Natural and Artificial Reefs in Mississippi Coastal Waters: Sport Fishing Pressure and Economic Considerations.

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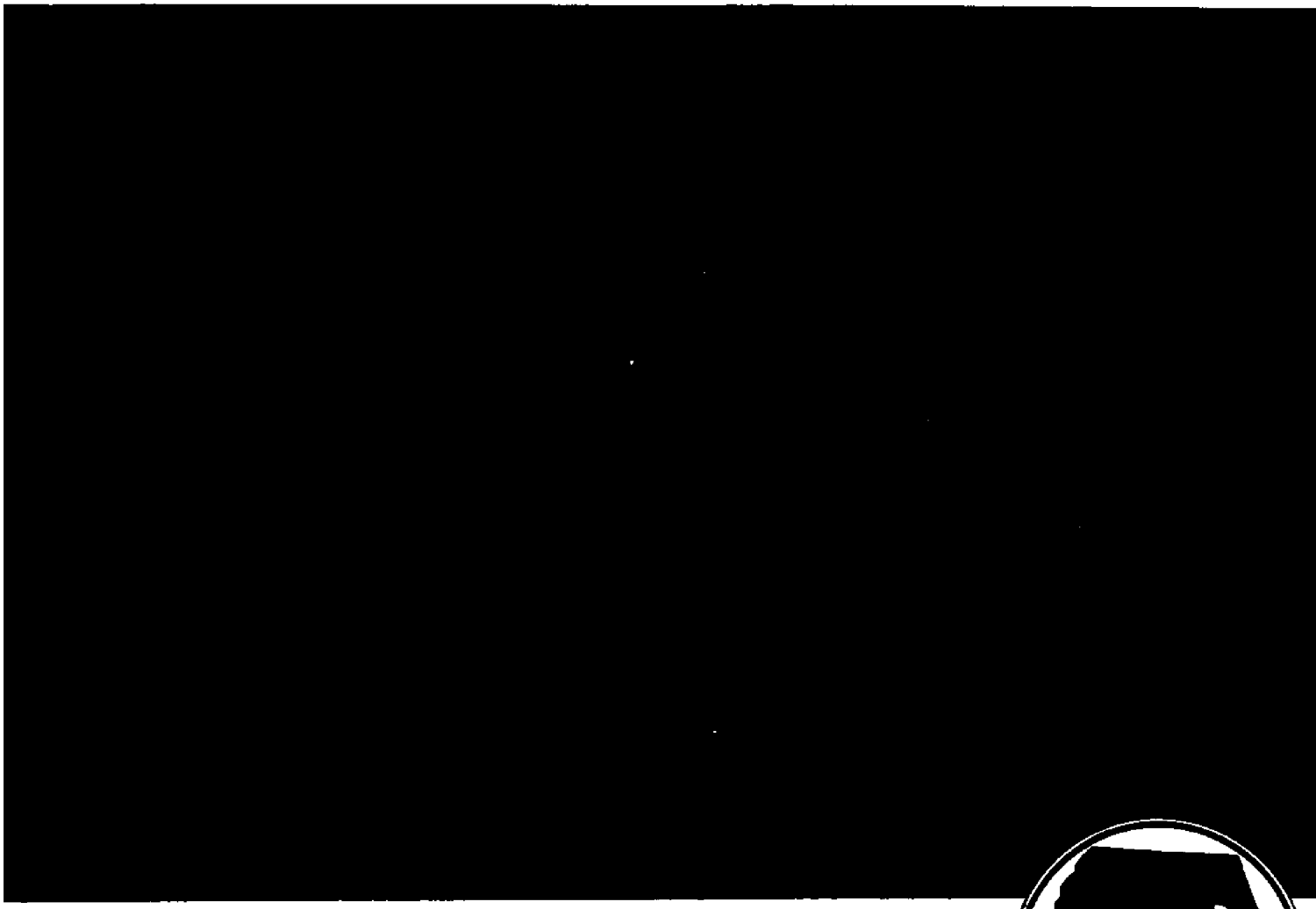

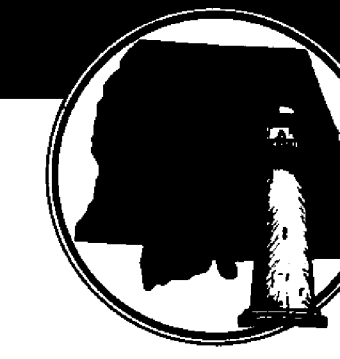

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NATURAL AND ARTIFICIAL REEFS IN MISSISSIPPI COASTAL WATERS: SPORT FISHING PRESSURE AND ECONOMIC CONSIDERATIONS

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by

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PREFACE

This study represents the initial research effort in an attempt to assess the sport fishing pressure at existing artificial and natural reefs in the Mississippi Sound. Activities are already underway that will develop new artificial fishing reefs in that area. Hopefully, this study will provide some useful input toward an efficient utilization of scarce resources for that purpose. This study was sponsored by the Mississippi-Alabama Sea Grant Consortium and the University of Southern Mississippi. Many people contributed to the completion of this study, but none more than Mr. Joe Seward of the Mississippi-Alabama Sea Grant Consortium who was pilot, surveyor, and navigator during the aerial surveying portion of the study. Mr. Walter Fountain of the Biloxi Chamber of Commerce and Mr. Tom McIlwain of the Gulf Coast Research Laboratory also provided valuable assistance.

