub and Warren (1974) and United States (1975).

[3]In this study, the word "State" usually has the connotation "the State of California," and when it is suggested that the State should act or make a decision, it is meant that some agency of the State of California should do so.

State governments although inland waters are usually managed by the State.[4] Further, it is also true that local government jurisdictions--cities and counties--often manage resources which facilitate access to the State's water resources. However, in this study, the activities of Federal and local government agencies are considered only as they impinge on State policy.[5]

It should be stressed that in this specification of the policy framework, the State is considered a monopolist: the water resources to be allocated cannot be supplied by other economic agents. Conceived as a democratic organism, however, the State must devise policies satisfactory to the electorate. The State must not "waste" the resources it manages: it must use them efficiently; on the other hand, it must ensure that the resources are distributed among the population of the State in a fashion considered equitable. A democratic State is a peculiar kind of monopolist--one which, in principle, is subject to periodic reexamination

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[4]Ketchum (1972, Chapter 11) presents a summary of the overlap of jurisdictions in the coastal land and water regions. These jurisdictions over various aspects of the coastal zone may be summarized briefly using this source. The Federal (National) Government claims jurisdiction of the seas out to a distance of 12 miles. The Coastal State has certain jurisdiction out to the 3 mile limit from the mean-high-tide line. The State controls the submerged land to the 3 mile limit, and the Federal Government controls the submerged land to the edge of the outer continental shelf. Jurisdiction over the land adjacent to the coast is subject to State law; direct management of zoning, etc., is usually delegated to local city or county government, although as has been seen in California, the State retains the right to reorganize land management practices in the coastal zone. See also Robbins and Hershmann (1976).

[5]With the focus of attention on State policy with regard to use and management of its water resources, it is of no concern whether a particular entrepreneur, be it private or public, can successfully manage a profitable urban recreational facility. The State and the facilities manager may have some overlapping areas of interest, although not necessarily from the same perspective; the State may be concerned with the side effects of successful Marina management policies. For a discussion of important factors in modern Marina management, see Ward and Cushman (1967).

and reformulation of its resource utilization and distribution policies.

Framing public policy analysis in terms of a concern for efficiency and equity is in no way novel. The issues have been stated clearly and comprehensively in the standard text The Economics of Outdoor Recreation of Clawson and Knetsch (1966) and in the coastal zone management literature by Russell and Kneese (1973). In empirical studies, however, the issues are not always faced even when it would seem to be most suitable to do so. The contribution of this study is to show that by raising the issues of equity and efficiency it is possible to ask different questions about State coastal zone and water recreation policy. It is first shown that from a particular viewpoint of efficiency in water resource management, the State must attempt to predict the future demand for recreational boats in order to maintain boater use of the water at optimal use levels. Further, from an enumeration and discussion of present-day distribution questions, it is concluded that the State must obtain information on the relative access of different income groups as well as the relative access of the populations of different parts of the State. Next, demand prediction is examined by considering evidence suggesting the importance of possible determinants of future demand; a review of available estimation literature is made to suggest the limitations of available data in predicting future demand. Finally, spatial distributions of boat ownership data are related to income data from the 1970 Census of Population to obtain estimates of the effects of available income, residential location with respect to boating facilities, and size of facilities in limiting access to the State's supply of coastal and inland recreational boating waters.

1.2 Research Motivation: Conflict and Controversy at Marina Del Rey

The distributions of population and suitable recreational waters in California have not been highly correlated ever since the rapid development of the Los Angeles metropolis after World War II. Although there have always been abundant water recreation sites in the San Francisco Bay and Delta, and on the rivers and lakes of northern California, there were relatively few suitable natural sites in the arid southern half of the State. By the late 1950's, the available coastal recreation sites at Newport Beach and in the Los Angeles and Long Beach Harbors had become congested. During the early 1960's, long-standing plans for the development of several man-made harbors came to fruition and, in 1962, construction of the largest of these, Marina Del Rey, was completed. The Marina, situated due west of the center of the metropolis, is conveniently located with respect to much of the urban population. The Marina has been managed since its construction by the Los Angeles County Small Craft Harbors Commission. Following harbor completion, leaseholds were sold by the County over the next 10 years to developers charged with the task of constructing land and water-related facilities within the harbor complex. By 1971, these leaseholds had been intensely developed: about 5,600 slips had been constructed and rented, almost 5,000 apartment units and been built, and extensive commercial activities had been attracted to the Marina and its surrounding land.

The construction and completion of the Marina and the adjacent commercial, residential, and moorage facilities were not without conflict and debate. The present study was initiated with two other projects which have provided detailed examination of the politics of the planning and development of the Marina and the practices of its management agency. One of the studies has particular relevance to the present endeavor.[6] Rood and Warren (1974)[7] show that the Marina Del Rey revenue bond obligations required the County of Los Angeles to give priority to private investment in the Marina; over time, this ensured that intense revenue-generating development would be required to meet bond repayment schedules. In this way, the final use of the Federal and County investment in the harbor construction was predetermined by the somewhat smaller private investment in revenue bonds. Also discussed by Rood and Warren were problems which had emerged in the evolving process of managing the Marina as it grew to an urban subarea as large as some of the smaller cities in the region. The Marina's management structure, designed to cope effectively with meeting the County's financial obligation to the bondholders, was ill-equipped to resolve disputes between slip-renters and leaseholders.

During the period of slip construction at Marina Del Rey, a common response of a boater dissatisfied with the service provided by a leaseholder was to move his boat to another anchorage. However, the option of changing storage location disappeared as slip construction at the

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[6]In the other, Moss & Warren (1975) examine the use of leasing as a technique of land management and refer in detail to the practice at Marina Del Rey.

[7]The details of the discussion in this section have been drawn from Rood and Warren (1974).

Marina was completed and as moorage facilities were filled. Because the region's only harbor expansion capacity seemed to be at Dana Point, far at the south of the urban area, and at Ventura Harbor, on the northwest fringe, boaters began calling for the construction of new harbor facilities at locations closer to the urban core. Unfortunately, specific suggestions for sites, such as at Paradise Cove west of Malibu, were met with vocal opposition from non-boating users of the sites and nearby residents.

At the time this study and the associated analyses were initiated, the question of the need to construct new recreational harbors in the Los Angeles metropolitan area seemed to be an issue of importance to many concerned with the development or conservation of the urban coastline. It was of interest, therefore, to examine the arguments leading to the conclusion that there was, indeed, a continuing need for the construction of new harbor facilities. At present, it may be the case that the general economic decline of 1974-75 and the shortage of long-term loan funds available for large-scale municipal construction projects have dampened interest in harbor construction. If, however, there is a resurgence of interest after the long-awaited economic revival, this study will prove to be a helpful addition to the sources of information used to assess the importance of new recreational boating facilities construction.

1.3 A Methodological Note

The methodology adopted here is the application of social scientific analysis to the study of a specific urban public policy issue: the identification of the efficiency and equity concerns in the allocation of State water resources suitable for recreational boating among the primarily urban residents of the State. In particular, the study concerns the investigation of temporal and spatial choices of recreational boaters and of those who provide services for their use; in consequence, it is appropriate to work within an economic-geographic tradition.[8]

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[8]As a consequence of choosing this particular interdisciplinary blend, it becomes necessary to use terms as normally used in economics and geography. For example, "demand" is to have the economist's meaning of "the mathematical relationship between the quantity of a good which is purchased by a consumer and the set of variables determining his choice"; these variables include his income, the price of the good, and, in principle, the

The discipline of economics is often called upon to provide both positive and normative analysis of social situations: it may be used either as a basis for describing the economic behavior of a system or as a way to deduce appropriate policies for manipulating the parameters thought to define a social system in order to obtain desired ends. Within the last 30 years, economics, especially the subdiscipline of microeconomics ("price theory"), has been largely reformulated so that it may be presented as a series of mathematical theorems deducible from a small set of axioms about the choice behavior of economic agents. To infer policy implications within an economic context or to define the behavioral aspects of a particular economic system, it is necessary to specify mathematically the structure of the system and then, by way of a theorem, to deduce the system's behavior.[9]

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prices of all other goods; "demand" also has the second meaning of "market demand" which refers to the relationship between the market price of a good and the total quantity of the good purchased by all consumers. In principle, market demand is obtained by some suitable aggregation of individual consumer demands. Market demand thus may depend on the preferences of individuals and also on the distribution of resources and income among them. The term "supply" also has individual and market meaning: it can mean either "the relationship between the quantity of a good offered for sale by an individual producer and the price offered" or "the relationship between the total quantity of a good which would be offered by all producers in a market and the price offered." The term "space" is used in either the physical-geographic sense of the one- two- or three-dimensional space in which real objects are located or in the mathematically analogous sense used by economists: a "commodity space" is a multidimensional space spanned by the set of all possible commodity bundles available to the consumer (for a formal analysis of the theory of the consumer, see Intriligator, 1971, Chapter 7). "Region" is used to imply a closed subset of a (multi-dimensional) space; the words "area" and "subarea" are used, according to convention, as synonyms for "region."

[9]For an early explanation of the use of mathematics in economics see Koopmans (1957).

In this study, as in much applied empirical work, an unevenness in the overall analytic structure may be perceived. As is often the case, there is no flawless logical bridge from the selected theoretical models to the empirical analysis possible using available data and statistical techniques. Policy recommendations, therefore may be based on sophisticated theory and crude summary measurements; sometimes the reverse is true. In the detailed discussion of efficiency, a fairly elegant theorem is presented to deduce policy options available to State administrators; it is found, though, that the data available to plan for future efficient resource use is insufficient to produce acceptably precise predictions. On the other hand, in discussions of equity in resource allocation, economics offers little theoretical guide to the State policy maker; in this situation, however, available data is quite adequate, using geographical techniques of modelling spatial association, to measure the importance of income and geographical location in determining access to boating recreation.

This study, then, has been shaped by the double requirement of placing the economic and geographical analysis into a public policy framework. It has been a further aim, moreover, to show that the particular public policy focus and the subsequent choice of social-scientific theory and technique may lead to new interpretations of old information. For this reason the study is based on either previously published information or information which has been and continues to be available to State administrators; in the latter category is the complete file of current and non-current boat registration information maintained by the California Department of Motor Vehicles.

While the procedure chosen is not the only way to produce valid and useful public policy recommendations, it does have the salutary feature of requiring the analysis to be subject to professional criticism from the standpoint of the selected disciplines. The choice of scientific style may be evaluated, in turn, in terms of the relative precision it affords decision-makers in distinguishing and choosing among the various policy options discussed.[10]

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[10]Conformance to the prevailing academic norm that analysis should be reported in the disinterested style often serves to obscure the extent to which policy analysis is a highly personal task. It should be clear, though, from this methodological discussion that the selection of theoretical tools is to some degree arbitrary and idiosyncratic to the investigator's style and purposes;

1.4 Overview

The following chapter introduces the concept of a public good to serve as a description of the State's water resources suited to recreational boating. It also defines the idea of a private good to describe recreational boating equipment. The question of efficiency is examined in terms of a microeconomic theorem of Sandmo (1973) which deduces the optimality conditions in a system in which a State-managed public good, subject to congestion, is being used by many consumers each of whom is also using his own private good. The optimality conditions are seen to lead to several options for State intervention; in particular, however, it suggests that, if the State is to plan for efficient future use of the resources under consideration, it must be able to predict the aggregate future demand for recreational boating.

The second chapter also presents a discussion of equity although in a less formal fashion; attention is given to the variety of ways in which the State's population may be partitioned when considering distributive questions. The equity issue is reduced so that it includes only geographical equity (relating residence location to water resource location) and income equity (relating the relative access of different income groups to water resources).

The third and fourth chapters constitute the empirical contribution of the study. The third raises the question of methodology in the prediction of future demand for recreational boats. It suggests, as determinants of changes in boating stock, several factors--prices of boats, income, supply of installment credit, and regional distribution of facilities--all of which should be explicitly considered in projecting future demand. It is found, though, that a thorough search for suitable California time series data yields insufficient information to estimate the parameters of a reasonably specified model.

Chapter 4 reports an investigation of the equity issues raised in the second chapter. The method models the probability that, at a particular time, a family will choose to purchase a boat. Choice is assumed to depend on the income level of the family, the distance between the family's residence and the nearest boat recreational

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usually from his viewpoint, success or failure depends on the extent to which he is able to prove, to his own satisfaction, what he had already set out to show.

facility, and the size of that facility. The technique introduces a logistic formulation of the probability of boat ownership using, as dependent variables, the "logits" of the per family ownership levels as they vary across the 325 zip code levels in the Los Angeles metropolitan region. As source of data on independent variables, the model uses published facilities stock data, income data from the 1970 Census of Population, and calculated straightline distances between zip code areas and recreational boating sites. The results of Chapter 4 suggest that the spatial distribution of recreational boats and, by implication, the spatial distribution of access to the State's water recreational resources, can be best explained by the spatial distribution with respect to facilities of the middle income and upper income groups in a metropolitan area.

The final chapter contains a review of the issues raised and addressed in earlier chapters and gives an evaluation of the relative importance of recreational boating facilities supply in making policy to manage the State's urban coastal regions.

The study has required the solution of some computational problems and the production of various data which are of interest but are peripheral to the main discussion. Appendix A presents an outline of the theorem discussed in Chapter 2. In Appendix B there is a description of the method of preparing the information on the Department of Motor Vehicles Master Vessel Registration file so that it could be later analyzed using standard statistical routines. Appendix C presents a series of 35 maps used to display the data analyzed in Chapter 4 and includes a detailed explanation of how the maps are to be read.

CHAPTER 2

EFFICIENCY AND EQUITY: THEORETICAL ANALYSIS

This chapter provides an elaboration of the policy questions facing the State of California in its management of coastal and inland waters. The State must plan for and maintain efficient use of its resources and also maintain what is to be considered an equitable distribution of access to the recreational sites. The analysis presented explicitly treats the fact that while the State-owned resource may be used by many persons at the same time, boating access requires that each boater provide for himself, either by purchasing or renting, a boat.[1]

2.1 A Classification of Recreational Goods and Services: The Distinction between Public and Private Goods

Economists make a useful distinction between those goods and services which are "packageable" and can be consumed by one individual to the exclusion of other individuals, and those which cannot be easily packaged and which, if they are provided for the use of one person, may usually

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[1]In this study there is some ambiguity about whether the individual consuming unit is a person (that is, a man or a woman), a household or family unit, or some other small group of acquaintances. In the theoretical analysis of efficiency of this chapter, the "consumer" is not specified as a person or a family and can be considered as either. In the empirical analysis of Chapter 4, it is assumed that only family units purchase boats; this is justified in the mapping appendix, Appendix C, where it is shown that the distribution of single individuals in the metropolitan area is such that the ownership of boats is low where the numbers of individuals is high.

A grammatical point has arisen in discussion of the drafts of this report. For simplicity in presentation, the boater is considered here to be a male (and therefore a male family head). While it is the case that most boaters may be males, it is not invariably so. Thus, the use of he/him/his is to be read as implying males or females. See also the discussion of Section 2.3.3.

be consumed at the same time by other persons. Goods which may be packaged are said to be "private" goods and non-packageable goods are called "public" goods. The classic example of a public good is "national defense." A boat is an example of a private good; in a literal sense, it may be placed in a large box. More precisely, the rights to consume the services of a particular private good may be held by a single individual, and other persons may be excluded from enjoying those services. The distinction between "public" and "private" is made according to technology of consumption and not according to the status of the owner of the resource.

Krutilla and Knetsch (1971), in discussing outdoor recreation economics, point out that much outdoor recreation is resource-oriented by which they mean that it is often associated with immobile types of resources such as lakes, seashores, and mountain ranges. These resources are often unique and are usually constrained to being public goods. On the other hand, many other forms of urban recreation--watching movies or concerts, attending sporting events, and watching television--involve the consumption of goods which are easily packaged. These forms of recreational activities usually require capital and labor resources which are more mobile and, therefore, may be located more efficiently with respect to market demand. Krutilla and Knetsch call these latter activities "market-oriented." Complex systems of property rights have been designed for both the efficient production and consumption of market-oriented recreational goods and services and for the protection of equity of all involved.[2]

In the context of resource-oriented recreation, an important insight about coastline regions and lake-frontage is that these regions represent the interface between resources for which markedly different systems of property rights have been designed. On the landward side of the boundary of the seashore or lake, the rights to small parcels of land may be bought or sold in market transactions. The water-body, whether a lake or the ocean, represents more closely a common property system, the ownership of which is usually vested in the public-at-large and which is usually managed by a combination of State and Federal agencies (Harrison, 1973). In pointing this out,

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[2]For examples which come to mind easily, consider the equity law covering the production and dissemination of television programs, movies, football games, horse-racing, and gambling of all kinds.

Harrison suggests that the sharp discontinuity in property rights systems has been responsible for the intense argument over proper management of coastal areas and large inland lakes. Experimentation in the design of innovative land-management institutions has often been the outcome of these disputes.[3]

Complicating the formation of urban public policy in many important situations is the complementary nature of certain public goods, often unpriced, and associated private goods which may be often high-priced. For example, in order to use a freeway, by definition a zero-priced good, it is first necessary to purchase or rent an automobile or to rent space on a bus. Similarly, if an individual wants to use the public services of a lake or the ocean-front for fishing, cruising, or sailing he must first purchase or rent a boat.

2.1.1 Private Consumption Goods

It may be considered that an individual does not consume public goods but that rather he produces "final consumption goods." For example, he produces a "journey to work" using the public services of a freeway, the private services of an automobile, and his own time as inputs. In a similar way, it may be considered that a boater produces a good called a "boating recreation day" using the services of a boat, a private good, and the public services of a lake or the ocean-front. From this perspective, the individual is considered to be a cost-minimizing firm providing goods for his own consumption as a utility-maximizing consumer. As a producer, the individual boater is concerned with possible changes in prices of any of the inputs to final consumption goods. It is usually the case that he perceives the direct cost of using the State-managed water recreation resources to be zero.

Some, but not all, recreational boating facilities in southern California and elsewhere have been designed not as recreational sites but rather as storage facilities and as access points for recreational boats sufficiently large to be safe on the open ocean; not all boaters have equipment suitable for obtaining benefits from the increased access. Other recreational facilities provide

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[3]California offers the examples of the San Francisco Bay Conservation and Development Commission; the Tahoe Regional Planning Agency, and, more recently, the California Coastal Zone Conservation and Development Commissions.

access to inland water-bodies which may be used by owners of small power boats and rowboats but are inaccessible to owners of boats which are too large to be transported easily on land. The distribution of benefits from the provision of access to either the coastal or inland water bodies is restricted to those who own or rent the suitable recreational equipment.

At any time, the number of slips and moorage spaces and the number of launching ramps serve as effective limits to the total level of access to the ocean or inland water recreation sites. The number of slips and ramps are, then, important indicators of the limits of total seasonal consumption of "recreational boating days." It is therefore possible that increasing or decreasing the price of using slips or ramps may be a useful device to control the degree of access of boaters to the ocean or the inland waterways.

2.2 Efficiency in Management of State Water Resources

Efficiency in production is one of the important public policy issues of interest to the State in the development of management practices concerning its water resources suitable for recreational boating. Efficient use of a public resource requires that it be used at some desired level of congestion. This may seem to be a paradoxical requirement; however, it is clear that the minimal level of congestion which could be used as a policy parameter is the maximum level of use at which no boater perceived unwanted interaction with surrounding recreationists. Use at less than this level is necessarily inefficient from an economic standpoint for, then, if one more boater were to begin recreating on the particular water resource, all the additional costs would be borne by the newly arrived boater, and these, it is assumed, would be less than his perceived additional benefits. Further, it can be seen that the level of desired congestion could be higher than this minimum if the additional benefits of an additional boater were less than the total additional costs, including the congestion costs perceived all the boaters using the public resource. In practice, definitions of non-congestion vary from person to person. This may not be an important problem in the management of those public resources, such as freeways, for which the tastes of consumers can be considered to be quite similar; in these cases, it may be easy to find "objective" methods of measuring the existence and size of congestion costs. On the other hand, the perception of congestion in recreational resources may differ widely because of wide divergences in the tastes and expectations of users.[4] However, although the selection of an appropriate method of measuring congestion may not be easy, the State must do so, and then it must choose a level of congestion which is to be considered optimal. Once this measure has been chosen and the standard level of congestion decided upon,[5] the State must choose policie which maintain this standard.

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[4]This rather abstract phrasing obscures the real differences between, say, a transportation link (such as a section of freeway) and a recreational resource. It is important to understand something about what people do when they recreate and why they do it. Two methods may be suggested: It is possible to watch people as they re-create and see how they do it (this method of observing and analyzing the behaviour of people in public places has been presented in several books of Goffman (e.g., 1971)); another way is to ask people what they think. Stankey (1971) has used the latter method in interviewing wilderness users to find variation in user definition of the carrying capacity of Federally managed, outdoor recreation resources. His conclusions are in part: "Solitude is expected by most users...most visitors rejected the idea that meeting other parties was an enjoyable experience... conflicts exist between hikers and horseback parties. Hikers tend to be 'purists.' The conflict was largely one-sided; horseback riders did not strongly object to hikers. Hikers, however, indicated conflicts with parties traveling with stock...85 percent of the canoeists were purists who strongly resented parties using outboard motors.

"Indirect controls (i.e., modification of wilderness infra-structure, manipulation of access) were more favored than direct controls. Horseback riders were more opposed than hikers to the elimination of trails. Both canoeists and motorboaters favored leaving portages rough; however, motorboaters opposed blocking off access roads to wildernesses."

[5]The State may choose to have different levels of congestion at different times at the same place because of daily, weekly, or seasonal patterns of use. The State may also choose to allow different levels of congestion at peak periods in order to promote use of its public resources at times at which there is no congestion. For a discussion of the peak period problem as a point of similarity in the management of highways and recreation resources see Goldin (1972).

This section presents a review of economic analysis which leads to the identification of policy options available to the State in the management of a public resource over which it has monopoly control. One possibility option is to consider some other distribution of rights to the water resources: they could be parcelled up in some manner and leased or sold, the property rights thereafter being allocated by a market system.[6] This option is

[6]The choice between systems of property rights is often made according to the test of whether exchanges of rights are more or less likely to be "Pareto optimal" by which it is meant that transactions do not leave any party feeling worse off. It can be shown that in a market for private goods, in which there are infinitely many buyers and sellers, and in which there is perfect information about all prices offered and about all goods, all agents will be price takers (that is, all prices will be set according to the activities of all agents), and all transactions will be Pareto optimal. It can also be shown that in this system, all resources will be used efficiently (see for example, Intriligator, 1971, chapter 10).

Seeking Pareto optimality only within competitive markets seems to limit unnecessarily the range of policy options available to the State in designing the legal structure (a fine example, in a democratic state, of a public good) which is to allow the system of production and consumption of goods and services. It is not clear that in the setting up of any new property rights system (in which there may be Pareto optimal transactions) there may not always be non-Pareto optimal reallocations of resources. The history of most countries, including the United States and most other former British colonies, provides many cases of non-optimal changes on the introduction of new systems of property rights.

The production of football games in England provides a useful recreational example. The modern game of Soccer was invented during the latter part of the nineteenth century and until after the Second World War it was almost exclusively a working-class game. The game was formalized, popularized, disseminated, and produced by working-class-based clubs. After the war, National recreational policy led to the increased subsidy of football stadiums, the introduction of week-night games, and later, the promotion of international football matches. These trends allowed the development of profit-oriented corporate ownership of teams. Taylor has convincingly argued that recent examples of field incursions during football games (characterized in the national and international press as "hooliganism") ignored in this analysis,[7] because, as will become evident, this study is restricted to making empirically based public policy recommendations which are pertinent to the current system of resource ownership.

A derivation of the conditions for optimal production of a private consumption good using a public good input and a private good input has been undertaken by Sandmo (see 1973). His analysis is outlined in mathematical form, following closely his presentation, in Appendix A. His analysis uses conventional microeconomic techniques but specifies that each individual's utility function is dependent on final consumption goods (e.g., "recreational boating days"). The final goods are produced according to a production function which depends not only on the complementary private goods (e.g., a boat, the

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have instead been real or symbolic attempts by working-class men to reassert control over the production of the sport (Taylor, 1972).

[7]This is not to say that it was not possible to have considered the possibility of setting up different property rights systems for the management of the State's recreational water resources. There has been significant experience with proposing and initiating new systems of property rights for the management of water resources which are subject to pollution through overuse by several users. Milliman (1955) discusses the simplest case of a municipal, natural, underground reservoir being over-used by two adjacent city corporations in the Los Angeles urban area. The introduction of property rights to water and the use of pricing led to the establishment and maintenance of an agreed upon level of pollution in a Pareto optimal manner. For a discussion of a similarly successful experience in the managment of a more complex distribution system see Weschler (1968). For a view of a set of city corporations in a large metropolitan area as independent entrepreneurs in a market for the distribution of a wide variety of geographically contained urban goods, public goods, and services see Ostrom, Tiebout, and Warren (1961) and Warren (1964). More specific to recreation, Anderson and Bonsor (1974) compare the situations of unique and non-unique recreational resources subject to congestion and suggest that non-unique resources might best be managed by introducing a market mechanism with profit-maximizing management; a unique resource must necessarily be managed as a monopoly, and they discuss the different distributional effects of perfect price discrimination and nominal pricing of access.

boater's time), but also on the level of consumption of the public good input by all other consumers. In this way it is possible to consider the effects of "market failure" by assuming that each consumer's use of the public good has a congestion effect upon each of the other users.

The conditions for optimality in production of final consumption goods are obtained by maximizing an individualistic social welfare function[8] subject to the production possibilities of the economy. Therefore, the welfare function is also a function of the consumer's production function for final consumption goods. Each production function depends on the quantity of the public good, the quantity of the private good, and the level of consumption of private goods by all users in the economy. Sandmo shows that, in the model in which the external effects are negligible, competitive behavior in the market for the private goods leads to a Pareto optimal allocation of private goods for each level of provision of the public good and for any initial allocation of resources. If congestion externalities are not insignificant, however, a competitive equilibrium in the private goods market is not Pareto optimal, although the allocation yielding maximal welfare is. To reach the maximal welfare allocation it is necessary that the price of the private good to the consumer be higher than the price of the private good to the producer (of the private good). This has the effect of requiring the price of the consumer's "private consumption good" be equated with his true marginal cost of production including not only the marginal cost of producing the private good input but also the marginal cost he imposes on all the users of the congested public good.[9]

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[8]By using the construct of a social welfare function, Sandmo (and, consequently, this analysis) parts company with the "property rights--public choice" school of analysis. For a recent review of the public choice literature see Furubotn and Pejovich (1972). For an introduction to the public choice approach to urban public policy analysis see Bish (1971). But see also Goldberg's critique of the "peculiar normative bias" of the public choice theorists (1973).

[9]"Marginal" cost is defined as the additional cost, at a given output level, of increasing the level of output by one unit; it is the first derivative of cost as a function of output level.

The optimality conditions lead to the identification of the following policy options available to the State in managing the public good at a level of congestion it has set as standard. In the case of too much congestion the State may:

1. Raise the price to the consumer of using the public good input to the private consumption good, or

2. Increase the supply of the public good which is being congested.

On the other hand, if the public good managed by the State is underutilized--that is, used at less than the desired carrying capacity--the State may attempt to promote its more efficient use by:

1. Lowering the price of access to the recreational resource, or

2. Decreasing the supply of the public good which is being underutilized.

The State may also intervene in controlling the access of individuals to the private good used in the production of the final consumption good.[10]

This analysis may be applied to the discussion of State recreational boating policy. Since launching ramps and slips are technologically effective access devices to water bodies, their supply (that is, the quantity of slips or ramps provided at given per-unit prices) becomes a useful policy tool for adjusting the per-day cost of using the State's public (that is, collectively consumed) water

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[10]The point is made by Sandmo: if the supplier of a public good also has access to the associated private good, then he can exclude consumers from the benefit of the given supply. Licensing of automobile drivers allows the State to restrict access to highways and roads to a certain skill/age/law-observant segment of the population; this point is not lost on boating organizations. There may be other important impediments to the acquisition of the private goods required to enjoy State-provided public goods: see Weschler and Warren, 1972, for a discussion of the importance of time, education, and psychic costs in limiting access of many groups to public goods and services and to the privileges of citizenship.

resources. The State also has the option of increasing the supply of the public good directly by producing new recreational water resources, a usual by-product of the construction of new reservoirs.

The State also has the option of intervening in the level of access of individuals to the private good inputs. There are several options available: The State may lower the costs of construction of new boats (e.g., by subsidizing directly the boat construction industry); the State may lower the cost of boat rental services by subsidizing private or public producers in the boat rental market; as noted, the State may license boat operators making it more expensive (perhaps prohibitively so, for some persons) to operate a boat.

