WEST FLOWER GARDENS

RESEARCH FACILITY

A Report

by

The Flower Gardens Feasibility Committee

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Proposed

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I. INTRODUCTION

This report is concerned with the feasibility of erecting a permanent structure on the West Flower Gardens Reef for the purpose of establishing a research facility at that site. The report is divided into three parts which deal with (1) a description of the reef and the proposed facility, (2) research, educational, and recreational potential of such a facility, and (3) problems in establishing the facility, economics, and conclusions.

There is no question of the technical feasibility of erecting a structure at the West Flower Gardens Reef. The committee is in agreement that such a facility would offer unique possibilities for scientific research. However, opinions are divided on whether or not the scientific merits of a shelf edge facility are worth the expenditure of the amounts of money necessary to establish and maintain this facility.

Description of the Reef

The West Flower Gardens Reef lies approximately 110 nautical miles south-southeast of Galveston, Texas. It is considered to be the northernmost living, shallow water coral reef on the continental shelves of the Atlantic Ocean. Scientifically, little has been published on the reef. Parker and Curray (1956) published a list of species (molluscs) from the reef. Stetson (1953) briefly described the corals and algal nodules collected at the Flower Gardens. Dr. Thomas E. Pulley of the Houston Museum of Natural History has led several collecting expeditions to the reef over the past several years but has not yet published the results. Levert and Ferguson (1969) published a short paper with many underwater photographs describing the general details of the geology and biology of the reef.

A large amount of geological and biological data has been obtained by the Texas A&M University Department of Oceanography during the past year. These data include detailed bathymetric and sub-bottom surveys that are presently being prepared as charts.

The crest of the reef is approximately a mile and one-half long and about three quarters of a mile wide. Depths on the crest of the reef vary from -60 to -80 feet and on a calm day the bottom may be clearly seen from the deck of a ship. Massive hemispherical heads of coral are abundant on the crest. Occasionally, clearings between several heads will form bowl-shaped depressions up to 10 feet deep floored with coarse carbonate sand and gravel. Some overturned or broken coral heads have been observed. This is attributed to either the anchoring operations of ships or to severe storms.

The reef slopes abruptly (about 45°) to a depth of about -160 feet at which point the sediment apron begins and this slopes gradually to depths of -350 to -400 feet. Two terraces are prominent on the south side of the reef. These are at about -160 feet and -240 feet. The terraces are probably erosional and represent still-stands of sea-level during late Pleistocene or early Holocene time. One core taken near the edge of the -240 ft terrace penetrated about 20 cm of sediment and pieces of bedrock were recovered in the core catcher.

Sub-bottom profiles show the reef to be underlain by a plug of salt. It is probable that this salt dome has been growing since mid-Tertiary time. There is no way, other than drilling, to determine the depth of the salt beneath the reef. Continuous seismic profiles show no reflecting horizons beneath the reef.

Physical oceanographic data at the site are practically non-existent. We have just received a print out of hydrographic data from the National Oceanographic Data Center that covers an area of a few hundred square miles surrounding the West Flower Gardens Reef. A few of the data points are relatively close to the Reef. The data include BT's, XBT's, salinities and some current measurements. A cursory examination of the data indicates that bottom temperatures at the crest of the reef are essentially the same as surface temperatures during the months of January and February. During the summer months a minor thermocline exists close to the surface. Surface temperatures range from 74°F in the summer to 66°F in mid-winter.

Surface currents are believed to vary from 0 to approximately 5 knots. No reliable current measurements are known to exist at this time.

The area is subject to frequent severe storms during the Fall and Winter months. Wind driven waves have been observed up to 20 feet high and 175 to 200 feet wave length after 12 hours of 45 knot winds. The hurricane season exists from June through October. Hurricanes and severe tropical storms pass close to the reef on an average of at least one a year. Wave forces during such storms are not known for this area.

As can be seen from the foregoing discussion, our knowledge of the physical environment at the Flower Gardens is very poor. This fact will be discussed in more detail in the section of this report dealing with the problems of establishing the facility.