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I. INTRODUCTION

Background and Problems

All sport fishermen know that concentrations of fish are likely to be found around bottom obstructions, jagged banks, passes, old trees, channels, old shipwrecks, and any irregularity in a generally smooth bottom of an area of water. Such conditions provide food and protection for smaller fish which attract larger fish in the marine food chain and, thus, are excellent sport fishing sites. Many areas of water, however, do not contain enough natural or artificially created "reefs" to satisfy the fishing pressure from sport fishermen in the area. The apparent solution to this problem is the construction of artificial reefs made from old tires, concrete rubble, old ships and barges, and similar materials.

Large scale efforts to enhance fishing by constructing artificial reefs in saltwater areas of the U.S. go back at least to the mid-1930's when such efforts took place in the New Jersey area. More recent efforts have occurred in California, New York, Virginia, Florida, the Carolinas, Georgia, Texas, Alabama, and Mississippi.

In the waters of the Mississippi Gulf Coast, the majority of efforts directed toward development of artificial fishing reefs have been by the Mississippi Gulf Fishing Banks Inc. or MGFB. The organization is a

non-profit corporation chartered by the State for the purpose of

> providing, generating, encouraging, and promoting recreation and recreational facilities along the Mississippi Gulf Coast and particularly encouraging and promoting sport fishing as a recreation in the Mississippi Sound and the Gulf of Mexico. [1]

Since its organization in 1968, the organization has succeeded in developing several reefs from tires, auto bodies, oyster shells,etc. A major project involving new developments made from the hulls of sunken Liberty ships is now well underway. Currently six of the hulls are being placed singularly or in groups to form artificial reefs. The organization hopes to obtain additional ships in the future.

At the present time, funds for the development of artificial reefs in the Mississippi Sound are derived from a 1/10 mill charge against the assessed valuation of property in Harrison County. The management of efforts to develop artificial reefs is under the direction of the Board of Directors and the officers of Mississippi Gulf Fishing Banks Incorporated. The 14 member Board of Directors consists of a diversified group of nine members of MGFB who must meet the following criteria:

(1) One member must be engaged in the tourist business;

(2) One member must be actively engaged in the charter boat business;

(3) One member must be actively engaged in the commercial fishing industry; and

(4) One member must be a private boat owner.

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[1]Constitution of Mississippi Gulf Fishing Banks, Inc.

In addition to the nine members selected from the membership of MGFB, the Board contains five additional members selected on the following basis:

(1) the President of the Jackson County Board of Supervisors,

(2) the President of the Harrison County Board of Supervisors,

(3) a representative of the Coast Chamber of Commerce to be selected by the Board,

(4) A representative of the Mississippi Marine Research Council to be designated by that body, and

(5) A representative of the Mississippi Marine Conservation Commission to be designated by that body.

In seeking to develop artificial reefs so that the public gets maximum benefit of the funds allocated for reef development, those in charge of managing the reef development must make important decisions.

What should the reefs be made of?

How many reefs should be built?

Where should they be located? and

Is a particular proposed reef development economically feasible - that is, worth the cost?

These are difficult questions and each requires considerable scientific analysis before the best decision can be made. In addition, the decisions are complicated by the fact that any reef development is subjected to location constraints because of commercial fishing and shipping in addition to the ever present financial constraint.

Purpose of this Study

Most organized reef construction efforts have in the past been carried out without the benefit of scientific analysis of such factors as location, material, and economic feasibility. Current and recent research efforts are making more and more knowledge available in the hope that optimum benefits can be gained from artificial fishing reef construction. However, research into one area of artificial reef construction remains quite limited. That area is the economics of artificial reef development. The purpose of this project is twofold: (1) it provides estimates of the fishing pressure on various types of artificial and natural fishing reefs in the Mississippi Sound; and (2) it provides some economic guidelines which should prove useful in determining the feasibility of artificial reefs. The study also makes recommendations that are designed to help achieve the conditions necessary for the reef to be economically justified.