2.2.1 State Policy on Promoting Efficient Use of Recreational Water Resources

Since the late fifties, the State of California policy on boater recreation has been consistent and positive; it may be assumed to have had, in large part, the aim of promoting efficient use of its coastal and inland water resources. The State has acted (in several ways) to lower the price of access to the water resources it manages. It has allocated funds towards the construction of some of the new recreational harbors and has underwritten or provided low-cost loans for the construction of many boat launching ramps. In addition, the State has acted to minimize some of the more egregious forms of congestion by promoting boat safety courses for new participants; in so doing, it has not only saved lives and prevented injury but also has raised the recreational carrying capacity of each existing body of water. The State's mandatory registration system provides low-cost identification service for boat-owners[11] as well as a source of individual and aggregated statistics available for county assessors, private insurance and boat sellers,

[11]The State's registration fee of $3 is so low that in 1975 many thousands of boaters caused havoc at the Department of Motor Vehicles by unnecessarily mailing in the additional $1 late fee (Los Angeles Times, 1975).

banks and credit agencies, and members of the general public.[12]

In addition the State has undertaken or commissioned several research and inventory projects during the last fifteen years.[13] The results of these projects have been, in many cases, widely disseminated and have formed the basis of much State and local planning for boat recreation. The best known and most sophisticated of these studies is the Leeds, Hill and Jewett report (California, 1974), a comprehensive study which was used during most of the 1960's and which was recently updated by Arthur Young & Company (California, 1973). Each of these studies has contained extensive information to estimate present and future demand and supply of boating facilities.[14] But see also the various other State

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[12]Data on an individual boat may be obtained within a minute or so by law enforcement agencies. County assessors are provided with monthly updates of lists of information on boats located (stored) within the county. Edited lists of information on boat and owner address information for boats currently registered in a county are available from the DMV at 25 cents per record. Extended information on boat, registered owner, and legal owner may be purchased from the DMV at $2 per record (access time for the general public is about 15 minutes at DMV branches). A complete file of all current and lapsed registration records is maintained by the DMV; a copy of this Master Vessel Registration File was made available for this study at no cost (analysis of this file forms the basis of this investigation).

[13]The State allocates a proportion of gasoline taxes to a revolving fund for use in managing the Department of Navigation and Ocean Development and in providing facilities construction financing.

[14]The Leeds, Hill and Jewett, 1964 report, "California Small Craft Harbors and Facilities Plan Comprehensive Report," covered the following tasks: making an inventory of existing boating facilities for recreational and commercial purposes; the collection of data on planned facilities; the evaluation of boater patterns of recreational use and the existing demand for boating facilities; the determination from questionnaire results, from population projections, and from levels of boat ownership, estimates of future demand for boating facilities; the estimation of cost of planning, construction, operation, and maintenance of boating facilities. The report is very

reports (California, 1958; 1959; 1960; 1961; 1966; 1968; 1970;) as well as the very informative "Final Report on the State Gasoline Tax paid on Gasoline Used in Propelling Boats During the 1971 Calendar Year" (California, 1972b).

When the State intervenes directly in the provision of harbor, moorage, and launching facilities, it also takes on the additional problem of ensuring the efficient management of the new physical plant. Slips and launching ramps must usually be sturdy in construction and therefore very durable; the construction of a new harbor is likely to involve a very long lead time. At the time a harbor project is initiated, the State should have confidence in its prediction of aggregate demand for the water resources for at least a decade thereafter. To do so, it must have some indication of how the residents of the State are likely to decide for or against boating in the fairly distant future. Unfortunately, the State's usual method of projecting future recreational boating demand--the extrapolation of time trends in per capita ownership of boats--takes little cognizance of how boaters might actually weigh the decision to participate. In the following chapter this empirical question of future demand projection is explored in some detail and the possibility of using an alternative estimation method, some formulation of a stock adjustment model, is assessed.

The efficient management of the State's public resources is not the only function of State government, however. Of at least equal importance is the concern for equitable distributions of resources among the different subpopulations within the State's jurisdiction. The concept of equity involves notions of relative deservingness and is not one for which the theoretical structure of economics allows recommendations as clear-cut as those dealing with efficiency in resource allocation. Instead, as is to be done here, it is usually left up to the political processes of legislation, adjudication, and management, to define explicitly or implicitly the allocation of resources to be considered equitable at any time. Given the desired distribution, economic analysis can make some estimate of the gap between the existing and the desired

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sophisticated; however, its future demand estimation is not so well done as some of the other tasks, partly as a result of lack of data and partly because of non-economic use of ideas of demand; the criticism of its use of time trends in boat ownership levels to predict future levels of ownership forms the basis of the next chapter.

distributions.[15] State of California boating policy seems to have considered equity in access to resources only in the limited sense of equal access among the populations of different regions of the State. The next section suggests some further issues of equity which might concern the State in forming recreational boating policy.

2.3 Equity Problems in the Management of State Recreational Resources

In a discussion of equity issues arising in the State's management of its water resources, it is possible to consider several ways of partitioning the population into subpopulations among which the resources may be allocated. Examples of such partitions are those concerning: geographical equity, or the appropriate division of resources among the geographically dispersed subpopulations of the State; intergenerational equity, or the division of resources among succeeding generations of residents of the State; income equity, or the division of resources among groups of differing income; age equity, or the partition among different age groups at a particular point in time; ethnic or racial equity, or the division among members of different ethnic or racial groups; and sex equity, the division or resources among males and females. The political question to be resolved in each case is: what is to be accepted as the correct distribution of resources among the selected partitions of the population? When that judgment has been made, the questions to be answered by the policy analyst become: what is the existing distribution of resources, how does this differ from the desired distribution, and what policy tools can be used to move toward the desired distribution?

2.3.1 Geographical Equity

Obtaining the correct distribution of water resources among geographically dispersed subpopulations in the State of California has been the basis of some of the most important policy decisions in the State's history. From

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[15]As Rivlin has pointed out, economics does not yet provide much in the way of policy recommendations for reaching some desired redistribution of wealth or income (1975). It is also the case that efficiency and equity often run counter to one another; for a discussion of the redistributive effects of introducing pricing of a previously unpriced good, see Huszar and Seckler (1974).

the perspective of geographical equity, it may be suggested that the massive California State Water Plan has been a successful attempt at redressing the supposed inequitable distribution of natural water resources among the residents of northern California and of southern California. While State water policy has been concerned more with the use of water as an input to all commercial, manufacturing, agricultural, and household production, it is also true that State policy makers have weighed the interests of residents of different regions and counties within the regions (see, for example, California, 1973). At present the measure used by the State in comparing the needs of different subareas of the State is either "slips per boat registered in the subarea and requiring moorage" or "ramps per trailerable boat registered in the subarea." The Arthur Young report recommends that the State set policy in the following way (California, 1973, p. 11):

> 1. Berthing facilities are required for all registered boats above (X) feet in length and all documented vessels.
>
> 2. Launching lane capacity is required to provide all boats under 18 feet in length with a utilization rate of (Y) launchings per year assuming 25 launchings per boat per year.
>
> The Department of Navigation and Ocean Development should establish the values of X and Y for each region in the State as a matter of policy. This determination will establish a clear and consistent definition of demand.

Such a policy, in the terms of this study, would establish a definition of supply of facilities rather than demand for them. It is clear, though, that the selection of an appropriate norm to serve as a basis for selecting the values of X and Y would be arbitrary. Before setting the norm, other equity issues, including those to be discussed next, should be considered.

2.3.2 Intergenerational Equity

Intergenerational equity is an important focus of much of the recent interest in natural resource allocation policy. The question of conservation is often phrased in terms of this concept: are we going to bequeath to our grandchildren a rich or poor, beautiful or ugly, complex or simple, natural environment? The perceived inability of traditional land and coastal management agencies to consider this problem has motivated many of those who sought the formation of the new California Coastal Conservation Commission.[16] Since the consumption of resources usually requires irreversible changes in their form,[17] intergenerational redistribution is an important consequence of any chosen present-day resource allocation decision. The construction of massive recreational harbors such as Marina Del Rey is not without the implication of narrowing the choices not only of present but also of future residents of the Los Angeles region.

2.3.3 Social Equity

The remaining resource partitions, involving age, sex, income, and ethnic or racial equity, may be brought under the rubric of "social equity." The paucity of discussion of social equity in the coastal zone management literature has been noted by Dickert and Sorenson (1974). In other contexts, at the levels of Federal and State policy-making, the distinct questions of social equity have been dealt with explicitly and are quite familiar. Important Federal and State policy addresses the questions of income redistribution, the proper provision of facilities and services for the aged, and discrimination with regard to race or sex in the housing and labor markets and in the provision of public education.

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[16]For an insider's view of individual motivations and political style of the coalition of organizations which orchestrated the successful passage of the new California Coastal Law, see Janet Adams' (1972) article "Proposition 20--A Citizen's Campaign." For a sociological analysis of the Sierra Club, one of the largest institutional members of the coalition, see the paper by Perry, et al (1975), "The Organizational Consequences of Competing Ideologies: Conservationists and Weekenders in the Sierra Club."

[17]Efficiency in production in economics, involving the idea that physical inputs are changed in the production of an output, always involves <u>inefficiency</u> in the thermodynamic sense. For a detailed discussion of the implications of this observation, see Georgescu-Roegen (1975).

In the discussion of the use of public water resources for recreational boating the issue of age equity may be resolved fairly simply for, although some persons are too young or too old to engage in recreational boating, the activity generally allows participation by members of a wide spectrum of age groups.

The effect of income in restricting access to coastal and inland waters is of larger significance, however. Recreational boating equipment is never inexpensive, ranging in price from a few hundred dollars for a small rowboat, to hundreds of thousands of dollars for the largest luxury yachts. The importance of available income in limiting access to boating recreation must be considered if the State is to consider equity among income groups in the distribution of its coastal and inland water resources.[18]

The relative access of different ethnic or racial groups is considered in this study to be of secondary importance. It is argued here that the important and well-documented traditions of housing and labor market discrimination have had the secondary effect of limiting minority group access to locations distant from ghetto areas. On the other hand, it is also true that low income Whites are restricted from certain activities because their level of geographical access is low and the investment required is too high. Thus, it is the low income of the minority population rather than direct discrimination which is considered responsible for the observed low participation rates of Black and Spanish Heritage families in recreational boating.[19]

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[18]Further problems arise when the State is engaged in providing recreational opportunities to residents of other States or Countries. See, for example, "Conflicts among Recreational Resource Users--The Case of Non-Canadian Participation in the Regional Sport Fisheries of British Columbia and the Yukon" (Sinclair and Reid, 1974).

[19]See Symonds and Weschler (1972) for an analysis of the results of interviewing boat ramp users at the launching sites at Marina Del Rey and Lake Castaic Reservoir. The analysis shows that the mean distance traveled to Marina Del Rey was 13 miles (standard deviation: 10 miles) and to Castaic 42 miles (standard deviation: 97 miles). The proportions of Blacks observed at the sites were 2.4 percent (MDR) and 7.0 percent (Castaic). The proportions Spanish were 1.2 percent (MDR) and 4 percent (Castaic). In Los Angeles County, the proportion Black in 1970 was 10.8 percent and the proportion Spanish was 18.5

Racial discrimination could be practiced by the direct control of access to boat recreation sites; possible discrimination situations are the sale of boats, the sale of boat rental services, and the rental of slip and launching services. Although in other places and at other times these transaction points have been the loci of racial discrimination against Black and Spanish Heritage groups in American society, there is no indication that they are so important at present.

The access of women relative to the access of men may, as with the question of relative racial group access, be subsumed under the question of inferior treatment of the particular group in the housing, credit, and labor markets. Also, there is strong evidence to suggest that women are socialized to accept inferiority to men in sporting and recreational activities.[20]

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percent. Note that about two-thirds of the observed cases are expected to lie within 1 standard deviation of the mean, which implies that the Marina Del Rey market area was far more tightly constrained than was the Castaic market. Notice also Maps C.4 and C.5 in Appendix C; these maps show the relationship between the two launching sites and the major concentrations of Blacks and Spanish Americans and suggest that residents from the high-minority concentrations would have to drive long distances to reach either of the two sites. See also Symonds, Warren and Stallard (1974) for statistics for the one-thousand-yard-wide jurisdiction of the South Coast Regional Commission (Los Angeles portion) showing that the proportions of Black and Spanish Heritage populations in this zone were 2.2 percent and 11.0 percent.

[20]To the extent that the State intervenes in the operation of the coastal land market as it underwrites the construction of new recreational facilities, the degree of racial, age, and gender redistribution of coastal access becomes important as a State policy issue. It is situations such as these that the Dickert, Sorenson article (1974) address. The redistributional aspects of the development of Marina Del Rey are not lost on private agents in the coastal zone development process. The Security Pacific Bank, in an article characterizing Marina Del Rey as an "example of what private and public organizations can accomplish," notes that Marina Del Rey has "attracted a wide variety of businesses which are oriented to the area's residents and boat owners which are, on the average, younger and more affluent than in Los Angeles as a whole" (Security Pacific Bank, 1975); for documentation of their assertion, see Symonds, Warren, and Stallard, (1974).

To summarize, it has been argued in this section that the State needs consider only one issue in its concern for a socially equitable distribution of its boating recreational waters: race, sex, and age questions can be subsumed under the problem of defining and maintaining the distribution of access among different income groups.

2.4 Summary

This chapter has addressed two distinct sets of policy issues confronting the State in managing its coastal and inland water resources. The State should make policy concerning the efficient use of the resources; that is, it must ensure use of the resources at the desired level of congestion. There should also be policy concerning the equitable use of resources: the State must ensure that the resources are distributed in some fashion, specified as public policy, among its different subpopulations.

Policy instruments available for obtaining efficient use include pricing at access points and adjusting the supply of water resources. The State may also exercise options of intervening directly in the markets for private recreational goods and services such as the markets for boats and boat services. To plan for efficient future use, the State must have some method to predict future aggregate demand for its water resources; it must predict the purchasing and recreational behavior of its population at future times.

In the present context, the problem of equity reduces to the determination of the appropriate distribution of access among spatially distinct subpopulations and among different income groups.[21] To institute policies designed to maintain or change a given distribution of access, the State must be able to measure levels of access among different income and spatially distinct subpopulations. It must also design policies which would alter levels of access among different groups. Policy instruments to achieve these goals include adjusting the relative costs of

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[21]Reducing the problems of relative access to the spatial and income partitions of the population simplifies the empirical analysis of Chapter 4. Income and distance can be used as (a priori) independent regressors in the spatial regression technique used to explain and predict probability of boat ownership; no other demographic data are needed. In this way, it is possible to avoid some of the "ecological fallacies" inherent in much spatial analysis (see Hawley and Duncan, 1957).

traveling to water resources and adjusting the supply of facilities in different parts of the State. Changing the level of access among income groups may be accomplished by altering the relative supply of facilities suited to specific high or low cost boat design.

CHAPTER 3

ESTIMATING THE FUTURE DEMAND FOR RECREATIONAL BOATING: AN ASSESSMENT

In the previous chapter it was claimed that the State should be concerned with the efficient management of its coastal and inland waters. This required the State to specify and maintain an optimal level of production of "recreational boating days" by recreationists who used as inputs both the State's water resources and private goods such as recreational boats and time. Since the production of these recreational days by the individual boater was seen to require his interaction in a variety of markets for boating goods and services, the State could choose to intervene in any of these markets to maintain efficient water resource use. Nevertheless, whether it chose to do so or not, if the State were also to plan adequately for future levels of recreational use, it had to evaluate information on the activities of boaters and other agents in these markets.

Present State recreational policy is based in large part on future demand estimates which are simple extrapolations of time trends in per capita boat ownership (see California, 1973). There are two deficiencies in their analysis: first, the data base for analysis consists of only four points (1963, 1966, 1969, and 1972) over a time period hardly longer than the extrapolation interval (1972 to 1980); and second, there is no attempt to integrate into the analysis any understanding of the factors affecting boat ownership, factors which might be predetermined or modified as public policy. A model is needed--preferably an economic model--which could be used to predict future levels of ownership. Taking note that a boat is a "consumer durable," such models might be found in the literature on the demand for cars, refrigerators, television sets, and washing machines, all of which, as are boats, are purchased for use over many years. In this chapter, a particular form of demand model called the "stock adjustment model" is introduced inductively by way of discussing the factors which might reasonably be expected to affect the decision to purchase a boat. Available data series are presented to be used to assess whether any reasonable specification of a stock adjustment model could be estimated.

In choosing boating as a recreational activity, each boater responds to the availability of various inputs. He is concerned with the prices of boats, the availability and location of boating facilities and water resources, the time losses caused by facilities and water-resource congestion, the quantity and distribution of on-site storage, the durability of the boat, and the availability and costs of credit in boat purchase. The first section of this chapter describes, with a series of models, the interests of boaters and other agents in the several markets for the recreational inputs; second, data is presented on the spatial distribution of recreational boating facilities and on the redistribution of storage of the fleet as boaters seek suitable sites distant from their homes; the third section displays data on durability of boats, demonstrating the importance of the relationship between the scrapping rate and the expected lifetime of the boat; Section 3 also presents available data on the use of credit in purchase and on the relationship between sales of boats and scrapping rates.[1] In the fourth section, a simple model to measure annual and per-trip costs of boating is proposed. The model predicts reasonably well the rental prices for boats and gives an intuitive understanding of the relative importance of spatial access to facilities in boat ownership and use. Finally, the stock adjustment model is introduced, and it is shown that there is insufficient data available to estimate with satisfactory precision the parameters of this model. The chapter concludes with a brief discussion of the implications of this finding.

3.1 Simple Models of the Choices Facing Market Agents

It is important to distinguish between the interests of the various agents in the boating services markets. Generally these markets are competitive. This section presents models of the choices of boaters, boat sellers, boat rental agents, slip and dry-storage rental agents, launching and harbor managers, and lending institutions. The models are acceptable to the extent that they explain or predict actual behavior.

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[1]Data for Sections 2 and 3 have been obtained using the analysis of the Master Vessel Registration File. A description of the categories of information on the File and the methods used to prepare the File for analysis are presented in Appendix B.

3.1.1 The Boater

The boater always has the choice of not owning a boat. His choice, if he wishes to take part in recreational boating, is based on whether the total costs of boating are higher if he purchases a boat or if he rents from someone else. In this study, it is assumed that a boater does not find it practical to own a boat for less than a full season because the buying and selling transaction costs are too high. Instead, each year, he calculates the total cost of owning and using a boat for the whole year, divides this cost by the number of days he intends to use the boat, and obtains a daily "rental" of the boat. If the per trip he calculates is less than the daily rental price offered by boat rental agencies, he then purchases a boat or retains the boat he already owns.

The boater's decision about where to store his boat depends on the relative cost of storage at different locations and upon the relative ease of access to recreation sites which the particular storage location allows. Most boat owners store their boats at home and transport them by trailer to recreation sites; but boats longer than about 25 feet cannot be dry-stored easily and must be moored at or near a recreation site. The boater's decision about when and where to use the boat depends upon the value he places upon his own time spent traveling to recreate and on the time actually spent on the water. For employed persons, especially, time is valued differently at different times of the week: on weekdays a boater values his time at his wage rate, while on the weekend it is valued at some small fraction.

3.1.2 Boat Rental Agencies

The choices facing the operator of a boat rental agency are based on his need to absorb all the capital and maintenance costs of owning his boat stocks and, as well, to cover the overhead costs of doing business. At the same time, the operator must offer rental prices which are sufficiently low to attract a profitable volume of business. If all boaters wanted to recreate on every suitable recreating day, it would be unlikely that a boat renter could survive because transaction and overhead costs would make it difficult to offer a service cheaper than owning a boat. Since, however, some boaters wish to boat only occasionally, boat renters can survive in a market for boat-equipment services dominated, perhaps, by private boat owners.

3.1.3 Boat Manufacturers and Boat Dealers

The choices facing the boat manufacturer are fairly straightforward to model: he must build and sell sufficient units at high enough prices to cover expenses and produce a profit. Because the equipment is durable, organized or unorganized markets for used boats may exist; boat manufacturers may be in competition with existing boat owners in the supply of units. New-boat dealers may also participate as brokers in used-boat markets.

It can be seen from the foregoing discussion that boat owners, boat sellers, and boat renters do not have identical interests. If prices of boats were to decrease relative to rental overhead and maintenance cost, more boaters would purchase boats, and the boat rental market would shrink. Some boat rental agencies would go out of business. If the boat stock reached a stationary level (perhaps defined in terms of available water resources and facilities) new-boat sales would decrease to the level of annual scrapping. If the per-trip costs of owning and using a boat became too high, a boatowner would sell his boat; alternatively, a potential boatowner would decide not to purchase one.

3.1.4 Slip and Dry-Storage Renters

The choices facing those who provide slips or dry-storage facilities for rent are also based on profit-maximizing. These entrepreneurs, whether private or public, must set per unit storage costs at a level which allows them to cover capital and labor costs. They compete not only among themselves but also with those boaters who have the option of storing boats at home. Land and capital costs must be covered by revenue from the sale of rental storage services. Land costs vary markedly with the location of the facility and consequently storage costs in high density coastal regions are much higher than at distant inland lakes. While the market for dry-storage is likely to be strictly competitive, the market for moorage may be subject to price-setting.

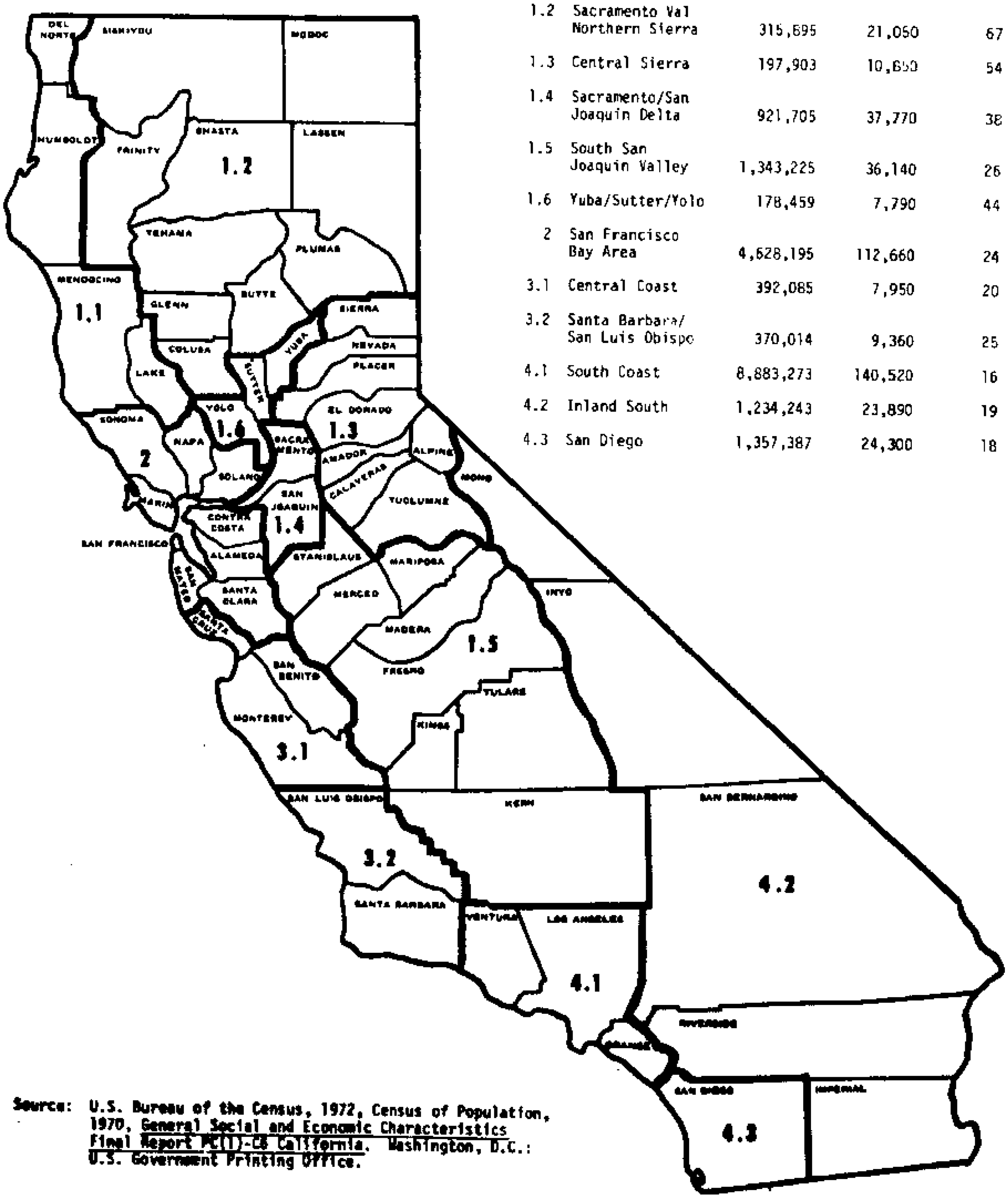
3.1.5 Lending Institutions

Lending institutions are involved at several levels in supplying credit used in the production of boating recreational services. Major financial institutions have supplied long-term loans or have purchased revenue bonds used in the construction of major harbor facilities (Rood and Warren, 1974). It may be assumed that local banks

MAP 3.1

CALIFORNIA BOATING REGIONS AND SUBREGIONS

	Subregion	Population (1970)	Registered Boats (1972)	Boats per Person
1.1	North Coast	184,921	10,710	58
1.2	Sacramento Val Northern Sierra	315,695	21,050	67
1.3	Central Sierra	197,903	10,650	54
1.4	Sacramento/San Joaquin Delta	921,705	37,770	38
1.5	South San Joaquin Valley	1,343,225	36,140	26
1.6	Yuba/Sutter/Yolo	178,459	7,790	44
2	San Francisco Bay Area	4,628,195	112,660	24
3.1	Central Coast	392,085	7,950	20
3.2	Santa Barbara/ San Luis Obispo	370,014	9,360	25
4.1	South Coast	8,883,273	140,520	16
4.2	Inland South	1,234,243	23,890	19
4.3	San Diego	1,357,387	24,300	18



Source: U.S. Bureau of the Census, 1972, Census of Population, 1970, General Social and Economic Characteristics Final Report PC(1)-C6 California. Washington, D.C.: U.S. Government Printing Office.

and savings and loan associations compete to supply credit to small boating businesses. The State of California maintains a revolving credit fund to assist cities and counties in the construction of ramps and other launching facilities. The data of Section 3.3.2 suggests that in recent years banks and savings corporations have increasingly supplied credit for new-boat purchases.

3.2 Spatial Distribution of the Fleet: Boater Response to Geographical Dispersion of Water Resources and Facilities Supply

The size of the recreational fleet and its distribution among the counties and regions of the State of California has been of interest to State agencies since the late 1950's (California, 1957, 1958, 1969), and since then various data have been published to indicate regional fleet and facilities stock levels (see, e.g., California, 1964; 1966; 1970; 1974). On the other hand, only the early study of Leeds, Hill and Jewett (California, 1964) has measured directly the responses and attitudes of boaters to changes in facilities supply. This study's findings have been the basis of subsequent California boat recreation policy-making. However, other pieces of indirect and partial evidence do exist, and they give some clues about recent boater behavior and preferences (see, especially, the study of gasoline use, California, 1972b).

This section presents another small set of data to indicate the inter-regional spatial preferences of boaters. The data are based, in part, on the analysis of the DMV Vessel Master File using the fact that each record on the File contains indication of the owner's county of residence and the boat's storage county.

The designation of regions to be used in summarizing spatial distribution is arbitrary. The State of California has used many such schemes for planning and administrative purposes. It has been found, by experience, that it is most convenient to follow county lines in designating regional boundaries. The regions and subregions used here were chosen to reflect similarities in levels of urbanization, the homogeneity of water resources, and the limitations of producing time-series data from available sources not having a common regionalizing scheme. The regions selected are not completely satisfactory but no less so than others which might have been used. The boundaries of regions and subregions are shown in Map 3.1.

TABLE 3.1

NUMBER OF REGISTERED BOATS BY PROPULSION AND LENGTH CLASS AND PERCENTAGE OF BOATS BY PROPULSION IN EACH LENGTH CLASS
California 1972

Length (feet)	Inboard	Outboard	InBoard/ Outdrive	Jet	Hand Propelled	Sailboat	Sailboat/ Aux. Motor	Other	Total in Length Class (% of Total Fleet)
8 to 11	390	26,630	60	90	1,990	4,300	820	1,920	36,200
(Row %)	1.1	73.6	.2	.2	5.5	11.9	2.3	5.3	8.3
12 to 15	4,140	194,170	960	150	6,190	10,940	500	5,700	222,750
(Row %)	1.9	87.2	.4	.1	2.8	6.9	.2	2.6	51.1
16 to 19	21,530	59,910	28,650	4,650	410	3,600	350	1,930	121,030
(Row %)	17.8	49.5	23.7	3.8	.3	3.0	.3	1.6	27.7

TABLE 3.1 - Continued

Length (feet)	Inboard	Outboard	InBoard/ Outdrive	Jet	Hand Propelled	Sailboat	Sailboat/ Aux. Motor	Other	Total in Length Class (% of Total Fleet)
20 to 25	9,330	5,390	7,340	440	10	4,730	2,770	1,730	31,740
(Row %)	29.4	17.0	23.1	1.4	0.0	14.9	8.7	5.5	7.3
26 to 29	14,040	1,740	600	0	0	950	3,770	610	21,710
(Row %)	64.7	8.0	2.8	0.0	0.0	4.4	17.4	2.8	5.0
40 or More	1,930	330	200	0	0	40	260	80	2,840
(Row %)	68.0	11.6	7.0	0.0	0.0	1.4	9.2	2.8	.7
Total	51,360	288,170	37,810	5,330	8,600	24,560	8,470	11,970	436,270
(Total %)	11.8	66.1	8.7	1.2	2.0	5.6	1.9	2.7	100

Note: Based on a 10% sample of current California registrations, November 30, 1972.
Missing values: 12,830.