Description of the Facility

Two configurations for the facility have been suggested. One concept is based upon a 100 foot platform placed upon the crest of the reef in water depths of 70 to 80 feet. The platform would contain laboratories, housing facilities, and support facilities for research conducted either from the platform itself or from an underwater habitat. Laboratories and other facilities placed upon the platform would be in prefabricated vans that could be easily exchanged when the need arises. The habitat would be placed upon the bottom immediately below the platform. Power, air and water will be supplied to the habitat via an umbilical that could be attached to one of the legs of the platform. The habitat should be equipped with emergency back-up services in event of a power failure on the platform.

An essential component of the surface support must be a deck decompression facility and a small dispensary/minor surgery complex.

The platform must be equipped with a helicopter pad and air and surface navigational aids. The minimum navigational aids would consist of a radio beacon and VHF and SSB transceivers.

A second concept visualizes a solid structure constructed on the crest of the reef and rising to a height of 75 feet above the water surface. The structure might be a cylinder about 50 feet in diameter with a larger rectangular platform surmounting it. This structure would be much more costly to construct but would have the advantages outlined below:

1. Laboratories could be situated either above or below the water surface. The underwater laboratories would be fitted with glass ports for underwater observation.

2. The habitat would be an integral part of the structure which would permit easy access of a physician in case of an emergency. Decompression could be undertaken either within the habitat or in a decompression chamber attached to the habitat.

3. A large air lock could be built into the base of the structure to permit launching and recovery of submersibles regardless of surface weather conditions.

4. A well constructed solid structure would be more apt to survive severe tropical storms and hurricanes than a platform.

The discussions of problems (page 12) including costs and conclusions are based upon the concept of a 100 foot platform installed on the West Flower Gardens Reef.

II. POTENTIAL OF PROPOSED FACILITY

Biological Oceanography

The fish fauna of the reef consists of typical Caribbean reef fishes, many of which are not known elsewhere along the Texas coast. A list of over 40 species has been compiled based on collections and sight identifications. Zoogeographically and ecologically, therefore, the reef here is of particular interest in terms of recruitment and the maintenance of the fauna, as well as the presence of certain faunal components in the face of environmental conditions possibly marginal to the existence of coral reefs.

Coral reefs provide innumerable opportunities for biological research. A simple assessment of the fauna is only the first meager step in describing the biology of a reef. Problems involving energetics and energy transfer between trophic levels within reef communities are yet to be worked out even on an elementary basis. A reef is a natural laboratory for the diving scientist who desires to study one of the immense number of problems concerning behavior and ethology of reef organisms. Physiological inquiries into tolerance to environmental factors, natural and man made, as well as metabolic functions are of prime importance to an understanding of the total biological picture of the reef community.

The Flower Gardens would serve particularly well as a standard station for monitoring pesticides, heavy metals, and other pollutants in view of recent detection of relatively high pesticide levels in certain resident fishes.

Physical Oceanography

Permanent facilities at the Flower Gardens could be utilized for the following programs:

1. Monitoring of standard oceanographic and meteorological variables
2. Optical measurements
3. Study of the seasonal aspects of 1 and 2, as well as short term weather effects such as cold fronts and hurricanes
4. Remote sensing (possibly with NASA)
5. Pollution monitoring
6. Testing and calibrating oceanographic equipment
7. Acoustic research programs
    a. Various propagation studies (possibly between two reefs) particularly to stress seasonal and short term weather effects
    b. Monitoring of ambient noise (shipping and biological) and possibly surveillance
    C. Acoustic calibration and testing

In addition to local interest in using a permanent laboratory on the Flower Gardens for underwater acoustics research, interest has been expressed by members of the Department of Mechnical Engineering of the University of Houston and the Applied Research Laboratory, Austin, Texas.

Geological Oceanography

The field work for the present geological program on the Flower Gardens is essentially completed. There may be a need to return to the reef area to fill in sample gaps in critical areas but this is not anticipated at the present time.