The approach taken by this study in gathering data on fishing pressure is unusual. Whereas in previous years, on-site boat surveys were used to determine fishing pressure, aerial surveying techniques were used in this study. The use of the fly-over technique allowed the survey to include sites within a much broader area than would otherwise have been possible. Approximately 300 square miles of water, containing 12 selected natural and artificial fishing areas, were surveyed during the months of April through December. In addition, two control areas were surveyed during the period July - December. Based on boat counts

developed from these surveys, estimates of the total fishing pressure were made in terms of the number of fisherman-days at each site. Monthly estimates reflected seasonal influences, and relationships between estimates for the same time period reflect the influence of location, type of reef, the extent of knowledge of its existence among fishermen, and fish concentration at the reef. The relationship between reef pressure and control area fishing pressure provides an indication of the potential drawing power of new artificial reefs.

Summary of Succeeding Sections

In Section II, the problem of investing in the construction and development of an artificial fishing reef is analyzed using economic theory. The management problem involved is essentially a capital investment problem. As such it is amenable to Benefit-Cost Analysis. The important considerations involved in carrying out a B-C study of an artificial reef project are presented. Also treated is the question of relevant benefits, and how to estimate them. The implementation of the analysis in terms of the development of artificial reefs are presented.

In Section III, the results of a survey of fishing pressure at existing natural and artificial reefs within the study area are presented. Section IV contains some conclusions and recommendations relative to the economic feasibility of additional artificial reefs.

II. ECONOMIC ANALYSIS OF THE PROBLEM OF INVESTING IN THE CONSTRUCTION OF ARTIFICIAL REEFS

Reef Construction - A Capital Investment Decision

The management decision involved in the question of whether or not to construct artificial fishing reefs falls in the category of capital investment decisions. As such, the body of economic literature that addresses itself to capital investment questions is applicable to the reef construction question. As applied to public investment decisions, the methodology used is usually referred to as cost-benefit analysis.[2] The essence of the procedure used is to define all current and future benefits of an investment, assign each benefit an "appropriate" dollar value, and reduce, by way of discounting, all benefits to their present value (their value at the present time). All costs associated with an investment are treated in a parallel manner. If the present value of the benefits exceeds the present value of the costs, the investment is considered to be feasible.

Determination of Relevant Costs

The cost side of the artificial reef question is by far the least

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[2]For a good review of the literature , see A. R. Prest and R. Turvey, "Cost Benefit Analysis: A Survey," Economic Journal, Vol. LXXV (December, 1965). pp. 683-735.

difficult to handle from both a theoretical and an empirical standpoint. There are no significant maintenance costs or future operating costs. Hence, the problem of estimating future costs does not arise. The basic cost is simply the cost of constructing the reefs in the first place. This is essentially the cost of securing, transporting, and placing the artificial reef materials less any salvage sales in some cases. The cost will vary with the size of reef, its nature, and its location, but once these questions have been settled, the present cost figure is relatively easy to ascertain. The preferable procedure is to obtain competitive bids on the job. The lowest bid (or combination, if several "jobs" are involved) would be treated as the present cost. Unless the present value of benefits of the reefs exceeds this figure, the artificial reef construction could not be justified on the basis of economics.

Determination of Relevant Benefits

The determination of the relevant benefits resulting from artificial reef construction is rather complex compared to the determination of costs. A crucial and complex issue which must be settled initially is the identification of relevant benefits. There are several benefits which result from the artificial reefs. Among these are: (1) increased productivity of the waters surrounding the reef in terms of the amount of aquatic and marine life which can be supported in these waters. (These benefits can be determined by marine biologists and are a necessary, but not sufficient, condition for the economic justification of a reef.), (2) greater fishing success of those fishermen who fish in the waters

surrounding the reef, and (3) because of (1) and (2) the attracting of a greater number of fishermen to the area.

Some of the above "benefits" may not be relevant for inclusion in the cost-benefit analysis of the artificial reef construction question. The determination of which benefits are relevant depends upon the identity and objectives of the decision-maker. In the case where the decision maker is a public body subject to pressure from special interest groups, the decision maker may be more task oriented than goal oriented, and its objectives may not be explicitly stated. In such cases, the objectives may be implicit, and they can be deduced from known facts or from knowledge of what the decision-maker's objectives should be in the light of some higher objective or constraint. In the case of a public body involved in reef construction, two objectives are apparently involved: (1) increasing the fishing success of existing fishermen and (2) attracting additional fishermen into the area as a way of boosting the economy of the area.