TABLE 3.2

NUMBERS OF REGISTERED BOATS BY SUBREGION AND PROPULSION AND PERCENTAGE OF BOATS BY PROPULSION IN EACH SUBREGIONAL FLEET
California 1972

Subregion	Inboard	Outboard	Inboard/ Outboard	Jet	Hand Propelled	Sailboat	Sailboat/ Aux. Motor	Other	Subregion Total (% of Calif. Fleet)
1.1 North Coast	770	8,490	610	30	210	90	30	230	10,460
	7.6	81.2	5.8	.3	2.0	.9	.3	2.2	2.4
1.2 Sacramento Valley/ Northern Sierra	1,190	17,170	1,320	60	390	370	50	160	20,710
	5.7	82.9	6.6	.3	1.9	1.8	.2	.8	4.7
1.3 Central Sierra	720	8,590	620	50	270	260	60	90	10,660
	6.8	80.6	5.8	.5	2.5	2.4	.6	.8	2.4
1.4 Sacramento-San Joaquin Delta	2,880	29,560	2,440	190	600	920	250	430	37,270
	7.7	79.3	6.5	.5	1.6	2.5	.7	1.2	8.5
1.5 South San Joaquin Valley	2,870	28,570	19.0	210	520	105	250	430	35,690
	8.0	80.1	5.4	.6	1.5	2.9	.7	1.2	8.2
1.6 Yuba/Sutter/Yolo	500	6,170	460	80	130	250	20	40	7,650
	6.5	80.7	6.0	1.0	1.7	3.3	.3	.5	1.8
2 San Francisco Bay Area	14,060	69,640	10,880	151	2,740	6,670	214	281	110,450
	12.7	63.1	9.9	1.4	2.5	6.0	1.9	2.5	25.3

TABLE 3.2 - continued

Subregion	Inboard	Outboard	Inboard/ Outboard	Jet	Hand Propelled	Sailboat	Sailboat/ Aux. Motor	Other	Subregion Total (% of Calif. Fleet)
3.1 Central Coast	960 12.3	5,420 69.5	630 8.1	60 .8	120 1.5	290 3.7	110 1.4	210 2.7	7,800 1.8
3.2 Santa Barbara/ San Luis Obispo	1,220 13.3	6,050 65.8	680 7.6	110 1.2	120 1.3	520 5.7	130 1.4	360 3.9	9,190 2.1
4.1 South Coast	20,920 15.1	76,860 55.6	14,400 10.4	2,650 1.9	2,570 1.9	10,830 7.8	4,460 3.2	5,580 4.0	138,290 31.7
4.2 Inland South	1,860 7.9	17,320 73.6	2,130 9.1	280 1.2	540 2.3	740 3.1	310 1.3	350 1.5	23,530 5.6
4.3 San Diego	3,240 13.6	13,980 58.6	1,680 7.0	100 .4	380 1.6	2,490 10.4	750 3.1	1,220 5.1	23,840 5.5
Out of State	170 23.0	350 47.3	50 6.8	0 0.0	10 1.4	80 10.8	40 5.4	40 5.4	740 .2
Total State Total %	51,360 11.8	288,170 66.1	37,810 8.7	5,330 1.2	8,600 2.0	24,560 5.6	8,470 1.9	11,980 2.7	436,280 100

Note: Based upon a 10% sample of current California registrations, November 30, 1972.
Missing values: 12,820.

3.2.1 Spatial Distributions of Length, Propulsion, and Use Categories of Boats

The relationship, for the California fleet, between boat length and mode of propulsion is shown in Table 3.1. Outboard power boats form a very high proportion, almost half, of the fleet. Trailered boats (that is, roughly, boats less than about 20 feet long) make up 87 percent of the California fleet. In Table 3.2 the spatial distribution of propulsion types is shown; the table indicates that in the urbanized coastal subregions of the State (the San Francisco Bay Area, the South Coast, Santa Barbara and San Luis Obispo, and San Diego), small outboards form relatively smaller proportions of the fleets than in the inland rural regions. Ocean-oriented, inboard power boats and sailboats form a correspondingly larger proportion.

Published stock data on the distribution of the uses of registered boats show that "pleasure" boats form well over 85 percent of the fleets in all counties. To establish further the relative importance of the rental market, Table 3.3 has been prepared to show the spatial distribution of the rental fleets in 1966 and 1974. The table shows that, in all subregions, the rental fleet has been and remains a very small proportion of the fleet although somewhat larger relative numbers are found in the North Coast subregion, the Central Sierra subregion, and the Inland South subregion.

3.2.2 Spatial Redistribution of Boat Storage, 1972

During the 1960's, second-home ownership became very popular among the urban population of the State. The rural portions of the State's coastline were used much more for weekend recreational purposes than in earlier periods. In northern California, inland lakes such as Clear Lake, in Lake County, and Lake Tahoe, lying in part in Placer and El Dorado Counties, became important second-home settlements for the San Francisco Bay population. In southern California, Lake Isabella, in Kern County, and Big Bear Lake, in San Bernardino County, began to serve as water-oriented, second-home locations for Los Angeles area residents. Also, good highway access opened up the Colorado River areas to the Los Angeles boater.

In order to minimize transportation costs, many boat-owners now store their boats at distant recreation sites. As a consequence, the spatial distribution of boats is somewhat different from the distribution of registered owners. The imbalance between the distributions of boat storage and owner residence is summarized in Table 3.4. It

TABLE 3.3

NUMBER OF BOATS REGISTERED AS LIVERY BY SUBREGION
California 1966 and 1974

		1966		1974	
		Livery Fleet Size	Proportion of Total Fleet	Livery Fleet Size	Proportion of Total Fleet
1.1	North Coast	1,156	10.0%	1,348	11.0%
1.2	Sacramento Val/ Northern Sierra	555	3.3%	870	3.4%
1.3	Central Sierra	335	4.4%	492	3.8%
1.4	Sacramento/San Joaquin Delta	723	2.3%	502	1.2%
1.5	South San Joaquin Valley	623	2.1%	379	1.0%
1.6	Yuba/Sutter/Yolo	88	1.3%	50	.6%
2	San Francisco Bay Area	1,708	1.8%	830	.7%
3.1	Central Coast	136	2.2%	169	1.8%
3.2	Santa Barbara/ San Luis Obispo	286	3.6%	198	1.9%
4.1	South Coast	1,104	.9%	897	.6%
4.2	Inland South	1,140	5.1%	1,036	3.9%
4.3	San Diego	637	3.1%	348	1.3%
	State-Wide	8,501	2.2%	6,803	1.4%

Source: California (1966) and California Department of Motor Vehicles Total Vessel Registrations by County, December 31, 1974.

TABLE 3.4

REGISTERED FLEET SIZE, RATIO OF STORED BOATS TO REGISTERED BOATS BY LENGTH CLASS, NUMBERS OF LAUNCHING LANES AND SLIPS 1966 AND 1970: BY SUBREGION, CALIFORNIA

	Launching Lanes 1966	Launching Lanes 1970	Length Less than 20 Feet: Registered Fleet Size	Length Less than 20 Feet: Ratio Boat Storage to Boat Registration	# of Registered Boats (<20 ft, 1972) per Lane (1970)	# of Slips 1966	# of Slips 1970	LENGTH 20 to 39 Feet: Registered Fleet Size	LENGTH 20 to 39 Feet: Ratio Boat Storage to Boat Registration	LENGTH >40 FEET: Registered Fleet Size	LENGTH >40 FEET: Ratio Boat Storage to Boat Registration	# of Registered Boats (>20 ft, 1972) per Slip (1970)
1.1 North Coast	188	271	9,970	1.29	47	4140	4255	720	1.18	20	--	.17
1.2 Sacramento Valley /Northern Sierra	200	179	19,800	1.05	111	3,358	3,305	1,160	1.08	90	--	.35
1.3 Central Sierra	119	167	10,380	1.24	62	1,586	2,203	470	1.57	0	--	.21
1.4 Sacramento/San Joaquin Delta	72	72	35,400	1.00	492	6,257	4,700	2,220	1.27	150	1.5	.50
1.5 South San Joaquin Valley	135	199	34,040	1.03	171	1,805	2,385	2,010	.85	90	.66	.88
1.6 Yuba/Sutter/Yolo	11	27	7,440	1.00	276	807	656	330	.72	20	--	.53
2. San Francisco Bay Area	272	252	97,170	.94	385	15,702	17,416	14,720	.96	770	.83	.89
3.1 Central Coast	12	33	7,120	.99	216	1,012	1,428	800	1.19	30	--	.58
3.2 Santa Barbara/ San Luis Obispo	27	27	8,110	1.02	300	860	1,282	1,180	1.04	70	--	.97
4.1 South Coast	154	147	114,980	.96	782	18,507	24,027	24,160	.99	1,380	1.06	1.06
4.2 Inland South	221	265	22,150	1.13	84	2,627	3,537	1,670	.86	70	--	.49
4.3 San Diego	79	79	19,520	1.02	247	3,155	5,286	4,580	1.1	200	--	.90
Out of State	--	--	520	.4	--	--	--	190	.16	40	--	
Total State	1,690	1,703	386,600		227	59,816	70,480	54,210		2,930		.77

Source: California (1966, 1970). Fleet size based upon 10% sample of current California registrations, November 1972.

shows the regional distribution by length of registered boats and the ratio of the number of boats stored in the region to the number of boats registered. The ratio is a simple indicator of the degree to which a subregion accepts boats from other subregions (proportion greater than 1) or places pressure on other subregions (proportion less than 1). The ratio is an indicator of net flows across subregional lines because, generally, there are storage transfers in both directions across the boundary. The breakdown by length indicates that some subregions place different demands upon other subregions according to the size of the boat. For example, the South Coast, because of its size, places significant pressure on some other subregions with only a small proportion (4 percent) of its trailered fleet; by contrast, it accepts the storage of an extra 6 percent of its over-40-foot moored boats (most of which, probably, are registered to owners living in the San Bernardino portion of the Los Angeles metropolitan area).

The effect of the redistribution of storage on the ratio of boat stocks to facilities stocks is also shown in Table 3.4. By comparing the per-ramp boat registration (less than 20 foot) to the ratio of boat storage to boat registration (less than 20 feet), it can be seen that boats are moved out of subregions which have high per-ramp ratios and into those which have low per-ramp ratios. This suggests that boaters seek out-of-county storage in regions which have low utilization of ramps. Similar comparison of per-slip boat registration (more than 20 foot) and the more-than-20-foot storage to registration ratios does not lead to such unambiguous results: boaters seem to move larger boats to subregions which have high utilization of slips. This suggests that the per-slip registration ratio is a useful but fairly crude measure of the availability of suitable storage facilities.

Table 3.5 shows the numbers of registered boats redistributed from the county of owner's residence to the county of boat storage by subregion. These data show that cross-county storage interactions are related to two types of recreational use pattern. The first pattern is associated with nearby storage when the most convenient storage location is on the other side of a nearby county line but in the same subregion (these numbers are on the diagonal of the table); the second pattern of cross-county storage moves the boat from one subregion to another (the off-diagonal numbers), usually from a metropolitan subregion to a less urbanized subregion. For example, in the San Francisco Bay Area where the county geographical scale is small, there is a large amount of out-of-county storage but about half of this originates and has destination in the Bay Area; the other half places demands on other subregions (most

TABLE 3.5

NUMBERS OF REGISTERED BOATS REDISTRIBUTED FROM COUNTY OF OWNER'S RESIDENCE
TO COUNTY OF BOAT STORAGE BY SUBREGION
California 1972

	BOAT STORAGE SUBREGION													
Subregion	1.1	1.2	1.3	1.4	1.5	1.6	2	3.1	3.2	4.1	4.2	4.3	Out of State	Total
1.1 North Coast	95	144	22	7	2	31	37	1	0	4	5	0	1	349
1.2 Sacramento Valley/ Northern Sierra	65	491	20	12	2	8	28	0	1	10	0	4	4	645
1.3 Central Sierra	17	11	162	114	12	8	40	1	1	6	5	3	2	382
1.4 San Joaquin Delta	136	138	573	162	49	121	388	5	8	75	13	6	5	1,677
1.5 South San Joaquin	23	20	124	228	620	3	125	34	91	88	34	13	8	1,411
1.6 Yuba/Sutter/Yolo	71	43	82	81	3	5	91	1	1	55	0	1	0	436
2 San Francisco Bay	2,776	791	1,900	1,451	222	110	7,918	360	28	85	29	147	33	15,850
3.1 Central Coast	30	26	50	22	19	2	97	226	12	12	4	5	0	505
3.2 Santa Barbara/ San Luis Obispo	30	8	3	5	23	0	3	15	76	169	16	--	3	351
4.1 South Coast	96	169	123	69	1,241	3	100	20	272	4,607	3,381	558	103	10,742
4.2 Inland South	30	26	8	8	39	0	19	1	14	617	429	279	30	1,500
4.3 San Diego	13	12	12	4	11	4	14	2	2	74	168	0	32	348
Out of State	28	41	91	29	17	8	77	6	13	5	45	127	0	437

Note: Based on 100% breakdown of out-of-county storage of boats currently registered, November 1972.

notably, the North Coast subregion which includes Lake County, the Central Sierra, and the Sacramento-San Joaquin Delta). There is very little movement of boats into the San Francisco Bay Area from other regions. The data of Table 3.5 suggest that subregional redistribution of boat storage drops off with distance to the storage location but is affected by available water resources and facilities.

3.2.3 Time Series Data on Boating Stocks and Facilities Stocks

The discussion of the previous section suggests that to determine the response of boaters to facilities supply increase, regional time series data should be obtained. A search of available sources to create time series on regional facilities stocks yielded the scanty data which is presented in Table 3.6. In the main, data are available only for the years 1962, 1966, and 1970 although some further data for the years 1959 and 1974 have been obtained for the South Coast region. The tabulation shows that percentage increases in numbers of launching lanes for the period were less than 26 percent with lowest values for the regions containing the two metropolitan areas (regions 2 and 4). On the other hand, the smallest increase in mooring facilities stock was 25 percent and increases for regions 2 and 4 were 55 percent and 76 percent, respectively. Table 3.7 allows comparison of these facilities stock increase data with the relative increases of different length classes of boats in the decade 1962 to 1972. The pattern reveals increases in all classes of boats in all regions but, usually, much higher increases of boat stocks in the length classes 22 to 25 feet and more-than-26 feet.

The time series data on stocks of facilities and stocks of boats do not allow the determination of whether new facilities have been built to relieve congestion of existing facilities or whether new boats have been purchase in response to expansion of facilities. All that can be seen from the data is that there is a good correlation between the increases in certain classes of boats and increases in boating facilities suited to the particular class. It does appear, from the cross-sectional data on out-of-county storage, that boaters seem to respond to the availability of uncongested launching facilities. It may also be noted that since the construction of new harbors requires a much longer lead time than the construction of new boats, it may be assumed that new harbor construction leads to increases in boating stock and not the converse.

TABLE 3.6

AVAILABLE DATA ON REGIONAL FACILITIES
STOCKS AND PERCENT INCREASES
1962 to 1970

	# Launching Lanes	# of Slips & Mooring Spaces
Region 1		
1962	673	14,269
1966	732	17,893
1970	832	17,436
% Increase (1962-70)	22%	25%
Region 2		
1962	256	11,246
1966	268	15,679
1970	252	17,416
% Increase (1962-70)	-2%	55%
Region 3		
1962	66	1,591
1966	61	2,369
1970	83	2,710
% Increase (1962-70)	26%	70%
Region 4		
1959		11,656
1962	428	18,735
1966	454	24,289
1970	502	32,921
1974		37,421
% Increase (1962-70)	11%	76%

Source: California (1959, 1964, 1966, 1970, 1974).

TABLE 3.7

NUMBERS OF REGISTERED BOATS BY LENGTH AND REGION
1962 and 1972, California

	Less Than 22 Feet	22 to 25 Feet	More Than 26 Feet
Region 1			
1962	73,706	1,072	1,083
1972	130,829	2,195	2,969
% Increase	77.5%	105%	174%
Region 2			
1962	62,558	2,769	4,148
1972	106,882	4,336	8,458
% Increase	70.9%	56.7%	104%
Region 3			
1962	9,658	317	528
1972	13,482	670	780
% Increase	39.6%	11.1%	48%
Region 4			
1962	107,421	4,642	7,967
1972	150,574	8,560	15,223
% Increase	40.2%	84.4%	91%

Source: California (1964; 1973).

TABLE 3.8

HULL MATERIAL AS A PERCENTAGE OF VINTAGE[1]
California Fleet 1972

	Wood	Aluminum	Steel	Plastic	Metal	Other
1971-1972	7.6	22.9	.6	66.0	0	2.9
1968-1970	8.3	27.3	.9	62.2	0	1.2
1963-1967	17.2	18.8	.5	54.5	7.3	1.8
1958-1962	37.2	1.2	0	51.3	10.3	.2
1953-1958	59.7	1.1	.1	29.8	8.9	.1
Before 1953	74.7	1.4	1.2	11.0	11.5	.2

[1]Vintage was calculated using the Vessel Master File variables "year built" or "year model." There was no information for about 10% of boats; it is assumed that these were older boats and that their hull materials were distributed according to the distributions shown for the older vintages.

Source: Based on 10% sample of current California registrations, November 30, 1972.

TABLE 3.9

SCRAPPING RATES, SIZE OF 1972 FLEET, AND EXPECTED LIFETIMES OF BOATS BY LENGTH AND PROPULSION
California

	Propulsion	Fleet Size (1972)	Scrapping Rate	Estimated Average Lifetime (Half-Life) in years
8-11 feet	Power	25,010	.09	7
	Sail	6,900	.07	10
	Other	4,640	.09	7
12-15 feet	Inboard	4,740	.08	8
	Outboard	193,960	.05	16
	Sail	11,270	.04	17
	Other	13,640	.06	12
16-19 feet	Inboard	21,210	.06	12
	Outboard	59,710	.04	17
	Inboard/ Outboard	30,820	.02	35
	Jet	4,582	.02	35
	Sail	3,860	.05	14
	Other	2,460	.07	10
20-25 feet	Inboard	3,860	.05	14
	Outboard	5,250	.05	14
	Inboard/ Outboard	7,060	.02	35
	Sail	6,820	.02	35
	Propulsion	30,470	.04	17
26-39 feet	Inboard	13,890	.03	23
	Outboard	1,880	.03	23
	Power	17,660	.03	23
	Sail	4,760	.02	35
	Propulsion	22,020	.03	23
40 feet or more	Power	2,170	.03	23
	Sail	380	.02	35
	Propulsion	2,610	.03	23

TABLE 3.10

NUMBERS OF BOATS AND PERCENTAGE OF OWNERS USING CREDIT IN PURCHASE BY LENGTH, PROPULSION, AND VINTAGE (YEAR MODEL OR YEAR BUILT) OF BOAT
California 1972

	1971-1972		1968-1970		1963-1967		1958-1962		1953-1958		Before 1953		Size of Fleet
< 12 feet													
Outboard	3,750	3.7	5,370	5.8	5,620	3.6	3,210	2.2	1,670	1.8	1,350	.7	21,770
Sailboat	1,630	1.8	1,390	2.2	1,140	2.6	50	---	40	---	---	---	4,250
Other	550	---	850	4.7	920	2.1	710	1	250	8	90	---	3,670
													29,490
12-15 feet													
Inboard	180	11.1	180	22.2	460	8.7	1,460	10.3	990	10.1	270	3.7	3,540
Outboard	19,970	22.0	30,190	15.6	39,390	10.1	46,710	8.9	27,560	5.1	5,870	1.4	169,690
Inboard/Outboard	200	55	370	37.8	350	25.7	---	---	---	---	---	---	930
All Sailboat	2,920	12.0	4,520	6.9	2,930	5.1	160	---	---	---	---	---	10,520
Other	1,830	7.7	2,520	9.1	2,670	6.0	2,760	3.6	370	2.7	250	3.4	10,420
													195,100
16-19 feet													
Inboard	1,720	50.6	2,490	41.4	6,730	25.6	5,440	16.0	2,300	8.3	1,210	7.4	19,890
Outboard	6,020	58.3	10,410	37.4	14,480	19.9	19,300	14.6	4,790	9.0	590	6.8	55,590
Inboard/Outboard	9,100	64.3	11,280	42.8	7,640	24.2	80	25	20	---	---	---	28,120
All Sailboat	1,580	24.1	1,050	21	960	9.6	50	---	60	---	50	---	3,730
Other	3,030	59.7	1,550	49.7	720	12.5	820	7.3	150	6.7	270	7.6	6,560
													113,870

TABLE 3.10 - continued

	1971-1972		1968-1970		1963-1967		1958-1962		1953-1958		Before 1953		Size of Fleet
20-25 feet													
Inboard	450	33.3	520	30.8	1,600	28.8	3,250	28	1,410	16.1	1,520	18.6	8,750
Outboard	540	29.6	920	21.7	1,360	17.2	1,520	17.8	660	13.6	160	12.5	5,140
Inboard/Outboard	2,310	58.4	3,100	48.1	1,710	26.3	20	---	---	---	---	---	7,140
All Sailboat	1,670	62.6	3,500	37.1	2,250	32.9	10	---	10	---	10	---	7,260
Other	350	56.3	90	55.6	690	21.7	660	13.6	50	---	200	5	2,040
													30,330
26-39 feet													
Inboard	520	55.8	1,300	59.2	4,100	48.5	3,390	45.7	830	27.7	3,120	25.0	13,260
Outboard	280	35.7	450	46.7	510	35.3	190	31.6	50	---	120	---	1,600
Inboard/Outboard	200	65.0	290	72.4	100	50	---	---	---	---	---	---	590
All Sailboat	1,340	67.9	1,820	57.7	1,290	34.9	30	---	50	---	80	---	4,610
Other	---	---	20	---	190	---	130	---	20	---	190	---	540
													20,600
40 feet or more													
Inboard	120	33	340	64.7	240	37.5	320	25	80	25	660	43.9	1,760
Outboard	160	69	140	64.3	1	---	2	--	---	--	---	---	330
Inboard/Outdrive	60	50	120	83	1	---	---	--	---	--	---	---	190
All Sailboat	50	80	90	67	50	60	90	44	---	--	---	---	280
Other	---	---	10	---	20	--	---	--	10	--	20	---	60
													2,620

Note: Based on 10% sample of current California registrations, November 30, 1972. Missing values (estimated) 15%.

3.3.1 Boat Durability, Annual Scrapping Rates, and the Expected Lifetimes of Boat Classes

Boat durability is an important quality to be assessed by the boater in purchasing a boat. Durability depends on many factors including the design of the boat, how it is to be used, and the hull material. The level of maintenance provided by the owner after purchase may also affect the boat's durability.[2] There have been marked changes in the construction materials used in boat construction in the last 20 years. Table 3.8 displays the proportion of each vintage of boat in the 1972 fleet constructed from the more widely used hull materials. Disregarding the possible effects of different scrapping rates for different materials, the table suggests that before the early 1950's nearly all boats were constructed from wood. Since then, there has been experimentation with various forms of metal hulls (and aluminum is now used in construction of about 20 percent of new boats); however, since the mid-fifties, the majority of boats have been constructed from plastic (fiberglass). Both aluminum and fiberglass are suited to mass production, are relatively light, and require low maintenance.

Using the 1972 registration information, estimates of scrapping rates have been calculated. The estimates use the numbers of boats registered in the period 1969 through 1971, but not re-registered in 1972; the annual scrapping rate, δ, is calculated by assuming that the proportion of boats which were not re-registered was three times the annual scrapping rate. It was found that the calculated scrapping rates did not vary much with vintage but were quite different for different length-propulsion classes. It was not possible to take hull material into consideration. It is assumed, though, that wooden boats may be scrapped at a faster rate than either plastic or aluminum boats.

Using the scrapping rate estimate and assuming that they are constant over time, it is possible to calculate estimates of average lifetime for each length-propulsion class of boat. The lifetime is assumed to be the time required for a vintage of boats to decay in size with scrapping until it is half its original size. The formula used is

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[2]Parks (1974) has presented these ideas on scrapping and has used them in modeling consumer choice in the discarding of automobiles. To estimate his models he was able to use the extensive data on automobile scrapping in the United States for the period 1947 through 1972.

$$(1 - \delta)^T = 1/2$$

Table 3.9 shows the estimated "all vintage" scrapping rates and expected lifetimes of various length propulsion classes. The numbers are expected to be more acceptable for those classes of boats which have a vintage mix which includes a sizable number of boats older than the average lifetime estimate (for example, small power boats and inboards of all lengths). There is great variability in the expected lifetimes: estimates range from about 8 years for small outboards to about 35 years for large sailboats.

3.3.2 Credit Use in Boat Purchase

The extent of credit use in the purchase of consumer durables and in the purchase of houses is of considerable interest in predicting future demand for these goods. Moreover, since the supply of credit may be controlled in a discriminatory fashion, it is important to investigate the effect of credit supply on the access of different population groups to goods, facilities, and the accumulation of wealth. In this study, credit use in boat purchase has been estimated by assuming that if the boat registration record contained information about a "legal owner" then the boat was being purchased using installment credit. (Lending institutions retain legal ownership while a loan is being paid and are required to notify the Department of Motor Vehicles when payment is complete.)

The extent of credit use by length, propulsion, and vintage is displayed in Table 3.10. The relative importance of credit use in boat purchase may be inferred by comparing the differences in use rates among owners of the different categories of boats. The data of Table 3.10 suggest that short-term loans are used to purchase smaller boats: the proportion of owners still using boat loans after 4 years is much lower than those using credit for initial purchase in 1971-72. In the purchase of large boats, there is no such rapid drop in credit use for the older vintages: large power boats often have legal owners even when the boats are more than 10 years old.

The information of Table 3.10 is only suggestive; it may be evaluated, however, by referring to the results of more complete studies of credit use in purchase of consumer durables and houses. Hendricks, Youmans and Keller (1973) have reported results of a major study of installment debt use in the purchase of household durables. Their conclusions may be summarized as follows:

1. Expenditures on major household durables were at about the same proportion of incom for family incomes over the range $5,000 t $15,000 per annum; the proportion was lower at lower incomes and also began to decline at higher incomes.

2. Although families at higher income levels were likely to be at later stages in the life-cycle, life-cycle and related family unit characteristics were insufficient to explain the major portion of the income that families at different income levels spent on automobiles and major household durables.

3. Over the fifties and sixties, the upward shift of income at all levels may have meant that the decline in expenditures as a proportion of income at high levels was offset, all or in part, by the greater proportion of income spent on durables by families whose income rose from low to not-so-low levels.

4. For individual families, perception of financial progress rather than income change itself was likely to be most important in influencing whether major discretionary expenditures, especially on major consumer durables, occurred at an accelerated rate.

5. Those who thought their financial position to be secure but that inflation rates would continue at a high rate were likely to consider major investment in consumer durables. Conversely, those who considered that their job security was low would choose to postpone major purchases even in times of high inflation.

6. In general, the ratio of outstanding debt to annual income was approximately constant for incomes up to $10,000, but began to fall at higher incomes. At $20,000 the proportion of installment debt used in the purchase of household consumer durables began to fall off very rapidly, with the absolute level of installment beginning to decline.

7. Supply factors, especially the liberalization of standards of credit-worthiness and the introduction of longer maturities, have been important determinants of increases in credit use.

8. Evidence from attitude surveys suggests that during the sixties, Americans became more favorably disposed toward borrowing.

Bell has reported analysis of long- and short-term debt structures of Black and White families at different stages of the lifecycle; his results corroborate and extend the Hendricks, Youmans and Keller study. He has shown that there is a greater incidence of short-term debt among Black families although total indebtedness among Black families is lower than among White families. He suggests this could be explained by the relatively greater shortage of owner-occupied housing (the most common form of wealth accumulation) available to Black families in metropolitan areas. He further suggests that, even if there were no segregation or discrimination in the housing market, greater job uncertainty among Black families would induce a higher ratio of short-term to long-term debt, especially when this uncertainty was coupled with expectations of smaller future earnings.

It seems appropriate, in making inferences from studies of the supply and demand for credit, to consider trailerable boats to be more like household goods, and larger power and sailboats more nearly like housing. It seems likely that the short-term attitudes and behavior of middle-income families dominate credit use in the purchase of smaller boats. The long-term credit use behavior of upper-income families should dominate the credit use of large moored boats. If these inferences are correct, several implications may be drawn:

1. Middle-income families, in times when prospects are good (most of the sixties), when attitudes toward credit use are becoming more positive, and when the supply of credit is extremely elastic, will purchase more consumer goods, including recreational boats. In times of expensive credit and high job uncertainty, middle-income consumers will not use credit to purchase durable goods regardless of the inflation rate.

2. High-income families are more likely to use boat ownership as one possibility among many in the management

of an extensive asset portfolio. Price discrimination by suppliers of credit may enable them to offer favorable limited-volume credit toward luxury boat purchase in times when the available long-term loan funds for housing are curtailed. In times of high inflation and recess, sales of large boats may remain as high as in times of low interest rates and general economic well-being. It is expected that sales of new luxury boats are determined by the number of high-income families, their spatial distribution with respect to recreational harbors, and the expansion of harbor capacity.

3. Low-income families of all ethnic groups are unlikely to be able to invest in housing much less expensive recreational equipment. They are more likely to use available short-term credit supply for necessities such as automobile purchase and medical costs than for recreational goods.

In short, changing supply and demand for long- and short-term credit should be considered in assessing the changes in boat ownership during the decade of the sixties and in projecting demand for water recreation in the late seventies.