The area of primary interest to the geologist is the sediment apron which surrounds the reef. This area begins at a depth of about -160 ft and extends to about -400 ft. Problems that need study in the area are:

1. Rate and mechanism of sediment transport
2. Distribution of primary sedimentary structures
3. Nature of sediment producing organisms indigenous to the area
4. Nature and attitude of any bedrock outcrops
5. Effects of storms on the sediment apron

Marine Biomedical

There are a number of areas in which medical research would be able to make use of a facility such as a habitat on the Flower Gardens. Some of them are as follows:

1. Loss of body heat - This is probably the greatest single problem related to man in the sea at this time. In almost every instance where divers have been operating other than in the tropics, their excursion is limited by their ability to stand the cold. The Marine Biomedical Institute has as one of its members a physician who has gained international recognition in the study of loss of body heat in underwater exposure. Although the water temperature at the Flower Gardens may not be particularly rigorous (66°F - 74°F year around), a great amount of work could be carried out on loss of body heat at that location.
2. Isolation - NASA supported the TEKTITE program principally because it afforded them an opportunity to study the effects of isolation in a hazardous environment on small groups of individuals. We feel that this was not a particularly valid experiment as carried out in the

TEKTITE progarm for two reasons. Firstly, the environment could not be considered hazardous since the water temperature, visibility, sheltered area and other underwater factors would not have been considered hazardous by experienced divers. Secondly, isolation was not as complete as desired because of the difficulty of controlling personnel moving about the habitat. An underwater habitat at the Flower Gardens which would permit more rigidly controlled isolation, and would indeed be hazardous in terms of currents, buffeting, water temperature, visibility, decompression problems and other things probably would provide a more realistic hazard than that of TEKTITE.

3. Rescue and Treatment - Although in the past most divers when injured underwater either can get to the surface by themselves or will die too quickly for recovery, there still remains the need to study underwater rescue techniques for diving personnel. It is doubtful if underwater surgery would be performed under any but the most extreme circumstances (such as disarticulation of a caught arm or leg of a diver). However, recovery of individuals from an underwater habitat should be developed. This might take the form of an underwater bag or stretcher which would have its own life support system for short movement to and from personnel transfer capsules and habitats, or the development of an underwater "life boat." The latter could be used as a recovery vehicle as well as an excursion vehicle. This vehicle should be so constructed as to mate with the deck decompression chamber. It also could have a fly away capability so that it could be air-lifted to a shore-based decompression chamber/surgery associated with the medical facility. The development of this evacuation technique

is of key importance since it is anticipated that diving in the Gulf area will increase at least 3-fold in the next 5 years.

4. Decompression - It is recognized that relatively little is known about the basic theory of decompression. In most cases decompression tables have been empirically developed with the use of what amount to fudge-factors. Such a facility as contemplated would provide excellent experience for physicians being trained as marine doctors, which is one of the goals of the medical school at Galveston.

5. General Physiology - This facility would provide underwater physiologists with an opportunity to conduct work on performance efficiency, respiration, fatigue, wound healing, and the use of exotic gases for decompression. Further, it would permit the use of laboratory animals for long-term underwater studies. Such things as growth, reproduction, nutrition, control of infection, and possible changes in drug tolerance should be studied.

6. Development of a Testing and Validation Facility - Although considerable work has been done in the design and development of closed-circuit breathing equipment, this still is in a somewhat primitive condition. The facility described above would be excellent for testing and evaluating such equipment. At the same time, other personnel equipment such as heated suits, tools and instruments and other diving gear could be tested.

Oceanographic Test Range

A permanent installation at the Flower Gardens could be developed into a test range that would be utilized by industry, government agencies, and academic institutions. Uses of the range would include testing of industrial equipment and products for maritime use with special attention to factors such as durability, influence of depth, biodeterioration, fouling, and chemical influences. Government agencies and academic institutions would use the range in their R&D programs for testing and calibration of instruments such as acoustic devices, etc.