If the objective of the decision-maker who constructs the reefs is simply to increase the fishing success of current fishermen, the relevant benefits are given by the present value of the product of the additional catch attributable to the reef and the appropriate unit value of a unit of catch. Any benefits occurring in future time periods will have to be discounted to determine their present value. The exact formula for calculating the present value of the benefits is

$$(1) \qquad PVB = \sum_{t=1}^{n} (\Delta C_t \, Ft \, V_t) \Big/ (1+i)^t$$

where:

ΔC = average increase in fish caught attributable to reef per fisherman
F = estimated number of fishermen
V = appropriate value of fish catch
PVB = the present value of benefits
i = the discount rate

It is important to note that it is appropriate to include only the increase in the fish catch in the calculation of benefits attributable to the reef. To estimate the increase in the fish catch, the decision-maker needs estimates of the catch at the reef site without the reef and with the reef. One way of obtaining this is to obtain estimates of the average fish catch per fisherman in non-reef areas similar to the reef site and then compare these estimates with the average fish catch per fisherman at the artificial reefs. The difference between these two can be attributed to the reef if the effects of other factors are held constant. The fish must be caught for any benefit to occur. An increase in the potential fish catch should not be counted as a benefit.

A second crucial item in the calculation of benefits due to increased catch is the appropriate dollar value per unit of catch that is assigned to the catch increase. Several alternative values have been posited as appropriate. One is the market value of the catch. This value has the advantage of not being arbitrary, and is obviously appropriate if the catch is placed on the commercial market or in cases where the fisherman is fishing only for food. One alternative value which some have advocated is the increase in recreational value to the fisherman

arising out of the increased catch. This is a nebulous figure and very difficult to ascertain and justify. However, it may be more appropriate from a conceptual standpoint in cases where the fisherman is fishing more for recreation than for food or the commercial market. (In those cases where the recreational fishing involves the charter boat industry, the increase in their business attributable to the reef should be included in measuring the benefits.)

The third variable involved in the calculation of the benefits of increased fishing catches due to artificial reefs is the number of fishermen using the reefs. This is the only item for which the design of the present study will provide information. Hence, data from the present study can not be used to evaluate the benefits of increased catches due to artificial reefs.

If the decision-maker is a public body financed out of general tax revenues, the appropriate benefits would appear to be those that accrue to the public at large--unless the public at large wishes to subsidize the sport fishing public for some reason. However, for the general case of artificial reefs financed by tax revenues, the appropriate benefits are those derived from the artificial reef construction. One could argue that only the increase in tax revenues resulting from the reef construction should be counted as a benefit on the theory that the project should generate enough tax revenues to pay for itself. It is felt that the latter approach is too stringent, and it is rejected for the following reason: the tax revenues expended on the reef construction project represent

a reduction in the disposable income of the area's residents; hence, the project is worthwhile if it results in additional income to the area's residents which is at least as great as this reduction. On this basis the total increase in area income is the appropriate measure of benefits.

The essence of the benefits, as defined above, is the new income in the area because of the reefs. How can the reefs generate new income? They do so by attracting non-local fishermen who spend money in the area which, in turn, increases the area's economic activity and income. An important point is implied in the above statement. Unless the reefs are at least partially constructed to meet the objective of increasing the recreational opportunities of the area's citizens, only the increase in area income resulting from expenditures in the area by fishermen residing outside the area should be included as benefits. Based on the above considerations, the appropriate benefits from the artificial reefs are estimated from equation (2):

$$PVB = \sum_{t=1}^{n} \frac{\Delta N_t E_t R_t}{(1+i)^t} \tag{2}$$

t = Time Period
PVB = Present value of benefits
Δ N = Number of new non-local fishermen attracted to the area because of the reefs,
E = Average expenditures per non-local fishermen in the area,
R = Dollars of income generated per dollar of sales,
i = Rate of discount

There would be additional benefits if the existing non-local fishermen increased their expenditures in the area because of the artificial reef construction. If that is the case, the formula should be modified as

follows: (3) $$PVB = \left(\sum_{t=1}^{n} \Delta N_t E_t R_t + \Delta E_t R_t F \right) \Big/ (1+i)^t$$

where: ΔE = is the change in expenditure by existing non-local fishermen
F = is the existing number of non-local fishermen.

It should be emphasized that the above analysis will only allow the decision-maker to determine the economic feasibility of a particular type of artificial reef at a particular site. The procedure would have to be repeated for each type of reef and reef location with the optimum site and type of reef being the one which had the greatest excess of present value of net benefits over present costs. Unless there are accessibility problems, the optimum site and type of reef are ultimately dependent upon the increase in marine life generated by the reef. The determination of this increase is a question marine biologists will have to answer. Their findings as to the conditions under which the artificial reefs generate the greatest increase in marine life provide an assessment of the necessary, but not sufficient, conditions for the economic justification of an artificial reef-provided that ceteris paribus conditions apply to the human factors involved.