3.3.3 Annual Sales of Boats: The Size of the California New Boat Market

Just as data on scrapping rates and use of credit can be important information about the demand for recreational boating services, similarly, annual sales of new boats can indicate changes in tastes and responses to changes in economic conditions. Data on California sales of recreational boats has been abstracted from the DMV Vessel Master File by assuming that all boats purchased in California have either a current or a non-current registration record on the File. Sales estimates are presented in Table 3.11. The available 1972 File contained data only for the year 1972 and earlier (and good data only for the years after 1966 when electronic registration was commenced; estimates for 1964 and 1965 have been obtained by assuming a low scrapping rate for boats purchased in these years and registered first in 1966). Estimates for 1973 sales can be made using published, end-of-year stock changes and estimated scrapping levels. Table 3.11 also shows available national sales and price data.

The sales estimates and the scrapping estimates for 1972 and 1973 are compared in Table 3.12. It should be

TABLE 3.11

AVAILABLE DATA ON NUMBERS OF BOATS SOLD AND PRICES BY PROPULSION: UNITED STATES: AND NUMBERS OF BOATS SOLD BY LENGTH AND PROPULSION, CALIFORNIA: BY YEAR, 1964 THROUGH 1972

OUTBOARDS

	UNITED STATES				CALIFORNIA			
	Units (000)	Factory Price	Price to Consumer	Markup	8-11 ft	12-15 ft	16-19 ft	20-25 ft
1964	250		523		2,680	11,330	3,600	390
1965	250		532		2,720	10,410	3,570	260
1966	266		548		2,760	10,040	3,280	360
1967	260	361	569	208	2,550	9,850	3,570	380
1968	283	368	575	215	2,670	10,540	3,610	380
1969	310	402	618	218	2,370	12,730	3,850	350
1970	276	425	642	216	2,360	11,280	2,780	340
1971	278	456	680	222	2,110	10,960	3,570	300
1972	375	678	716	208	2,270*	11,330*	3,857*	348*

TABLE 3.11 - continued

INBOARD

	UNITED STATES				CALIFORNIA			
	Units (000)	Factory Price	Price to Consumer	Markup	16-19 ft	20-25 ft	26-39 ft	40+ ft
1964					2,400	590	1,020	100
1965					1,520	300	960	80
1966					1,320	250	780	80
1967	8,861		12,175		1,120	180	580	60
1968	7,995		16,285		1,210	290	390	100
1969	7,304		16,787		1,070	170	560	230
1970	6,887		16,564		910	180	350	160
1971	3,732		18,326		680	240	220	130
1972	5,160		23,062		930*	270*	350	180

TABLE 3.11 - continued

INBOARD-OUTDRIVE

	UNITED STATES				CALIFORNIA		
	Units (000)	Factory Price	Price to Consumer	Markup	12-15 ft	16-19 ft	20-25 ft
1964	12,000		3,860			20	310
1965	17,000		3,740			210	1,880
1966	32,000		3,764			160	2,870
1967	36,000		3,931	1,111		170	3,580
1968	42,000		3,960	1,223		120	3,920
1969	49,000		4,120	1,080		150	4,250
1970	43,000		4,243	1,103		190	6,250
1971	44,000		4,562	1,119		100	4,560
1972	63,000		4,888	1,212		60*	5,612*

TABLE 3.11 - continued

SAILBOATS

	UNITED STATES				CALIFORNIA					
	Units (000)	Factory Price	Price to Consumer	Markup	<12	12-16 ft	16-19 ft	20-25 ft	26-39 ft	40+ ft
1964					180	250	110	170	60	20
1965					810	1,070	620	760	600	20
1966					560	1,170	300	1,000	450	20
1967	24,730		862		620	1,390	390	720	690	60
1968	33,461		836		680	1,470	410	1,050	640	10
1969	36,583		826		510	1,800	450	1,110	660	60
1970	40,993		883		520	1,900	560	910	700	60
1971	65,711		801		810	1,700	690	920	800	50
1972	82,686		692		1,040*	1,650*	970*	850*	650	90

*Numbers obtained by analyzing the file have been multiplied by a correction factor of 1.3. For explanation see Appendix B.

Source: California sales data based on a 10% sample of all registration records on the DMV Vessel Master File for November 30, 1972. National sales price and quantity data abstracted from the National Association of Engine and Boat Manufacturers Newsletter: Intercom (various dates).

TABLE 3.12

ESTIMATED NUMBERS OF BOATS SCRAPPED AND NUMBERS OF BOATS SOLD, BY LENGTH AND PROPULSION
California 1972 and 1973

	1972			1973		
	Estimated # of Units Scrapped	Estimated # of Units Sold	Ratio Scrapped to Sold	Estimated # of Units Scrapped	Estimated # of Units Sold	Ratio Scrapped to Sold
<16 Foot Power	12,328	13,751	.9	11,600	12,200	1
<16 Foot Sail	930	1,627	.6	920	3,400	.3
16-25 Foot Power	5,169	13,227	.6	5,200	15,683	.4
16-25 foot Sail	360	1,380	.2	360	2,205	.2
26-39 Foot Power	570	940	.6	530	753	.7
26-39 Foot Power	97	839	.1	112	1,000	.1

Sources: Data abstracted from State of California Department of Motor Vehicle Statistical Report: Currently Registered Vessels, January 1, 1973 and January 6, 1974.

stressed that the sales data are subject to very large errors (see Appendix B). For this reason the ratio of scrapping to sales for these years may be subject to errors of up to 40 percent. However, it is still clear that there is wide variation among length and propulsion classes. The ratios may be interpreted as giving a measure to the rate at which the components of the fleet are expanding or contracting: if the fleet size is stationary from one year to the next, the ratio is 1; if the fleet size is contracting, the ratio is more than 1, and if it is expanding, the ratio is less than 1.

In terms of the policy framework of Chapter 2, the magnitude of annual sales of boats is of importance to the State only to the extent that insight is obtained about purchaser preferences and responses. It is to be expected, though, that State policy directed towards increasing the total stocks of boats is likely to receive explicit support from boat manufacturers and sellers of new boats.

3.4 Estimates of Annual and Per Trip Costs of Owning and Using a Boat

The discussion of this chapter has stressed the importance to the boater of prices of the inputs to his recreational experience. Using the pieces of data presented so far, it is possible to make estimates of annual and per-trip costs facing the recreational boater and affecting his decision to buy or rent a boat.

Assume that the boatowner amortizes the price, P, of the boat over the expected lifetime, L, of the equipment and that he uses the boat N times per year. For simplicity, assume that the boat is used at only one location which is a distance d miles from his residence. The annual cost of boating, C_A, may be written.

$$C_A = \underbrace{C_{A,fixed}}_{\text{annual fixed cost}} + \underbrace{N\, C_{trip,var}}_{\text{additional variable per-trip cost}} \qquad (3.4.1)$$

The total per-trip cost is obtained by dividing total annual costs by the number of days the boat is used,

$$C_{trip} = C_A/N \qquad (3.4.2)$$

The annual fixed cost, $C_{A,fixed}$, is made up of amortization costs, interest costs on installment debt, and storage costs. Taking into consideration the Federal tax rebate on loan interest (using the Federal tax rate f(w), a function of hourly wage rate, w), the monthly per-foot storage rate, s, the length, L, of the boat, the annual fixed cost can be written as

$$C_{A,fixed} = \underbrace{P/L}_{\text{amorti-zation}} + \underbrace{Pr(1 - f(w))}_{\text{interest}} + \underbrace{12sL}_{\text{storage}} \qquad (3.4.3)$$

The variable per-trip costs are composed of travel costs and on-water costs. Define c_d and c_{tr} as the per-mile costs of traveling by car and trailing a boat, n_h as the number of hours spent recreating on the water, M as the hourly maintenance rate, f_{tr} and f_b as the fractions of the wage rate at which the boater values his time in traveling and boating. Then, assuming a speed limit of 55 miles per hour, the variable trip cost can be specified as

$$C_{trip,var} = \underbrace{2d\ (c_d + c_{tr} + f_{tr}w/55)}_{\text{travel costs}} + \underbrace{n_h(M + f_b w)}_{\text{on-water costs}} \qquad (3.4.4)$$

Estimates of annual costs, per-trip costs, and variable trip costs are obtained by substituting reasonable values into the expressions specified. The assumptions used and the estimates are given in Table 3.13. The per-trip fixed cost may be compared with posted rental agency prices. The estimates are indeed plausible: Los Angeles region prices for small power boat rental is between $10 and $20 per day; for larger boats, prices listed by Blue-Jacket Marine Inc. (1974) varied from $90/day (28 foot Luhrs Sedan) to $180/day (36 foot Grand Banks Diesel).

In general, the calculations suggest that boaters are likely to be very sensitive to certain costs. While the annual investment in a trailer boat is reasonably low, the additional per-trip cost to distant sites is high. The additional cost of trailing a boat 200 miles to a second home is $40 suggesting that there is incentive to

TABLE 3.13

COMPARISON OF TRIP COSTS FOR TRAILERED OUTBOARDS AND MOORED INBOARDS

	Annual Fixed Cost	Per Trip Fixed Cost	Variable per Trip Cost	
			20 Mile Round Trip	40 Mile Round Trip
15 foot outboard (middle income boater)	$ 400	$ 21	$10	$88
40 foot inboard (upper income boater)	$3,500	$100	$25	$70

Assumptions: 15 foot outboard (price, P, $1,500; estimated lifetime, L, 10 years; number of days used per year, N, 18.5; loan interest rate, r, 11%; monthly storage rate, s, $1 per foot; in-use maintenance cost per hour, M, $1). 40 foot inboard (P, $30,000; L, 30 years; N, 34; r, 8%; s, $2; M, $4). Middle income boater (hourly wage rate, w, $5, tax rate, f(w), 30%). Upper income boater (hourly wage rate, $12.5, tax rate, 50%). All boaters (f_{tr}, f_b, .2; number of hours per trip, n, 5; travel cost per mile, c_d and trailing costs per mile (outboard only), c_{tr}, 0.1).

The assumptions are based, wherever possible, upon data presented in this chapter. Travel time costs are reasonable estimates ob-obtained from the transportation literature. Estimates of number of days of recreation per year have been obtained from California (1972b).

store boats at second home locations. This cost and the cost of driving a car to a site are very dependent upon the per-mile costs. It is expected that doubling the gasoline price since 1972 has had noticeable effects on regional boating patterns. The annual fixed cost of owning a large boat is very high, out of the range of middle-income families. It is also clear that in order to obtain reasonable benefits from owning a large boat it must be used very often, preferably at a site close to the owner's residence. As noted, large power boats are used far more often (35 days per year) than are outboard trailer boats (18 days per year); also, moorage facilities close to large metropolitan areas are more likely to be congested than are those left over from earlier commercial activities in non-metropolitan coastal areas.

3.5 Estimating Future Demand for Recreational Boats: Assessing the Use of Dynamic Demand Models

This chapter has presented various data to lend credence to the idea that a person's choice to own a boat is rational and is dependent on several factors. The State's policy problem has been defined as requiring the estimation of aggregate future demand for boating water resources, this problem being reducible to one of predicting future boat ownership levels. Established prediction methods use the extrapolation of regional per capita boat ownership trends. Several demand factors are worth considering. They are: boaters seem to respond to changes in regional facilities supply; credit use seems to be an important factor in boat purchase; and prices of boats and available incomes should be important determinants of the decision to purchase a boat. Further, annual scrapping of boats is not negligible, suggesting the importance of durability to purchasers. If, as is claimed here, each of these factors is an important determinant of earlier boat ownership levels, it is reasonable to propose a dynamic model which included these factors explicitly. Various forms of consumer durable demand models might be explored; it is necessary, though, to use only one to point out the estimating problems with existing data.

Williams has proposed several stock adjustment models for consumer durable purchase and has used, to estimate them, British quarterly sales data on automobiles and vacuum cleaners (1972a) and stock data for television sets and refrigerators (1972b). A reasonable stock adjustment model for recreational boat purchase might be assumed to have the following form: existing stocks of durables in the population may influence purchases in two ways: through a saturation effect and through a replacement effect. The saturation effect postulates that there is an "optimal stock level" S_T^* for each year, T, determined by socioeconomic characteristics of the population, and prices and income level. Changes in stock from year T-1 to year T are proportional to the difference between actual stocks of boats and the optimal stock level given the conditions in that year. In symbolic form (with ν_{1T} and ν_{2T} as stochastic disturbances):

$$S_T - S_{T-1} = P(S_T^* - S_{T-1}) + \nu_{1T} \qquad (3.4.1)$$

and

$$S_T^* = \beta_0 + \beta_1 X_{1T} + \nu_{2T} \qquad (3.4.2)$$

If there were only one socioeconomic or price determinant of optimal stock size, there would still be three parameters to be estimated. If x_T were considered to be a vector of, say, four variables (e.g., price of the boat, per capita income level, a measure of credit availability, and supply of boat facilities stocks), then there would be, instead, six parameters to be estimated. Further, if scrapping is to be included in the specification, then at least one more parameter, δ, must be estimated.

Before proceding further with a detailed specification, it is reasonable to ask whether there is sufficient data to estimate any reasonably specified form. In California (1972) it has been shown that, because of limitations in reporting procedures, published stock data is acceptably precise only for the years 1963, 1966, 1969, and 1972 (and, by now, 1973 and 1974). There are only four data points available if boat stock were considered to be the dependent variable. Further, the data of Section 3.3.3 show that if annual sales of boats were the dependent variable, suitable California data exist for at best nine data points (1964 through 1972).

Any attempt to estimate a model using such short time-series data bases could produce parameter estimates of such low confidence levels that extrapolation for more than a year or two would have unacceptably low precision. O'Herlihy's experience in estimating new car sales is instructive: in reporting estimations using 14 data points he was forced to rely on 33 percent confidence levels to avoid reporting only a time trend (1965). Accordingly, he predicted (extrapolated) only over a period of 5 years.

This chapter may be summarized briefly. Cross-section analysis of boat registration data for 1972 has suggested that (1) regional facilities stock distributions are important determinants of boat ownership and boat use and (2) installment credit supply factors may also affect boat purchase decisions. Further, it is expected, on a priori grounds, that prices of boats and available income are determinants of boater recreational demand. A dynamic time series model may be proposed as a substitute for simple per capita trend extrapolation. Unfortunately, the limitations of previously published boat stock time series and available boat sales data make the estimation of any such model--and therefore its predictive use--subject to intolerably high uncertainty. As it stands then, public policy determination should rely on the following conclusion: there is no satisfactory method of producing estimates of future demand for recreational boats until further data become available.

CHAPTER 4

MODELING BOAT OWNERSHIP IN METROPOLITAN LOS ANGELES

In the second chapter, it was claimed that the State should be concerned with the distribution of its recreation water resources among the residents of the State. It was stated that there was a wide variety of ways to partition the State's population in a concern for equity in distribution; several of the more important partitions were discussed in some detail. It was reasoned, though, that in the present context, the State need consider only two questions: (1) Is it important to know whether families living in different parts of the State have different levels of access to the water resources managed by the State? and (2) Is it important that families of different income levels have different levels of access to the resources? It was asserted that these questions could be answered only by the political process. Nevertheless, if it decided that these issues were important, the State had then to obtain empirical data on the distribution of access. In the analysis to be presented in this chapter, it is assumed that each question has been answered affirmatively and that empirical analysis is required to assist in policy formation. To this end, this chapter addresses the problem of measuring relative access to recreational waters by modeling the probability of boat ownership as a function of family income, the distance to the nearest recreational facility, and the capacity of that facility.

The method used to research the distributional questions is dictated by available data. These data include the spatial distributions (by zip code) of numbers of boats registered in the Los Angeles metropolitan area, family income data (by zip code) from the Fifth Count of the 1970 Census of Population, and 1970 facilities inventory data for the southern California region. These data are known with acceptable precision; however, from this information, the income of each boatowner cannot be known, nor can it be determined which facilities are preferred and used by each boater. In studying the relationship between boat ownership, family income, and the size and location of facilities, it is necessary to select a method which allows the prediction of the spatial distribution of boat ownership given the spatial distributions of families and facilities. In this study, the choice of a suitable equation to be estimated is seen to follow from a technique for converting the dichotomous dependent variable "boat ownership" into a continuous variable "probability of boat ownership." The conditions usually placed on a probability function suggest a limited set of estimating equations. The method of "logistic analysis" is used to derive an equation of the log-log form to relate the probability of boat ownership to the suggested predictors.

The method of logistic analysis as a way of considering the estimation of a dichotomous variable is introduced in the next section; in this discussion the form of the dependent variables is defined. Section 4.2 discusses the independent variables chosen to explain the probability of a family choosing to own a boat. The equations thereby specified were estimated using Los Angeles metropolitan area data; these equations lead to useful empirical information to describe the levels of access of different income and geographically distinct groups within the metropolitan area. The equations, therefore, provide information about approximately half the population of the State. It is of further interest to compare the Los Angeles area data with data for other parts of the State and, to do this, the estimated equations are used to predict levels of ownership in other coastal and inland areas in the State. The predicted values are compared with observed values in Section 4.6. The various results of this chapter are summarized in Section 4.5.

4.1 Modeling the Probability of Owning a Boat: Logistic Analysis

The problem discussed in this section is the derivation of a suitable form of function to be used to model the way in which a family chooses to own a boat.[1] The choice is dichotomous: a family either chooses or does not choose to own a boat. It can be postulated, though, that the probability of choice is a continuous real number, p, having the property

$$0 \leq p \leq 1 \tag{4.1}$$

Assume, for the discussion, that the probability is determined by a set of three (independent) variables, x_1, x_2, and x_3. A suitable general form for the probability function is

[1]The discussion of this section follows that of Theil (1971, Section 12.5).

$$p = \frac{1}{1 + f(x_1, x_2, x_3)} \tag{4.2}$$

if it is also required that

$$f(x_1, x_2, x_3) \geq 0 \tag{4.3}$$

Condition 4.3 preserves the range requirement (4.1) on the probability function. Simple algebraic manipulation leads to

$$p/(1-p) = 1/f(x_1, x_2, x_3) \tag{4.4}$$

and taking the natural logarithm,

$$\log (p/(1-p)) = - \log f(x_1, x_2, x_3) \tag{4.5}$$

The left hand side of equation 4.5 has been termed the "logit" of the probability p. It is a transformation of the probability into a function which has the value $-\infty$ when $p = 0$, 0 when $p = .5$, and ∞ when $p = 1$. The logit function thus conforms to the usual requirements to be placed on the dependent variable in multiple regression analysis and is therefore a desirable form to be used.

If the function $f(x_1, x_2, x_3)$ is assumed to have the explicit form

$$f(x_1, x_2, x_3) = \exp (- \beta_0 - \beta_1 \log x_1$$

$$-\beta_2 \log x_2 - \beta_3 \log x_3) \tag{4.6}$$

then it follows that the probability has the form of the logistic function (in three variables)

$$p = \frac{1}{1 + e^{-\beta_0} x_1^{-\beta_1} x_2^{-\beta_2} x_3^{-\beta_3}} \tag{4.7}$$

It is this fact which gives logistic analysis its name.[2] Further, given the specific form for the function f, it can be seen that the logit, L(p) is represented by

$$L(p) = \log (p/(p-1)) = \beta_0 + \beta_1 \log x_1 + \beta_2 \log x_2 + \beta_3 \log x_3 \qquad (4.8)$$

Equation 4.8 shows that the logit of the probability can be represented as a linear function of the logarithms of the independent determinants. It is in a form which may be easily estimated using ordinary least squares multiple regression analysis.

It is not possible to observe directly the probability, p, used to calculate the dependent variable. Instead it is necessary to estimate p by using observed frequencies. If the number of boats in a given zip code area i is given by $NFAMILIES_i$, and the number of boats of class j in zip code area i is $NBOATS_{ij}$, then the logit function (for class j) can be estimated as

$$L(p_{ij}) = \log(p_{ij}/(1-p_{ij})) = \log \frac{NBOATS_{ij}/NFAMILIES_j}{(1-NBOATS_{ij}/NFAMILIES_j)} \qquad (4.9)$$

It is clear from the definition of the logarithm that the logit $L(p_{ij})$[3] can be calculated only if

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[2]The use of "logistic" or "logit" analysis is becoming popular in investigations in which it is necessary to predict that one of a set of mutually exclusive events will occur. The discussion of scrapping, previously cited (Parks, 1974) is an example. Transport mode choice is another kind of either/or choice and Lave (1970) and others have modeled the "modal split" problem in this fashion. Theil's presentation of logistic analysis includes a summary of his use of the method in analyzing automobile purchase.

[3]Notice that if p is much less than 1 then L(p) is approximately equal to log p. Usually in spatial analysis this approximation is made. This particular derivation is used even though, as will be seen, the

$$\text{NFAMILIES}_j > \text{NBOATS}_{ij} > 0 \qquad (4.10)$$

To conclude, the method of ordinary least squares can be used to estimate the relationship of the form

$$\log \frac{\text{NBOATS}_{ij}}{\text{NFAMILIES}_j - \text{NBOATS}_{ij}} = \beta_0 + \beta_1 \log x_{1ij}$$

$$+ \beta_2 \log x_{2ij} + \beta_3 \log_{3ij} + \epsilon_{ij} \qquad (4.11)$$

The added error term, ϵ_{ij}, represents an additional random disturbance assumed to have zero mean and variance σ^2.

Selecting a log-log form of the equation to be used to model the probability of boat ownership allows a simple interpretation of the parameters. It can be easily seen, by partial differentiation, that

$$\frac{x_k}{L} \frac{\partial}{\partial} \frac{L(p)}{x_k} = \beta_k \quad (k = 1,2,3) \qquad (4.12)$$

The expression of the left hand side is called the "elasticity of the logit of the probability with respect to the independent variable x_k." It is usually interpreted as "the percent change in L(p) resulting from a 1 percent change in x_k." It allows a simple interpretation, then, of the effect on the dependent variable of changes in one of the independent variables.

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normal approach could have been taken without significantly altering the regression results. The particular approach to the geographical problem was suggested by the paper of Pyle and Rees (1971) which used log-log and log-linear regression analysis to model patterns of death and disease in Chicago.

4.2 Selecting the Predictors of the Probability of Boat Ownership

The selection of predictors of boat ownership must be done intuitively but taking into account the discussion of demand put forward in Chapter 3. A suitable start can be made by considering the fixed and variable costs of boating remembering that the data to be analyzed is cross-sectional and restricted to one large metropolitan region. Accordingly, some of the cost determinants of Section 3.4 do not vary. In fact, the fixed costs of owning a boat of a particular length-propulsion class i can be seen to be almost constant (i.e., assuming that regardless of the age of a boat of class i it is being amortized at approximately the same amount each year and is being used at approximately the same number of days per year). Further, it can be seen from equation 3.4.4 that, if differences in maintenance across the class i and differences in income of owners are ignored, the variable trip costs are approximately linear with respect to distance to the site used. It seems reasonable then to assume that, for a boater living in zip code j, owning a boat of class i, and using it at a location k, costs are given by a simple linear function of the distance to be traveled, d_{ij}. That is, if a_i and b_i are constants

$$c_{trip,ijk} = a_i + b_i d_{jk} \tag{4.13}$$

The sample calculations of Section 3.3.3 indicate the range of estimates of fixed and variable costs by comparing the costs of owning and operating an expensive (large inboard) or an inexpensive (small outboard) boat. The costs, as noted there, are never negligible: for at least some low-income families it may be assumed that there is a minimum income level $I_{min,i}$ required to afford a boat of class i. It is to be expected that for larger and more expensive boats the minimum level of income is higher than for the smaller, less expensive boats. There may also be an upper limit on the level of boat ownership: certain classes of boats may never be purchased by upper-income families, perhaps, because the travel costs to use the boats are perceived as being too high. Therefore, it may be hypothesized that, for each boat class i, there is a maximum income $I_{max,i}$ such that, if a family has income greater than this, it does not choose to own a boat of that class. For some classes, $I_{max,i}$, is expected to be infinite.

From these simplifying notions, the first and second predictors of ownership have been selected. The probability of boat ownership of boat class i in zip code area j is a function of the proportion of families in the zip code area having incomes between $I_{min,i}$ and $I_{max,i}$. Thus, referring to equation 4.11,

$$x_{1ij} = \frac{NFAMILIES_j(I_{min,i} \leq I < I_{max,i})}{NFAMILIES_j} \qquad (4.14)$$

The second predictor, reflecting the importance of distance costs in operating a boat, is chosen to be the distance of the zip code to the nearest suitable facility (relative to the average distance of all zip codes to their nearest facilities of that type, $\overline{d_{ijk}}$)

$$x_{2ij} = d_{ijk}/\overline{d_{ijk}} \qquad (4.15)$$

Selection of the third variable is based on the assumption that the relative size of the nearest facility affects the decision to purchase and own a boat. Thus, it is to be expected that, in the vicinity of a large reservoir, the level of ownership should be higher; similarly near large recreational boating harbors, the level of ownership of moored boats should be higher than near smaller harbors. The simplest measures of size of facility seems to be the number of lanes at a rampsite or the number of slips at a recreational harbor. The following representations of the third variable are used:

$$x_{3ij} = NSLIPS_j/\overline{NSLIPS} \qquad (4.16)$$

or $$x_{3ij} = NRAMPS_j/\overline{NRAMPS} \qquad (4.17)$$

where $NSLIPS_j$ (or $NRAMPS_j$) is the number of slips (ramps) at the nearest harbor (rampsite) and $\overline{NSLIPS}$ ($\overline{NRAMPS}$) is the average number of slips (ramps) at harbors (rampsites) in the region.

4.3 Estimation Procedure

The appropriate values of $I_{min,i}$ and $I_{max,i}$ for each boat class are unknown. They must be determined empirically by estimating the equation for each dependent variable a large number of times using different values for $I_{max,i}$ and $I_{min,i}$. The income range which maximizes the explained variance is considered the correct range. Also, it is not known beforehand whether the appropriate "nearest facility" is a rampsite or a harbor site; for each income range, therefore, the equation is estimated twice, once each for each facility type.

The complete set of dependent variables is shown in Table 4.1. Thirty length-propulsion classes of boats have been selected. Some of these classes are overlapping and highly correlated: for example, almost all power boats less than 16 feet long are outboards, so it is expected that equations involving variables 1 and 15, or 2 and 16 should have almost identical parameters and statistics. Also, the variables "new" and "new credit" should act similarly and, as well, act like the total set of vintages for the particular length propulsion class. Therefore, the equation triplets (2,3,4), (11, 12,13), and (18,19,20) should show similar behavior.

Table 4.1 shows the mean of each "logit" dependent variable, its standard deviation, the mean probability calculated from the mean of the logit variable, and the range of the probability calculated from the values which are obtained from the values plus and minus two standard deviations from the mean of the logit. (Since the logit is a logarithm, the probability is assumed to have a range which is skewed about the mean.) It is immediately clear that only for small power boats is there ever a high level of ownership probability. In some areas, up to 10 percent of families might be expected to own outboard power boats, although, in other areas, the proportion owning this class of boat is likely to be much less. For all other classes of boats, the proportion owning a boat rarely reaches above 1 percent of families, this fact being a measure of the importance of the various boating activities.

The independent variables used to explain the variation in the thirty dependent variables are given in Table 4.2. It is to be noted that the income variables and the facilities variables are for the year 1970 while the boat ownership is for 1972.

TABLE 4-1

THE DEPENDENT VARIABLES: LOGITS OF THE PROPORTIONS OF FAMILIES OWNING BOATS OF GIVEN LENGTH PROPULSION CLASS, MEANS AND STANDARD DEVIATIONS, CALCULATED MEAN PROBABILITY OF OWNERSHIP PER ONE THOUSAND FAMILIES, AND THE RANGE OF PROBABILITY ABOUT THE MEAN

Variable Number		Name of Variable	Year	Mean of Variable	Standard Deviation	Mean Probability P per 1000 Families	Range of P[1]
1	Logit	outboard 8-11 foot	1972	-5.9595	.8836	2.6	.44 to 15
2	"	outboards 12-15 foot	"	-4.0212	.7919	22	3.7 to 87
3	"	outboards 12-15 foot new	"	-7.3180	.9666	.66	.10 to 4.6
4	"	outboards 12-15 foot new, credit	"	-8.2317	.8498	.27	.05 to 1.5
5	"	outboards 16 foot or more	"	-4.73	.8431	8.8	1.6 to 48
6	"	jet boats	"	-6.9221	.9483	1.0	.15 to 6.6
7	"	inboards less than 16 foot	"	-7.5050	.8216	.55	.10 to 2.8
8	"	inboards 16-19 foot	"	-5.8856	.8817	2.8	.48 to 14
9	"	inboards 20-25 foot	"	-6.7004	.9001	1.2	.20 to 7.4
10	"	inboard-outdrive less than 16 foot	"	-8.5292	.7191	.20	.05 to .83
11	"	inboard-outdrive 16-19 foot	"	-5.6825	.9698	3.4	.49 to 24
12	"	inboard-outdrive 16-19 foot new	"	-7.4221	.9467	.60	.09 to 4.0
13	"	inboard-outdrive 16-19 foot new, credit	"	-7.8033	.9195	.41	.06 to 2.6
14	"	inboard-outdrive 20-25 foot	"	-6.757	.9291	1.2	.18 to 7.5
15	"	all power boats 8-11 foot	"	-5.9356	.8799	2.6	.45 to 15
16	"	all power boats 12-15 foot	"	-3.9863	.7913	18	3.6 to 90
17	"	all power boats 16-19 foot	"	-4.1934	.8605	15	2.7 to 84
18	"	all power boats 20-25 foot	"	-5.7600	.8303	3.2	.60 to 17
19	"	all power boats 20-25 foot new	"	-7.8601	.8928	.39	.06 to 14
20	"	all power boats 20-25 foot new, credit	"	-8.1112	.8260	.30	.06 to 1.6
21	"	all power boats 26-32 foot	"	-6.6262	.9519	1.3	.20 to 8.9
22	"	all power boats 33-39 foot	"	-6.9803	1.0443	.93	.12 to 7.5
23	"	all power boats 40 foot or more	"	-7.8620	1.0763	.39	.05 to 3.3
24	"	all sail boats 8-11 foot	"	-7.1116	1.0844	.82	.09 to 7.1
25	"	all sail boats 12-15 foot	"	-6.5639	1.1326	1.4	.15 to 14
26	"	all sail boats 16-19 foot	"	-7.3801	1.0738	.62	.07 to 5.3
27	"	all sail boats 20-25 foot	"	-6.8273	1.1120	1.1	.12 to 10
28	"	all sail boats 26-32 foot	"	-7.5408	1.2075	.53	.05 to 2.8
29	"	all sail boats 33-39 foot	"	-8.0443	1.0751	.32	.04 to 2.8
30	"	all sail boats 40 foot or more	"	-8.4284	.9244	.22	.03 to 1.4

[1]Range of P is based on the standard deviation of the logit of P. Thus, the range of P is skewed about its mean.