Education and Recreation

Educationally, a reef is a natural classroom which can be used to illustrate basic principles of behavior, animal diversity, ecology, and population dynamics. The greatest asset in this respect is that students can view numerous interacting organisms in their natural habitat in a relatively undisturbed condition.

A permanent facility would be a natural site for training marine technicians and support personnel for underwater habitats.

Because of their beauty, diversity and abundance of colorful organisms, coral reefs are of considerable value as aesthetic resources, particularly where they are accessable to the public. The establishment of undersea parks in coral reef tracts off Key Largo, Florida, the Exuma Cays in the Bahamas, St. John in the Virgin Islands and Hawaii confirms the interest of the general public in visiting and preserving these scenic phenomena. The recently developing Mexican resort of Cozumel owes much of its success to the fact that some rather impressive coral reefs exist off its shores.

It is recognized that the Flower Gardens probably would not become a recreational area serving large numbers of people because of the relative difficulty of access and the relatively hazardous diving conditions.

During research operations either on the surface or in a habitat, tourists should not be permitted on the facility.

III. PROBLEMS, ECONOMICS AND CONCLUSIONS

Problems in Establishing the Facility

Scientific

It appears that there is not sufficient scientific interest on the campus of any single university to effectively utilize or fully support a permanent installation such as the one contemplated for the Flower Gardens. Most scientists are unwilling to commit themselves to a career on a single reef. Consequently, other sources of scientific personnel would need to be tapped in order to efficiently utilize the facility. The TEKTITE II program ran for 213 days not including the time spent in placing and recovering the habitat. The response from American scientists was not sufficient to fill out the program. This resulted in inviting foreign scientists to participate. It is possible that a considerable amount of effort would be required to recruit scientific programs in sufficient numbers to effectively utilize the proposed facility.

Operations such as calibration, tests, and monitoring of meteorological, physical oceanographic and acoustic parameters can be expected to be on-going projects. Certain other research projects, such as biology and geology, would be of shorter duration. This indicates a fairly steady turnover of scientific personnel.

Some groups that have already expressed interest in the area are:

1. Texas A&M University
2. Texas Maritime Commission
3. Louisiana State University
4. University of Texas Medical Branch (to provide medical support)
5. University of Texas
6. Houston Underwater Club
7. Houston Museum of Natural Sciences
8. Project TEKTITE II
9. Texas Conservation Council
10. Texas State Legislative Committee on Oceanography
11. University of Houston

In addition, we believe that the following would be interested:

1. Various oil companies
2. U.S. Coast Guard
3. U.S. Geodetic Survey
4. IDOE
5. NSF
6. U.S. Navy
7. NASA
8. Divecon
9. NIH
10. NOAA

Weather

Due to the possibility of frequent severe storms in the area of the Flower Gardens, the platform and the habitat should be constructed and anchored to withstand excessive wave and wind forces. As the reef crest is composed primarily of hard coral with the salt dome caprock an unknown distance below the surface, drilling will be necessary for the emplacement of the foundation pilings. This will add considerable expense to the cost of platform installation.

Logistics

As it has already been noted, the Flower Gardens are nearly 110 nautical miles from Galveston, which would be the most logical base of support. This constitutes from 12 to 24 hours steaming time for a 90ft work boat, depending upon weather. This distance would serve both as a help and a hindrance. It would greatly reduce the stream of casual visitors. This would permit a much more rigorous control over the program and the personnel, and would lead to greater efficiency and personnel safety.

The difficulties related to logistical support are obvious. For economy reasons, it would seem that the program could expect routine boat service no more often than twice weekly. This would pose no problem to the platform operations, particularly if proper advance planning occurs. It would permit normal routine re-supply for support of the manned activity.