Another procedure that is sometimes used to estimate the benefits of an artificial reef or similar publicly created recreation facility is the net recreational value of the reef (facility). This approach estimates the recreational value of the artificial reef by the following general procedure:

(4) $$PVB = \sum_{t=1}^{n} \frac{F_t \, V_t}{(1+i)^t}$$

where: PVB, i, and t are as previously defined
F = estimated number of fisherman days spent at the reef (or additional extra days spent because of the reef in the case where some fishing was already occurring)
V = recreational value of one fisherman day

This procedure is most appropriate in cases where the reef (facility) provides a source of recreation where none previously existed, and the public wishes to subsidize the fishing population (recreationist). One obvious problem in this approach is determining the appropriate recreational value of a fisherman day. If the facility merely enhances an existing recreational site, it is appropriate to include in the calculation of the estimated net recreational value of the reef only the new fisherman days created or the improvement in the value of a recreational day to the existing fisherman.

In terms of the decision making value, the result of this procedure is of considerably less value than the results achieved by either of the other two approaches outlined above. This approach is most appropriate if the sole object of the reef is to provide new or enhanced sources of recreation to area citizens.

III. ESTIMATES OF PRESENT FISHING PRESSURE AT SELECTED ARTIFICIAL AND NATURAL REEFS

In order to assess and analyze the degree of fishing pressure at existing artificial fishing reefs in the study area, a survey was undertaken around a sample of natural and artificial reefs in the study area. The survey was conducted during the period from April to December, 1974. Because of the size of the study area and the wish to include samples from every representative portion of the area, it was determined that aerial surveying was the most efficient means of achieving the study objective. Flights were conducted at random intervals over twelve sample sites in the study area and over two randomly selected "control areas". Thus, a total of fourteen sites were surveyed. The basic purpose of these surveys was to generate estimates of the fishing pressure at existing artificial reefs and to provide background data for the further biological and economic assessment of artificial reefs.

Description of Survey Sites

The location of the survey sites is presented in Figure 1. Site 1 is a shell area located in the mouth of the West Pascagoula River. Site 2 is the north side of Round Island and an adjacent shell area. Site 3, located in Horn Island Pass, is made up of a wooden platform,