TABLE 4.2

THE INDEPENDENT VARIABLES: LOGARITHMS OF PROPORTIONS OF FAMILIES IN SELECTED INCOME RANGES, RELATIVE DISTANCES TO NEAREST FACILITIES, RELATIVE SIZE OF NEAREST FACILITIES, MEANS AND STANDARD DEVIATIONS

Variable Number		Name of Variable	Year	Mean of Variable	Standard Deviation
31	Log	proportion families $0 to "poverty"	1970	-2.8437	.5049
32	"	proportion families $10,000 and above	"	- .5457	.2711
33	"	proportion families $15,000 and above	"	-1.2572	.4888
34	"	proportion families $25,000 and above	"	-2.8658	.9005
35	"	proportion families $50,000 and above	"	-5.0561	1.3351
36	"	proportion families $10,000 to $15,000	"	-1.2959	.2542
37	"	proportion families "poverty" to $10,000	"	-1.1642	.3987
38	"	proportion families $15,000 to $25,000	"	-1.5339	.3978
39	"	proportion families $10,000 to $25,000	"	- .7397	.2836
40	"	relative size of nearest rampsite, $R/\overline{R}$[1]	"	- .7388	1.2861
41	"	relative distance to nearest rampsite $D_R/\overline{D}_R$[1]	"	- .2877	.8245
42	"	relative size of nearest harbor $S_H/\overline{S}_H$[1]	"	-1.036	1.8309
43	"	relative distance to nearest harbor $D_H/\overline{D}_H$[1]	"	- .6944	.2423

[1]The distance to the nearest facility is weighted by the average value of each zip code area to its nearest facility ($\overline{D}_R$ or $\overline{D}_H$). The size of the nearest facility is weighted in the same way. The average values for the Los Angeles region were: $\overline{R}_1$ = 13.0 ramps, $\overline{D}_R$ = 12.7 miles, $\overline{S}$ = 2,296 slips, $\overline{D}_S$ = 14.7 miles.

TABLE 4.3

COEFFICIENTS OF DETERMINATION (R^2) OBTAINED IN ESTIMATING THE LOG-LOG FORM OF THE EQUATION FOR THE LOGIT OF THE PROBABILITY OF BOAT OWNERSHIP: BY BOAT CLASS, VARYING THE INCOME RANGE PROPORTION AND SELECTING EITHER THE NEAREST HARBOR(H) OR THE NEAREST RAMPSITE (R) DISTANCE AND FACILITY SIZE VARIABLES

	Income Range																			
	No Income		0-Poverty		10K+		15K+		25K+		50K+		10-15K		Pov.-10K		15-25K		10-25K	
	H	R	H	R	H	R	H	R	H	R	H	R	H	R	H	R	H	R	H	R
Outboards < 12'	.05	.05	.32	.34	.38	.40	.42	.44*	.41	.43	.32	.33	.06	.06	.34	.34	.32	.34	.23	.23
Outboards 12-15'	.02	.02	.13	.16	.19	.23	.10	.13	.07	.06	.02	.03	.23	.23	.14	.17	.15	.19	.26	.29*
Outboards 12-15' new	.00	.02	.05	.09	.09	.14	.06	.10	.03	.07	.02	.04	.07	.08	.11	.16*	.07	.11	.14	.14
Outboards 12-15' new, credit	.02	.00	.02	.00	.04	.03	.03	.01	.02	.01	.03	.01	.05	.03	.09*	.07	.02	.02	.04	.03
Outboards 16' >	.01	.01	.14	.18	.23	.28	.15	.19	.06	.09	.05	.05	.18	.19	.22	.26	.20	.24	.28	.32*
Jet boats	.02	.02	.20	.22	.24	.28	.17	.20	.08	.09	.03	.04	.12	.13	.24	.26	.23	.26	.27	.30*
Inboards < 16'	.03	.01	.10	.09	.14	.14	.08	.08	.04	.00	.01	.00	.13	.08	.18*	.18	.10	.09	.15	.00
Inboards 16-19'	.03	.00	.27	.27	.34	.36*	.25	.26	.12	.13	.07	.06	.17	.14	.34	.30	.29	.29	.34	.34
Inboards 20-25'	.15	.00	.28	.28	.33*	.33	.30	.30	.28	.26	.26	.23	.19	.17	.31	.30	.29	.29	.28	.28
Inboard-Outdrive < 16'	.00	.00	.00	.00	.05	.06	.06	.07	.06	.08	.06	.06	.01	.00	.08	.09*	.04	.04	.01	.01
Inboard-Outdrive 16-19'	.02	.00	.30	.33	.40	.43*	.32	.35	.19	.21	.12	.13	.15	.14	.36	.38	.36	.00	.37	.38
Inboard-Outdrive 16-19' new	.01	.01	.24	.27	.26	.30	.26	.23	.10	.13	.08	.09	.07	.07	.32	.35*	.21	.25	.23	.25
Inboard-Outdrive 16-19' new, credit	.01	.00	.10	.12	.18	.21	.10	.00	.03	.04	.02	.02	.13	.14	.26	.28*	.15	*.00	.22	.24
Inboard-Outdrive 20-25'	.06	.07	.26	.27	.33	.34*	.31	.32	.24	.24	.18	.17	.10	.07	.32	.32	.30	.31	.26	.00

TABLE 4.3 - continued

	Income Range																					
	No Income		0-Poverty		10K+		15K+		25K+		50K+		10-15K		Pov.-10K		15-25K		10-25K	
	H	R	H	R	H	R	H	R	H	R	H	R	H	R	H	R	H	R	H	R
All power 8-11'	.06	.05	.32	.34	.33	.40	.41	.44*	.40	.42	.32	.33	.06	.06	.34	.34	.32	.33	.22	.23
All power 12-15'	.02	.02	.13	.16	.19	.23	.10	.14	.07	.06	.02	.03	.23	.23	.12	.17	.15	.19	.26	.29*
All power 16-19'	.014	.005	.25	.27	.33	.37	.22	.25	.10	.12	.05	.06	.22	.22	.29	.32	.28	.31	.37	.40*
All power 20-25'	.09	.07	.31	.32	.37	.40*	.34	.37	.27	.29	.22	.22	.14	.14	.35	.36	.32	.35	.31	.32
All power 20-25' new	.03	.04	.15	.17	.18	.19	.20	.21*	.18	.19	.16	.16	.03	.04	.19	.18	.17	.18	.10	.11
All power 20-25' new, credit	.03	.04	.07	.08	.11	.12*	.11	.12	.09	.09	.08	.08	.03	.04	.10	.11	.10	.11	.07	.08
All power 26-32'	.22	.19	.39	.40	.45	.46	.49	.49	.50*	.50	.45	.44	.22	.20	.44	.43	.43	.43	.34	.34
All power 33-39'	.19	.17	.30	.30	.35	.34	.42	.41	.49*	.47	.48	.46	.21	.19	.40	.38	.31	.30	.22	.21
All power 40+'	.17	.17	.18	.20	.20	.21	.25	.27	.36	.37	.42*	.41	.27	.27	.27	.29	.17	.19	.17	.18
All sail 8-11'	.04	.06	.00	.22	.29	.32	.34	.36	.33	.34	.29	.30	.05	.06	.37	.38*	.25	.27	.16	.16
All sail 12-15'	.07	.08	.22	.23	.26	.27	.33	.34	.35	.36*	.31	.32	.09	.09	.31	.31	.25	.26	.13	.14
All sail 16-19'	.14	.14	.23	.24	.26	.27	.32	.33	.35*	.34	.29	.29	.17	.16	.32	.31	.24	.25	.16	.17
All sail 20-25'	.13	.13	.32	.33	.37	.38	.42	.43*	.41	.41	.34	.34	.14	.13	.43	.42	.35	.36	.23	.24
All sail 26-32'	.20	.18	.32	.31	.37	.36	.44	.43	.50*	.49	.48	.47	.22	.20	.45	.43	.33	.31	.23	.22
All sail 33-39'	.20	.19	.23	.23	.25	.24	.33	.32	.45	.43	.46*	.44	.37	.35	.35	.29	.22	.22	.22	.20
All sail 40+	.13	.10	.13	.10	.13	.10	.15	.12	.23	.19	.29	.25	.30*	.27	.16	.12	.13	.11	.21	.19

*The maximum value of R^2 for each set of 20 equations for particular length propulsion class.

TABLE 4.4

REGRESSION RESULTS FOR THE BEST FIT EQUATION FOR EACH LENGTH PROPULSION CLASS

Equation Number	Boat Class	Number of Zip Codes in Regression	Selected Predictors: Annual Income Range	Selected Predictors: Facilities Type	Regression Results: Constant Term	Regression Results: Proportion Families in Selected Range	Regression Results: Relative Distance to Nearest Facilities	Regression Results: Relative Size of Nearest Facilities	R^2	F Ratio	Hypotheses Rejected
1	Outboard 8-11 ft	286	$15,000 & above	Rampsite	-4.45	1.08 (14.1)***	-1.96 (4.0)***	1.56 (4.7)***	.44	74***	1
2	Outboard 12-15 ft	287	$10,000 to $25,000	Rampsite	-2.82	1.49 (10.4)***	.015 (.3)	.133 (4.2)***	.29	39***	1,5
3	Outboard 12-15 ft new	264	Poverty to $10,000	Rampsite	-8.28	-.947 (6.6)***	-.023 (.3)	.170 (3.8)***	.16	16**	4
4	Outboard 12-15 new/credit	179	Poverty to $10,000	Harbor	-8.91	-.569 (3.5)***	.065 (.89)	.044 (1.2)	.09	5.4*	2,4,5
5	Outboards 16 ft or more	288	$10,000 to $25,000	Rampsite	-3.40	1.69 (11.3)***	-.049 (.95)	.134 (4.0)***	.32	44***	
6	Jet Boats	256	$10,000 to $25,000	Rampsite	-5.35	2.07 (9.9)***	.022 (.34)	.184 (4.6)***	.30	36***	2,5
7	Inboards less than 16 ft	251	Poverty to $10,000	Harbor	-8.5	-.88 (6.8)***	.07 (1.1)	.03 (1.0)	.18	18**	2,4,5
8	Inboards 16-19 ft	205	$10,000 & above	Rampsite	-4.7	1.84 (12.5)***	.023 (.45)	.106 (3.03)**	.36	52***	5
9	Inboards 20 to 25 ft	285	$10,000	Harbor	-6.05	1.26 (8.5)***	-.39 (7.8)***	.04 (1.54)	.33	45***	
10	Inboard/Outdrive less than 16 ft	161	Poverty to $10,000	Rampsite	-9.18 (3.9)***	.60 (3.9)***	.04 (.3)	.08 (1.7)	.09	5	4,5

TABLE 4.4 - continued

Equation Number	Boat Class	Number of Zip Codes in Regression	Selected Predictors: Annual Income Range	Selected Predictors: Facilities Type	Regression Results: Constant Term	Proportion Families in Selected Range	Relative Distance to Nearest Facilities	Relative Size of Nearest Facilities	R^2	F Ratio	Hypotheses Rejected
11	Inboard/Outdrive 16-19 ft	286	$10,000 & above	Rampsite	-4.30	2.14 (14.7)***	-.03 (.63)	.165 (4.6)***	.43	72***	
12	Inboard/Outdrive 16-19 ft new	257	Poverty to $10,000	Rampsite	-8.56	-1.42 (11.6)	-.04 (.6)	.153 (3.8)***	.35	45***	4
13	Inboard/Outdrive 16-19 ft new/credit	227	Poverty to $10,000	Rampsite	-9.19	-1.27 (9.3)***	.013 (.2)	.132 (2.98)**	.28	29.5***	4,5
14	Inboard/Outdrive 20-25 ft	278	$10,000 & above	Rampsite	-5.73	1.78 (11.3)***	-.20 (3.5)***	.07 (1.75)	.34	47***	3
15	Power 8-11 ft	287	$15,000 & above	Rampsite	-4.43	1.07 (13.9)***	-.194 (3.9)***	.16 (4.8)***	.44	73***	1
16	Power 12-15 ft	288	$10,000 to $25,000	Rampsite	-2.78	1.50 (10.5)***	.02 (.34)	.13 (4.1)***	.29	39***	1,5
17	Power 16-19 ft	288	$10,000 to $25,000	Rampsite	-2.68	1.94 (13.5)***	-.02 (.35)	.12 (3.8)***	.40	62***	
18	Power 20-25 ft	286	$10,000 & above	Rampsite	-4.81	1.61 (12.5)***	-.29 (6.0)***	.11 (3.3)***	.40	63***	3
19	Power 20-25 ft new	229	$15,000 & above	Rampsite	-6.87	.78 (7.1)***	-.17 (2.30*	(.05) (1.2)	.21	20**	3
20	Power 20-25 ft new/credit	194	$10,000 & above	Rampsite	-7.67	.96 (4.2)***	-.16 (2.2)*	-.01 (.3)	.12	8.6**	3

TABLE 4.4 - continued

Equation Number	Boat Class	Number of Zip Codes in Regression	Selected Predictors: Annual Income Range	Selected Predictors: Facilities Type	Regression Results: Constant Term	Proportion Families in Selected Range	Relative Distance to Nearest Facilities	Relative Size of Nearest Facilities	R^2	F Ratio	Hypotheses Rejected
21	Power 26-32 ft	274	$25,000 & above	Harbor	-5.05	.58 (12.4)***	-.44 (9.4)***	.03 (1.4)	.50	91***	
22	Power 33-39 ft	269	$25,000 & above	Harbor	-5.20	.65 (12.4)***	-.43 (8.3)***	.02 (.32)	.49	84***	
23	Power 40 ft or more	211	$50,000 & above	Harbor	-5.96	.41 (9.5)***	-.45 (7.2)***	.02 (.54)	.42	49***	
24	Sailboat 8-11 ft	252	Poverty to $10,000	Rampsite	-9.02	-1.61 (11.4)***	-.26 (3.9)***	.05 (1.1)	.38	52***	4
25	Sailboat 12-15 ft	245	$25,000 & above	Rampsite	-4.46	.74 (10.8)***	-.27 (4.0)***	.07 (1.5)	.36	49**	
26	Sailboat 16-19 ft	262	$25,000 & above	Harbor	-5.77	.601 (8.8)***	-.387 (6.2)***	.05 (1.7)	.35	43***	1,2
27	Sailboat 20-25 ft	232	$15,000 & above	Rampsite	-5.18	1.36 (11.8)***	-.407 (5.2)***	.06 (1.5)	.43	65***	1,3
28	Sailboat 26-32 ft	198	$25,000 & above	Harbor	-5.60	.772 (7.7)***	-.501 (7.7)***	-.016 (.49)	.50	77***	
29	Sailboat 33-59 ft	86	$50,000 & above	Harbor	-6.19	.419 (9.6)***	-.470 (7.6)***	.015 (.45)	.46	55***	
30	Sailboat 40 ft or more	86	$10,000 to $25,000	Harbor	-10.5	-1.41 (4.4)***	-.211 (2.3)*	.012 (.26)	.30	11.6***	4

Note: The numbers in parentheses are the absolute values of the t-ratio; *** indicates a regression significant at .01 rejection level; ** indicates a regression significant at the .05 rejection level; * indicates a regression significant at the .1 rejection level.

The estimation procedure described above required the selection of the most appropriate income and location predictors to predict each of the boat choice logit variables. The equation estimated had, in each case, the form of equation 4.11. Each of the thirty dependent variables of Table 4.1 was regressed on each of the nine income variables and each facilities distance-size pair of variables. Additionally, equations were estimated without any income variable in order to obtain an estimate for the assumption that ownership was not dependent upon income but merely on nearness to a facility and size of facility. Six hundred (30 x (9+1) x 2) equations were estimated using the multiple regression procedure of the Statistical Package for the Social Sciences (SPSS; Nie et al, 1971). From each of the 20 equations for each dependent variable, the best fit was selected, selection being based on finding the equation for which R^2 was highest. The complete set of values of R^2 is shown in Table 4.3.

The thirty best fit equations are summarized in Table 4.4. From right to left the columns of the table indicate the number and name of boat class for the dependent variable, the number of zip codes for which ownership was non-zero in the Los Angeles metropolitan area (there were 325 zones on the map and, for 322 zones, income data was available. See Appendix C). The income range selected as the best predictor of ownership of the particular class is shown in the next column. This is followed by the designation of harbor or rampsite as the facility type which predicted better. Next, the estimated parameters are listed together with t-statistics and levels of significance indicated. Then the value of the coefficient of determination, R^2, and the F-ratio statistic indicating the level of significance of the three dimensional vector of parameters, β_1, β_2, β_3, being different from zero.

From a statistical point of view, the selected set of equations is acceptable. Most equations have values of R^2 between .2 and .6, a range to be expected in cross-sectional analysis. For only two is R^2 less than .1 and three have values between .1 and .2. Moreover, most of the equations have highly significant F-ratios (24 at the 1 percent level, 4 at the 5 percent level, 1 at the 10 percent level, and 1 unacceptable at the 10 percent level). These results suggest that the general form of the equation may be accepted and that the probability of boat ownership may be modeled in terms of income, distance to the nearest facility, and the size of the nearest facility.

The regression results may be assessed as well, from an economic point of view. Several hypotheses can be adduced from the discussion of the previous sections and the equations can be evaluated in terms of whether they allow the hypotheses to be accepted. Six hypotheses will be stated:

1) Consider two classes of boats for which the propulsion type is the same but the length of class i' is greater than the length of class i". It is to be expected that, in general, the price and the fixed costs of class i' will be greater than the price and fixed costs of class i". It is to be expected then that the minimum income required to purchase class i' would be greater than the minimum income required to purchase class i". However, because the income data from the Census does not allow fine distinctions, the first hypothesis becomes: if length of i' is greater than length of i" for the same propulsion type, then $I_{MIN,i'} \geq I_{min,i''}$.

2) If a boat is less than 20 foot long it is likely to be trailered: the probability of boat purchase is therefore more likely to be affected by the presence of a rampsite facility. The highest value of R^2 should be obtained for an equation using the variable "relative distance to the nearest rampsite" and "relative size of nearest rampsite."

3) Using an argument similar to that for boats less than 20 feet long, if the boat is more than 20 foot long then the highest value of R^2 should be obtained for the variable "relative distance to the nearest harbor" and "relative size of the nearest harbor."

4) The sign of the best fit income variable should be positive, indicating that as the proportion of families in the correct income range goes up, the probability of choice of boat ownership increases.

5) The sign of the relative distance variable should be negative indicating that probability of boat ownership decreases as the distance to the nearest facility increases.

6) The probability of boat ownership should increase with increasing relative size of the nearest boating facility: the sign of the facility-size variable should be positive.

The best fit equations do not always conform to the expectations expressed in the six hypotheses. To assist in evaluating the equations, the last column in Table 4.5 indicates which of the hypotheses has been rejected.

The equation pairs (1,2), (15,16), and (26,27) reject the first hypothesis. These results suggest that, in fact, the very small (8-11 foot) power boats are not "like" the 12-15 foot power boats, and the 16-19 foot sailboats are not "like" the 20-25 foot sailboats. This can be believed on the basis that the smallest power boats are likely to be car-top (or boat-top) boats while those over 12 foot are likely to be transported by trailer. The 16-19 foot sailboats are probably catamarans and are not moored. The two classes are likely to appeal to different families.

Four equations reject the second hypothesis: jet boats, 16-19 foot sailboats, new outboards with credit, and less than 16 foot inboards seem to be predicted by nearness to harbors rather than nearness to rampsites. In the Los Angeles region there are few locations where jet boats can be safely used, the remaining suitable sites being at the Colorado River. The 16-19 foot sailboats, likely to be catamarans, are most suited to ocean use and are likely to be predicted by distance to the coastline, a variable which, in the Los Angeles region correlates highly with distance to the nearest harbor. For the remaining boat classes, neither facility size nor distance to facility variable is significant.

The third hypothesis is rejected by the equations 14 and 27 and by the triplet (18, 19, and 20). Each of these dependent variables is in the 20-25 foot length class, suggesting that the distinction between trailered and moored boats is better made at some point between 20 and 26 foot.

The fourth hypothesis, stating that the income parameter should be positive, is rejected by equations 3, 7, and 10 (all of which are 12-15 foot power boats), by the pair 12 and 13 (new and new-credit variables for the 16-19 foot inboard-outboard class) and the shortest and longest sailboat categories.[4] For the longest sailboat class, the next best equation uses the income proportion "$50,000 and above," although the best equation uses the variable "$10,000 to $15,000" with a negative parameter. For the other equations under consideration, the income class "$10,000 and above" usually predicts fairly well but not as well as "poverty to $10,000" with negative coefficient. These results may be understood by considering that the second best equation gives a good idea of the income class which is, in fact, purchasing and owning the boats but that ownership is even higher in those areas where the lower-middle income families do not live.

The fifth hypothesis is rejected in equations 2,4 6, 7, 8, 12, 15, and 16, but in each case the standard error of the constant is larger than the constant and these rejections can be ignored.

The sixth hypothesis is never rejected.

Although the general performance of the estimation procedure seems reasonable, there were only three equations having significant coefficients for all three variables. These are the equations for small power boats, small sailboats, and 20-25 foot power boats. All the other equations have at most two significant parameters. The "relative number of slips" variable is never significant, although the "relative number of ramps" variable often is. The "relative distance" variables are each, on occasion, significant. Several points should be noted. First, the spatial distribution of rampsties is somewhat more diverse than that of the harbor sites. Thus, even though there are few "nearest rampsites" in the metropolitan area, there are even fewer "nearest harbors" so that the latter size variable has small variance. Also, there is high collinearity between some of the income variables (especially the

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[4]Table 4.3, indicating the values of the coefficients of determination obtained for different income ranges, can be used to assess the changes in explanatory power obtained by changing the upper or lower limit of the income ranges presented in Table 4.4 as the "best fit" ranges. It should be stressed that this method does not produce <u>exact</u> estimates of the income limits of the group purchasing boats of a particular class; rather, the income class estimate should be interpreted as follows: it is more reasonable to assume that the stated income group owns boats of class i than that any other income group does so.

upper income groups) and the distance to the nearest harbor, which, as has been suggested earlier, correlates highly with distance from the coastline in the Los Angeles region. It is possible that repeating the analysis in a different metropolitan region would produce more significant parameters for the relative harbor size variable.

The results of the estimation procedure may be summarized. The ownership of the largest components of the fleet: power boats of length between 12 and 25 feet, are best predicted by the distribution of the proportion of families in the income range $10,000 and above; these ownership distributions are somewhat modified by the relative size of the nearest rampsite. Distance to the nearest rampsite has no explanatory power. On the other hand, the distributions of the larger, moored power boats, and of all sailboats, are best predicted by knowing the distribution of the proportions of families of income $15,000 and above (in the case of larger boats the income range is $25,000 and above or $50,000 and above). For moored boats or sailboats, the probability of ownership falls off rapidly with distance from the nearest harbor. For larger boats, the elasticity of distance is almost as large as the elasticity of the income group proportion, suggesting that for large boats, the probability of ownership is not only strongly affected by the proportion of families in high income brackets but also by where they choose to live in relationship to available harbor facilities.

4.4 Inter-County Comparisons of Boat Ownership

The equations estimated in the previous section have been used to explain the spatial distributions of ownership of boats throughout the Los Angeles metropolitan area. It is also of interest to obtain some understanding of the relative levels of ownership among the coastal and inland counties of the State. This can be attempted by considering that the smaller northern and central urbanized counties are much smaller than the Los Angeles area and may be considered to be of the same order of magnitude as a zip code area. This, of course, is a fiction but it allows the use of the estimated equations to "predict" levels of ownership. The predicted values can be compared with the actual ownership levels.

In order to use the equations, two further approximations must be made. Facility capacity (slips or ramps) can be approximated by the total capacity of the county;

TABLE 4.5

ASSUMPTIONS USED IN PREDICTING LEVELS OF BOAT OWNERSHIP IN SELECTED NORTHERN AND CENTRAL CALIFORNIA URBAN COUNTIES

		Income Proportion						Ramp Site		Harbor	
County	# of Families	10K+	10-25K	15K+	25K+	50K+	8-25K	Dist.	# of Ramps	Dist.	# of Slips
Alameda	266,500	.576	.522	.274	.054	.0085		6	26	7	3,262
Contra Costa	146,304	.659	.579	.348	.08	.009		6	35	7	5,167
Marin	52,938	.698	.564	.431	.134	.02		3	26	2.5	3,174
San Francisco	164,436	.532	.460	.273	.072	.013		6	8	7	1,555
San Mateo	146,755	.706	.605	.393	.101	.016		3	13	7	1,325
Santa Clara	261,889	.661	.589	.350	.072	.008		6	23	20	322
Sonoma	52,831	.479	.441	.196	.038	.0047	.573	10	17	20	214
San Diego	328,019	.506	.457	.231	.049	.007		3	79	3	5,286
Kern	83,503	.428	.396	.176	.032	.004	.533	25	30	100	1,000
Sacramento	203,324	.426	.389	.197	.037	.005	.6	3	48	10	3,169
Fresno	101,846	.412	.374	.173	.038	.004	.589	26	81	30	1,023
San Joaquin	72,716	.475	.434	.192	.042	.006	.620	2	24	7	1,531
Stanislaus	50,528	.419	.380	.168	.039	.006	.513	3	30	50	83

Source: United States (1972a).
California (1970).

TABLE 4.6

COMPARISON OF PREDICTED (P) AND OBSERVED (O) LEVELS OF BOAT OWNERSHIP IN SELECTED NORTHERN AND CENTRAL URBAN COUNTIES, 1972

	Length Propulsion Class													
	Outboards 12-15 ft		All Power 16-19 ft		All Power 20-25 ft		All Power 26-39 ft		All Power 40+ ft		Sailboat 20-25 ft		Sailboat 12-15 ft	
	P	O	P	O	P	O	P	O	P	O	P	O	P	O
Alameda	24.7	37.2	21.4	21.5	4.4	4.0	2.7	4.3	.5	.6	1.3	1.8	1.7	2.5
Contra Costa	30.5	33.1	27.2	39.6	5.1	8.4	3.6	5.5	.5	.34	1.8	1.7	2.3	3.9
Marin	28.0	35.3	24.9	27.0	6.9	10.0	7.6	12.3	1.1	1.3	3.2	4.9	4.0	6.0
San Francisco	17.7	13.6	14.5	9.4	3.4	2.9	2.9	3.3	.6	.5	1.3	1.7	2.0	.85[2]
San Mateo	28.1	29.5	26.6	25.2	5.7	4.2	4.1	3.8	.9	.6	2.8	1.8	3.1	3.0
Santa Clara	29.6	39.1	26.7	27.5	4.4	4.8	1.9	2.9	.6	.7	1.9	1.9	2.1	4.2[1]
Sonoma	13.0	70.0[1]	15.3	31.6[1]	2.6	3.6	1.2	2.3	.2	.2	.6	.6	1.1	1.9
San Diego	18.0	26.8	19.2	16.3	3.3	5.2	3.6	4.0	.5	.6	1.5	2.3	2.1	3.4
Fresno	17.6	56.7[1]	10.3	22.5[1]	2.4	2.9	1.2	19.	.2	.0	.7	.7	1.2	1.1
Kern	17.0	46.1[1]	12.6	25.9[1]	2.2	2.2	1.2	.72	.1	.0	.4	.5	1.7	1.6
Sacramento	17.0	70.6[1]	13.2	28.8[1]	3.1	3.8	1.7	5.8[1]	.3	.6[1]	.6	.9	1.0	1.6
San Joaquin		96.0[1]	15.1	35.4[1]	4.4	5.8	2.4	3.6	.4	.4	.8	.7	1.7	1.0
Stanislaus	16.0	115.0[1]	11.9	22.2[1]	3.2	4.2		2.8	.2	.6[1]	.2	1.4[1]	1.6	3.0[1]

[1]Observed value indicates that it is more than double the predicted value.
[2]Observed value indicates that it is less than one-half the predicted value.

this capacity is to be considered to be at a fixed distance from the center of population, at which it is assumed that all the county's income groups live. It is clear that selection of the distance to be used requires some judgment; the estimates used here in calculating the predicted values are shown in Table 4.5. To establish a rough level of precision, it is considered that the predicted per family boat ownership levels should have no more than 100 percent error.[5] The predicted and actual values are compared in Table 4.6. The performance of the equations under the assumptions was surprisingly good for all but the inland urban areas where the prediction is often low by a factor of up to 4. From these results a tentative inference can be drawn: the probability of boat ownership in all urban coastal areas is explained by similar variables. However, the probability of ownership of small power boats is much higher in inland, urbanized regions than would be expected if those regions were part of coastal metropolitan areas; the recreational behavior of inland families seems to be different from that of coastal families.