Emergency transportation would be of the most concern. It should be expected that emergencies will arise which require rapid evacuation of personnel or procurement of equipment. This necessitates helicopter service with navigational aids. Only a rough estimate has been obtained as to the probable cost of operating helicopter service to this facility. It would appear that we could expect to pay something in the vicinity of $500 per trip. Further, it seems certain that there would be times during which a helicopter could not make this trip. We should, thus, expect that at times the facility would be completely isolated. It would be imperative, therefore, that a physician be present at all times, and that minor surgery facilities be available on the platform.

The presence of a physician should pose no serious problem since the Marine Biomedical Institute, through the University of Texas Medical Branch at Galveston, has agreed to assume all responsibility for medical support on the facility.

Man-in-the-Sea

Depth of Operation - It is recognized that during stormy weather wave action can be felt more than 100 feet below the surface. When translated into lateral movement, a problem which must be considered by the ocean engineer is the construction of a facility which would, to some extent, act like an underwater sail. This would put considerable stress on an underwater facility during such heavy weather. For this reason, it would seem desirable to have the facility as deep as possible, commensurate with other operational considerations.

Our investigation suggests that the optimum depth from the standpoint of manned operation should be about 70-80 ft of water. We have suggested this depth since it appears to give the greatest flexibility to the diving personnel. It allows the best possible excursion toward the surface and at the same time permits emergency surfacing with the probability that the diver can be recovered and recompressed in time to survive.

Under these conditions the diver would be considered to be saturated with gas at this pressure after approximately 12 hours exposure. He would require approximately 48 hours of decompression treatment before returning to sea level pressure. We calculate that if he is living and saturated at a depth of between 70 and 80 ft, he can ascend to within 60 ft of the surface and descend to at least 200 ft for short periods of mild work. He could not however, ascend immediately to 60 ft after a working dive at 200 ft depth. At the end of a 200 ft dive the individual must return to his habitat and remain there an estimated 12 hours before he could again conduct an excursion to within 60 ft of the surface.

If the gas used in the habitat is compressed air, in event of an emergency a saturated diver probably could come directly to the surface and survive if recompressed in a deck decompression chamber within 5 minutes after reaching the surface. This would, however, be considered hazardous. If he had just returned from an extended excursion to 200 ft, it might prove fatal.

It is essential to have a deck decompression chamber in this facility. The size of this chamber depends upon the number of individuals who may be expected to be in the underwater habitat at any one time. For example, a modestly equipped deck decompression chamber which could, under crowded conditions, support four people probably would cost at least $50,000. A facility capable of accommodating as many as 10 people would no doubt cost at least $50,000 in an austere model. This chamber must have at least a 10 atmosphere (absolute) operating pressure and be able to support all habitat personnel for at least 3 days. It must have both a medical and a personnel lock.

Since it is anticipated that a personnel transfer capsule would be employed in returning people to the surface, the deck decompression chamber must mate to the personnel transfer capsule.

It is important to emphasize that decompression capability must not be marginal either in terms of its depth rating or in terms of its facilities.

We must consider the possibility that an injured aquanaut must be evacuated to a shore-based hospital while still under pressure. For this reason, it would be desirable to have the deck decompression chamber mobile so that it could be shifted to a barge or deck of a larger vessel and permit steaming toward Galveston while decompression is underway. In a later generation, it would be wise to have facilities whereby the deck decompression chamber could again be transferred to truck and carried directly to the decompression chambers which will be in operation under the sponsorship of the Marine Biomedical Institute.

It should be axiomatic that decompression short cuts must not be taken on an injured man.

If engineering and other operational considerations dictate that the facility should be at a greater depth than 70-80 ft, the only additional constraint which would be imposed would be that the aquanaut could be brought to the surface only in a pressure vessel such as a personnel transfer capsule. Also, he would not be able to conduct a vertical excursion to a depth as close as 60 ft. below the surface.

We should consider that the absolute maximum depth at which the habitat would be placed if compressed air is to be used for the breathing mixture would be 150 ft. Under these conditions, however, it would be dangerous for the diver to descend to a deeper depth since he would be vulnerable to nitrogen narcosis. His vertical excursion probably would be no higher than 100 ft. Thus, the location of a habitat at these great depths would limit the vertical excursion capability, would reduce the safety factor, and place most of the reef complex beyond his reach.

