GENERAL CONSIDERATIONS PREREQUISITE TO FURTHER GALVESTON BAY SHELL REMOVAL

by

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FOREWORD

The estuaries of Texas are among the most important natural resources of the State, and their exploitation should be planned and managed to derive the greatest benefit for the state's population. It should be recognized that exploitation means not only removal of products created by the estuarine system, but also the enjoyment and usage of the waters. Typically, the estuaries provide for recreation and navigation, serve as receivers of pollutants from municipalities and industry, and serve as spawning and nursery grounds for most of the commercial marine products of the State. These examples, although generalized, indicate the broad spectrum of services and demands to which the valuable estuarine waters are subjected. Clearly, the interplay of the various user groups can, and often does, lead to conflicts of interest.

One of the most representative conflicts of interest is related to the removal of oyster shell from estuarine waters. Currently, the area where this conflict is most evident is in Galveston Bay, the largest (335,000 acres) and most valuable of all the Texas estuaries.

Shell dredging has developed into a major coastal industry, marketing shell for construction material and industrial processes that require calcium carbonate which oyster shell readily supplies. However, the continued mining of shell from the bay has reduced the reserves to the point that what shell remains is contained within major, exposed oyster reefs which have value in their present location. This value is related to recreation, oyster production, conservation, estuarine ecology and possible detrimental effects of shoreline erosion and changes in circulation caused by reef removal. Recognizing this value, the Texas Parks and Wildlife Commission currently enforces a policy which protects these reefs from further dredging. Whether or not the policy should be relaxed is under constant review and, as such, is the subject of considerable controversy.

This unsponsored study was undertaken to determine the general considerations and problems involved in the analysis necessary for any decision on the future of the reefs. Included in the study are gross economic evaluations of recreation benefits and oyster production related to the reefs, possible results of removing the reefs, alternative measures of reef transplanting, general evaluations of industry needs, and an analysis of limestone as an alternate source of the calcium carbonate raw material required for industry.

The general evaluation of many of the factors involved indicates that comprehensive estuarine planning is of vital importance when decisions are to be made affecting the ecosystem on one hand and the needs of a growing industrial and metropolitan complex on the other. The investigations and findings of this report are not intended to favor or disfavor any action or decision on the future of the reefs. However, the report does intend to recognize and explain many of the factors that must be considered, and, in addition, indicate areas for which study, preceeding any decision, is required.

PREFACE

The investigation presented in this report involves a general evaluation of the relation of oyster shell to the coastal region. Of particular interest is the gross economic evaluation of the various factors to be analyzed when the removal of shell, a natural resource, is considered.

The authors wish to express their gratitude to all those who assisted in the data collection and preparation of this paper. Special appreciation is expressed to Professor Stanley A. Arbingast for his useful suggestions and to Professor E. F. Gloyna who provided financial assistance by means of a Public Health Service Traineeship.

Appreciation is also conveyed to Ann Hill and Virginia Thomas who typed this paper.

ABSTRACT

Research was undertaken to determine the general factors that should be considered in analyzing the values of the remaining oyster shell in Galveston Bay. The shell has value, in the present reef form, for recreation, oyster production, shore protection and, possibly, circulation control. When dredged from the bay, shell has value for industrial purposes and construction material and is an important element in the economy of the Houston-Galveston area.

An analysis of these various factors has been made to the extent that available information will allow. Also included are general evaluations of oyster shell transplanting, artificial reef construction, and the potential of limestone as a substitute resource for shell. General estimates of costs, values and benefits of the various elements are presented.

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Chapter I

INTRODUCTION

The oyster shell in the bays of Texas is a valuable natural resource that is important to the economy of the coastal regions. Buried shell is mined to be processed by industry for the development of products or used in its natural state for road building materials. Galveston Bay (defined in this paper as including Trinity Bay and East Bay) has historically supplied the majority of the annual shell production from all the Texas bays. However, continued dredging of shell has depleted most of the available reserves in the bay. The deposits that remain compose the major, exposed oyster reefs (Hanna's Reef, Todd's Dump Reef, Vingt et Un Reef, Moody's Reef, Fisher's Reef, Dollar Reef, and No Name Reef) which are currently protected from further dredging by Texas Parks and Wildlife Commission policy.

The policy is based on the principle that the bay is multifunctional and therefore, serves the interests of many different user groups. Since the bay is public domain the interests of a particular user group should not unreasonably restrict the interests of other user groups.

Shell reserves have been depleted in Galveston Bay except for what remains in the exposed reefs. The demand for shell necessitates a continued supply, if possible. However, the exposed reefs have uses, such as oyster production, that contribute to the interests of other bay user groups. These uses indicate a fundamental point in the consideration of further shell removal from Galveston Bay; that shell deposits underlying exposed shell overburden must be evaluated in a different category than shell deposits underlying sediment overburden.

The objective of this paper is to determine the general considerations prerequisite to the approval of further dredging of the major, exposed reefs in Galveston Bay. The analysis must necessarily develop the uses of shell and shell reefs, the economics of the problem, and the possible results of reef alteration.

The figures developed in this paper are general estimates, because sufficient information required to make a more exact evaluation is either unknown or unobtainable. However, the figures presented are reasonable approximations that serve to indicate relative values useful in the economic comparisons involved in the analysis.

Some of the elements presented are viewpoints expressed by various user groups. However, to make a general analysis, this information is presented so that a more comprehensive understanding of the complexity of the problem can be derived.

It is recognized that there are many possibilities for reef alteration that could be considered, such as partial removal of some of the reefs or complete removal of one or two of the reefs. However, a detailed review of the many alternatives is beyond the scope of this paper because sufficient data on the various individual possibilities is unavailable.

The only alternative considered in this paper is complete reef removal. Still, the elements involved in this limited analysis are typical of those required when considering any other alternative.

Chapter II

THE RELATION OF OYSTER REEFS AND OYSTER REEF REMOVAL TO RECREATION

One of the many aspects to be considered in studying the feasibility of removing the remaining, exposed reefs (reefs rising above the bay bottom) in Galveston Bay is the value of the reefs to recreation. Shell reefs are among the most popular fishing spots in the bay, not because shell is there, but because the interstices within the reefs offer hiding places for small organisms which are food for small fish. The small fish are followed by larger fish which attract the fishermen (1).[1] This is similar to the appeal of the grass flats in the Laguna Madre in South Texas, which provide the food fish and small animals, and, as a result, tend to attract and concentrate schools of larger fish. Therefore, the popularity of reefs is attributable to the possibility of making or increasing a day's catch in these areas.

The popularity of the reefs in Galveston Bay can be verified by the findings of a study by W. R. More, marine biologist for the Texas Parks and Wildlife Department (2). His study covered fishing locations and catch from those locations by sport boats in Galveston Bay for one year, beginning June 1, 1963.