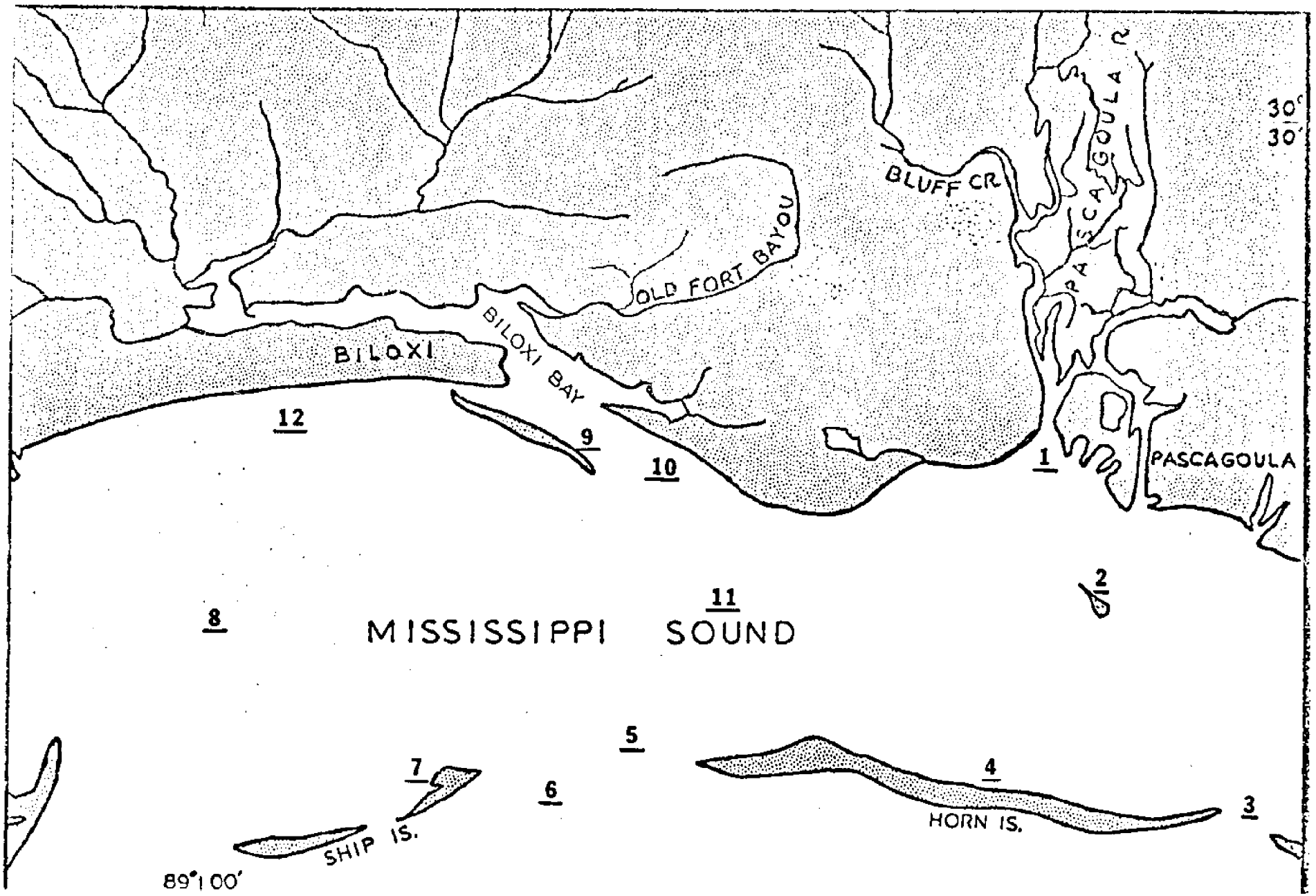

FIGURE I

Approximate location of artificial and natural fishing reefs included in the study.

rip-rap, and the foundation of the old Horn Island light. Site 4 is the so-called middle ground on the north side of Horn Island - a natural shallow area. Site 5 is another natural reef, the Isle of Capri Pass which is a natural shallow area that once was an island. Location 6 is an artificial reef created between Horn Island and Ship Island by dumping old auto bodies. Location 7 is a rip-rap pile on the edge of the channel on the northeast end of Ship Island. Site 8 is a sunken barge located between Ship Island and the mainland. Site 9 is a natural reef composed of shells lying off the northeast end of Deer Island, and Site 10 is a similar area lying southeast of Site 9. Location 11 is a sunken tugboat lying between the west end of Horn Island and the mainland. Site 12 consists of a series of pilings ringed with automobile tires lying just off the beach. Control areas are located on the east and west sides of Site 11. Six of the 12 sites are natural reefs and six are artificial or manmade (deliberately or accidently) reefs.

Survey Methodology

In order to obtain estimates of fishing pressure at the sample sites, boat counts were developed from aerial surveys of the sites. Survey flights were made on 59 days throughout the period of April through December. Thirty-two of these days were weekdays selected at random subject to weather conditions, 27 days were weekend days (Saturday or Sunday) also selected at random, weather permitting. A morning and an afternoon flight were made on these days. The fact

that weather conditions limited the aerial survey to good weather creates some bias in the results, since we have no counts for days on which weather conditions were adverse. In order to minimize the maximum possible error involved in cases where there were differences in the morning and afternoon boat counts, one half of the difference between the two counts was added to the highest count. An average daily boat count was developed for weekdays and weekend days on a monthly basis, and the resulting totals multiplied by the number of weekdays and weekend days available to obtain estimated monthly boat counts. Benchmark data developed from previous surveys in the Mississippi Sound were available which produced monthly estimates of people per boat. The latter data were used to develop estimates of the total man days of fishing at each sample location.

Survey Results

A summary of the survey results is presented in Tables 1 and 2. Table 1 contains data on the average monthly pressure at each reef site and control area during the survey period of April through December. Table 2 contains data on the average monthly pressure at each site, the pressure at each site relative to the control area average, and the pressure at the various artificial reef sites relative to the average for the natural reef sites.

In analyzing the data on fishing pressure at the fishing reefs, it is helpful to have some standard of comparison. This is the primary reason for the inclusion of data on Control Areas. The data indicate

TABLE 1

UNADJUSTED ESTIMATES OF FISHING PRESSURE AT SELECTED SITES
IN THE MISSISSIPPI SOUND, APRIL-DECEMBER 1974

Site	Type of Fishing Area	April	May	June	July	August	September	October	November	December	Total
1	Natural Reef	83	294	374	372	356	205	86	50	172	1992
2	Natural "	37	55	111	83	195	129	28	25	48	710
3	Artificial "	7	31	15	17	36	19				125
4	Natural "	289	925	826	806	898	495	447	302	281	5269
5	Natural "	89	171	139	44	54	30	10			537
6	Artificial "	111	86	69	66	62	46			11	451
7	Artificial "	215	632	494	616	716	391	171	112	120	3466
8	Artificial "	7	22	508	22	36	22			11	628
9	Natural "	148	360	384	392	421	264	214	175	94	2452
10	Natural "	99	195	283	196	247	340	137	60	94	1651
11	Artificial "	19	19	24	17	34	16			11	140
12	Artificial "	28	60	53	17	67	59	50	190	124	648
Coast		203	783	926	751	591	561	317	200	295	4627
Control Area # 1		*	*	*	17	31	25	43	44	35	195
Control Area # 2		*	*	*	22	31	25	58		48	184