We recommend, therefore, that at least on the first generation habitat it be established in 70-80 ft. of sea water.

Exertion - Currents have not been accurately measured over extended periods of time at the Flower Gardens location. One unsubstantiated report indicates a current which might have been as much as 6-7 knots. On the other hand, most observers indicate that currents range between 0-3 knots on the surface. The presence of ripple marks at a depth of 80 ft suggests that at times bottom currents must be at least 3 knots. Wave action causing a 3 ft lateral movement at a depth of 80 ft has been observed. In currents above 3 knots, excursions from the habitat could be dangerous. We recommend that extensive studies be made with current meters to determine precisely the range of currents which might be experienced at the Gardens. It would appear, however, that engineering considerations might place more limitations on the use of the habitat than would man. It has been observed that there are long periods of time during which currents are of sufficiently low velocity to allow manned operations on the Gardens. It may be necessary, however, to limit excursions to periods of low current velocity. This should pose no serious problem on the operations.

Bottom Time - Of considerable question is whether or not it would be more feasible for individuals to live on the surface and move to the bottom by way of personnel transfer capsules rather than live on the bottom in a habitat at ambient pressures. It would be less expensive to build and operate a surface decompression chamber which would hold aquanauts at the bottom depth while on the deck of the ship or the platform above the water. Personnel then could be transfered to the personnel transfer capsule and carried to the operating depth for their daily work, returning to the surface under pressure for rest periods. Under such conditions, no elaborate underwater facility need be maintained, although emergency underwater facilities and some permanent instrumentation would require a modest underwater dry facility. This, however, could be rather mobile.

There is some question as to whether the scientists would spend more time working on the bottom if they lived at the surface under bottom pressures than if they remained in a habitat on the bottom. Such an arrangement would avoid many creature comfort and medical problems. Some believe that the scientist might not go into the water as freely. Several individuals who participated in the underwater TEKTITE program have indicated that more work is accomplished if the individual can go into the water environment without a major effort. The question of long-term underwater observation from portholes should be considered. It would appear that much was accomplished in study of fish behavior from long-term observations from underwater ports of the present TEKTITE habitat. This may call for transportable underwater two-man habitats which could be located at various places and remain only as long as observations were needed. Such an arrangement, however, would not prevent the aquanauts from living on the surface as indicated before.

It seems clear that whichever way is used, by proper planning the individual would have approximately the same amount of allowable bottom time in the water. Since most underwater activities are limited to no more than 2-4 hr periods because of the temperature and fatigue, it would not be unreasonable to transfer these individuals to and from the surface chamber on each dive.

From the standpoint of economy the overall cost of operation from a deck facility rather than underwater habitats would indicate that dry living on the deck would be less expensive. This would not provide the training and experience needed for future operations where deck living may not be feasible. Thus, although presently contemplated operation on the Flower Gardens would not dictate the need for an underwater habitat, if this is to be the first generation of further underwater exploration in which depths much greater than 100 ft would be contemplated, then it would be wise to start with the underwater habitat at this point. The future, however, would necessitate the use of mixed gases such as helium/oxygen rather than compressed air as anticipated for the present generation. Using such breathing mixture the vertical excursion limits must be altered.

Economics

Costs

It is estimated that the initial cost of the facility will be between three and four million dollars. This includes the cost of the platform and its emplacement, and the housing and laboratory facilities on the platform. It does not include the cost of the habitat and its support equipment.

Logistical costs will be the major item of expense during the operation of the facility. Charter of a ship large enough to transport vans and heavy equipment, fuel, water, food, etc., will cost about $1,000 per day. Two days will be required to make the round trip including time for loading and unloading at the platform. If two trips are made each week, the cost will be $4,000 per week or $200,000 per year.

It is difficult to estimate the operational expenses for such a project but we can examine the cost of TEKTITE II to give us a ballpark figure.