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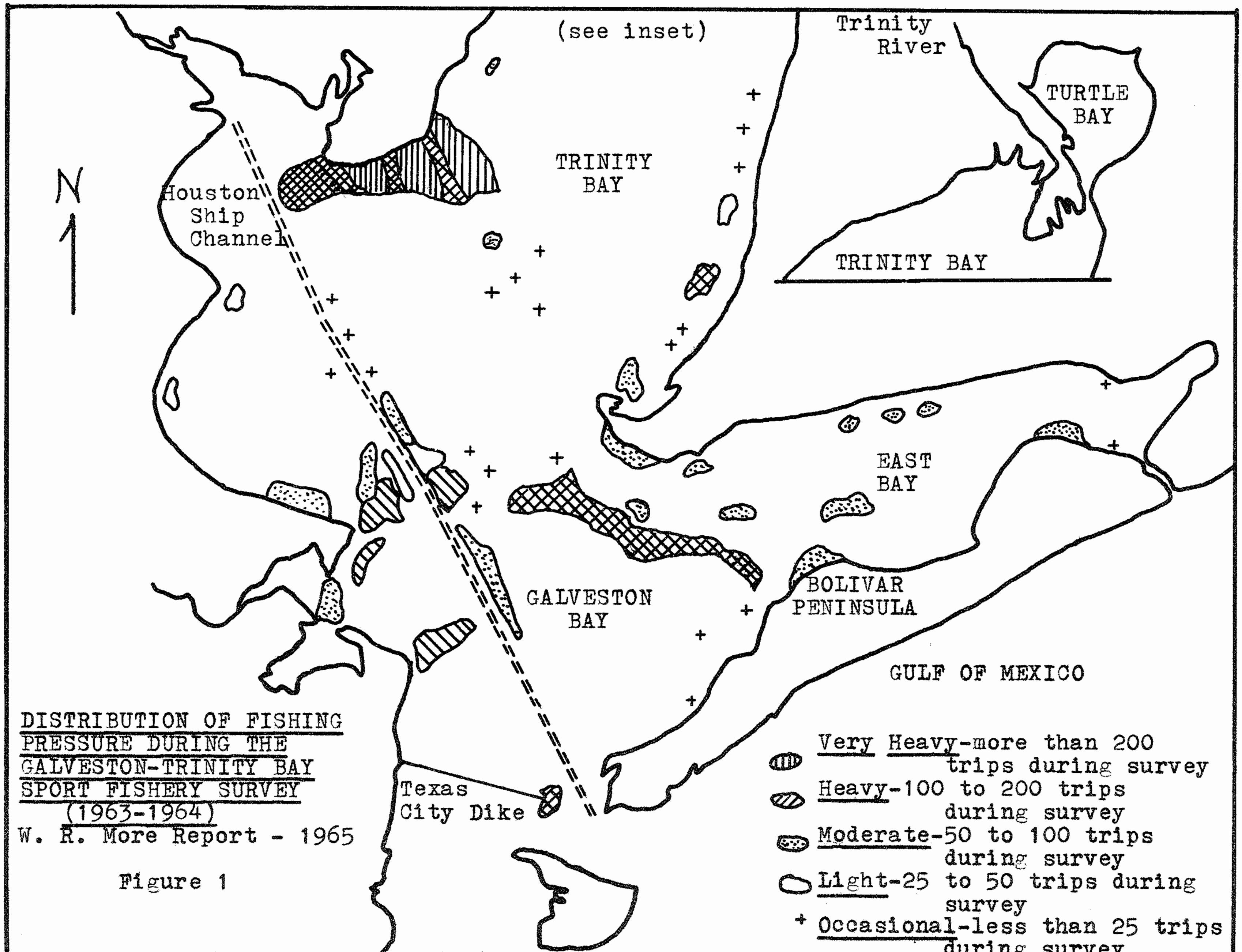
[1] Numbers in parentheses represent references in bibliography.

It was found that approximately 102,000 anglers fished in the areas shown on Figure 1. By comparing Figure 1 with Figure 2, which is a map showing the location of the major reefs, it can be seen that the fishing pressure was concentrated around the large exposed reefs, indicating the fisherman's preference for these areas.

In addition, it was found that approximately 75 percent of the fishermen questioned were from the Harris County area. If it is assumed this percentage will be typical in any future year, the estimated growth of the Houston area population, which is expected to continue to be at a rate greater than the growth of the State as a whole, can be utilized to anticipate increasing numbers of fishermen in the bay, and, therefore, growing fishing pressure around the major reefs. Furthermore, the Texas Parks and Wildlife Department estimates that fishing as outdoor recreation will increase more than fourfold by 1990, which is more than double the rate of increase in population for the State as a whole (3).

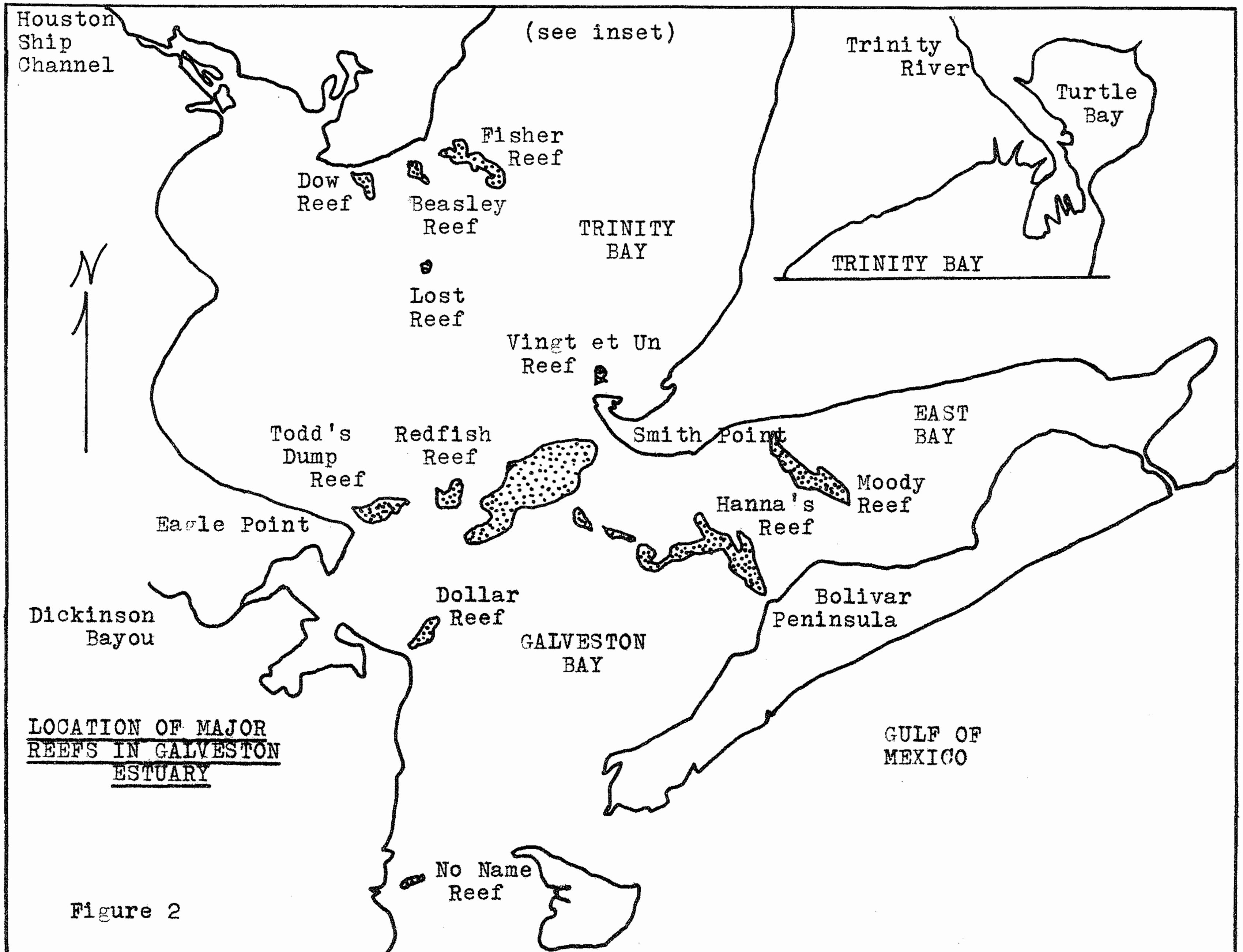
Therefore, it can be estimated that the growth in fishing activity in Galveston Bay will increase at a rate greater than the rate of population growth of the Houston metropolitan area. Moreover, it can be assumed that if the reefs are removed, the rate of growth of fishing activity will be diminished since a major portion of the preferred fishing areas will no longer exist.

An estimate of the total reduction in fishing activity resulting from removal of favored fishing areas would depend on the growing popularity of fishing, the growing population around Galveston Bay, and the amount



(see inset)
Trinity River
TURTLE BAY
TRINITY BAY
N
Houston Ship Channel
TRINITY BAY
EAST BAY
GALVESTON BAY
BOLIVAR PENINSULA
GULF OF MEXICO
Texas City Dike
DISTRIBUTION OF FISHING PRESSURE DURING THE GALVESTON-TRINITY BAY SPORT FISHERY SURVEY (1963-1964)
W. R. More Report - 1965
Very Heavy-more than 200 trips during survey
Heavy-100 to 200 trips during survey
Moderate-50 to 100 trips during survey
Light-25 to 50 trips during survey
Occasional-less than 25 trips during survey

Figure 1



LOCATION OF MAJOR REEFS IN GALVESTON ESTUARY

Figure 2

of reef removed. It is assumed that the reduction in fishing effort would average over the next 10 or 20 years approximately 100,000 angler-days per year. It should be recognized that removal of the reefs will not necessarily cause a fisherman to shelve his equipment and stay home, but removal of a fisherman's favorite areas will cause him to seek other areas, or possibly other bays, which would result in benefits lost to Galveston Bay.