4.5 Summary

This chapter has reported a method to estimate the probability that a family owns a boat. The method identified for each boat class, the income group whose spatial distribution with respect to boat facility locations best explains the zip code level distribution of the particular class of boat in the Los Angeles metropolitan area. Boats were classified by length and propulsion, ownership of each boat class being considered independent of the choice of owning each other class. The probability that a family owned a boat of a particular class was modeled using the so-called "logistic" method. The logit of the probability is considered to be a linear function of the logarithms of proportion of families in the correct boat buying range, relative distance to the nearest appropriate facility, and the relative capacity of the nearest facility. The correct income range predictor and the correct facility type were obtained by experimenting with ranges and facility type and the variables which produced the highest coefficient of determination (R^2) were considered to be correct.

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[5]This non-statistical estimate of prediction error seems acceptable given the looseness of the predicting procedure.

A set of thirty best fit equations was obtained using this procedure. The equations were considered reasonable from both a statistical and an economic viewpoint. Although few equations had three significant parameters, most had two; most of the equations were significant at the 1 percent level. The signs of the parameters were correct, except in a few easily understood cases.

The predictive power of the equations was tested by comparing predicted and actual levels of ownership for the smaller urbanized counties of the San Francisco Bay Area and the Sacramento and San Joaquin Valleys. The models predicted satisfactory values for most Bay Area counties but predicted low values for small boat ownership in the inland regions. This general level of performance was explained by suggesting that the tastes and opportunities of inland middle-income families differ from those of metropolitan dwellers.

In conclusion, this chapter has presented an analysis to suggest that to predict the level of ownership of any particular boat class it is appropriate to consider that ownership is restricted to those who can afford to purchase a boat of that kind. The distribution of small power boats is much better predicted by the distribution of families with income in the upper half (over $10,000) of the income distribution. The size of the nearest rampsite facility seems to have a small effect on ownership choice. On the other hand, the distributions of sailboats and all boats needing wet-storage are best predicted by the distribution of families in the upper one-third (over $15,000), one-fifteenth (over $25,000), or one-eightieth (over $50,000) of the income range.[6] Moreover, distance from the nearest facility is very important in predicting the distribution of moored boats and sailboats. The probability of ownership of these classes drops off very rapidly with distance from the coastline.

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[6]Proportions based on 1970 Census data for Los Angeles County.

CHAPTER 5

REVIEW OF THEORETICAL AND EMPIRICAL FINDINGS AND POLICY RECOMMENDATIONS

5.1 Overview

The State's policy interests of concern in this study have been identified as efficiency in production and equity in distribution of the State's recreational water resources. The analysis has been designed to be used as additional information in forming State of California recreational boating policy. The research has been guided by social scientific theory and technique in reorganizing existing sources of data to provide a new perspective. The major substantive questions raised are: (1) At present, who uses the State's recreational boating resources? and (2) Can the State predict the future demand for recreational boating resources? The State is considered in the analysis to be the sole manager of the coastal and inland waters suitable for recreational boating.

Data sources used in the analysis have included major published reports on California recreational boating, associated research on coastal zone management policy, and, as a large source of previously unanalyzed data, a complete copy of the California Department of Motor Vehicles Vessel Registration File. Theory and empirical technique have been selected from the disciplines of economics and geography.

Although the institutional focus of the analysis has been on the State of California, much of the empirical geographical focus has been, instead, on the metropolitan areas of the State, in particular, the Los Angeles metropolitan area. While the resources to be managed by the State are coastal or inland, the recreational activity is considered to be an urban recreational activity originating at an urban family's residence and having destination at some, perhaps distant, recreational site. It is useful to consider the Los Angeles metropolitan area in some detail and as a basis for comparison with other areas because it contains over half the population of the State. The distribution of housing, transportation, education, and recreational opportunities among families in this region must preoccupy California State policy-makers.

The Los Angeles region is well known for two conditions which have made it preeminent among modern American cities. The construction of the extensive freeway network since the Second World War has allowed the development of the "spread city" of which Los Angeles is the best known example. Transportation in the region is largely by automobile. There is no competing mass transportation system. The freeways allow reasonably rapid access to the center of the metropolis from its far distant edges. The second condition is a by-product of the first; the daily production of automobile smog for which the automobile is notorious. These two conditions: high intraregional accessibility by automobile and polluted atmospheric conditions in the central and inland parts of the region have shaped the spatial distributions of income groups in the metropolitan area. Lower income groups are in high concentrations in the older, more central parts of the city; it is in South Central Los Angeles and in East Los Angeles that the major concentrations of Blacks and Spanish Heritage Americans are located. Middle and upper middle income families are located in a rough ring around the center of the urban area (see the income maps of Appendix C). The highest income families are concentrated in areas distant from the center of the metropolis and near to the coastline which on the west and the south forms a natural edge to the region.

It is within this institutional and urban framework that this study is presented for evaluation. In the next section the major empirical results and conclusions of the earlier chapters are reviewed. The final section presents some additional policy recommendations.

5.2 Summary of Results

In Chapter 2 it is shown that a concern for efficiency in the use of the State's coastal and inland water surfaces suitable for recreational boating requires the resources to be used at some level of congestion to be set as public policy. The policy analysis used here takes into consideration that the final consumption goods used by boaters are "recreational boating days" requiring in the production process the "public good" recreational water resource input and the "private good" inputs such as the boat and the boater's time. It is shown that the State has several policy tools available to it in maintaining some particular prescribed congestion level. These tools include pricing or subsidizing access to resources (using launching ramps and slips as pricing sites much as bridge toll booths are used) and expanding or contracting the supply of the water resource itself. As well, the State can potentially intervene in the markets for private good inputs to the activity, such as for new boats and used boats, for rental of boats, for wet and dry storage, and for credit used in boat purchase. Further, the State may continue to intervene in the markets for slip and launching services. If the State is to plan for future efficient production, it must, however, have some method to predict the future aggregate demand for recreational boating. This requires the State to have some knowledge of the boater's response to changes in prices of inputs to the recreational experience.

The State's concern for equity in distribution of State water recreational resources may require considering a large number of partitions of the population. In this study several were considered including geographically based partitions, the intergenerational partition of the residents of the State, and the "social" divisions of age, race, sex, and income. It was argued, in Chapter 2, that in the recreational boating content, the State's concern for equity could be reduced to the setting of or maintaining some distribution of water resources among different income groups and among geographically dispersed subpopulations. To carry this out, the State has first to propose some method of measuring relative access of different groups to the resources and then to devise policies to alter incentives of different groups so that relative access distribution would conform to State policy requirements. Intervention to achieve equitable distribution requires an understanding of the aggregate demand functions of different subpopulations.

Within the theoretical framework proposed, it is found that there is little data available to guide State policy-makers. The third and fourth chapters of this study report empirical analysis which is expected to be of use in applying ideas of efficiency and equity to recreational water resource management.

In Chapter 3, the State's use of time trend extrapolation of boat ownership was criticized as inadequate as a method to predict future aggregate demand. The method not only does not take into consideration those market parameters which might be expected to affect demand for recreational boating but, further, does not allow the State to assess the possibility of intervening and altering the demand parameters. It is proposed in Chapter 3 that an alternative demand prediction method be used. A search of the literature on consumer durables yields a variety of more or less successful attempts to model the demand for cars, refrigerators, television sets, and washing machines--all goods which like recreational boats are purchased for use over many years. The economic models used are varieties of the "stock adjustment model." Chapter 3 presented an inductive discussion to suggest the possible explicit form of the stock adjustment model suited to recreational boating. Demand factors investigated were regional facilities supply data, regional spatial behavior, availability and use of consumer credit, the durability of equipment, and prices of recreational boats. Each of these variables is expected to act as an independent predictor of the quantity of boats purchased each year or the stocks of boats owned each year, depending upon the form of equation selected.

Chapter 3 proceeded by presenting a breakdown of the California Master Vessel Registration File to show that it could be used to provide some of the information required to estimate some of the dependent or independent demand factors. Durability of boats was investigated and expected lifetimes calculated to show that boats might be expected to last at least 10 years (small power boats) and up to 30 years (large inboard power boats and sailboats). The extent of installment credit was demonstrated and data was presented to suggest that credit supply has been an important demand determinant in the last 10 to 15 years. Fairly precise sales price and quantity data were demonstrated for the period 1964 through 1972. A comparison between estimated sales and estimated scrapping for the years 1972 and 1973 was used to suggest the stake that boat manufacturers and boat dealers might have in the continued expansion of the recreational fleet. The spatial distribution of the boating facilities stock was investigated and seen to have some relationship to the redistribution of boating stock as boaters responded to incentives to minimize transportation costs. Some estimates of annual and per trip costs of recreational boating were made.

The discussion of Chapter 3 concluded that not all the suggested predictors of boating demand should be ignored. However, it was pointed out that the stock and sales data for the State of California are available only for the period 1964 through 1971 (or, if another analysis is done, through 1974). It was argued, in Chapter 3, that analysis of a data series of eight points could yield parameter estimates of such low significance that prediction of demand, based on statistical estimation of a stock adjustment model using these data, would have large uncertainty if extrapolation over 10 years were attempted. Simple time trend extrapolation has as much predictive value as a more theoretically acceptable method--but no more. It is to be concluded that although it is possible to obtain many pieces of information about boater behavior and preferences it is not possible to produce acceptable demand estimates to be used as a justification for construction of large recreational facilities which require long lead times.

Chapter 4 took up the problem of producing information on the distributional questions arising out of a concern for equitable distribution of the State's water resources. The analysis was formulated in terms of the prediction of the probability that a family would purchase a boat of a certain length-propulsion class. It was shown that the probability of boat ownership could be estimated using a log-log equation relating the logit of the probability to three independent variables in logarithmic form. The fleet was partitioned into thirty, at times overlapping classifications each of which was used to obtain the logit of the probability of per family ownership. Two of the three independent predictors were selected using annual and per trip cost functions as a rationale: the high fixed cost suggested a minimum income threshold for each boat class and high travel costs the possibility of an upper income limit for some classes; travel costs also suggested that distance to the nearest facility would be a determinant of probability of ownership. The income predictor was considered to be the logarithm of the proportion of families in the correct income range and the distance predictor was chosen as the logarithm of the distance to the nearest suitable facility (divided by the average distance of all points in the urban area to the nearest facility). The third predictor was selected using the idea that the size of the nearest suitable facility would also determine the probability of boat ownership. The "correct" income range and the "correct" nearest facility (harbor or launching site) were unknown a priori. The correct income range and the correct facility determinants were obtained by selecting the estimated equation for each dependent variable for which the coefficient of multiple determination was maximum. Data used in the statistical analysis consisted of cross-sectional zip code level data for the Los Angeles metropolitan area.

The estimated form of each of the thirty best fit equations was seen, in almost all cases, to be statistically significant in explaining the probability of family boat ownership. Each dependent variable: income, distance to nearest facility, and size of nearest facility was seen to be statistically significant for at least some of the equations (excepting for the size of harbor facility variable for which there were very few data points in the Los Angeles metropolitan area). The series of best fit equations was further evaluated in economic terms: most of the estimated parameters had the correct sign;

probability of ownership of the larger and more expensive boats was predicted by proportions of higher income groups; small trailerable boat ownership was best predicted by nearness to launching facilities; larger, wet-stored boat ownership was best predicted by nearness to harbor facilities.

The estimations of Chapter 4 were further tested by predicting ownership levels in other urban areas of the State; it was seen that the data for Los Angeles was typical of the metropolitan populations of the San Francisco Bay area and San Diego but not of the inland Delta and Sacramento-San Joaquin Valley urban counties.

The analysis of Chapter 4 allows several conclusions to be drawn. The distribution of trailerable boat ownership is best predicted by the distribution of families in the income range $10,000 and above (1969 data) indicating that participation in this broad class of water recreation --lake fishing, water skiing--is confined to the upper one-half of the income range. Distance to the nearest facility is not an important predictor of boat ownership except for the largest trailer boats. However, using this analysis, it is seen that the probability of ownership does increase if the size of the nearest launching site increases.

Further, the distribution of all sailboats and all moored boats is strongly determined by the proportion of families in the income range $15,000 and above and as the boats become larger, by the ranges $25,000 and above and $50,000 and above. These forms of boating seem, then, to be limited to the upper one-third of the income range, or for longer boats, to the upper one-fourteenth or the upper one-eightieth of the income range. Moreover, the probability of ownership of sailboats and large power boats is strongly biased toward coastal harbor or ramp-site facilities: at a distance of about 15 miles from the coast the probability of boat-ownership drops to about one-third its value at the coast.

The implications of Chapters 3 and 4 lead to the expectation that boat owners are highly influenced in their decisions to purchase recreational boats by the price of the boat, by the cost of transportation, by the available family income, by facility supply, and by the availability of consumer credit. Each of these factors should be considered in an attempt to understand past ownership behavior and in predicting future demand. Many of these factors have changed dramatically in California, especially in the Los Angeles metropolitan region during the decade of the sixties; they should not be lightly ignored in empirical analysis. Unfortunately, the available time series data do not allow prediction over the time spans required for large recreational facility planning. It is fairly certain, though, that if new facilities are provided, access to State boating water resources will be limited to those who can afford to purchase or rent the necessary boating equipment. With a largely privately owned fleet, the high cost of boat purchase will continue to limit water recreation access to those in the upper one-half of the income spectrum or, in the case of the more rigorous off-shore coastal activities, to those in the upper one-third to one-eightieth of the income range.

5.3 Policy Recommendations

This study was conceived as a vehicle for enumerating policy options and for producing information upon which to base choices from among them. It does not require that a large set of specific policy recommendations be spelled out. However, two ideas motivating the research should be brought out explicitly at this point. The first has to do with the availability of information to research of relevance to public policy. The second concerns the relative access of different income groups to public resources.

The work reported in this study has relied heavily on published information put together by the State of California at various times to justify or to determine recreational boating policy. This study has also used a large, previously unpublished set of registration records containing categories of information not usually available to other analysts. The State's open information policy which has allowed access to basic data by independent investigators is to be commended. It allows the production of small-scale research projects and thereby promotes the testing of competing ideas. It is recommended that this open information policy be continued.

The second idea has to do with the different levels of access of high- and low- income families to the coastline resources. It has been noted that, for at least two reasons, low-income families are concentrated in the center of the urban area and far from the coastline, and upper-income residential concentrations are almost always within easy access to the oceanfront. The issue raised here is not whether the coastline is being taken over by upper middle- and upper- income families but whether these families, having moved to the coastline to escape the smog and to purchase larger residential living areas, should be provided with the specialized facilities along the coastline which upper-income recreational styles require. With high concentrations of upper-income families in coastal parts of the metropolis there is also high demand for facilities--such as Marina De Rey--which only such families can afford. At the same time, those restricted to the central urban core or displaced there by increasing market prices in older coastal areas are confined not only to a polluted environment but are also unable to use any of the services of the coastline. It is recommended that this equity issue be a central focus of marine recreational policy.

APPENDIX A

OPTIMAL PRODUCTION OF PUBLIC GOODS SUBJECT TO CONGESTION EXTERNALITY

The discussion in Section 2.1 of efficiency in the management of State water recreational resources relies heavily on two theorems reported by Agnar Sandmo; this appendix presents an unelaborated outline of his analysis. The interested reader is to be directed to the original source (Sandmo, 1973).

In the economy to be modelled there are s customers each of which has preference ordering over n final consumption goods.[1] The quantity of final consumption good j consumed by consumer k is written

$$X_j^k \quad (k = 1, \dots s;\ j = 1, \dots n) \tag{A.1}$$

The preference structure for each consumer is described by a utility function

$$u^k = u^k(X_1^k, \dots X_n^k),\ (k = 1, \dots, s) \tag{A.2}$$

(see Intriligator, 1971, Section 7.2 for an axiomatic presentation of the properties of the utility function). Each consumer produces the final consumption goods according to a production function. For simplicity, it is assumed that each private final consumption good is produced from only one public good and only one private good. It is further assumed that the same production technology is generally available and is used by all consumers. The

[1]Certain terms are defined in Section 2.1 which should be read in conjunction with this Appendix.

production is described by production functions of the form

$$X_j^k = \phi_j(y_j^k, z_j) \quad (k = 1, \ldots s;\ j = 1, \ldots n) \qquad (A.3)$$

The expression A.3 is to be read as follows: consumer k produces a quantity X_j^k of the j-th final consumption good using as inputs to the production process a quantity, y_j^k, of a private good which is combined with the quantity, z_j, of the public good input. Note that consumers may vary the quantity of the private good input but that each consumer uses the same level of public good input.

The possibility of externality in production of the final consumption goods is introduced by respecifying the function so that it reflects that each individual's production is affected by the total level of use of the private goods by all consumers. In the congestion case,

$$X_j^k = \psi_j \left(y_j^k, \sum_{i=1}^{s} y_j^i, z_j\right) \quad (k = 1,\ldots s;\ j=1,\ldots n) \qquad (A.4)$$

The optimality conditions for the economy are obtained by maximizing a social welfare function subject to the constraint determined by the production possibilities of the economy. The social welfare function is assumed to be individualistic, written as

$$W = W(u^1, \ldots u^s) \qquad (A.5)$$

and W is considered to be an increasing function of all its arguments (that is, an increase in the utility of any consumer is assumed to increase social welfare). Let the total production and consumption of private good j be y_j

$$y_j = \sum_{i=1}^{s} y_j^i \quad (j = 1, \ldots n) \qquad (A.6)$$

The production possibilities of the economy are expressed in terms of the transformation function

$$F(y_1, \ldots y_n; z_1, \ldots z_n) = 0 \qquad (A.7)$$

The Lagrangian, therefore, has the form

$$W(u^1, \ldots u^s) - \lambda F(y_1, \ldots y_n; z_1, \ldots z_n) \qquad (A.8)$$

Optimality Without Congestion Externality

The first order conditions at the point of maximal social welfare are derived by taking into consideration the form of the production functions given by A.3. Using the "chain rule" for partial differentiation the conditions may be expressed in the following way

$$\frac{\partial W}{\partial u^k} \frac{\partial u^k}{\partial x_j^k} \frac{\partial \phi_j}{\partial y_j^k} - \lambda \cdot \frac{\partial F}{\partial y_j} = 0 \quad (k=1, \ldots s; j=1, \ldots n) \qquad (A.9)$$

or equivalently

$$W_k u_j^k \frac{\partial \phi_j}{\partial y_j^k} - \lambda \frac{\partial F}{\partial y_j} = 0 \quad (k=1, \ldots s; j=1, \ldots n) \qquad (A.10)$$

and

$$\sum_{i=1}^{s} W_i u_j^i \frac{\partial\phi_j}{\partial z_j} - \lambda \frac{\partial F}{\partial z_j} = 0 \quad (j=1, \dots n) \qquad (A.11)$$

Rewriting A.9 and A.10, three optimality conditions can be derived:

$$\frac{u_j^k \; (\partial\phi_j/\partial y_j^k)}{u_r^k \; (\partial\phi_r/\partial y_r^k)} = \frac{\partial F/\partial y_j^j}{\partial F/\partial y_r}$$

$$(k=1, s;\; j,r=1, \dots, n) \qquad (A.12)$$

A.12 shows that the marginal rate of substitution between any pair of private goods should be the same for all consumers and equal to the marginal rate of transformation (the efficiency condition for private goods).

$$\sum_{i=1}^{s} \frac{u_j^i(\partial\phi_j/\partial z_j)}{u_r^i(\partial\phi_r/\partial y_r^k)} = \frac{\partial F/\partial z_j}{\partial F/\partial y_r} \quad (j,r=1, \dots n) \qquad (A.13)$$

A.13 shows the efficiency condition for public goods to be equality between the sum over all consumers (i) of the marginal rates of substitution between each public good, j, and some private good, r.

$$W_i u_j^i(\partial\phi_j/\partial y_j^i) = W_k u_j^k(\partial\phi/\partial y_j^k) \quad (i,k=1, \dots s; j=1, \dots n)$$

$$(A.14)$$

The optimal distribution of private goods is such as to equate the marginal social utility of each good among all consumers.

If, for each public good, the marginal rate of substitution is calculated with respect to the private good which contributes to the same final consumption good (i.e., set j=r in A.13)

$$\sum_{i=1}^{s} \frac{\partial\phi_j/\partial z_j}{\partial\phi_j\ \partial y_j^i} = \frac{\partial F/\partial z_j}{\partial F/\partial y_j} \quad (j = 1, \ldots n) \qquad \text{(A.15)}$$

then a useful operationalization can be deduced. The left side, the sum of the marginal rates of substitution of the public good with the private good can be identified with marginal benefits, and the right side, the marginal rate of transformation can be identified with marginal costs. More specifically, if the level of output of final consumption good is kept constant for each consumer,

$$dX_j^i = \frac{\partial\phi_j}{\partial y_j^i} dy_j^i + \frac{\partial\phi_j}{\partial z_j} dz_j = 0 \qquad \text{(A.16)}$$

then A.15 becomes

$$\sum_{i=1}^{s} \left[- \frac{dy_j^i}{dZ_j}\right]_{dX_j^i=0} = \frac{\partial F/\partial z_j}{\partial F/\partial y_j} \quad (j = 1, \ldots n) \qquad \text{(A.17)}$$

The marginal willingness to pay is the maximum quantity of private goods input that the consumer will be willing to give up in exchange for an increased provision of the public good output holding constant his level of final good output.

Optimality Conditions with Congestion Externality

If the production function for final consumption goods now has the form given by equation A.4, the economy is considered to be characterized by congestion externalities in consumption. Again, the optimality problem requires maximizing the social welfare function subject to the production possibilities function (expression A.8), but, in this case, taking into consideration the production function given by A.4. In this situation the first order optimality conditions become

$$W_k u_j^k \frac{\partial \psi_j}{\partial y_j^k} + \sum_{i=1}^{s} W_i u_j^i \frac{\partial \psi_j}{\partial y_j} - \lambda \frac{\partial F}{\partial y_j} = 0$$

$$(k=1, \ldots s; j=1, \ldots n) \qquad (A.18)$$

and

$$\sum_{i=1}^{s} W_i u_j^i \frac{\partial \psi_j}{\partial z_j} - \lambda \frac{\partial F}{\partial z_j} = 0 \quad (j=1, \ldots n) \qquad (A.19)$$

On rearranging these equations to remove the dependence on λ,

$$\frac{W_k u_j^k(\partial\psi_j/\partial y_j^k) + \sum_{i=1}^{s} W_i u_j^i(\partial\psi_j/\partial y_j)}{W_k u_r^k(\partial\psi_r/\partial y_r^k) + \sum_{i=1}^{s} W_i u_r^i(\partial\psi_r/\partial y_r)} = \frac{\partial F/\partial y_j}{\partial F/\partial y_r}$$

$$(k=1, \ldots s; j,r=1, \ldots n) \qquad (A.20)$$

$$\frac{\sum_{i=1}^{s} W_i u_j^i(\partial\psi_j/\partial z_j)}{W_k u_r^k(\partial\psi_r/\partial y_r^k) + \sum_{i=1}^{s} W_i u_r^i(\partial\psi_r/\partial y_r)} = \frac{\partial F/\partial z_j}{\partial F/\partial y_r}$$

$$(k=1, \ldots s; j,r=1, \ldots n) \qquad (A.21)$$

and

$$W_i u_j^i(\partial\psi_j/\partial y_j^i) = W_k u_j^k(\partial\psi_j/\partial y_j^k)$$

$$(i,k=1, \ldots s; j=1, \ldots n) \tag{A.22}$$

substituting from A.22 into A.20 and A.21 gives

$$\frac{u_j^k(\partial\psi_j/\partial y_j^k)\left(1 + \sum_{i=1}^{s} \frac{\partial\psi_j/\partial y_j}{\partial\psi_j/\partial y_j^i}\right)}{u_r^k(\partial\psi_r/\partial y_r^k)\left(1 + \sum_{i=1}^{s} \frac{\partial\psi_r/\partial y_r}{\partial\psi_r/\partial y_r^i}\right)} = \frac{\partial F/\partial y_j}{\partial F/\partial y_r}$$

$$(k=1, \ldots s; j,r=1, \ldots n) \tag{A.23}$$

and

$$\frac{\sum_{i=1}^{s} \frac{\partial\psi_j/\partial z_j}{\partial\psi_j/\partial y_j^i}}{1 + \sum_{i=1}^{s} \frac{\partial\psi_j/\partial y_j}{\partial\psi_j/\partial y_j^i}} = \frac{\partial F/\partial z_j}{\partial F/\partial y_j} \quad (j=1, \ldots n) \tag{A.24}$$

Equations A.23 and A.24 are to be compared with equations A.12 and A.13 (respectively) of the previous derivation. It is seen that introducing externality into the production of final consumption goods alters the optimality conditions for the allocation of private goods and of public goods. This may be understood in terms of Pareto optimality and competitive equilibrium. If there are no externalities in the use of private goods (condition A.3 holds) then competitive behavior in the market for the private goods leads to a Pareto optimal allocation for each level of provision of public goods. In the situation where congestion is explicitly considered, to achieve an optimum (i.e., a maximal social welfare) two conditions are necessary: the first (A.23) requires that there be a reduction in the private goods with the greatest congestion effects relative to the allocation where only "private" marginal rates of substitution are taken into account. The second condition (A.24) requires that for the optimum to obtain in the congested situation there should be an increased provision of the congested public goods relative to the allocation where only the summed marginal rates of substitution are considered. But these two policy requirements hold only if

$$1 \mathrel{\overline{\overline{>}}} 1 + \sum_{i=1}^{s} \frac{\partial\psi_j/\partial y_j}{\partial\psi_j/\partial y_j^i} > 0 \quad (j=1, \ldots n) \tag{A.25}$$

or, for convenience, defining c_j by

$$c_j \equiv 1 + \sum_{i=1}^{s} \frac{\partial\psi_j/\partial y_j}{\partial\psi_j/\partial y_j^i} \quad (j=1, \ldots n) \tag{A.26}$$

then

$$1 \mathrel{\overline{\overline{>}}} c_j > 0 \tag{A.27}$$

Condition A.25 has the following interpretation: noting that $\partial\psi_j/\partial y_j^i$ is assumed negative, suppose that all consumers increase their private goods input y_j^i infinitesimally, representing an increase in their use of the public good; the immediate effect is to increase the level of output of the final good for all consumers. However, congestion should also increase. Condition A.25 says that the second effect does not outweigh the first.

Sandmo also introduces the normative analysis of the system by considering the equations A.23 and A.24 as suggesting public policy rules for optimal public goods production and optimal user charges. Assume that the economy acts competitively with private good r being the numeraire good. Moreover, no externality in use occurs with good r so that $\partial\psi_r/\partial y_r = 0$. Let p_j be the competitive price faced by the producers of good j. Producers then equate the marginal rate of transformation to the ratio of prices

$$\frac{\partial F/\partial y_j}{\partial F/\partial y_r} = p_j \tag{A.28}$$

Suppose now that consumers of good j face price p_j'. In equating the marginal rate of substitution to the ratio of prices, each consumer is assumed to neglect the effect of his own use of public good, j, on the aggregate use. The equilibrium demands of consumers are characterized then by

$$\frac{u_j^k(\partial\psi_j/\partial y_j^k)}{u_r^k(\partial\psi_r/\partial y_r^k)} = p_j' \quad (k=1, \ldots s; j=1, \ldots n) \tag{A.29}$$

For equilibrium if there is no congestion, using A.12, A.28, and A.29, it is seen that

$$p_j = p_j' \tag{A.30}$$

But in the congestion case, taking into consideration A.23, A.26 through A.29,

$$\frac{q_j}{p_j} = \frac{1}{c_j} \quad (j=1, \ldots n) \tag{A.31}$$

Since from A.27, c_j lies between 0 and 1, it follows that p_j', the price to be faced by consumers, should be higher than p_j, the price to be faced by producers, in the socially optimal situation. The policy implication is that the consumer price for the good j should be set higher than marginal cost and the increment be seen as a user charge for the public good.

Finally, if π_j is the shadow price for the public good j, given by the marginal cost of producing an increment of the public good, it follows from A.24 that

$$\frac{\sum_{i=1}^{s} \frac{\partial\psi_j/\partial z_j}{\partial\psi_j/\partial y_j^i}}{c_j} = \frac{\pi_j}{p_j} \quad (j=1, \ldots n) \qquad \text{(A.32)}$$

and comparison with the uncongested case (equation A.15) shows that the measure of benefits has been augmented by a factor $1/c_j$, so that the provision of the public good should be larger than in the uncongested case.

Sandmo draws the following conclusion from this analysis:

> In comparison with a system where consumer and producer prices are identical...we have shown (1) that the existence of congestion externalities implies optimal prices that are systematically higher for consumers than for producers and such that the deviations are larger, the higher is the level of congestion; (2) that the consequent reduction in congestion-creating activities should be accompanied by increased provision of the public goods the limited capacities of which give rise to the congestion phenomena.

In the remainder of his paper, Sandmo generalizes his theorems to take into consideration that many public goods (e.g., a river, the coastline) and many private goods (e.g., time) are used as inputs in the production of several final consumption goods. The interested reader is directed to his discussion.