The overall program expenses were $3 million. Operational expenses in the Virgin Islands were $1.2 million. The scientific program ran for a total of 213 days. This does not include the time spent in placing and recovering the habitat. On a daily basis the overall cost for keeping 5 men in the habitat was $14,000 per day while the actual operational cost was $5,640 per day. It must be remembered, however, that for TEKTITE II the habitat was already in existence at the beginning of the program and also that TEKTITE II was emplaced in a protected bay very close to shore so that logistics were not a great problem. Considering the increased logistical problems on the Flower Gardens, a figure of about $7,000 per day for operational costs does not seem far out of line. This would require a yearly operational budget of $1,400,000 for operating the facility a total of 200 days per year.

Of course, 200 days per year is an ambitious program and it may be that diving operations will only require about 100 days per year. Also, there will be many experiments that can be conducted from the facility without the need of divers. Costs for such experiments will be substantially lower than those requiring divers.

Benefits

The economic value to the State of Texas and the nation of an offshore research facility is difficult to evaluate. Meteorological information obtained at such a facility would provide much more accurate weather forecasting for the Texas coastal areas and important tracking information on tropical storms and hurricanes. This kind of information could be of immediate value by providing more accurate predictions of hurricane tracks thus allowing a greater length of time for preparation for the storm in the predicted landfall area. This alone could save the State millions of dollars in damages due to storms.

Other economic benefits would be of longer range. These might include: (1) advances in marine engineering, (2) development of new fisheries techniques, (3) establishment of new marine oriented industries along the Texas Coast due to the proximity of an offshore test facility.

Conclusions

An important advantage of the proposed facility over the Tektite II program is that it provides for research other than that conducted by man-in-the-sea. Although the man-in-the-sea concept is almost as glamourous as man-in-space, we feel that the NASA approach (where reaching the site is the major goal) should not be applied to marine research. There are many extremely important research problems in the marine environment totally unrelated to man-in-the-sea. The major goal of a marine research program, such as envisioned for the Flower Gardens Facility is the effective utilization of the natural resources of the sea. The man-in-the-sea aspects of the program should be subordinate to this major goal.

If funds are readily available, we feel that the State of Texas should embark upon a program eventually leading to the establishment of an offshore research facility. Because of its leadership in all phases of marine sciences, Texas A&M University should be charged with the administration of the facility.

Because no single institution can hope to support and maintain such an installation, an effort should be made to canvass various institutions and establishments in the region concerning their interest and potential for participation in a program of research and education based at the offshore laboratory. These institutions should be asked to define the probable limits of their participation, the conditions under which they would desire to participate, and their possible input to the program in terms of funds and personnel.

Not enough is known concerning the substrate or the hydrographic conditions, particularly in the case of extremes in wave and current activity, to justify embarking upon the design of an offshore research tower and underwater habitat to be placed at the Flower Gardens. If the decision is made to go ahead with such a project, the first step must involve an in-depth study of climatic and hydrographic conditions at the site, particularly extreme conditions, as well as a substantial study into the subsurface geology of the area. The latter would presumably involve drilling operations. Sea Grant funds should be made available for this study.

The facility should be administered by a full-time scientific director and his staff. An advisory committee consisting of representatives of participating institutions will assist the director in establishing programs and policies.

REFERENCES

Levert, C.F. and H.C. Ferguson, Jr., 1969, Geology of the Flower Gardens Bank, northwest Gulf of Mexico. Gulf Coast Assoc. of Geological Societies, v. 19, pp. 89-100.

Parker, R.H. and J.R. Curray, 1956, Fauna and Bathymetry of Banks on Continental Shelf, northwest Gulf of Mexico. Amer. Assoc. Petroleum Geologists Bull., v. 40, pp. 2428-2439.

Stetson, H.C., 1953, The Sediments of the Western Gulf of Mexico, Part I. Papers in Phy. Oceanography and Meterology of MIT and Woods Hole Oceanog. Inst., v. 12, pp. 1-45.