The Sport Fishing Institute reports that the Federal government uses for computation a value of $3.00 per angler-day for "net economic benefits" generated from the types of sport fishing involved in the Galveston Bay area (4). This value incorporates all types of fishermen in Galveston Bay. Therefore, it is reasonable to assume that those anglers utilizing a boat generate higher than average net economic benefits, because of boat rental, gasoline, maintenance, and depreciation of craft and engine. Such added expenses for anglers utilizing a boat would justify net economic benefits of at least $5.00 per angler-day. This would amount to at least 0.5 million dollars in economic benefits from sport fishing lost in the Galveston Bay area per year if the reefs were removed and not replaced.

The Texas Water Development Board has published a report on the economic value of Corpus Christi Bay (5). The report estimates that the value of that estuary for recreation and sport fishing was $151 per surface acre per year in 1958. If it is assumed that approximately the same value could be applied to Galveston Bay, which is near a much larger population, then a rough estimate of the magnitude of the benefits of Galveston Bay for these uses can be derived. The bay covers approximately 334,000 acres which would develop benefits, utilizing the $151 per surface acre per year, of 50 million dollars per year. If the loss in benefits caused by reef removal was just one percent, the result would be the same as the loss in benefits estimated earlier based on $5.00 per angler-day. Such a low percentage is not unreasonable since the favored fishing areas will have been removed. It should be recognized that the figures on Corpus Christi Bay are 1958 estimates and that estimates today would undoubtedly be higher.

In addition to the benefits for sport fishing, the reefs have other values related to recreation and bay usage that, although difficult to place a dollar amount on, warrant consideration. The reefs of significant size such as Todd's Dump provide protection from winds and rough water on their lee side and, therefore, allow recreation during windy periods. If protection were removed, some fishermen or pleasure boaters might be forced to remain ashore (6). The large reefs may also provide a potential safety factor to those in the immediate area unfortunate enough to be caught on the bay during a sudden squall.

Finally, the shallow reefs provide an additional source of recreation when winter winds and accompanying low tides expose some portions of these reefs. This allows those interested to walk the reefs or wade the shallow water covering the reefs and collect oysters. Such activity provides recreation and food for those who participate, and is apparently a significant activity, although no figures are available (6).

There has been considerable discussion whether or not dredge cuts offer good fishing. In conversations with fishermen in the Galveston Bay area, it was found that most of the cuts that are popular fishing areas, for certain kinds of fish, are through or on the edge of an oyster reef. However, some cuts that were mentioned were not adjacent to an oyster reef, but supplied fishing, in general, for other species. This tends to support the idea that the cuts remaining after a dredge has passed may have some value to sport and commercial fishermen alike.

In addition, the contention of dredgers, that the deep cuts (current maximum depth about 40 feet) provide sanctuary for fish, may have merit if certain conditions are present. In comparison, the deep holes in Offatts Bayou in Galveston offer excellent fishing during the wintertime because of warmer temperatures in the deeper waters. However, Offatts Bayou is virtually landlocked except for the opening to West Bay in the western end. Circulation is considerably restricted and mixing by wave action is held to a minimum which allows temperature stratification to be more pronounced. Most of the deep holes dredged in the bay are subject to circulation and wave action where fetch is sufficient to allow wave generation from all directions. Therefore, these holes are less likely to maintain a significant temperature stratification which would be the advantage offered by the landlocked and protected deep holes for good wintertime fishing.

Dredging of Galveston Bay has deepened the water in localized areas and has probably increased that area's potential for recreational boating and sailing, and, therefore, can be said to possibly have improved small craft navigation to a certain extent. Moreover, deepening of the bay waters has probably improved its potential as a receiver of pollutants by increasing its dilution characteristics, and according to a publication by the shell dredgers, has tended to extend the life of the bay by creating more room for storage of silt and mud which is brought into the bay by Trinity River and San Jacinto River floodwaters each year (7) (8).

Furthermore, the dredgers contend that the deepening of the bay has been beneficial because it has improved circulation. However, no evidence has been found to support this contention, although it can be agreed that circulation patterns have obviously been altered. Whether such alteration has been beneficial or detrimental to bay production cannot be determined with the information available.

Of the above mentioned possible advantages of dredging, only one, the effect on circulation, is at this time of significance in this paper. According to a statement of the shell dredgers presented in 1967, "the remaining known deposits of dredgable shell in Galveston Bay constitute less than 3 percent of the total acreage of Galveston Bay" (9). If such is true, removal of the remaining shell would not create a significant increase in recreational benefits, dilution potential or the extention of the life of the bay. However, since most of the remaining deposits are the exposed reefs of the bay which rise from the bay floor to near the surface in the areas as shown on Figure 2, it is possible that removal of these deposits could affect circulation as much or more than any other past change in bay bottom. Although there is insufficient evidence at this time to estimate what the change may be and whether or not such change would have an adverse or beneficial effect on circulation in Galveston Bay, it seems a study should be made to attempt to determine the outcome before removal of the reefs rather than permitting removal and hoping for beneficial results.

Chapter III

EROSION AND CIRCULATION

In considering removal of the exposed reefs in Galveston Bay it is necessary to determine what effect reef removal may have on existing current patterns and shoreline stability. Todd's Dump, as shown in Figure 2, is located offshore of Eagle Point and acts as a partial barrier to protect that point from erosion by wave action due to northeasterly winds which could be quite expensive to those landowners involved.

Although it would be impossible to say for certain at this time that such serious erosion may develop, such a possibility can be visualized. Northers that blow across Trinity Bay build up wind waves that can become of considerable height when such a long fetch is available. Todd's Dump and the spoil banks along the channel currently provide protection for the beach area at Eagle Point in that the developed waves tend to break on the reef and are considerably reduced in size before reaching the beach. Should the reef be removed, almost the full energy of these waves would impinge on the previously protected shoreline area. Further scouring of the beach can be visualized when the set-up of water during a strong, blowing norther leaves the beach, creating an undertow, which probably would remove material from the beach to be deposited in the deeper water offshore of the point. Similar situations exist, although wave action would be less severe, for Fisher's Shoals, which protects some of the shoreline east of Houston Point from southerly winds, and, to a certain extent, Redfish Reef, which offers some protection to Smith's Point from westerly winds.