APPENDIX B

THE CALIFORNIA MASTER VESSEL REGISTRATION FILE

This appendix describes the format structure of the California Department of Motor Vehicles (DMV) Master Vessel Registration File. Next, a method used to reformat each record to allow for flexible analysis is described; this method uses a knowledge of the way records are created and updated on the File. Finally, there is included a discussion of estimates of the magnitudes of errors in calculations based on the use of the copy of the File current on November 30, 1972.

B.1 A General Description of the Master Registration File

Each boat in California of length greater than 8 feet is required to be registered if it is to be used as recreational equipment on the State's waterways. Exceptions are made for boats of 5 or more net tons gross burden for which the option of Coast Guard documentation is available.[1] Each boat registered with the California DMV is assigned a unique registration number which remains with it through subsequent registration periods.

At the time of initial registration, a variable-formatted registration record is created on the File. The categories of information necessary to describe the boat and its owner are selected and the information is stored. Some categories are optional to the DMV and others are always completed for each registered boat. If the initial registration is incomplete, an incomplete record is created and the registrant is notified. When the DMV is given the required information, the record is updated and the "incompleteness switch" on the record is turned off.

From time to time registration information must be changed. For example, at the end of each registration cycle, the record becomes non-current. If the boat is

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[1]In 1972 there were 1,304 documented boats based in California ports, of which 271 were less than 30 feet long, 846 were between 30 and 41 feet, and 187 were over 42 feet (California 1972b, p. 45).

then re-registered, the record is updated to show the current registration year. If the boat is not re-registered the record remains unchanged on the File. Thus, at any time the File contains a mixture of currently and previously registered boat records.

If a boat is transferred to a new owner, the only information changes on the record are the name and address of the new registered owner and the possible name and address of the new legal owner. Once a loan is paid off, the DMV is notified and the record is purged of the separate legal owner's name and address.

If the boat is junked, given another number, documented, moved out-of-state, or withdrawn from registration, the record remains on the File, but the appropriate "switch" is turned on to indicate that there is no boat in California to correspond to the record. It seems that few boaters actually notify the DMV when their boats are scrapped or moved out-of-state, and these records do not seem to be good indicators of the extent of removal from the fleet. In this study, the large number of boats with non-current registration records at the end of the recording year are considered to have been junked or otherwise removed from the Fleet.

It is not of interest to describe the detailed format of the File; this information should be released only by the DMV. However, to create confidence in the methods used it is important to describe the record structure and the types of information contained in each record.

Since the record contains optional data fields, it is of variable length. The first field of the record indicates the actual length of the record. Second, the order of the data fields for those categories used is specified. Third, because rapid scanning of record status is important for law-enforcement uses, status information is indicated. Finally, the optional and required data fields follow to complete the record. A diagram of the overall structure of the record is shown in Table B.1.

The bit structure of the five-byte mask indicates the presence of selected optional fields.[2] For example,

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[2]On the IBM 360 and 370 computers, memory consists of entities called "bytes." Each byte consists of 8 "bits": a bit is a binary digit which is 0 or 1 (alternatively either "off" and "on"). The program discussed in this appendix was written by Earl Cooper, formerly consultant programmer at the University Computer Center,

TABLE B.1

SUMMARY REPRESENTATION OF THE DEPARTMENT OF MOTOR VEHICLES VESSEL MASTER FILE RECORD STRUCTURE

Name of Field	Length of Field	Purpose
Header	2 bytes	Indicates overall length of record.
Mask	5 bytes (40 bits)	Indicates which optional fields are used used for this record.
Record Status	4 bytes (32 bits)	Indicates the status of registration (see text for further details).
Required Fields		Information required concerning boat and owner for each registration record (see Table B.2).
Optional Fields		Additional information which is not always required for each registration record.

if the bit structure of the first byte of the mask is 10110011, then the first, third, fourth, seventh, and eighth optional categories appear in the optional field as categories one, two, three, four, and five (there are five categories since there are five bits "on" in the first byte; if there are bits on in the other four bytes of the mask variable, there will follow further optional fields).

The optional fields of importance in this study were: boat situs county (used if the boat is stored in a county different from the registrant's address county), date last purchased, year built, year model, legal owner, zip code, builder's name, and situs city.

The bit structure of the four-byte record-status was also important in the preparation of the File. If the record status contained an "on" switch--indicating the boat had been junked, had been given a new number, had been moved out-of-state, had been documented, or the title had been surrendered--then, in the reformatting process, the boat was considered to have been removed from the fleet. The record was counted but not retained on the new file.

Most of the required fields were important in the analysis used in this study. The fields and their categories are listed in Table B.2.

B.2 Description of the Reformatting Process

In order to analyze the Master Vessel Registration File, it was necessary to write a special computer program to reformat the record structure. The program written had to calculate the length of the record and work out which optional categories had been used for this record. The record was then rewritten on various working files which had fixed-length, fixed-category records which could be analyzed using the Statistical Package for the Social Sciences (SPSS). (In fact, any other convenient package of statistical routines would have required similarly reformatted records.) Records were assigned to three categories: "reformatted," "lost," and "rejects." The flow-chart for the program is presented in Figure B.1 (the flow-chart has been slightly simplified; in fact, three "reformatted" files were created to minimize the expense of using the complete California File when it was

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University of Southern California. The program was written using PL/1; for an excellent introduction to PL/1 programming, see Conway and Gries (1973).

TABLE B.2

REQUIRED FIELDS AND FIELD CATEGORIES ON THE DMV VESSEL MASTER FILE USED IN CONSTRUCTING REFORMATTED RECORDS

Field	Categories Available
Type license	pleasure, livery, dealer, manufacturer, commercial, fee-exempt youth group, fee-exempt government
Year of registration	calendar year through which the vessel is registered: options (in 1972) were 1966-68, 1969-71, and 1972
Use description	pleasure, livery, commercial, vessel for passenger hire, dealer, manufacturer, fee-exempt youth group, fee-exempt government
Type hull	amphibious, cruiser, runabout, sailboat, houseboat, barge, rowboat, kayak/canoe, other unknown
Hull material	concrete, wood, aluminum, steel, plastic, metal, other, unknown
Propulsion	inboard, outboard, inboard-outdrive, sailboat, jet, handpropelled, auxiliary and sail, other, unknown
Radio communication	send only, recieve only, send and receive, neither, unknown
Paper issue date	year, month, and day paper was issued
Registered owner county	a code 01 through 58, 60 for out-of-state
Registered owner Zip code	

TABLE B.2 - continued

Field	Categories Available
Legal owner code	a code to identify new applications, transfers, and presence of a legal owner: 1) dealer/manufacturer, no legal owner required 2) transfer with legal owner 3) transfer without legal owner 4) new application with legal owner 5) new application without legal owner (codes 2 and 4 indicate the presence of a legal owner and codes 1, 3, and 5 indicate absence of legal owner)
Length	feet and inches
Registered owner city	a numerical code

Source: California (1967).

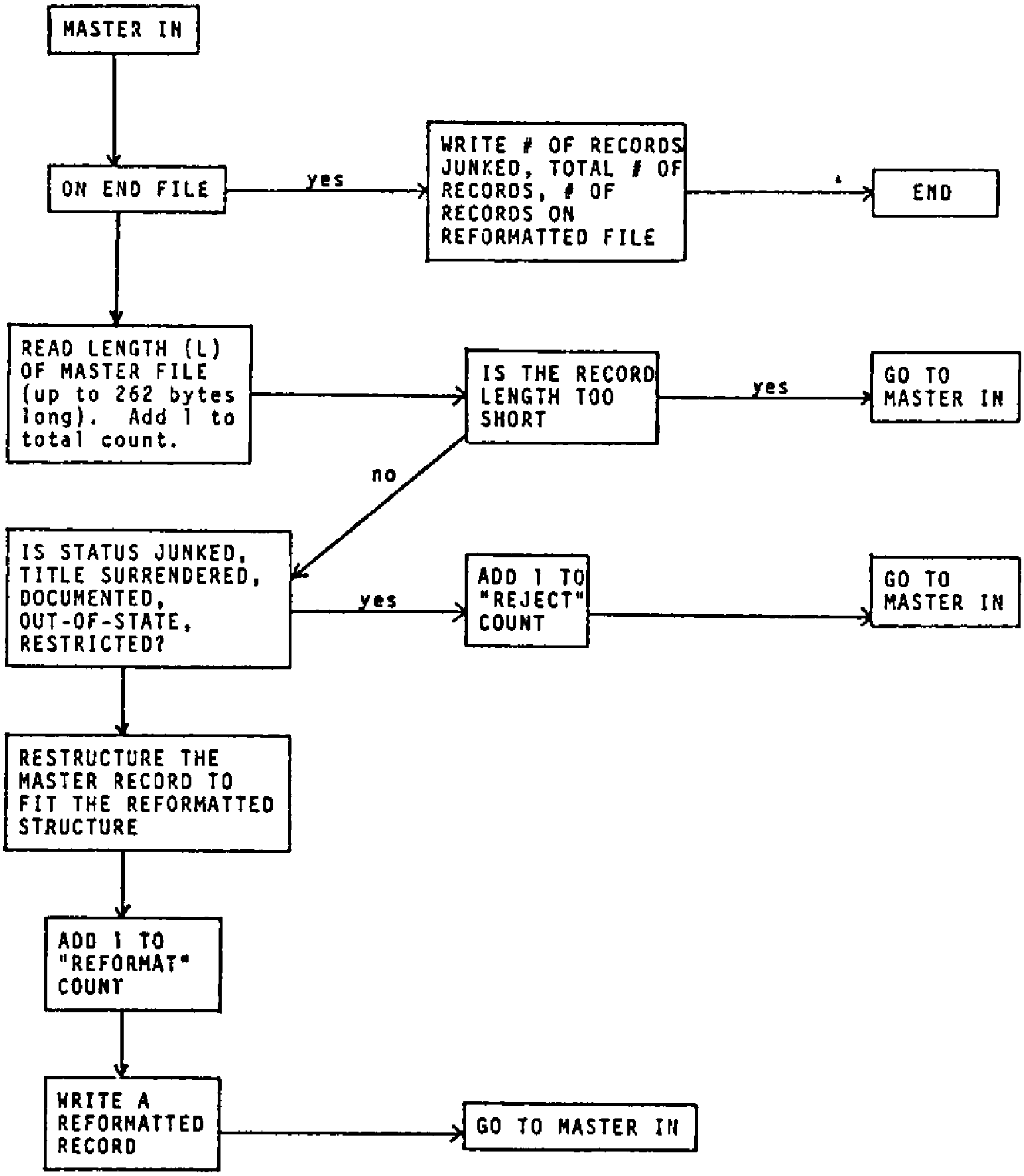

Figure B.1 Flow Chart of Reformatting Program.

TABLE B.3

RECORD COUNTS OBTAINED IN THE REFORMATTING OF THE DMV VESSEL MASTER FILE

	Name of File*			
	Reformatted	Rejects	Lost	Master
Total Record on File	631,290	8510	11640	651,440
Percent of Total Records on Master File	96.9%	1.3%	1.79%	100%

*See text for description of files.

of interest to look at a special set of records such as those registered in Southern California).

A record was designated "lost" if it was too short and appeared to contain insufficient information. In this case, the total record count was added-to, but the record was discarded. Most "lost" records referred to new boats purchased during the latter part of 1972. The "reformatted" file, then, probably contains an undercount of boats purchased in 1972. A detailed analysis in the next section suggests a new-boat undercount of about 30 percent. Since the discarded records were, in fact, "lost," it is not possible to give further details about them. How the 30 percent undercount of new-boat sales for 1972 was distributed among the length-propulsion classes cannot be known. In data presented in Chapter 3 an adjustment was applied to all but the longest classes.

A second set of records were counted separately and "rejected" because they referred to boats which had been junked or in some other way removed from the fleet. A later breakdown showed that about 70 percent of "rejects" were for boats moved out-of-state and about 25 percent were for boats which had been junked.

The remaining records processed were added to the reformatted file. Table B.3 shows the number of records in each group. A breakdown of the reformatted file showed that there were 445,290 current records and 183,430 prior-period records on this file. (Note that this implies that the ratio of non-current registrations to "notified, scrapped, etc." records was 183,430 to 8,510 or 22:1; using non-current records to obtain scrapping estimates (as is done in Chapter 3) yields much higher, but more plausible, scrapping estimates than if the "notified junked" records had been used.)

B.3 Errors in Estimate of Calculated Variables

Published stock levels for California were interpolated to find the "official" values for the stocks of boats in California and to compare the State's allocation of short and rejected records with the one suggested here. Table B.4 shows the results of a graphical interpolation to obtain stock levels for November 30, 1972.

Using the SPSS breakdown to obtain the estimates of current and prior records on the reformatted file led to a slight underestimate of the sizes of these groups. This underestimate is attributed to the use of a 10 percent

TABLE B.4

GRAPHICAL INTERPOLATION TO FIND "OFFICIAL" CURRENT AND PRIOR BOAT REGISTRATION LEVELS ON NOVEMBER 30, 1972

	Date of Published Stock Levels				
	3-31-72	6-30-72	9-30-72	11-30-72	12-31-72
Total Current Registration Records	377,794	419,463	446,769	456,000	456,000
Total Prior Registration Records	235,131	210,215	199,261	196,400	196,288
Total Registration Records	612,925	629,683	646,030	651,400	652,546

Source: State of California, Department of Motor Vehicles, Quarterly Boat Registration Summaries.

TABLE B.5

COMPARISON OF ESTIMATES OF COUNTS OF CURRENT AND PRIOR RECORDS

	Method of Analysis			Error Estimate	
	SPSS Breakdown	SPSS Breakdown Corrected	Official Interpolation for November 30, 1972	Error	Rejects + Losses
Total Current Record	445,290	447,116	456,000	8,884	
Total Prior Record	183,430	184,152	196,400	12,248	
Total Record	628,690	631,268	651,400	20,132	20,150

sample in the breakdown procedure. The underestimate was 0.4 percent. Table B.5 shows the comparison between the SPSS, the corrected, and the "official interpolation" in order to obtain an idea of the differences among the estimates. The estimated "error" is satisfactorily close to the sum of "rejects" + "losses."

Revised estimates of the total current and total prior records suggest that about 80 percent of the "losses" should be considered current losses. Thus, the revised estimate of the total error in new-boat sales is about 8,900 boats (about a 30 percent error). The estimates of error in various counts are as shown in Table B.6 (all counts are underestimates; that is, "low").

Excepting for the new-boat sales estimates, the level of undercount error may be neglected for policy purposes.

TABLE B-6

ESTIMATES OF ERRORS IN CALCULATIONS USED IN THIS STUDY

Current registrations	2.4% (low)
Prior registrations	7.1% (low)
New boat sales	30.7% (low)
Scrapping rates	4.7% (low)

APPENDIX C

MAPPING METROPOLITAN LOS ANGELES INFORMATION

This appendix on the mapping of demographic and boat ownership data for the Los Angeles metropolitan region has the following structure: first, the construction of the map base is described; second, the necessity for a decision rule for selecting the levels of shading of each of the maps is discussed and the decision rule is described; third, an introduction and discussion of the demographic and income data is provided; fourth the boat ownership distributions are described and compared; and finally, to review the method, it is shown that the various maps can be used to obtain a qualitative comparison of two subareas (zip code areas) of the metropolis.

This appendix contains a total of 35 maps. There are 15 demographic and income maps derived from the Fifth Count of the 1970 Census of Population and 20 showing distributions of boats by length class and propulsion type. The ten maps showing some aspect of the income structure of the region include: the proportion of families under the poverty level, the median income, the Gini index of family income inequality, and 7 maps showing the distributions of families with incomes greater than given lower bounds. Maps indicating the distributions of Black and Spanish heritage are also presented.

C.1 <u>The Map Base</u>

The selection of the zip code area as a suitable subareal unit for the SYMAP base map was made on various pragmatic grounds. Since the boat registration records contained the registrant's zip coded address, it was straightforward to produce an aggregate record for each zip code area in the Los Angeles metropolitan area. The selection of the metropolitan area as the region of interest required that over 300 zip code areas be included in the analysis; by contrast, selecting the census tract as the subareal unit would have required the mapping of over 3,500 data points for each map. The availability of the 1970 Census tabulations of the Fifth Count file allowed the convenient production of census data which could be compared with the boat-ownership data.

The map base for the Los Angeles area was constructed so that it could itself be distributed as a public data resource. An accurate base map was drawn up and prepared for digitizing. This digitizing was carried out according to the format requirements of the CALFORM mapping procedure and a computer routine was written to produce the SYMAP base map data (Harvard, 1968; 1971).

It should be noted that in this study the 1972 boat ownership data is compared with the 1970 Census data. Some differences between the two files occur. The Fifth Count of the census provided data for 325 zip code areas within the five-county area selected as the region of interest; however, between 1970 and 1972, some of the zip code areas had been divided into two or more parts. In addition, the northern part of Los Angeles (Lancaster, Palmdale) had been zip coded. As a result, there were 368 zip codes in the area of interest for 1972. Thus, in order to be able to compare spatial distributions of boats with spatial distributions of demographic information, the 1970 zip code scheme was selected. Further, the northern part of Los Angeles County was ignored and the boat ownership data aggregated when necessary to conform to the 325 zip code scheme.

The map base is particularly suited to mapping spatial distributions of data for which there is an address, including zip code, for each piece of data to be mapped. It is expected, therefore, that other investigators will find the map base to be useful. It is to be provided in either the 325 or 368 zone version.[1] The map base is converted easily from the CALFORM format to the SYMAP conformant or contour mapping formats.

C.2 Selection of Legends

Within the computing process of the SYMAP package, the selection of legends to be placed on the map is a procedure which is separate from the one creating the outlines of the subareal units. The legends selected for the tasks described here have been chosen to allow the reader to identify the location of the important recreational boating facilities used by Southern California boatowners. The number of slips and ramps available at each site in 1970 is included in the legend. Although some facilities have been expanded since 1970, this was

[1]The map base may be obtained by contacting Mr. John McDonald, Department of Geography, USC.

the most recent set of complete facilities data available (California, 1970).

The legends also include a few city and other place names for convenience in understanding the maps. The map base may be compared with the standard, commercially available, zip code maps, such as those produced by Thomas Bros (1972) or Western Economic Research (1971). If the reader wishes to locate the zip code level information for a particular area in the metropolitan region, he is directed to these sources; much effort has gone into making the SYMAP conformant outlines discernible and recognizable in the printed maps displayed here. The claim is made that the maps are sufficiently precise to allow the identification of characteristics of particular sub-areas.

C.3 Choice of Cutting Points on the Maps

Each of the variables chosen for presentation in this appendix was more or less continuous. However, the SYMAP program maps by using a few, discrete ranges of values; the number of ranges and the relative size of each range may be selected by the program user. In this project, ranges were selected so that the relative skewness of different variables might be apparent by comparing the maps. The procedure chosen for determining the cutting points between ranges required a series of steps: the marginals routine of the Statistical Package for the Social Sciences (SPSS) was used to calculate the mean, the standard deviation, the maximum value, and the minimum value of each variable mapped; the mean value was chosen to be one of the cutting points; the rest of the cutting points were chosen so that the ranges on either side of the mean cutting point were in the series: 1 standard deviation, 1 standard deviation, 2 standard deviations, 2 standard deviations, 2 standard deviations, 4...(see the following section for a detailed example of the procedure). In each case the series on either side of the mean was truncated by the upper or the lower extreme value for the variable being mapped. In the maps displayed, the ranges have been renumbered so that the ranges above the mean value are called 1+, 2+, 3+, ... (until the maximum value is included in a range), and (moving to the left) the ranges below the mean value cutting point are numbered 1-, 2-, 3-, ... (until the minimum value is included in the range).

The SYMAP program prints a summary legend indicating the proportion of the total range of the variable in each value range. The mean value, the standard deviation, and the proportion of the range represented by the standard deviation (as a percentage) have been added subsequent to the computer-mapping to each summary legend.

C.4 Demographic Maps

The demographic characteristics chosen for presentation in this section have been selected to illustrate the various determinants or correlates of boat ownership which are discussed in detail in the text. Most of the variables used have well-understood definitions, although some explanations will have to be given. A "household," for Census purposes, includes all the persons who occupy a group of rooms or a single room that constitutes a housing unit. The "head of the household" is the person who is regarded as the head by the other members. A "primary individual" is a person not living in a family group who is the head of a household. A "family" is defined as a group of two or more persons residing together who are related by blood, marriage, or adoption (see for further reference, U.S. Department of Commerce, 1972).

In the analysis of Chapter 4, it is considered unlikely that either more than one member of a family owns a boat or that a family owns more than one boat. It is also considered, there, that primary individuals do not own boats. These are rather strong, a priori, suppositions and may in some cases be unwarranted. It is found, though, that most individuals have incomes less than $10,000. Partial demonstration of this fact can be seen from certain of the maps which may be used to compare the total numbers of families in zip code areas with the "number of families plus the number of individuals." But first, it is necessary to demonstrate the general characteristics of each of the maps. Map C.7 is used as an example.

The summary legend of Map C.7 indicates that the variable mapped is the "Number of Families" in the "Los Angeles Metropolitan Area" with "Zip Code Areas" being the subareal unit. The minimum number of families in a zip code area is seen to be 14; the maximum is 29,573 families. The mean number of families per zip code area (averaging over all 325 zip code areas) is 7,460, the standard deviation is 3,032, and this represents 17.02 percent of the total range. There are three areas for which no information was available on the number of families ("total missing data points is 3").

The value ranges are shown to be 14 to 2,468 for the lowest range (designated 2-), 2,468 to 7,460 for the second range (designated 1-), 7,460 to 12,492 for the third range (called 1+ because it is the first range above the mean cutting point), 12,492 to 17,524 for the fourth (2+), 17,524 to 27,588 for the fifth (3+), and 27,588 to 29,573 for the highest range (4+). The second, third, and fourth ranges are of equal size, each representing one standard deviation of the total range (17.02%).

The lowest range is represented by a set of dots (::::::). On this map there are 54 zip code areas in the lowest range and 123 zip code areas in the second range which is represented by (‡‡‡‡‡). Thus, 177 zip code areas or slightly more than half have the value of "Number of Families" below the mean. There is only one zip code area in the 4+ range (more than 4 standard deviations above the mean).

The map C.12 shows the distribution of "Number of Families Plus Number of Individuals." A comparison shows that there is slightly greater skewing of this variable than of the "Number of Families." From the two maps it can be seen that the magnitude of the variables is usually larger if the zip code area is larger, and also if the density of population is larger. It is to be emphasized that care must be taken in comparing one part of a map with another when absolute numbers are mapped in this fashion. It is clear that if two adjacent areas are aggregated and treated as one, the resulting number mapped will be larger than either of its component numbers. In fact, the heavily shaded area at Huntington Beach (just east of the Sunset Bay legend) was subdivided after 1970 into three smaller zip code areas. Usual alternatives to mapping absolute numbers are to display a proportion for the area or to display an areal density. In the latter case, a variable such as "number of families per acre" is not necessarily a useful indicator and introduces an extraneous variable, area, into the discussion. In the former case, proportions are often suggestive indicators, especially if the distribution of the denominator is known.

Maps C.3 and C.6 show the "proportion of families below poverty"[2] and the "proportion of families with female head of household." To obtain an estimate of the

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[2]The poverty level is based on an "economy" food plan developed by the Department of Agriculture. It takes

absolute distribution of poverty families, for example, one can compare Map C.3 with Map C.7 which shows the distribution of the number of families. Maps C.3 and C.6 can also be considered as displays of characteristics of zip code areas: for example, the Central City zip code areas are characterized by both high poverty levels and high proportions of female heads-of-household.

The proportion of the population of Spanish Heritage or Black is shown in Maps C.4 and C.5. These maps should be compared with the distribution of the population, reasonable proxies for which are the distributions shown in Maps C.7 and C.12. Alternatively, Maps C.4 and C.5 give a good indication of the distributions of Spanish families and of Black families.[3] The two maps show that the distributions of Black and Spanish populations are quite different. While the mean proportion (averaging over 325 zip code areas) of Blacks is almost the same as the mean proportion of Spanish (about 7 percent), it is obvious that the Black population is far more concentrated than the Spanish population. The highest range for Spanish Americans is 41 to 45 percent while for the Black population it is 80 to 93 percent. The highest concentrations of the Black population are in the area just south of the Central City while the highest concentration of Spanish population is just east of downtown in the East Los Angeles unincorporated area. It is probable, though, that if a smaller-scaled grid (such as the census tract) had been used, higher concentrations of Spanish population would have been obtained in some subareas.

C.5 Income Distributions

A standard method of indicating the income level in a subarea of an urban area is to show the median income of the families in the statistical reporting unit. The median is a kind of averaging measure: it is the value which separates the higher-value half of the families from the lower-value half. If used as a single measure

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into account family size and number of children. A family is classified as living in poverty if its total money income is less than approximately three times the cost of the "economy" food plan. See U.S. Department of Commerce, 1972c.

[3]Notice that the ranges for the Spanish population are not precisely in the established series. This is the result of correcting a computational error.

of income within a subarea, the median is somewhat deceptive; there must also be some indication of the range of the variation about the median. A suitable and well-recognized measure of income inequality is obtained by computing the Gini index of family income inequality using (as is done to compute the median) the Census income tabulation for the zip code area. The Gini index, however, is not so well-known and deserves some explanations of how it is calculated.

The Gini index is closely related to the Lorenz curve, a device long used to depict concentrations of population or income. To draw a Lorenz curve for income, the tabulation of numbers of families in increasing income ranges is used to plot the cumulative proportion of income owned by the cumulative proportion of families. With the family groups ordered from lowest to highest income, the Lorenz curve always has an upwardly curving shape, except for the condition of perfect equality of income, in which case the curve is a straight line from the point (0,0) to the point (1,1). The Gini index of family income inequality is then defined as the ratio of the area between the diagonal and the Lorenz curve to the area under the diagonal. If the income in the area is equally distributed, the Gini index has the value 0 and if the income is highly unequally distributed the index approaches 1. (For a more complete discussion, see, for example, United States, 1972b).

In those areas, then, in which there is a wide range of income among families the Gini index is high, while in those areas in which nearly every family has about the same income, no matter how high or low, the index is relatively low. The reader is cautioned to note that in comparing the median income and Gini index of income inequality maps (Maps C.1 and C.2), the symbols used to map high and low ranges of the variables change meanings from one map to the other. The reader should pay careful attention to the legend information for each map.

If maps C.1 and C.2 are compared closely, it is seen that there are homogeneous high and low income areas in the metropolis. Palos Verdes Peninsula has a high median income and low Gini index showing that this area is homogeneous in the income range between about $20,000 and $30,000 per year. There is a zip code area just west of Pasadena which has a very high Gini index of income inequality but a low median income. This area contains a mixture of very high income families and very low income families.

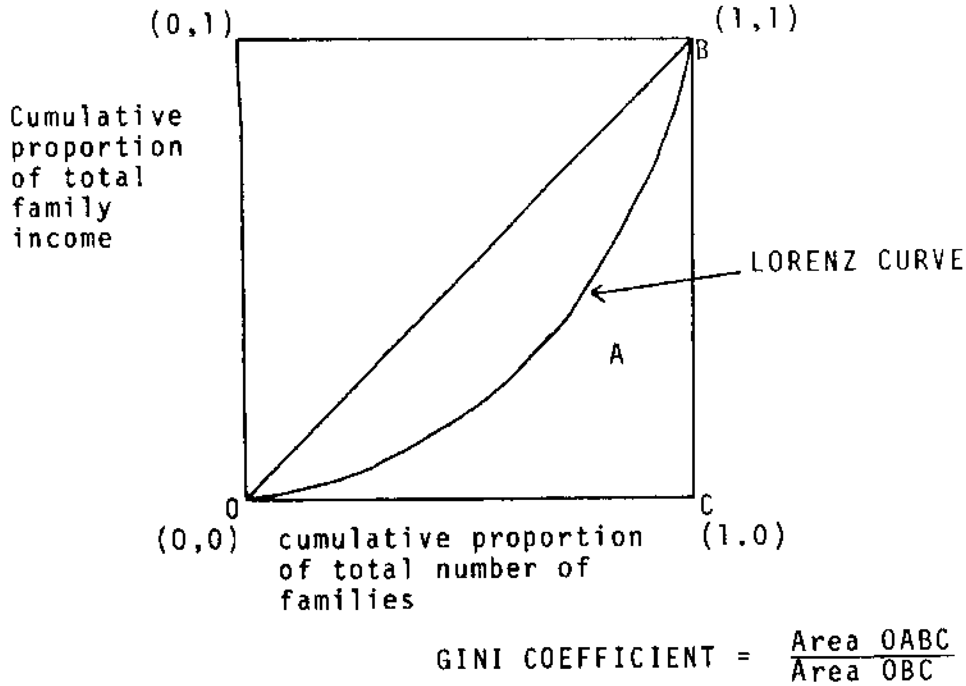

Figure C.1 Lorenz Curve for Measuring Family Income Concentration in Relation to the Number of Families.

The two income variables and the proportion variables are often called "neighborhood" variables because they describe characteristics of the geographical areas rather than characteristics of the families within the subareas. Care must be taken in spatial analysis if it is necessary to impute neighborhood characteristics to the individual occupants of the area. The unacceptable use of this kind of identification is called the "ecological fallacy" (see the discussion of Hawley and Duncan, 1955).