*Not available

TABLE 2

FISHING PRESSURE AT SELECTED SITES EXPRESSED AS MONTHLY AVERAGES AND RELATIVE TO CONTROL AREA

Site		Average Monthly Fishing Pressure April-December	Fishing Pressure Relative to Control Area Average	Artificial Reef Fishing Pressure Relative To Natural Reef Average
Natural	Manmade			
1		221	10.52	*
2		79	3.76	*
	3	14	.67	.064
4		496	23.62	*
5		60	2.86	*
	6	50	2.38	.229
	7	385	18.33	1.766
	8	70	3.33	.321
9		272	12.95	*
10		183	8.71	*
	11	15	.71	.068
	12	72	3.43	.330
Control Area # 1		22	1.05	*
Control Area # 2		20	.95	*
Control Area Average		21	1.00	*
Natural Reef Average		218	10.41	*
Artificial Reef Average		101	4.81	.463

*Not applicable

that all of the natural reef sites had a total fishing pressure greater than either of the Control Areas or the Control Area average. Two of the artificial fishing reef sites had lower fishing pressure than the average of the Control Areas. These were Site No. 3, the rip-rap and platform in Horn Island Pass, and Site No. 11, the sunken tugboat lying between the west end of Horn Island and the mainland. The remainder of the artificial sites had fishing pressure ranging from 2.38 to 18.33 times the Control Area average. These data indicate that, as a general rule, the presence of artificial fishing reefs in an area does increase fishing pressure in that area.

The natural fishing reefs had heavier fishing pressure than the artificial reefs. None of the natural reefs had a lower fishing pressure than the Control Area average, and the natural reef average exceeded the pressure at all but one of the artificial reefs. Thus, the data indicate that while artificial reefs do increase fishing pressure in an area, they do not generate the degree of fishing pressure that is generated by natural fishing reefs. There are several possible explanations for this observation: (1) The artificial reefs may fail to produce and attract the fish population that is characteristic of natural reefs; (2) the artificial reefs may be less accessible than the natural reefs; (3) the natural reefs may encompass a greater fishing area, and/or (4) the location of artificial reefs may not be as widely known among fishermen as that of the natural reefs. Inspection of the locations of the artificial reefs lends little support to the possibility that inaccessibility is a problem. Some of the reefs with

the highest fishing pressure required the greatest travel distance. Both the least-fished and the most-fished artificial reefs were approximately the same distance from shore. On the other hand, three of the natural reefs were very close to the mainland and only one of the artificial reefs was very close to the mainland. Thus, while this may account to some extent for the relatively greater fishing pressure on the natural reefs, this possibility must be considered doubtful, particularly since the natural reef which had the heaviest fishing pressure was the farthest from the mainland.

With respect to Possibility No. 1 (artificial reefs produce, attract, and support a smaller fish population than natural reefs). There is little evidence from other studies that this is the case. In fact, the whole rationale for artificial reef development is predicated upon a large body of evidence that does not support this possibility. However, since it is likely that the fish producing ability of artificial reefs will vary depending on the characteristics of the location of the reef, it is quite possible that some of the artificial reefs included in this study are poor producers and, hence, have been avoided by fishermen for that reason. Unfortunately, no comparative data exist that allow any conclusion to be drawn relative to this possibility. This leaves Possibilities No. 3 & 4 as the most likely explanations of why fishing pressure at artificial reefs was less than at natural reefs in the study area. The natural areas, especially the two areas with the heaviest fishing pressure,encompass a greater fishing area and thus provide

greater fishing opportunities than the artificial reefs. Knowledge of the existence of an artificial reef depends on several factors: (1) the length of time since the reef was installed, (2) the extent to which it is either visible above the surface or marked by buoys, and/or (3) the extent to which it is identifiable on existing maps and charts. None of the artificial reefs included in the survey has been in existence as long as the natural reefs, and several are not visible from the surface except in the form of buoys. Unfortunately, many non-local fishermen do not attach any significance to these particular buoys as opposed to the hundreds of other buoys in the Mississippi Sound. Except for No. 6, all of the artificial reefs are noted in some degree on a two year old map of the Mississippi Sound and its approaches. These markings do not, however, always fully identify the nature and extent of the artificial reef. In summary, then, while the location of most of the existing artificial reefs can be ascertained without great difficulty on the part of fishermen, it is unlikely that fishermen know and recognize these sites with the relative ease with which they ascertain the natural reefs. The policy implication of this is that any artificial reef development should be well marked and its location well publicized.