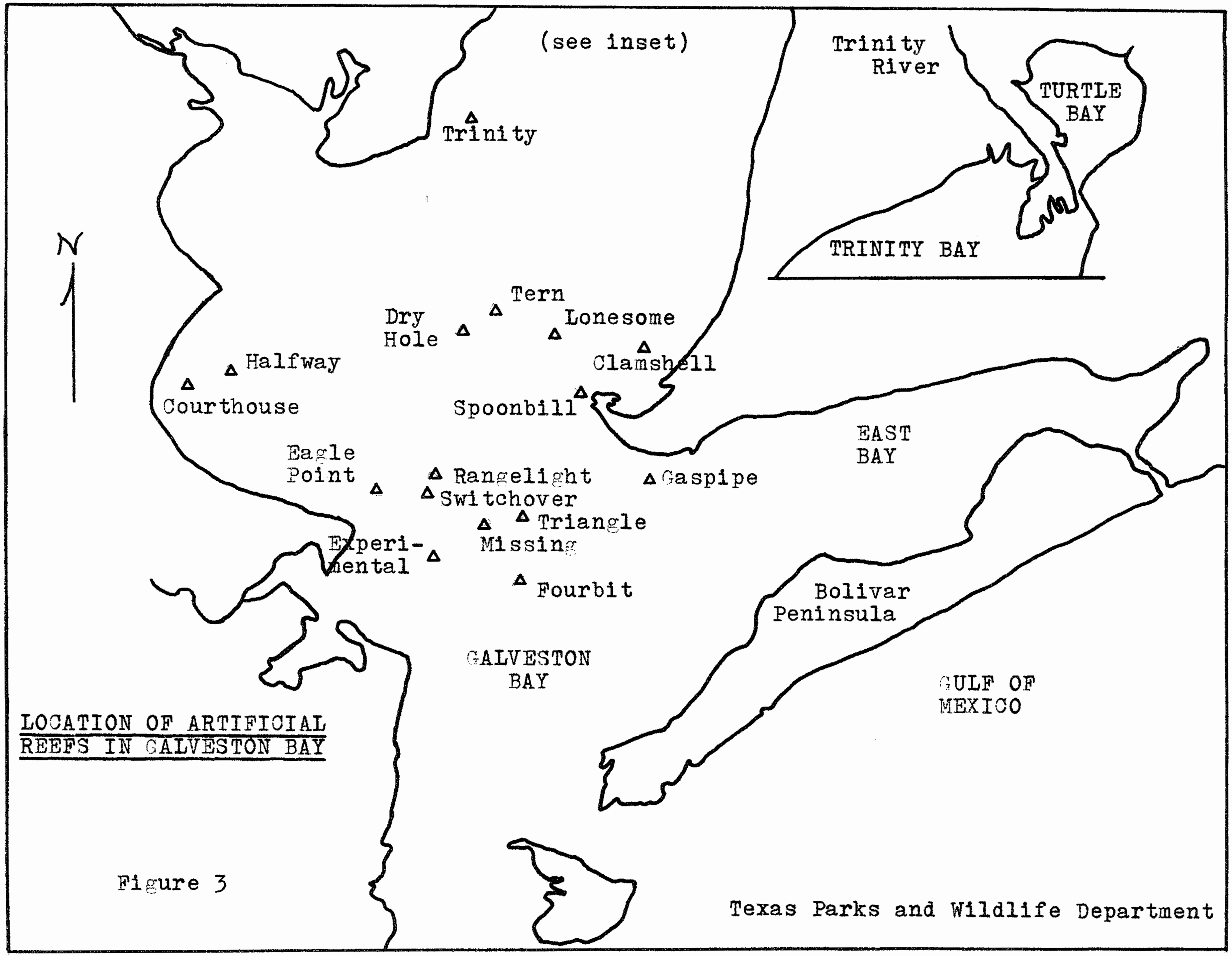
In addition to possible detrimental effects of erosion, problems also may develop if existing current patterns are altered because of changes in bottom contour resulting from removal of the reefs. The ecology of Galveston Bay has been subjected to man-made alterations such as the Houston Ship Channel, the Texas City Dike, and the dredging of buried shell. However, removal of the large reefs may cause changes in circulation that could have more lasting effects and such effects may or may not be detrimental to the bay's productivity. Therefore, it seems that while removal of the reefs may not harm or may even increase productivity of the bay there is also the distinct possibility that changes in circulation patterns could damage Galveston Bay production potential permanently. Such being the case, a study of possible effects should be undertaken to predict what may result rather than hoping for the best.

Chapter IV

TRANSPLANTING AND ARTIFICIAL REEF CONSTRUCTION

On all reefs, live oysters are found only in a thin surface layer. As generations of oysters die their shells remain, adding height to the reef, and providing "culch" (setting surface) for the next generation of "spat" (young oysters). Over a period of many years a substantial depth of oyster shell is formed and this quantity of shell is the source of oyster shell production. However, the significant remaining deposits of shell in Galveston Bay are beneath crusts of live oysters in the main reefs protected by Texas Parks and Wildlife Commission policy. Current policy prohibits dredging within 300 feet of the protected reefs thus denying the shell dredgers access to the underlying shell.

One of the main considerations in analyzing the feasibility of removing the reefs is the possibility of transplanting oysters from their present location on the major reefs to some other area. Removal of the thin surface crust of live oysters would allow access to the shell presently unobtainable. The Texas Parks and Wildlife Department has had good success in the development of artificial reefs, in which a "pad" of oyster shell is placed on the bay bottom in areas expected to be conductive to oyster growth. Most of the reefs, as shown on Figure 3, have been placed in the general area of Redfish Reef and Todd's Dump. However,



<u>LOCATION OF ARTIFICIAL REEFS IN GALVESTON BAY</u>

Figure 3

some have been located farther north into Trinity Bay where the oyster growing environment is, although inferior at this time, expected to improve with the development of the Trinity River Project, which will improve the control of the river's floodwaters and could allow phased outlet of floodwaters into the bay. Most of the artificial reefs up to this time can be termed successful, meaning they have continued to support oyster growth, but are recognized to be more experimental than reefs developed for production (6).

Since 1958, the Texas Parks and Wildlife Department has supervised a program allowing the removal of shell beneath a towhead reef[2] provided the dredgers develop a foundation of oyster shell at a location approved by a state biologist and transfer the oyster crust of the towhead to the new foundation. Such procedure, along with the artificial reef program, has created shell reefs in 18 locations, as shown on Figure 3, covering a total of approximately 300 acres (10). Most of these reefs continue to produce oysters which indicates that transplanting may be potentially successful.

However, the reefs that have been developed are small in size, averaging about 15 acres, and are either experimental or towhead transplants, which do not contribute significantly to commercial oyster production. When transplanting the larger reefs is considered, the picture changes significantly.

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[2] Towhead reefs are defined as reefs of 10 acres or less in size.

Transplanting the major reefs in the bay is a much larger operation and encompasses problems that are not significant in the small reef development. For a small reef, relocation involves a small volume of shell contained in a relatively small area which reduces costs and simplifies placement. In addition, the same general environment is maintained for the transplanted oysters.

However, there are over 3,000 surface acres of exposed shell on the major productive reefs (10), which is a much greater area to transplant than any previously experienced. According to Texas Parks and Wildlife Department estimates based on information available and construction costs in 1962, a figure of approximately $5,000 per acre would be required to transplant Todd's Dump. The figure included a three-foot pad of shell for the inferior soft bottom in the vicinity of the present reef. There were approximately 1,300 acres of exposed reef in the Todd's Dump area which resulted in a transplant cost of approximately 6½ million dollars. In Todd's Dump Reef proper there are now approximately 400 acres which would cost about 2.0 million dollars to transplant proportioned on the 1962 figures. The 1962 estimates did not include the cost of constructing the transplanted reef to some natural characteristics, such as the longitudinal ridge, typical of the major reefs. In addition, it seems the cost did not include factors such as potential drop or increase in production because of the new environment at the site of relocation and loss of production during transplant and development periods. Finally, should a relocation plan be developed, consideration must be given to possible changes in the bay's salinity gradient as a result of inflow changes such as the Trinity River Project would cause. Relocation may result in more production for several years, but production could be adversely affected following completion of the Project. If transplanting is to an area which is presently inferior but will improve when the Project is complete, production would be lost until improved conditions develop. Production would then revive as salinity reached more ideal conditions, assuming the location was predicted accurately and the relocated reef was not silted over by project completion time. Either way, additional costs over direct transplanting costs are possible.

The problems of transplanting mentioned above, although basically concerned with Todd's Dump, are typical problems to be encountered in transplanting any of the major reefs. Moreover, the added cost of transplanting would increase the price of shell considerably if the dredgers were to completely absorb the cost of transplanting as a requisite to obtaining the shell below. It is doubtful that any other source of funds is available to accomplish the work. Finally, the changes in bay salinity gradients resulting from changes in inflow patterns may be distinctly different then estimates now indicate. This possibility would considerably increase the risk of mis-location and failure.

Therefore, transplanting seems to be dependent on many factors. Small scale operations have been successful but large scale transplanting involves many problems that apparently increase the risk of failure. Recognizing the large sum of money involved, it seems a study of longrange aspects affecting transplanting success, especially changes in salinity gradients caused by greater control of inflow, is one of the prerequisites to approving alteration of the major reefs.

One possible alternative to a complete transplant operation may be the development of artificial seed reefs from which, it would be anticipated, large, new oyster producing reefs could begin. By laying a series of ridges of dredged shell in areas of optimum oyster growing conditions it would be hoped that, eventually, natural expansion from the seed ridges would create large oyster beds capable of sustaining continued oyster production to supplant production from the major existing reefs.

Such reef development has the advantage of being much less expensive when compared to transplanting, although it must be recognized that it will take considerable time for the new reefs to develop. Moreover, the reefs will probably be suitable areas, assuming good development, for sports fishermen and commercial oystermen.