To complete the demographic/income map section, several maps are included to show the distributions of families with incomes greater than selected minimum levels. Map C.7 has been previously discussed; it shows the distribution of all families with income greater than zero (that is, "all families"). Maps C.8 through C.11 indicate the number of families with income greater than $10,000, greater than $15,000, greater than $25,000, and greater than $50,000. Maps C.12 through C.15 show distributions of families plus individuals, those with incomes greater than $10,000, greater than $15,000, and greater than $25,000. These maps indicate a progressive "filtering out" of lower income groups. It is seen that while the population of families of income greater than $10,000 is somewhat widely distributed over the metropolitan area, large concentrations of families with income greater than $25,000 are nearly all within about 10 miles of the coastline. This trend is even more pronounced for the families with income over $50,000. It is not true to say, however, that all upper-income families live in these few areas; in fact, only about 40 percent of families in the income range over $50,000 live in the areas designated by levels 2+ through 5+.

C.6 Boat Ownership Distributions

Boat ownership distributions have been produced according to the general procedure outlined for the demographic data. Distributions are shown for power boats disaggregated into seven length classes (8 to 11 feet, 16 to 19 feet, 20 to 25 feet, 26 to 32 feet, 33 to 39 feet, and 40 feet or more). Similar maps are produced for sailboats. Since several different designs of power boats are of interest, several propulsion types in the length ranges from 12 to 25 feet have been mapped.

Each boat ownership distribution has been mapped in a fashion similar to that used to map the number of families above specified income levels and therefore maps from each group may be compared with one another. Visual inspection would seem to differentiate the maps in the following ways. Power boat distributions for boats between 12 and 25 feet appear to have a definite "inland" structure; there are reasonably high levels of ownership along the axis from Long Beach through Norwalk and out towards Claremont. This structure is not at all apparent for very short power boats, for power boats longer than 26 feet, and for all sailboats; these boats seem to be "coastal-oriented" since the peak numbers are along the coastal portions of the metropolitan region. On visual comparison, the 12 to 25 feet power boats seem to correlate with the income map "all families above $10,000," but the "coastal-oriented" boat-ownership distributions seem to be closest to the income distribution "all families above $15,000." These casual observations are refined and tested in a more formal way in Chapter 4.

C.7 Review: Comparison of the Characteristics of Two Zip Code Areas

The various maps may also be compared area by area in detail. Using the identifying numbers given to the ranges, it is possible to compare different areas in a standardized fashion. As a review of the methods outlined in this appendix, it is instructive to compare two areas which are alike in some ways and not in others; for ease of comparison, the Palos Verdes Peninsula area, and the Norwalk area have been selected. Map C.7 shows that each has relatively high numbers of families (2+ for Palos Verdes, 3+ for Norwalk); the "number of families plus the number of individuals" scores down a range in each case (Map C.12 shows 1+ for Palos Verdes and 2+ for Norwalk). From Map C.5 it is seen that the proportion of Blacks in each area is very low (1-) and Map C.4 shows that the proportions of Spanish population are somewhat different (1- for Palos Verdes and 1+ for Norwalk). The proportions of families below poverty in each case is low (Map C.3 shows 1-) and in both areas the number of female heads of household is low (C.6 shows 1- for Norwalk and 2- for Palos Verdes).

Differences in income structure of the areas can be seen from the two income summary maps; C.1 shows that the median income in Palos Verdes is 3+ while in Norwalk it is 1+. In each case the level of inequality is very low (Map C.2 shows that the Gini index for each area is in the 2- range). It is to be assumed then that Norwalk is a homogeneous middle income area while, as previously noted, Palos Verdes is a homogeneous, upper-middle income area. These conclusions are supported by the relatively low numbers of upper-income families in Norwalk (see Maps C.9 through C.11) and the relatively high numbers in Palos Verdes (with very high relative numbers in the ranges $25,000 and $50,000 and above).

Boat ownership situations in the two areas are different. There are high levels of small trailer boats (12 to 15 and 16 to 19 feet power boats) in Norwalk but other power boat levels are only slightly above average (see Maps C.22 through c.28). In Palos Verdes, though, there are higher levels in the upper length ranges for powerboats. There are low levels of sailboat ownership (1-) in the Norwalk area and very high levels in the Palos Verdes area (see Maps C.29 through C.35).

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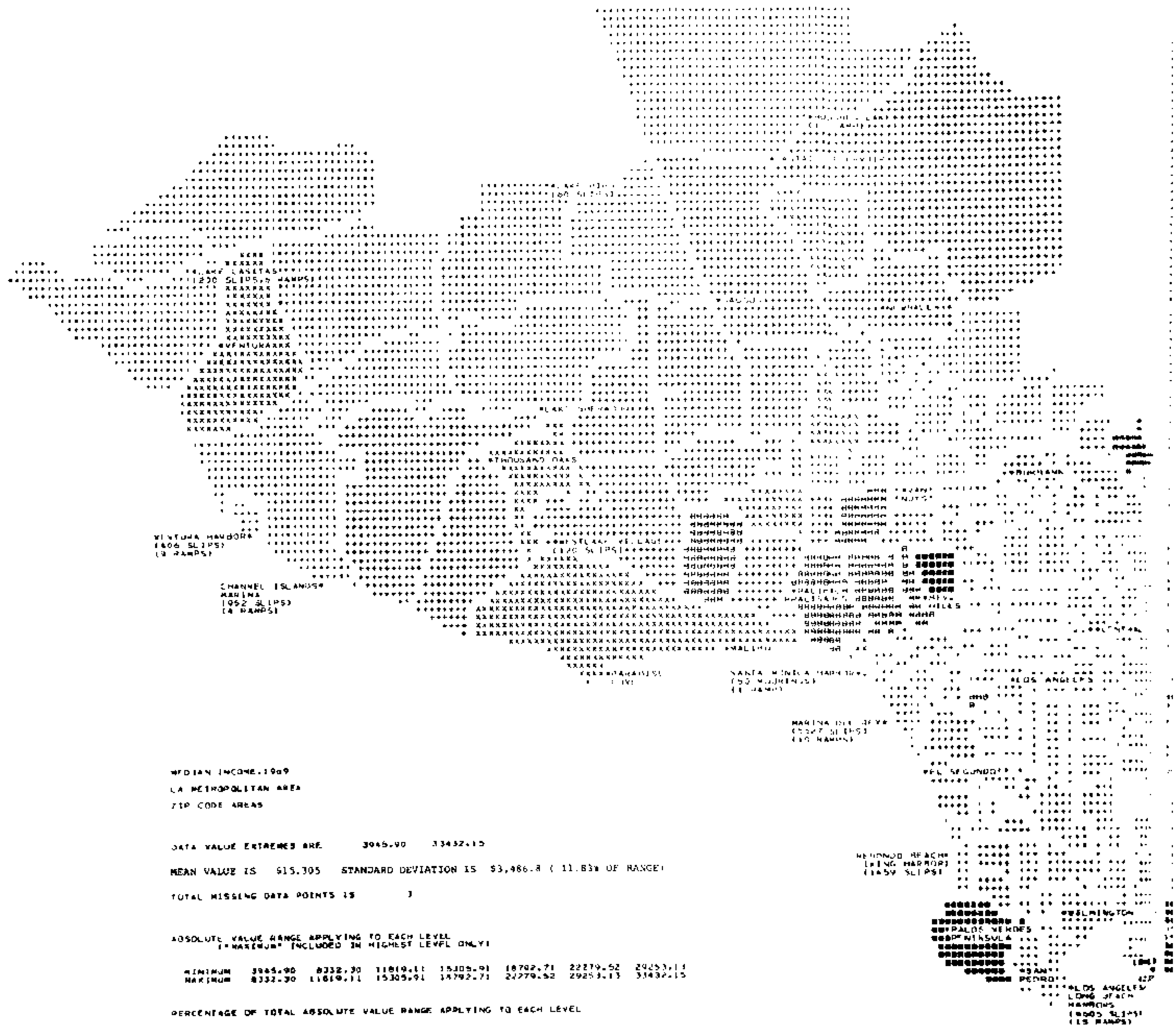
LOS ANGELES METROPOLITAN AREA ZIP CODE MAPS

The maps in this section present information from the 1970 Census of Population and from the analysis of the California Department of Motor Vehicles 1972 Vessel Master File. The maps display data for those urbanized parts of the counties of Los Angeles, Ventura, Orange, San Bernardino, and Riverside which, together, make up the contiguous Los Angeles Metropolitan Area. The map base has 325 zones conforming to the zip code areas for which 1970 Fifth Count Census data was available.



MEDIAN INCOME,1969

LA METROPOLITAN AREA

ZIP CODE AREAS

DATA VALUE EXTREMES ARE 3945.90 33432.15

MEAN VALUE IS $15,305 STANDARD DEVIATION IS $3,486.8 (11.83% OF RANGE)

TOTAL MISSING DATA POINTS IS 3

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	3945.90	8332.30	11819.11	15305.91	18792.71	22279.52	29253.13
MAXIMUM	8332.30	11819.11	15305.91	18792.71	22279.52	29253.13	33432.15

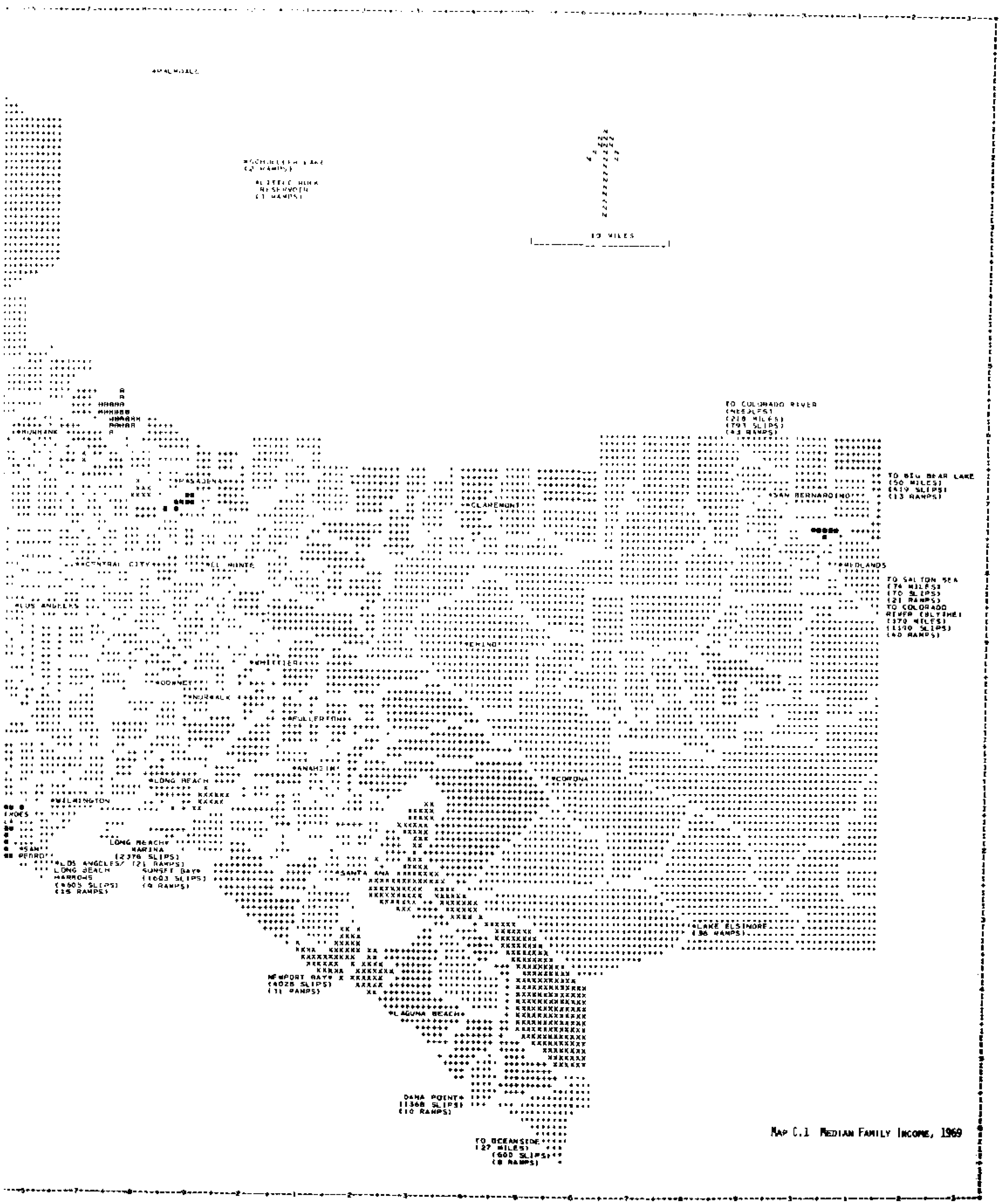
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

14.88	11.83	11.83	11.83	11.83	23.65	14.17

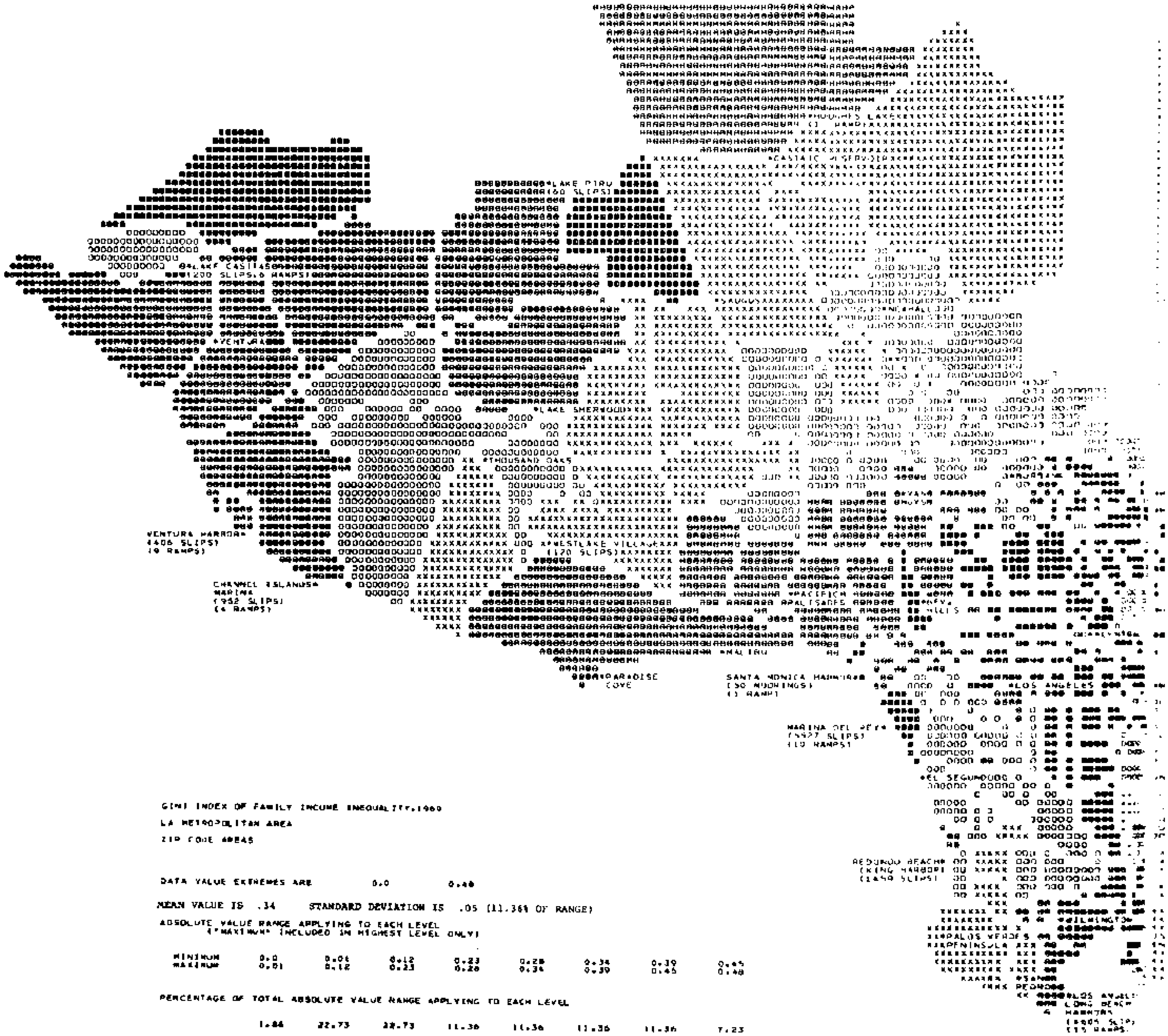
FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	3-	2-	1-	1+	2+	3+	4+
FREQ.	51	150	65	17	7	3	1

Map C.1 Median Family Income, 1969



Map C.1 Median Family Income, 1969



GINI INDEX OF FAMILY INCOME INEQUALITY,1969

LA METROPOLITAN AREA

ZIP CODE AREAS

DATA VALUE EXTREMES ARE 0.0 0.48

MEAN VALUE IS .34 STANDARD DEVIATION IS .05 (11.36% OF RANGE)

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.06	0.12	0.23	0.28	0.34	0.39	0.45
MAXIMUM	0.01	0.12	0.23	0.28	0.34	0.39	0.45	0.48

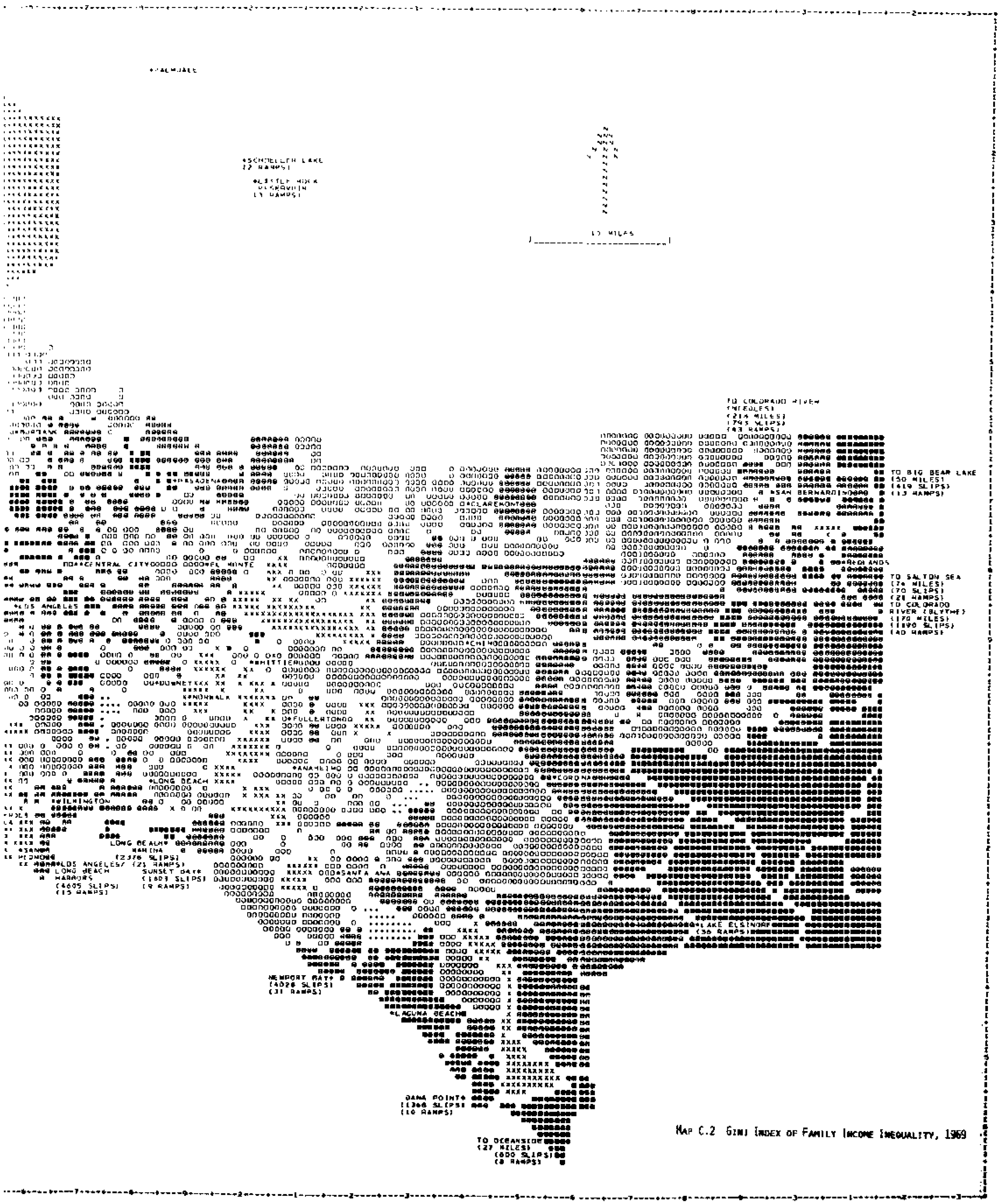
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

1.84	22.73	22.73	11.36	11.36	11.36	11.36	7.23

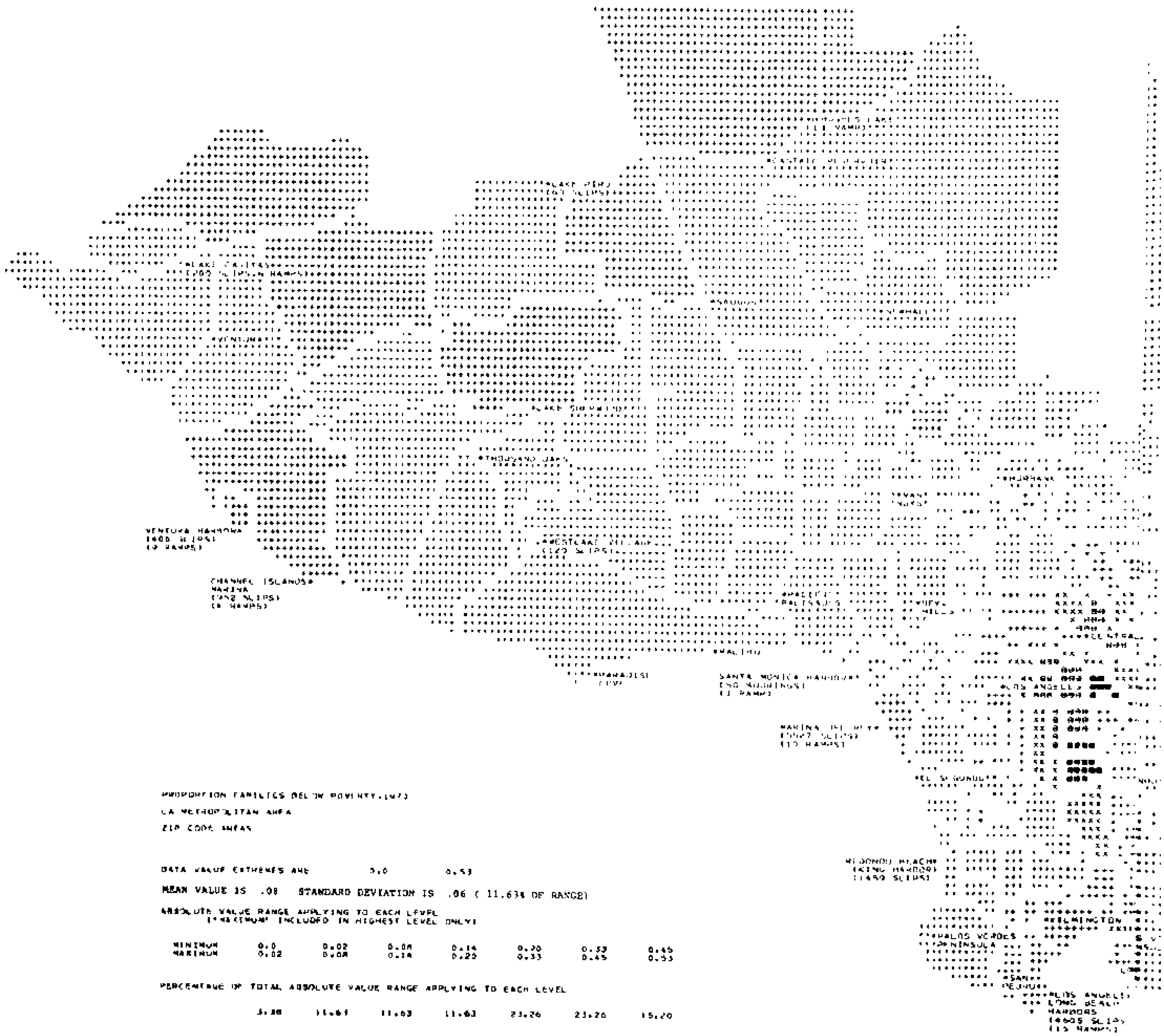
FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	5-	4-	3-	2-	1-	1+	2+	3+
FREQ.	3	0	0	32	122	129	36	3

Map C.2 Gini Index of Family Income Inequality, 1969



MAP C.2 GINI INDEX OF FAMILY INCOME INEQUALITY, 1969



PROPORTION FAMILIES BELOW POVERTY,(47)

LA METROPOLITAN AREA

ZIP CODE AREAS

DATA VALUE EXTREMES ARE 0.0 0.53

MEAN VALUE IS .08 STANDARD DEVIATION IS .06 (11.63% OF RANGE)

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.02	0.08	0.14	0.20	0.33	0.45
MAXIMUM	0.02	0.08	0.14	0.20	0.33	0.45	0.53

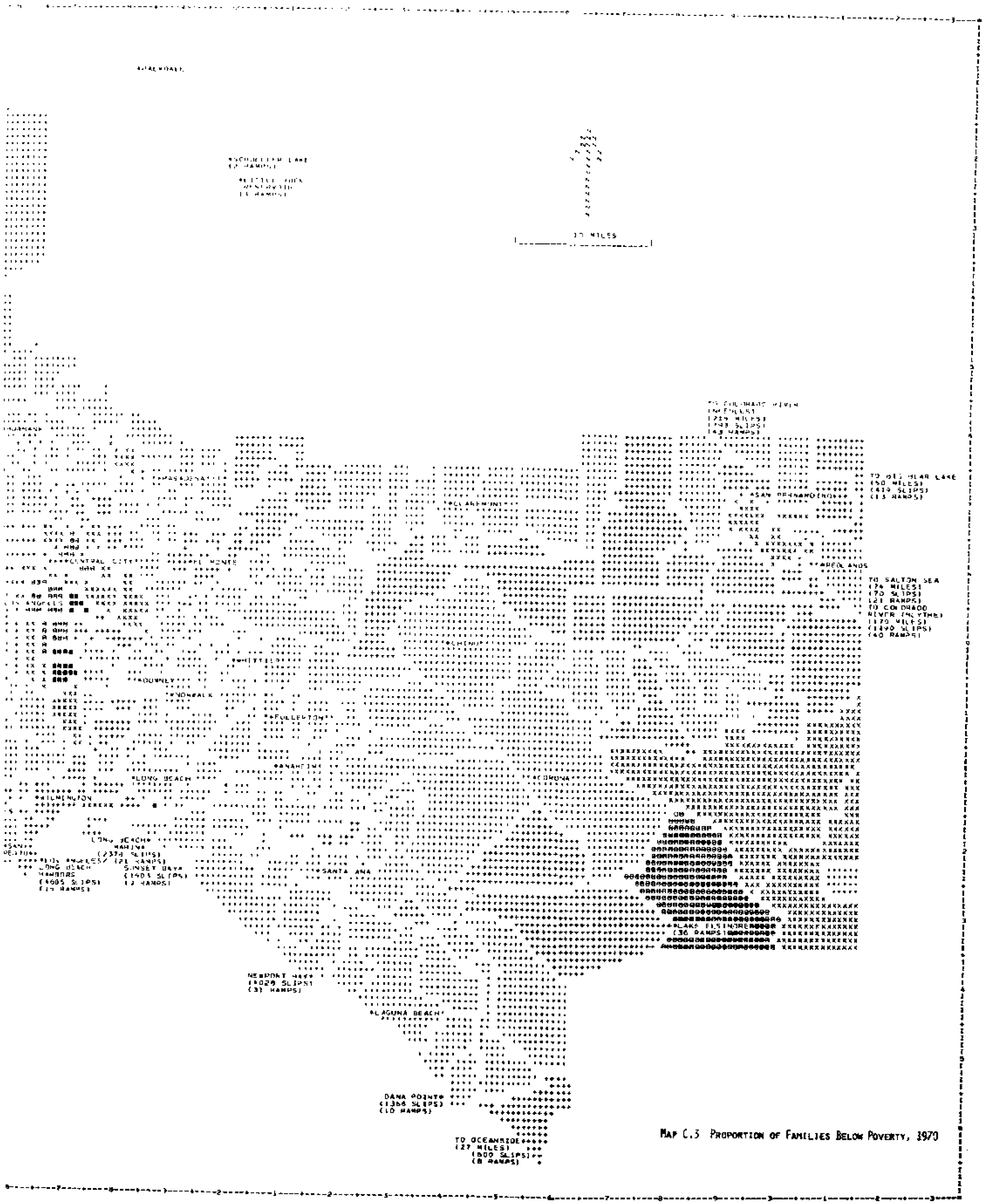
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

3.88	11.63	11.63	11.63	23.26	23.26	15.20

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	2-	1-	1+	2+	3+	4+	5+
SYMBOLS	1	2	3	X	5	6	7
FREQ.	10	203	76	20	10	3	1

MAP C.3 PROPORTION OF FAMILIES BELOW POVERTY, 1970



MAP C.3 PROPORTION OF FAMILIES BELOW POVERTY, 1970