Value of Recreation at Survey Sites

An attempt is made in this section to assign an approximate dollar value to the recreational activity enjoyed by the fishermen at the survey sites included in the study. It should be clearly understood that the estimates included in this section represent only the estimated valu

of recreation occurring at the survey sites and under no condition can these estimates be taken as the estimated value of recreation occurring because of the survey sites. Thus, these values cannot be compared to reef development costs and used to assess the economic feasibility of the reef development. Since many available alternative fishing sites exist in close proximity to the survey sites, the recreational benefits enjoyed at these sites would have been enjoyed regardless of the existence or nonexistence of the survey sites. As noted in Section Two, the benefits which should be attributed to the sites are only those benefits gained from those sites that would not have been gained otherwise. The present scale of artificial reef construction in the area is so small that such benefits are almost certainly negligible.

The estimated recreation benefits enjoyed at the survey sites were obtained by multiplying the estimated fishermen days at each site by "per recreation-day" values obtained from the Water Resources Council principles and standards for planning.[3]

The Water Resources Council principles and standards for planning classifies recreation day activities into two categories with a range of daily values associated with each category. A "general recreation day" is given a value ranging from $0.75 to $2.25, and a "specialized recreation day" is given a value ranging from $3.00 to $9.00. In assigning values to recreation activities, the council has stated that:

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[3]Federal Register, "Water Resource Council, Water and Related Land Resources, Establishment of Principles and Standards for Planning," pp. 51-53.

> The applicable rule to follow, taking cognizance of the unique circumstances of a particular setting, including the availability of actual market data and experience, is to use that procedure which appears to provide the best measure or expression of willingness to pay by the actual consumer of the recreation good or service ....[4]

The Water Resource Council principles and standards are ultimately only guidelines, and it remains impossible in most cases to remove the element of subjectivity from the process of assigning dollar values to recreational activities. Recreational activities at the survey sites are a case in point. Most of the survey sites probably meet the criteria for "specialized outdoor recreation day," but there is some variation in the degree to which different sites meet the criteria for the different values of a specialized recreation day.

The recreation day values eventually chosen as most appropriate for the survey sites are given in Table 3 along with the total estimated value of all recreation at each survey site based on those respective per-day values given in Column 2.

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[4]Ibid, p. 51

TABLE 3

ESTIMATED VALUE OF RECREATIONAL BENEFITS
ENJOYED AT SURVEY SITES, APRIL 1974-DECEMBER 1974

Site	Per Day Recreation Value	Estimated Value of Recreation Benefits	
		Total Value April-December*	Average Monthly Value
1	$3.00	$ 5,973	$ 664
2	3.00	2,133	237
3	9.00	1,125	125
4	9.00	40,167	4,463
5	9.00	4,833	537
6	9.00	4,050	450
7	9.00	31,194	3,466
8	6.00	3,768	419
9	3.00	1,884	209
10	3.00	7,353	817
11	6.00	834	93
12	3.00	417	46
Control Area #1	6.00	1,176	196
Control Area #2	6.00	1,104	184

*Data are available for control areas only for the period July through December.

IV POLICY IMPLICATIONS OF THE RESULTS

Policy implications are present in several findings of this study. These are enumerated and briefly discussed in this section.

If the development of artificial reefs is to be contingent upon the economic feasibility of those reefs, then it is essential that benefits and costs of the reefs be appropriately defined and estimated. This is discussed in more detail in Section II, but several points are important enough to merit summarizing in this section.

The appropriate benefits for any reef development project will be dependent upon the purpose of that project. If the objective of the decision-maker who constructs the reefs is only to increase the fishing success of those currently fishing a given body of water, the appropriate benefit measure is the present value of the product of the additional fish catch attributable to the reef and the appropriate unit value of each additional unit of catch.

If the reef development is to be financed out of local tax revenue, and unless the reefs are at least partially constructed to increase the recreational opportunities of local citizens, then only the increase in area income resulting from local expenditures of nonlocal fishermen attracted to the area by the reef development should be included in the benefits of

the development. Thus, total benefits would be the present value of the product of the additional expenditures by nonlocal fishermen occurring because of the reef development and the average ratio of income generated per dollar of sales to nonlocal fishermen.

Since, in the minds of many people, a major objective of any artificial reef development program is an increase in local area income, it should be stressed that this benefit is contingent upon one and/or both of two things happening: (1) The reef development must be of sufficient size and fish producing capability and sufficiently well publicized to cause a net increase in the number of nonlocal fishermen attracted to, and spending money in, the local area; and/or it should be of sufficient size and fish producing capability to cause the present nonlocal fishing populace to increase their local expenditures for fishing. The implication of these conditions is that any reef development project designed to promote the local economy will have to be of large scale and well publicized.

The results of the survey of fishing pressure at existing artificial and natural reefs indicate that the reefs do attract considerable fishing pressure as a rule, but that a particular reef may or may not attract any additional fishing pressure. The amount of fishing pressure which may be expected at a particular reef development is dependent upon, the size of the development, its accessibility, the extent to which its location is known and publicized and ultimately upon its fish producing capability. Because of the latter factor, any reef development should be based upon the advice of a competent marine biologist.