The possibility of artificial seed reefs has been proposed by some of the shell dredging companies who have offered to supply the material and equipment required to construct the new reefs (7), as a compromise measure for obtaining some of the valuable shell deposits currently inaccessible. By providing a base for oysters to build new reefs, some of the problems, such as loss of favored fishing areas, involved in the controversy may be considerably reduced in scale. However, the problems of shore erosion and alteration of circulation exchange and salinity patterns where reefs are removed and new reefs developed would still be present. The magnitude of these problems and the amount of time required for the seed reefs to develop would be the major factors influencing the acceptability of the proposal.

Chapter V

OYSTER PRODUCTION

One of the main reasons for prohibiting further dredging of the remaining exposed reefs in Galveston Bay is that the reefs support nearly all of the annual oyster production from Texas bays. Most of the Galveston Bay production in recent years has been from Redfish Reef, Todd's Dump and Hanna's Reef, but nearly all the reefs contribute to oyster development within the bay.

The oyster industry has a history of fluctuating production levels. However, beginning in 1962, oyster production began a dramatic rise, as shown on Figure 4. Aided by good growing seasons, a reduction in minimum size limit from $3\frac{1}{2}$ to 3 inches (1965), easing of pollution restrictions in some areas and increased harvesting effort, including boats from the lower Texas coast and Louisiana, production reached a maximum in 1965 of 4.6 million pounds of oyster meats (10).

It must be recognized that, although production has increased over the last several years, it is unlikely the rise will be sustained. Production will continue to fluctuate, but will probably maintain a much higher average than past decades for reasons such as smaller size limits, increased effort, and increased demand.

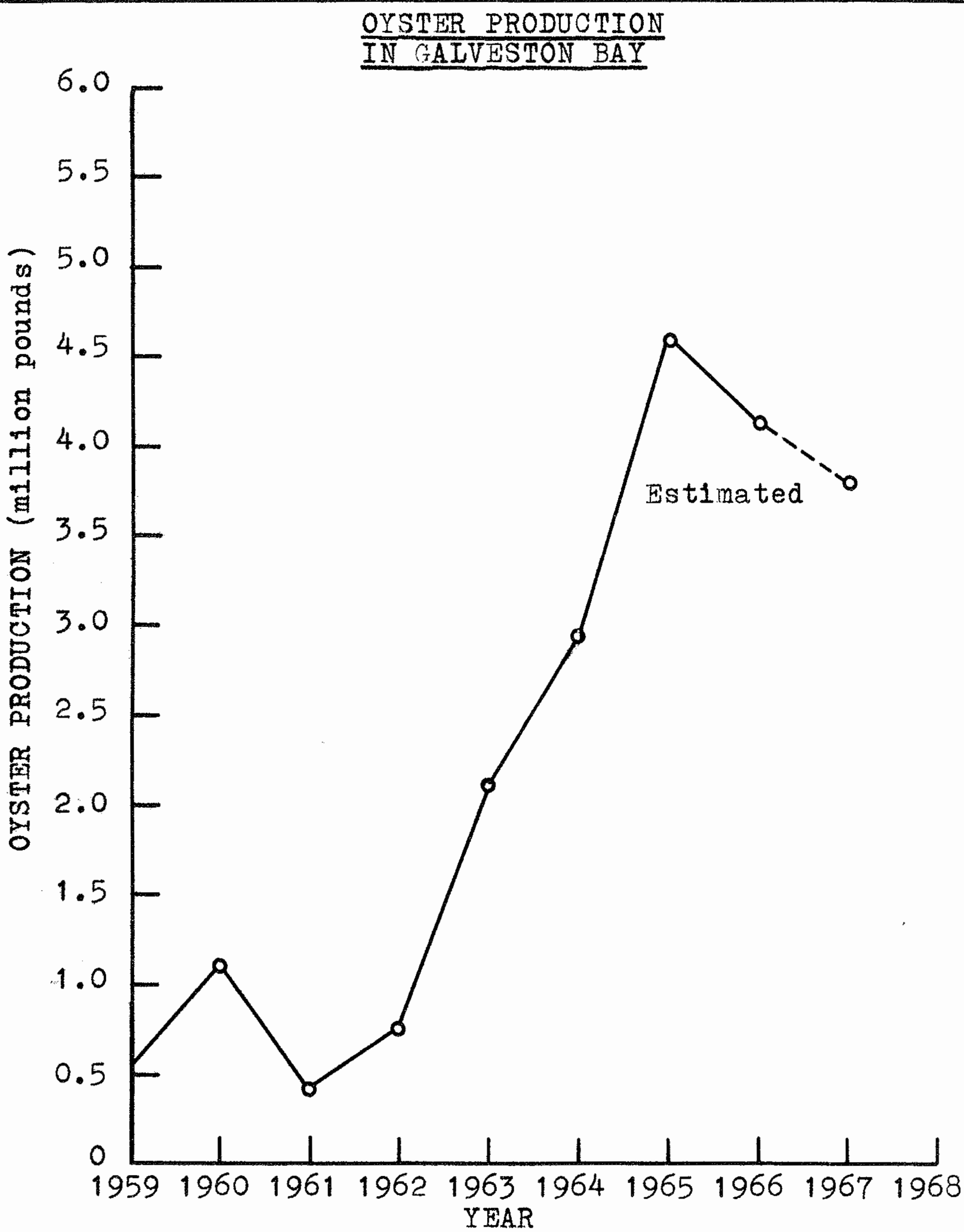

Figure 4

Texas Parks and Wildlife Department

The reservoirs and diversions that are proposed for the Trinity River may have considerable effect on the oyster industry. By controlling the outlet of floodwaters, mixing of the bay can be controlled to a greater extent than is now possible. If such is the case, the oyster production in Galveston Bay could rise markedly. Oyster farmers could increase their investment since risk of loss will have been reduced because oysters will be subject to less frequent fresh water kills. The experimental reefs, as shown in Figure 3, have been located mostly north of Redfish Reef. This area is expected to be where the salinity level most conducive to oyster production will tend to stabilize when projects proposed on the upper watersheds are completed. The area in which Redfish Reef and Todd's Dump are located may be within this zone of production and could be expected to play an important part in increased oyster production should such development take place as predicted.

Assuming that the average oyster production of 2.5 million pounds of the last seven years, the period of the dramatic rise in production, can be sustained, the annual landed value of the oyster fishery would be approximately 1.0 million dollars. Any development that would tend to stabilize salinity fluctuations in the bay could increase revenues from oyster production. However, since projects that would control salinity to any great extent are planned for some future date, the possibility of improving average production in the near future is remote. Therefore, the influences of such projects will not be considered except for recognition of the future importance of the reefs in improved salinity areas for greater production.

Chapter VI

DREDGING AND RELATED INDUSTRY

Contradicting the demand for leaving the major exposed reefs undisturbed is the demand for shell by industries that require the calcium carbonate shell supplies to manufacture and develop products. The industries are an important factor in the economy of the Houston-Galveston area and it must be recognized that continued supply of a calcium carbonate resource is essential to the life of the industries that require it.

The first use of shell was for surfacing unpaved roads. Although not an ideal surfacing agent, because it eventually crushes to powder, shell was about the only material in the area available for such use. As shell became more and more available, usage grew to include coverage for parking lots and driveways and as aggregate for concrete and bituminous highways, a use for which shell is much more serviceable than plain shell surfacing.

However, in recent years, the use of shell as road material has been declining. Apparently, the increasing price of shell has put limestone in a more competitive position with shell when the added benefits of using limestone as road material, such as better wearing quality, are considered (11) (13).

Around 1930, the first cement plant using shell as a source for calcium carbonate was completed in the Houston area. There are now four cement plants in the Houston-Galveston area that, together, make up a group that is one of the major users of shell. Their continued operation is important to the growing Houston-Galveston area.

In addition, shell is used as a raw material in the manufacture of lime which is used as a purifier in water treatment operations, as an element in the manufacture of dry ice, as a neutralizing agent and as a soil stabilizing agent. Many industries in the Houston-Galveston area require chemical processes which use the lime in various ways as an aid in product development.

Finally, reef shell is used in chicken feeds as a means of providing calcium carbonate used by poultry in the formation of eggshell and as roughage in cattle feeds. The Houston area is the second largest producer of poultry oyster shell in the world.

All of the industries mentioned need a supply of a calcium carbonate material to continue operation. Oyster shell is the cheapest source of that material in the Gulf Coast area. All of the industries have made large investments in plants and equipment and all of the industries have employees that make their living on products that use oyster shell.

Shell is supplied to the industries by the shell dredging companies who are most dependent on the continuation of shell production. Considerable capital is invested in dredges and operating equipment, and since most of the production has historically come from the Galveston Bay area it is logical to assume that most of the benefits that accrue to the economy from such an investment are dispersed in the Galveston Bay region.

However, supply, frequently mentioned in the foregoing paragraphs is the main problem facing the industries associated with shell production. According to recent newspaper accounts, most of the dredges that have been operating in Galveston Bay have had to move to other areas in search of other shell reserves, as a result of the depletion of available shell deposits in Galveston Bay. What shell remains in the bay is contained mainly within the major exposed reefs, inaccessible by Texas Parks and Wildlife Commission policy.

Chapter VII

OYSTER SHELL RESERVES

Shell reserves in Galveston Bay are at least reasonably well approximated by the J. G. Turney Survey. Approximately 100 million cubic yards remain in the bay of "which only 50 million to 60 million cubic yards would be economically feasible to dredge", according to Mr. Cecil Haden (12). In a statement before the Texas Game and Fish Commission during a public hearing on April 10, 1963, Mr. Cecil Haden, consultant to the Lone Star Cement Corporation, explained that at that time approximately 120 million cubic yards remained of which 80 million cubic yards was economically feasible to dredge. As approximately 40 million cubic yards have been removed since that time, there should remain approximately 40 million cubic yards of dredgable shell. Allowing for discovery of additional shell deposits, approximations in the Turney Survey, and reef building over the five-year period beginning in 1963, it seems that an average of 50 million cubic yards of shell reserves, derived from the 1963 figures and the figures in Mr. Haden's recent correspondence, is reasonable.

At current average production rates of 8 million cubic yards per year, as shown in Figure 5, there exist available shell reserves to supply approximately six years production. This shell has a total landed value, at an average $2.00 per cubic yard for shell, of 100 million dollars and a

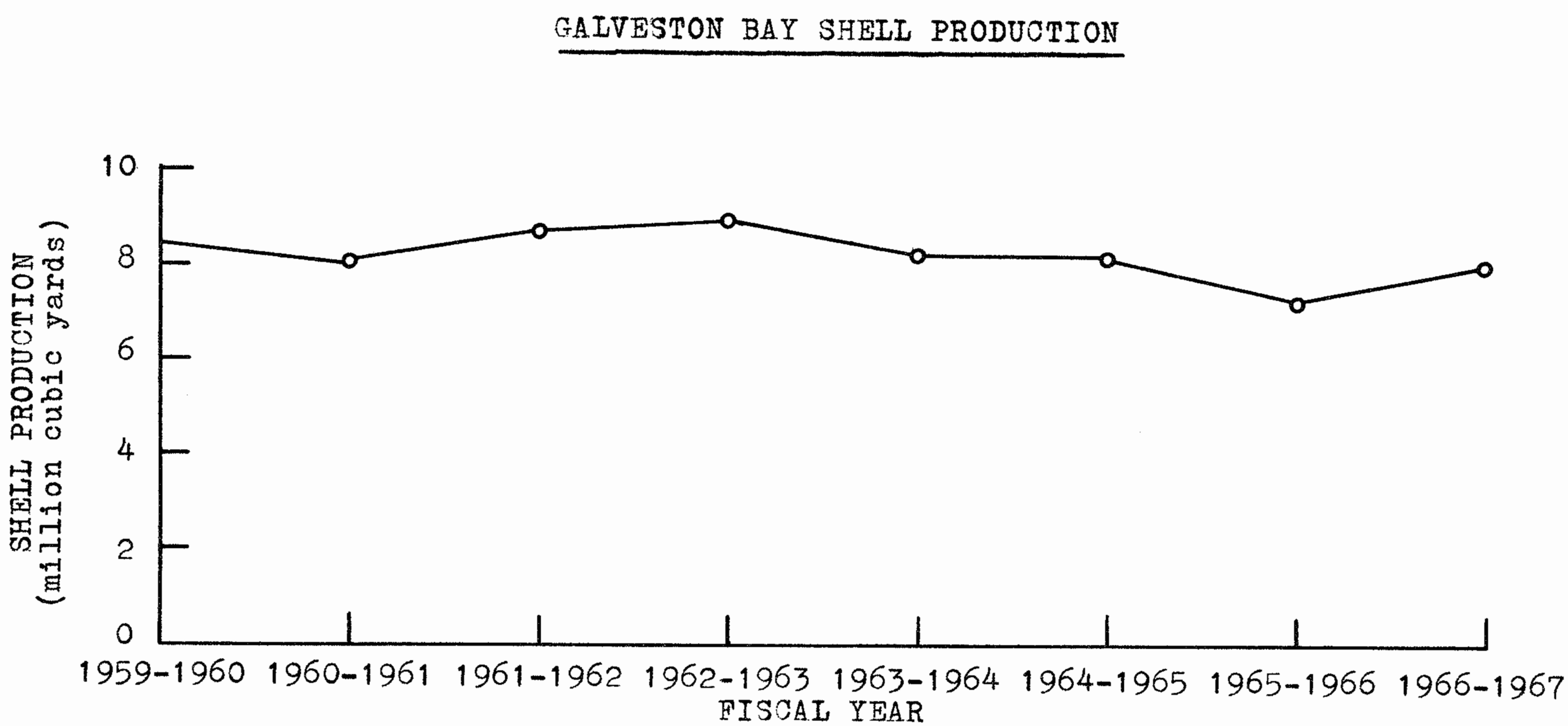

Figure 5

Texas Parks and Wildlife Department

present worth value, using 6 percent interest, of approximately 82 million dollars. After six years, it is assumed that all available shell in the bay would be removed and dredging operations would be halted.

However, reserves do exist in other bays and at the present time the focus is on San Antonio Bay where, although reserves are unknown, there appears to be a substantial amount of shell. Most of the dredging concerns have now moved their operations to that bay, which will necessarily increase the price of shell because of the increased hauling distance.

Mr. Hugh O. Meloy, technical consultant for Lone Star Cement Company, stated in May, 1967, that the added cost for shell to users in the Houston-Galveston area, as a result of dredging operations moving to San Antonio Bay, would be approximately 20 percent (9). Such an increase in cost would be economically prohibitive according to Mr. Meloy.

There are alternatives to obtaining San Antonio Bay shell. One is to consider the reserves in other bays but the hauling distance would still be a problem. A second possibility would be to cease operations which would be very costly, and, therefore, unlikely, as long as other reasonable alternatives exist. The last possibility would be for the dredgers to obtain permission to remove the remaining shell in Galveston Bay. Therefore, an analysis of the losses in benefits to the Galveston Bay area, resulting from removing the reefs, is necessary to determine the net added costs for shell from other bays.

It is recognized that there are alternatives to consider in further dredging of existing reefs in Galveston Bay. For example, transplanting from the main reefs as discussed in a previous section, may develop new oyster beds which may allow continued production and recreational benefits after a period of development. Partial removal of some of the reefs, leaving ridges of shell undisturbed, would allow continued oyster production and recreational benefits, and supply some shell to industry. However, an analysis of the many possibilities is beyond the scope of this paper, because of the lack of information necessary to answer the many questions that develop. Therefore, it is assumed for comparison purposes that the only alternative is complete removal of the Galveston Bay reefs.

The second assumption in developing a comparison of the values involved in obtaining San Antonio Bay shell versus Galveston Bay shell is that there is no net loss in benefits in San Antonio Bay because of dredging. Dredging applications in San Antonio Bay were approved in areas of principally buried shell and many exposed reefs have been protected from dredging. Oyster production from San Antonio Bay is only a small portion, usually less than 10 percent, of the total production from Texas bays. Therefore, the losses in San Antonio Bay benefits are probably more than offset by the benefits to the coastal area from the mining of the buried shell within the bay and the assumption seems reasonable for these approximate estimates.

To obtain San Antonio Bay shell, the added cost would be approximately 40 cents per cubic yard (using 20 percent of the average $2.00 landed value of shell). Assuming that there exist sufficient reserves of buried shell in San Antonio Bay to offset the 50 million cubic yards available in the exposed reefs in Galveston Bay, the added cost to industry would be a total of approximately 20 million dollars. The present worth of the added cost, which is assumed to be spread evenly over the six-year comparative period, would be approximately 16 million dollars, again using a 6 percent interest rate.

In comparison, the estimable benefits lost by removing Galveston Bay shell would be approximately 1.0 million dollars per year in oyster production and at least 0.5 million dollars per year in recreational benefits. Such benefits would be lost over a longer period of time than the estimated six-year shell production period since the reefs, being completely removed, probably could not rebuild. Figure 6 is a plot of present worth of recreation and oyster production benefits lost in Galveston Bay versus time and of added cost for obtaining San Antonio Bay shell versus time. At 18 years the present worth of estimable benefits lost in Galveston Bay equals the present worth of the added cost for obtaining shell from San Antonio Bay, and beyond 18 years, the benefits lost exceed the added cost. The 18 years necessary to reach an equalization point would probably begin at some time within the six-year reef removal period, since silt deposited directly on the reef from the dredging operation would probably cover the live oysters and put the reef out of production before all the reef shell is removed.

If removal of the reefs results in erosion problems, and has a detrimental effect on circulation, which tends to effect the ecology and production of the bay, the total benefits lost in removing the shell from

PRESENT WORTH OF ADDED COSTS AND BENEFITS LOST FOR DURATION OF OCCURRENCE

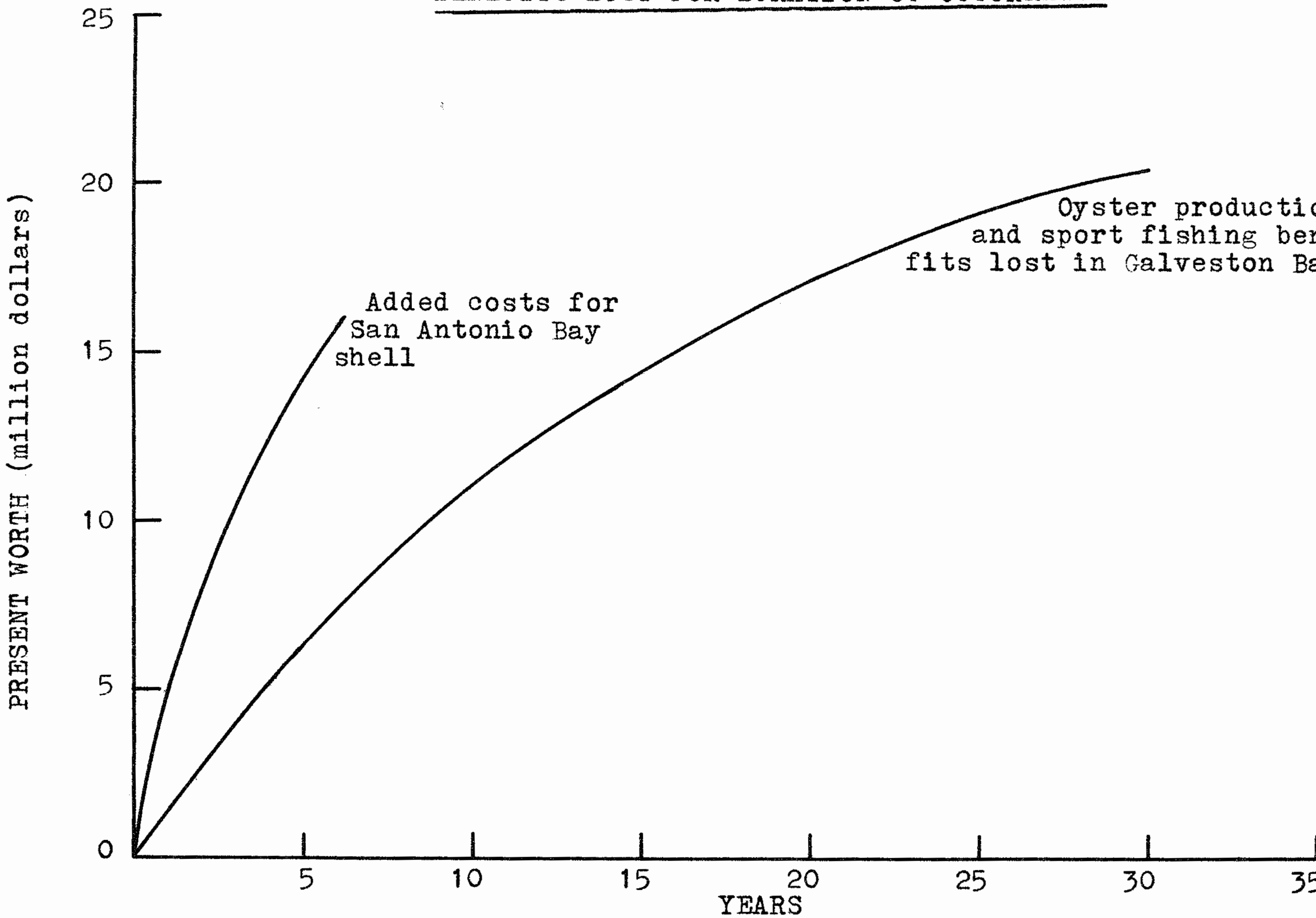

Figure 6

Galveston Bay would probably far exceed the added cost of having to obtain shell from San Antonio Bay. The lack of available information does not allow a review of the potential problems of erosion and circulation changes. However, the possibility of the existence of such problems, in addition to the other benefits lost, indicates that a detailed study of their magnitude would be essential in considering reef alteration.

Chapter VIII

THE POTENTIAL OF LIMESTONE AS A SUBSTITUTE FOR OYSTER SHELL

It is evident that the oyster shell industry is faced with supply problems because of increasing demands, depleting reserves and growing emphasis on conservation. When available San Antonio Bay reserves are depleted, the focus must return to Galveston Bay shell, shift to other bays, or to other sources of calcium carbonate supply, assuming no other major shell deposits are discovered.

Consideration of alternate calcium carbonate sources, including available supply and additional costs, must, for an accurate determination, be based on the amount of available shell remaining in the bays near the Houston-Galveston trade area. The State of Texas has recently allocated 285,000 dollars to finance a study by the Texas Parks and Wildlife Department to determine the amount and location of shell reserves remaining in all the bays of Texas. Until results of the study are available, no accurate estimate of the life of the shell industry in the Houston-Galveston area can be derived.

However, assuming that reserves are limited, that no major reserves remain that would substantially extend the life of the shell industry and that current restrictions on shell dredging continue without change, it is possible to discuss alternate source of supply of calcium carbonate for industry, specifically limestone. The potential of limestone, as a substitute for shell, is one of the necessary factors to be determined in the consideration of Galveston Bay shell removal.

According to the Sport Fishing Institute the current "cost differential for crushed limestone delivered at dockside in Galveston, as an alternative to shell, is about 58 cents per ton" (4). This differential, verified as reasonable in an interview with a leading shell producer, is a general figure for high grade limestone of approximately 90 to 95 percent calcium carbonate content. It is recognized that possible alterations in processing limestone may be necessary, but considering the assumption that shell reserves are limited the alterations will be required in the near future if the industries are to continue operation. Furthermore, it is recognized that not all limestone has the high calcium carbonate percentage that shell supplies, but through personal interviews with limestone suppliers and reports on limestone, it was found that limestone with calcium carbonate content of approximately 98 percent, which is comparable to shell, can be supplied (13) (14). The high calcium limestone would necessarily be more expensive because it is not as readily available as high grade limestone and it requires increased quality control to meet the 98 percent calcium specifications. The higher cost involved would probably indicate a cost differential of approximately 68 cents. Some users of shell, such as the cement and lime manufacturers, need the high calcium lime. However, high grade limestone (90 - 95 percent calcium carbonate) can be used as road building material which is currently the major use of shell. Therefore, an average cost differential of approximately 63 cents per ton appears reasonably justified for comparison purposes.

Applying the 63 cents figure, a general comparison can be made between use of limestone over Galveston Bay shell in a manner similar to the previous comparison of additional costs of San Antonio Bay shell over Galveston Bay shell. As estimated earlier, there remains approximately 50 million cubic yards of shell in the bay that is economically feasible to dredge. According to the Texas Parks and Wildlife Department, a cubic yard of shell weighs approximately 1,500 pounds. Therefore, it can be estimated that there remains approximately 37 million tons of shell. For a like amount of limestone, the total cost differential at current prices can be estimated to be 23 million dollars, spread over six years, assuming the comparison would be based on delivery of limestone equal to current production rates of shell in Galveston Bay. The present worth of the cost differential would be approximately 19 million dollars at 6 percent interest.

In comparison, the estimated recreation and oyster production benefits lost from removing Galveston Bay shell, as noted in the earlier comparison of added costs of obtaining San Antonio Bay shell, would be based on the time period required for the benefits lost to equal the added costs for limestone. From Figure 6 it can be seen that to reach 19 million dollars in losses in recreational benefits and oyster production benefits on the present worth scale, would require a time period of about 25 years. After 25 years, the estimable benefits lost would exceed the added cost for obtaining limestone.

The comparison indicates that the added cost of utilizing limestone as a substitute for Galveston Bay shell would increase costs by at least 25 percent. It must be recognized that there are obviously additional costs incurred in substituting limestone for shell because of equipment changes, possible multiple handling, and processing changes which may increase the cost of limestone. However, to estimate any additional costs that may further increase the added cost of limestone indicated above would require further studies, as information is unavailable at this time. However, the added costs for San Antonio Bay shell and limestone have been compared only to the estimated benefits lost for recreation and oyster production. Losses from erosion and effects on bay production caused from circulation changes have not been detailed and such losses, if any, may offset to some extent the additional costs for limestone.

There are other factors that can be considered which could affect the cost differential markedly. The basic factor in the differential is the cost of transportation of the raw material from the Balcones Escarpment area of Central Texas to the Houston-Galveston area. There seems to be a definite possibility that hauling rates can be lowered. One of the factors that can influence the lowering of rates is the potential demand for limestone as a shell substitute in the Houston-Galveston area. If the demand were permanent and constant, as it evidently would be if shell resources were depleted, the railroads could charge less per ton shipped on the assurance of a long-term market. In addition, the greater volume may lead to economies of quantity handling not available today.

Another factor would be the greater utilization of rolling stock controlled by the railroads. Costs influencing the hauling rates consist principally of mortgage payments, maintenance, labor, operation and depreciation. Some of these costs, such as mortgage payments, and to a certain extent labor and depreciation, are constant. Therefore, increasing use of available rolling stock would not proportionately increase costs. Since the anticipated greater demand will call for increased shipments, the increased turn-around for rail cars should, justifiably, lower the unit cost of hauling.

Finally, it seems that with demand causing increasing shipment of limestone, there may develop the possibility of quantity discounts of freight rates. Such discounts may be initiated either voluntarily by the railroads or forced by the Railroad Commission to lower the price of transported limestone, needed as a raw material by industry in the Houston-Galveston area.

Considering all of these factors, it seems that there is a possibility of lowering freight rates and, therefore, lowering the cost of limestone to the Houston-Galveston area. To what extent the price can be lowered is unknown and information to make an estimate is unavailable. However, any lowering in rates will decrease the cost differential between Galveston Bay shell and limestone.

Finally, a major factor that could affect the cost differential is the possibility of rising shell prices. As the reserves are depleted, competition for what shell remains may force the price of shell up. The result also would be a reduction in the cost differential, assuming limestone does not go up proportionately since high quality limestone reserves are estimated to be sufficient for approximately 150 years at current production rates (14).

The combination of the above factors affecting the cost differential indicates that, in the future, the price of shell and limestone will tend to approach a value that will make the two resources more competitive than at the present time. Although it is recognized that other problems exist in utilizing limestone as a substitute resource for shell, it seems that, based on the above observations which may affect the cost differential, one of the prerequisites to approving the removal of Galveston Bay shell is a thorough study of the possibilities of limestone as a substitute for shell.

Chapter IX

CONCLUSIONS

The oyster shell in the bays of Texas is a resource which has considerable value, and, as a resource of the State of Texas on public lands, belongs to the State. The mining of the resource is controlled by the Texas Parks and Wildlife Department, and the revenue received from the sale of shell at 15 cents per cubic yard, which amounted to approximately 1.5 million dollars in 1966, is a vital portion of the annual funds available to finance the functions of the Department.

The shell is utilized by industry to develop products that are important to the economy of the Houston-Galveston area. The basic industries utilizing shell need a continuous supply of resources to maintain their operations, supply their markets, and meet their payrolls.

However, shell reserves in Galveston Bay have been decreasing and nearly all deposits that remain make up the major, exposed reefs in the bay, which are restricted from dredging by Texas Parks and Wildlife Commission policy. The situation brings to light a fundamental point in considering the shell dredging operations of Texas bays; that deposits of buried shell must be evaluated in a different category from deposits of shell in large, exposed reefs.

Buried shell deposits have capital value that can benefit the dredging concerns, industry requiring a calcium carbonate resource, satellite industry, employees associated with developing products from shell, and ultimately the consumer. Therefore, the industries associated with shell production and product development have an interest in the bays and, since the bays are multifunctional, it must be recognized that one of the users is the group of shell dredgers. As with any other bay user group, the extent of operations should be controlled, within reasonable limits, so as not to interfere with the operations of other user groups. Little evidence has been found that would indicate that the removal of buried shell is detrimental to the interests of other user groups of the bay.

However, the shell contained in the exposed reefs of Galveston Bay is used in numerous ways. The reefs are popular fishing areas and supply most of the annual oyster production from all Texas bays. Furthermore, some of the reefs provide the shoreline with protection from waves that could cause serious and expensive erosion. Finally, the reefs tend to affect the circulation patterns within the bay and removal of the reefs may or may not be detrimental to bay production adjusted to existing conditions.

The capital value of the shell in the bay, when removed, far exceeds the benefits derived, on a short term basis, from leaving the shell undisturbed. It is estimated the shell reserves in the bay would last, at current production levels, approximately six years and when completely removed all benefits from shell would cease. However, the benefits derived from leaving the shell undisturbed would continue for many years. The significant variable, therefore, in the basic economic comparison is time and time seems to be in favor of those opposing reef removal.

It is apparent that the shell industry faces a supply problem. By obtaining buried shell from San Antonio Bay the industry can continue operations but producers utilizing shell for products must pay a higher unit price because of the increased hauling distance over Galveston Bay shell. The additional cost is justified when the losses in recreational benefits and oyster production that would occur by taking the exposed reefs in Galveston Bay are considered.

Limestone is available in large quantity and a sufficient amount contains the calcium carbonate content required by most industry presently utilizing shell. The cost differential between limestone and shell tends to restrict limestone from direct competition. However, recognizing the limited reserves of shell, it seems that limestone can be made more competitive by reducing freight rates. Furthermore, as shell reserves shrink, the unit price should rise because of competition for the remaining reserves, resulting in a price more closely competitive with limestone. It is recognized that the cost of limestone is higher than shell but when all shell reserves are removed, a substitute, probably limestone, will be required for industry to continue operation.

The shell in Galveston Bay, to remain undisturbed, must, on a purely economic basis, produce benefits equal to the added cost of utilizing limestone. The reefs do have large value for recreational benefits and oyster production, but the most significant factor is the value of reefs for circulation control of the bay. Whether or not reef removal would alter circulation patterns enough to upset the ecology of the bay is impossible to say at this time because of lack of information. However, if removal did alter patterns to the detriment of bay production, losses in benefits would probably far exceed the added costs of using limestone since approximately 75 percent of Texas' commercial catch can be related to the Galveston Estuary. Therefore, a study should be made to determine what the effects of reef removal would be on circulation and bay production before removal is approved.

If it was found that circulation patterns were not significantly altered and bay production not adversely affected by reef removal, then it seems that a study, based on up to date information, of the potential of artificial reef development, transplanting and partial reef dredging methods should be undertaken. The study should determine if the benefits associated with the reefs can be maintained after the shell within the major reefs is removed.

Therefore, to make a complete analysis of the possibility of removing the shell reefs requires much more information than is now available. The extent of shell reserves remaining in the bays, the effects of reef removal on circulation, the potential of limestone and the growing emphasis on conservation are all factors that must, necessarily, be better understood before any definite conclusions can be offered.

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